PERIPHYTON OCCURRENCE STUDY OF TWO CENTRAL FLORIDA STREAMS

Payne and Little Payne Creek, Hardee County

Physical, chemical, and biological sampling was conducted at Payne and Little Payne Creeks in Hardee County in 2010 and 2011 by Peggy Morgan, Gitta Schmitt, and Charlie Thompson of the DEP Southwest Regional Operations Center. These streams were sampled to determine causes and consequences of previously observed extensive algal coverage. Occurrence of nuisance algae during this study was not consistently related to habitat or macroinvertebrate community quality, and could not be totally explained by nutrient, flow or light conditions. However, periphyton dependence on light availability within the stream reach was apparent, and there was one example of a high flow event followed by loss of periphyton growth, possibly indicating periphyton loss related to scouring or high water levels.

Background

A healthy, well-balanced stream community may be maintained with some level of human activity, but excessive human disturbance may result in waterbody degradation. Human stressors may include increased inputs of nutrients, sediments, and/or other contaminants from watershed runoff, adverse hydrologic alterations, undesirable removal of habitat or riparian buffer vegetation, and introduction of nuisance (generally exotic) plants and animals. The Rapid Periphyton Survey (RPS) is a tool used as an indicator of a healthy community of attached algae (periphyton) in a stream. This method was developed to assess potential human impacts on growth of periphyton in a stream with a focus on increased nutrient loading. With increased nutrient loads there is a greater possibility for algal growth. Sort term

occurrences of shorter attached algae is natural and expected; however, long and pervasive attached algae can be indicative of water quality problems such as excess nutrients. This year long sampling effort was a special study looking at the health of these two creeks and the potential reasons for thick algal mats that were occasionally observed by regional DEP biologists. These locations made good case studies for how and when periphyton grows in a stream and possible reasons for its persistence or lack thereof. This report summarizes the general characteristics of RPS observations, the relationships between the RPS and other bioassessment tools and possible environmental variables effecting RPS observations.

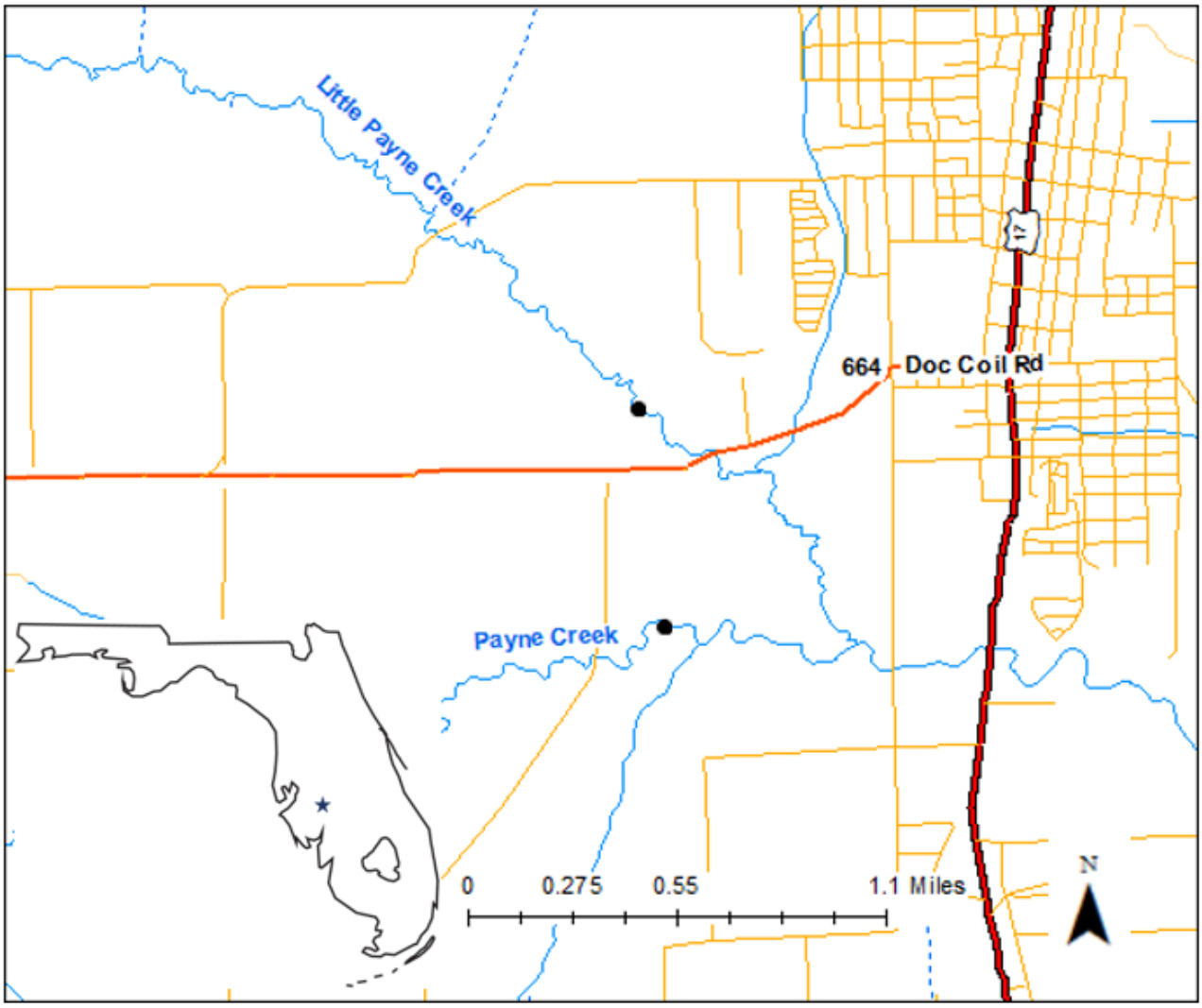


Figure 1. Location of Payne Creek and Little Payne Creek in Hardee County. Sample locations are represented by black dots. Insert of general location within the state of Florida.



Figure 2. Little Payne Creek from bridge looking downstream.



Figure 3. Payne Creek from bridge looking downstream.

Site Description

Payne Creek and Little Payne Creek are located in Hardee County, Florida within the Peace River watershed. Both streams are approximately 5m in width and less than 1m in depth, on average. Both sampling locations are in wooded areas upstream of the convergence of these two streams.

Methods

Sample Collection

Biological and water quality samples were collected and physical observations were made in Little Payne and Payne Creeks monthly for one year, from May 2010 to March 2011. Several sampling events over the summer months were not completed because of high water levels. During each sampling event, surface water samples were collected for analysis of nutrients, chlorophyll *a*, color, conductivity, and turbidity following DEP Standard Operating Procedures (SOP). Samplers took field measurements of pH, dissolved oxygen, temperature and specific conductance, and measured stream velocity and discharge using a Marsh McBirney meter, per USGS methodology.

To assess stream flora, samplers conducted the Rapid Periphyton Survey (RPS) per DEP SOP FS 7230, and collected the dominant algal taxa (where applicable). The RPS assesses the extent and thickness of algae in the stream reach. Under this assessment low levels of short attached algae are natural and expected; however, long and pervasive attached algae can be indicative of water quality problems. For the RPS, samplers assign a thickness rank for algae at 99 points along 11 transects in the stream, and measure canopy cover in the middle of each transect. When RPS is used as a biological indicator in association with stream numeric nutrient criteria, algal ranks 4 (6-20 mm), 5 (2-10 cm), and 6 (>10 cm) are considered of excess length, and a coverage of over 25% of the 99 points is considered pervasive.

To assess stream fauna and habitat, samplers collected a Stream Condition Index (SCI) sample per DEP SOP SCI 1000 and conducted the Stream Habitat Assessment (HA) per DEP SOP FT 3100. The SCI assesses how closely the macroinvertebrate community (*e.g.*, aquatic insects, clams, crayfish) of a stream resembles the macroinvertebrate community of an undisturbed or “reference” condition. The Habitat Assessment is a rapid field method and companion tool to the SCI, in which a sampler scores eight in-stream and riparian components to estimate the influence of habitat factors on the resident aquatic organisms.

All water quality and biological samples were analyzed at the DEP Central Laboratory in Tallahassee.

Additional data sources

We used additional data sources to understand the relationship between stream flow and periphyton growth. First, we obtained rainfall data from the National Oceanic and Atmospheric Administration's National Climatic Data Center for the area focusing on two time periods, 15 days prior to and 30 days prior to each sampling event. If the number of days between sampling was less than 30, the associated rain measurement was the total rainfall between sampling events. Second, we included stream water level data from a water level gauge set up by the US Geologic Survey (USGS) on Payne Creek downstream of the sample sites.

Data analysis

The available data allowed for two avenues of analysis. Most information gathered was in the form of a monthly value for the stream reach (i.e., water quality variables, SCI, HA, velocity) while some data were available by individual transect in the stream reach (i.e., canopy cover, periphyton occurrence). We used linear regression to look for relationships between overall periphyton presence in each stream for each visit and possible explanatory parameters for which there was a single data point for each month. Statistical information is only presented for relationships with $R^2 > 0.50$. Periphyton coverage and canopy cover are available through the RPS assessment at each transect along the stream and these data were examined averaged over the whole stream and in each separate transect.

Results

General RPS analysis

In these two streams, RPS results typically showed either very little to no algal growth or excessive growth (Figures 4 and 5). Instances of long growth did not last for more than a month or two. There

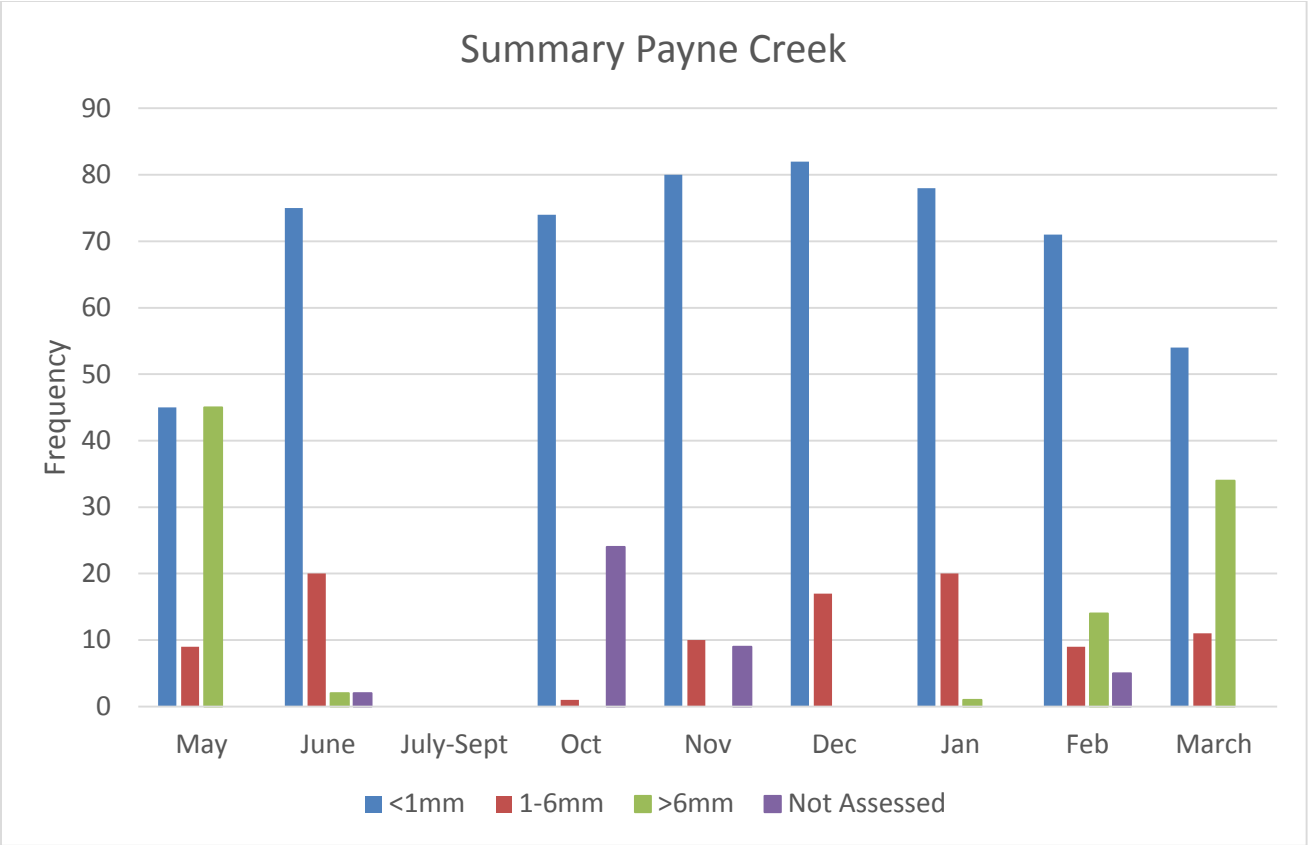


Figure 4. Summary of Payne Creek RPS periphyton rank division counts in each month sampled.

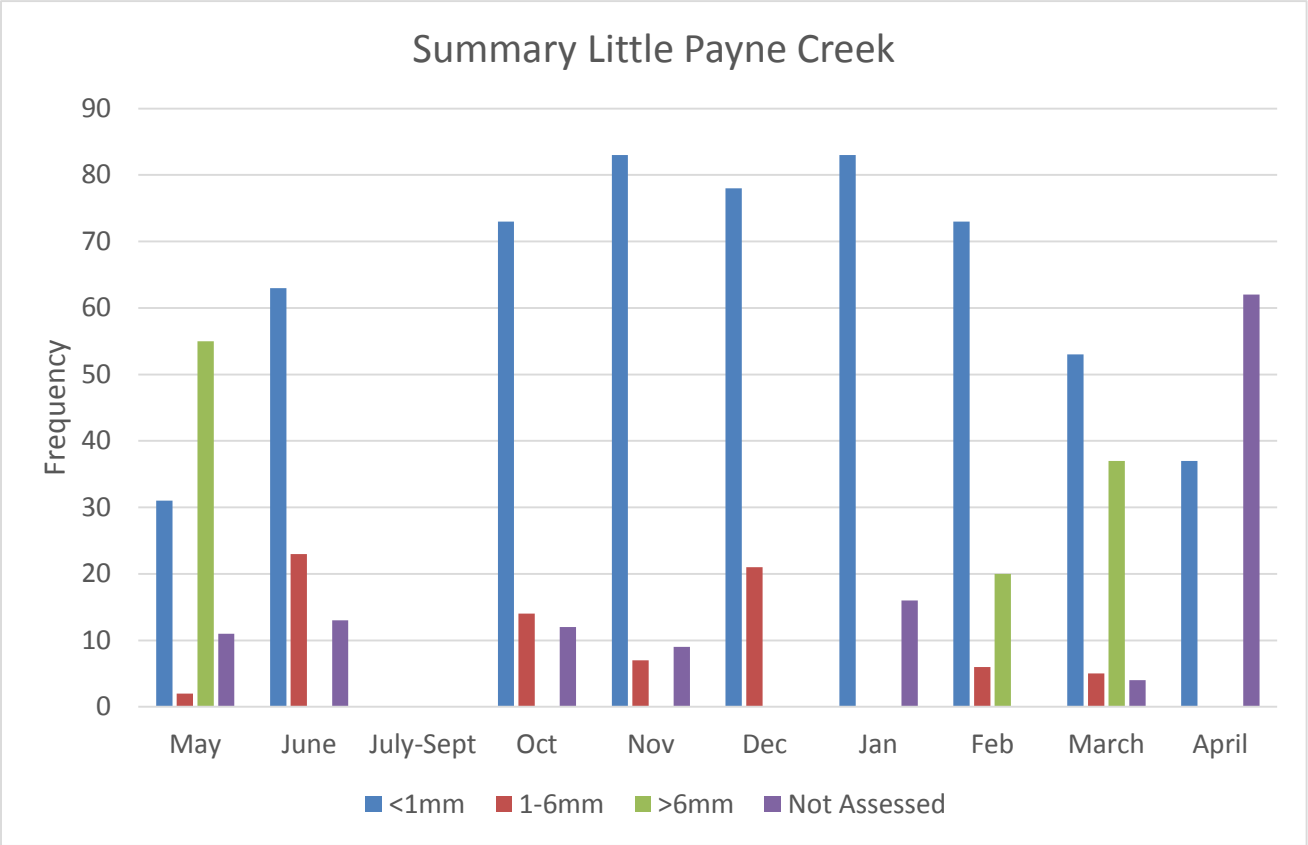


Figure 5. Summary of Little Payne Creek RPS periphyton rank counts in each month sampled.

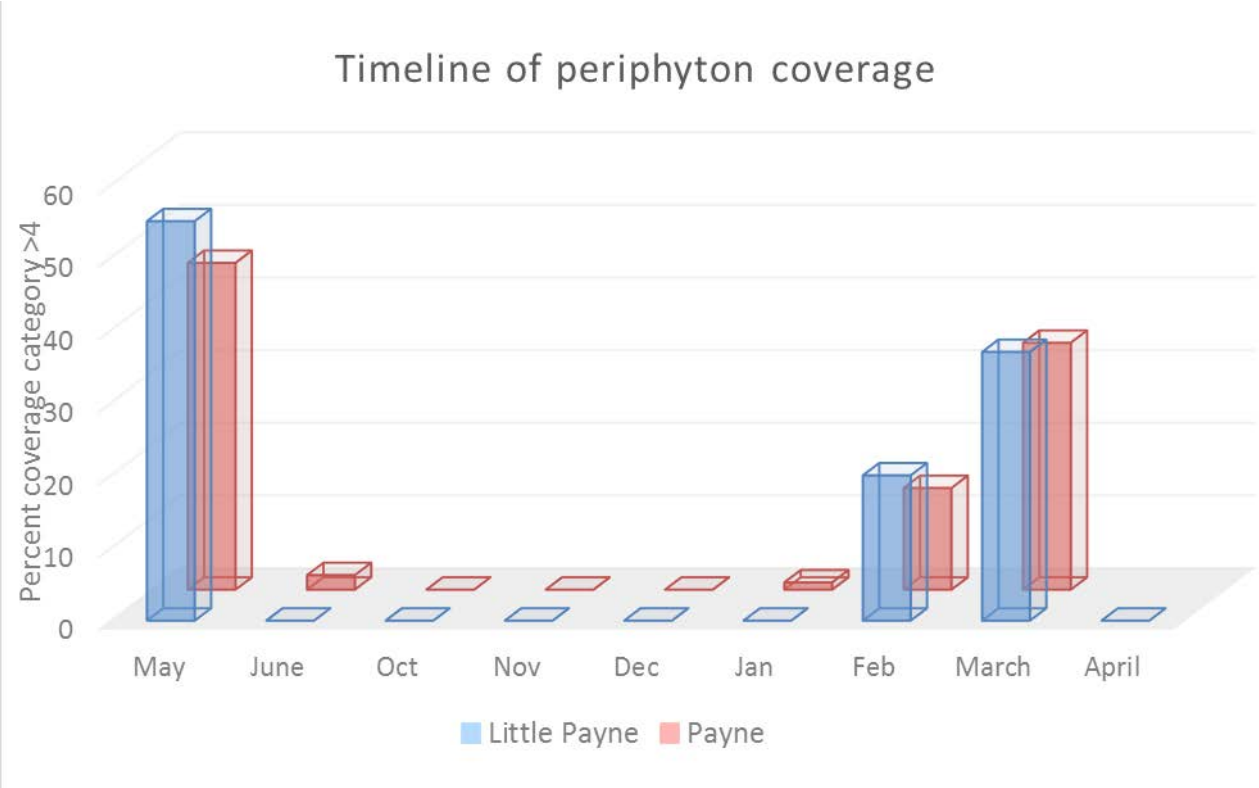


Figure 6. Bar graph of monthly periphyton coverage greater than rank four.

was a rain event in April 2011 that caused the majority of points in Little Payne Creek to be designated as not accessible (purple) while samplers were not able to assess Payne Creek that month at all. Points could not be assessed because the water was too dark to see algae or because the water was too deep to reach the bottom (not accessible). Both streams exceeded the floral threshold for algae in May 2010 and March 2011, as greater than 25% of points had long algae (Figure 4). The fact that extensive periphyton growth occurred during the same months at both creeks (Figure 6) suggests that both streams are influenced and respond similarly.

Other assessment methods

The average SCI score for Payne Creek was 63 out of a possible 100 points and Little Payne Creek was 57, both corresponding with a "Healthy" designation. There were also several instances where the two streams had SCI scores in the "Exceptional" category (>64 points). The average stream habitat assessment score for Payne Creek was 105 and 114 for Little Payne Creek, which are in the suboptimal range. We investigated the relationship between the RPS, SCI, and HA to see if high algae growth and cover have significant impacts on these other measures of stream health. For these remaining figures and

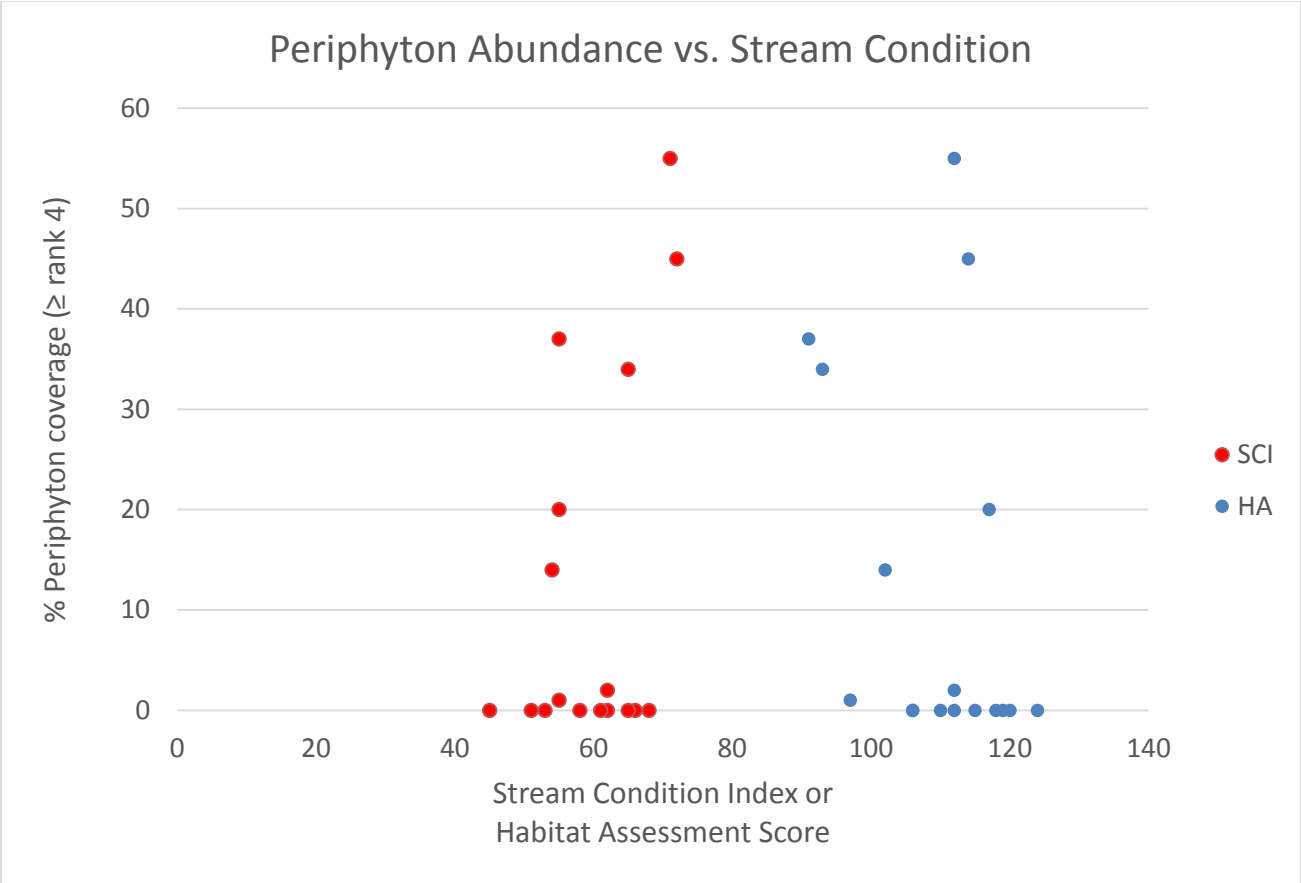


Figure 7. Relationship between periphyton coverage (≥ Rank 4 in the RPS), and SCI and HA scores for Payne and Little Payne Creeks.

analyses, we used the percent of RPS points with long algae growth that would be considered a nuisance (Rank 4, 5, 6) to represent the amount of periphyton.

There was not a consistent response in HA scores with increasing algae coverage for Payne and Little Payne data combined (Figure 7). Habitat smothering by extensive periphyton growth could lower the HA score and intense smothering can exclude some habitats altogether, further lowering the score. With Payne and Little Payne data combined the SCI showed a slight but decrease with an increase in algae coverage (Figure 7). Algae could have various effects on the invertebrate communities and thus the SCI score for a stream. With light algae coverage, the increase in potential food sources, increase in oxygen (produced from photosynthesis) and possible additional habitat could increase the SCI score. However, with very heavy or long duration of high growth and coverage algae impacts could harm invertebrate communities with high swings of oxygen (very low at night to very high in the day), hypoxia or anoxia (low or no oxygen) in bottom waters as dead algae decompose, and smothering of other productive habitats.

Nutrients and light availability

We examined nutrient levels in the stream to determine if an increase in nutrients led to an increase in algae growth. These nutrient data came from grab samples that were collected at the same time as the RPS was performed. A grab sample represents a "snapshot" of the nutrient levels in the stream at the time of sampling. There was no direct relationship between high algae coverage and nutrient concentrations (Figure 8). When algae were already present in this stream system there were higher percentages of long periphyton observed with increasing total phosphorus concentrations. However, the observed increase in algae growth with increasing total phosphorus is misleading because similar high phosphorus levels are also seen with no observed algae. This result suggests that after some other environmental factor is met that allows initial algae growth, total phosphorus is a factor in promoting growth to nuisance levels. As nutrient measurements were collected only once per month this single collection can miss pulses of higher nutrients coming into the stream at other times.

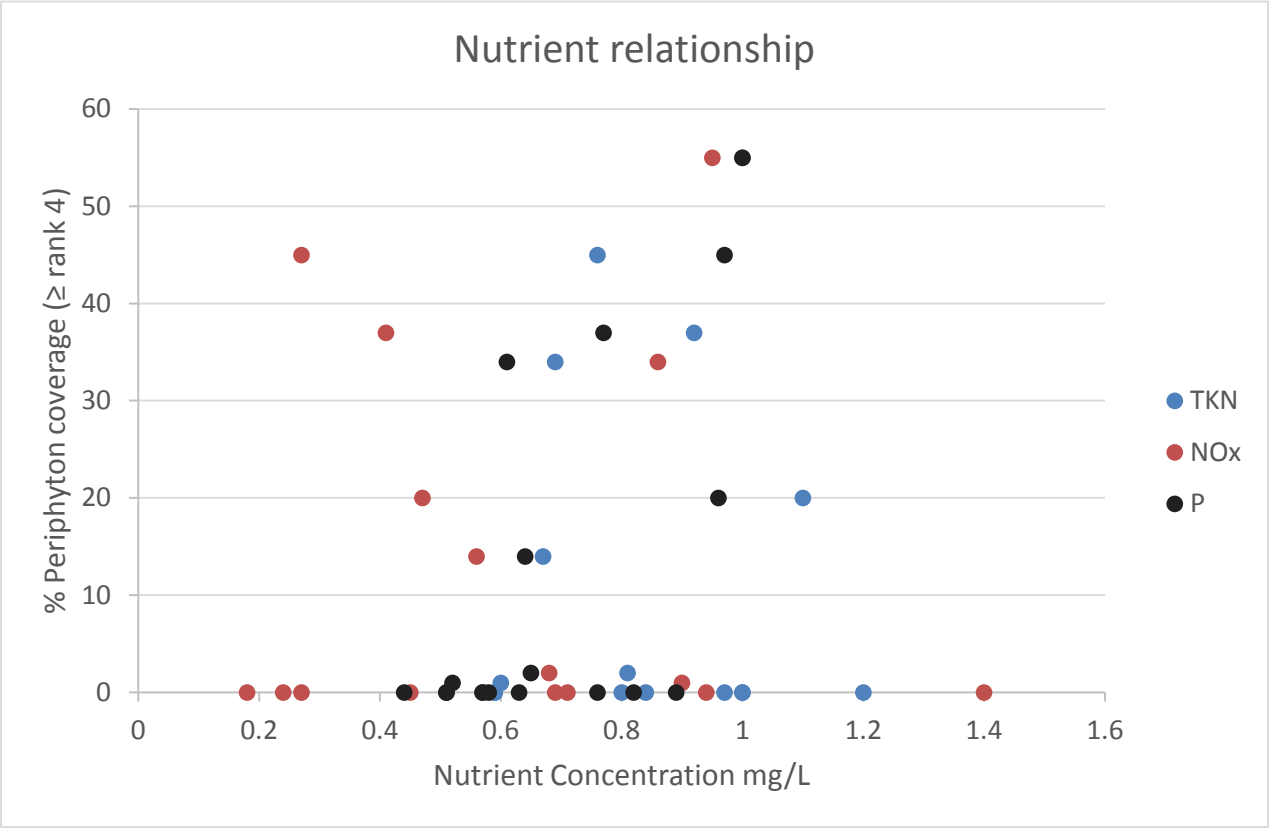


Figure 8. Relationship between percent periphyton coverage greater than or equal to rank four and TKN, nitrate/nitrite, and total phosphorus nutrient concentrations for Payne and Little Payne Creeks.

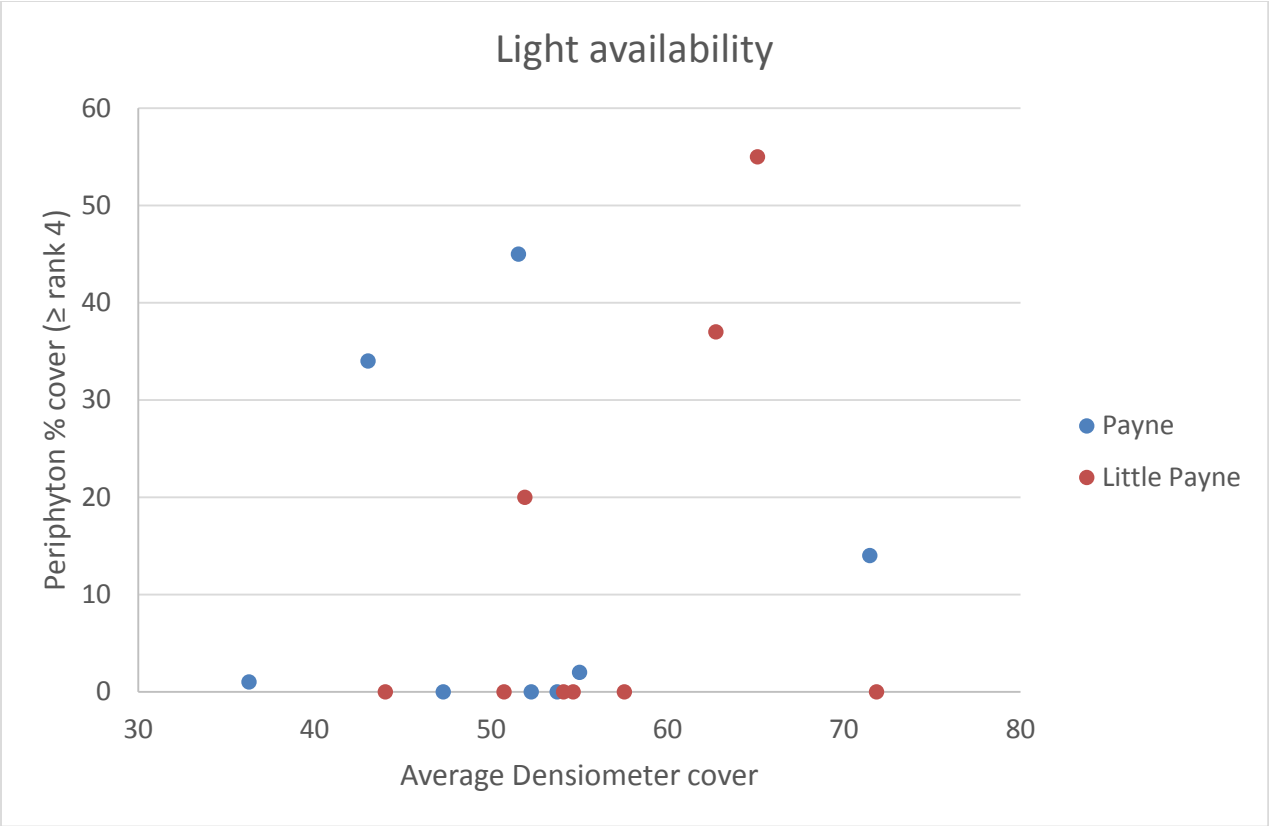


Figure 9. Average light availability by densitometer for each month in each stream and the relationship to percent periphyton coverage.

Canopy cover is measured in the middle of the stream channel for each transect using a densiometer, a tool used to estimate the number of points on a grid that are covered by leafy canopy. Densiometer readings are used as a proxy for how much light reaches the stream surface that algae can use to grow. A higher densiometer cover means less light available in the stream. Densiometer readings were not well correlated with algae cover (Figure 9).

Stream flow measurement results

It has been shown in other systems and hypothesized here that increased flow can scour and remove algae, however there is limited data to support that conclusion in this study. We hypothesized that rainfall should have a direct relationship to measured flow rates, so we compared measured flow to total rainfall in the 15 and 30 days prior to sampling. The relationship between 15 day total rainfall and flow is a better fit than between flow and 30 day total rainfall (Figure 10), which suggests that rainfall

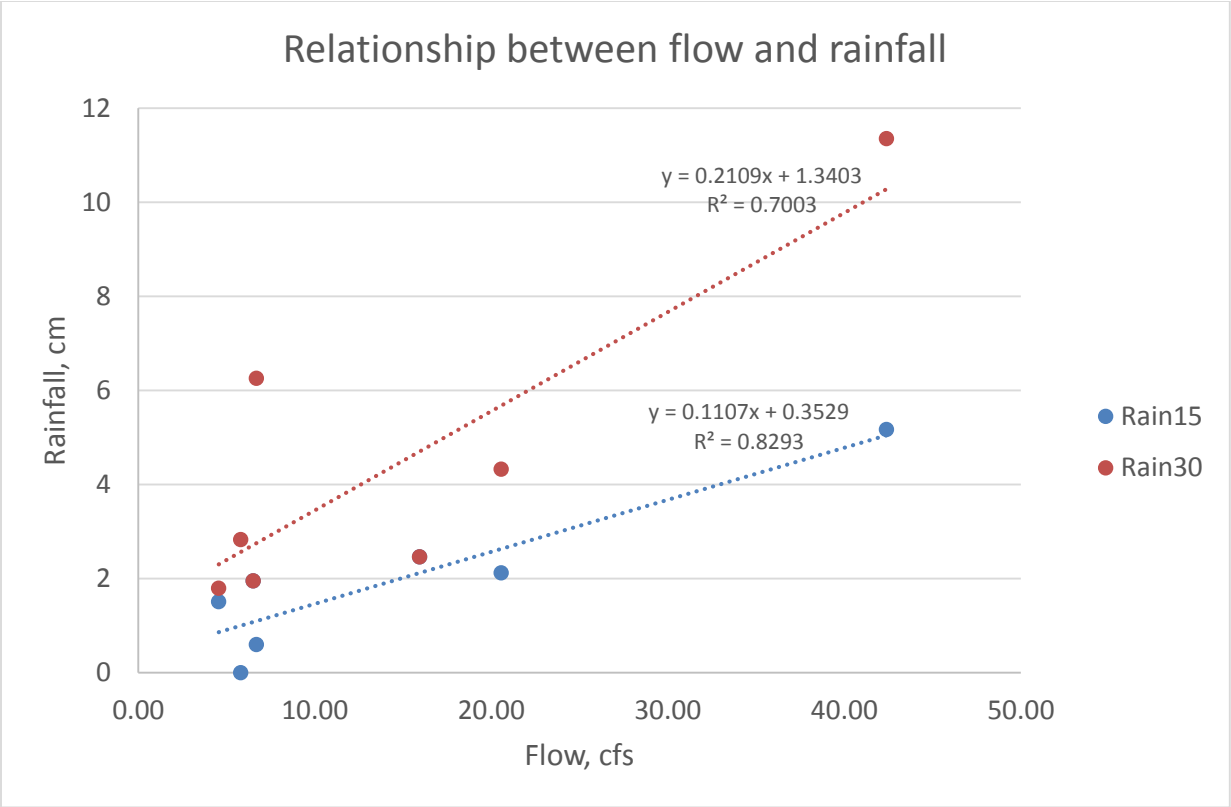


Figure 10. Representation of relationship between amounts of observed rainfall 15 days before SCI sampling and 30 days before sampling and subsequent measured flow on sampling day.

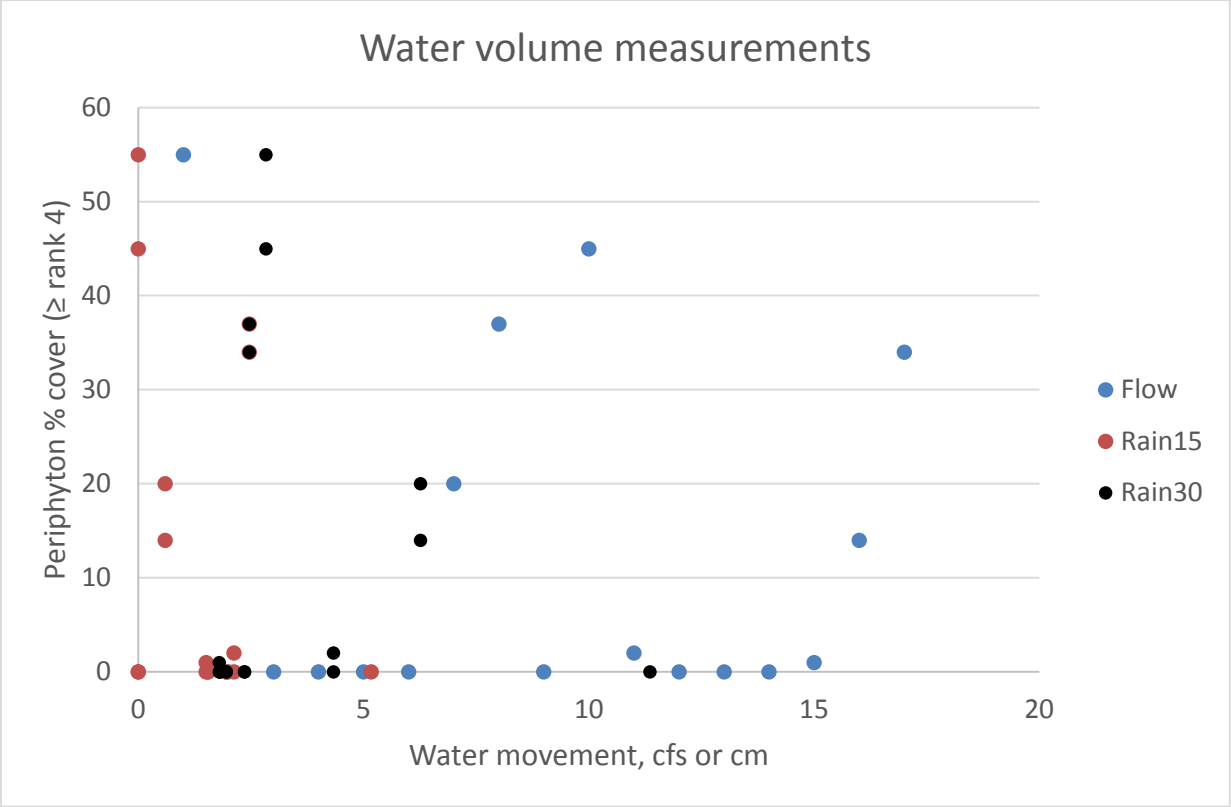


Figure 11. Relationship between percent periphyton coverage of ranks four or greater and three measurements of creek water volume: measured flow at the time of sampling in cubic feet per second, and rainfall 15 and 30 days prior to sampling.

moves quickly into the stream and does not have a long residence time in the surrounding landscape. However, there is no relationship between rainfall or measured flow rates and periphyton growth and coverage (Figure 11). The sampling dates at which the highest flow was measured at the sites did not contain any periphyton of rank four or higher, possibly suggesting that high flow discourages periphyton growth in these streams. We reviewed the USGS hydrograph for Payne Creek to look for occurrences of high intensity flow that may cause scouring of algae communities. There were several high rainfall events during this study. Over the summer months when rainfall was heaviest, samples were not collected due to inaccessibility. One high water event was in late January before the February RPS sample event. The second was in early April, between the March and April sampling events. In March, there was high periphyton growth and coverage, but in April, there was no observed periphyton in Little Payne Creek (Figure 12).

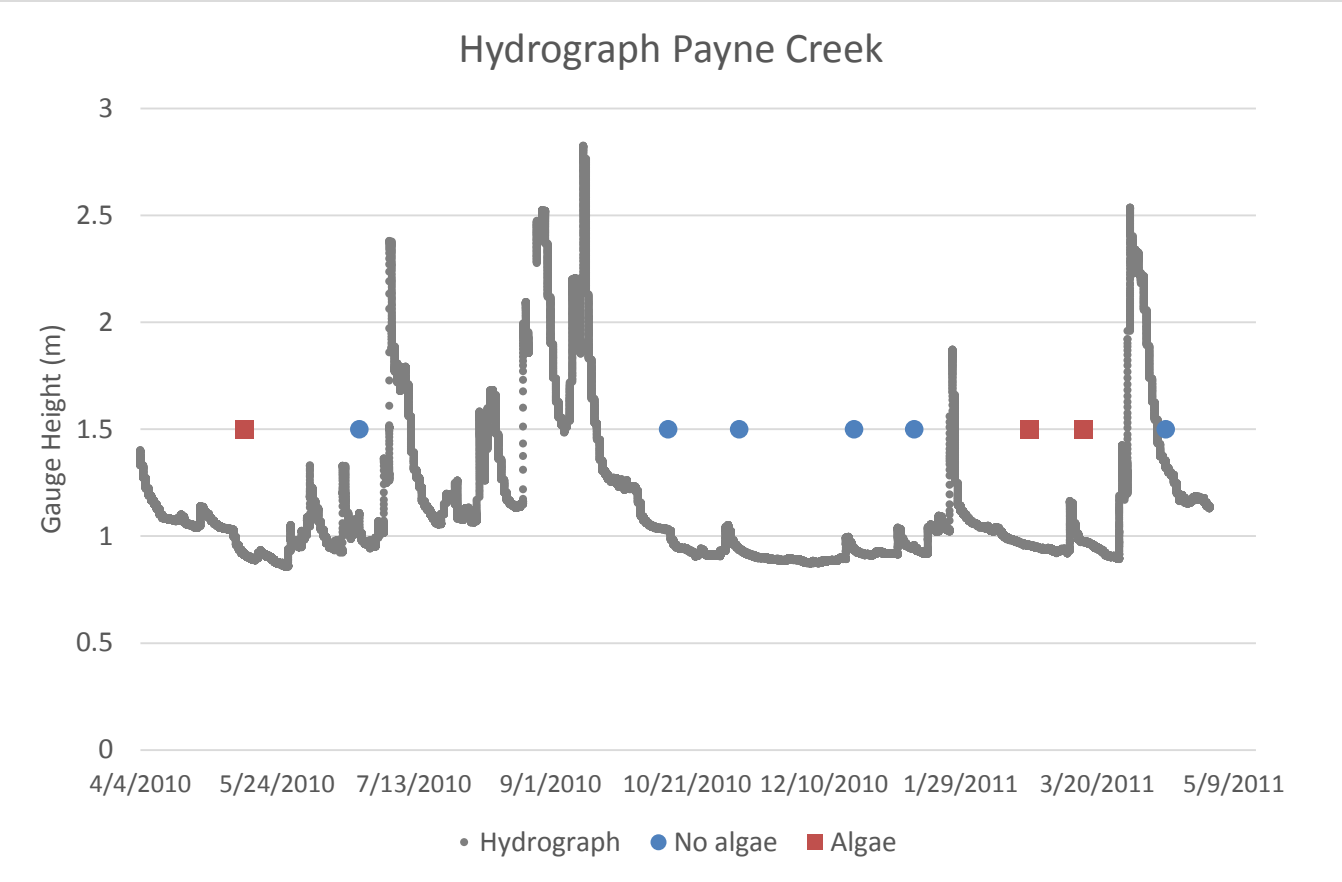


Figure 12. Hydrograph of Payne Creek USGS gauge with RPS sampling dates indicated by presence or absence of periphytic algal growth.

Stream by transect analysis

To look further at potential causes of high algae growth, we looked at the location in each stream where the algae was most common. For Payne Creek there did not appear to be a consistent part of the stream

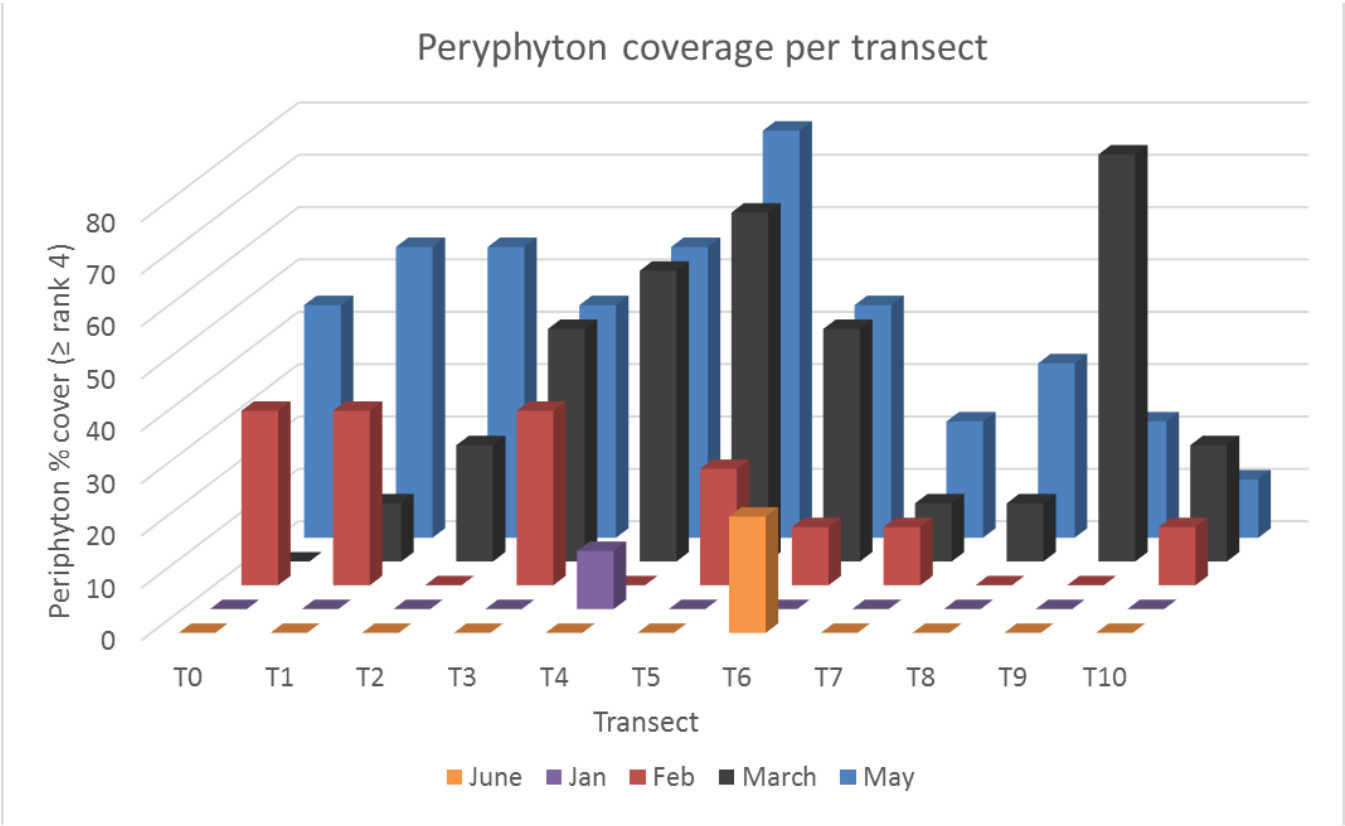


Figure 13. Months with observed periphyton ≥ rank four and the associated total count of those points per transect (T) for Payne Creek.

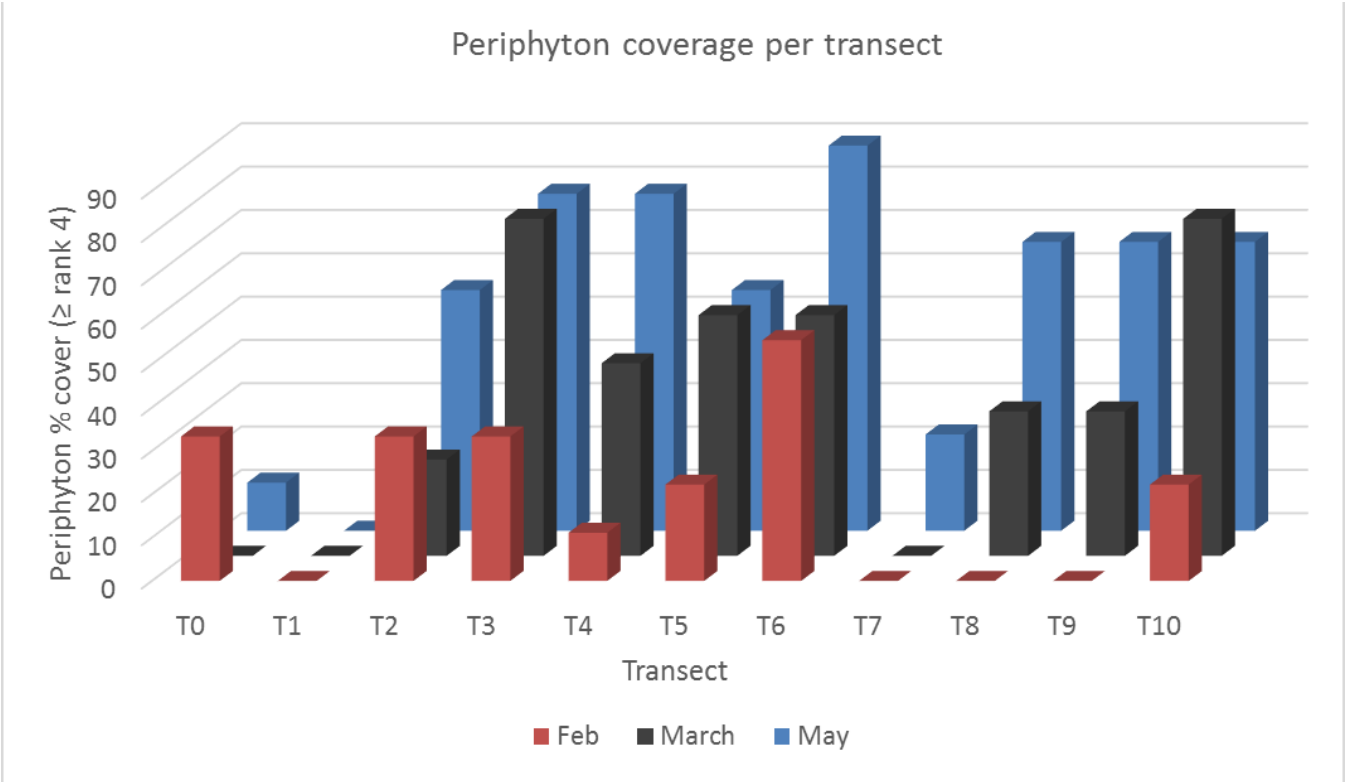


Figure 14. Months with observed periphyton ≥ rank four and the associated total count of those points per transect (T) for Little Payne Creek.

with extensive algae, which indicates that the issues causing this floral imbalance are not localized and algae growth is most likely not limited by stream characteristics (Figure 13). In Little Payne Creek there are gaps in the stream stretch that consistently show little or no algae growth (Figure 14). There may be something in these areas inhibiting growth.

Growth inhibition observed in some transects could be due to increased canopy cover in these areas or lack of substrate. Therefore we next examined the relationship between algae lengths at each transect and the measured canopy cover for that transect to see if light availability could be an important factor. There was a weak relationship between canopy cover and algae coverage in Payne Creek (Figure 15). However, there was a stronger relationship between canopy cover and algae coverage in Little Payne Creek (Figure 16). When conditions are right for algal growth there is more algae at locations with less canopy cover (increased light availability) in both creeks, but canopy cover has a more drastic impact on the algae growth in Little Payne Creek than it does in Payne Creek.

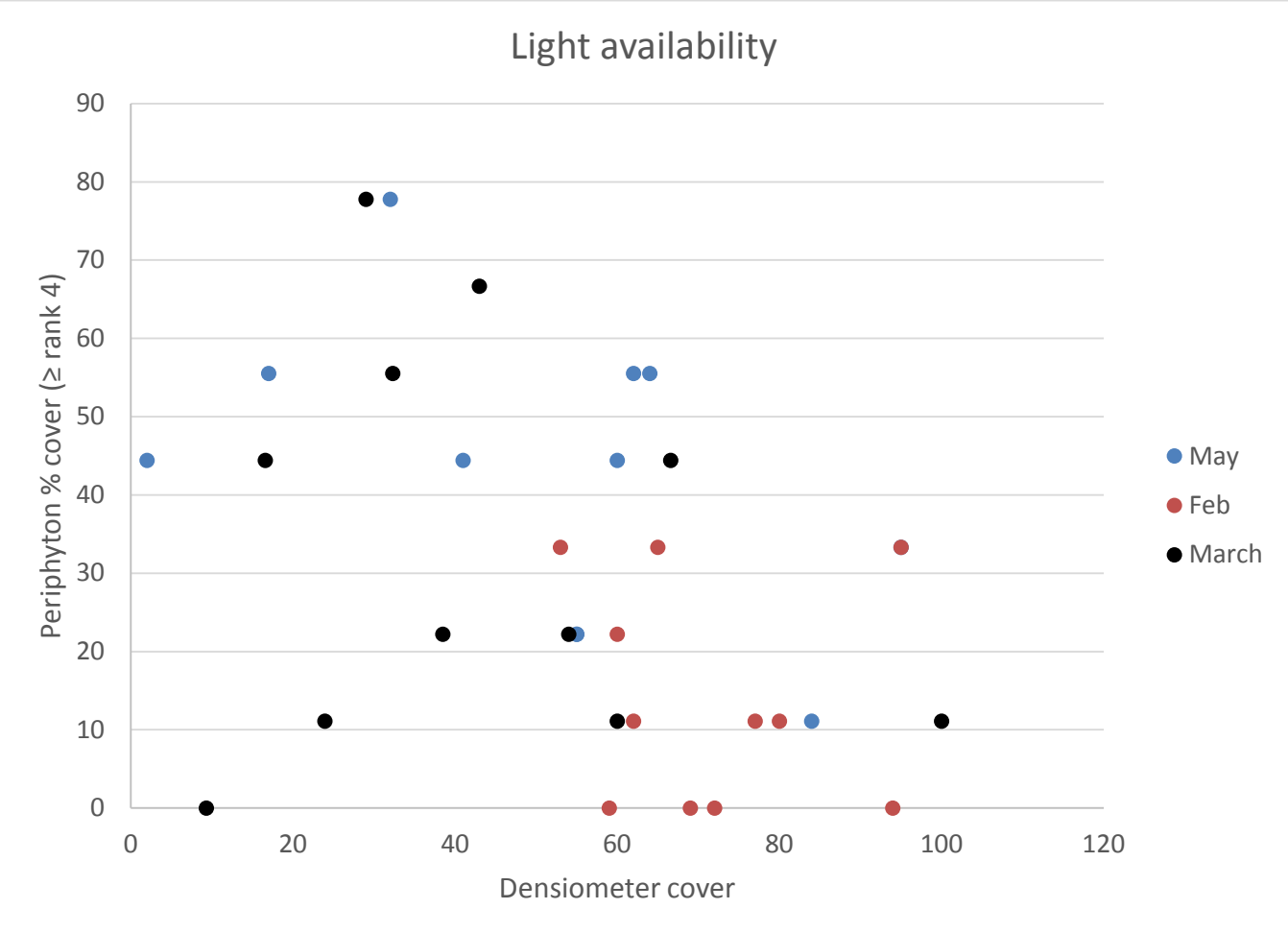


Figure 15. Light availability, as densitometer cover, in relation to percent coverage of periphyton ≥ rank four on each stream transect for Payne Creek.

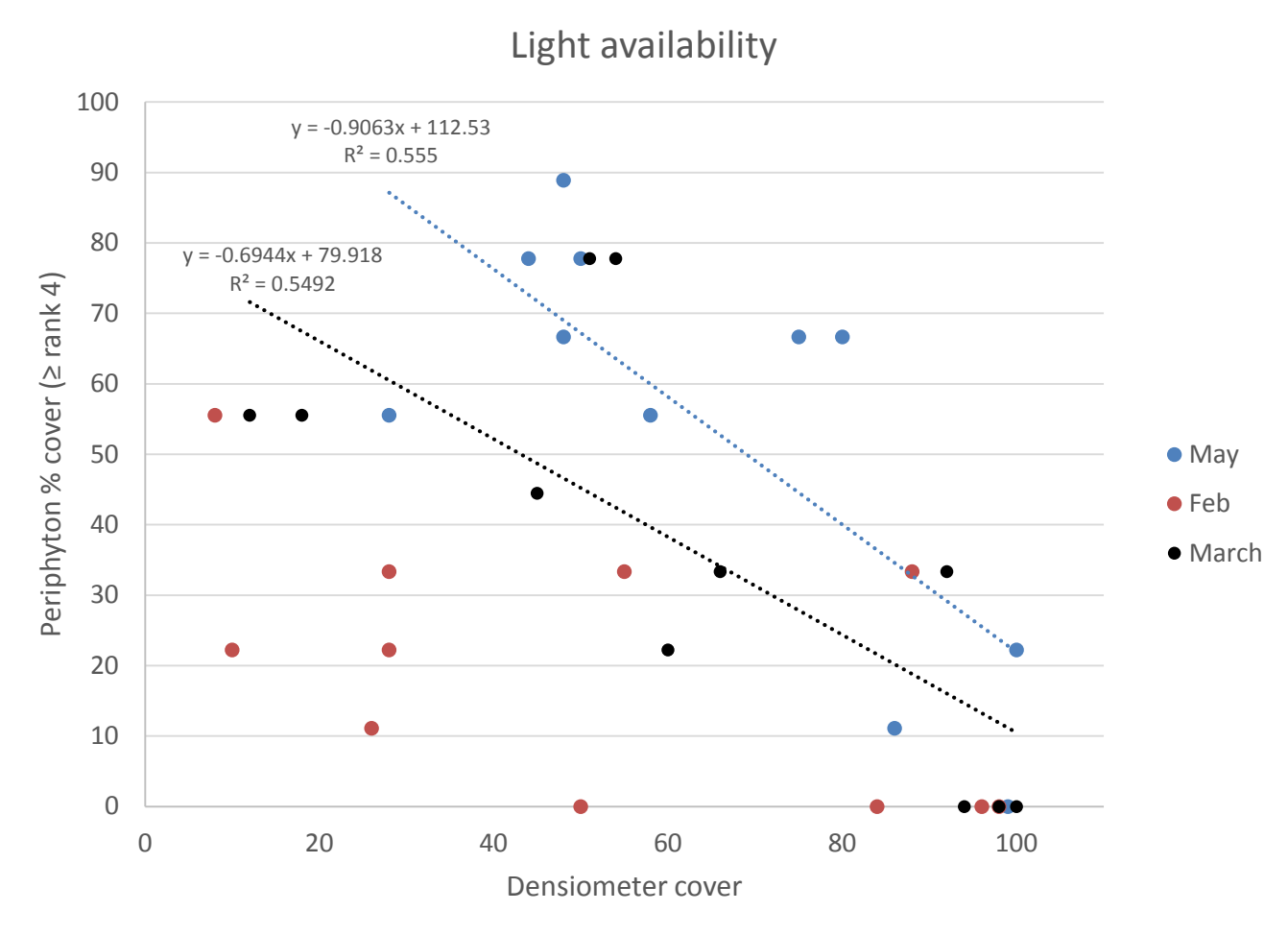


Figure 16. Light availability, as densitometer cover, in relation to percent coverage of periphyton ≥ rank four on each stream transect for Little Payne Creek

Conclusions

This long term study and data analysis identified several possible responses of periphyton coverage to environmental factors. There were observed changes in length and prevalence of periphyton coverage from month to month. However, these changes were not clearly related to water nutrient concentrations, temperature, or measured flow, nor did they correspond to fluctuations in other stream bioassessment methods. Two of the probable causes of changing algae coverage were changes in flow rate and light availability. After looking in depth at each transect along a stream reach, periphyton dependence on light availability was apparent. There was one example of a high flow event on the hydrograph followed by loss of periphyton growth, possibly indicating scouring or high water causing periphyton to slough off.