Linking Biologic Metrics to Hydrologic Characteristics in Austin, Texas Streams

Aaron Richter

Environmental Resource Management Division
Watershed Protection Department
City of Austin

SR-11-15

Abstract

Urbanization can alter the hydrology of creeks as land use changes as represented by increases in impervious cover. Flow regime change is modeled directly on the basis of impervious cover in the City of Austin; however, it would be helpful for planning purposes if other aspects of the environmental integrity of urban creeks could be modeled on the same basis. Benthic macroinvertebrates and diatoms are used as biological indicators of creek health, but an adequate direct relationship between the impervious cover and these biological metrics has not been found. Relationships between flow and biological health were investigated in order to form an indirect link so that changes in biological health could be predicted by changes to impervious cover. Pearson correlations and step-wise regression was performed on 35 hydrologic metrics and 25 biological metrics using sub-daily and daily flow data from the US Geologic Survey in 14 creeks in Austin, Texas. Data were grouped by impervious cover period or water year. The sub-daily flow data grouped by impervious cover period created the best model using mean--area (avg neg flowrate changes/watershed area),FHn (avg times mean flow > 75%-tile), and TQmean (fraction of time daily mean flow > mean for period) as the predictive hydrologic metrics to describe biological health of the creeks. Correlations were strongest between hydrology and the sensitive taxa biologic metrics. As the hydrology becomes flashy, one result of an increase in impervious cover, the sensitive taxa decrease at a site thereby decreasing the overall biological health of a site. It is recommended that this indirect link be used in water quality improvement projects to predict how the biological health of a creek in Austin will be affected by changes in land use.

Introduction

Urbanization, which can be represented by increasing impervious cover, can have detrimental effects on the hydrology of urban creeks as land use changes. Increases in impervious cover can reduce baseflow, increase the number of high-flow events, decrease the duration of high-flow events, and increase the average rise and fall of stream flow. This shift in hydrology is often modeled to determine how a particular change in impervious cover will alter the flow regime. While flow dynamics have been shown to alter the composition and function of aquatic ecosystems (Stanford and Ward 1979, Dynesius and Nilsson 1994), it is less common to model

how these changes in the flow regime alter specific biological aspects of the aquatic environment. To preserve the structure of aquatic communities it is imperative that the natural flow regime of a stream be maintained (Sparks 1992, Dynesius and Nilsson 1994). However, this is difficult to accomplish in an urbanizing environment where land use changes continuously. Successful preservation of the aquatic system is most likely to occur when the hydrologic parameters that are biologically relevant to the region are minimally altered in a human influenced flow regime. If the changes in community composition could be modeled using these biologically relevant hydrology parameters, watershed managers could make more informed decisions about how a proposed change in impervious cover would alter the aquatic environment.

Benthic macroinvertebrates and diatoms are used by the City of Austin to measure the biological health of streams. Evaluation of these communities can provide a sensitive measure of contamination or physical and structural degradation of aquatic habitats (Barbour et. al. 1998, Plafkin et. al 1989). Community composition is transformed into numerous metrics which reflect aspects of the community structure such as intolerant taxa richness (Barbour et. al. 1994). These metrics and indices based on these metrics are used in TCEQ water quality standards regulations to classify waterbodies for aquatic life protection. A model that predicts how these metrics would change based on changes in impervious cover, through changes in hydrology, would be an extraordinarily useful management tool for Watershed Protection Department Planning and Policy and Environmental Resource Management staff. In order to build a proper model, the relationship between hydrology and biological health in the intermittent streams of central Texas must be well understood and statistically sound.

Most of the research on the relationship between stream hydrology and biological health has been focused on perennial streams in the North and Southeast regions of the United States. A regional investigation of this relationship is more appropriate, as the hydrologic characteristics of perennial streams may impact the biological health differently from intermittent streams, which are more common in central Texas (Poff and Ward 1989). Intermittent streams show more variation among hydrologic indices that affect the biology of streams, and the indices that cause biological difference in perennial streams may not coincide with hydrologic indices of intermittent streams (Olden and Poff 2003). Two regionalized studies have been done to investigate the relationship of hydrology in Austin creeks to the biological health. One study showed that the parameters in the Indicators of Hydrologic Alteration (IHA) could be used to explain some variation in the community composition of certain taxa in the macroinvertebrate communities (COA 2000). The IHA are a set of parameters grouped by magnitude, timing, frequency, duration, and rate of change which have been used to assess hydrologic changes in streams (Richter et. al. 1996). Findings showed that the high pulse duration and date of the high pulse of flow were important factors affecting the biological health in Austin streams. Further study was conducted in order to create a predictive model for biological health based on changes in hydrology (COA 2010).

The first goal of this study is to validate or improve upon the stochastic relationship previously developed between stream hydrology and aquatic life in Austin, Texas. Previous methods only used daily flow values grouped by impervious cover period; however, the current study uses both daily and sub-daily flow values grouped by either impervious cover period or water year to determine which combination of data best predicts the existing aquatic life. The second

objective of this study is to determine relationships between stream hydrology and aquatic life on a taxonomic scale. While the prediction of general aquatic life is useful to the City of Austin, knowledge of how the hydrology affects specific aspects of the biological community is useful in planning to preserve and restore the natural balance of these aspects to the benefit of the diversity and resilience of the aquatic ecosystem as a whole.

Methods

Flow and biological data were combined in four separate ways based on the type of flow data used for analysis and the data period used in the analysis. Flow data was either daily or sub-daily flow collected from USGS gauges in Austin, TX. Some daily flow records extend back to 1958. Data periods used in the analysis were either one water year or multiple years grouped by similar impervious cover estimates which the City of Austin has previously computed. The nine periods of impervious cover include 1958-1968 (P1), 1969-1975 (P2), 1976-1985 (P3), 1986-1992 (P4), 1993-1996 (P5), 1997-1998 (P6), 1999-2001 (P7), 2002-2004 (P8), and 2005-2007 (P9). For the impervious cover grouping of the data a year was defined as January through December; however, one water year was defined as October to September using the later year as the label. Daily and sub-daily flow data were used to compute 35 different hydrologic metrics for each USGS gauge site and data period (Table 1).

Table 1: Name and description of the 35 hydrologic metrics computed from flow data.

ID	Description
Qmean	Mean flow rate (cfs)
Qmean-area	Mean flow rate (cfs) divided by the area of the watershed in 100 ac units
SD	Standard deviation of the flow rate
COV	Coefficient of variation in the flow rate
Qpeak	Peak flow rate (cfs)
Qpeak-area	Peak flow rate (cfs) divided by the area of the watershed in 100 ac units
Q10	10th percentile flow rate, exceeded 90% of the time (cfs)
Q90	90th percentile flow rate, exceeded 10% of the time (cfs)
Q90-area	90th percentile flow rate, exceeded 10% of the time (cfs) divided by the area of the watershed in 100 ac units
Q50	Median flow rate, 50th percentile (cfs)
Q50-area	Median flow rate, 50th percentile (cfs) divided by the area of the watershed in 100 ac units
Qmean+	Mean of non-zero flow rates (cfs)
Qmean+-area	Mean of non-zero flow rates (cfs) divided by the area of the watershed in 100 ac units
Qgeomean	Geometric mean for flow rates (cfs)
Qmean(ln)	Mean of the non-zero flow rates assuming lognormal distribution (cfs)
Qmean(ln)-area	Mean of the non-zero flow rates assuming lognormal distribution (cfs) divided by the area of the watershed in 100 ac units
SD(ln)	Standard Deviation of the non-zero flow rates assuming lognormal distribution
COV(ln)	Coefficient of Variation of the non-zero flow rates assuming lognormal distribution
BFR	Baseflow ratio, fraction of total flow that is baseflow
Tdry	Fraction of time flow is less than 0.1 cfs
T3xQ50	Fraction of time flow exceeds three times the median flow rate for the POR
TQmean	fraction of time flow exceeds the mean flow rate for the POR

Table 1 (cont): Name and description of the 35 hydrologic metrics computed from flow data.

ID	Description
TQ90	fraction of time flow exceeds the 90th percentile flow rate for the POR
TQ0.25yr	Fraction of time the flow exceeds the 3-month peak flow rate (UV data only)
TQ0.5yr	Fraction of time the flow exceeds the 6-month peak flow rate (UV data only)
TQ0.75yr	Fraction of time the flow exceeds the 9-month peak flow rate (UV data only)
TQ1yr	Fraction of time the flow exceeds the 1-year peak flow rate (UV data only)
Mean+	the average of positive flow rate changes (cfs)
Mean+-area	the average of positive flow rate changes (cfs) divided by the area of the watershed in 100 ac units
Mean-	the average of negative flow rate changes (cfs)
Mean--area	the average of negative flow rate changes (cfs) divided by the area of the watershed in 100 ac units
FHn	Average number of times per year the flow pulse exceed the POR 75th percentile flow rate (for WY analyses it is the number of times during that WY
FHd	Average length of high flow pulses (days)
FLn	Average number of times per year the flow pulse is less than 0.1 cfs (for WY analyses it is the number of times during that WY
FLd	Average length of low flow pulses (days)

Aquatic life data has been collected by the City of Austin since the 1990's and is used as part of the Environmental Integrity Index (EII) and other short term targeted projects. City of Austin (COA) biologic sites were chosen to match the USGS gauge sites for comparison of the biologic data to the hydrologic data. When a direct match could not be found we chose a representative site (upstream or downstream) where the hydrology would be similar to the USGS gauge (Table 2). If no comparable site could be found then the data for that site were not used in the analysis.

Table 2: USGS and COA site list paired for analysis.

USGS site #	USGS site name	COA site #	COA site name
08154700	Bull Creek @ Loop 360	350	Bull Creek @ Loop 360 First Crossing
08155200	Barton Creek @ SH 71 near Oak Hill	48	Barton Creek @ Hwy 71 DS of Little Barton
08155240	Barton Creek DS of Lost Creek Blvd	51	Barton Creek Downstream of Lost Creek Blvd
08155400	Barton Creek US of Barton Springs	879	Barton Creek Between Dams US of Pool
08155541	West Bouldin Creek @ Oltorf Rd	845	West Bouldin Creek @ Guerrero Park
08155541	West Bouldin Creek @ Oltorf Rd	3854	West Bouldin Creek @ Oltorf Street
08156800	Shoal Creek @ 12th Street	116	Shoal Creek @ 24th Street
08156800	Shoal Creek @ 12th Street	621	Shoal Creek @ 12th Street
08156910	Waller Creek @ Koenig Lane	780	Waller Creek @ 51st Street
08157000	Waller Creek @ 38th Street	781	Waller Creek @ Shipe Park
08157500	Waller Creek @ 23rd Street	624	Waller Creek Upstream of 23rd Street
08157600	East Bouldin Creek @ S. 1st Street	119	East Bouldin Creek @ Elizabeth St
08157700	Blunn Creek @ Little Stacy Park	364	Blunn Creek Upstream of Big Stacy Pool
08158030	Boggy Creek @ Manor Rd	2754	North Boggy Creek @ Manor Rd
08158035	Boggy Creek @ Webberville Rd	837	North Boggy Creek @ Nile Street
08158045	Ft Br Boggy Ck @ Manor Rd	125	Fort Branch Creek Upstream of Manor Rd
08158050	Boggy Creek @ US Hwy 183	493	North Boggy Creek @ Delwau Lane
08158200	Walnut Creek @ Dessau Rd	464	Walnut Creek Downstream of IH35
08158380	Little Walnut Creek @ Georgian Dr	839	Little Walnut Creek @ Hermitage Drive
08158380	Little Walnut Creek @ Georgian Dr	3860	Little Walnut Creek @ Georgian Dr

Table 2 (cont): USGS and COA site list paired for analysis.

USGS site #	USGS site name	COA site #	COA site name
08158600	Walnut Creek @ Webberville Rd	503	Walnut Creek Upstream of Freescale
08158600	Walnut Creek @ Webberville Rd	4021	Walnut Creek @ SPRR Bridge
08158700	Onion Creek near Driftwood	612	Onion Creek near Driftwood (Hwy 150)
08158800	Onion Creek @ Buda	610	Onion Creek @ Buda
08158810	Bear Creek DS FM 1826 near Driftwood	1534	Bear Creek Downstream of Bear Creek Pass
08158810	Bear Creek DS FM 1826 near Driftwood	4112	Bear Creek @ Bear Creek Pass
08158819	Bear Creek near Brodie Lane near Manchaca	1088	Bear Creek @ Bears Den Court
08158819	Bear Creek near Brodie Lane near Manchaca	3935	Bear Creek @ Escondido
08158827	Onion Creek @ Twin Creeks Rd near Manchaca	236	Onion Creek @ Twin Creeks Road
08158840	Slaughter Creek @ FM 1826 near Austin	623	Slaughter Creek @ FM 1826
08158840	Slaughter Creek @ FM 1826 near Austin	1085	Slaughter Creek @ Escarpment Blvd
08158860	Slaughter Creek @ FM 2304 near Austin	1083	Slaughter Creek @ River Oaks Drive
08158920	Williamson Creek @ Oak Hill	344	Williamson Creek Dwnstrm Joe Tanner
08158970	Williamson Creek @ Jimmy Clay Rd	492	Williamson Creek @ Pleasant Valley
08159000	Onion Creek @ US Hwy 183	255	Onion Creek @ McKinney Falls ds Lower Falls

Biological data collected by the City of Austin consists of the identification and enumeration of benthic macroinvertebrates and diatoms. Methodology for the collection of both communities may be found in the City of Austin Standard Operating Procedures Manual (COA 2011). For each sample collected, the City computes metrics that help determine the structural and functional attributes of the biologic communities present (Table 3). Once a year the City uses certain biologic metrics computed from samples collected for use in the Environmental Integrity Index to compute an Aquatic Life Score, which represents the overall aquatic health of a sample site. A brief description of the calculation of the Aquatic Life Score is taken from the EII Quality Assurance Project Plan (COA 2008):

Diatom and benthic macroinvertebrate components are calculated separately, then averaged equally to determine the total Aquatic Life Sub-index score for each site. Metric scores are used to determine the individual component scores as detailed below.

Four metrics are used to determine the diatom aquatic life component: Cymbella Richness, Percent Motile Taxa, Percent Similarity to Reference Sites and Pollution Tolerance Index.

Nine metrics are used to determine the benthic macroinvertebrate aquatic life component: Hilsenhoff Biotic Index, Number of Ephemeroptera Taxa, Number of EPT Taxa, Number of Intolerant Taxa, Number of Taxa, Percent Dominance (Top 3 Taxa), Percent of Total of Chironomidae, Percent of Total as EPT, Percent of Total as Predators. The EII scores for each of these metrics are calculated, then averaged equally by group (diatom, benthic) to yield the total component scores.

The 5th and 95th percentiles for each metric are calculated and extreme values are set to either the 5th or 95th percentile to prevent outliers from determining the range of scores against which sites would be compared. The truncated metrics are converted to EII scores on a 100-point scale using linear interpolation between the 5th (equal to 0) and 95th (equal to 100) percentile values:

EII Metric Score = 100(truncated metric – 5th percentile)/(95th percentile – 5th percentile)*

For one diatom metric (Percent Motile) and three benthic macroinvertebrate metrics (HBI, % Chironomidae, and % Dominance), lower scores imply better conditions. For these metrics, the calculated score is subtracted from 100 to determine the final metric score.

The calculation of the Aquatic Life Score normally incorporates a correction to the score based on biological reference sites. In this study uncorrected Aquatic Life Scores were computed for each sample site and data period as all of the biological reference sites used in the score correction do not correspond to USGS sites. After the calculation of uncorrected Aquatic Life Scores was complete the individual aquatic life metrics were averaged by sample site and data period.

Table 3: Biological community metrics.

Metric Name	Calculation Method	Source Notes	Use*
Benthic macroinvertebrate metrics			
# Organisms	Total number of benthic organisms in sample		
# Taxon	Number of unique benthic taxa	TCEQ 2005, Plafkin et al 1987[1]	Qual, Quant, EII
% Dominance (1 taxa)	Number of organisms of most numerous single taxon as percent of total number of organisms	Plafkin et al 1987, TCEQ 2005	Qual
% Dominance (3 taxa)	Number of organisms of top 3 most numerous taxa as percent of total number of organisms	TCEQ 2005	Quant, EII
% Dominant Guild	Number of organisms of most numerous feeding group as percent of total number of organisms	TCEQ 2005	Qual
HBI	Average PTI value of all organisms; organisms with no known PTI value in the FSDB are excluded from the calculation of the HBI	Hilsenhoff 1987	Qual, EII
# Diptera Taxa	Number of unique taxa in order Diptera	TCEQ 2005	Quant
# Ephemeroptera Taxa	Number of unique taxa in order Ephemeroptera	TCEQ 2005	Quant, EII
% EPT	Number of organisms in orders Ephemeroptera, Plecoptera and Trichoptera as percent of total organisms	TCEQ 2005	Quant, EII
# EPT Taxa	Number of unique taxa in orders Ephemeroptera, Plecoptera and Trichoptera	Plafkin et al 1987	Qual, EII
EPT/EPT+Chironomidae	Number of organisms in Ephemeroptera, Plecoptera and Trichoptera orders as percent of the sum of number of organisms in Ephemeroptera, Plecoptera Trichoptera orders and Family Chironomidae		
% Chironomidae	Number of organisms in Chironomidae family as percent of total organisms	TCEQ 2005	Qual, Quant, EII
% Elmidae	Number of organisms in Elmidae family as percent of total organisms	TCEQ 2005	Qual
# Non-Insect Taxa	Number of unique taxa not in Class Insecta	TCEQ 2005	Qual
% Collector-Gatherer	Number of organisms in CG feeding group as percent of total organisms	TCEQ 2005	Qual, Quant
% Predator	Number of organisms in Predator feeding group as percent of total organisms	TCEQ 2005	Qual, EII
% Filterer	Number of organisms in Filterer feeding group as percent of total organisms	TCEQ 2005	Quant
% Grazers	Number of organisms in Scraper feeding group as percent of total organisms	TCEQ 2005	Quant
% Trichoptera as Hydropsychidae	Number of organisms in Family Hydropsychidae as percent of total organisms in Order Trichoptera	TCEQ 2005	Qual
Ratio of Intolerant to Tolerant	Ratio of number of organisms with PTI value ≥ 6 to number of organisms with PTI < 6	TCEQ 2005	Qual
# Intolerant Taxa	Number of unique taxa with a PTI value ≤ 4	TCEQ 2005	Quant, EII
% Tolerant	Number of organisms with a PTI value ≥ 8.5 as percent of total number of organisms	TCEQ 2005	Quant
Quantitative ALU	TCEQ quantitative aquatic life use score	TCEQ 2005	
Qualitative ALU	TCEQ qualitative aquatic life use score	TCEQ 2005	

Table 3 (cont): Biological community metrics.

Metric Name	Calculation Method	Source Notes	Use*
Diatom metrics			
# Organisms	Total number of diatom organisms in sample		
# Taxon	Total number of unique diatom taxa in sample		EII
PTI	Average pollution tolerance index value		EII
Cymbella Richness	Number of taxa in the Cymbella, Encyonema, Encyonemopsis, and Reimeria genera		EII
% Motile Taxa	Number of organisms in Navicula, Nitzschia, Surrirella, Craticula, Diadesmis, Luticola, Sellaphora, Hippodonta, Tryblionella, Geisselaria genera as percentage of the total number of organisms		EII
% Similarity to Reference	Community similarity index calculated using percentages of organisms in both reference and test samples. Reference conditions are generated from data collected at reference sites in biologically equivalent time periods.		EII

*Qual=Qualitative ALU (Harrison 1996), Quant=Quantitative ALU (Davis 1997), EII=Use in EII
1. Modified to include count of all taxa, not just at family level.

Data Analyses

Principal component analysis was performed on each set of flow and data period data in order to initially detect which hydrologic parameters may be correlated with each other (Olden and Poff 2003). Pearson correlations were performed on each data set in order to further determine which hydrologic parameters may cause problems of collinearity, which hydrologic metrics were significantly correlated to the calculated Aquatic Life Score, and which hydrologic parameters were significantly correlated to each biologic metric.

One of the objectives in this analysis was to create a stochastic model that could predict an Aquatic Life Score based on hydrology parameters computed by a mechanistic computer based model. While the results of the computer model are the subject of a separate study, multiple regression models were created to predict the Aquatic Life Score and the biological metrics that compose the Aquatic Life Score from the hydrologic metrics. Step-wise regression was used to create a large volume of models, which included the null and full models. Models with the smallest Schwarz Bayesian Criteria value and a parameter of input of 3 or 4 hydrologic parameters were chosen as the optimal model for description and interpretation (Shtatland et. al. 2001, Schwarz 1978). Watershed size may influence the Aquatic Life Score and several of the hydrologic parameters including Qmean, Qpeak, Q90, Q50, Qmean+, Qmean(ln), mean+, and mean-. These parameters were removed from the final step-wise model creation as they were correlated with area. Instead, the area corrected parameters were used to represent these hydrologic aspects. Data periods with less than 40% validated flow measurements were left out of all analysis.

Results

Principal component analysis (PCA) of the sub-daily flow data that was grouped by impervious cover period shows that most of the metrics which involved the time above some threshold of flow (TQmean, TQ0.25yr, TQ0.5yr, TQ0.75yr, TQ1yr, TQ90) were likely to be correlated as they were clustered together in the plots (Figure 2).

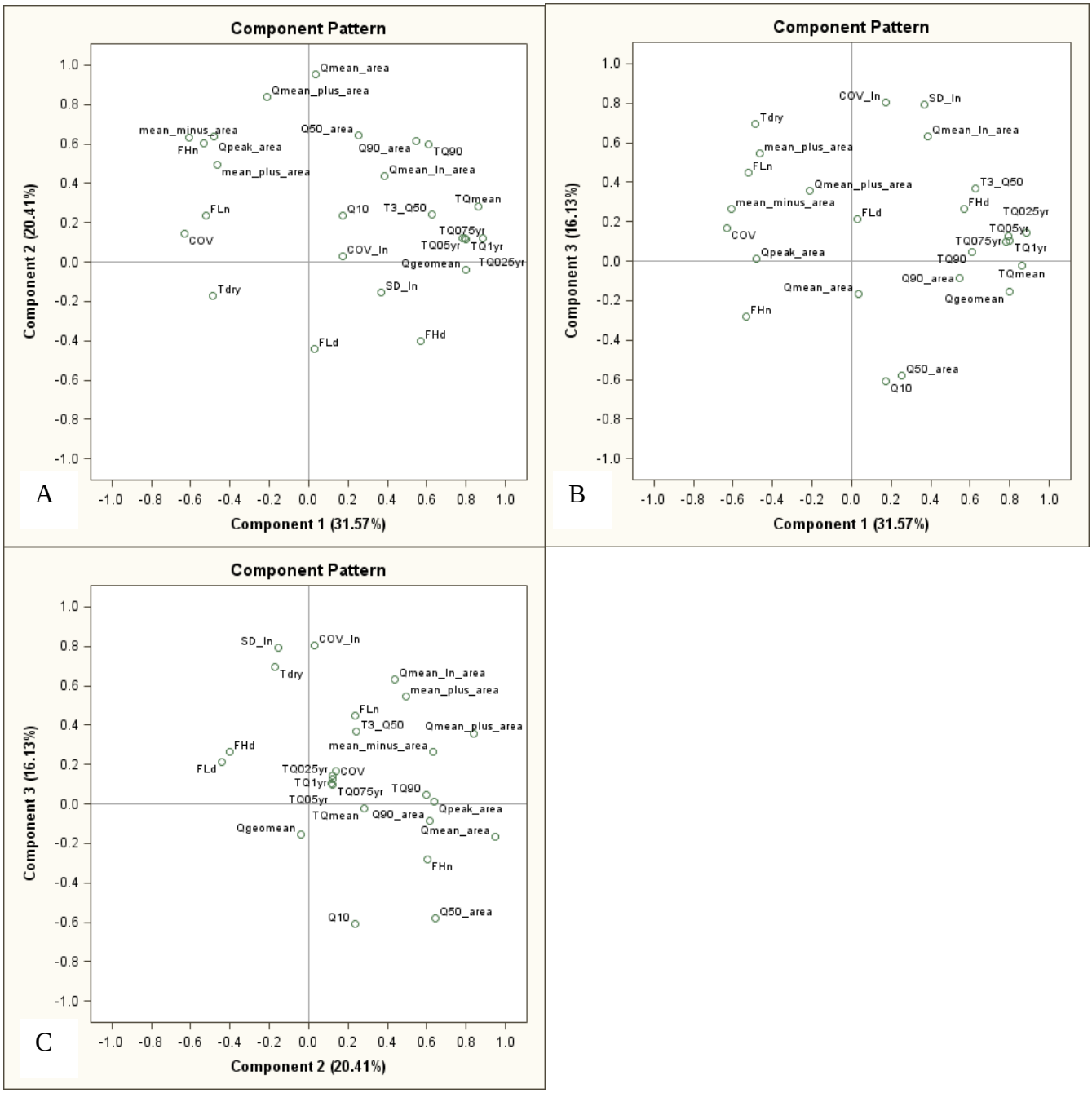

Figure 2: A) Axis 1 versus Axis 2, B) Axis 1 versus Axis3, C) Axis 2 versus Axis 3 of the Principal Component Analysis of hydrologic metrics computed from sub-daily flow data grouped by impervious cover period.

Mean--area, Qpeak-area, FHn, and Mean+-area may also be correlated in this data set. Similar trends could be seen in the datasets using the sub-daily flow data grouped by water year and the daily flow data grouped by water year with the exception that FHn was more closely related to the TQmean. PCA plots for the daily flow data grouped by impervious cover period showed that the parameters were more dispersed with the exception of mean+-area and mean--area which still seemed to be highly correlated.

Pearson correlation was used as a second check for correlated parameters before the regression analysis was performed (Appendix A). It was confirmed that the TQXXyr metrics were highly correlated ($r \geq 0.8$) with each other in both the sub-daily flow grouped by impervious cover period dataset (Table 4) and the sub-daily flow grouped by water year dataset (Table 5). Qmean+-area was highly correlated to Qmean-area and mean--area in the daily flow grouped by impervious cover dataset (Table 6) and the daily flow grouped by water year dataset (Table 7). SD(ln) and COV(ln) were highly correlated in all datasets. Mean--area and FHn were not highly correlated to each other according to the Pearson correlation analysis.

Table 4: Pearson correlations for metrics calculated from the sub-daily flow grouped by impervious cover period with $r \geq 0.8$.

	COV(ln)	Mean--area	TQ0.5yr	TQ0.75yr	TQ1yr
SD(ln)	0.9097				
Mean+-area		0.7801			
TQ0.25yr			0.8494	0.8045	0.8142
TQ0.5yr				0.9781	0.9577
TQ0.75yr			0.9781		0.9809

Table 5: Pearson correlations for metrics calculated from the sub-daily flow grouped by water year with $r \geq 0.8$.

	COV(ln)	T3xQ50	TQmean	TQ90	TQ0.75yr	TQ1yr
Q90-area			0.8147	0.8101		
SD(ln)	0.8829					
TQmean		0.8211		0.8559		
TQ90		0.7919	0.8559			
TQ0.5yr					0.9586	0.9286
TQ0.75yr						0.9657

Table 6: Pearson correlations for metrics calculated from the daily flow grouped by impervious cover period with $r \geq 0.8$.

	Qmean-area	COV(ln)	Mean+-area	Mean--area
Q90-area	0.8326			
Qmean+-area	0.8109		0.8795	0.8217
Qmean(ln)-area		0.8117		
SD(ln)		0.9020		
Mean+-area				0.9010

Table 7: Pearson correlations for metrics calculated from the daily flow grouped by water year with $r \geq 0.8$.

	Qmean-area	COV(ln)	T3xQ50	TQmean	Mean--area
Q90-area	0.8966				
Qmean+-area	0.8405				0.8277
SD(ln)		0.8840			
TQmean			0.8174		
TQ90			0.8137	0.8810	

Relationships between hydrologic parameters and the Aquatic Life scores appeared slightly more correlated in the sub-daily flow models than in the daily flow models (Appendix B). Q10, Qmean(ln)area, COV(ln), and Tdry were all more highly correlated when data were grouped by

water year while the rest of the parameters seemed to be more highly correlated when the data were grouped by impervious cover period. COV(ln) showed a weak relationship in each dataset and may not be important to the Aquatic Life Score; however, the stronger correlations with Tdry and Q10 in water years is probably due to the fact that these metrics are more related to drought than to changes in impervious cover. Rainfall would be more variable in a multi-year time period and thus the time the creek is dry would be less accurate, leading to a weaker correlation. The highest correlated parameter in every dataset was mean--area which had strong negative relationships with coefficients ranging from -0.6434 to -0.8759. In the sub-daily flow datasets other parameters that exhibited high correlations with the Aquatic Life scores include Qpeak-area, Qmean+-area, BFR, and mean+-area. While Q90, Qmean+-area, BFR, mean+-area, FHn and FLn were parameters that showed higher correlations to the Aquatic Life scores in the daily flow datasets. All of these parameters except the Q90 and BFR correlated negatively with the Aquatic Life scores.

The negative correlation between mean--area and the Aquatic Life Score implies that the overall health in aquatic life will decrease as there are larger average drops in flow rates in the data period. The relationship is similar for increases in flow rates during the data period as well, based on the correlation with mean+-area. This correlation confirms that rapid rises and falls in flow can be detrimental to benthic communities as the changes in flow can scour habitat as well as the invertebrates themselves (Bunn and Arthington 2002). Along with the other parameters that were highly correlated to the Aquatic Life score, it appears that a more stable, or less flashy, flow regime will support healthier aquatic environments. When the flow is altered to become more “flashy” the aquatic life suffers. Most of these parameters can be linked to impervious cover, as an increase in impervious cover generally leads to decreased base flow fractions, a higher number of high-flow events with shorter duration, and rapid rises and falls in stream flow. The daily flow dataset also suggests that the number of days spent below a specific flow rate can be detrimental to the aquatic health of the system, which confirms earlier analysis performed by the City of Austin showing that the intermittency of flow in Austin streams is an important factor related to the biological health (COA 2010). However, this characteristic seems to be overshadowed by other important factors related to biological health.

The top ten models created to predict Aquatic Life scores from hydrologic parameters in each set of data showed that the impervious cover periods could provide much higher adjusted R^2 values with a smaller amount of explanatory variables (Table 8). The best model created from the sub-daily flow values grouped by water year incorporated the mean--area, FHd, and Tdry to predict the Aquatic Life scores. While the model seemed to accurately predict high Aquatic Life Scores, there was too much variability at lower scores to make the model a viable option (Figure 3).

Table 8: Top ten models based on the Schwarz Bayesian Criteria for predicting Aquatic Life scores from hydrologic parameters in each dataset.

Daily Values – Impervious Cover Period

Intercept	Qmean-area	Qpeak-area	Q10	Q50-area	Qmean+-area	Qmean(ln)-area	SD(ln)	T3xQ50	TQmean	TQ90	mean--area	FLn		N	ADJRSQ	AIC	SBC
84.990		1.103	8.312	-245.242		23.432					-272.608			50	0.8465	235.2193	247.3714
81.386		0.962	7.993	-239.141		19.050		15.099			-264.308			49	0.8517	234.1714	248.3489
83.064		1.112	5.952			18.224					-321.847	0.700		50	0.8435	236.2879	248.4400
80.874		0.925	8.832	-350.828		16.846			32.320		-246.181			49	0.8508	234.5130	248.6904
74.573		0.923	6.011				1.307				-247.593			51	0.8343	238.6055	248.7322
84.629		1.027				20.952					-278.893			52	0.8247	240.8440	248.9454
84.104		1.245				17.779					-313.550	0.483		51	0.8335	238.8829	249.0097
81.657		0.996	9.079	-323.963		19.550				48.542	-264.627			49	0.8497	234.9036	249.0810
77.405		1.130					1.056				-257.033			52	0.8239	241.1041	249.2055
79.271	-194.671	1.339			9941.381				54.471		-240.391			50	0.8409	237.2255	249.3776

Daily Values – Water Year

Intercept	COV	Qpeak-area	Q10	Q90-area	Q50-area	Qmean+-area	Qgeomean	Tdry	TQmean	TQ90	mean--area	FHd		N	ADJRSQ	AIC	SBC
85.315				-52.443	-223.920	16231.158		-24.772	38.846		-220.591			112	0.5679	579.9215	599.3754
83.086					-208.431			-16.982	46.636		-111.375			114	0.5299	588.0803	601.9759
84.246		0.540		-54.240	-216.693	16876.402		-22.398	36.644		-242.972			111	0.5701	580.2683	602.5013
86.603				-41.732	-165.272	19032.255	0.286	-24.220			-249.725			112	0.5558	583.2118	602.6657
84.599			1.700	-54.077	-228.347	16737.662		-22.769	37.661		-226.458			111	0.5692	580.4983	602.7312
85.062				-53.539	-233.576	16307.571		-24.273	46.962		-224.515	-0.046		111	0.5688	580.6100	602.8430
88.496				-42.679	-155.613	21338.735		-25.710			-277.150			113	0.5410	586.1701	602.8448
84.540	0.398			-52.088	-195.880	16031.610		-23.446	33.698		-227.741			111	0.5675	580.9863	603.2193
83.731					-232.044	7369.728		-18.191	31.150		-177.415			113	0.5391	586.6793	603.3541
86.650				-53.019	-161.416	18940.992		-25.255		39.743	-256.078			112	0.5532	583.9118	603.3656

Subdaily Values – Impervious Cover Period

Intercept	Qmean-area	Q10	Q90-area	FLd	Qmean(ln)-area	Tdry	TQmean	TQ90	mean+-area	mean--area	FHn	FLn	TQ0.25yr	N	ADJRSQ	AIC	SBC
79.487	-118.720						79.138			-407.247				52	0.8282	239.7197	247.8211
79.385	-110.365						77.391		28.938	-484.490				51	0.8301	240.0097	250.1365
79.055	-137.606	3.884					82.223			-373.875				51	0.8301	240.0180	250.1447
80.788	-98.744						93.089	-51.769		-412.141				51	0.8299	240.0628	250.1895
82.158	-148.978					-6.804	81.943			-342.880				51	0.8291	240.3562	250.4829
80.447	-133.209						81.238			-352.592		-0.063		51	0.8290	240.3820	250.5087
84.535	-209.339	7.669	71.781							-346.965			383.489	50	0.8363	238.8155	250.9676
77.819	-113.155				-23.088		103.290		68.649	-519.886				50	0.8363	238.8201	250.9722
80.415	-126.343			-0.055			79.864			-403.925				51	0.8269	241.0422	251.1690
80.937	-94.243						68.352			-418.725	-0.040			51	0.8268	241.0755	251.2023
83.545							32.329			-516.717	-0.114			52	0.8163	243.4596	251.5610

Table 8 (cont): Top ten models based on the Schwarz Bayesian Criteria for predicting Aquatic Life scores from hydrologic parameters in each dataset.

Subdaily Values – Water Year																	
Intercept	Qmean-area	COV	Q50-area	Qmean+-area	SD(ln)	Tdry	TQmean	mean--area	FHd	TQ0.25yr				N	ADJRSQ	AIC	SBC
88.320						-14.769		-363.749	-0.062					116	0.5749	586.0534	597.2034
84.982					0.541	-17.224		-376.327	-0.051					115	0.5865	583.6857	597.6232
85.887						-12.941		-353.706	-0.053	170.497				115	0.5862	583.7845	597.7220
86.197		0.505				-13.761		-403.246	-0.069					115	0.5857	583.9369	597.8744
85.563	-99.853					-19.275	29.219	-194.276		209.462				114	0.5977	581.3481	598.0731
85.806	-86.980	0.598				-18.956	29.853	-256.163	-0.050					113	0.6096	578.6786	598.1911
84.970			-135.697			-15.033	30.678	-334.002	-0.048					114	0.5964	581.7436	598.4686
86.819	-138.671			4865.027		-24.853	24.486	-253.544		194.094				113	0.6081	579.1481	598.6605
85.326						-11.706	12.762	-370.215	-0.057					115	0.5823	584.9093	598.8468
87.452	-134.218			5325.128		-24.766	29.465	-296.365						114	0.5950	582.1477	598.8727

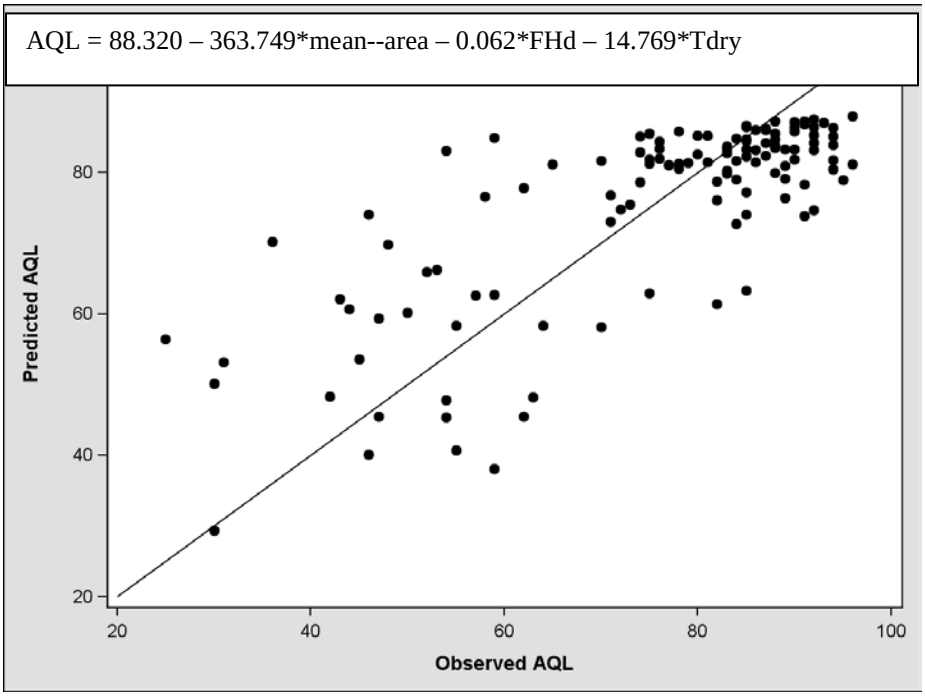

Figure 3: Comparison of the predicted Aquatic Life scores and the observed Aquatic Life scores. The predicted Aquatic Life score is calculated from the sub-daily model which categorized samples by water year.

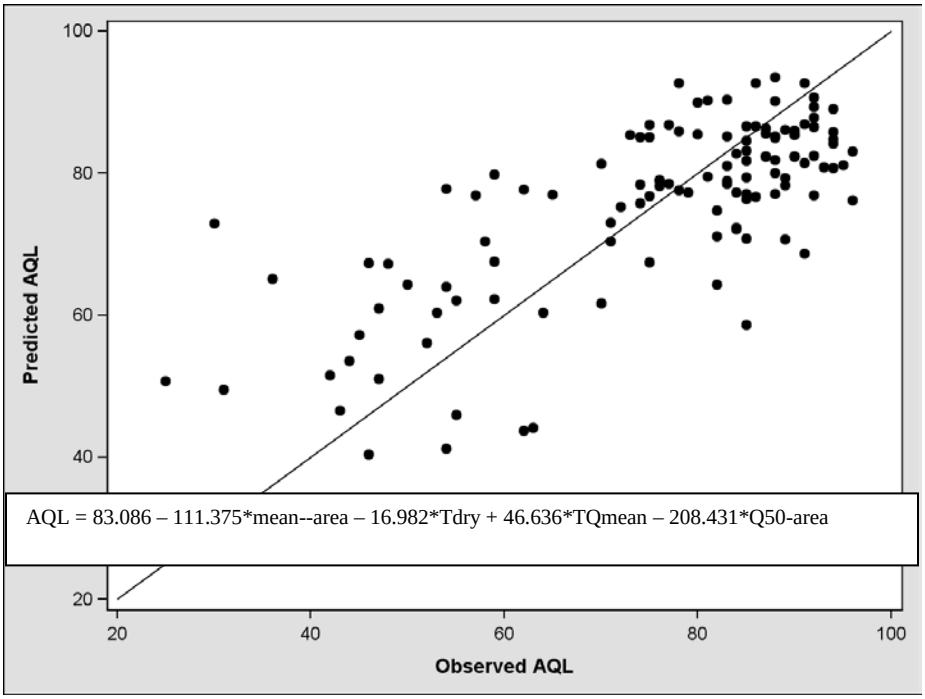

Figure 4: Comparison of the predicted Aquatic Life score and the observed Aquatic Life score. The predicted Aquatic Life score is calculated from the daily model which categorized samples by water year.

The model with the second lowest Schwarz Bayesian Criteria (SBC) was chosen from the list of models created by the daily flow values grouped by water year instead of the

model with the lowest SBC due to the excessive number of parameters in this model. The lowest SBC model tended to under predict high Aquatic Life Scores and over predict low Aquatic Life Scores and should not be used for further analysis similar to the model based on the sub-daily flow data grouped by water year (Figure 4).

Like the model chosen from the daily flow data grouped by water year, the model chosen from the daily flow data grouped by impervious cover period did not have the lowest SBC. The model was chosen for the high adjusted R^2 value with the fewest amount of parameters used in the model from the list of the lowest SBC models. While the model predicted the Aquatic Life score well, the explanatory capability of the model is suspect (Figure 5). Both Qpeak-area and Qmean(ln)-area have negative relationships with the Aquatic Life Score; however, in the model they represent an increase in the Aquatic Life Score. Statistically, this model could be used to further predict Aquatic Life scores from hydrologic parameters but caution should be used if trying to use the model for explanation based on the correlation analysis.

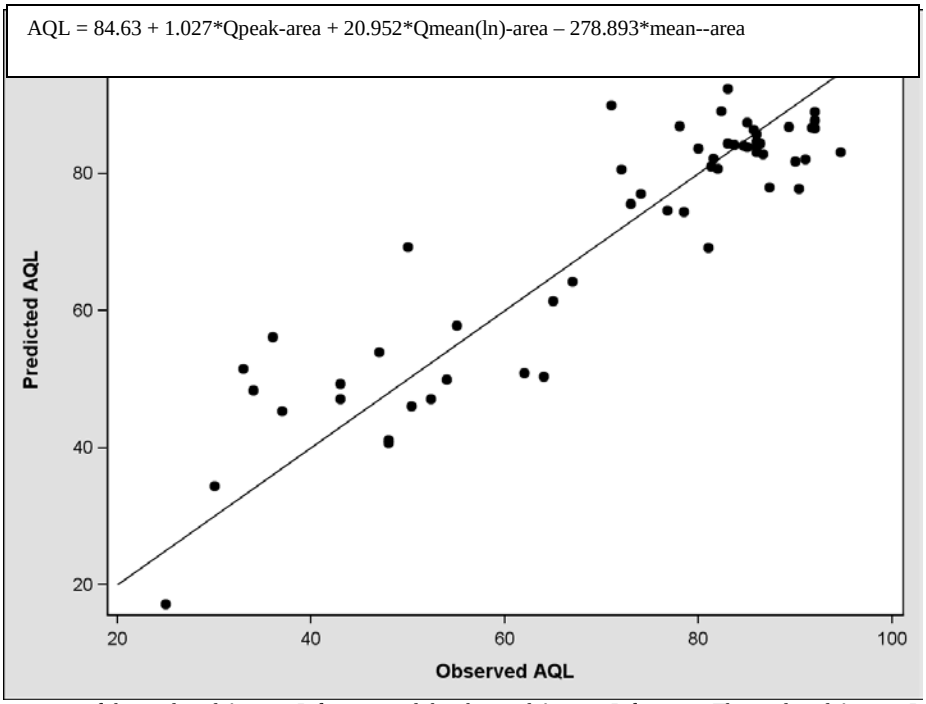

Figure 5: Comparison of the predicted Aquatic Life score and the observed Aquatic Life score. The predicted Aquatic Life score is calculated from the daily model which categorized samples by impervious cover period.

The model chosen from the sub-daily flow values grouped by impervious cover period predicts the Aquatic Life score well and the parameters are aligned similar to the correlation analysis (Figure 6). In addition, significant differences in hydrologic metrics are apparent when using sub-daily flow data versus daily flow data. Metrics where such differences exist include the Mean--area, Mean+-area, FHn, FHd, FLn, FLd, BFR, and Qpeak-area. Each of these parameters will be more accurately represented in a sub-daily flow dataset. Because many of these parameters are included in the models it is recommended that the sub-daily model should be used in the prediction and explanation of the Aquatic Life Scores. The model suggests that the Aquatic Life score will decrease

with larger drops in stream flow rates, higher frequency of flows above the 75th percentile, and less time spent above the mean flow. The relation between mean--area and FHn with biological health has been discussed earlier. However, the increase in biological health with an increase in the time spent above the mean flow is also informative. In intermittent streams a lack of flow is detrimental to the aquatic life in the system. The time the creeks are in this dry state decreases as the amount of time the flow is above the mean increases. Thus the importance of this parameter to the model may be related to the observed importance of the level of intermittency of the creeks.

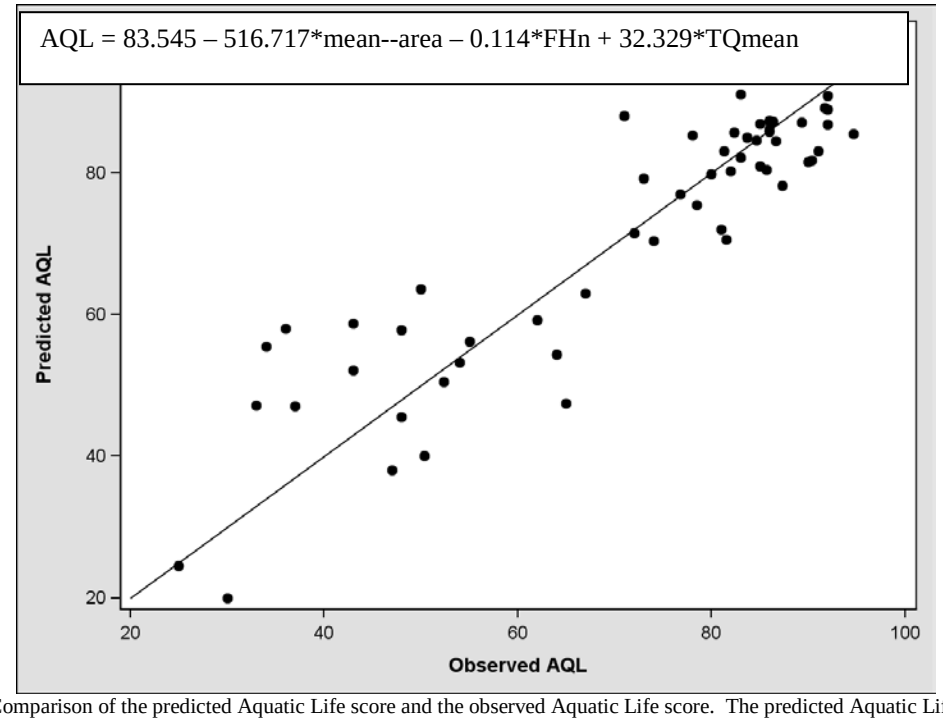

Figure 6: Comparison of the predicted Aquatic Life score and the observed Aquatic Life score. The predicted Aquatic Life score is calculated from the sub-daily model which categorized samples by impervious cover period.

Correlations performed on the hydrology and biology parameters showed that the stronger correlations existed in the data sets grouped by impervious cover period (Appendix C). There were only slight differences between the correlations produced from the daily flow values and the sub-daily flow values. In the two impervious cover period datasets, 13 biological metrics share the same top correlated hydrology parameters. Mean+-area had higher correlation statistics when used with the daily flow values while the BFR was more correlated to parameters within the sub-daily flow value dataset. In addition, only slight differences existed between the coefficients of correlation between the datasets. In 13 of 29 biological metrics the coefficient of correlation was higher for sub-daily values while 8 were higher using daily flows and 6 had similar coefficients of correlation in both datasets. The average drop in flow rate (mean--area) was the highest correlated parameter for many of the biological metrics in every dataset. Previous studies have shown that the number of low flow pulses, duration of low flow pulses, number of high flow pulses, duration of high flow pulses, high pulse levels, low pulse levels, number of days with zero flow, and rate of the rise in flow contribute to the explanation of HBI, EPT/EPT+Chironomidae, Taxa Richness, EPT taxa,

Diptera taxa, Percent Dominance, Percent Chironomidae, and Percent EPT (COA 2000). The dataset used to complete this previous analysis consisted of daily flow data grouped by year. In the current investigation, correlations performed on the daily flow values grouped by water year confirmed that the number of low flow pulses, number of high flow pulses, high pulse levels, number of days with zero flow, and rates of the rise and fall had the strongest relationships to the above biological metrics (Appendix C). However, the duration of high and low flow pulses were not strongly correlated to these variables.

To further understand the relationships between the Aquatic Life Scores and the hydrology parameters, step-wise regression was performed on the biological metrics that are included in the Aquatic Life Score calculation. The top models showed that better predictions could be reached using the impervious cover periods to group flow values (Appendix D). While the sub-daily flow models had slightly higher adjusted coefficients of determination, the daily flow models did explain more variability in the PTI, percent EPT, and percent Chironomidae. The biologic parameters with the highest coefficients of determination were the number of Ephemeroptera taxa, number of EPT taxa, number of intolerant taxa, Pollution Tolerance Index (diatoms), and the percent similarity (diatoms) ($R^2 > 0.7$). Hydrologic parameters that were major components involved in the creation of these models were Qmean-area, mean--area, FHd, FLd, Qgeomean, TQmean, and Tdry. Increases in the average flow typically showed a negative effect on the biological parameters, while the geometric mean of the flow had the opposite effect if present in the model. These biological parameters also showed negative responses to increases in the average drop in flow rates and time the creek was dry. Biological parameters showed positive responses to an increase in TQmean, duration of low flow pulses, and duration of high flow pulses.

It appears that flashy hydrology where there are large rises and falls in flow at short durations is detrimental to the more sensitive taxa. This could be caused by scouring of resources or the invertebrates themselves from the area. The life cycle of these more sensitive groups may also require a longer duration of stable flows to sustain a representative population in a community. The HBI was positively influenced by the average drop in flow rates and the number of low flow events. This is another biological parameter that is influenced by sensitive taxa. As the flows become more flashy the sensitive taxa decrease in overall abundance which causes the HBI to increase. The adjusted R^2 values for the HBI models were much lower than the sensitive taxa models, perhaps suggesting that the flow regime is not as important to this more robust measure of the benthic macroinvertebrate community. Low adjusted R^2 values were obtained from the models for percent Chironomidae, percent EPT, and percent predators. It may be more difficult to predict how a particular group of invertebrates will respond to hydrology alterations relative to the entire community. The average drop in flow rates was also the most important factor within the models for percent dominance and number of taxa in the macroinvertebrate community. As the average drop rates increased the dominance increased and the number of taxa decreased. The flashy flows decreased the more sensitive taxa leaving the more tolerant species to persist in the harsher conditions.

Conclusion

Many of the hydrologic parameters were correlated with each other in every dataset. Qmean was usually correlated with other forms of flow such as the Q90 or Qgeomean. The area corrected Qmean was also correlated with other forms of area corrected flow. If further analysis of this type is to be done, the number of flow characteristics should be reduced to the minimum necessary for accurate predictions. Q50, Q90, and Qmean(ln) were not highly correlated with any biological metric nor were they instrumental in any of the models created. Of the parameters that represented the actual flow of the creek, the Qpeak and Qgeomean were the best metrics in predicting the aquatic life in streams; however, the Qmean was also useful. The hydrologic parameters TQ0.25yr, TQ0.5yr, TQ0.75yr, and TQ1yr were closely correlated. Only one of these characteristics is necessary to perform proper analysis of the sub-daily data. The mean--area was correlated to the mean+-area and the BFR. While all of these parameters correlated well to the Aquatic Life Score, the mean--area is the only necessary characteristic as the other parameters do not have as high of correlations.

Correlations and regression relationships seemed to be stronger when flow data was grouped by impervious cover period. This may be due to how impervious cover affects flow. Natural flow variation from year to year can be variable, but if the flow is grouped into a multi-year structure, where years share characteristics of flow, then some of the variability in the flow dynamics will be reduced. This would allow for stronger relationships to be seen in the data. Metrics created from the sub-daily flow data will more accurately represent creek flow regimes and should be used over daily flow data. It also appears that the sub-daily flow data may allow for a model that is easier to explain while providing similar predictive power to the daily flow model. This paper presents many models for predicting an Aquatic Life Score from hydrologic characteristics. While an optimal model is suggested, it is by no means the only model that should ever be considered. As the computer model that will output hydrologic characteristics is better suited to accurately predict certain aspects of flow, other models should be considered if the parameters in the optimal stochastic biologic model cannot be accurately predicted by the selected hydrologic model.

Relationships found between the Aquatic Life Scores and hydrologic characteristics are best explained by the loss of sensitive taxa due large scouring flows. This is shown by the strong relationships between the rise/fall in flow and the number of Ephemeroptera, EPT taxa, and Intolerant taxa. Longer durations of stable flow also seem to help these organisms carry out their longer life-cycles. These sensitive taxa are involved in several of the metrics used in the calculation of the Aquatic Life Score, so it is logical that strong relationships exist between the Aquatic Life Score and certain hydrologic characteristics. Other aspects of the Aquatic Life Score are not explained well by the hydrologic characteristics, such as the percent of Chironomidae. This is thought to be a non-sensitive group of organisms, thus they may be better adapted to large changes in flow. Overall the sensitive taxa tend to decrease in number as the flows become flashy, which can be a result of an increase in impervious cover.

These results show how aquatic life is related to intermittent flow in central Texas. The relationships between aquatic life and flows in this hydroclimatic region have been previously shown to be different than in other hydroclimatic regions. Thus these region specific expanded results should allow hydrologists, biologists, and engineers to evaluate not only overall aquatic health in planning scenarios but also a more taxonomic specific response.

Chosen models from the above analysis as documented in this report are as follows:

- Sub-daily flow based on water year:

  AQL = 88.320 – 363.749*mean--area – 0.062*FHd – 14.769*Tdry

- Daily flow based on water year:

  AQL = 83.086 – 111.375*mean--area – 16.982*Tdry + 46.636*TQmean – 208.431*Q50-area

- Daily flow based on impervious cover group:

  AQL = 84.63 + 1.027*Qpeak-area + 20.952*Qmean(ln)-area – 278.893*mean--area

- Sub-daily flow based on impervious cover period:

  AQL = 83.545 – 516.717*mean--area – 0.114*FHn + 32.329*TQmean

Of these selected models, the final one (sub-daily flow data grouped by impervious cover period) created the best model using mean--area, FHn, and TQmean as the predictive hydrologic metrics to describe biological health of the creeks

Recommendations

- Further statistical analysis of these types of data should be performed as more are collected to arrive at a minimally complicated model with the best predictive power possible. The present study serves as a guide for future analysis.

- Because many more hydrologic parameters are available for the sub-daily models it is recommended that these be used in the prediction and explanation of the Aquatic Life Scores.

- The model described above as the sub-daily flow data grouped by impervious cover period should be used until additional analyses indicate a better model is supported.

- It is recommended that the indirect link between impervious cover and Aquatic Life use scores from these local data be used in water quality improvement projects to predict how the biological health of a creek in Austin will be affected by changes in land use.

References

Bunn, S.E. and A.H. Arthington. 2002. Basic Principles and Ecological Consequences of Altered Flow Regimes for Aquatic Biodiversity. Environmental Management 30(4): 492-507 pp.

Barbour, M.T., J.B. Stribling, and J.R. Karr. 1994. Multimetric approach for establishing biocriteria and measuring biological condition. Biological Assessment and Criteria: Tools for Water Resource Planning and Decision-Making, Davis, S.W. and T.P. Simon (eds.), Lewis (CRC) Publishers. Boca Raton, Florida.

Barbour, M.T., J. Gerritson, B.D. Snyder, and J.B. Stribling. 1998. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates and fish. 2nd Edition.

City of Austin (COA). 2000. Effects of Hydrology on Bioassessment in Austin, Texas. Watershed Protection and Development Review Department, Environmental Resource Management Division, Water Resource Evaluation Section.SR-00-02.

City of Austin. 2008. EII (NCR, PI, AQL) Quality Assurance Project Plan. Watershed Protection and Development Review Department, Environmental Resource Management Division, Water Resource Evaluation Section.

City of Austin (COA). 2010. Impacts of Stream Hydrologic Characteristics on Ambient Water Quality and Aquatic Health in the Austin, Texas Area. Watershed Protection and Development Review Department, Environmental Resource Management Division, Water Resource Evaluation Section.SR-10-18.

City of Austin. 2011. Water Resource Evaluation Standard Operating Procedures Manual. Watershed Protection and Development Review Department, Environmental Resource Management Division, Water Resource Evaluation Section. First compiled August 2004.

Dynesius, M. and C. Nilsson. 1994. Fragmentation and flow regulation of river systems in the northern third of the world. Science 266: 753-762 pp.

Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomologist 20:31-39.

Olden, J.D. and N.L. Poff. 2003. Redundancy and the Choice of Hydrologic Indices for Characterizing Streamflow Regimes. River Research and Applications 19: 101-121 pp.

Plafkin, J.L., and M.T. Barbour, K.D. Porter, S.K. Gross, R.M. Hughes. 1989. Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. US Environmental Protection Agency EPA/440/4-89/001.

Poff, N.L. and J.V. Ward. 1989. Implications of Streamflow Variability and Predictability for Lotic Community Structure: A Regional Analysis of Streamflow Patterns. Canadian Journal of Fisheries and Aquatic Sciences 46: 1805-1817 pp.

Richter, B.D., J.V. Baumgartner, J. Powell, and D.P. Braun. 1996. A Method for Assessing Hydrologic Alteration within Ecosystems. Conservation Biology 10(4): 1163-1174 pp.

Schwarz, G. 1978. Estimating the dimension of a model. The Annals of Statistics 6(2). 461-464 pp.

Shtatland, E. S., E. Cain, and M.B. Barton. 2001. The Perils of Stepwise Logistic Regression and How to Escape Them Using Information Criteria and The Output Delivery System. SUGI 26 Proceedings: Paper 222-26.

Sparks, R.E. 1992. Risks of altering the hydrologic regime of large rivers. Pages 119-152 in J. Cairns, Jr., B.R. Niederlehner, and D.R. Orvos, editors. Predicting ecosystem risk: advances in modern environmental toxicology, Vol. 20. Princeton Scientific Publishing. Princeton, New Jersey.

Standford, J.A. and J.V. Ward. 1979. Stream regulation in North America. Pages 215-236 in J.V. Ward and J.A. Stanford editors. The ecology of regulated streams. Plenum Press, New York.

Texas Commission on Environmental Quality (TCEQ). 2005. Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data. TCEQ Surface Water Quality Monitoring Program. RG-416. (http://www.tnrcc.state.tx.us/water/quality/data/wqm/vol2_draft_chapters.pdf)

Appendix A – Correlations of hydrologic parameters.

Sub-daliy Flows grouping by Impervious Cover Period

	Qmean	Qmean-area	SD	COV	Qpeak	Qpeak-area	Q10	Q90	Q90-area	Q50	Q50-area	Qmean+
Qmean	1	-0.04246	0.93667	-0.27696	0.64256	-0.37853	0.12585	0.96316	0.24499	0.70438	0.08676	0.98447
Qmean-area	-0.04246	1	-0.0716	0.03051	-0.17085	0.59708	0.26591	-0.08588	0.66848	0.21759	0.72832	-0.12214
SD	0.93667	-0.0716	1	-0.35751	0.84479	-0.3604	0.26664	0.83841	0.17766	0.66587	0.11177	0.92391
COV	-0.27696	0.03051	-0.35751	1	0.23693	0.54063	-0.19191	-0.40781	-0.49233	-0.37228	-0.23556	-0.24334
Qpeak	0.64256	-0.17085	0.84479	0.23693	1	-0.14785	0.03268	0.55728	-0.00775	0.30773	-0.09044	0.67455
Qpeak-area	-0.37853	0.59708	-0.3604	0.54063	-0.14785	1	-0.02915	-0.43576	0.06998	-0.27451	0.22026	-0.40415
Q10	0.12585	0.26591	0.26664	-0.19191	0.03268	-0.02915	1	0.06088	0.16872	0.4499	0.61335	0.04948
Q90	0.96316	-0.08588	0.83841	-0.40781	0.55728	-0.43576	0.06088	1	0.30626	0.70592	0.05532	0.95095
Q90-area	0.24499	0.66848	0.17766	-0.49233	-0.00775	0.06998	0.16872	0.30626	1	0.44614	0.56038	0.17636
Q50	0.70438	0.21759	0.66587	-0.37228	0.30773	-0.27451	0.4499	0.70592	0.44614	1	0.5255	0.62711
Q50-area	0.08676	0.72832	0.11177	-0.23556	-0.09044	0.22026	0.61335	0.05532	0.56038	0.5255	1	-0.01204
Qmean+	0.98447	-0.12214	0.92391	-0.24334	0.67455	-0.40415	0.04948	0.95095	0.17636	0.62711	-0.01204	1
Qmean+-area	-0.2415	0.77909	-0.2656	0.23431	-0.2607	0.61137	-0.0235	-0.28774	0.43989	-0.06266	0.28951	-0.25338
Qgeomean	0.8819	-0.03066	0.79141	-0.35605	0.58529	-0.42792	0.36671	0.87055	0.30899	0.84985	0.27063	0.86893
Qmean(ln)	0.74069	-0.00183	0.58343	-0.41925	0.29188	-0.37752	-0.0625	0.83272	0.36153	0.70348	0.11312	0.74614
Qmean(ln)area	0.17795	0.31374	0.12106	-0.23054	-0.07329	0.01989	-0.12782	0.24713	0.48636	0.35671	0.14542	0.19482
SD(ln)	0.29962	-0.28861	0.29689	-0.2368	0.1149	-0.29005	-0.35021	0.3908	0.01718	0.13417	-0.42175	0.3677
COV(ln)	0.13413	-0.12917	0.14957	-0.05902	0.029	-0.0881	-0.25281	0.18869	-0.04239	0.046	-0.29199	0.20123
BFR	0.39823	-0.40732	0.34093	-0.71737	0.20401	-0.60313	-0.00604	0.55292	0.32333	0.35041	-0.05074	0.39068
Tdry	-0.42722	-0.29855	-0.45179	0.43624	-0.26355	0.10536	-0.5439	-0.42138	-0.3859	-0.51504	-0.64765	-0.33165
T3xQ50	0.53387	0.15853	0.49844	-0.21122	0.31786	-0.14481	-0.029	0.54433	0.47259	0.52914	0.02241	0.50855
TQmean	0.57828	0.28404	0.4928	-0.59262	0.21774	-0.24012	0.21577	0.65953	0.78663	0.74766	0.44564	0.51672
TQ90	0.46557	0.5805	0.29403	-0.25749	0.09317	0.00011	0.13614	0.45192	0.72683	0.56544	0.53345	0.41234
TQ0.25yr	0.70859	0.10926	0.62376	-0.39609	0.27144	-0.2557	0.01635	0.7554	0.44149	0.72722	0.19059	0.66329
TQ0.5yr	0.70604	0.10851	0.65919	-0.2759	0.31773	-0.21713	0.02027	0.69066	0.32375	0.53617	0.10419	0.66859
TQ0.75yr	0.78869	0.10574	0.70993	-0.23251	0.40118	-0.20168	0.0352	0.7506	0.29732	0.53711	0.09332	0.755
TQ1yr	0.81742	0.09548	0.76292	-0.21505	0.4548	-0.19598	0.04981	0.77162	0.29822	0.54053	0.08445	0.78411
mean+	0.28168	-0.07529	0.22876	0.24767	0.36764	-0.01992	0.17153	0.16901	-0.17319	0.13184	-0.12314	0.33011
mean+-area	-0.35722	0.3439	-0.3187	0.44127	-0.224	0.48952	-0.10978	-0.41463	-0.08407	-0.29606	-0.05863	-0.32528
mean-	0.65879	-0.05025	0.64106	0.12076	0.65359	-0.16832	0.25609	0.53698	-0.00342	0.48703	0.03602	0.68277
mean--area	-0.48483	0.5656	-0.48025	0.54531	-0.34574	0.68542	-0.14096	-0.53912	0.0193	-0.3666	0.0839	-0.49345
FHn	-0.34175	0.57782	-0.32823	0.44774	-0.22137	0.679	0.20802	-0.42592	-0.01867	-0.15887	0.39735	-0.39069
FHd	0.29955	-0.30622	0.23156	-0.46447	0.05905	-0.4363	-0.16239	0.39859	0.1381	0.18484	-0.18005	0.35372
FLn	-0.349	0.07122	-0.33246	0.4855	-0.29246	0.35738	-0.35574	-0.37866	-0.18739	-0.34154	-0.35035	-0.34095
FLd	-0.05135	-0.35705	-0.12712	0.00226	0.05519	-0.22136	-0.21605	-0.02788	-0.18355	-0.16945	-0.30542	0.03685

Appendix A – Correlations of hydrologic parameters (cont.)

Sub-Daily Flows grouping by Impervious Cover Period (cont.)

	Qmean+-area	Qgeomean	Qmean(ln)	Qmean(ln)area	SD(ln)	COV(ln)	BFR	Tdry	T3xQ50	TQmean	TQ90	TQ0.25yr
Qmean	-0.2415	0.8819	0.74069	0.17795	0.29962	0.13413	0.39823	-0.42722	0.53387	0.57828	0.46557	0.70859
Qmean-area	0.77909	-0.03066	-0.00183	0.31374	-0.28861	-0.12917	-0.40732	-0.29855	0.15853	0.28404	0.5805	0.10926
SD	-0.2656	0.79141	0.58343	0.12106	0.29689	0.14957	0.34093	-0.45179	0.49844	0.4928	0.29403	0.62376
COV	0.23431	-0.35605	-0.41925	-0.23054	-0.2368	-0.05902	-0.71737	0.43624	-0.21122	-0.59262	-0.25749	-0.39609
Qpeak	-0.2607	0.58529	0.29188	-0.07329	0.1149	0.029	0.20401	-0.26355	0.31786	0.21774	0.09317	0.27144
Qpeak-area	0.61137	-0.42792	-0.37752	0.01989	-0.29005	-0.0881	-0.60313	0.10536	-0.14481	-0.24012	0.00011	-0.2557
Q10	-0.0235	0.36671	-0.0625	-0.12782	-0.35021	-0.25281	-0.00604	-0.5439	-0.029	0.21577	0.13614	0.01635
Q90	-0.28774	0.87055	0.83272	0.24713	0.3908	0.18869	0.55292	-0.42138	0.54433	0.65953	0.45192	0.7554
Q90-area	0.43989	0.30899	0.36153	0.48636	0.01718	-0.04239	0.32333	-0.3859	0.47259	0.78663	0.72683	0.44149
Q50	-0.06266	0.84985	0.70348	0.35671	0.13417	0.046	0.35041	-0.51504	0.52914	0.74766	0.56544	0.72722
Q50-area	0.28951	0.27063	0.11312	0.14542	-0.42175	-0.29199	-0.05074	-0.64765	0.02241	0.44564	0.53345	0.19059
Qmean+	-0.25338	0.86893	0.74614	0.19482	0.3677	0.20123	0.39068	-0.33165	0.50855	0.51672	0.41234	0.66329
Qmean+-area	1	-0.25387	-0.12128	0.52736	0.02527	0.23002	-0.60345	0.25916	0.173	0.03774	0.40077	-0.08528
Qgeomean	-0.25387	1	0.72802	0.20882	0.18107	0.03782	0.47697	-0.46212	0.48009	0.66641	0.44844	0.65843
Qmean(ln)	-0.12128	0.72802	1	0.59154	0.55013	0.3999	0.47524	-0.23969	0.51022	0.68048	0.50772	0.78978
Qmean(ln)area	0.52736	0.20882	0.59154	1	0.64446	0.70976	0.04949	0.13934	0.42719	0.50486	0.53948	0.43245
SD(ln)	0.02527	0.18107	0.55013	0.64446	1	0.90969	0.26117	0.25266	0.48555	0.27078	0.0824	0.35399
COV(ln)	0.23002	0.03782	0.3999	0.70976	0.90969	1	0.00499	0.28145	0.30366	0.11599	0.07997	0.19543
BFR	-0.60345	0.47697	0.47524	0.04949	0.26117	0.00499	1	-0.30377	0.3175	0.64218	0.13971	0.48637
Tdry	0.25916	-0.46212	-0.23969	0.13934	0.25266	0.28145	-0.30377	1	-0.03207	-0.45803	-0.25011	-0.33533
T3xQ50	0.173	0.48009	0.51022	0.42719	0.48555	0.30366	0.3175	-0.03207	1	0.67389	0.5146	0.62382
TQmean	0.03774	0.66641	0.68048	0.50486	0.27078	0.11599	0.64218	-0.45803	0.67389	1	0.7102	0.75454
TQ90	0.40077	0.44844	0.50772	0.53948	0.0824	0.07997	0.13971	-0.25011	0.5146	0.7102	1	0.58637
TQ0.25yr	-0.08528	0.65843	0.78978	0.43245	0.35399	0.19543	0.48637	-0.33533	0.62382	0.75454	0.58637	1
TQ0.5yr	-0.06346	0.55696	0.61743	0.27184	0.28203	0.15067	0.34482	-0.30646	0.51075	0.54496	0.50009	0.84944
TQ0.75yr	-0.06654	0.61261	0.60431	0.21756	0.25478	0.12471	0.31596	-0.31905	0.51274	0.52365	0.50246	0.80448
TQ1yr	-0.08093	0.63266	0.62176	0.22831	0.27349	0.14365	0.31864	-0.34503	0.5469	0.55033	0.51028	0.81418
mean+	0.16051	0.24726	0.14121	0.35427	0.39077	0.54249	-0.28952	0.04723	0.13192	-0.0608	0.03834	0.03221
mean+-area	0.72011	-0.41645	-0.26356	0.43875	0.22556	0.51128	-0.67283	0.41704	-0.07745	-0.33212	-0.01127	-0.31387
mean-	-0.03681	0.6355	0.44783	0.26351	0.33778	0.35201	-0.05225	-0.23295	0.37729	0.26036	0.25031	0.36852
mean--area	0.77334	-0.55203	-0.404	0.13424	-0.18734	0.04926	-0.75207	0.38829	-0.16301	-0.37987	-0.01264	-0.37228
FHn	0.47225	-0.34603	-0.38398	-0.12993	-0.47949	-0.27346	-0.68949	-0.03793	-0.3133	-0.36397	0.03426	-0.40594
FHd	-0.26336	0.36398	0.51716	0.27357	0.37313	0.21665	0.56007	0.05654	0.25087	0.41807	0.16762	0.50266
FLn	0.39183	-0.47166	-0.28267	0.04294	0.05692	0.08382	-0.56239	0.65393	0.10254	-0.35212	-0.12752	-0.31478
FLd	-0.11307	0.08804	0.02497	0.01166	0.03685	0.01481	0.13523	0.37631	-0.12621	-0.08602	-0.086	-0.05604

Appendix A – Correlations of hydrologic parameters (cont.)

Sub-Daily Flows grouping by Impervious Cover Period (cont.)

	TQ0.5yr	TQ0.75yr	TQ1yr	mean+	mean+-area	mean-	mean--area	FHn	FHd	FLn	FLd
Qmean	0.70604	0.78869	0.81742	0.28168	-0.35722	0.65879	-0.48483	-0.34175	0.29955	-0.349	-0.05135
Qmean-area	0.10851	0.10574	0.09548	-0.07529	0.3439	-0.05025	0.5656	0.57782	-0.30622	0.07122	-0.35705
SD	0.65919	0.70993	0.76292	0.22876	-0.3187	0.64106	-0.48025	-0.32823	0.23156	-0.33246	-0.12712
COV	-0.2759	-0.23251	-0.21505	0.24767	0.44127	0.12076	0.54531	0.44774	-0.46447	0.4855	0.00226
Qpeak	0.31773	0.40118	0.4548	0.36764	-0.224	0.65359	-0.34574	-0.22137	0.05905	-0.29246	0.05519
Qpeak-area	-0.21713	-0.20168	-0.19598	-0.01992	0.48952	-0.16832	0.68542	0.679	-0.4363	0.35738	-0.22136
Q10	0.02027	0.0352	0.04981	0.17153	-0.10978	0.25609	-0.14096	0.20802	-0.16239	-0.35574	-0.21605
Q90	0.69066	0.7506	0.77162	0.16901	-0.41463	0.53698	-0.53912	-0.42592	0.39859	-0.37866	-0.02788
Q90-area	0.32375	0.29732	0.29822	-0.17319	-0.08407	-0.00342	0.0193	-0.01867	0.1381	-0.18739	-0.18355
Q50	0.53617	0.53711	0.54053	0.13184	-0.29606	0.48703	-0.3666	-0.15887	0.18484	-0.34154	-0.16945
Q50-area	0.10419	0.09332	0.08445	-0.12314	-0.05863	0.03602	0.0839	0.39735	-0.18005	-0.35035	-0.30542
Qmean+	0.66859	0.755	0.78411	0.33011	-0.32528	0.68277	-0.49345	-0.39069	0.35372	-0.34095	0.03685
Qmean+-area	-0.06346	-0.06654	-0.08093	0.16051	0.72011	-0.03681	0.77334	0.47225	-0.26336	0.39183	-0.11307
Qgeomean	0.55696	0.61261	0.63266	0.24726	-0.41645	0.6355	-0.55203	-0.34603	0.36398	-0.47166	0.08804
Qmean(ln)	0.61743	0.60431	0.62176	0.14121	-0.26356	0.44783	-0.404	-0.38398	0.51716	-0.28267	0.02497
Qmean(ln)area	0.27184	0.21756	0.22831	0.35427	0.43875	0.26351	0.13424	-0.12993	0.27357	0.04294	0.01166
SD(ln)	0.28203	0.25478	0.27349	0.39077	0.22556	0.33778	-0.18734	-0.47949	0.37313	0.05692	0.03685
COV(ln)	0.15067	0.12471	0.14365	0.54249	0.51128	0.35201	0.04926	-0.27346	0.21665	0.08382	0.01481
BFR	0.34482	0.31596	0.31864	-0.28952	-0.67283	-0.05225	-0.75207	-0.68949	0.56007	-0.56239	0.13523
Tdry	-0.30646	-0.31905	-0.34503	0.04723	0.41704	-0.23295	0.38829	-0.03793	0.05654	0.65393	0.37631
T3xQ50	0.51075	0.51274	0.5469	0.13192	-0.07745	0.37729	-0.16301	-0.3133	0.25087	0.10254	-0.12621
TQmean	0.54496	0.52365	0.55033	-0.0608	-0.33212	0.26036	-0.37987	-0.36397	0.41807	-0.35212	-0.08602
TQ90	0.50009	0.50246	0.51028	0.03834	-0.01127	0.25031	-0.01264	0.03426	0.16762	-0.12752	-0.086
TQ0.25yr	0.84944	0.80448	0.81418	0.03221	-0.31387	0.36852	-0.37228	-0.40594	0.50266	-0.31478	-0.05604
TQ0.5yr	1	0.9781	0.95771	0.09221	-0.25095	0.37521	-0.31142	-0.29067	0.34541	-0.2328	-0.07201
TQ0.75yr	0.9781	1	0.98091	0.15243	-0.24281	0.43972	-0.30602	-0.26636	0.30263	-0.23044	-0.06902
TQ1yr	0.95771	0.98091	1	0.19448	-0.24958	0.51181	-0.32286	-0.28839	0.33325	-0.24857	-0.06996
mean+	0.09221	0.15243	0.19448	1	0.55579	0.81759	0.08262	-0.12591	-0.06881	-0.06596	0.02216
mean+-area	-0.25095	-0.24281	-0.24958	0.55579	1	0.12409	0.78008	0.31286	-0.35093	0.40926	-0.1042
mean-	0.37521	0.43972	0.51181	0.81759	0.12409	1	-0.19788	-0.24009	0.11928	-0.25813	0.01381
mean--area	-0.31142	-0.30602	-0.32286	0.08262	0.78008	-0.19788	1	0.56023	-0.45819	0.58271	-0.17653
FHn	-0.29067	-0.26636	-0.28839	-0.12591	0.31286	-0.24009	0.56023	1	-0.65402	0.4017	-0.34228
FHd	0.34541	0.30263	0.33325	-0.06881	-0.35093	0.11928	-0.45819	-0.65402	1	-0.37987	0.63047
FLn	-0.2328	-0.23044	-0.24857	-0.06596	0.40926	-0.25813	0.58271	0.4017	-0.37987	1	-0.18214
FLd	-0.07201	-0.06902	-0.06996	0.02216	-0.1042	0.01381	-0.17653	-0.34228	0.63047	-0.18214	1

Appendix A – Correlations of hydrologic parameters (cont.)

Sub-Daily Flows grouping Water Year

	Qmean	Qmean-area	SD	COV	Qpeak	Qpeak-area	Q10	Q90	Q90-area	Q50	Q50-area	Qmean+
Qmean	1	0.11002	0.8689	0.34292	0.73773	-0.18294	0.22372	0.92856	0.35382	0.56403	0.07242	0.98811
Qmean-area	0.11002	1	0.13965	0.49037	0.09053	0.57934	0.29212	0.10077	0.78733	0.16967	0.7024	0.08604
SD	0.8689	0.13965	1	0.38635	0.93194	-0.0627	0.28757	0.71183	0.27558	0.3138	-0.021	0.848
COV	0.34292	0.49037	0.38635	1	0.58964	0.66602	0.09051	0.17984	0.1897	-0.08173	0.03763	0.35627
Qpeak	0.73773	0.09053	0.93194	0.58964	1	0.08977	0.2041	0.55295	0.12967	0.2006	-0.0588	0.72492
Qpeak-area	-0.18294	0.57934	-0.0627	0.66602	0.08977	1	0.02964	-0.24234	0.10622	-0.22112	0.20911	-0.18189
Q10	0.22372	0.29212	0.28757	0.09051	0.2041	0.02964	1	0.18433	0.32859	0.27242	0.34677	0.16095
Q90	0.92856	0.10077	0.71183	0.17984	0.55295	-0.24234	0.18433	1	0.46236	0.59468	0.09254	0.91342
Q90-area	0.35382	0.78733	0.27558	0.1897	0.12967	0.10622	0.32859	0.46236	1	0.41651	0.70969	0.31634
Q50	0.56403	0.16967	0.3138	-0.08173	0.2006	-0.22112	0.27242	0.59468	0.41651	1	0.55022	0.55082
Q50-area	0.07242	0.7024	-0.021	0.03763	-0.0588	0.20911	0.34677	0.09254	0.70969	0.55022	1	0.04144
Qmean+	0.98811	0.08604	0.848	0.35627	0.72492	-0.18189	0.16095	0.91342	0.31634	0.55082	0.04144	1
Qmean+-area	-0.04866	0.77418	-0.0058	0.48245	0.00391	0.54857	0.07026	-0.05978	0.52847	0.00616	0.41887	-0.00019
Qgeomean	0.71106	0.1396	0.45639	0.04237	0.36684	-0.2333	0.30588	0.71498	0.39632	0.84074	0.37975	0.73199
Qmean(ln)	0.66482	0.0982	0.47098	0.0808	0.27214	-0.21373	-0.04311	0.71825	0.36551	0.60055	0.13188	0.67285
Qmean(ln)area	0.03122	0.27746	0.01503	0.15291	-0.02542	0.11434	-0.08202	0.05816	0.25284	0.10171	0.11465	0.09922
SD(ln)	0.25171	0.01304	0.25196	0.21508	0.106	-0.04157	-0.24088	0.28972	0.09434	0.05383	-0.22394	0.30619
COV(ln)	0.07243	0.08731	0.12128	0.24656	0.02739	0.08908	-0.18181	0.0918	0.05685	-0.06778	-0.19891	0.13529
BFR	0.35707	-0.16057	0.19666	-0.49561	0.04165	-0.60422	0.11409	0.47633	0.35082	0.45614	0.22643	0.31126
Tdry	-0.38631	-0.26167	-0.35911	0.06289	-0.23171	0.08234	-0.44545	-0.37762	-0.38499	-0.3595	-0.40098	-0.29915
T3xQ50	0.59333	0.49625	0.44456	0.3028	0.31059	0.0134	0.20177	0.61121	0.69291	0.56456	0.47369	0.58421
TQmean	0.50213	0.54342	0.3185	0.10426	0.17523	-0.08884	0.29435	0.56056	0.81467	0.73525	0.75098	0.47848
TQ90	0.43873	0.68155	0.29629	0.34393	0.1811	0.07875	0.23647	0.46979	0.81011	0.45816	0.62723	0.43094
TQ0.25yr	0.65298	0.16531	0.64498	0.21805	0.36474	-0.14512	0.07552	0.75412	0.50486	0.32844	0.07488	0.62578
TQ0.5yr	0.63562	0.13556	0.69041	0.32554	0.44601	-0.0639	0.12174	0.61899	0.32088	0.14285	-0.07227	0.60258
TQ0.75yr	0.64718	0.12165	0.70665	0.38434	0.50208	-0.02592	0.08861	0.59115	0.25956	0.09652	-0.11165	0.62274
TQ1yr	0.68127	0.12953	0.75779	0.46634	0.5913	0.00562	0.10179	0.57146	0.23044	0.09469	-0.11908	0.65833
mean+	0.26034	0.11752	0.28831	0.46619	0.35419	0.21483	0.0348	0.15088	-0.02338	-0.00965	-0.13082	0.32403
mean+-area	-0.24846	0.30803	-0.15527	0.35602	-0.08679	0.452	-0.13448	-0.27448	-0.01083	-0.23354	-0.04723	-0.17565
mean-	0.64386	0.1816	0.67125	0.64163	0.75647	0.1673	0.21603	0.46496	0.13512	0.18226	-0.04505	0.66347
mean--area	-0.35667	0.56722	-0.24921	0.46508	-0.14167	0.7034	-0.14111	-0.38275	0.11936	-0.31005	0.12588	-0.31808
FHn	0.4674	0.09991	0.40335	0.06377	0.15818	-0.21566	0.023	0.50925	0.35524	0.46908	0.18819	0.46129
FHd	-0.21294	0.33114	-0.18049	0.33036	-0.08987	0.44975	0.05545	-0.2433	0.04935	-0.15068	0.13675	-0.21769
FLn	0.11281	0.02974	0.00456	-0.05669	-0.00204	-0.163	-0.1362	0.15805	0.17095	0.30156	0.27853	0.17091
FLd	-0.28967	-0.02524	-0.25772	0.16655	-0.17874	0.24617	-0.27802	-0.28766	-0.17108	-0.26091	-0.18889	-0.27198

Appendix A – Correlations of hydrologic parameters (cont.)

Sub-Daily Flows grouping Water Year (cont.)

	Qmean+-area	Qgeomean	Qmean(ln)	Qmean(ln)area	SD(ln)	COV(ln)	BFR	Tdry	T3xQ50	TQmean	TQ90	TQ0.25yr
Qmean	-0.04866	0.71106	0.66482	0.03122	0.25171	0.07243	0.35707	-0.38631	0.59333	0.50213	0.43873	0.65298
Qmean-area	0.77418	0.1396	0.0982	0.27746	0.01304	0.08731	-0.16057	-0.26167	0.49625	0.54342	0.68155	0.16531
SD	-0.0058	0.45639	0.47098	0.01503	0.25196	0.12128	0.19666	-0.35911	0.44456	0.3185	0.29629	0.64498
COV	0.48245	0.04237	0.0808	0.15291	0.21508	0.24656	-0.49561	0.06289	0.3028	0.10426	0.34393	0.21805
Qpeak	0.00391	0.36684	0.27214	-0.02542	0.106	0.02739	0.04165	-0.23171	0.31059	0.17523	0.1811	0.36474
Qpeak-area	0.54857	-0.2333	-0.21373	0.11434	-0.04157	0.08908	-0.60422	0.08234	0.0134	-0.08884	0.07875	-0.14512
Q10	0.07026	0.30588	-0.04311	-0.08202	-0.24088	-0.18181	0.11409	-0.44545	0.20177	0.29435	0.23647	0.07552
Q90	-0.05978	0.71498	0.71825	0.05816	0.28972	0.0918	0.47633	-0.37762	0.61121	0.56056	0.46979	0.75412
Q90-area	0.52847	0.39632	0.36551	0.25284	0.09434	0.05685	0.35082	-0.38499	0.69291	0.81467	0.81011	0.50486
Q50	0.00616	0.84074	0.60055	0.10171	0.05383	-0.06778	0.45614	-0.3595	0.56456	0.73525	0.45816	0.32844
Q50-area	0.41887	0.37975	0.13188	0.11465	-0.22394	-0.19891	0.22643	-0.40098	0.47369	0.75098	0.62723	0.07488
Qmean+	-0.00019	0.73199	0.67285	0.09922	0.30619	0.13529	0.31126	-0.29915	0.58421	0.47848	0.43094	0.62578
Qmean+-area	1	0.00233	0.0958	0.66602	0.34408	0.43577	-0.40999	0.22375	0.34986	0.32801	0.52058	0.03272
Qgeomean	0.00233	1	0.52293	0.03443	-0.0113	-0.10049	0.41764	-0.33925	0.59642	0.66006	0.4772	0.40473
Qmean(ln)	0.0958	0.52293	1	0.45265	0.60293	0.46172	0.36108	-0.16811	0.52522	0.54804	0.43603	0.57923
Qmean(ln)area	0.66602	0.03443	0.45265	1	0.65955	0.78565	-0.13692	0.25587	0.20976	0.22437	0.27738	0.0941
SD(ln)	0.34408	-0.0113	0.60293	0.65955	1	0.88285	-0.02813	0.32662	0.2768	0.13239	0.16784	0.3306
COV(ln)	0.43577	-0.10049	0.46172	0.78565	0.88285	1	-0.15747	0.33354	0.14123	0.02159	0.11107	0.17743
BFR	-0.40999	0.41764	0.36108	-0.13692	-0.02813	-0.15747	1	-0.49658	0.34872	0.48862	0.18994	0.41268
Tdry	0.22375	-0.33925	-0.16811	0.25587	0.32662	0.33354	-0.49658	1	-0.27431	-0.39062	-0.24771	-0.27383
T3xQ50	0.34986	0.59642	0.52522	0.20976	0.2768	0.14123	0.34872	-0.27431	1	0.82108	0.79192	0.53412
TQmean	0.32801	0.66006	0.54804	0.22437	0.13239	0.02159	0.48862	-0.39062	0.82108	1	0.85587	0.46824
TQ90	0.52058	0.4772	0.43603	0.27738	0.16784	0.11107	0.18994	-0.24771	0.79192	0.85587	1	0.41911
TQ0.25yr	0.03272	0.40473	0.57923	0.0941	0.3306	0.17743	0.41268	-0.27383	0.53412	0.46824	0.41911	1
TQ0.5yr	0.01406	0.26297	0.37472	0.01383	0.23964	0.10771	0.26956	-0.25883	0.36637	0.26536	0.25322	0.77766
TQ0.75yr	0.01034	0.23227	0.33473	-0.0061	0.22612	0.10179	0.21092	-0.23317	0.30789	0.19923	0.19732	0.70268
TQ1yr	0.01565	0.24375	0.36627	0.00222	0.23143	0.1203	0.17643	-0.2376	0.32493	0.1943	0.20272	0.6729
mean+	0.4396	0.09179	0.25305	0.62543	0.53615	0.64674	-0.32746	0.17599	0.19452	0.01669	0.13547	0.07135
mean+-area	0.71741	-0.24595	-0.02058	0.73514	0.47227	0.66822	-0.53904	0.45123	0.00727	-0.12399	0.04597	-0.20936
mean-	0.24224	0.34374	0.39044	0.25989	0.38412	0.35213	-0.15885	-0.12615	0.38391	0.20806	0.28315	0.33455
mean--area	0.75641	-0.34208	-0.21271	0.37845	0.17599	0.30525	-0.68203	0.3873	0.01176	-0.10769	0.11986	-0.27264
FHn	0.02062	0.48039	0.52703	0.10056	0.22065	0.10901	0.43427	-0.18614	0.59595	0.60906	0.54908	0.55783
FHd	0.25627	-0.181	-0.21398	-0.02933	-0.18551	-0.10079	-0.47997	0.03838	-0.07083	-0.09747	0.06893	-0.26238
FLn	0.08152	0.50273	0.06862	0.02937	-0.0957	-0.05223	0.21547	0.0973	0.26256	0.33748	0.26219	0.33003
FLd	0.10602	-0.30212	-0.18641	0.02172	0.03644	0.05497	-0.40962	0.4521	-0.10502	-0.24229	-0.11563	-0.24676

Appendix A – Correlations of hydrologic parameters (cont.)

Sub-Daily Flows grouping by Water Year (cont.)

	TQ0.5yr	TQ0.75yr	TQ1yr	mean+	mean+-area	mean-	mean--area	FHn	FHd	FLn	FLd
Qmean	0.63562	0.64718	0.68127	0.26034	-0.24846	0.64386	-0.35667	0.4674	-0.21294	0.11281	-0.28967
Qmean-area	0.13556	0.12165	0.12953	0.11752	0.30803	0.1816	0.56722	0.09991	0.33114	0.02974	-0.02524
SD	0.69041	0.70665	0.75779	0.28831	-0.15527	0.67125	-0.24921	0.40335	-0.18049	0.00456	-0.25772
COV	0.32554	0.38434	0.46634	0.46619	0.35602	0.64163	0.46508	0.06377	0.33036	-0.05669	0.16655
Qpeak	0.44601	0.50208	0.5913	0.35419	-0.08679	0.75647	-0.14167	0.15818	-0.08987	-0.00204	-0.17874
Qpeak-area	-0.0639	-0.02592	0.00562	0.21483	0.452	0.1673	0.7034	-0.21566	0.44975	-0.163	0.24617
Q10	0.12174	0.08861	0.10179	0.0348	-0.13448	0.21603	-0.14111	0.023	0.05545	-0.1362	-0.27802
Q90	0.61899	0.59115	0.57146	0.15088	-0.27448	0.46496	-0.38275	0.50925	-0.2433	0.15805	-0.28766
Q90-area	0.32088	0.25956	0.23044	-0.02338	-0.01083	0.13512	0.11936	0.35524	0.04935	0.17095	-0.17108
Q50	0.14285	0.09652	0.09469	-0.00965	-0.23354	0.18226	-0.31005	0.46908	-0.15068	0.30156	-0.26091
Q50-area	-0.07227	-0.11165	-0.11908	-0.13082	-0.04723	-0.04505	0.12588	0.18819	0.13675	0.27853	-0.18889
Qmean+	0.60258	0.62274	0.65833	0.32403	-0.17565	0.66347	-0.31808	0.46129	-0.21769	0.17091	-0.27198
Qmean+-area	0.01406	0.01034	0.01565	0.4396	0.71741	0.24224	0.75641	0.02062	0.25627	0.08152	0.10602
Qgeomean	0.26297	0.23227	0.24375	0.09179	-0.24595	0.34374	-0.34208	0.48039	-0.181	0.50273	-0.30212
Qmean(ln)	0.37472	0.33473	0.36627	0.25305	-0.02058	0.39044	-0.21271	0.52703	-0.21398	0.06862	-0.18641
Qmean(ln)area	0.01383	-0.0061	0.00222	0.62543	0.73514	0.25989	0.37845	0.10056	-0.02933	0.02937	0.02172
SD(ln)	0.23964	0.22612	0.23143	0.53615	0.47227	0.38412	0.17599	0.22065	-0.18551	-0.0957	0.03644
COV(ln)	0.10771	0.10179	0.1203	0.64674	0.66822	0.35213	0.30525	0.10901	-0.10079	-0.05223	0.05497
BFR	0.26956	0.21092	0.17643	-0.32746	-0.53904	-0.15885	-0.68203	0.43427	-0.47997	0.21547	-0.40962
Tdry	-0.25883	-0.23317	-0.2376	0.17599	0.45123	-0.12615	0.3873	-0.18614	0.03838	0.0973	0.4521
T3xQ50	0.36637	0.30789	0.32493	0.19452	0.00727	0.38391	0.01176	0.59595	-0.07083	0.26256	-0.10502
TQmean	0.26536	0.19923	0.1943	0.01669	-0.12399	0.20806	-0.10769	0.60906	-0.09747	0.33748	-0.24229
TQ90	0.25322	0.19732	0.20272	0.13547	0.04597	0.28315	0.11986	0.54908	0.06893	0.26219	-0.11563
TQ0.25yr	0.77766	0.70268	0.6729	0.07135	-0.20936	0.33455	-0.27264	0.55783	-0.26238	0.33003	-0.24676
TQ0.5yr	1	0.95855	0.92859	0.11702	-0.16251	0.37399	-0.21726	0.39131	-0.19383	0.09322	-0.19714
TQ0.75yr	0.95855	1	0.9657	0.15825	-0.14118	0.42216	-0.191	0.35655	-0.16169	0.00668	-0.17638
TQ1yr	0.92859	0.9657	1	0.20457	-0.13533	0.52434	-0.18211	0.35975	-0.15253	-0.0058	-0.18657
mean+	0.11702	0.15825	0.20457	1	0.74306	0.76636	0.37482	0.02774	-0.07933	-0.01361	-0.05516
mean+-area	-0.16251	-0.14118	-0.13533	0.74306	1	0.27897	0.785	-0.17455	0.1195	-0.05668	0.1809
mean-	0.37399	0.42216	0.52434	0.76636	0.27897	1	0.12019	0.19691	-0.10635	0.00892	-0.19416
mean--area	-0.21726	-0.191	-0.18211	0.37482	0.785	0.12019	1	-0.24322	0.34136	-0.1078	0.31251
FHn	0.39131	0.35655	0.35975	0.02774	-0.17455	0.19691	-0.24322	1	-0.32867	0.29219	-0.23917
FHd	-0.19383	-0.16169	-0.15253	-0.07933	0.1195	-0.10635	0.34136	-0.32867	1	-0.20057	0.62611
FLn	0.09322	0.00668	-0.0058	-0.01361	-0.05668	0.00892	-0.1078	0.29219	-0.20057	1	-0.21919
FLd	-0.19714	-0.17638	-0.18657	-0.05516	0.1809	-0.19416	0.31251	-0.23917	0.62611	-0.21919	1

Appendix A – Correlations of hydrologic parameters (cont.)

Daily Flows grouping by Impervious Cover Period

	Qmean	Qmean-area	SD	COV	Qpeak	Qpeak-area	Q10	Q90	Q90-area	Q50	Q50-area	Qmean+
Qmean	1	-0.03338	0.91682	0.11645	0.8211	0.03521	0.13173	0.97075	0.12015	0.70752	0.06268	0.98523
Qmean-area	-0.03338	1	-0.12103	-0.26397	-0.18095	0.67296	0.28907	-0.0697	0.83256	0.23343	0.76222	-0.11093
SD	0.91682	-0.12103	1	0.4104	0.96835	0.0967	0.04996	0.82797	-0.03719	0.47447	-0.07631	0.92923
COV	0.11645	-0.26397	0.4104	1	0.53251	0.28705	-0.17909	-0.02985	-0.47095	-0.17443	-0.40678	0.1776
Qpeak	0.8211	-0.18095	0.96835	0.53251	1	0.11284	0.02638	0.7265	-0.10183	0.39201	-0.11945	0.84646
Qpeak-area	0.03521	0.67296	0.0967	0.28705	0.11284	1	0.22071	-0.05441	0.44298	0.09885	0.369	-0.00395
Q10	0.13173	0.28907	0.04996	-0.17909	0.02638	0.22071	1	0.07977	0.19523	0.46307	0.6066	0.05766
Q90	0.97075	-0.0697	0.82797	-0.02985	0.7265	-0.05441	0.07977	1	0.15668	0.71571	0.0402	0.95987
Q90-area	0.12015	0.83256	-0.03719	-0.47095	-0.10183	0.44298	0.19523	0.15668	1	0.35959	0.65707	0.04958
Q50	0.70752	0.23343	0.47447	-0.17443	0.39201	0.09885	0.46307	0.71571	0.35959	1	0.49885	0.63157
Q50-area	0.06268	0.76222	-0.07631	-0.40678	-0.11945	0.369	0.6066	0.0402	0.65707	0.49885	1	-0.03156
Qmean+	0.98523	-0.11093	0.92923	0.1776	0.84646	-0.00395	0.05766	0.95987	0.04958	0.63157	-0.03156	1
Qmean+-area	-0.2185	0.81085	-0.24494	-0.09765	-0.28842	0.58037	0.01226	-0.25809	0.64574	-0.03237	0.37527	-0.23589
Qgeomean	0.87201	-0.00236	0.74488	0.02358	0.68651	0.02436	0.39932	0.86675	0.17511	0.85467	0.25966	0.86022
Qmean(ln)	0.77502	-0.01066	0.56427	-0.13225	0.4613	-0.10382	-0.07592	0.84484	0.20742	0.67885	0.05214	0.78702
Qmean(ln)area	0.06118	0.31116	-0.05825	-0.10947	-0.10775	0.19829	-0.15615	0.09519	0.37072	0.18363	0.04767	0.08934
SD(ln)	0.29458	-0.27003	0.19868	0.03571	0.15443	-0.13105	-0.38604	0.36335	-0.09816	0.09328	-0.4736	0.36023
COV(ln)	0.13208	-0.11318	0.06931	0.06905	0.03737	0.02056	-0.26324	0.1696	-0.0771	0.01775	-0.3253	0.19346
BFR	0.16251	-0.18422	-0.00652	-0.56915	-0.01124	-0.34858	0.10372	0.32067	0.33125	0.3072	0.15942	0.12112
Tdry	-0.41505	-0.31672	-0.30789	0.31756	-0.27907	-0.1708	-0.55638	-0.41502	-0.35851	-0.52395	-0.63903	-0.31914
T3xQ50	0.49742	0.23305	0.38061	0.04411	0.31617	0.20113	0.05379	0.48917	0.35422	0.53591	0.07247	0.46593
TQmean	0.56615	0.41441	0.32498	-0.42216	0.2335	0.15434	0.31172	0.62338	0.68825	0.78488	0.55555	0.49553
TQ90	0.57232	0.59597	0.39829	-0.1958	0.27148	0.31083	0.21936	0.55283	0.6485	0.65154	0.5651	0.51721
mean+	0.93803	-0.09059	0.97064	0.36865	0.91556	0.09704	0.11527	0.85155	-0.02254	0.55439	-0.03328	0.95307
mean+-area	-0.27691	0.65498	-0.23859	0.17077	-0.26252	0.62726	0.04962	-0.35929	0.3204	-0.13428	0.22192	-0.28428
mean-	0.88947	-0.11686	0.9627	0.44378	0.9302	0.12383	0.11089	0.78986	-0.07889	0.47962	-0.07856	0.9162
mean--area	-0.41874	0.6172	-0.34595	0.14289	-0.35029	0.56384	-0.06307	-0.48733	0.24462	-0.30793	0.15563	-0.42723
FHn	-0.28137	0.5815	-0.18349	0.18662	-0.15734	0.63058	0.2753	-0.39044	0.17054	-0.14863	0.36934	-0.30681
FHd	0.05753	-0.40178	-0.01159	-0.21794	-0.02694	-0.4082	-0.19779	0.16464	-0.13298	-0.04172	-0.32056	0.11224
FLn	-0.31424	0.09379	-0.22329	0.30205	-0.21909	0.21768	-0.3773	-0.36497	-0.07931	-0.36586	-0.38062	-0.2807
FLd	-0.03092	-0.43067	-0.04481	-0.06673	-0.02254	-0.39661	-0.25969	0.08481	-0.20049	-0.18849	-0.35383	0.08496

Appendix A – Correlations of hydrologic parameters (cont.)

Daily Flows grouping by Impervious Cover Period (cont.)

	Qmean+-area	Qgeomean	Qmean(ln)	Qmean(ln)area	SD(ln)	COV(ln)	BFR	Tdry	T3xQ50	TQmean	TQ90	mean+
Qmean	-0.2185	0.87201	0.77502	0.06118	0.29458	0.13208	0.16251	-0.41505	0.49742	0.56615	0.57232	0.93803
Qmean-area	0.81085	-0.00236	-0.01066	0.31116	-0.27003	-0.11318	-0.18422	-0.31672	0.23305	0.41441	0.59597	-0.09059
SD	-0.24494	0.74488	0.56427	-0.05825	0.19868	0.06931	-0.00652	-0.30789	0.38061	0.32498	0.39829	0.97064
COV	-0.09765	0.02358	-0.13225	-0.10947	0.03571	0.06905	-0.56915	0.31756	0.04411	-0.42216	-0.1958	0.36865
Qpeak	-0.28842	0.68651	0.4613	-0.10775	0.15443	0.03737	-0.01124	-0.27907	0.31617	0.2335	0.27148	0.91556
Qpeak-area	0.58037	0.02436	-0.10382	0.19829	-0.13105	0.02056	-0.34858	-0.1708	0.20113	0.15434	0.31083	0.09704
Q10	0.01226	0.39932	-0.07592	-0.15615	-0.38604	-0.26324	0.10372	-0.55638	0.05379	0.31172	0.21936	0.11527
Q90	-0.25809	0.86675	0.84484	0.09519	0.36335	0.1696	0.32067	-0.41502	0.48917	0.62338	0.55283	0.85155
Q90-area	0.64574	0.17511	0.20742	0.37072	-0.09816	-0.0771	0.33125	-0.35851	0.35422	0.68825	0.6485	-0.02254
Q50	-0.03237	0.85467	0.67885	0.18363	0.09328	0.01775	0.3072	-0.52395	0.53591	0.78488	0.65154	0.55439
Q50-area	0.37527	0.25966	0.05214	0.04767	-0.4736	-0.3253	0.15942	-0.63903	0.07247	0.55555	0.5651	-0.03328
Qmean+	-0.23589	0.86022	0.78702	0.08934	0.36023	0.19346	0.12112	-0.31914	0.46593	0.49553	0.51721	0.95307
Qmean+-area	1	-0.20796	-0.08918	0.63152	0.04565	0.23831	-0.52274	0.20588	0.26048	0.15797	0.4083	-0.18841
Qgeomean	-0.20796	1	0.71402	0.06022	0.13882	0.0162	0.3007	-0.45448	0.451	0.66677	0.56015	0.79968
Qmean(ln)	-0.08918	0.71402	1	0.42454	0.56813	0.42515	0.28195	-0.20337	0.482	0.61874	0.56043	0.63463
Qmean(ln)area	0.63152	0.06022	0.42454	1	0.66566	0.81171	-0.1779	0.2739	0.38285	0.29807	0.36496	0.03901
SD(ln)	0.04565	0.13882	0.56813	0.66566	1	0.90195	-0.02617	0.31204	0.45484	0.13068	0.03848	0.26597
COV(ln)	0.23831	0.0162	0.42515	0.81171	0.90195	1	-0.18843	0.31565	0.321	0.03384	0.04329	0.14799
BFR	-0.52274	0.3007	0.28195	-0.1779	-0.02617	-0.18843	1	-0.4251	0.07492	0.55707	0.02546	-0.07882
Tdry	0.20588	-0.45448	-0.20337	0.2739	0.31204	0.31565	-0.4251	1	-0.02622	-0.50963	-0.33558	-0.28667
T3xQ50	0.26048	0.451	0.482	0.38285	0.45484	0.321	0.07492	-0.02622	1	0.61021	0.52062	0.42386
TQmean	0.15797	0.66677	0.61874	0.29807	0.13068	0.03384	0.55707	-0.50963	0.61021	1	0.76671	0.36289
TQ90	0.4083	0.56015	0.56043	0.36496	0.03848	0.04329	0.02546	-0.33558	0.52062	0.76671	1	0.4784
mean+	-0.18841	0.79968	0.63463	0.03901	0.26597	0.14799	-0.07882	-0.28667	0.42386	0.36289	0.4784	1
mean+-area	0.8795	-0.29069	-0.22079	0.51525	0.05974	0.28249	-0.69439	0.30086	0.22853	-0.09167	0.25317	-0.15595
mean-	-0.18426	0.75253	0.57023	0.04151	0.2738	0.17893	-0.16332	-0.25656	0.3788	0.27585	0.41592	0.98637
mean--area	0.82172	-0.47282	-0.34952	0.36863	-0.08497	0.15732	-0.68796	0.35004	-0.00132	-0.28848	0.07093	-0.31343
FHn	0.56648	-0.26787	-0.35436	0.11435	-0.30395	-0.0456	-0.63595	-0.06367	-0.15863	-0.28511	0.04853	-0.13988
FHd	-0.30875	0.09769	0.23805	-0.01094	0.29544	0.11334	0.44936	0.15424	-0.0187	0.06728	-0.23518	-0.04201
FLn	0.53301	-0.44595	-0.21704	0.43448	0.3281	0.40161	-0.65896	0.70676	0.18878	-0.37784	-0.16575	-0.18202
FLd	-0.25608	0.11286	0.20779	-0.01785	0.22434	0.0969	0.29767	0.29631	-0.18519	-0.07514	-0.2229	-0.04722

Appendix A – Correlations of hydrologic parameters (cont.)

Daily Flows grouping by Impervious Cover Period (cont.)

	mean+-area	mean-	mean--area	FHn	FHd	FLn	FLd
Qmean	-0.27691	0.88947	-0.41874	-0.28137	0.05753	-0.31424	-0.03092
Qmean-area	0.65498	-0.11686	0.6172	0.5815	-0.40178	0.09379	-0.43067
SD	-0.23859	0.9627	-0.34595	-0.18349	-0.01159	-0.22329	-0.04481
COV	0.17077	0.44378	0.14289	0.18662	-0.21794	0.30205	-0.06673
Qpeak	-0.26252	0.9302	-0.35029	-0.15734	-0.02694	-0.21909	-0.02254
Qpeak-area	0.62726	0.12383	0.56384	0.63058	-0.4082	0.21768	-0.39661
Q10	0.04962	0.11089	-0.06307	0.2753	-0.19779	-0.3773	-0.25969
Q90	-0.35929	0.78986	-0.48733	-0.39044	0.16464	-0.36497	0.08481
Q90-area	0.3204	-0.07889	0.24462	0.17054	-0.13298	-0.07931	-0.20049
Q50	-0.13428	0.47962	-0.30793	-0.14863	-0.04172	-0.36586	-0.18849
Q50-area	0.22192	-0.07856	0.15563	0.36934	-0.32056	-0.38062	-0.35383
Qmean+	-0.28428	0.9162	-0.42723	-0.30681	0.11224	-0.2807	0.08496
Qmean+-area	0.8795	-0.18426	0.82172	0.56648	-0.30875	0.53301	-0.25608
Qgeomean	-0.29069	0.75253	-0.47282	-0.26787	0.09769	-0.44595	0.11286
Qmean(ln)	-0.22079	0.57023	-0.34952	-0.35436	0.23805	-0.21704	0.20779
Qmean(ln)area	0.51525	0.04151	0.36863	0.11435	-0.01094	0.43448	-0.01785
SD(ln)	0.05974	0.2738	-0.08497	-0.30395	0.29544	0.3281	0.22434
COV(ln)	0.28249	0.17893	0.15732	-0.0456	0.11334	0.40161	0.0969
BFR	-0.69439	-0.16332	-0.68796	-0.63595	0.44936	-0.65896	0.29767
Tdry	0.30086	-0.25656	0.35004	-0.06367	0.15424	0.70676	0.29631
T3xQ50	0.22853	0.3788	-0.00132	-0.15863	-0.0187	0.18878	-0.18519
TQmean	-0.09167	0.27585	-0.28848	-0.28511	0.06728	-0.37784	-0.07514
TQ90	0.25317	0.41592	0.07093	0.04853	-0.23518	-0.16575	-0.2229
mean+	-0.15595	0.98637	-0.31343	-0.13988	-0.04201	-0.18202	-0.04722
mean+-area	1	-0.121	0.90102	0.70333	-0.47066	0.67547	-0.35981
mean-	-0.121	1	-0.27153	-0.07281	-0.07443	-0.13744	-0.05365
mean--area	0.90102	-0.27153	1	0.78155	-0.51425	0.71613	-0.38474
FHn	0.70333	-0.07281	0.78155	1	-0.68714	0.41788	-0.54982
FHd	-0.47066	-0.07443	-0.51425	-0.68714	1	-0.3289	0.71537
FLn	0.67547	-0.13744	0.71613	0.41788	-0.3289	1	-0.30035
FLd	-0.35981	-0.05365	-0.38474	-0.54982	0.71537	-0.30035	1

Appendix A – Correlations of hydrologic parameters (cont.)

Daily Flows grouping by Water Year

	Qmean	Qmean-area	SD	COV	Qpeak	Qpeak-area	Q10	Q90	Q90-area	Q50	Q50-area	Qmean+
Qmean	1	0.16235	0.89307	0.61618	0.84174	0.23367	0.22127	0.92588	0.27237	0.58114	0.07412	0.99098
Qmean-area	0.16235	1	0.11866	0.44455	0.07891	0.65071	0.33628	0.1778	0.89664	0.22397	0.70871	0.14135
SD	0.89307	0.11866	1	0.67195	0.98062	0.29423	0.14634	0.7142	0.15566	0.31184	-0.05984	0.8891
COV	0.61618	0.44455	0.67195	1	0.75233	0.75083	0.14909	0.44263	0.30658	0.08935	0.02614	0.62084
Qpeak	0.84174	0.07891	0.98062	0.75233	1	0.40448	0.13321	0.63009	0.06171	0.25746	-0.09441	0.84117
Qpeak-area	0.23367	0.65071	0.29423	0.75083	0.40448	1	0.22488	0.11197	0.3937	-0.01206	0.22006	0.21601
Q10	0.22127	0.33628	0.14634	0.14909	0.13321	0.22488	1	0.21254	0.33868	0.27464	0.34777	0.16412
Q90	0.92588	0.1778	0.7142	0.44263	0.63009	0.11197	0.21254	1	0.38903	0.62439	0.11456	0.9133
Q90-area	0.27237	0.89664	0.15566	0.30658	0.06171	0.3937	0.33868	0.38903	1	0.35687	0.70983	0.24824
Q50	0.58114	0.22397	0.31184	0.08935	0.25746	-0.01206	0.27464	0.62439	0.35687	1	0.54249	0.57024
Q50-area	0.07412	0.70871	-0.05984	0.02614	-0.09441	0.22006	0.34777	0.11456	0.70983	0.54249	1	0.04969
Qmean+	0.99098	0.14135	0.8891	0.62084	0.84117	0.21601	0.16412	0.9133	0.24824	0.57024	0.04969	1
Qmean+-area	0.01201	0.84046	-0.00206	0.39247	-0.01386	0.55184	0.12529	0.02301	0.71493	0.06852	0.48986	0.03878
Qgeomean	0.7082	0.20919	0.45594	0.24127	0.4295	0.04653	0.32953	0.72562	0.34491	0.84914	0.38949	0.7292
Qmean(ln)	0.69694	0.14495	0.55776	0.3181	0.41099	0.03558	-0.05439	0.74432	0.29495	0.5856	0.10121	0.70202
Qmean(ln)area	0.01217	0.35346	-0.00962	0.16578	-0.05002	0.1342	-0.09721	0.04527	0.34368	0.06341	0.09612	0.05646
SD(ln)	0.22646	0.02746	0.25013	0.30642	0.13916	0.07921	-0.27153	0.25394	0.07711	0.01334	-0.2579	0.26568
COV(ln)	0.04553	0.0837	0.09243	0.27744	0.02784	0.11925	-0.19357	0.06263	0.07968	-0.09614	-0.2207	0.09146
BFR	0.12318	0.01709	-0.03399	-0.36043	-0.07496	-0.29757	0.14077	0.24853	0.25925	0.47962	0.44603	0.0859
Tdry	-0.38347	-0.27709	-0.30379	-0.08225	-0.23832	-0.11443	-0.44757	-0.38316	-0.33193	-0.36887	-0.38944	-0.3118
T3xQ50	0.58066	0.53402	0.42592	0.45032	0.34156	0.26678	0.21863	0.61333	0.65289	0.57857	0.46181	0.57501
TQmean	0.49829	0.62704	0.29555	0.26932	0.19254	0.19005	0.33959	0.56713	0.75664	0.74149	0.77257	0.47932
TQ90	0.52789	0.65211	0.36146	0.45018	0.2645	0.25645	0.28079	0.57838	0.75101	0.54569	0.60447	0.52466
mean+	0.89957	0.11772	0.93843	0.70936	0.90297	0.32689	0.19028	0.72539	0.12432	0.35982	-0.05137	0.90439
mean+-area	-0.07022	0.66865	-0.00472	0.45214	0.018	0.64069	0.11455	-0.12258	0.44482	-0.12549	0.19577	-0.04434
mean-	0.89224	0.12645	0.9202	0.74424	0.911	0.35011	0.17925	0.70624	0.11353	0.34301	-0.06852	0.90746
mean--area	-0.22833	0.58926	-0.15163	0.34729	-0.10727	0.58944	-0.01419	-0.26961	0.31561	-0.24094	0.11435	-0.19303
FHn	-0.28206	0.34622	-0.20321	0.17552	-0.14793	0.35685	0.11638	-0.33783	0.07854	-0.27532	0.05527	-0.26285
FHd	0.37313	0.1863	0.21485	0.08012	0.10275	-0.06691	0.02603	0.45587	0.33919	0.55146	0.35229	0.35837
FLn	-0.33368	-0.05387	-0.25026	0.02707	-0.19444	0.07237	-0.36887	-0.35226	-0.18604	-0.35425	-0.31808	-0.27966
FLd	-0.03355	-0.14534	-0.06971	-0.15728	-0.06973	-0.29038	-0.22658	0.00875	0.00626	0.09012	0.06718	0.00138

Appendix A – Correlations of hydrologic parameters (cont.)

Daily Flows grouping by Water Year (cont.)

	Qmean+-area	Qgeomean	Qmean(ln)	Qmean(ln)area	SD(ln)	COV(ln)	BFR	Tdry	T3xQ50	TQmean	TQ90	mean+
Qmean	0.01201	0.7082	0.69694	0.01217	0.22646	0.04553	0.12318	-0.38347	0.58066	0.49829	0.52789	0.89957
Qmean-area	0.84046	0.20919	0.14495	0.35346	0.02746	0.0837	0.01709	-0.27709	0.53402	0.62704	0.65211	0.11772
SD	-0.00206	0.45594	0.55776	-0.00962	0.25013	0.09243	-0.03399	-0.30379	0.42592	0.29555	0.36146	0.93843
COV	0.39247	0.24127	0.3181	0.16578	0.30642	0.27744	-0.36043	-0.08225	0.45032	0.26932	0.45018	0.70936
Qpeak	-0.01386	0.4295	0.41099	-0.05002	0.13916	0.02784	-0.07496	-0.23832	0.34156	0.19254	0.2645	0.90297
Qpeak-area	0.55184	0.04653	0.03558	0.1342	0.07921	0.11925	-0.29757	-0.11443	0.26678	0.19005	0.25645	0.32689
Q10	0.12529	0.32953	-0.05439	-0.09721	-0.27153	-0.19357	0.14077	-0.44757	0.21863	0.33959	0.28079	0.19028
Q90	0.02301	0.72562	0.74432	0.04527	0.25394	0.06263	0.24853	-0.38316	0.61333	0.56713	0.57838	0.72539
Q90-area	0.71493	0.34491	0.29495	0.34368	0.07711	0.07968	0.25925	-0.33193	0.65289	0.75664	0.75101	0.12432
Q50	0.06852	0.84914	0.5856	0.06341	0.01334	-0.09614	0.47962	-0.36887	0.57857	0.74149	0.54569	0.35982
Q50-area	0.48986	0.38949	0.10121	0.09612	-0.2579	-0.2207	0.44603	-0.38944	0.46181	0.77257	0.60447	-0.05137
Qmean+	0.03878	0.7292	0.70202	0.05646	0.26568	0.09146	0.0859	-0.3118	0.57501	0.47932	0.52466	0.90439
Qmean+-area	1	0.08201	0.12292	0.65253	0.30399	0.36478	-0.22168	0.14776	0.45	0.44499	0.53305	0.04218
Qgeomean	0.08201	1	0.51954	0.00799	-0.04725	-0.12432	0.33572	-0.34414	0.59595	0.67299	0.5839	0.56526
Qmean(ln)	0.12292	0.51954	1	0.40723	0.56801	0.42152	0.20326	-0.16613	0.54419	0.52033	0.51009	0.53529
Qmean(ln)area	0.65253	0.00799	0.40723	1	0.63808	0.77279	-0.14276	0.27988	0.27977	0.2147	0.27359	0.02197
SD(ln)	0.30399	-0.04725	0.56801	0.63808	1	0.88396	-0.28731	0.38655	0.28665	0.07891	0.15822	0.20329
COV(ln)	0.36478	-0.12432	0.42152	0.77279	0.88396	1	-0.28938	0.3863	0.1661	-0.01466	0.08911	0.08543
BFR	-0.22168	0.33572	0.20326	-0.14276	-0.28731	-0.28938	1	-0.51866	0.1974	0.41833	0.13748	-0.10362
Tdry	0.14776	-0.34414	-0.16613	0.27988	0.38655	0.3863	-0.51866	1	-0.24809	-0.40019	-0.28289	-0.23881
T3xQ50	0.45	0.59595	0.54419	0.27977	0.28665	0.1661	0.1974	-0.24809	1	0.81738	0.81373	0.45163
TQmean	0.44499	0.67299	0.52033	0.2147	0.07891	-0.01466	0.41833	-0.40019	0.81738	1	0.88103	0.29689
TQ90	0.53305	0.5839	0.51009	0.27359	0.15822	0.08911	0.13748	-0.28289	0.81373	0.88103	1	0.41772
mean+	0.04218	0.56526	0.53529	0.02197	0.20329	0.08543	-0.10362	-0.23881	0.45163	0.29689	0.41772	1
mean+-area	0.85446	-0.07453	-0.01836	0.54533	0.30772	0.41734	-0.49809	0.27783	0.26588	0.14786	0.29782	0.08936
mean-	0.07817	0.55151	0.53787	0.07057	0.25206	0.13931	-0.17404	-0.21559	0.43898	0.27357	0.41348	0.96448
mean--area	0.82774	-0.22366	-0.1058	0.55353	0.28838	0.40403	-0.56495	0.37149	0.09382	-0.01929	0.15339	-0.07452
FHn	0.42895	-0.23842	-0.28508	0.18805	-0.01939	0.10496	-0.59852	0.141	-0.11057	-0.1654	0.02002	-0.10251
FHd	0.09795	0.43162	0.52377	0.12918	0.17338	0.08055	0.40323	-0.2089	0.52785	0.60616	0.47141	0.13123
FLn	0.34099	-0.36513	-0.12188	0.43127	0.40252	0.40526	-0.59752	0.78401	-0.12357	-0.31461	-0.17959	-0.18437
FLd	-0.11451	0.22782	-0.06308	-0.12086	-0.15325	-0.09447	0.25702	0.20136	0.04717	0.02503	-0.00681	-0.06552

Appendix A – Correlations of hydrologic parameters (cont.)

Daily Flows grouping by Water Year (cont.)

	mean+-area	mean-	mean--area	FHn	FHd	FLn	FLd
Qmean	-0.07022	0.89224	-0.22833	-0.28206	0.37313	-0.33368	-0.03355
Qmean-area	0.66865	0.12645	0.58926	0.34622	0.1863	-0.05387	-0.14534
SD	-0.00472	0.9202	-0.15163	-0.20321	0.21485	-0.25026	-0.06971
COV	0.45214	0.74424	0.34729	0.17552	0.08012	0.02707	-0.15728
Qpeak	0.018	0.911	-0.10727	-0.14793	0.10275	-0.19444	-0.06973
Qpeak-area	0.64069	0.35011	0.58944	0.35685	-0.06691	0.07237	-0.29038
Q10	0.11455	0.17925	-0.01419	0.11638	0.02603	-0.36887	-0.22658
Q90	-0.12258	0.70624	-0.26961	-0.33783	0.45587	-0.35226	0.00875
Q90-area	0.44482	0.11353	0.31561	0.07854	0.33919	-0.18604	0.00626
Q50	-0.12549	0.34301	-0.24094	-0.27532	0.55146	-0.35425	0.09012
Q50-area	0.19577	-0.06852	0.11435	0.05527	0.35229	-0.31808	0.06718
Qmean+	-0.04434	0.90746	-0.19303	-0.26285	0.35837	-0.27966	0.00138
Qmean+-area	0.85446	0.07817	0.82774	0.42895	0.09795	0.34099	-0.11451
Qgeomean	-0.07453	0.55151	-0.22366	-0.23842	0.43162	-0.36513	0.22782
Qmean(ln)	-0.01836	0.53787	-0.1058	-0.28508	0.52377	-0.12188	-0.06308
Qmean(ln)area	0.54533	0.07057	0.55353	0.18805	0.12918	0.43127	-0.12086
SD(ln)	0.30772	0.25206	0.28838	-0.01939	0.17338	0.40252	-0.15325
COV(ln)	0.41734	0.13931	0.40403	0.10496	0.08055	0.40526	-0.09447
BFR	-0.49809	-0.17404	-0.56495	-0.59852	0.40323	-0.59752	0.25702
Tdry	0.27783	-0.21559	0.37149	0.141	-0.2089	0.78401	0.20136
T3xQ50	0.26588	0.43898	0.09382	-0.11057	0.52785	-0.12357	0.04717
TQmean	0.14786	0.27357	-0.01929	-0.1654	0.60616	-0.31461	0.02503
TQ90	0.29782	0.41348	0.15339	0.02002	0.47141	-0.17959	-0.00681
mean+	0.08936	0.96448	-0.07452	-0.10251	0.13123	-0.18437	-0.06552
mean+-area	1	0.11428	0.9199	0.54836	-0.1281	0.46787	-0.21039
mean-	0.11428	1	-0.01765	-0.04772	0.11621	-0.15114	-0.08101
mean--area	0.9199	-0.01765	1	0.68785	-0.20392	0.6083	-0.27251
FHn	0.54836	-0.04772	0.68785	1	-0.42432	0.44726	-0.48036
FHd	-0.1281	0.11621	-0.20392	-0.42432	1	-0.23943	0.19397
FLn	0.46787	-0.15114	0.6083	0.44726	-0.23943	1	-0.29266
FLd	-0.21039	-0.08101	-0.27251	-0.48036	0.19397	-0.29266	1

Appendix B – Correlation between Aquatic Life scores and hydrologic parameters

Parameter	Aquatic Life Scores			
	UV-ICP	UV-WY	DV-ICP	DV-WY
Qmean	**0.51366**	0.41896	**0.51254**	0.41609
Qmean-area	**-0.52453**	-0.33275	**-0.51332**	-0.2506
SD	**0.50312**	0.34786	0.41694	0.34824
COV	**-0.55364**	-0.24225	-0.06221	0.00061
Qpeak	0.36054	0.21734	0.40295	0.27697
Qpeak-area	**-0.63562**	**-0.52697**	-0.34985	-0.2278
Q10	0.13619	0.19655	0.13638	0.18136
Q90	**0.56666**	0.43462	**0.5615**	0.42789
Q90-area	0.08801	0.04323	-0.14905	-0.04726
Q50	0.43893	0.33884	0.4395	0.33969
Q50-area	-0.11872	-0.01614	-0.15949	0.00742
Qmean+	**0.52117**	0.38925	**0.52086**	0.39205
Qmean+-area	**-0.65726**	-0.47172	**-0.63311**	-0.40471
Qgeomean	**0.58886**	0.38737	**0.57764**	0.3796
Qmean(ln)	0.44332	0.27503	0.43329	0.26157
Qmean(ln)area	0.0039	-0.20956	-0.13865	-0.2604
SD(ln)	0.31205	-0.02911	0.25289	-0.08051
COV(ln)	0.07607	-0.15613	0.04054	-0.19521
BFR	**0.80096**	**0.6341**	**0.55734**	0.42348
Tdry	-0.3334	-0.45285	-0.30847	-0.46811
T3xQ50	0.28865	0.16221	0.20965	0.17469
TQmean	0.49542	0.2602	0.39936	0.25367
TQ90	0.04897	0.04275	0.06383	0.13206
TQ0.25yr	0.46973	0.37633		
TQ0.5yr	0.36335	0.27917		
TQ0.75yr	0.3487	0.23844		
TQ1yr	0.36442	0.24003		
mean+	0.04251	-0.14613	0.4248	0.27753
mean+-area	**-0.6229**	**-0.51708**	**-0.69707**	-0.49417
mean-	0.30266	0.10001	0.39818	0.27073
mean--area	**-0.87586**	**-0.71921**	**-0.87428**	**-0.64336**
FHn	**-0.65601**	0.27434	**-0.68355**	**-0.52427**
FHd	0.48798	-0.39829	0.47673	0.23979
FLn	**-0.52336**	0.16644	**-0.56147**	**-0.54532**
FLd	0.13782	-0.36873	0.3412	0.15826

Appendix C – Correlations of hydrologic and biologic parameters

Sub-daliy Flows grouping by Impervious Cover Period

	DIATOMS					Benthic macroinvertebrates				
	# of Taxa	% Motile	% Similarity	PTI	Cymbella Richness	# of Organisms	# of Taxa	% Dominance (Top 1)	HBI	Diptera Taxa
Qmean	0.07716	-0.38647	0.44147	0.44519	0.39815	0.19621	0.44461	-0.4308	-0.30883	0.26881
Qmean-area	-0.15372	0.33	-0.43699	-0.38369	-0.51371	-0.39308	-0.54698	0.36131	0.38215	-0.31837
SD	0.1257	-0.3003	0.38381	0.36377	0.39425	0.30399	0.46135	-0.41609	-0.29465	0.36724
COV	0.0432	0.46169	-0.44617	-0.56778	-0.44451	-0.14398	-0.42489	0.40339	0.40153	-0.28892
Qpeak	0.04295	-0.23382	0.36779	0.28149	0.17377	0.18186	0.32662	-0.29125	-0.16238	0.10331
Qpeak-area	-0.02505	0.39138	-0.424	-0.45931	-0.47639	-0.32607	**-0.64485**	0.47195	0.56299	-0.33491
Q10	0.12354	0.0101	0.04838	0.0388	0.10947	-0.14007	0.02812	-0.14054	-0.13682	0.1388
Q90	0.00625	-0.48083	0.50557	0.53618	0.44072	0.18008	0.47293	-0.47545	-0.3601	0.25999
Q90-area	-0.18122	-0.21125	0.08615	0.23351	-0.08336	-0.22724	-0.09656	-0.081	-0.01983	-0.13686
Q50	-0.05625	-0.34889	0.24945	0.37163	0.24521	-0.02925	0.29368	-0.3472	-0.31347	0.17374
Q50-area	-0.11149	0.18575	-0.2191	-0.15017	-0.2399	-0.22692	-0.14269	0.03402	0.00832	-0.04711
Qmean+	0.07718	-0.39883	0.44021	0.46513	0.40849	0.25062	0.48547	-0.4355	-0.32359	0.27226
Qmean+-area	-0.20484	0.2779	-0.52978	-0.39477	-0.5851	**-0.40314**	-0.62142	0.52541	0.50455	**-0.39479**
Qgeomean	-0.06279	-0.4659	0.35854	0.50837	0.35425	0.14833	0.49033	-0.48515	-0.43474	0.25472
Qmean(ln)	-0.0908	-0.4509	0.37054	0.49854	0.36088	0.11903	0.35431	-0.36181	-0.33957	0.12538
Qmean(ln)area	-0.21033	-0.11474	-0.11308	0.09237	-0.17983	-0.11621	-0.0576	0.05816	0.01716	-0.10143
SD(ln)	0.02887	-0.31894	0.27834	0.35791	0.2593	0.17883	0.28051	-0.16883	-0.12904	0.2187
COV(ln)	0.02092	-0.09253	0.03602	0.10871	0.03357	0.09171	0.10576	-0.03183	-0.03326	0.13475
BFR	-0.07222	**-0.69761**	**0.68795**	**0.79427**	**0.57314**	0.21499	0.59205	**-0.64944**	**-0.52214**	0.31924
Tdry	-0.04843	0.10275	-0.33813	-0.18495	-0.25097	-0.08372	-0.24042	0.31506	0.24399	-0.19278
T3xQ50	0.03983	-0.29365	0.30561	0.46302	0.19157	-0.05236	0.1247	-0.04922	-0.04872	0.11423
TQmean	-0.18015	-0.54417	0.38445	0.62326	0.2674	-0.0761	0.25033	-0.37152	-0.31183	0.09602
TQ90	-0.07852	0.0578	-0.23373	0.04881	-0.22783	-0.12382	-0.05169	-0.01499	-0.10216	-0.10266
TQ0.25yr	-0.09137	-0.4658	0.30442	0.51835	0.38835	0.13369	0.34574	-0.38843	-0.26826	0.18541
TQ0.5yr	0.03203	-0.30173	0.20448	0.32241	0.31009	0.30423	0.34311	-0.31287	-0.12381	0.25052
TQ0.75yr	0.04315	-0.28686	0.19853	0.30951	0.28054	0.28178	0.34101	-0.30346	-0.10152	0.25792
TQ1yr	0.04108	-0.30488	0.24715	0.33526	0.29809	0.25882	0.31385	-0.2976	-0.11144	0.2415
mean+	0.25079	0.06757	0.02281	-0.00956	0.08857	0.02872	0.05862	0.02391	0.02589	-0.01623
mean+-area	-0.00047	0.34764	-0.45318	-0.43622	-0.39623	-0.30162	-0.51407	0.49229	0.47431	-0.32959
mean-	0.21446	-0.12938	0.20405	0.19701	0.2272	0.08147	0.22116	-0.18411	-0.16862	0.05271
mean--area	-0.10215	0.4679	**-0.63039**	-0.64815	**-0.60445**	**-0.49817**	**-0.76296**	**0.59591**	**0.6837**	**-0.51836**
FHn	0.08552	**0.59923**	-0.55956	**-0.67003**	-0.55915	-0.27115	-0.56723	0.48364	0.47711	-0.19712
FHd	**-0.29863**	-0.57401	0.16198	0.60499	0.27363	0.17495	0.45858	-0.37644	-0.46972	0.1569
FLn	0.17164	0.30778	-0.3153	-0.37612	-0.30405	-0.28028	-0.4602	0.50602	0.57337	-0.19512
FLd	**-0.37266**	-0.28378	-0.15926	0.25415	-0.14971	0.17292	0.25297	-0.04951	-0.26674	-0.07703

Appendix C – Correlations of hydrologic and biologic parameters (cont.)

Sub-Daily Flows grouping by Impervious Cover Period (cont.)

	Benthic macroinvertebrates									
	Ephemeroptera Taxa	**Percent Chironomidae**	**Percent Elmidae**	**Noninsect Taxa**	**EPT Taxa**	**Percent EPT**	**Percent Collector**	**Percent Predator**	**Percent Filterer**	**Percent Grazer**
Qmean	0.36953	-0.32405	0.34534	0.10568	0.48119	0.32002	-0.1415	-0.36145	0.18476	0.06221
Qmean-area	-0.54539	0.36999	-0.13628	**-0.43272**	-0.56362	-0.26781	-0.05459	-0.02327	0.04743	**-0.32902**
SD	0.4095	-0.2939	0.31922	0.10202	0.50113	0.31243	-0.07792	-0.38692	0.10131	0.06578
COV	-0.45652	0.33428	-0.1649	-0.22235	-0.43638	-0.33235	0.00649	0.33738	-0.0079	-0.12691
Qpeak	0.23932	-0.22824	0.35162	0.07102	0.35948	0.14539	-0.17411	-0.25108	0.16959	0.16237
Qpeak-area	-0.63397	0.29313	-0.30031	**-0.40254**	-0.64931	-0.37706	0.1398	0.18911	-0.0741	**-0.39408**
Q10	0.05071	-0.09013	0.31926	-0.27672	0.09846	0.17599	0.2501	-0.17144	-0.16722	0.02673
Q90	0.4445	-0.37832	0.2895	0.15936	0.53254	0.34528	-0.148	-0.38054	0.18125	0.04223
Q90-area	-0.0512	-0.07889	0.06345	-0.2221	-0.03448	0.08178	-0.05474	-0.41965	0.02684	-0.11814
Q50	0.31455	-0.29325	**0.47438**	-0.01499	0.36556	0.36254	0.08202	-0.33701	0.01025	0.02397
Q50-area	-0.18106	0.09509	0.25285	-0.18314	-0.16985	0.06452	0.11825	-0.0636	-0.0434	-0.10638
Qmean+	0.40431	-0.31938	0.32198	0.16483	0.51214	0.31933	-0.19021	-0.35154	0.21806	0.10722
Qmean+-area	-0.56949	**0.51729**	-0.31496	-0.37996	-0.64749	-0.40855	-0.11595	0.12749	0.09309	-0.30047
Qgeomean	0.5014	-0.41395	**0.47019**	0.0794	0.57845	0.45316	-0.02816	**-0.45827**	0.10288	0.17529
Qmean(ln)	0.36667	-0.30253	0.19843	0.17089	0.40275	0.35368	-0.18943	-0.27073	0.22505	-0.03285
Qmean(ln)area	-0.0056	0.09129	-0.054	0.00052	-0.05527	0.03032	-0.18673	-0.00144	0.2226	-0.17101
SD(ln)	0.28715	-0.03228	-0.05919	0.29667	0.2682	0.022	**-0.27685**	-0.00421	0.23472	-0.07508
COV(ln)	0.11196	0.13711	-0.09801	0.19736	0.06796	-0.06367	**-0.23811**	0.16267	**0.23944**	-0.13582
BFR	0.60709	-0.63342	0.25298	0.35409	**0.67093**	0.42727	0.04532	-0.4415	-0.03891	0.21063
Tdry	-0.19297	0.2378	-0.42058	0.08767	-0.2687	-0.23353	-0.01485	0.23529	0.01731	-0.01604
T3xQ50	0.15588	-0.00359	0.07431	0.02619	0.1697	0.01292	-0.19587	-0.4148	0.2275	-0.0778
TQmean	0.30928	-0.35958	0.26251	-0.02146	0.34834	0.36115	-0.03068	**-0.48268**	0.08687	-0.0638
TQ90	-0.07681	0.0532	0.08791	-0.15636	-0.03421	0.18686	-0.10531	-0.28331	**0.24891**	-0.17055
TQ0.25yr	0.3535	-0.34561	0.14778	0.13258	0.38819	0.33343	-0.14705	-0.30797	0.15202	-0.05446
TQ0.5yr	0.23337	-0.23274	0.1067	0.16499	0.32288	0.19478	-0.06883	-0.27761	0.05489	0.00033
TQ0.75yr	0.21421	-0.21351	0.11936	0.15278	0.31973	0.17323	-0.08002	-0.28193	0.07228	0.00333
TQ1yr	0.20555	-0.23148	0.11828	0.09677	0.31215	0.19589	-0.11883	-0.2989	0.1186	-0.02045
mean+	0.0159	0.07332	0.20935	-0.0542	0.05998	-0.00592	-0.10447	0.09234	0.03531	0.15686
mean+-area	-0.48704	0.49545	-0.26314	-0.21341	-0.56893	-0.45855	-0.08569	0.41391	-0.00317	-0.18866
mean-	0.18035	-0.15503	0.42163	-0.07468	0.2698	0.22083	-0.13743	-0.19045	0.10645	0.16665
mean--area	**-0.74295**	**0.53858**	-0.37682	-0.36669	**-0.81269**	**-0.60843**	-0.06509	0.38961	-0.08705	-0.2632
FHn	**-0.63484**	0.47289	-0.1834	-0.3335	-0.62859	-0.35364	0.20092	0.26451	-0.0716	-0.31782
FHd	0.61938	-0.43902	-0.04639	0.2684	0.55328	0.46788	-0.20897	-0.32447	0.21401	0.14908
FLn	-0.53209	0.41388	-0.3039	-0.14363	-0.51872	**-0.49597**	0.11776	0.22317	-0.13379	-0.17682
FLd	0.43909	-0.20875	-0.1271	0.20425	0.34732	0.29362	-0.09653	-0.16951	0.12365	0.3444

Appendix C – Correlations of hydrologic and biologic parameters (cont.)

Sub-Daily Flows grouping by Impervious Cover Period (cont.)

	Benthic macroinvertebrates								
	Trichoptera as Hydropsychidae	Intolerant/ Tolerant	Intolerant Taxa	Percent Tolerant	% Dominance (Top 3)	Dominant Guild	EPT/ EPT+Chiron	Quantitative ALU	Qualitative ALU
Qmean	0.07214	0.36879	0.49991	-0.19713	-0.4957	-0.04254	0.35459	0.40205	0.4909
Qmean-area	-0.12024	-0.22575	-0.53778	-0.2066	0.41598	0.20299	-0.38541	-0.50812	-0.4821
SD	0.08592	0.29516	0.53886	-0.2043	-0.47595	-0.15333	0.36571	0.43929	0.4828
COV	0.11763	-0.41468	-0.50531	0.16679	0.45956	0.14611	-0.3699	-0.40963	-0.51497
Qpeak	0.11964	0.14541	0.35833	-0.15555	-0.35427	0.02223	0.23986	0.30352	0.33987
Qpeak-area	0.04402	-0.43926	-0.69003	-0.05066	0.49405	**0.32676**	-0.41783	-0.5742	-0.59211
Q10	0.19004	0.20542	0.12981	-0.15297	-0.15415	-0.10807	0.1595	0.19714	0.11337
Q90	0.00989	0.43551	0.56007	-0.20301	-0.54525	-0.07194	0.39315	0.43193	0.53727
Q90-area	-0.1526	0.12289	-0.00447	-0.26476	-0.04335	-0.10594	0.05932	-0.04997	0.05619
Q50	0.08077	0.45604	0.41992	-0.18623	-0.37909	-0.1779	0.34553	0.34301	0.39593
Q50-area	0.05366	0.10959	-0.10976	-0.25853	0.03756	0.03605	-0.01607	-0.10068	-0.07606
Qmean+	0.05729	0.35037	0.51533	-0.1708	-0.51322	-0.02323	0.35603	0.41577	0.50854
Qmean+-area	-0.22347	-0.39883	-0.68246	0.07043	0.59058	0.25056	-0.55546	**-0.64752**	-0.6087
Qgeomean	0.09136	**0.49709**	0.58698	-0.21236	-0.54426	-0.16542	0.46319	0.52126	0.57925
Qmean(ln)	-0.06802	0.37966	0.41819	-0.16219	-0.43046	-0.01409	0.3284	0.27144	0.40122
Qmean(ln)area	-0.22251	0.01848	-0.08475	-0.0648	0.00299	0.14687	-0.06357	-0.18264	-0.03312
SD(ln)	-0.19844	0.06362	0.25961	0.0568	-0.28722	0.09157	0.07489	0.06135	0.21997
COV(ln)	-0.19582	-0.02687	0.05056	-0.01553	-0.1505	0.20495	-0.07361	-0.09013	0.02435
BFR	0.01335	0.47493	**0.70637**	-0.16633	**-0.69085**	**-0.32882**	**0.59608**	0.6091	**0.7265**
Tdry	-0.13623	-0.36833	-0.3534	**0.42902**	0.35308	0.06038	-0.28571	-0.31348	-0.35459
T3xQ50	-0.1179	0.09159	0.18279	0.02117	-0.16411	-0.01788	0.08233	0.04161	0.19095
TQmean	-0.04889	0.38204	0.38119	-0.24173	-0.41598	-0.14855	0.39526	0.26669	0.4321
TQ90	-0.00625	0.14672	-0.01586	-0.14211	-0.07943	0.02785	0.07591	-0.08337	0.02662
TQ0.25yr	-0.03727	0.3573	0.38037	-0.15554	-0.4218	-0.10099	0.38791	0.29364	0.46149
TQ0.5yr	-0.03987	0.2079	0.27783	-0.14564	-0.35395	-0.03086	0.26726	0.22673	0.34505
TQ0.75yr	-0.02471	0.18654	0.27133	-0.15451	-0.34767	-0.01796	0.24438	0.22769	0.34008
TQ1yr	-0.02456	0.17841	0.2718	-0.17261	-0.35009	0.02073	0.26761	0.21763	0.34022
mean+	-0.07862	-0.01596	-0.01445	-0.11945	-0.02247	0.03228	0.0243	0.04297	0.03199
mean+-area	**-0.28678**	-0.40217	-0.6106	-0.01752	0.54184	0.21957	-0.52137	-0.54771	-0.58338
mean-	0.02441	0.18857	0.23983	-0.15223	-0.24352	-0.01602	0.26171	0.23271	0.26688
mean--area	**-0.2789**	**-0.53793**	**-0.82309**	0.05333	**0.76818**	0.16044	**-0.70437**	**-0.73621**	**-0.78784**
FHn	0.24972	-0.33122	-0.59803	0.07772	0.49057	0.2646	-0.5287	-0.55658	-0.62935
FHd	-0.12181	0.32074	0.46161	-0.04414	-0.4399	-0.08492	0.46809	0.41169	0.54301
FLn	0.04973	-0.43738	-0.51241	**0.37078**	0.50924	0.0984	-0.57997	-0.54189	-0.577
FLd	-0.11717	0.08582	0.1428	0.08134	-0.06156	-0.0682	0.21649	0.20796	0.26853

Appendix C – Correlations of hydrologic and biologic parameters (cont.)

Sub-Daily Flows grouping Water Year

	DIATOMS					Benthic macroinvertebrates				
	# of Taxa	% Motile	% Similarity	PTI	Cymbella Richness	# of Organisms	# of Taxa	% Dominance (Top 1)	HBI	Diptera Taxa
Qmean	0.2563	-0.00665	0.23598	0.18661	0.34093	0.32267	0.36818	-0.31494	-0.29987	0.24789
Qmean-area	-0.14096	0.34035	-0.29005	-0.29213	-0.31973	-0.0662	-0.37507	0.30975	0.16025	-0.18411
SD	0.25338	0.04603	0.18399	0.14073	0.30356	0.29032	0.32539	-0.24204	-0.26126	0.27045
COV	0.0465	0.24208	-0.03246	-0.24985	-0.13969	0.05614	-0.23721	0.2692	0.11012	-0.08791
Qpeak	0.21023	0.01757	0.22553	0.11129	0.22502	0.17795	0.20157	-0.15514	-0.15659	0.18556
Qpeak-area	-0.15577	0.34224	-0.16161	-0.55704	-0.37769	-0.10596	-0.50868	0.43329	0.29503	-0.23455
Q10	0.09351	0.05568	-0.00345	-0.00924	0.08608	0.11933	0.08959	-0.11333	-0.16503	0.17313
Q90	0.12322	-0.09386	0.2404	0.2365	0.31457	0.22924	0.31104	-0.30161	-0.29049	0.18131
Q90-area	-0.17357	0.07166	-0.11504	0.03841	-0.14228	-0.03347	-0.10972	0.05026	-0.02385	-0.10146
Q50	0.01226	-0.17371	0.13761	0.24934	0.20272	0.04067	0.15929	-0.23627	-0.3182	0.07947
Q50-area	-0.15337	0.01746	-0.10535	-0.01095	-0.13174	-0.11744	-0.16276	0.03248	-0.06984	-0.1177
Qmean+	0.24235	0.00157	0.2227	0.17335	0.31644	0.3154	0.34953	-0.29313	-0.28504	0.22424
Qmean+-area	-0.20387	0.32673	-0.3551	-0.34626	-0.39536	-0.13016	-0.45697	0.40513	0.26455	-0.23002
Qgeomean	-0.00604	-0.1376	0.16097	0.20764	0.1869	0.13458	0.19759	-0.26101	-0.35207	0.06431
Qmean(ln)	0.12599	-0.06768	0.0884	0.19863	0.2681	0.12481	0.21816	-0.22415	-0.21916	0.14172
Qmean(ln)area	-0.08803	0.12668	-0.22383	-0.09166	-0.1135	-0.10454	-0.18625	0.23771	0.10646	-0.06657
SD(ln)	0.08373	0.06188	-0.09078	0.02256	0.04304	0.05235	0.03967	0.07805	0.08537	0.09882
COV(ln)	0.02763	0.11337	-0.18705	-0.08406	-0.01313	-0.01334	-0.07273	0.2302	0.11789	0.02563
BFR	0.03425	-0.47204	0.20541	0.63431	0.46615	0.16447	0.55571	-0.47903	-0.34148	0.26293
Tdry	-0.11183	0.07466	-0.12495	-0.24131	-0.30351	-0.18125	-0.23676	0.23596	0.43643	-0.11821
T3xQ50	-0.04977	-0.00641	0.02079	0.17722	0.00342	0.1143	0.05371	0.0452	-0.08824	-0.01332
TQmean	-0.11524	-0.13423	-0.00465	0.25437	0.04091	0.0555	0.07942	-0.11945	-0.19568	0.0015
TQ90	-0.14465	0.05276	-0.17739	0.03834	-0.16203	0.06108	-0.05735	0.07286	-0.11558	-0.11298
TQ0.25yr	0.00093	-0.24184	0.19465	0.3465	0.28052	0.17719	0.25905	-0.23373	-0.2675	0.17758
TQ0.5yr	0.23228	-0.06429	0.11473	0.1952	0.39955	0.30625	0.29891	-0.20338	-0.11644	0.31743
TQ0.75yr	0.33809	0.01741	0.1498	0.14733	0.40153	0.31622	0.31165	-0.19514	-0.09541	0.31054
TQ1yr	0.3485	0.02877	0.16588	0.13664	0.38037	0.34731	0.31616	-0.20478	-0.11726	0.31429
mean+	0.14221	0.23359	-0.12667	-0.14551	0.03593	0.02681	-0.08863	0.17058	0.04087	-0.00824
mean+-area	-0.09327	0.33675	-0.32471	-0.38361	-0.28836	-0.16934	-0.40805	0.42727	0.32003	-0.20321
mean-	0.28161	0.16645	0.05198	-0.01031	0.18363	0.16014	0.06856	-0.02228	-0.12798	0.09219
mean--area	-0.14011	0.44523	-0.36247	-0.53211	-0.46159	-0.26838	-0.62552	0.53186	0.4939	-0.36128
FHn	-0.11923	-0.25821	0.01297	0.32599	0.13159	0.18828	0.26635	-0.18123	-0.22956	0.09633
FHd	-0.17764	0.2456	-0.16519	-0.30247	-0.41335	-0.13271	-0.43431	0.26791	0.26484	-0.22573
FLn	-0.20328	-0.26102	-0.00907	0.23262	0.0523	0.03775	0.02376	-0.09872	-0.24112	-0.0681
FLd	-0.11047	0.12679	-0.00932	-0.17728	-0.30106	-0.11741	-0.27591	0.33448	0.34654	-0.14379

Appendix C – Correlations of hydrologic and biologic parameters (cont.)

Sub-Daily Flows grouping Water Year (cont.)

	Benthic macroinvertebrates									
	Ephemeroptera Taxa	**Percent Chironomidae**	**Percent Elmidae**	**Noninsect Taxa**	**EPT Taxa**	**Percent EPT**	**Percent Collector**	**Percent Predator**	**Percent Filterer**	**Percent Grazer**
Qmean	0.41453	-0.22035	-0.05484	0.04927	0.48744	0.28259	-0.22412	-0.2936	0.30602	-0.17281
Qmean-area	-0.26012	0.23671	-0.31562	-0.30708	-0.25972	-0.00335	-0.04155	-0.09121	0.07514	-0.25371
SD	0.39983	-0.17674	-0.07474	-0.01806	0.47921	0.26911	-0.19755	-0.21617	0.23743	-0.1991
COV	-0.20193	0.21287	-0.22782	-0.22445	-0.14896	0.06145	-0.09059	0.01852	0.1309	-0.06517
Qpeak	0.18054	-0.08492	0.01638	-0.04109	0.27789	0.17666	-0.17124	-0.19932	0.2425	-0.1233
Qpeak-area	-0.4644	0.31193	-0.25579	-0.3163	-0.45553	-0.08191	0.07794	0.19088	0.00183	-0.06902
Q10	0.17259	-0.122	0.0201	-0.18108	0.24336	0.24693	0.18902	-0.2567	-0.04033	-0.14352
Q90	0.40267	-0.25553	-0.09101	0.06141	0.456	0.26868	-0.20251	-0.30047	0.25287	-0.131
Q90-area	0.04538	-0.03467	-0.24875	-0.14398	0.04682	0.11068	-0.08018	-0.26214	0.06859	-0.21967
Q50	0.34857	-0.21493	-0.03745	-0.06328	0.31448	0.22089	-0.02927	-0.2986	0.23716	-0.17438
Q50-area	-0.03928	-0.05081	-0.11708	-0.1846	-0.06243	0.12507	0.10847	-0.2449	0.03504	-0.15474
Qmean+	0.39253	-0.17815	-0.06554	0.05646	0.45887	0.26394	-0.25774	-0.26501	0.34109	-0.16455
Qmean+-area	-0.34735	0.48387	-0.33254	-0.27832	-0.3906	-0.14822	-0.11507	0.09924	0.16217	-0.22143
Qgeomean	0.37718	-0.24538	-0.05458	-0.04809	0.38374	0.30531	-0.10185	-0.32918	0.31379	-0.16215
Qmean(ln)	0.35461	-0.1027	-0.07493	0.07007	0.29031	0.11488	-0.19579	-0.08702	0.24096	-0.16752
Qmean(ln)area	-0.08232	0.39463	-0.13567	-0.08339	-0.1703	-0.16856	-0.14232	0.15767	0.21227	-0.18011
SD(ln)	0.07232	0.30249	-0.14592	0.09935	0.00564	-0.13997	-0.27934	0.13154	0.21574	-0.14475
COV(ln)	-0.00995	0.41463	-0.1279	0.01325	-0.09874	-0.19803	-0.24599	0.26073	0.21732	-0.13683
BFR	0.58537	-0.44606	0.13441	0.34631	0.60292	0.15	-0.08225	-0.30139	0.0526	-0.13138
Tdry	-0.38066	0.33578	-0.17866	0.12888	-0.42661	-0.41238	-0.15752	0.42701	-0.06925	0.17335
T3xQ50	0.23142	-0.0015	-0.24113	-0.00977	0.19235	0.09172	-0.21675	-0.26773	0.29826	-0.24227
TQmean	0.27015	-0.17202	-0.17725	-0.03658	0.23434	0.23184	-0.03702	-0.36195	0.16571	-0.20515
TQ90	0.12618	0.00278	-0.24408	-0.09354	0.0844	0.18387	-0.09652	-0.29734	0.19172	-0.12114
TQ0.25yr	0.40553	-0.26457	-0.16962	0.09444	0.39833	0.21792	-0.21434	-0.18363	0.15531	-0.10784
TQ0.5yr	0.28541	-0.12094	-0.13003	0.13876	0.38006	0.1157	-0.2006	-0.13997	0.08365	-0.07571
TQ0.75yr	0.25534	-0.0784	-0.10176	0.15202	0.37496	0.10243	-0.21546	-0.11406	0.08184	-0.05778
TQ1yr	0.27615	-0.08617	-0.09542	0.12919	0.38221	0.11117	-0.23879	-0.10298	0.13562	-0.107
mean+	-0.04611	0.28886	-0.06188	-0.14241	-0.05296	0.02272	-0.1679	0.13511	0.25073	-0.1573
mean+-area	-0.36708	0.52486	-0.17523	-0.18165	-0.43105	-0.26813	-0.08407	0.38407	0.09344	-0.13144
mean-	0.12802	0.02941	-0.04625	-0.16516	0.17146	0.22515	-0.18972	-0.09722	0.27551	-0.20832
mean--area	-0.58956	0.47467	-0.26897	-0.30785	-0.63717	-0.32791	-0.03025	0.35706	-0.06435	-0.10828
FHn	0.51574	-0.20249	-0.1512	0.129	0.4204	0.19036	-0.14766	-0.19435	0.19844	-0.1198
FHd	-0.45756	0.19861	-0.13311	-0.24509	-0.41635	-0.08791	0.13971	0.11566	-0.10561	0.00705
FLn	0.18066	-0.14444	-0.12331	-0.01007	0.11258	0.14784	-0.24149	-0.13506	0.30679	-0.07381
FLd	-0.38551	0.23077	-0.09593	0.03639	-0.37857	-0.27027	0.08456	0.33007	-0.18699	0.23879

Appendix C – Correlations of hydrologic and biologic parameters (cont.)

Sub-Daily Flows grouping by Water Year (cont.)

	Benthic macroinvertebrates								
	Trichoptera as Hydropsychidae	Intolerant/ Tolerant	Intolerant Taxa	Percent Tolerant	% Dominance (Top 3)	Dominant Guild	EPT/ EPT+Chiron	Quantitative ALU	Qualitative ALU
Qmean	0.03485	0.1157	0.42024	-0.19006	-0.3834	-0.0052	0.29518	0.30484	0.43384
Qmean-area	-0.02578	-0.07407	-0.31972	-0.10883	0.36216	0.13801	-0.19776	-0.31587	-0.32255
SD	0.06578	0.15522	0.38769	-0.1693	-0.308	-0.10505	0.28368	0.30535	0.39075
COV	0.1724	-0.00821	-0.21931	0.01001	0.26797	0.17706	-0.10449	-0.23034	-0.20945
Qpeak	0.12711	0.08275	0.25644	-0.11043	-0.18936	0.00495	0.1577	0.15019	0.24608
Qpeak-area	0.16324	-0.08883	-0.50839	0.11608	0.46955	0.23541	-0.2614	-0.41779	-0.50341
Q10	0.18653	0.07439	0.17783	-0.12922	-0.14513	-0.05382	0.22713	0.196	0.17864
Q90	-0.05527	0.14491	0.35738	-0.18493	-0.37114	0.00626	0.30843	0.26054	0.41529
Q90-area	-0.14968	0.03248	-0.04059	-0.15739	0.07175	0.01739	0.04043	-0.0856	0.0132
Q50	0.02603	0.14909	0.29626	-0.15773	-0.29863	-0.01777	0.25003	0.22726	0.28516
Q50-area	0.01762	0.01949	-0.07778	-0.10496	0.07203	0.00065	0.05384	-0.05529	-0.04531
Qmean+	0.03161	0.09133	0.38591	-0.17951	-0.36404	0.02129	0.26534	0.27457	0.40513
Qmean+-area	-0.02947	-0.18819	-0.46251	-0.03023	0.45604	0.18397	-0.37018	-0.4406	-0.46769
Qgeomean	0.0419	0.11239	0.30255	-0.18131	-0.3244	0.04895	0.31459	0.26679	0.34044
Qmean(ln)	-0.11857	0.0722	0.26895	-0.15902	-0.26771	-0.01962	0.12082	0.13661	0.24053
Qmean(ln)area	-0.18581	-0.10761	-0.18791	-0.09109	0.17246	0.15903	-0.27323	-0.2685	-0.22441
SD(ln)	-0.22481	-0.03152	-0.01459	-0.07593	-0.0047	0.0601	-0.18897	-0.16537	-0.03223
COV(ln)	-0.20178	-0.09567	-0.11131	-0.05272	0.14437	0.14648	-0.27488	-0.25796	-0.16464
BFR	-0.19165	0.17838	0.57848	-0.24105	-0.56597	-0.25375	0.3753	0.44209	0.61721
Tdry	-0.13536	-0.26491	-0.41997	0.36256	0.29081	0.07021	-0.43477	-0.40679	-0.37898
T3xQ50	-0.13161	0.00494	0.09771	-0.15146	-0.05249	0.0796	0.07421	0.01745	0.14573
TQmean	-0.08651	0.08592	0.13766	-0.1937	-0.15214	-0.01187	0.21742	0.10169	0.22935
TQ90	-0.09552	0.00741	-0.04064	-0.15944	0.0677	0.05906	0.08232	-0.03571	0.05192
TQ0.25yr	-0.13421	0.18944	0.30586	-0.11893	-0.27398	-0.01661	0.2995	0.21348	0.3813
TQ0.5yr	-0.08703	0.11011	0.2861	-0.0933	-0.26471	-0.052	0.17592	0.22667	0.30458
TQ0.75yr	-0.06436	0.08327	0.28277	-0.08439	-0.25578	-0.06344	0.13821	0.2238	0.29598
TQ1yr	-0.03033	0.07913	0.31623	-0.09698	-0.25218	-0.05658	0.14259	0.22916	0.29406
mean+	-0.02577	-0.12414	-0.11894	-0.11875	0.11938	0.10727	-0.07711	-0.13294	-0.08416
mean+-area	-0.10942	-0.22301	-0.46041	-0.00398	0.43304	0.2183	-0.41772	-0.43689	-0.49001
mean-	0.06173	-0.02004	0.11842	-0.16093	-0.04461	0.01187	0.15711	0.0566	0.13756
mean--area	-0.08401	-0.26873	-0.6573	0.08083	0.65911	0.18785	-0.52063	-0.58008	-0.68227
FHn	-0.14768	0.06711	0.27132	-0.11736	-0.24322	-0.05655	0.24982	0.24542	0.31319
FHd	0.3008	-0.06858	-0.41106	0.14668	0.33927	0.20121	-0.24959	-0.35076	-0.43059
FLn	-0.07774	0.03324	0.03782	-0.02279	-0.11044	0.08004	0.15618	0.04689	0.17993
FLd	0.13547	-0.09271	-0.35624	0.23394	0.37587	0.20008	-0.33088	-0.32981	-0.37672

Appendix C – Correlations of hydrologic and biologic parameters (cont.)

Daily Flows grouping by Impervious Cover Period

	DIATOMS					Benthic macroinvertebrates				
	# of Taxa	% Motile	% Similarity	PTI	Cymbella Richness	# of Organisms	# of Taxa	% Dominance (Top 1)	HBI	Diptera Taxa
Qmean	0.07694	-0.38706	0.43894	0.44394	0.39689	0.19373	0.44175	-0.42925	-0.30833	0.26618
Qmean-area	-0.13405	0.33395	-0.43327	-0.39159	-0.49448	-0.39796	-0.55707	0.36803	0.36931	-0.32315
SD	0.12278	-0.27142	0.41566	0.33954	0.30266	0.22675	0.39892	-0.35543	-0.21513	0.2275
COV	0.16322	0.12887	-0.01715	-0.09107	-0.04159	0.24842	0.07689	0.10641	0.09862	0.04642
Qpeak	0.11323	-0.22664	0.41725	0.29857	0.25134	0.25688	0.40157	-0.34549	-0.20064	0.20124
Qpeak-area	-0.01965	0.20463	-0.27686	-0.25419	-0.35484	-0.20142	-0.46908	0.31432	0.32587	-0.17504
Q10	0.10162	0.00146	0.0382	0.03013	0.10231	-0.13199	0.02381	-0.14343	-0.14183	0.14229
Q90	0.01421	-0.46861	0.4965	0.51893	0.43254	0.18208	0.46595	-0.46984	-0.35792	0.25824
Q90-area	-0.16311	0.01329	-0.08516	-0.029	-0.25869	-0.32831	-0.31486	0.10994	0.16279	-0.24435
Q50	-0.04717	-0.34171	0.25009	0.36197	0.24187	-0.03108	0.28912	-0.34819	-0.31468	0.16676
Q50-area	-0.10464	0.2074	-0.23925	-0.18456	-0.26865	-0.25631	-0.18727	0.0634	0.03541	-0.0883
Qmean+	0.07537	-0.4056	0.443	0.47122	0.41348	0.24273	0.47954	-0.43374	-0.32461	0.26424
Qmean+-area	-0.19173	0.2821	-0.52683	-0.38754	**-0.57062**	**-0.40428**	-0.62339	0.52331	0.46394	**-0.4033**
Qgeomean	-0.06232	-0.45513	0.34467	0.49372	0.34059	0.13538	0.47141	-0.47393	-0.4261	0.23883
Qmean(ln)	-0.05386	-0.40506	0.34234	0.45478	0.33209	0.12762	0.3517	-0.35808	-0.33722	0.14179
Qmean(ln)area	-0.11771	0.01049	-0.18938	-0.03738	-0.24529	-0.13478	-0.15723	0.15866	0.10946	-0.1115
SD(ln)	0.0537	-0.27806	0.24524	0.31038	0.22474	0.17018	0.23692	-0.09965	-0.08186	0.2009
COV(ln)	0.04947	-0.06348	0.01964	0.08573	0.01545	0.08367	0.0759	0.00038	-0.01046	0.13081
BFR	-0.16834	-0.52573	**0.59367**	0.5913	0.37178	-0.0859	0.27259	-0.49773	-0.39869	0.16303
Tdry	-0.06104	0.07662	-0.3215	-0.15589	-0.23705	-0.05916	-0.21361	0.30313	0.22065	-0.18507
T3xQ50	0.06824	-0.2106	0.19156	0.35753	0.1404	-0.07821	0.0479	0.02259	0.00361	0.09626
TQmean	-0.17629	-0.4272	0.2852	0.47476	0.16872	-0.1504	0.14558	-0.29418	-0.27096	0.04643
TQ90	-0.11749	0.0721	-0.23992	-0.02775	-0.24845	-0.15871	-0.06046	-0.04445	-0.13966	-0.11471
mean+	0.1659	-0.23803	0.37296	0.32225	0.30598	0.23481	0.404	-0.3384	-0.24561	0.22081
mean+-area	-0.04626	0.43692	-0.5792	-0.49447	-0.55974	-0.35125	**-0.65634**	**0.64997**	**0.47796**	-0.36923
mean-	0.17829	-0.20213	0.34382	0.27294	0.28129	0.25492	0.38956	-0.31178	-0.23657	0.21648
mean--area	-0.06876	**0.53962**	**-0.68811**	**-0.71089**	**-0.657**	**-0.40157**	**-0.75315**	**0.6498**	**0.61805**	**-0.42434**
FHn	0.09932	**0.62436**	-0.55773	**-0.73605**	-0.51361	-0.20301	-0.55148	0.49247	0.47698	-0.22624
FHd	**-0.25811**	-0.53358	0.39161	0.56642	0.27613	0.06732	0.31192	-0.35628	-0.38516	0.08875
FLn	0.10015	0.25812	-0.34232	-0.39685	-0.31815	-0.18632	-0.45252	0.53369	0.53025	-0.19352
FLd	**-0.33851**	-0.45083	0.15862	0.44919	0.08367	0.22629	0.30861	-0.22908	-0.36001	-0.01678

Appendix C – Correlations of hydrologic and biologic parameters (cont.)

Daily Flows grouping by Impervious Cover Period (cont.)

	Benthic macroinvertebrates									
	Ephemeroptera Taxa	**Percent Chironomidae**	**Percent Elmidae**	**Noninsect Taxa**	**EPT Taxa**	**Percent EPT**	**Percent Collector**	**Percent Predator**	**Percent Filterer**	**Percent Grazer**
Qmean	0.36765	-0.32428	0.34344	0.10297	0.47902	0.32077	-0.14025	-0.36026	0.18352	0.05872
Qmean-area	-0.54586	0.35166	-0.13379	**-0.45767**	-0.56695	-0.24463	-0.01266	-0.00716	0.02827	**-0.38621**
SD	0.27827	-0.25427	0.33403	0.09248	0.4078	0.21584	-0.18661	-0.29578	0.20416	0.12214
COV	-0.02507	0.05412	0.0242	0.048	0.05586	-0.07445	-0.13005	0.01958	0.07337	0.13485
Qpeak	0.28064	-0.2548	0.34638	0.10853	0.41171	0.19165	-0.18514	-0.28211	0.18325	0.17204
Qpeak-area	-0.45798	0.15593	-0.15332	**-0.47455**	-0.41855	-0.12633	0.11548	-0.08956	-0.03072	**-0.40655**
Q10	0.04896	-0.09148	0.3212	-0.28798	0.0961	0.18319	0.2476	-0.18029	-0.15631	0.0172
Q90	0.43214	-0.37127	0.30026	0.14406	0.52537	0.3493	-0.1429	-0.38016	0.18147	0.0404
Q90-area	-0.26192	0.0467	-0.03469	-0.36018	-0.26323	-0.04662	0.05019	-0.27236	-0.02409	-0.28781
Q50	0.30937	-0.29613	**0.47352**	-0.02584	0.36408	0.37071	0.08077	-0.34146	0.01093	0.02569
Q50-area	-0.21897	0.11957	0.22419	-0.22493	-0.20838	0.04029	0.11349	-0.07355	-0.04931	-0.1245
Qmean+	0.40176	-0.32319	0.31823	0.15894	0.50936	0.32157	-0.18666	-0.3518	0.21428	0.10132
Qmean+-area	-0.55796	0.48822	-0.30653	-0.40331	-0.64036	-0.36101	-0.08504	0.12051	0.08601	-0.34817
Qgeomean	0.48407	-0.40273	**0.47162**	0.06136	0.56343	0.44763	-0.01857	**-0.44876**	0.09481	0.17204
Qmean(ln)	0.3535	-0.28385	0.19295	0.15841	0.39529	0.35235	-0.20925	-0.26528	**0.25767**	-0.03898
Qmean(ln)area	-0.11319	0.21169	-0.11245	-0.03937	-0.17416	-0.07733	-0.14462	0.0944	0.19849	-0.20708
SD(ln)	0.23945	-0.0109	-0.09036	0.27359	0.21593	-0.01234	**-0.27325**	0.00332	0.22658	-0.10302
COV(ln)	0.07426	0.15258	-0.10589	0.17238	0.03399	-0.07432	**-0.22361**	0.14576	**0.23334**	-0.14444
BFR	0.36803	-0.53164	0.22203	0.09429	0.38332	0.29549	0.19117	-0.3102	-0.11952	0.01034
Tdry	-0.16274	0.21558	-0.4185	0.10522	-0.24133	-0.21403	-0.03602	0.21828	0.02864	0.00492
T3xQ50	0.06273	0.09012	0.05704	-0.03856	0.07989	-0.03398	-0.18449	-0.34772	0.22834	-0.13709
TQmean	0.21908	-0.30644	0.27742	-0.11877	0.25084	0.338	0.05573	**-0.43127**	0.0443	-0.15895
TQ90	-0.04953	-0.00479	0.15117	-0.22677	-0.00993	0.25181	-0.02132	-0.26896	0.208	-0.2356
mean+	0.29068	-0.23626	0.37511	0.07963	0.41871	0.25914	-0.17877	-0.30963	0.21035	0.14186
mean+-area	-0.60499	**0.61363**	-0.27782	-0.41093	**-0.68254**	-0.42007	-0.06892	0.23234	0.10195	-0.35188
mean-	0.2716	-0.20198	0.36634	0.0651	0.39951	0.24217	-0.18971	-0.28096	0.22095	0.1464
mean--area	**-0.72996**	**0.64962**	-0.39101	-0.41504	**-0.80335**	**-0.55583**	-0.06453	0.37593	0.03234	-0.37551
FHn	**-0.62644**	0.55794	-0.12326	-0.38509	-0.62416	-0.38441	0.04812	0.33535	-0.0447	-0.21499
FHd	0.44219	-0.42042	-0.0504	0.20062	0.39729	0.31546	-0.2136	-0.26801	0.19694	0.12306
FLn	-0.48819	0.51365	-0.3369	-0.12328	-0.5428	**-0.52361**	-0.04074	0.34159	-0.01961	-0.23234
FLd	0.50899	-0.3126	-0.12937	0.28277	0.42564	0.31992	-0.18628	-0.26646	0.15218	0.2546

Appendix C – Correlations of hydrologic and biologic parameters (cont.)

Daily Flows grouping by Impervious Cover Period (cont.)

	Benthic macroinvertebrates								
	Trichoptera as Hydropsychidae	**Intolerant/ Tolerant**	**Intolerant Taxa**	**Percent Tolerant**	**% Dominance (Top 3)**	**Dominant Guild**	**EPT/ EPT+Chiron**	**Quantitative ALU**	**Qualitative ALU**
Qmean	0.07085	0.36795	0.49825	-0.19731	-0.49395	-0.04228	0.35542	0.40031	0.48861
Qmean-area	-0.11477	-0.21694	-0.54294	-0.21254	0.41262	0.22813	-0.35683	-0.51025	-0.4885
SD	0.11332	0.22414	0.41217	-0.16738	-0.41212	0.01344	0.27116	0.3476	0.40876
COV	0.18283	-0.20389	-0.05146	0.07024	0.07144	0.02555	-0.02572	0.0253	-0.04622
Qpeak	0.12726	0.18529	0.41668	-0.1654	-0.39544	-0.00057	0.26213	0.35887	0.39808
Qpeak-area	0.10611	-0.21209	-0.44541	-0.18887	0.27825	**0.33862**	-0.17571	-0.38327	-0.39773
Q10	0.1996	0.20339	0.13125	-0.15497	-0.15622	-0.10475	0.16105	0.19399	0.11293
Q90	0.02326	0.4321	0.55356	-0.20448	-0.54075	-0.06734	0.39108	0.42779	0.53021
Q90-area	-0.13649	-0.00418	-0.23689	-0.27308	0.13293	0.06234	-0.11378	-0.24635	-0.1719
Q50	0.08342	0.45476	0.41863	-0.18958	-0.3796	-0.17997	0.3499	0.3446	0.39535
Q50-area	0.04011	0.08112	-0.14925	-0.25888	0.0791	0.02635	-0.05	-0.13379	-0.11891
Qmean+	0.05314	0.35299	0.51198	-0.17553	-0.5107	-0.02249	0.35916	0.41412	0.5059
Qmean+-area	**-0.22659**	-0.37311	-0.67672	0.03055	0.57597	0.27592	-0.49797	-0.63463	-0.60244
Qgeomean	0.09172	**0.49563**	0.56762	-0.21292	-0.5331	-0.15905	0.45475	0.50785	0.56407
Qmean(ln)	-0.0545	0.36034	0.41248	-0.15715	-0.43543	0.01839	0.31899	0.26879	0.39329
Qmean(ln)area	**-0.22281**	-0.07911	-0.205	-0.01533	0.08982	0.21462	-0.17841	-0.2669	-0.16358
SD(ln)	-0.21125	0.01724	0.21211	0.07492	-0.22181	0.12047	0.03971	0.02401	0.15838
COV(ln)	-0.17879	-0.05157	0.02355	0.01608	-0.12362	0.21575	-0.08744	-0.10068	-0.00861
BFR	-0.08753	0.41385	0.48074	-0.25956	-0.4843	-0.19516	0.42592	0.35959	0.47433
Tdry	-0.14865	-0.35768	-0.33159	**0.41699**	0.33809	0.06021	-0.26059	-0.28892	-0.32812
T3xQ50	-0.12814	0.04115	0.09256	0.04196	-0.10031	0.05104	0.01303	-0.0579	0.08266
TQmean	-0.0393	0.37529	0.29694	-0.2683	-0.34089	-0.082	0.34565	0.19122	0.32641
TQ90	0.03862	0.23092	0.02227	-0.173	-0.11755	0.08221	0.12314	-0.0383	0.05006
mean+	0.11559	0.24965	0.41787	-0.15637	-0.40697	0.00846	0.28893	0.35274	0.4149
mean+-area	-0.19287	-0.42863	**-0.72133**	0.06084	**0.65127**	**0.3502**	-0.53341	**-0.67673**	**-0.6968**
mean-	0.13242	0.22828	0.39957	-0.14217	-0.3906	0.03812	0.26355	0.34196	0.38578
mean--area	-0.1528	**-0.51773**	**-0.81831**	0.10277	**0.73457**	0.32093	**-0.70619**	**-0.76599**	**-0.82313**
FHn	0.08741	-0.35762	-0.63218	0.01524	0.52711	0.31933	-0.53793	-0.55241	-0.64728
FHd	0.0481	0.20191	0.4102	0.12434	-0.37241	-0.11814	0.42821	0.37767	0.45456
FLn	-0.21832	-0.47817	-0.57056	**0.30005**	0.57585	0.23794	**-0.58033**	-0.58979	-0.60875
FLd	-0.1322	0.20626	0.33601	0.00811	-0.28957	-0.03335	0.33113	0.33019	0.38965

Appendix C – Correlations of hydrologic and biologic parameters (cont.)

Daily Flows grouping by Water Year

	DIATOMS					Benthic macroinvertebrates				
	# of Taxa	% Motile	% Similarity	PTI	Cymbella Richness	# of Organisms	# of Taxa	% Dominance (Top 1)	HBI	Diptera Taxa
Qmean	0.25092	0.00129	0.22752	0.17912	0.33363	0.31861	0.36396	-0.31152	-0.29279	0.24187
Qmean-area	-0.107	0.29689	-0.20887	-0.30872	-0.25521	-0.03083	-0.32711	0.24869	0.10349	-0.16035
SD	0.40188	0.11789	0.18231	0.09359	0.31792	0.45405	0.41814	-0.26741	-0.27315	0.27202
COV	0.18525	0.1598	0.09095	-0.08386	0.06838	0.21404	0.02399	0.05925	-0.04812	0.04628
Qpeak	0.30224	0.05127	0.26979	0.12605	0.29053	0.28738	0.31539	-0.21638	-0.18811	0.21097
Qpeak-area	0.04419	0.25677	0.03875	-0.31365	-0.08283	0.08798	-0.2246	0.17793	0.07425	-0.05909
Q10	0.09777	0.06996	-0.02265	-0.03247	0.07325	0.11107	0.07977	-0.10504	-0.15758	0.17845
Q90	0.10557	-0.08255	0.20767	0.21352	0.29333	0.22156	0.29374	-0.28956	-0.29294	0.16839
Q90-area	-0.16313	0.13306	-0.16903	-0.10805	-0.18912	-0.04316	-0.18718	0.13172	0.00881	-0.1379
Q50	0.00518	-0.16366	0.13468	0.24194	0.19351	0.04372	0.15681	-0.2366	-0.31446	0.0723
Q50-area	-0.1508	0.00951	-0.07834	-0.00821	-0.11952	-0.10584	-0.15206	0.01945	-0.09176	-0.11157
Qmean+	0.23951	0.0104	0.21822	0.16654	0.31402	0.31284	0.34973	-0.291	-0.28212	0.21877
Qmean+-area	-0.16656	0.29876	-0.28434	-0.35252	-0.33929	-0.09933	-0.42336	0.36731	0.21124	-0.22538
Qgeomean	-0.01627	-0.12053	0.13729	0.18924	0.16737	0.13272	0.18671	-0.24768	-0.35121	0.05657
Qmean(ln)	0.13576	-0.0233	0.07421	0.15958	0.26269	0.12483	0.21276	-0.19993	-0.20181	0.14561
Qmean(ln)area	-0.07901	0.15576	-0.2262	-0.14333	-0.12056	-0.10673	-0.2207	0.34549	0.16133	-0.09823
SD(ln)	0.06264	0.06829	-0.10266	-0.00977	0.00714	0.03556	0.00087	0.09189	0.13999	0.07836
COV(ln)	-0.02294	0.09125	-0.22073	-0.08099	-0.05075	-0.02466	-0.1009	0.20697	0.16104	0.00915
BFR	-0.03719	-0.38831	0.07832	0.46887	0.364	-0.02768	0.28561	-0.27445	-0.31092	0.0607
Tdry	-0.1136	0.07933	-0.14194	-0.22762	-0.3076	-0.18249	-0.23288	0.23365	0.44104	-0.11226
T3xQ50	-0.02836	-0.01325	0.00823	0.13834	0.0118	0.12427	0.04323	0.05456	-0.09612	-0.00518
TQmean	-0.11134	-0.11166	0.00012	0.19631	0.02702	0.05599	0.04772	-0.09578	-0.20771	-0.00787
TQ90	-0.12997	0.01203	-0.11561	0.04784	-0.09522	0.10143	-0.01101	0.02067	-0.19645	-0.0787
mean+	0.33635	0.13975	0.17787	0.04959	0.26612	0.33728	0.31067	-0.21566	-0.24442	0.19316
mean+-area	-0.0669	0.4153	-0.24442	-0.4928	-0.3442	-0.08677	-0.44117	0.40578	0.26027	-0.23131
mean-	0.30745	0.14241	0.17422	0.04671	0.25731	0.31369	0.29459	-0.21041	-0.23411	0.19294
mean--area	-0.1362	0.43954	-0.32334	-0.62647	-0.44146	-0.1409	-0.55688	0.48923	0.35759	-0.2733
FHn	-0.08489	0.43041	-0.27009	-0.60879	-0.48317	-0.10689	-0.55488	0.4521	0.244	-0.26887
FHd	-0.08055	-0.28825	0.01987	0.32904	0.2081	0.15979	0.13715	-0.13634	-0.08944	0.08929
FLn	-0.03026	0.2365	-0.14427	-0.42401	-0.3852	-0.16402	-0.39492	0.44967	0.4711	-0.22794
FLd	-0.14704	-0.33034	-0.02336	0.34393	0.19966	-0.004	0.1434	-0.18912	-0.117	0.11784

Appendix C – Correlations of hydrologic and biologic parameters (cont.)

Daily Flows grouping by Water Year (cont.)

	Benthic macroinvertebrates									
	Ephemeroptera Taxa	Percent Chironomidae	Percent Elmidae	Noninsect Taxa	EPT Taxa	Percent EPT	Percent Collector	Percent Predator	Percent Filterer	Percent Grazer
Qmean	0.41023	-0.21214	-0.05885	0.04678	0.48484	0.27545	-0.2383	-0.29751	0.30877	-0.16779
Qmean-area	-0.19943	0.15344	-0.31761	-0.28986	-0.20168	0.06972	0.01326	-0.09311	0.05402	-0.31059
SD	0.44007	-0.18074	-0.0591	0.09697	0.50882	0.2522	-0.24566	-0.20077	0.25873	-0.168
COV	0.04854	0.042	-0.18612	-0.10337	0.12141	0.15886	-0.15335	-0.09339	0.16101	-0.1112
Qpeak	0.27346	-0.12728	0.01159	0.04084	0.37265	0.17413	-0.22928	-0.19396	0.25813	-0.12328
Qpeak-area	-0.17663	0.11263	-0.23511	-0.26233	-0.11336	0.08049	0.00527	0.0208	0.03549	-0.2129
Q10	0.15609	-0.10457	0.02262	-0.1949	0.23162	0.24469	0.17827	-0.2528	-0.03184	-0.14289
Q90	0.39698	-0.24303	-0.09628	0.04167	0.44831	0.27366	-0.20674	-0.30785	0.26069	-0.13279
Q90-area	-0.02895	0.00342	-0.27194	-0.17852	-0.04282	0.10532	-0.03604	-0.19792	0.05032	-0.26615
Q50	0.34603	-0.21104	-0.03946	-0.06539	0.3145	0.21942	-0.03873	-0.30847	0.24314	-0.17053
Q50-area	-0.02533	-0.07251	-0.11665	-0.18379	-0.04967	0.14755	0.13957	-0.23549	0.02378	-0.18827
Qmean+	0.39236	-0.18028	-0.06816	0.05618	0.46188	0.261	-0.26745	-0.27378	0.33761	-0.1579
Qmean+-area	-0.29465	0.40216	-0.34384	-0.27353	-0.33971	-0.07512	-0.07427	0.06978	0.14448	-0.27089
Qgeomean	0.37245	-0.23308	-0.06078	-0.05817	0.37955	0.30825	-0.10762	-0.33631	0.3168	-0.16185
Qmean(ln)	0.33898	-0.06853	-0.07903	0.05092	0.28267	0.10288	-0.23743	-0.0769	0.27238	-0.16253
Qmean(ln)area	-0.10215	0.4693	-0.16497	-0.09967	-0.20568	-0.21609	-0.17354	0.20654	0.23471	-0.19268
SD(ln)	0.01476	0.31372	-0.16804	0.07865	-0.04921	-0.1709	-0.28955	0.15183	0.19274	-0.12017
COV(ln)	-0.05197	0.41137	-0.14717	-0.00656	-0.13485	-0.2201	-0.26512	0.27544	0.19327	-0.11977
BFR	0.37821	-0.32562	0.17809	0.1676	0.34929	0.075	0.05029	-0.25701	0.00138	-0.10711
Tdry	-0.38456	0.33806	-0.17737	0.13259	-0.42899	-0.42255	-0.17283	0.42699	-0.06688	0.18072
T3xQ50	0.21968	0.01712	-0.24423	-0.02204	0.1814	0.10976	-0.18371	-0.27297	0.29236	-0.24413
TQmean	0.2517	-0.17908	-0.18032	-0.07539	0.21507	0.27081	0.01628	-0.36278	0.14522	-0.22312
TQ90	0.19754	-0.07337	-0.23272	-0.09759	0.15357	0.28598	-0.03853	-0.32063	0.20188	-0.1561
mean+	0.31236	-0.10767	-0.01417	0.02031	0.38833	0.24746	-0.24851	-0.2104	0.33959	-0.14561
mean+-area	-0.35407	0.4481	-0.29026	-0.27384	-0.3902	-0.11454	-0.0484	0.2265	0.09781	-0.18939
mean-	0.29202	-0.07459	-0.02941	-0.00585	0.36929	0.24013	-0.25841	-0.17962	0.33703	-0.14836
mean--area	-0.50021	0.54048	-0.30647	-0.31061	-0.54648	-0.21305	-0.02956	0.31873	0.05783	-0.16012
FHn	-0.54906	0.37214	-0.07622	-0.39151	-0.54157	-0.03077	0.20642	0.10375	-0.04681	0.01527
FHd	0.2966	-0.16074	-0.15104	0.07579	0.22654	0.06541	-0.0892	-0.19854	0.12258	-0.15435
FLn	-0.45949	0.49857	-0.17437	-0.02504	-0.52532	-0.39785	-0.03968	0.40261	-0.05277	0.08517
FLd	0.18395	-0.14293	-0.11763	0.09654	0.17871	0.02819	-0.31689	0.01656	0.21131	-0.02065

Appendix C – Correlations of hydrologic and biologic parameters (cont.)

Daily Flows grouping by Water Year (cont.)

	Benthic macroinvertebrates								
	Trichoptera as Hydropsychidae	Intolerant/ Tolerant	Intolerant Taxa	Percent Tolerant	% Dominance (Top 3)	Dominant Guild	EPT/ EPT+Chiron	Quantitative ALU	Qualitative ALU
Qmean	0.02681	0.10974	0.41642	-0.1922	-0.38038	-0.01244	0.28787	0.29958	0.43029
Qmean-area	-0.03279	-0.04995	-0.27496	-0.10508	0.26443	0.15952	-0.11509	-0.27166	-0.27222
SD	0.03146	0.12642	0.4688	-0.14798	-0.32665	-0.04809	0.26105	0.34667	0.42358
COV	0.13688	0.06625	0.05066	-0.07373	0.01795	0.09268	0.05442	-0.01019	0.03964
Qpeak	0.11389	0.08889	0.36008	-0.11612	-0.25687	-0.01173	0.17079	0.22546	0.31371
Qpeak-area	0.14748	0.07251	-0.16429	-0.02155	0.18116	0.12766	-0.06464	-0.17327	-0.20939
Q10	0.19342	0.06664	0.16777	-0.12968	-0.13423	-0.06249	0.21565	0.18564	0.16566
Q90	-0.05763	0.13867	0.34767	-0.19365	-0.35968	0.00995	0.30604	0.25161	0.40368
Q90-area	-0.15242	0.00602	-0.13148	-0.14388	0.13333	0.09106	-0.00172	-0.15585	-0.08821
Q50	0.02575	0.13998	0.29515	-0.16308	-0.29841	-0.02298	0.24735	0.22671	0.28428
Q50-area	0.03324	0.02351	-0.06962	-0.0962	0.04796	0.01944	0.08149	-0.04892	-0.03965
Qmean+	0.01947	0.0904	0.38575	-0.18422	-0.36159	0.01212	0.26427	0.27472	0.4077
Qmean+-area	-0.04828	-0.16085	-0.42345	-0.0396	0.39599	0.20361	-0.29461	-0.40213	-0.42295
Qgeomean	0.03751	0.10986	0.29183	-0.1856	-0.31264	0.04789	0.30881	0.25725	0.33335
Qmean(ln)	-0.10989	0.04699	0.25483	-0.16018	-0.24508	-0.01279	0.09908	0.11995	0.22768
Qmean(ln)area	-0.20633	-0.14335	-0.22883	-0.06978	0.28039	0.19681	-0.34507	-0.33168	-0.27821
SD(ln)	-0.20027	-0.06808	-0.06748	-0.04407	0.04109	0.03785	-0.22851	-0.1982	-0.08195
COV(ln)	-0.14517	-0.12174	-0.15028	-0.03527	0.15929	0.09598	-0.30551	-0.27829	-0.19694
BFR	-0.15346	0.14955	0.3767	-0.172	-0.32496	-0.19474	0.2174	0.2687	0.34545
Tdry	-0.13991	-0.26802	-0.42091	0.36475	0.29945	0.06071	-0.44463	-0.40884	-0.37804
T3xQ50	-0.11771	0.01182	0.07922	-0.14409	-0.06418	0.09987	0.08166	0.0086	0.12472
TQmean	-0.06102	0.10045	0.11207	-0.19233	-0.14126	0.01863	0.23835	0.09175	0.20303
TQ90	-0.05727	0.04314	0.01288	-0.16208	-0.01937	0.09177	0.18288	0.02629	0.1216
mean+	0.11499	0.02716	0.35142	-0.1431	-0.26198	0.03596	0.20106	0.23912	0.33573
mean+-area	0.01792	-0.19594	-0.45821	0.02829	0.44943	0.23499	-0.3518	-0.40483	-0.49788
mean-	0.12613	0.02785	0.3312	-0.15636	-0.26179	0.02776	0.18695	0.22977	0.31112
mean--area	0.03573	-0.22158	-0.58112	0.07038	0.55013	0.28217	-0.4701	-0.52705	-0.64125
FHn	0.23341	-0.10119	-0.53987	0.05948	0.49906	0.30415	-0.2817	-0.40467	-0.57755
FHd	-0.14898	0.00142	0.13208	-0.1172	-0.16578	0.02734	0.16351	0.05969	0.1745
FLn	-0.14604	-0.25044	-0.51723	0.18135	0.53798	0.2449	-0.5246	-0.48821	-0.54785
FLd	-0.04929	-0.06894	0.1171	0.22252	-0.23867	-0.11133	0.10645	0.08107	0.2124

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset.

Sub-daily Flows grouped by Impervious Cover Period

HBI																	
Intercept	Mean--area	FLn	Tdry	Qpeak-area	FHd									N	ADJRSQ	AIC	SBC
4.851	14.696	0.008												53	0.4955	-68.0518	-61.9758
4.945	14.767	0.012	-0.644											52	0.5193	-69.8324	-61.7310
4.905	18.982													54	0.4576	-64.9524	-60.9017
4.779	10.684	0.008		0.003										52	0.5081	-68.5365	-60.4351
5.021	13.061	0.007			-0.024									52	0.5077	-68.4979	-60.3965

Ephemeroptera																	
Intercept	Qmean-area	Qmean+-area	Qgeomean	Qmean(ln)-area	Tdry	mean+-area	mean--area	FHn	FHd	TQ0.5yr	TQ0.75yr	TQ1yr	FLd	N	ADJRSQ	AIC	SBC
2.984			0.139	-3.957		11.786	-49.542		0.164	455.671		-1789.127		48	0.7355	-2.4265	13.7763
4.312	-30.125	1073.127	0.136		-3.395				0.144	460.734		-1797.550		48	0.7308	-1.4404	14.7624
4.405	-29.976	1084.436	0.105		-3.671				0.172		1215.823	-2395.323		48	0.7280	-0.8581	15.3447
4.337	-26.400	1260.454	0.082		-3.065		-17.962		0.152		1130.275	-2253.645		47	0.7406	-2.7023	15.5259
4.127							-37.752	-0.011					0.027	52	0.6634	7.5460	15.6474

EPT																	
Intercept	Qmean-area	TQ90	Qgeomean	mean--area	FHn	FHd	FLd							N	ADJRSQ	AIC	SBC
6.746	-14.930		0.166	-53.443		0.113								51	0.7325	61.4396	71.5664
6.971	-12.397		0.174	-61.765			0.030							51	0.7298	61.9986	72.1253
7.013			0.115	-69.286	-0.016		0.031							51	0.7298	62.0016	72.1284
6.932		-14.573	0.180	-66.071		0.148								51	0.7282	62.3390	72.4657
6.478			0.121	-79.923			0.040							52	0.7127	64.5322	72.6336

Intolerant																	
Intercept	Qmean-area	TQ1yr	TQ0.5yr	Qgeomean	Tdry	Mean--area	Q90-area	COV						N	ADJRSQ	AIC	SBC
9.682	-58.585			0.212	-4.480		12.714							51	0.7378	73.2818	83.4086
9.666	-56.171	-2496.575	685.596	0.296	-4.619		10.886							49	0.7618	69.6746	83.8520
9.330	-43.597			0.177	-3.159	-31.484	9.476							50	0.7444	72.7436	84.8957
8.011	-15.062			0.202		-72.556								52	0.7153	76.9917	85.0931
9.370	-20.457			0.215		-52.295		-0.194						51	0.7292	75.0826	85.2094

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Sub-daily Flows grouped by Impervious Cover Period (cont.)

Dominance (Top 3)																	
Intercept	Qgeomean	TQmean	Qmean(ln)-area	Mean--area	T3xQ50	COV(ln)								N	ADJRSQ	AIC	SBC
54.368		-115.146	62.026	411.979	36.223	-0.748								50	0.6706	277.0419	289.1941
47.549				567.904		-0.269								53	0.6115	283.5396	289.6157
56.998		-67.549	49.578	449.394		-0.583								51	0.6439	280.5145	290.6413
44.765				561.111										54	0.5825	286.6214	290.6721
51.826	-0.613			504.560		-0.255								52	0.6219	282.9593	291.0607
Taxa																	
Intercept	Qmean-area	Qpeak-area	Mean--area	FHn	TQ0.75yr	TQ1yr								N	ADJRSQ	AIC	SBC
24.939	-36.009		-176.435		5418.356	-7752.315								51	0.6396	180.6402	190.7670
23.288			-227.096											54	0.5744	187.1569	191.2076
24.375			-193.122	-0.045										53	0.5959	185.2039	191.2800
24.574			-190.666	-0.048	5566.723	-8810.191								51	0.6362	181.1628	191.2896
24.141		-0.042	-180.188											53	0.5954	185.2688	191.3449
Percent Chironomidae																	
Intercept	Qmean-area	Qpeak-area	Q10	Q50-area	Qmean+-area	Qgeomean	COV(ln)	T3xQ50	TQmean					N	ADJRSQ	AIC	SBC
12.700		-0.153		664.543	12152.515	-1.070		87.256	-197.106					49	0.5631	297.8671	312.0446
13.044		-0.143	-11.766	839.337	12737.938			83.252	-232.096					49	0.5629	297.8918	312.0692
11.329		-0.128		589.230	13992.803			78.049	-218.076					50	0.5391	299.9912	312.1433
11.347	314.368	-0.165					0.295	60.249	-212.430					50	0.5357	300.4001	312.5522
12.741	297.060	-0.157						71.722	-215.271					51	0.5077	302.7910	312.9177
Percent EPT																	
Intercept	T3xQ50	TQmean	TQ90	Mean--area	FHd	FLd								N	ADJRSQ	AIC	SBC
46.682				-421.601	1.081									53	0.3934	324.8525	330.9285
53.969				-514.302										54	0.3585	327.0290	331.0797
47.020	-45.717		142.924	-455.670	1.102									51	0.4519	321.0235	331.1503
48.809	-51.272	100.438		-393.580		0.275								51	0.4502	321.1947	331.3215
53.775	-54.118	94.523		-434.781										52	0.4182	323.4493	331.5507
Percent Predators																	
Intercept	Q10	Q90-area	Q50-area	Qgeomean	Qmean(ln)-area	T3xQ50	mean+-area	Mean--area	FHd	FLd				N	ADJRSQ	AIC	SBC
41.559		-132.803	478.457	-1.673	47.793									51	0.4117	308.3432	318.4699
47.170		-95.571			45.142	-44.892		185.886		-0.296				50	0.4281	307.6586	319.8108
43.663		-136.090	413.172	-1.550	49.247					-0.190				50	0.4264	307.8183	319.9704
35.637	-16.855	-122.248	654.460				88.815							51	0.3891	310.4589	320.5857
43.143		-128.230	403.722	-1.449	51.216				-0.577					50	0.4173	308.6981	320.8502

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Sub-daily Flows grouped by Impervious Cover Period (cont.)

Quantitative ALU																	
Intercept	Qmean-area	Q90-area	Qgeomean	SD(ln)	T3xQ50	Mean--area	FHn	FLn						N	ADJRSQ	AIC	SBC
33.928			0.377		-11.865	-107.599	-0.049							51	0.6088	158.7539	168.8807
32.179	-56.221		0.434					-0.084						52	0.5843	161.2460	169.3474
34.787	-87.063	18.690	0.396	-0.334				-0.067						50	0.6239	157.4466	169.5988
35.878				-0.348		-139.657	-0.057							52	0.5811	161.6688	169.7703
31.682						-172.993								54	0.5335	165.8098	169.8605
Qualitative ALU																	
Intercept	Qmean-area	Q90-area	Qgeomean	Tdry	TQmean	Mean--area	FHn	FHd	FLn	TQ0.25yr	FLd			N	ADJRSQ	AIC	SBC
33.012	-98.548	22.226		-11.330						172.065	0.093			50	0.7198	146.9484	159.1005
30.672	-81.771			-10.720	30.945						0.093			51	0.7010	149.6791	159.8058
29.234	-73.865				33.241				-0.094					52	0.6828	152.0820	160.1834
29.819			0.258			-132.184	-0.049							52	0.6808	152.4366	160.5380
30.948	-89.065	19.492	0.286	-8.990				0.302						50	0.7111	148.6611	160.8132
Pollution Tolerance Index (Diatoms)																	
Intercept	Qmean-area	COV	Qpeak-area	Q90-area	T3xQ50	TQmean	FHd	FLn	FLd					N	ADJRSQ	AIC	SBC
2.273	-4.245					4.135	0.021							45	0.7003	-123.1353	-115.5680
2.370	-5.189					4.686								46	0.6793	-120.7340	-115.0586
2.297	-4.731					4.695			0.004					45	0.6915	-121.7196	-114.1524
2.602	-4.865	-0.023				4.101								45	0.6888	-121.2950	-113.7278
2.820	-8.815	-0.040	0.004	2.639	1.441			-0.005						42	0.7362	-126.7751	-113.5324
Percent Similarity (Diatoms)																	
Intercept	Qmean-area	COV	Qpeak-area	Q90-area	Qgeomean	Tdry	T3xQ50	TQ90	FHn	FHd				N	ADJRSQ	AIC	SBC
65.651	-318.557			137.441		-24.556	41.212	-176.912		-1.002				42	0.7169	228.9388	242.1815
69.226	-354.362		0.112	135.132		-27.237	34.264	-136.149	-0.125	-1.279				40	0.7460	225.2290	242.2553
65.047	-400.120		0.090	151.269		-27.525	40.279	-148.394		-0.979				41	0.7313	227.2025	242.3371
75.606	-350.533	-1.003	0.145	113.759		-24.442	36.238	-118.317	-0.132	-1.482				39	0.7531	224.5940	243.5123
67.879	-335.507			134.692	-0.739	-30.784	48.914	-161.741		-0.811				41	0.7241	228.4928	243.6273
Percent Motile (Diatoms)																	
Intercept	Q50-area	T3xQ50	TQmean	TQ90	FHd	FLd								N	ADJRSQ	AIC	SBC
36.659	423.509		-271.765	275.385		-0.333								44	0.6154	268.9286	278.3877
31.870	645.615	40.002	-317.020	232.383		-0.267								43	0.6308	267.7975	279.1484
27.653	836.075	55.395	-334.011	204.876										44	0.6026	270.5360	279.9951
35.313			-261.203	343.357		-0.418								45	0.5783	272.5460	280.1133
37.222	389.248		-228.883	239.536	-1.267									44	0.6006	270.7822	280.2413

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Sub-daily Flows grouped by Impervious Cover Period (cont.)

Cymbella Richness (Diatoms)																	
Intercept	Qmean-area	COV	Q90-area	Tdry	Mean--area	FHn	FHd	TQ0.25yr	FLd					N	ADJRSQ	AIC	SBC
5.502					-28.826	-0.024			-0.040					45	0.5375	29.7046	37.2719
6.631	-21.106	-0.183						58.865	-0.037					44	0.5624	27.8922	37.3513
4.897	-27.981		6.395				0.168		-0.070					44	0.5615	27.9962	37.4553
5.322	-20.692			-1.533			0.205		-0.067					44	0.5589	28.2840	37.7431
5.449	-28.391		5.569	-1.321			0.146		-0.060					43	0.5830	26.4008	37.7517

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Sub-daily Flows grouped by Water Year

HBI																
Intercept	Q90-area	Qmean+-area	Tdry	TQ90	mean--area	FHd	TQ0.25yr	TQ0.5yr	TQ0.75yr					N	ADJRSQ	AIC	SBC
4.785	3.462	-493.423	1.445		19.106		-30.538	75.946						114	0.4263	-115.7276	-96.1571
4.842	4.506	-424.360	1.448	-2.331	17.587		-29.350	72.873						113	0.4429	-118.3598	-95.9935
4.791	3.466	-491.040	1.431		19.004		-26.025		104.828					114	0.4174	-113.8748	-94.3042
4.774	4.483	-424.515	1.491	-2.436	16.484	0.002	-27.102	71.910						112	0.4518	-119.3708	-94.2087
4.848	4.494	-421.980	1.433	-2.313	17.497		-24.850		99.377					113	0.4336	-116.3542	-93.9879
Ephemeroptera																	
Intercept	Q50-area	COV(ln)	Tdry	mean+-area	mean--area	FHn	FHd							N	ADJRSQ	AIC	SBC
3.769			-1.404	4.159	-35.956	0.073	-0.006							115	0.5571	36.1785	52.9532
3.728			-1.168		-23.384	0.072	-0.007							116	0.5385	40.2193	54.1983
3.711		0.011	-1.383		-26.150	0.067	-0.006							115	0.5506	37.9394	54.7141
3.529			-1.304	5.174	-42.618	0.083								116	0.5353	41.0383	55.0173
3.904	-6.387		-1.712	3.831	-32.777	0.078	-0.005							114	0.5618	35.8325	55.4031
EPT																	
Intercept	Q10	Tdry	mean+-area	mean--area	FHn	FHd	TQ1yr							N	ADJRSQ	AIC	SBC
7.151		-2.301		-50.738	0.064	-0.010	401.432							115	0.5537	186.3149	203.0896
7.578		-2.466		-51.916		-0.013	498.250							116	0.5384	189.4306	203.4096
7.218		-2.655	6.064	-69.091	0.065	-0.009	390.169							114	0.5639	184.4519	204.0225
6.841		-2.492	7.632	-79.394	0.081		398.258							115	0.5496	187.4268	204.2016
6.340	0.705			-56.000	0.073	-0.010	437.096							115	0.5495	187.4381	204.2128
Intolerant																	
Intercept	Qpeak-area	Tdry	mean--area	FHd	TQ0.5yr	TQ0.75yr	TQ1yr							N	ADJRSQ	AIC	SBC
9.152		-3.150	-71.925	-0.017	-368.746		1335.752							115	0.5367	245.1273	261.9020
8.918		-2.972	-70.625	-0.015			413.982							116	0.5218	248.0100	261.9889
8.960		-2.971	-71.534	-0.016		-848.785	1739.063							115	0.5354	245.4641	262.2389
9.404		-3.442	-71.964	-0.017										117	0.5042	251.4014	262.5846
9.342	-0.026	-3.592	-53.858	-0.014	-406.835		1492.503							114	0.5453	243.7913	263.3618
Dominance (Top 3)																	
Intercept	SD(ln)	COV(ln)	mean+-area	mean--area	TQ0.75yr	FLd								N	ADJRSQ	AIC	SBC
52.779	-2.081	0.488	-74.972	578.853		0.082								115	0.5037	626.4535	643.2282
43.548				412.790		0.089								118	0.4551	634.8741	643.2615
46.998	-0.553			428.650		0.087								117	0.4667	633.2419	644.4251
43.279			-34.033	519.181		0.082								117	0.4647	633.7018	644.8849
45.016				400.336	-944.774	0.081								117	0.4645	633.7457	644.9288

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Sub-daily Flows grouped by Water Year (cont.)

Taxa																
Intercept	mean--area	FHd	TQ0.25yr	TQ0.5yr	TQ0.75yr	TQ1yr								N	ADJRSQ	AIC	SBC
23.033	-159.805	-0.035				1105.123								117	0.4658	441.8818	453.0650
23.105	-159.961	-0.035			640.497									117	0.4615	442.8474	454.0305
23.578	-164.407	-0.037	-81.229			1576.177								116	0.4700	441.9035	455.8824
24.123	-168.597	-0.038												118	0.4348	447.7399	456.1273
23.295	-162.423	-0.036		-485.844		2328.090								116	0.4686	442.2132	456.1922
Percent Chironomidae																	
Intercept	Qmean+-area	SD(ln)	COV(ln)	T3xQ50	TQmean	mean+-area	TQ0.25yr	TQ0.75yr						N	ADJRSQ	AIC	SBC
9.156	7096.209		0.180	27.594	-50.947		-361.491							115	0.4452	610.2373	627.0120
8.487	10335.697		0.283	30.471	-62.087	-50.553	-447.468							114	0.4612	607.6543	627.2249
8.876	6880.463		0.190	26.446	-46.089		-527.921	1187.961						114	0.4550	609.0320	628.6025
5.590	7848.270	0.832		25.714	-52.140		-375.165							115	0.4372	611.9723	628.7470
8.238	10035.005		0.290	29.288	-57.108	-49.086	-604.449	1138.319						113	0.4699	606.6037	628.9700
Percent EPT																	
Intercept	Qmean-area	COV	Tdry	T3xQ50	TQmean	TQ90	mean--area	TQ1yr						N	ADJRSQ	AIC	SBC
47.296		1.136	-26.341				-280.991							117	0.2267	737.1512	748.3343
47.559		1.886	-28.199				-370.539	-3564.598						116	0.2483	734.6784	748.6574
51.462	-134.895	1.729	-36.521	-44.787	90.639									115	0.2678	732.4544	749.2292
54.551	-156.396	1.113	-43.121	-34.810		150.706								115	0.2650	732.9150	749.6897
52.643			-29.239				-177.091							118	0.1930	741.3421	749.7295
Percent Predators																	
Intercept	COV(ln)	Tdry	TQmean	TQ90	mean+-area	mean--area	FLd							N	ADJRSQ	AIC	SBC
28.589				-58.738	63.588		0.110							117	0.2821	667.5054	678.6885
26.020		16.342		-55.475		209.609								117	0.2739	668.8876	680.0708
28.205			-31.432		56.297		0.099							117	0.2710	669.3681	680.5513
27.514	0.171			-68.027		191.228	0.092							116	0.2926	666.6826	680.6615
27.240		15.514		-51.343	52.999									117	0.2679	669.8797	681.0629
Quantitative ALU																	
Intercept	Qmean-area	Q90-area	Tdry	TQ90	mean--area	FHd								N	ADJRSQ	AIC	SBC
33.018			-5.932		-100.166	-0.023								117	0.3986	392.4506	403.6338
34.370		-8.010	-7.799		-88.083	-0.024								116	0.4123	390.6197	404.5986
34.450	-17.775		-8.434		-65.906	-0.021								116	0.4088	391.3388	405.3178
32.258			-5.400		-118.352									118	0.3690	397.2918	405.6792
34.948	-50.208		-11.708	16.793		-0.020								116	0.4068	391.7497	405.7287

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Sub-daily Flows grouped by Water Year (cont.)

Qualitative ALU																	
Intercept	COV	Tdry	mean--area	FHd	TQ0.25yr									N	ADJRSQ	AIC	SBC
30.231	0.227	-3.473	-139.391	-0.030										116	0.5427	347.4363	361.4152
29.542	0.257		-155.885	-0.029										117	0.5257	350.8883	362.0715
29.495			-129.324	-0.021	83.041									117	0.5252	351.0163	362.1995
30.209		-3.212	-117.464	-0.023	68.498									116	0.5385	348.5279	362.5068
31.187		-3.973	-121.339	-0.027										117	0.5232	351.5281	362.7112
Pollution Tolerance Index (Diatoms)																	
Intercept	Qmean-area	Qpeak-area	Q90-area	Qgeomean	TQmean	mean--area	TQ0.25yr							N	ADJRSQ	AIC	SBC
2.812		-0.008					8.187							83	0.3541	-193.8656	-186.5026
2.795	-1.978	-0.005			1.115									82	0.3732	-195.4858	-185.6684
2.824	-5.780		2.961											83	0.3430	-192.3945	-185.0315
2.817	-2.463	-0.005		-0.009	1.597									81	0.3925	-197.2346	-184.9628
2.832		-0.006				-2.888	7.106							82	0.3669	-194.6226	-184.8052
Percent Similarity (Diatoms)																	
Intercept	Qmean-area	COV	Q90-area	Qmean+-area	COV(ln)	T3xQ50	TQ90	mean--area	TQ0.25yr					N	ADJRSQ	AIC	SBC
51.604								-240.699						84	0.1223	492.9553	497.8640
54.690				-6666.630										84	0.1183	493.3451	498.2538
52.285				-6689.355					290.771					83	0.1474	491.4302	498.7932
51.070				-8046.288		15.362								83	0.1388	492.2885	499.6515
50.932	-241.840	1.693	152.624		-0.162		-99.160							80	0.2331	485.1528	499.8789
Percent Motile (Diatoms)																	
Intercept	Qmean-area	Q90-area	Q50-area	Qgeomean	TQmean	TQ0.25yr								N	ADJRSQ	AIC	SBC
15.765	151.815				-57.372									83	0.2589	480.2217	487.5847
12.593	234.518	-104.979												83	0.2510	481.1378	488.5009
11.586	253.002	-78.111	-189.537											82	0.2760	479.1757	488.9931
13.119	179.713		-296.056			-385.153								82	0.2747	479.3318	489.1491
14.734	171.022			0.377	-77.714									82	0.2727	479.5670	489.3844
Cymbella Richness (Diatoms)																	
Intercept	Qmean-area	Qmean+-area	Tdry	FHd	TQ0.5yr	TQ0.75yr	TQ1yr							N	ADJRSQ	AIC	SBC
5.188	-8.871		-2.213	-0.008		355.686								81	0.3820	92.6639	104.9356
5.163	-9.192		-2.156	-0.007	193.093									81	0.3789	93.1035	105.3752
4.634		-637.797		-0.009		391.235								82	0.3505	96.0051	105.8225
4.609		-657.034		-0.009	213.103									82	0.3498	96.0911	105.9085
5.252	-8.873		-2.293	-0.008			490.793							81	0.3723	94.0086	106.2804

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Daily Flows grouped by Water Year

HBI														
Intercept	Qmean-area	Qpeak-area		Qmean+-area	Tdry	T3xQ50	TQ90	FHd	FLn			N	ADJRSQ	AIC	SBC
4.764	15.027	-0.063		-589.589	1.417		-3.793		0.034			111	0.3901	-106.0208	-86.6260
4.671	15.698	-0.068		-619.880	1.519	0.933	-5.750		0.032			110	0.4064	-108.2833	-86.1178
4.862	6.055				1.428		-3.641					114	0.3216	-96.3039	-85.2212
4.714	11.793			-547.048	1.411		-3.070		0.030			112	0.3630	-101.8247	-85.2006
4.745	15.194	-0.058		-591.366	1.407		-4.509	0.003	0.036			110	0.4000	-107.0207	-84.8552
Ephemeroptera															
Intercept	Qmean-area	SD	COV	Qmean+-area	Tdry	TQ90	mean+-area	FHn				N	ADJRSQ	AIC	SBC
4.629	-18.022	0.002			-3.086	7.412	3.792	-0.078				111	0.5606	34.9522	54.3470
4.908	-20.280				-3.532	8.950	4.566	-0.085				112	0.5420	38.9058	55.5299
4.734	-24.232		0.149	933.197	-3.637	6.140		-0.077				111	0.5559	36.2028	55.5976
4.741	-19.793		0.101		-3.374	7.857	3.639	-0.084				111	0.5547	36.5235	55.9183
4.572	-20.818	0.003		889.884	-3.141	5.745		-0.067				111	0.5547	36.5304	55.9252
EPT															
Intercept	Qmean-area	SD	Q10	Qmean+-area	Tdry	TQ90	mean+-area	FHn				N	ADJRSQ	AIC	SBC
8.404	-27.859	0.008	0.822	1265.195	-4.740			-0.133				111	0.5974	169.7777	189.1725
7.972	-12.320	0.008	0.783		-3.196			-0.125				112	0.5844	172.5765	189.2006
7.743	-17.779	0.007	0.755		-3.229	6.128		-0.115				111	0.5940	170.7514	190.1462
8.161	-30.936	0.007	0.794	1131.900	-4.606	5.292		-0.124				110	0.6036	168.8728	191.0383
8.138	-24.946	0.006	0.719		-4.299	7.144	3.655	-0.131				110	0.5996	170.0689	192.2344
Intolerant Taxa															
Intercept	Qmean-area	SD	Q10	Q90-area	Tdry	FHn	FHd					N	ADJRSQ	AIC	SBC
10.142	-19.034	0.009			-5.613	-0.136						113	0.5547	233.4429	247.2963
9.897	-20.486	0.009	0.643		-4.834	-0.142						112	0.5641	231.8662	248.4903
10.531	-16.101	0.009			-5.676	-0.166	-0.016					112	0.5637	231.9951	248.6193
10.182		0.008		-7.773	-5.554	-0.174						113	0.5450	235.9851	249.8385
10.275	-17.657	0.009	0.601		-4.943	-0.170	-0.015					111	0.5715	230.7995	250.1942
Dominance (Top 3)															
Intercept	Qmean-area	SD	Q90-area	Q50-area	Tdry	TQmean	FHn	FLn				N	ADJRSQ	AIC	SBC
44.344	130.267	-0.025				-27.919		1.003				113	0.4362	622.0188	635.8722
42.191	89.662	-0.030						1.139				114	0.4113	626.1533	637.2360
40.366	69.738	-0.027					0.356	0.960				113	0.4277	623.7736	637.6270
45.109			51.528	233.953		-65.877		1.281				113	0.4246	624.4143	638.2677
46.524	118.465	-0.027			-11.984	-27.873		1.299				112	0.4418	621.7925	638.4166

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Daily Flows grouped by Water Year (cont.)

Taxa														
Intercept	Qmean-area	SD	Q10	Q90-area	Qmean+-area	mean--area	FHn	FLn			N	ADJRSQ	AIC	SBC
22.869		0.018				-35.949	-0.241				114	0.4472	434.6593	445.7420
24.081		0.019			-2600.158		-0.337				114	0.4472	434.6781	445.7608
24.097	-37.104	0.019	1.820				-0.368				113	0.4592	433.0332	446.8867
24.809	-35.191	0.019					-0.280	-0.196			113	0.4573	433.4500	447.3034
23.807		0.019		-7.956		-28.692	-0.268				113	0.4570	433.5074	447.3608

Percent Chironomidae														
Intercept	Qmean-area	Qpeak-area	Q90-area	Q50-area	Qmean(ln)-area	COV(ln)	T3xQ50	TQmean	mean--area	FLn	N	ADJRSQ	AIC	SBC
10.407				275.316	17.118		40.862	-104.538		0.508	112	0.4361	595.9617	612.5858
11.616		-1.123		189.011	12.530		39.188	-90.593	91.179		111	0.4503	593.8839	613.2787
11.169				195.000	16.362		37.241	-95.990	51.414		112	0.4294	597.3479	613.9720
10.555	319.916	-2.042	-104.093		17.699		39.401	-75.744			111	0.4460	594.8076	614.2024
10.531		-1.460		212.498		0.150	36.978	-83.410	113.279		111	0.4449	595.0344	614.4292

Percent EPT														
Intercept	Qmean-area	COV	Qpeak-area	Q90-area	Qgeomean	Tdry	T3xQ50	TQ90			N	ADJRSQ	AIC	SBC
50.536	-200.482		2.231			-37.756	-47.177	220.746			112	0.3177	705.5262	722.1503
50.272				-58.749		-37.731	-37.914	195.544			113	0.2831	710.4085	724.2619
49.605	-183.537		2.232		0.351	-35.020	-52.358	202.682			111	0.3223	705.6796	725.0744
50.860	-126.696	1.777				-38.301	-47.498	178.519			112	0.3006	708.4542	725.0783
52.234	-99.778					-36.379	-42.404	183.305			113	0.2767	711.4725	725.3259

Percent Predators														
Intercept	COV	Qpeak-area	Qmean+-area	Qmean(ln)-area	Tdry	mean--area	FHn				N	ADJRSQ	AIC	SBC
34.558			-17630.284			315.611	-0.862				114	0.2923	650.9787	662.0614
36.251		-1.099	-16844.398			338.546	-0.877				113	0.3096	649.0171	662.8706
30.979			-14913.853		12.133	263.320	-0.714				113	0.3082	649.2612	663.1146
34.896			-19717.253	9.273		302.841	-0.777				113	0.3052	649.7663	663.6197
36.735	-1.032		-16455.692			320.712	-0.872				113	0.3050	649.8035	663.6570

Quantitative ALU														
Intercept	Qmean-area	SD	COV	Qmean+-area	SD(ln)	COV(ln)	Tdry	mean+-area	mean--area	FHn	N	ADJRSQ	AIC	SBC
34.424	-98.784		0.689	5420.457		-0.058	-12.643	21.323	-73.790		110	0.4665	373.1461	395.3116
34.742	-35.653	0.010					-10.461			-0.126	113	0.4038	383.4240	397.2774
33.799	-40.593	0.008					-9.793	22.194	-53.500		112	0.4219	380.7398	397.3639
35.710	-97.318		0.718	5550.808	-0.280		-12.316	19.525	-76.133		110	0.4566	375.2965	397.4620
34.092	-94.078		0.825	6100.934		-0.054	-12.267		-43.847		111	0.4388	378.1807	397.5755

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Daily Flows grouped by Water Year (cont.)

Qualitative ALU														
Intercept	Qmean-area	SD	Q10	TQmean	mean--area	FHn	FHd	FLn			N	ADJRSQ	AIC	SBC
30.483	-41.584	0.011		15.154		-0.168	-0.041	-0.246			111	0.5793	330.2141	349.6089
29.473		0.012	1.081		-34.855	-0.156					113	0.5457	337.3938	351.2472
29.681		0.013			-36.936	-0.130					114	0.5299	340.4683	351.5511
29.954		0.012			-29.168	-0.128		-0.131			113	0.5439	337.8657	351.7192
28.807		0.014			-47.594						115	0.5137	343.4949	351.8070
Pollution Tolerance Index (Diatoms)														
Intercept	Qmean-area	SD	COV	Qpeak-area	Q50-area	Qmean+-area	mean+-area	mean--area			N	ADJRSQ	AIC	SBC
2.906	-2.996					498.255		-6.362			79	0.5135	-208.6483	-198.9729
2.874	-3.386	-0.001	0.055			528.852		-7.457			77	0.5483	-212.9344	-198.4214
2.882	-3.343	-0.001	0.054			473.928	1.036	-9.056			76	0.5627	-214.7145	-197.7826
2.885	-4.079			0.026		572.193		-7.088			78	0.5259	-209.8483	-197.7541
2.873					-4.175	438.173		-7.200			79	0.5042	-207.0841	-197.4087
Percent Similarity (Diatoms)														
Intercept	Qpeak-area	Qmean+-area		mean+-area	mean--area	FLn					N	ADJRSQ	AIC	SBC
49.556	1.655				-115.804						80	0.1348	471.3570	478.6136
52.411					-77.299						81	0.0961	474.0196	478.8573
47.967	2.252				-168.346	0.548					79	0.1610	469.7614	479.4368
46.627	2.117			55.001	-287.673	0.721					78	0.1817	468.6311	480.7253
53.083		-5918.563									81	0.0735	476.0651	480.9028
Percent Motile (Diatoms)														
Intercept	Qmean-area	SD	Qpeak-area	Q90-area	TQmean	FHn					N	ADJRSQ	AIC	SBC
12.894	477.351	0.042	-2.712	-112.045	-64.513						77	0.3493	456.9405	471.4536
13.949	189.617	0.030			-72.994						79	0.2824	463.1936	472.8690
9.400	144.887	0.031			-57.839	0.434					78	0.3066	461.2880	473.3822
10.527	215.729	0.044	-1.812		-72.339	0.468					77	0.3330	458.9900	473.5031
15.318	257.939	0.041	-1.664		-87.418						78	0.3028	461.7336	473.8278
Cymbella Richness (Diatoms)														
Intercept	SD	Q90-area		Tdry	TQ90	FHn					N	ADJRSQ	AIC	SBC
4.604	0.003					-0.091					80	0.2650	100.4411	107.6976
4.967	0.004				-3.957	-0.087					79	0.2834	99.2934	108.9688
5.419	0.004			-1.689	-5.006	-0.078					78	0.3118	96.8753	108.9695
5.402	0.003	-3.005		-1.914		-0.075					78	0.3096	97.1387	109.2329
4.876	0.003			-1.288		-0.085					79	0.2784	99.8669	109.5422

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Daily Flows grouped by Impervious Cover Period

HBI														
Intercept	Qmean-area	SD	Qmean+-area	TQmean	TQ90	mean+-area	FLn				N	ADJRSQ	AIC	SBC
5.131	8.503				-7.249		0.044				52	0.4588	-63.1891	-55.0876
5.071	12.883			-3.594		-3.507	0.076				51	0.4819	-64.7250	-54.5983
5.089	11.755				-7.248	-2.146	0.069				51	0.4766	-64.1527	-54.0259
5.117	12.866		-452.427		-6.930		0.065				51	0.4710	-63.5579	-53.4311
5.144	9.892	0.001			-9.416		0.045				51	0.4695	-63.3961	-53.2693
Ephemeroptera														
Intercept	Qmean-area	SD	Qmean+-area	Qgeomean	TQmean	mean--area	FLn				N	ADJRSQ	AIC	SBC
4.322	-35.678		1753.225	0.125			-0.151				51	0.6221	14.9341	25.0609
4.061	-40.173		1638.607		7.758		-0.145				51	0.6168	15.7261	25.8529
4.261	-29.787		1884.686	0.097		-8.546	-0.103				50	0.6354	13.8285	25.9806
4.015	-38.349		1688.672	0.079	4.424		-0.139				50	0.6341	14.0298	26.1819
4.318	-34.592	-0.002	1548.367	0.183			-0.133				50	0.6333	14.1529	26.3050
EPT														
Intercept	Qmean-area	Q90-area	Q50-area	Qmean+-area	Qgeomean	COV(ln)	mean--area	FLn			N	ADJRSQ	AIC	SBC
7.636	-17.172				0.212		-19.965				52	0.7111	64.8325	72.9339
7.294			-38.529		0.201		-26.137				52	0.7042	66.1567	74.2581
7.463	-24.149			1156.718	0.203		-25.660				51	0.7162	64.7469	74.8736
7.816	-50.745	10.143			0.241			-0.126			51	0.7162	64.7492	74.8759
7.451	-14.611				0.196	0.018	-22.084				51	0.7121	65.5537	75.6805
Intolerant Taxa														
Intercept	Qmean-area	Q90-area	Qgeomean	COV(ln)	Tdry	mean--area	FHn				N	ADJRSQ	AIC	SBC
8.304	-14.540		0.218			-25.717					52	0.7180	76.4543	84.5557
7.945			0.164			-33.428					53	0.7008	78.8307	84.9067
10.663	-34.702		0.232		-4.968		-0.118				51	0.7296	75.0075	85.1343
7.727			0.153	0.032		-34.792					52	0.7139	77.2527	85.3541
9.930	-69.493	14.215	0.238		-4.849						51	0.7267	75.6101	85.7369
Dominance (Top 3)														
Intercept	Qmean-area	COV	Qpeak-area	Q10	Qgeomean	SD(ln)	COV(ln)	TQ90	mean+-area	mean--area	N	ADJRSQ	AIC	SBC
56.992				-11.589			-0.536	-118.041	128.630		51	0.6476	279.9267	290.0534
67.324		-2.328		-12.676			-0.542	-134.065	134.438		50	0.6648	278.0122	290.1643
58.777			-0.959	-10.412			-0.569	-106.122	147.611		50	0.6645	278.0631	290.2152
34.807					-0.852	2.674	-0.901			201.840	51	0.6417	280.8662	290.9929
59.308	101.555		-1.273	-11.104			-0.483	-154.061	128.968		49	0.6767	276.8597	291.0372

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Daily Flows grouped by Impervious Cover Period (cont.)

Taxa														
Intercept	COV	Qgeomean	Qmean(ln)-area	COV(ln)	TQmean	mean--area					N	ADJRSQ	AIC	SBC
19.512	1.080			0.100		-84.909					52	0.6165	183.2109	191.3123
24.993		0.494		0.101	-24.973	-74.988					51	0.6343	181.4547	191.5815
26.589		0.522	8.725		-33.212	-82.251					51	0.6320	181.8042	191.9309
23.589				0.104		-82.361					53	0.5911	185.8641	191.9402
20.248	1.135					-81.894					53	0.5870	186.4284	192.5044

Percent Chironomidae														
Intercept	Qpeak-area	Q10	Q50-area	SD(ln)	T3xQ50	TQmean	mean+-area	mean--area	FHn		N	ADJRSQ	AIC	SBC
11.069	-1.762		669.537		90.617	-168.987		148.404			50	0.6110	290.4916	302.6437
12.105	-1.610	-8.785	861.737		97.044	-187.068		128.261			49	0.6241	289.4426	303.6200
7.620	-2.161	-13.335	726.635		84.739	-153.482	54.054		0.833		48	0.6394	287.9591	304.1619
15.725	-1.610	-11.605	922.284		86.327	-201.532	72.633				49	0.6192	290.1669	304.3444
6.997	-1.676		828.134	0.888	84.957	-188.156		137.787			49	0.6172	290.4612	304.6386

Percent EPT														
Intercept	Qmean-area	SD	Qpeak-area	Qmean+-area	Qgeomean	T3xQ50	TQ90	mean--area	FHd	FLn	N	ADJRSQ	AIC	SBC
35.889	-455.650	-0.047	2.529				415.680			-1.589	50	0.5175	314.7738	326.9259
28.578	-439.484	-0.046	2.669				421.809		0.262	-1.433	49	0.5279	314.4185	328.5959
39.639	-307.794	-0.044	2.787			-48.503	438.287	-176.882			49	0.5268	314.5523	328.7297
36.300	-569.593	-0.043	2.564	12524.209			393.356			-2.156	49	0.5262	314.6240	328.8014
35.504	-437.927	-0.060	2.495		0.900		369.678			-1.419	49	0.5205	315.2908	329.4683

Percent Predators														
Intercept	Qmean-area	COV	Qpeak-area	Q90-area	Qgeomean	T3xQ50	mean--area	FHn	FLn		N	ADJRSQ	AIC	SBC
54.075		-4.800		-109.121			143.930				52	0.3203	315.5187	323.6201
40.871			-1.722			-41.682	148.807				52	0.3076	316.5554	324.6568
41.839	326.016		-1.788	-132.067		-44.654			0.985		50	0.3763	312.5082	324.6603
33.388			-1.921		-1.160			1.166			52	0.3044	316.8159	324.9173
42.858						-64.934			1.205		53	0.2662	318.8779	324.9540

Quantitative ALU														
Intercept	Qmean-area	Qgeomean	T3xQ50	TQmean	mean--area	FLn					N	ADJRSQ	AIC	SBC
33.090		0.428		-16.571	-55.466						52	0.6237	155.6700	163.7714
32.690	-58.532	0.406				-0.367					52	0.6225	155.8386	163.9400
32.946					-63.485						54	0.5791	160.0542	164.1049
33.019		0.371	-9.510		-51.741						52	0.6212	156.0300	164.1314
31.188		0.232			-56.132						53	0.5995	158.2225	164.2986

Appendix D: Top five models based on the Schwarz Bayesian Criteria for predicting components of the Aquatic Life score from hydrologic parameters in each dataset (cont.).

Daily Flows grouped by Impervious Cover Period (cont.)

Qualitative ALU														
Intercept	Qmean-area	Qmean+-area	Qgeomean	Qmean(ln)-area	COV(ln)	Tdry	mean--area	FHd			N	ADJRSQ	AIC	SBC
29.736			0.293				-62.654				53	0.7063	146.8473	152.9233
29.426			0.278		0.045		-64.589				52	0.7117	146.7372	154.8387
29.721			0.250	3.600			-67.560				52	0.7107	146.9257	155.0271
28.658			0.316				-57.890	0.044			52	0.7067	147.6904	155.7918
32.453	-84.041	6405.650	0.262			-8.033	-65.397				50	0.7357	143.6627	155.8149
Pollution Tolerance Index (Diatoms)														
Intercept	Qpeak-area	Q90-area	Qmean+-area	Qmean(ln)-area	T3xQ50	TQ90	mean+-area	mean--area	FHn		N	ADJRSQ	AIC	SBC
2.787	0.028		450.516		1.062	-3.671		-6.800	-0.020		42	0.7893	-137.7869	-124.5442
2.653			536.699		1.380	-3.601		-8.320			44	0.7549	-132.0940	-122.6349
2.829	0.026		392.333		0.908	-3.672	0.928	-7.635	-0.021		41	0.7919	-137.5791	-122.4445
2.765	0.031	-0.757	573.643		1.007	-3.137		-7.613	-0.019		41	0.7917	-137.5334	-122.3989
2.783	0.029		365.898	0.281	1.010	-3.294		-6.645	-0.019		41	0.7905	-137.2535	-122.1189
Similarity (Diatoms)														
Intercept	Qmean-area	COV	Q10	Q90-area	Qgeomean	Tdry	T3xQ50	TQmean	FHd	FLn	N	ADJRSQ	AIC	SBC
44.490	-497.398	4.079		170.288	-1.329	-67.684	28.317		0.454	1.000	40	0.7495	224.5470	241.5734
46.022	-503.948	4.432		183.610	-0.895	-70.266			0.508	1.355	41	0.7306	227.3227	242.4573
41.871	-530.117	4.654	6.370	183.522	-1.723	-66.555	29.631		0.482	1.028	39	0.7548	224.2660	243.1842
44.294	-458.461	3.339		161.810		-63.245			0.479	1.408	42	0.7102	230.0792	243.3219
39.792	-485.675	4.944		151.640	-1.437	-68.688		58.448	0.500	1.321	40	0.7403	226.3132	243.3395
Motile Taxa (Diatoms)														
Intercept	Qmean-area	Q50-area	T3xQ50	TQmean	TQ90	FHd					N	ADJRSQ	AIC	SBC
43.085		556.181		-260.335	242.490	-0.424					44	0.5542	276.1705	285.6296
45.768	194.627			-177.483		-0.536					45	0.5274	278.1330	285.7003
38.083	153.157			-222.341	179.507	-0.456					44	0.5427	277.4203	286.8794
35.286		698.751		-306.003	323.089						45	0.5150	279.4001	286.9674
31.318		912.152	46.382	-351.048	268.887						44	0.5396	277.7427	287.2018
Intercept	SD(ln)	Tdry	T3xQ50	mean--area	FLn						N	ADJRSQ	AIC	SBC
5.288		-2.339		-23.618	0.160						45	0.4935	34.1654	41.7326
3.983	0.112			-15.864							46	0.4557	36.7614	42.4369
4.848				-21.118	0.080						46	0.4537	36.9483	42.6237
4.843				-15.932							47	0.4196	38.9695	42.7531
4.067			2.784	-16.221							46	0.4421	37.9789	43.6543