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Preliminary CPOM Data Summary

Summer of 2010

By

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Introduction

Course particulate organic matter (CPOM) is generally defined as any organic matter that is greater in diameter than 1mm. Leaf litter, seeds, trees and branches, along with myriad other organic materials found in aquatic systems are carried down streams each year. As velocities slow and material becomes water logged and settles out, it begins to decompose and the bacteria involved in this process consume oxygen in the process. This study is an attempt to quantify the loads of CPOM that various tributaries deliver to the Jordan River each year and to aid in our understanding of their impact downstream.

Brief Summary of Methods

Six tributaries along the Wasatch Front were studied and each of these tributaries was sampled in three locations: at the mouth of the canyon, below their initial debris basin(s), and at their confluence with the Jordan River. The debris basins are designed to slow the flow and allow sediment and larger material, such as logs and large branches, to settle out. At each collection site stream width and average channel depth were measured. A 500 micron mesh net was inserted in the stream at equal spatial intervals across the stream and held at each location for 30 seconds. Initially this was long enough to gather a measurable amount of CPOM. In July and September the sample interval was increased in multiples of the 30 second period in order to acquire adequate amounts of CPOM. The velocity of the water directly adjacent to the net was also measured at each interval across the stream. After collection in the 500 micron net, the sample was rinsed in a 1mm sieve to remove material less than 1mm in diameter. Samples were then processed to determine the total dry weight. The total dry weight was then burned to determine the portion of the dry weight that was actual volatile solids and thus organic. The concentration of dry volatile matter per liter of water that passed through the net was then calculated and these concentrations were extrapolated using detailed flow measurements obtained from Salt Lake County to estimate average daily and monthly loads.

Methods *(inserted from separate document)*

CPOM sampling was performed monthly from April to November in 2010 and monthly throughout 2011. In addition, during the high flow periods of the spring and during the heavy leaf fall periods of September to November of 2011, samples were collected biweekly to more accurately account for the higher CPOM delivery periods.

During relatively low-flow conditions (< approximately 300 cfs), samples were collected with a standard 10 inch x 18 inch sweep net, obtained from Wildlife Supply Company. The only mesh available is 500 µm whereas the standard separation between FPOM (VSS) and CPOM is defined using a 1 mm mesh size. Therefore, samples were immediately rinsed in a 1 mm- mesh soil sieve for accurate separation of particle sizes. At each site, samples were collected at ¼, ½ and ¾ distance across a horizontal transect. Where or when the stream depth was > approximately 30 cm, and floating debris was visible, samples were collected with the net at the surface and with the net resting on the bottom in order to collect floating debris as well as bed *load material. All samples were composited and the entire process was performed in duplicate. The duration of sample collection was timed in order to calculate loading and the duration of each "set" was adjusted in order to collect sufficient sample for accurate measurement as well as to limit sample volume to < approximately 200 g dry weight to facilitate sample handling, drying and combustion in the laboratory. Concentration or mass of the organic debris was determined by dividing the sample mass by the product of the stream velocity x net dimensions. During high flows or during the autumn leaf fall, typical duration of net placement was 10 to 30 seconds. During low flow conditions of winter and summer, net placement was extended to 60 seconds or more in order to collect sufficient sample volume. During very high flow conditions (> approximately 300 cfs), we used a 3-inch trash pump. About ½ of the cross-linkages of the intake screen were removed to facilitate the uptake of the debris. The intake screen was weighted with approximately 40-pounds of steel plates to ensure that the screen remained on the stream bottom. Sample collections from the surface were not performed during these high flows because the turbulence caused sufficient mixing that the leaf material was rapidly saturated and was assumed to be homogeneous throughout the water column. Also, because of this homogeneity, sample collection was only performed near the center of the channel. The discharge volume from the pump was measured using a 55-gallon drum and each of duplicate samples included ten volumes (550 gallons) of water. Similarly this material was sieved using the 1 mm soil sieve to collect the CPOM fraction.*

Where samples were collected near stream gauges, these flow measurements were used to calculate loads. Where stream gauge data were not available, channel dimensions were measured and velocity measurements were performed using a _______ flow meter.

Preliminary Results and Discussion

All of the data and flow calculations have been inserted and developed in spreadsheets (see attached). The sites for which calculations are currently complete are those on Mill Creek, Little Cottonwood Creek, and Big Cottonwood Creek. The flows used for calculations at LCC @ Canyon Mouth and LCC BL Debris Basin are only estimates, as the flows were actually recorded several miles downstream of these sampling sites. Significant amounts of water are both added to and diverted from Little Cottonwood Creek between these sites.

At this point, we can very conservatively estimate that Little Cottonwood Creek had a spring runoff load (May, June and July) of about 55,000kg (see attached spreadsheet). Of this, about 50,000kg was delivered with the high flows in June. The load from Big Cottonwood Creek was about 25,000kg at its Jordan River confluence during this time. The load from Mill Creek was estimated to be about 6,000 kg. At LCC BL DB samples were collected on three different days (June 3rd, 4th and 7th). The average of these three samples was used in the load calculations.

During these high flows we were not able to do cross section measurements because of the inherent danger from the deep, swift water. The samples that were collected were collected at the very edge of the streambed where the velocity is likely the lowest as was the observed debris carried by the current. The force and velocity of the water was also such that the net created a large amount of resistance and rather than flowing through, much or the water flowed around our net. These two factors alone lead one to believe that our current estimations of CPOM during high flows are gross underestimates of the actual amount.

There is also a drastic difference between average daily flows such that taking the instantaneous flow measured when a sample was collected and extrapolating that data for the whole month, rather than using a true monthly flow average and the CPOM concentration resulted in a difference as large as a 560kg monthly load to more than a 22,000kg monthly low. This error could occur in either direction depending on the instantaneous flow compared to average flows.

The dynamics of the CPOM concentrations are unknown, but one would generally expect higher concentrations at higher flows due to the greater velocity and force of the water. It is also known that larger masses of CPOM are associated the flows that occur during the ascending limb of the hydrograph rather than the descending limb due to the CPOM that had accumulated over the late summer and winter months - since the previous spring runoff period. Higher velocities also have a greater momentum and can dislodge and carrier greater amounts of CPOM both in particle size and the overall mass. The velocity at any one point in a cross section of a stream is also highly variable changing in both a horizontal and a vertical locations as well characteristics of the bottom contour.

Once the other sites have been analyzed and loads calculated, CPOM concentration to flow ratios can be evaluated more closely. Because of constant variability in CPOM concentrations, longer sampling periods will be implemented in the future. A slight modification of our site locations will also be very beneficial in helping determine more accurate flow and velocities. For example, both Little and Big Cottonwood Creeks are highly regulated beginning at the mouth of the respective canyons, including diversions to drinking water treatment facilities. In addition to water being removed for treatment, there are, in the case of Little Cottonwood Creek, seven or eight different locations where water is added or removed to the stream in less than five miles of stream length. Relocating sampling sites to the locations where flow gauges and flumes will improve these estimates.

Measuring the velocity of the water passing through our net was an ongoing challenge. The first flow meter we attempted using was extremely inaccurate as it could measure the extreme velocities we encountered during the spring high flows. This was replaced with another, much more accurate electronic flow meter during the second sampling run. However, this second meter also was unable to accurately read the highest velocities observed at Big and Little Cottonwood Creek sites during peak run off. In addition to using measured velocities, we determined velocities by back calculating from gauged flows that were measured either at or near the site. These back calculated velocities, and those obtained with our second flow meter are quite similar. Differences are possibly due to an over estimation of water depth and width due to rocks and other benthic morphology that was unaccounted for in our measurements. Relocating our sites to flumes where possible would reduce this discrepancy and create a more evenly distributed flow in the cross section where samples are collected.

Both Big and Little Cottonwood Creeks are fairly comparable to each other while Mill Creek's loads are likely more comparable with those of City Creek and Emigration, while Red Butte had nearly undetectable amounts of CPOM. Red Butte, however, will vary greatly from the other streams of comparable size due to the complications added this year with the oil spill and the large reservoir just upstream of our canyon mouth site for this stream. Red Butte is also a much smaller stream. This site should either be moved above the reservoir to the flume location for the canyon site or disregarded for future studies. Once these calculations are complete, they will improve our very conservative estimation of CPOM loads as well as help direct future analysis.

Also, this initial effort was an attempt to measure CPOM carried with the stream bedload, as we assumed that this material would constitute the greatest amount of material carried by the stream. However, we observed relatively large amounts of CPOM floating on the surface; as branches, leaves, twigs, seeds and dislodged macrophytes. The quantity of this material is unknown, but certainly contributes a substantial amount of organic debris that has not been accounted for thus far. In the future collection of samples at the surface, (floating CPOM) and throughout the water column (suspended CPOM) should be included with measurements of the bedload CPOM. Accurate measurements of CPOM will be complicated, requiring much more frequent sampling intervals, particularly during runoff events and sampling at various depths from the surface to the bottom in order to obtain accurate results.

Other conditions that were not captured are the effects of storm events, and seasonal changes such as seeds being release in the spring/summer from the thousands of trees lining the banks, and the dropping of leaves in the fall. These events could likely drastically add to these initial measurements of CPOM being transported to the river. The large percentage, 80-90% in Big and Little Cottonwood Creek, of the total CPOM collected over three months that was due to high flows, suggests that specific events could have large impacts on the total loads. In our future studies, we will likely cut back on the number of tributaries being sampled in order to more fully evaluate these variables. Only after these methods are perfected should actual measurements be used to calculate loadings, and particularly the necessary load reductions that may be proposed in order to achieve TMDL goals.

In light of these other important sources that have not been measured, this preliminary data suggests that there is a large enough quantity of CPOM entering the Jordan River as to fulfill the huge data gap that the large amounts of prescribed of SOD and methane dictate.