

Estimating Mass of Nutrients Removed from Mechanical Harvesting of Aquatic Plants and Tussocks from Orange Lake, Alachua County Florida

Florida Fish & Wildlife Conservation Commission
Aquatic Habitat Conservation and Restoration Section
Submitted by: Patrick McCord, FWC Project Manager

Background

The Florida Fish and Wildlife Conservation Commission's (FWC) Aquatic Habitat Conservation and Restoration Section frequently removes floating aquatic plants and associated organic detritus, muck sediment and/or peat from lakes and associated littoral wetlands as part of a strategy for improving aquatic habitat on public waterbodies throughout the state. Projects of this type typically involve the use of specialized floating barges referred to as "mechanical harvesters" or a terrestrial trac driven excavator mounted on top of a traditional floating barge to collect the material targeted for removal. Typically, the collected material is removed from the lake and deposited on a nearby upland property, where it is later tilled into the upland soil. Complete removal of spoil to a nearby upland is preferred, but this scenario is not always feasible. Under certain circumstances, the collected material may be deposited on spoil islands within the water body that have been legally permitted by state and federal environmental authorities specifically for this purpose.

Any event that results in temporary disturbance of flooded organic material, whether from natural disturbances or active management of fish and wildlife habitat, could potentially result in liberation, and eventually re-assimilation, of in-situ nutrients. However, the fact remains that in-lake disturbances only involve internal nutrient sources that already exist within the water body, and therefore do not result in any net import or export of nutrients from the system. However, mechanical harvesting projects that utilize upland spoil sites result in the direct removal of nutrient laden spoil from the system. This document summarizes a process that was developed to quantify the total mass of nutrients and organic carbon removed from Orange Lake (Alachua County) during a recent mechanical harvesting project that utilized a privately-owned upland disposal site. The project was funded by FWC with a total cost of \$517,845.

Methods

Most environmental or soils analysis laboratories can easily determine the nutrient content of a small sample of spoil material. However, the data derived from such analysis are typically reported as a mass per unit mass, often grams per kilogram, with no unit of volume referenced. One key factor that must be accounted for is the data will always be reported as a dry weight. Therefore, in order to correlate this data to a real-world field application, such as determining the amount of nutrients contained in a given volume of organic spoil removed from a lake for habitat enhancement purposes, it is necessary to first relate the total volume of fresh un-dried, or partially dried spoil material to a total dry weight.

Since we can estimate the total volume of spoil removed from the lake, either by direct measurement of spoil piles, or by calculating based on the known volume of dump truck payload

and total number of loads hauled, we can determine the total fresh weight of the spoil by weighing representative samples of uniform size/volume. A small amount of spoil from each sample is then dried in an oven to determine moisture content, or % dry weight, of each sample; this step was performed by the University of Florida Wetlands Biogeochemistry Laboratory (UF WBL). The total sample fresh weights are then multiplied by the % dry weight value for each sample to calculate the total sample dry weight. We now have a dry weight for the known volume of each sample, so we simply multiply proportionally to bring the value up to full scale of the total volume of spoil material removed from the water body.

Spoil was removed from Orange Lake in Alachua County over a ten-week period from April 1st to June 7th, 2019. Samples were collected approximately five weeks after project completion on July 11th, 2019. Spoil samples were extracted from windrowed piles at five sites that were distributed over a 16-acre upland pasture. Sample sites were selected to represent material that had been deposited at various stages of the project to account for variability in the composition of vegetation and organic material collected across the restoration site, and represented material that had been dewatering for a period of 30 to 105 days. Five samples of uniform volume were collected and weighed at each sample site. An average fresh weight was calculated for each sample site. The five samples collected were combined and mixed thoroughly to create a composite of the material extracted from each site. A sub-sample of this material was collected and placed in plastic zip-loc bags for each site and sent to the UF WBL to determine % dry weight, total Nitrogen, Total Phosphorus, and Total Carbon.

The following summary highlights the procedures used to collect samples and calculate the mass of Total Nitrogen, total Phosphorus and total Carbon removed from Orange Lake during the project.

1. Collect known volume of material to be sampled. A square sod plugging device (3" X 3" X 2.75" / 24.75in³) was used to extract spoil samples from five different sites within the 16-acre spoil site.
2. Five samples of uniform volume were collected, weighed, and an AVERAGE FRESH WEIGHT per unit volume was calculated for each sample site.
3. The five spoil samples were placed in a five-gallon bucket and mixed thoroughly with a small hand shovel to create a composite of the material collected from each site.
4. A small sub-sample (approximately 16oz/2 cups) was collected from the composite material for nutrient content analysis. Only a small amount of material is required for analysis; a sandwich size plastic zip-loc bag full of material is more than adequate.
5. Steps 1-4 were replicated at five different sampling locations.
6. The Wetland Biogeochemistry Laboratory at the University of Florida oven-dried the material to determine % Dry Weights and performed the nutrient content analysis. Specific methods and QA/QC details are described in Report #: WBL 2019-40 (attached).

Values used for calculation of total mass of nutrients removed from Orange Lake:

- a. Total volume of spoil removed- **45,000 yd³**
- b. Average (n=25) DRY WEIGHT of spoil per unit volume- **115.6 kg/yd³**
- c. Average (n=5 composite) TN Concentration- **34.8062 g/kg**
- d. Average (n=5 composite) TP Concentration- **0.7559 g/kg**
- e. Average (n=5 composite) TC Concentration- **455.9521 g/kg**

Calculations

Total Dry Weight of Spoil Removed

DRY WEIGHT (kg/yd³) X TOTAL VOLUME of spoil (yd³) = TOTAL DRY WEIGHT of spoil removed from Orange Lake.

$$115.6 \text{ kg/yd}^3 \times 45,000 \text{ yd}^3 = 5,202,000 \text{ kg TOTAL DRY WEIGHT SPOIL}$$

Total Nitrogen Removed

TN (g/kg) X TOTAL DRY WEIGHT SPOIL (kg) = TOTAL NITROGEN REMOVED

$$34.8062 \text{ g/kg TN} \times 5,202,000 \text{ kg Spoil} = 181,061,852.4 \text{ g}$$

OR

$$\text{TN} = \mathbf{181.062 \text{ metric tons}} \text{ (cost: \$2,860/mt N)}$$

Total Phosphorus Removed

TP (g/kg) X TOTAL DRY WEIGHT SPOIL (kg) = TOTAL PHOSPHORUS REMOVED

$$0.7559 \text{ g/kg TP} \times 5,202,000 \text{ kg Spoil} = 3,932,191.8 \text{ g}$$

OR

$$\text{TP} = \mathbf{3.932 \text{ metric tons}} \text{ (cost: \$131,700/mt P)}$$

Total Carbon Removed

TC (g/kg) X TOTAL DRY WEIGHT SPOIL (kg) = TOTAL CARBON REMOVED

$$455.9521 \text{ g/kg TC} \times 5,202,000 = 2,371,862,824.2 \text{ g}$$

OR

$$\text{TC} = \mathbf{2,371.863 \text{ metric tons}} \text{ (cost: \$218/mt C)}$$



Sampling Date	Sample ID	Wet/Fresh Weight (g) (Composite Avg.)	Fixed Sample Volume (in ³)	Conversion Factor (inches ³ / yd ³)	Sample Multiplier (# sample units / yd ³)	Moisture Content %	% Dry Weight	Dry Spoil kg / yd ³	TN Conc. (g/kg)	TP Conc. (mg/kg)	TC Conc. (g/kg)
7/11/2019	FWC-OL1	151	24.75	46656	1885.1	58.86	41.14	117.1	34.44	767.34	468.82
7/11/2019	FWC-OL2	282	24.75	46656	1885.1	75.67	24.33	129.3	32.26	697.91	439.10
7/11/2019	FWC-OL3	320	24.75	46656	1885.1	79.99	20.01	120.7	38.23	800.00	489.78
7/11/2019	FWC-OL4	332	24.75	46656	1885.1	81.95	18.05	113.0	33.49	863.85	443.65
7/11/2019	FWC-OL5	375	24.75	46656	1885.1	86.14	13.86	98.0	35.62	650.25	438.42

115.6	34.80619	755.86884	455.95212	AVERAGES
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Orange Lake Tussock Harvesting Spring 2019	Metric Tons Removed		
	TN	TP	TC
Estimate 45,000 yd ³ of spoil 36 acre footprint 1,250 yd ³ per acre	181.062	3.932	2371.863

Nutrient Content of Dense Floating Tussocks with Peat/Muck Attached on Orange Lake

Analyte	kg/yd ³	Metric tons/10,000 yd ³	Metric tons/acre
TN	4.024	40.236	5.029
TP	0.087	0.874	0.109
TC	52.708	527.081	65.885



Wetland Biogeochemistry Laboratory
Analytical Report for Non-Certified Analysis
Laboratory Results

Report number: **WBL 2019-40**

Project: **Orange Lake (193007-193011)**

For:

Patrick McCord
Florida Fish & Wildlife
1239 SW 10th Street
Ocala, FL 34471

A handwritten signature in black ink that reads "Patrick W. Inglett".

Dr. Patrick W. Inglett
WBL Technical Director
pinglett@ufl.edu

A handwritten signature in black ink that reads "Sophia L. Barbour".

Sophia L. Barbour
WBL Lab Manager and QA Officer
sophia.barbour@ufl.edu

Date Reported: **8/2/2019**

These test results meet all of the requirements of the WBL QA/QC standards. All results relate only to the samples. All questions regarding this analytical report should be directed to the WBL Laboratory Manager, who signed this report.

WBL, Soil & Water Sciences Department UF, 1692 McCarty Dr, Rm 2181, Gainesville, FL 32611
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Wetland Biogeochemistry Laboratory
Analytical Report 2019-40
Project: Orange Lake
Samples submitted by: Patrick McCord
Date reported: 8/2/2019

WBL No.	Received Date	Sampling Date	Sample ID	Sample Type	Analyses	Sample Flags	Moisture Content %	% Dry Weight	TN Conc. (g/kg)	TN Flags	TC Conc. (g/kg)	TC Flags	% LOI	TP Conc. (mg/kg)	TP Flags	%MC Date	TN/TC Analysis Date	TP Analysis Date
19-3007	7/11/2019	7/11/2019	FWC-OL1	Soil	% Dry weight; TP; TN		58.86	41.14	34.44		468.82		89.92	767.3		7/22/2019	7/25/2019	8/2/2019
19-3008	7/11/2019	7/11/2019	FWC-OL2	Soil			75.67	24.33	32.26		439.10		89.77	697.9		7/22/2019	7/25/2019	8/2/2019
19-3009	7/11/2019	7/11/2019	FWC-OL3	Soil			79.99	20.01	38.23		489.78		92.40	800.0		7/22/2019	7/25/2019	8/2/2019
19-3010	7/11/2019	7/11/2019	FWC-OL4	Soil			81.95	18.05	33.49		443.65		80.28	863.8		7/22/2019	7/25/2019	8/2/2019
19-3011	7/11/2019	7/11/2019	FWC-OL5	Soil			86.14	13.86	35.62		438.42		91.04	650.2		7/22/2019	7/25/2019	8/2/2019

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Flags:

- U:** Value < MDL (non-detect)
I: Value ≥ MDL but < PQL
Q: Actual holding time > Approved holding time
T: Actual temperature > Approved temperature
F: QC fail
B: Sample amount below minimum required
N: Not enough sample for analysis

All soil, sediment, and plant data calculated based on dry weight.

Matrix	Parameters	Units	Methods	MDL	PQL	Range of Std Curve
	Non Certified					
Soil/Plant	Total Phosphorus of Extracts	mg/L	SM4500-P F	0.03	0.1	0-4 mg/L
Soil/Plant	Total Nitrogen	mg	WBL-AN-010	0.02	0.06	0-1.5 mg N
Soil/Plant	Total Carbon	mg	WBL-AN-010	0.035	0.10	0-10 mg C

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QA/QC - Total Nitrogen / Total Carbon

Duplicates: < 20%						
Sample ID	TN			TC		
	Expected %	Observed %	%RSD (Precision)	Expected %	Observed %	%RSD (Precision)
Rep 19-3009	3.82	4.09	5	48.98	48.83	0

QC Standards: 85-115%						
Sample ID	TN			TC		
	Expected %	Observed %	% Accuracy	Expected %	Observed %	% Accuracy
Peach Leaves 1	2.94	2.73	93	47.18	44.50	94
Peach Leaves 2	2.94	2.91	99	47.18	43.57	92
WBL Std Soil 1	3.30	3.50	106	45.84	44.25	97

CCCS: 85-115%						
Sample ID	TN			TC		
	Expected %	Observed %	% Accuracy	Expected %	Observed %	% Accuracy
CCCS 1	10.36	10.50	101	71.09	71.24	100
CCCS 2	10.36	10.45	101	71.09	71.24	100

Matrix Blank: < MDL				
Sample ID	TN (< 0.02 mg)		TC (< 0.035 mg)	
	Observed (mg)	Pass	Observed (mg)	Pass
Sand 1	0.01	yes	-0.04	yes

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QA/QC - Total Phosphorus

Duplicates: < 20%			
Sample ID	I (mg/kg)	II (mg/kg)	%RSD (Precision)
TP Rep 19-3008	698	679	2
Anl Rep 19-3011	2.630	2.645	0

Spikes: 85-115%				
Sample ID	Sample Conc (mg/L)	Expected Conc (mg/kg)	Observed Conc (mg/kg)	% Recovery
TP Sp 19-3009	4.016	1380	1405	102
Anl Sp 19-3008	3.017	4.017	4.071	101

QC Standards: 85-115%			
Sample ID	Expected Conc (mg/L)	Observed Conc (mg/L)	% Accuracy
QC P 1 (P268-505)	0.603	0.578	96
QC P 2 (P268-505)	0.603	0.607	101
Peach Leaves 1	1370	1376	100
WBL Std Soil 1	868	859	99

CCCS: 90-110%			
Sample ID	Expected Conc (mg/L)	Observed Conc (mg/L)	% Accuracy
CCCS 1	1.000	0.963	96

PQL: 70-130%			
Sample ID	Expected Conc (mg/L)	Observed Conc (mg/L)	% Accuracy
PQL 1	0.100	0.102	102

CCB: < 0.03 mg/L			
Sample ID	Max Allowed Conc (mg/L)	Observed Conc (mg/L)	Pass
CCB 1	0.030	0.021	yes