Progress Report for the Ohio Nutrient Plan - DRAFT

Outline for Region 5 State Nutrient Criteria Plans Update:
Plan Activities: List all activities that state included in plan (up to Spring 2004; see Tracking Table).

- Collect stream data (chl a, nutrients, habitat, fish, inverts)--headwaters and wadeable
  - Completed

- Analyze summer study
  - Ongoing: macroinvertebrate samples are currently being processed, and water chemistry data from O'Bannon Creek is being collated.

- Amend plan based on initial findings
  - Completed; however, the plan is being further amended to reflect, yet again, more budget problems.

- Determine if more stratification is needed
  - Completed for methods assessment (see Progress Summary below), but ongoing for the study as a whole.

- Provide R5 with progress update
  - Completed, see the following Progress Summary

Revision of Plan: Provide a description of any proposed changes to the plan.

- The three horizontal transects within a sampling site will be discard and replaced by a single transect within a given sampling site consisting of a composite sample of 15 rock scrapings and three sample splits of the resulting composite. The 15 rocks will be collected within a riffle-run complex representative of a given stream reach.

- Canopy cover estimates will be discarded as the degree of open arc is a better predictor of chlorophyll a concentrations. The degree of open arc will be calculated by averaging the results of several readings taken throughout a sample transect.

- Because of the omnipresent (and tiresome) budget problems, the original sampling plan is being scaled back such that samples will only be collected within TMDL basins. The upshot of this is that the yearly sample size will decrease and it will take longer to accrue a sample size sufficient to support the development of effects-based water quality criteria; hence, the adoption date for rivers and streams is likely to be pushed backed two years to 2008 - 2009.

Summary - Conclusions

The methods used in the present study to determine chlorophyll *a* concentrations from periphyton in Ohio streams appear to meet the data quality objectives outlined in the study plan. The primary objective of the first year of this study was to pilot the methods, especially with respect to within-transect, and between transect variability at a given site. The within-transect variability was generally low with most of the transects having a coefficient of variation less than twenty percent. Between transect (i.e., within sampling site) variability was higher, as was expected, and generally fell below sixty percent. The within sampling site variability was likely enhanced by the frequent spates and scouring stream flows experienced during the 2003 sampling period. Rainfall during the summer of 2003 was anomalously high and likely confounded all results. That said, longitudinal patterns in chlorophyll concentrations for each stream were similar between sampling passes and responded to habitat factors in a predicted fashion. The degree of open arc between the canopy of both streams banks was most strongly correlated with chlorophyll *a* concentration, and chlorophyll *a* concentrations were consistently higher downstream from the O'Bannon Creek WWTP compared to upstream.

Based on the above, the following changes to the study plan are proposed:

- The three horizontal transects within a sampling site will be discard and replaced by a single transect within a given sampling site consisting of a composite sample of 15 rock scrapings and three sample splits of the resulting composite. The 15 rocks will be collected within a riffle-run complex representative of a given stream reach.

- Canopy cover estimates will be discarded as the degree of open arc is a better predictor of chlorophyll a concentrations. The degree of open arc will be calculated by averaging the results of several readings taken throughout a sample transect.

The results have yet to be interpreted in light of water chemistry nutrients. Also, automated data loggers for hourly dissolved oxygen and a stream flow gauge were not installed in O'Bannon Creek until this fall and so will be available next summer. Data from automated data loggers and stream flow gauges will be available for the Olentangy River and Rocky Fork. This study should be repeated next summer, along with an expanded number sites across a wider range of habitat conditions and potential nutrient loads (e.g., ditched agricultural streams, municipal WWTPs, and forested watersheds).

Summary - Methods

Periphyton samples for chlorophyll *a* extraction and quantification were collected twice at fourteen sites from three streams during the summer of 2003. At each site, the following physical habitat variables were assessed: the degree of open arc between the canopy of opposing stream banks, the canopy cover in the reach where chlorophyll *a* samples were collected, the compass direction parallel to the direction of stream flow, and a qualitative measure of overall stream habitat quality at each sampling location using the Qualitative Habitat Evaluation Index (QHEI). Pebble counts were made at ten locations, but only contributed information already captured in the QHEI and were discontinued as an inefficient use of resources.

Periphyton samples were collected from three transects at each sampling location by scraping a known area from five large-gravel to cobble-sized rocks along each transect. All transects were located in a riffle-run complex. The scrapings from a transect were composited using a known volume of rinse water, and three 5 ml aliquots were drawn from the composite, and filtered separately. The amount of chlorophyll a on the resulting filters was determined fluorometrically using the acidification method found in EPA Method 445.

Data from field sampling and laboratory analysis were analyzed using basic statistical summaries (means, variance) and simple correlation matrices.

Summary - Results

Habitat variables were compared by simple correlation as shown in Graphic 1. All habitat factors showed some degree of inter-correlation with each other. The degree of open arc (expressed as the absolute value of the cosine of the bearing) and the amount of canopy cover (expressed as a percentage of presence/absence from densitometer readings) were the most strongly correlated with each other as one would intuitively expect. QHEI scores were also correlated with canopy cover and the degree of open arc. The QHEI includes riparian quality as a component of the overall score, so some degree of inter-correlation might be expected. The correlation between bearing and the other habitat factors was an artifact of site location as nine of the fourteen sampling locations were oriented nearly due north and south and two were east-west. The two east-west oriented sites had higher than average QHEI scores and relatively open canopies.

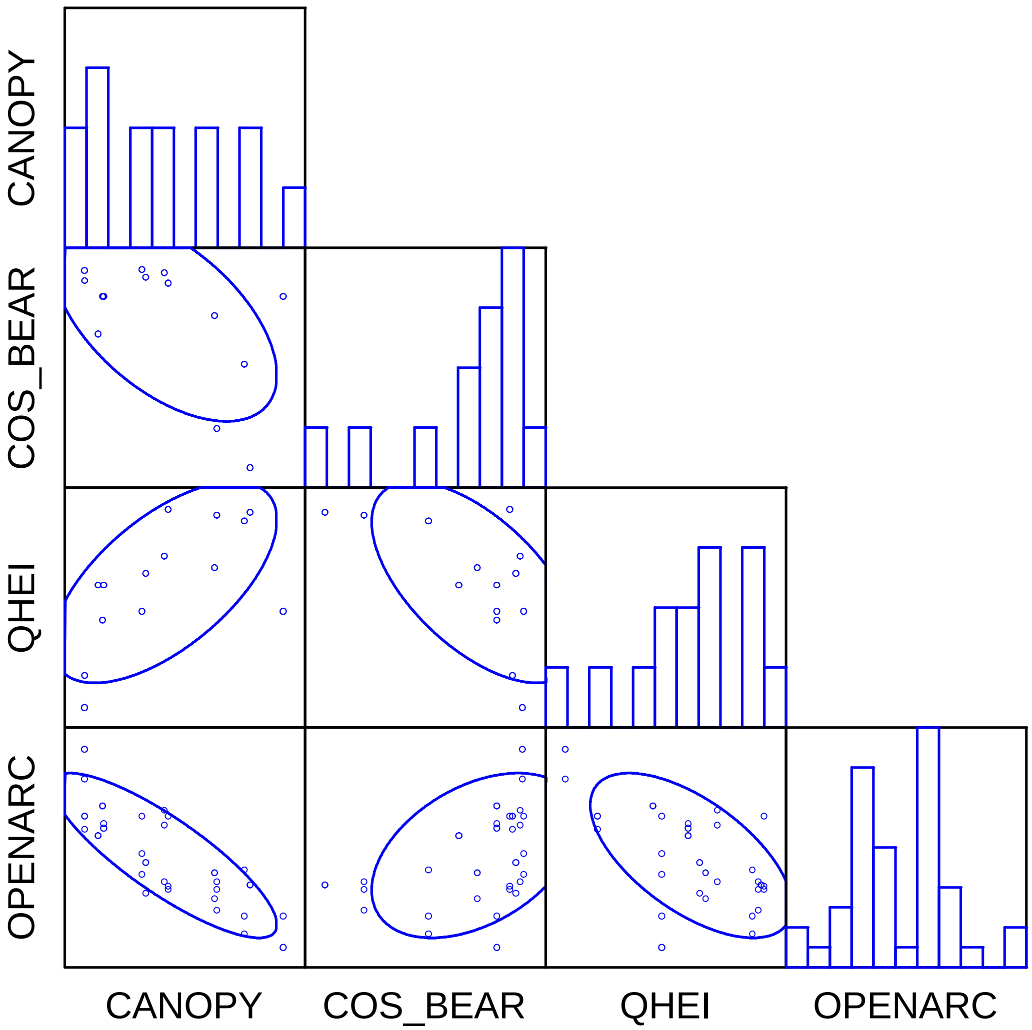
Variation between chlorophyll *a* concentrations on filters from a given composite was generally low (see Graphic 2) except at three sampling transects (see Graphic 3). For these latter three, results from one filter drawn from each respective transect composite was excluded due to the large between-filter coefficient of variation that it imparted. In each case, the one filter discarded was obviously different from the other two relatively similar filters. Overall within-transect variation between filters was lower in this study than that found in a similar study in Indiana.

Longitudinal patterns in chlorophyll *a* concentrations were roughly similar between passes in Rocky Fork and O'Bannon Creek (Graphic 4). The highest chlorophyll concentrations for either pass in Rocky Fork occurred at RM 7.1 where the canopy was much reduced and the habitat was comparably poor. In O'Bannon Creek, chlorophyll concentrations were highest downstream from the O'Bannon Creek WWTP in either pass. Also, at RM 6.5 of O'Bannon Creek, a sewer line crossing was installed immediately upstream from the sampling station between the first and second pass resulting in a layer of sediment covering the substrate and reduced amounts of periphyton. For the Olentangy River, a scouring event took place between when the first sample was collected at RM 12.4 and when the other first pass samples were collected (Graphic 5). Flood and scour events were frequent during the entire summer of 2003 and affected all three streams such that only the first pass on Rocky Fork is likely to have been collected following two weeks of relatively stable flows. Despite that, the fact that longitudinal patterns in Rocky Fork and O'Bannon Creek were similar between passes, and inter-sample variation between filters was generally low, the methods appear to be appropriate and are meeting the data quality objectives.

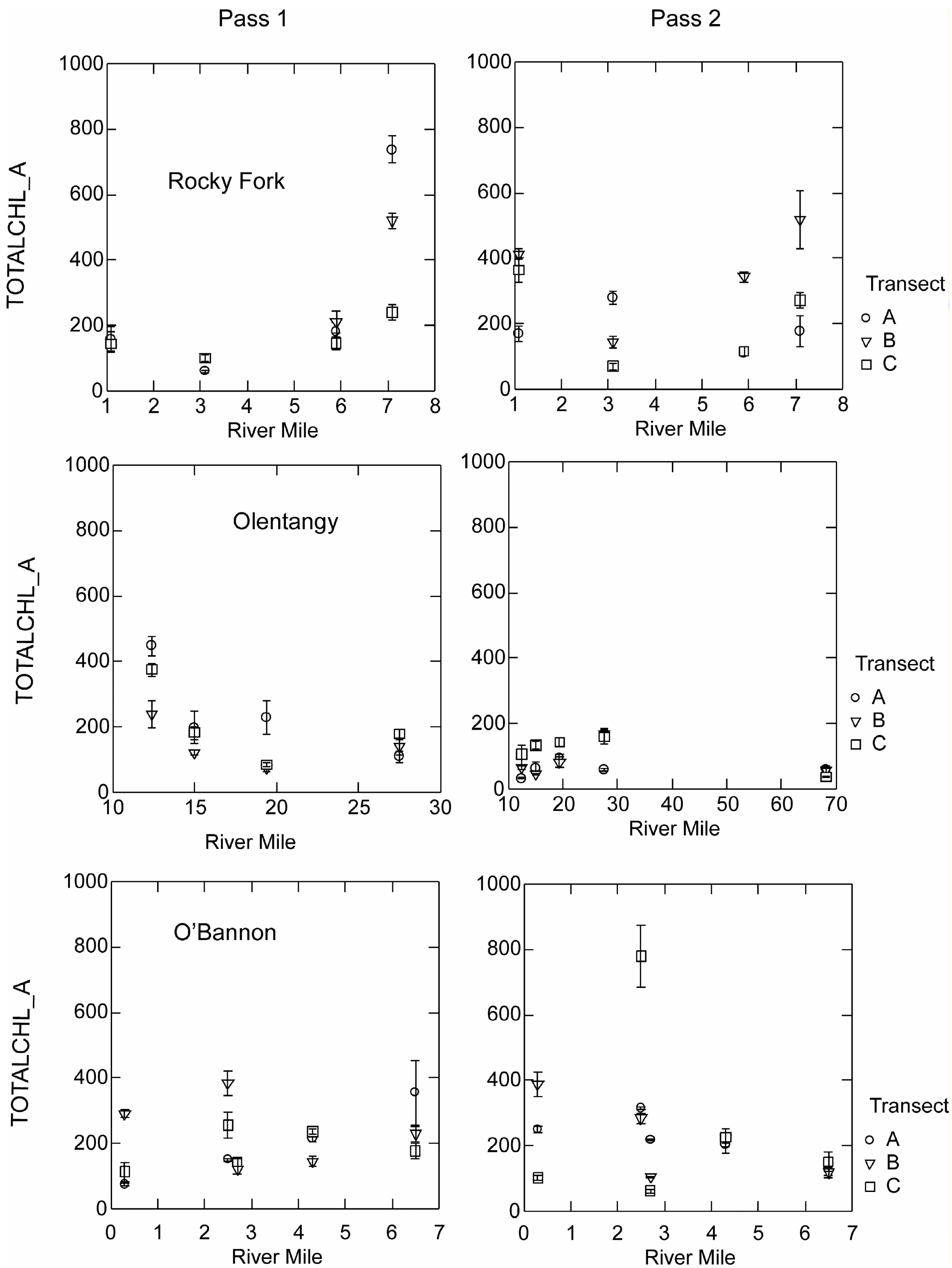
Two habitat variables correlated with chlorophyll *a* concentrations (Graphic 6): the amount of open arc (positive association) and canopy density (negative association). These associations were expected as they are indicators of how much direct sunlight is likely to hit the stream. Unexpectedly, QHEI did not show a correlation with the amount of chlorophyll, though the linear trend was in the predicted direction (negative). Several factors may explain this latter finding. First, the frequency of flood and scour events may have masked the association; second, the relatively narrow range of QHEI scores was skewed toward good to excellent habitat so poor to fair habitat sites were under-represented in the samples, and finally, overall habitat quality is likely to have a more subtle effect than canopy or the degree of open arc and therefore greater sample size may be needed to detect significant trends in the data. Compass bearing was not associated with chlorophyll *a* concentrations, but like the QHEI, the bearing data were skewed toward one end of the distribution (i.e., the north-south direction).

Graphic 1. Pearson correlation matrix - habitat factors.

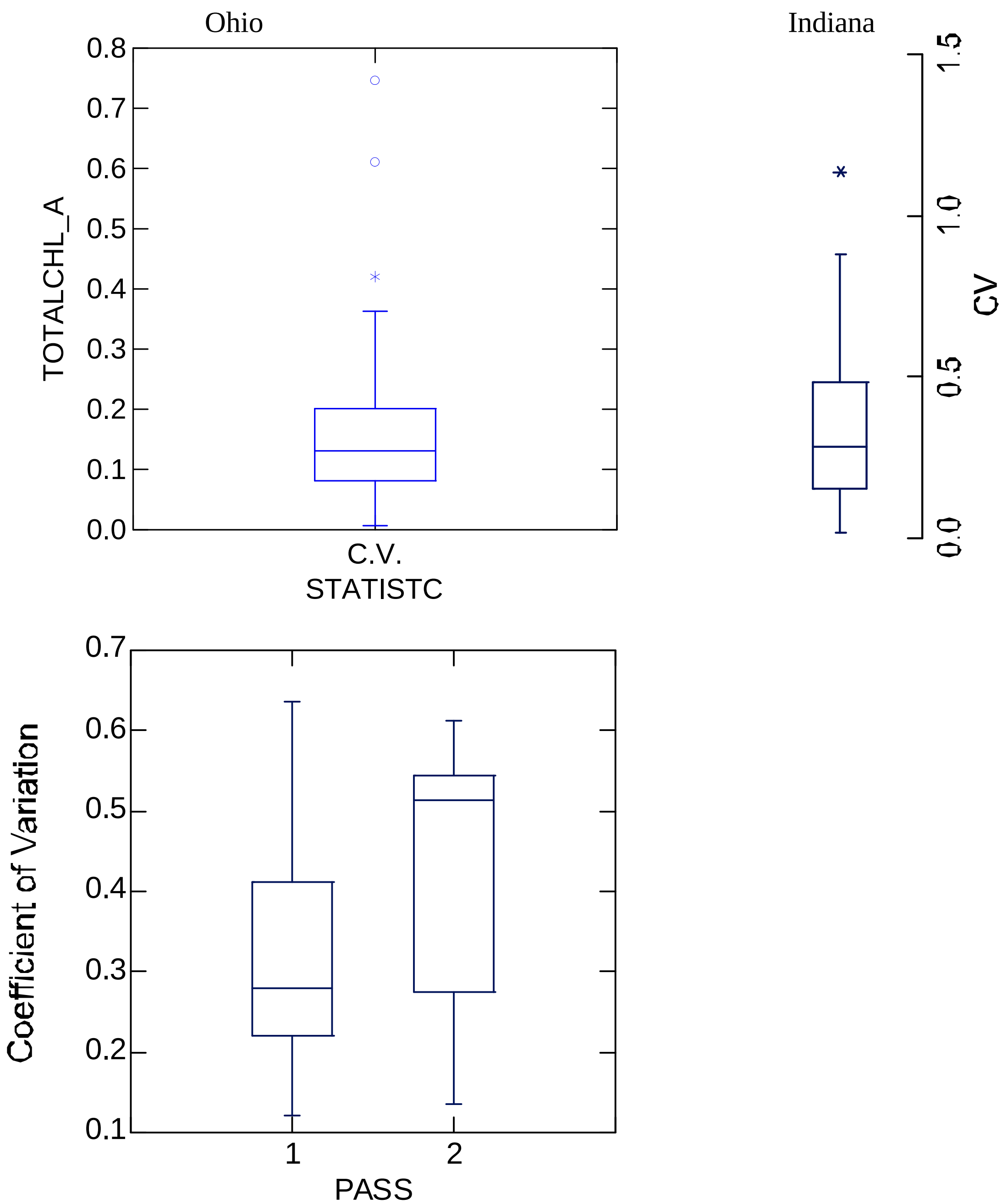
	CANOPY	COS_BEAR	QHEI	OPENARC
CANOPY	1.000			
COS_BEAR	-0.552***	1.000		
QHEI	0.621***	-0.601***	1.000	
OPENARC	-0.840***	0.419*	-0.615***	1.000



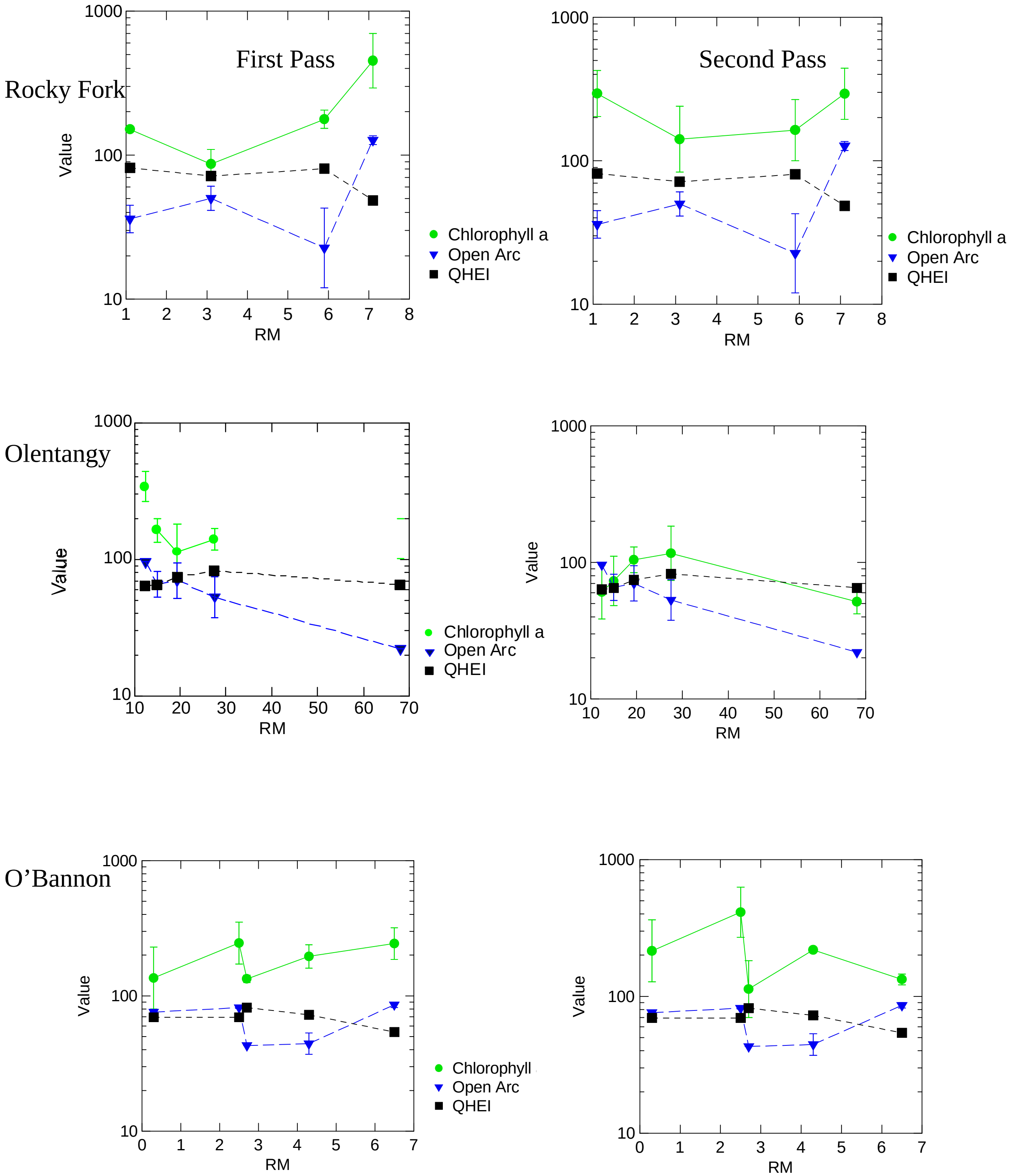
Graphic 2. Plots of mean within-transect chlorophyll *a* concentrations (mg•m^{-2}) ± 1 SE by pass for sampling locations in the 2003 MS4G/Nutrient study.



Graphic 3. Top - box and whisker plots of coefficient of variation (C.V.) values from within sampling transect chlorophyll *a* concentrations for Ohio (left) and Indiana (right). The three samples falling outside the upper hinge were inspected, and three respective, visually obvious, outlier filters were discarded from further analysis. Bottom - Within-sampling station C.V. by pass for Ohio.

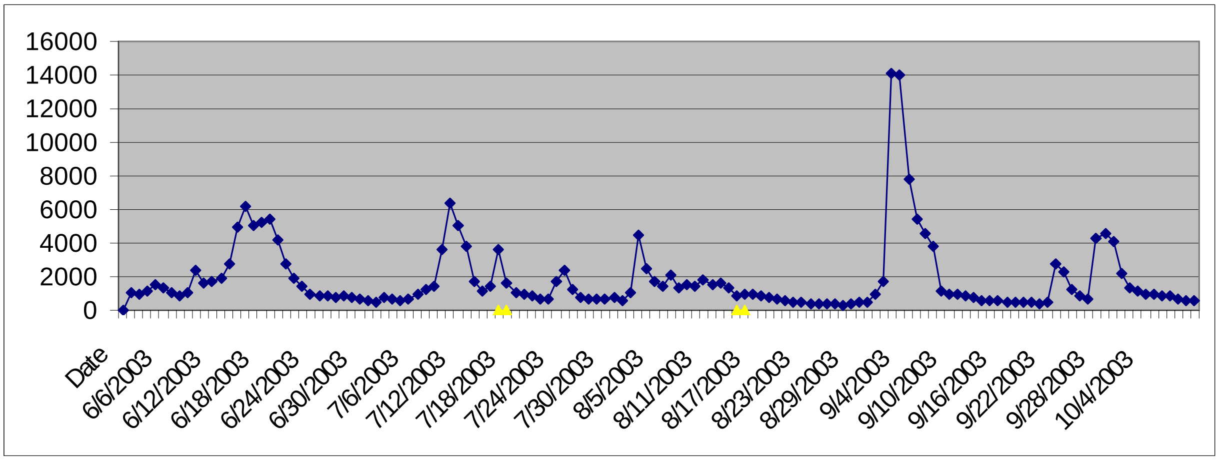


Graphic 4. Longitudinal plots of mean, between-transect total chlorophyll a (mg•m^{-2}) ± 1 SE, open arc, and QHEI scores by pass for sampling locations in Rocky Fork, Olentangy River and O'Bannon Creek, 2003.

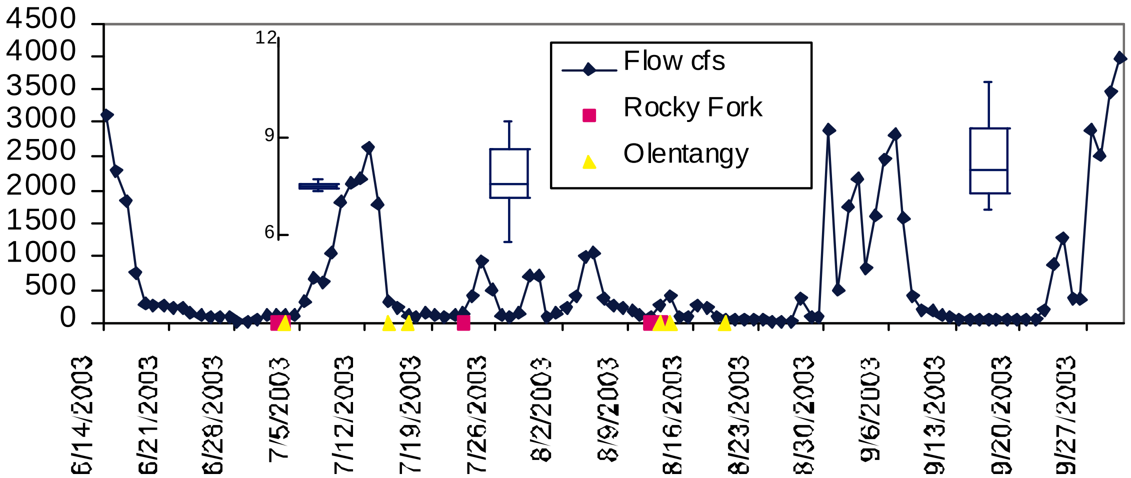


Graphic 5. Flow hydrographs for the Little Miami River (O'Bannon Creek) at Milford, Ohio, and the Olentangy River at Worthington, Ohio.

Little Miami River at Milford



Olentangy River at Worthington, Ohio. The periphyton sampling dates are indicated for Rock Fork and the Olentangy River. Box plots show the distribution of hourly dissolved oxygen concentrations for a given date in the Olentangy River near Worthington, Ohio.



Graphic 6. Pearson correlation plots for habitat variables and total chlorophyll *a* concentrations from sites where periphyton samples were collected following two weeks of relatively stable flow. Correlation coefficients are shown above each respective plot. Bonferroni adjusted probabilities are noted with asterisks.