Metadata-Florida Carbon Project Lab Data

Contacts

Name of PI	Sabine Grunwald
Institution	University of Florida
Department	Soil and Water Sciences
Address	2181 McCarty Hall, Gainesville, FL 32611 0290
Email	sabgru@ufl.edu
Phone	+1 352 294 3145

Investigator(s)
Name: Willie G. Harris
Institution / Department: Soil and Water Sciences Department, University of Florida
Address: 2181 McCarty Hall 2169, Gainesville, FL 32611 0290
Email: apatite@ufl.edu

Name: Nicholas B. Comerford,
Institution / Department: UF/IFAS North Florida Research and Education Center - Quincy
Address: 155 Research Road Quincy, Florida 32351-5677
E-mail: nbc@ufl.edu

Funding Source to Collect Data

USDA-CSREES-NRI grant award 2007-35107-18368
Contract Number 66389

National Institute of Food and Agriculture (NIFA) – Agriculture and Food Research Initiative (AFRI)

Core project of the North American Carbon Program (NACP)

Publications from this Project (that used data from this project)

Chaikaew P., A. Hodges and S. Grunwald. 2017. Estimating the value of ecosystem services in a mixed-use watershed: a choice experiment approach. Ecosystem Services J. 23(2017), 228-237. doi.org/10.1016/j.ecoser.2016.12.015.

Merrill H.R., S. Grunwald and N. Bliznyuk. 2017. Semiparametric regression models for spatial prediction and uncertainty quantification of soil attributes. Stoch. Environ. Res. Risk Assess. J., 1-13. doi:10.1007/s00477-016-1337-0.

Ross, C.W., S. Grunwald, D.B. Myers and X. Xiong. 2016. Land use, land use change and soil carbon sequestration in the St. Johns River Basin, Florida, USA. Geoderma Reg. 7, 19–28. doi:10.1016/j.geodrs.2015.12.001.

Knox N. M., S. Grunwald, M.L. McDowell, G.L. Bruland, D.B. Myers, W.G. Harris. 2015. Modelling soil carbon fractions with VNIR and MIR spectroscopy. Geoderma 239-240: 229-239.

Xiong X., S. Grunwald, D. B. Myers, J. Kim, W. G. Harris, N. B. Comerford, and N. Bliznyuk. 2015. Assessing uncertainty in soil organic carbon modeling across a highly heterogeneous landscape. Geoderma 251-252: 105-116.

Xiong X., S. Grunwald, D.B. Myers, J. Kim, W.G. Harris and N.B. Comerford.. 2014. Holistic environmental soil-landscape modeling of soil organic carbon. Environmental Modeling and Software J. 57: 202-215.

Xiong X., S. Grunwald, D.B. Myers, C.W. Ross W.G. Harris and N.B. Comerford. 2014. Interaction effects of climate and land use/land cover change on soil organic carbon sequestration. Science of Total Environment J. 493: 974-982. http://dx.doi.org/10.1016/j.scitotenv.2014.06.088

Ross C.W., S. Grunwald, D.B. Myers. 2013. Spatiotemporal modeling of soil organic carbon stocks across a subtropical region. Science of the Total Environment J. 461-462: 149-157.

Azuaje E.I., N.B. Comerford, W.G. Harris, J.B. Reeves III, and S. Grunwald. 2011. Loblolly and slash pine control aggregate soil carbon and soil carbon mineralization. Forest Ecology and Management J. 263: 1-8.

Vasques G.M., S. Grunwald, N.B. Comerford and J.O. Sickman. 2010. Regional modeling of soil carbon at multiple depths within a subtropical watershed. Geoderma 156: 326-336.

Vasques G.M., S. Grunwald and W.G. Harris. 2010. Building a spectral library to estimate soil organic carbon in Florida. J. Environ. Qual. 39: 923-934.

Vasques G.M., S. Grunwald, N.B. Comerford and J.O. Sickman. 2010. Upscaling of dynamic soil organic carbon pools in a north-central Florida watershed. Soil Sci. Soc. Am. J. 74: 870-879.

Vasques G.M., S. Grunwald and J.O. Sickman. 2009. Visible/near-infrared spectroscopy modeling of dynamic soil carbon fractions. Soil Sci. Soc. Am. J. 73: 176-184.

Vasques G.M., S. Grunwald and J.O. Sickman. 2008. Comparison of multivariate methods for inferential modeling of soil carbon using visible/near-infrared spectra. Geoderma 146: 14-25.

Detailed data description

Purpose of sampling (what project, to answer what questions, etc.)

Name: Rapid Assessment and Trajectory Modeling of Changes in Soil Carbon across a Southeastern Landscape

Objectives: The overall goal of the project was to quantify the pools of soil carbon (C) and fractions of soil C across the State of Florida, compare current and historic soil C content, and assess environmental factors / stressors that impart control on soil C using spatially-explicit models.

General sampling location

State(s): Florida, USA

Sample design (short)

Brief sample design is provided in the publications listed above.

Sampling Design (detailed)

The sampling design was a random-stratified approach with a portion of the sampled locations collocated with historic sampling sites (FSCD). One-half of the sample locations were chosen to coincide with those in the historic dataset. Two primary strata, soil suborder and LC/LU were used to capture the broad range of soil C variability across Florida (Fig. 1). Both properties were selected due to their strong relationships to soil C documented in the literature. Soil suborder distinguishes between major soil characteristics, in particular, hydrologic soil conditions (wetness/dryness) of sites.

The surface area of Florida was stratified by 13 classes of LC/LU (FFWCC, 2003) and 10 soil suborders (NRCS, 2006) using ArcGIS (Environmental System Research Institute, ESRI, Redlands, CA) leading to a total of 63 designed LC/LU-suborder classes. These classes represent about 69% of Florida's land area, reach nearly every county, and capture the most prominent combinations of LC/LU and soil suborder. The historic soil survey pedon dataset was also stratified by suborder and LC/LU. Sampling locations (n=550) were randomly chosen from the historical soil survey sites and the remainder were randomly chosen from the stratified land area of Florida. Sample populations were assigned randomly to the combined LC/LU-suborder strata proportional to their actual surface area.

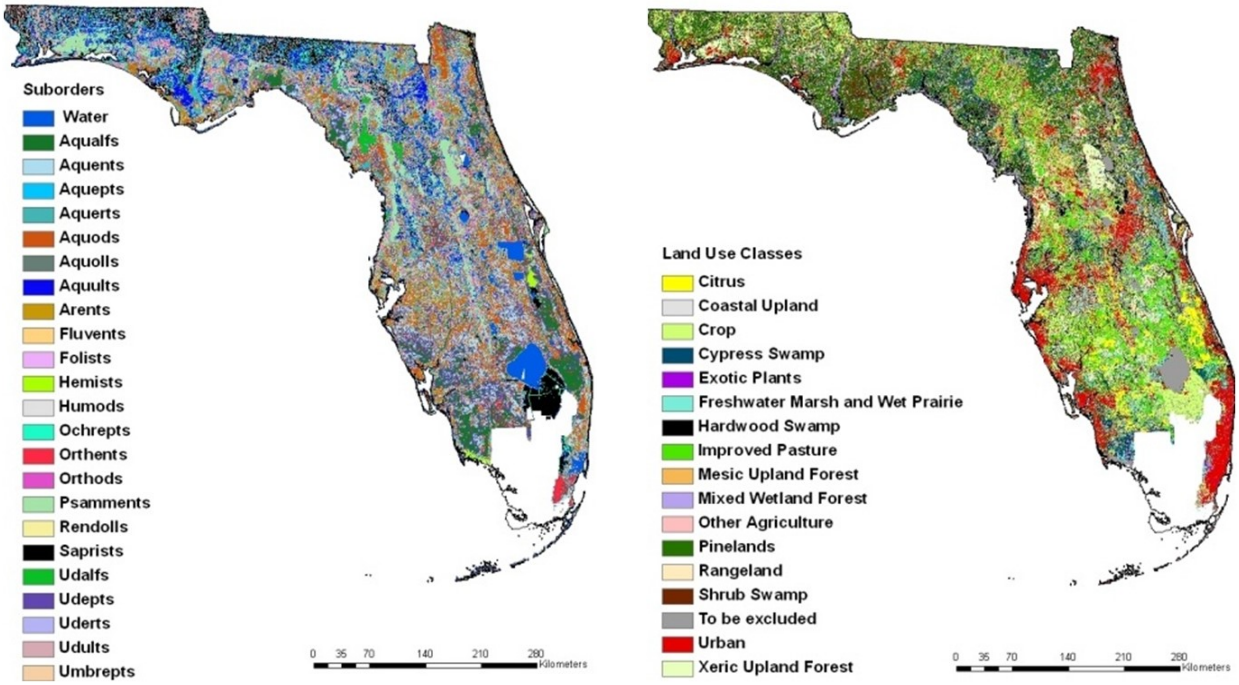

Fig. 1. a) Map of soil suborder for the extent of the study area derived from NRCS SSURGO digital data (NRCS, 2006). b) Map of Land Cover/Land Use (LC/LU) for the extent of the study area (FFWCC, 2003).

Sample Collection Protocol

The sample locations were located by differential global positioning system. Four 20 x 5.8 cm soil cores were collected from each site within a 2 m diameter area. The four soil samples were bulked in the field, and placed in a cooler until they could be transported to the lab and processed. Four litter samples (when litter was present) were taken also within 2 m of the sample location. A metal sampling template was used to control sample surface area. The samples were bulked and placed into a cooler. Land cover/LU was determined and confirmed in the field and profile morphology was observed by auguring (2 m) to determine soil suborder (Fig. 2).

Fig. 2. Four surface samples (20 x 5.8 cm) were collected and bulked from each location. Profiles were observed by augering 2 meters to determine soil suborder. Litter samples and descriptions of land cover / land use were taken at each sampling location (photos Lisa Stanley left, Aja Stope right).

Phase I Sample Collection

The original sample design was implemented from March 2008 until June 2009. We collected 927 samples during this campaign, 453 from historic soil survey locations and the remainder from the random-stratified reconnaissance locations. Many of the original designed historic and reconnaissance locations could not be sampled due to a variety of issues encountered in the field (e.g. site under a newly developed shopping center or parking lot, wetness, lack of permission or access). Additionally, few sites had different LC/LU or soil suborders than designed. This led to a shortage of samples in some of the LC/LU-suborder classes as well as a reduced number of total samples. Two LC/LU-suborder combinations were found not to exist – artifacts of the LC/LU coverage development. Additionally, some areas were sparsely sampled (due to constraints by field conditions outlined above), a situation that might have proven problematic for the geospatial modeling objectives of the project. Overall, the designed LC/LU-suborder classes lacked a total of 65 samples. To mitigate these problems a second phase of sample locations was designed.

Phase II Sample Design and Collection

The second phase of the sampling complemented Phase I to achieve the goals of ~1,000 samples, improve the spatial distribution of observation sites, and to fulfill the desired sample population within each of the design strata. Ten areas from across Florida with sparse sample distributions were selected and their land area stratified according to the original design (Fig. 3). Random locations were again drawn from the specific LC/LU-suborder strata having deficient populations after Phase I. Phase II was implemented between June ‘09 and August ’09 shortly after the close of Phase I. An additional 85 locations were sampled resulting in a final collection of 1,014 samples.

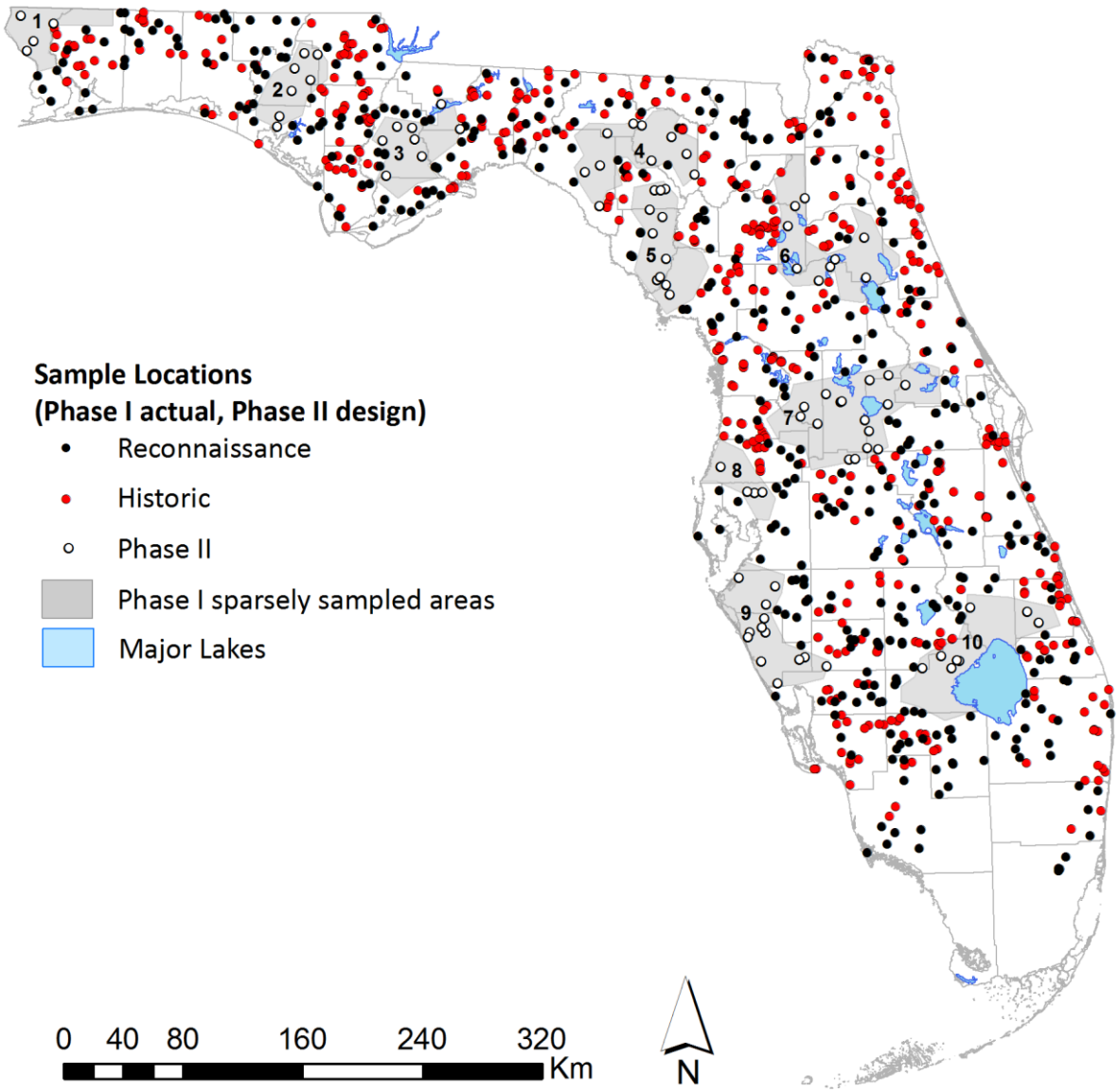

Fig. 3. The Phase II sampling protocol was implemented to rectify some unavoidable shortcomings in the Phase I result. In phase 1 the random selection of observation sites left some areas of Florida sparsely covered and some samples were physically not accessible. The resulting sparsely covered areas are highlighted in light grey and were used to constrain the Phase II random-stratified sample placement.

Sample acquisition and processing

Sample Collection Protocol

The sample locations were located by differential global positioning system. Four 20 × 5.8 cm soil cores were collected from each site within a 2 m diameter area. The four soil samples were bulked in the field, and placed in a cooler until they could be transported to the lab and processed. Four litter samples

(when litter was present) were taken also within 2 m of the sample location. A metal sampling template was used to control sample surface area. The samples were bulked and placed into a cooler. Land cover/LU was determined/confirmed in the field and profile morphology was observed by auguring (2 m) to determine soil suborder.

Analytical laboratory methods

Sample Processing

Soil samples were processed as collected. Upon return to the lab, fresh weight was measured and a moisture content sample was taken and the sample oven dried. Next the bulk sample was air dried and an air-dry moisture content sample was taken and oven dried. Finally, the bulk sample was sieved to retrieve the fine earth fraction (<2mm), mixed thoroughly, and stored in plastic containers. Mineral and organic material larger than 2 mm were retained for later processing. Subsamples were collected from the bulk sample for lab measurements. A portion of the subsample was ball milled for use in some of the lab procedures. The bulk sample was archived for future work and sample containers barcoded (labeled). Litter samples were dried at 105° C and weighed.

Overview

The dataset contains 1080 samples:

- 1014 samples from Florida Carbon Project Phase I and II. **SiteID < 4000**.
- 66 samples were randomly selected from Grunwald's and Jongsung Kim's project in Everglades Water Conservation Area. **SiteID > 6000.** The number 66 was chosen to achieve a balance of sample density in different land use and land cover types.
- SiteID column is the key to link the table to all other tables, i.e., flscpCoord.txt, flscpEnv.txt, flscpField.txt, flscpLab.txt, and flscpVNIR.txt.

Lab Data Description

Variable (column) Name	Data Type	Units	Meta Data
SiteID	Number	-	The Florida Carbon Project site ID. A sequential index inclusive of Phase I (1-1000), replacement (2000), and PhaseII (3000) samples. Includes all samples missing or not between 1 and 1000. SiteID > 6000 are samples from Jongsung Kim's project in Everglades Water Conservation Area.
Longitude	Decimal	degrees	Geographic Coordinate - longitude in decimal degrees, WGS84
Latitude	Decimal	degrees	Geographic Coordinate - latitude in decimal degrees, WGS84
Easting	Decimal	m	Easting (m), FGDL Albers HARN Map projection parameters:

			Albers Conical Equal Area map projection: Albers False_Easting: 400000.00000000 False_Northing: 0.00000000 Central_Meridian: -84.00000000 Standard_Parallel_1: 24.00000000 Standard_Parallel_2: 31.50000000 Central_Parallel: 24.00000000 Linear Unit: Meter (1.000000) Geographic Coordinate System: GCS_North_American_1983_HARN Datum: D_North_American_1983_HARN Prime Meridian: 0
Northing	Decimal	m	Northing (m), FGDL Albers, HARN <u>Map projection parameters:</u> Albers Conical Equal Area map projection: Albers False_Easting: 400000.00000000 False_Northing: 0.00000000 Central_Meridian: -84.00000000 Standard_Parallel_1: 24.00000000 Standard_Parallel_2: 31.50000000 Central_Parallel: 24.00000000 Linear Unit: Meter (1.000000) Geographic Coordinate System: GCS_North_American_1983_HARN Datum: D_North_American_1983_HARN Prime Meridian: 0
SampledSuborder	String	-	The field designated soil suborder of the site
SampledLULC	String	-	The field designated land cover/land use for the site
TCpct	Decimal	% wt	Percent total carbon m/m. <u>Procedure:</u> Combustion catalytic oxidation (Shimadzu SSM-5000A) Standards: Carbon Potassium Hydrogen Phthalate 1000 ppm C = 2.125g Potassium Hydrogen Phthalate/L DDI water, previously dried at 105-120ºC for about 1 hour in the muffle furnace then cooled in a desiccator. • 20 mg C is the upper limit for the short cell (long cell is less) • To date, 0.1 mg of C is the lowest correctly measured standard curve measurement Quartz wool is used as a medium to put the liquid on. Evenly distribute the known amount of standards in the same boat. A max of 0.5 ml of liquid sample is best, although 1 ml has worked. Splashing, incomplete combustion. Sample size: ~0.5g of solid material is the limit for good sample size. More than 0.5g, there is not as much contact, leads to incomplete combustion and dirties the instrument.

			Reference: G:\Data\FL Carbon\Original data\LabData\State C project Data and Photos\Shimadzu 5000 operation\Measuring Solid TC and TN.doc
ICpct	Decimal	% wt	Percent inorganic carbon m/m Procedure: 0.05 to 0.5 gram of soil, 1 mL 24% H_3PO_4 acid at 200 degrees C on Shimadzu gas analyzer.
SOCpct	Decimal	% wt	Percent soil organic carbon m/m, derived by TCpct minus ICpct
RCpct	Decimal	% wt	Percent recalcitrant carbon m/m Procedure: Hydrolysable carbon 6M HCl – 495.87 mL of Concentrated HCl (12.1N) in 1 L 1g soil:10mL 6 M HCl Measured into a glass digestion tube, record weight Digested on the block at 116ºC for 16 hrs, use reflux bulbs Wash digested soil into 40 ml centrifuge tubes. Wash sample 3 times in centrifuge with DDI to remove acid residue. Weigh and record 20 ml scintillation vial Remove and wash soil into 20 ml scintillation vials Dry at 80ºC for 2-3 days. Solid Phase Measurement: Measure TC in the original sample and the residue left from the digest: Record weight of dried sample and scintillation vial Ball mill the residue 1 minute Weigh 0.1 to 1 gram of ball milled residue into a ceramic combustion boat, Depending on the amount of TC in the residue, it must range between 1 mg to 20 mg TC in the sample. Analyze the residue for TC with the Solid phase of the Shimadzu TOC-5000 hydrolysable fraction = TC of bulk soil – TC of the residue The true measure of labile C is whether it is subject to microbial degradation. Acid digest hydrolyzes polysaccharides and nitrogenous material, leaves the polyaromatic humics and lignin. Reference: G:\FL_carbon\Documentation\Protocols\6M HCl Hydrolyzable carbon.doc
MCpct	Decimal	% wt	Percent moderately available carbon m/m MCpct = TCpct – HCpct - RCpct

HCpct	Decimal	% wt	Percent hot water extracted carbon m/m <u>Procedure:</u> Revised on 09-22-09 by Aja Stoppe This method is intended to be comparable to J.O Sickman and X. Chunhao. Original method from Sparling et al. (1998) and Gregorich et al. (2003) Equipment needed Water bath Vacuum filter and Buchner funnels TOC analyzer 35 centrifuge tubes + lids 0.22 µm GV membranes (Fisher No. GVWP04700) 1:10 soil to hot water ratio 50 centrifuge tubes + lids (Before use, these tubes are washed in an alkaline bath then an acid bath. W/O this treatment the tubes add dissolved carbon to the solution) 4g soil : 40mL DDI water ratio, Measure soil into a 50 mL centrifuged tube, add 40mls DDI For Every run there is: 10% Blanks, 10% soil replication, 1 spiked sample and one check soil. Samples are treated in an 80ºC water bath for 16 hrs. Samples are vortexed for 10 seconds, then filtered. Vacuum filter samples through 0.22 µm GV membranes Filter into 35 ml centrifuge tubes. Filtrated solutions can be stored at 4ºC Samples are measured on the TOC analyzer for Carbon and Nitrogen <u>Reference:</u> G:\Data\FL Carbon\Original data\LabData\Protocols\Hot water extractable C protocol.doc
HNpct	Decimal	% wt	Percent hot water extracted nitrogen m/m <u>Procedure:</u> See that of HCpct
LOIpct	Decimal	% wt	Loss on ignition % <u>Procedure:</u> The Loss on Ignition (LOI) organic matter determination is used for analyzing soil samples in which the organic matter content is greater than 6%. This procedure involves exposing the soil sample to high temperatures in an oxygen atmosphere in order to convert any organic carbon compounds to carbon dioxide, which is then lost to the atmosphere. The difference between the soil dry weight and the weight of the sample after ignition is then used to calculate the amount of organic matter in the sample. This procedure has been reported to be consistent with even with lower SOM levels (<6%) such as sandy soils in Florida. Studies are on-going to determine the suitability and for possible replacement method for WB procedure. Procedure for pH below 7 1) Label and accurately weigh (to 4 decimal places) an oven

			dried glass vial. 2) Add approximately 1-2 g of soil to the vial. 3) Place sample in the oven at a constant temperature of 105 ºC and allow sample to dry for a minimum of 2 hrs, best over night. 4) Remove sample from the oven at the end of two hours and place immediately into a desiccator to cool. Allow sample to cool to room temperature (approximately 30 minutes) and then accurately weigh sample and vial. 5) After weighing, place sample into a muffle furnace and heat at 500ºC for a minimum of 6 hours. 6) At the end of the heating period, allow samples to cool and then transfer immediately to a desiccator. Allow samples to cool to room temperature in the desiccator. 7) After samples reach room temperature, remove from the desiccator and accurately weigh sample and vial. 8) The % OM is calculated as follows: % OM = (Oven Weight – Furnace Weight) * 100 Sample Dry Weight where: oven weight = weight of beaker + sample after drying at 105oC • furnace weight = weight of beaker plus sample after ignition in muffle furnace at 350ºC • sample dry weight = weight of sample plus beaker after drying at 105ºC minus weight of vial <u>Reference:</u> G:\Data\FL Carbon\Original data\LabData\Protocols\Loss on Ignition Protocol.doc
TNpct	Decimal	% wt	Percent total nitrogen m/m <u>Procedure:</u> TNpct by gas combustion analysis (Waters Ag Lab)
TPpct	Decimal	% wt	Percent total phosphorus m/m <u>Procedure:</u> TPpct was measured by acid digestion and ICP (Waters Ag Lab)
TCgkg	Decimal	g TC kg^{-1}	Total carbon in g kg^{-1}, TCgkg = TCpct × 10
ICgkg	Decimal	g IC kg^{-1}	Inorganic carbon in g kg^{-1}, ICgkg = ICpct × 10
SOCgkg	Decimal	g SOC kg^{-1}	Soil organic carbon in g kg^{-1}, SOCgkg = SOCpct × 10
RCgkg	Decimal	g RC kg^{-1}	Recalcitrant carbon in g kg^{-1}, RCgkg = RCpct × 10
MCgkg	Decimal	g MC kg^{-1}	moderately available carbon in g kg^{-1}, MCgkg = MCpct × 10
HCgkg	Decimal	g HC kg^{-1}	Hot water extractable carbon in g kg^{-1}, HCgkg = HCpct × 10
HNgkg	Decimal	g HN kg^{-1}	Hot water extractable nitrogen in g kg^{-1}, HNgkg = HNpct × 10
TNgkg	Decimal	g TN kg^{-1}	Total nitrogen in g kg^{-1}, TNgkg = TNpct × 10
TPgkg	Decimal	g TP kg^{-1}	Total phosphorus in g kg^{-1},

			TPgkg = TPpct × 10
LOIgkg	Decimal	g LOI kg^{-1}	Loss on ignition in g kg^{-1}, LOIgkg = LOIpct × 10
TC	Decimal	kg TC m^{-2}	Mass of total carbon present in the top 20 cm (kg TC m^{-2}) TC = (TCpct/100) × BDod × (20 cm depth × 10000 cm^{-2} surface/ 1 m^{-2} surface) × (1 kg C/1000 g C)
IC	Decimal	kg IC m^{-2}	Mass of inorganic carbon present in the top 20 cm (kg IC m^{-2}) IC = (ICpct/100) × BDod × (20 cm depth × 10000 cm^{-2} surface/ 1 m^{-2} surface) × (1 kg IC/1000 g IC)
SOC	Decimal	kg SOC m^{-2}	Mass of soil organic carbon in the top 20 cm (kg SOC m^{-2}) SOC = (SOCpct/100) × BDod × (20 cm depth × 10000 cm^{-2} surface/ 1 m^{-2} surface) × (1 kg SOC/1000 g SOC)
RC	Decimal	kg RC m^{-2}	Mass of recalcitrant carbon in the top 20 cm (kg RC m^{-2}) RC = (RCpct/100) × BDod × (20 cm depth × 10000 cm^{-2} surface/ 1 m^{-2} surface) × (1 kg RC/1000 g RC)
MC	Decimal	kg MC m^{-2}	Mass of moderately available carbon in the top 20 cm (kg MC m^{-2}) MC = (MCpct/100) × BDod × (20 cm depth × 10000 cm^{-2} surface/ 1 m^{-2} surface) × (1 kg MC/1000 g MC)
HC	Decimal	kg HC m^{-2}	Mass of hot water extractable carbon in the top 20 cm (kg HC m^{-2}) HC = (HCpct/100) × BDod × (20 cm depth × 10000 cm^{-2} surface/ 1 m^{-2} surface) × (1 kg HC/1000 g HC)
HN	Decimal	kg HN m^{-2}	Mass of hot water extractable nitrogen in the top 20 cm (kg HN m^{-2}) HN = (HNpct/100) × BDod × (20 cm depth × 10000 cm^{-2} surface/ 1 m^{-2} surface) × (1 kg HN/1000 g HN)
TN	Decimal	kg TN m^{-2}	Mass of total nitrogen in the top 20 cm (kg TN m^{-2}) TN = (TNpct/100) × BDod × (20 cm depth × 10000 cm^{-2} surface/ 1 m^{-2} surface) × (1 kg TN/1000 g TN)
TP	Decimal	kg TP m^{-2}	Mass of hot total phosphorus in the top 20 cm (kg TP m^{-2}) TP = (TPpct/100) × BDod × (20 cm depth × 10000 cm^{-2} surface/ 1 m^{-2} surface) × (1 kg TP/1000 g TP)
RCrSOC	Decimal	1	Ratio of RC and SOC
HCrSOC	Decimal	1	Ratio of HC and SOC
HNrSOC	Decimal	1	Ratio of HN and SOC
TNrSOC	Decimal	1	Ratio of TN and SOC
FMoistBulkWt	Decimal		Field moist bulk weight
FMWaterPct	Decimal	% wt	Field moist water content %
ADryBulkWt	Decimal		Air dry bulk weight
ODryBulkWt	Decimal		Estimated oven dry bulk weight (corrected ADryBulkWt based on subsample air dry water content)
ADWater	Decimal	% wt	Air dry water content %
ADWaterPct	Decimal	% wt	Air dry water content of subsample %
FMBulkWaterPct	Decimal	% wt	Field moist bulk sample water percent (field moist-air dry)
BDod	Decimal	g cm^{-3}	Oven dry bulk density
BDad	Decimal	g cm^{-3}	Air dry bulk density
BDfm	Decimal	g cm^{-3}	Field moist bulk density
BDodMethod	String	-	The method of calculation or estimation of BDod
BDadMethod	String	-	The method of calculation or estimation of BDad
BDfmMethod	String	-	The method of calculation or estimation of BDfm
pHw	Decimal	-	1:1 Soil:water pH

			Procedure: Cited from the SSSA Methods of Soil Analysis, part 3-chemical methods p.487 Aja Stoppe March 10, 2008 1) Calibrate the pH meter a. press “ON” b. wash probe with DDI water c. push “cal/means” d. put probe into 1st pH buffer, wait for it to stabilize, push “Enter” e. repeat step d. for the next 2 pH buffers f. the machine is now calibrated, start reading samples and recording pH measurements 2) Weigh out 10 g if air-dry soil into a 50 or 100 ml beaker 3) Add 10 mL of DDI water, mix well with glass stir rod 4) Let stand for 10 minutes 5) Swirl the suspension in the beaker and insert the electrode into the suspension. The probe position in the beaker needs to be consistent from sample to sample 6) Read pH and record a pHw 7) Between pH readings, rinse the electrodes with DDI water. Blotting the probe is not necessary. 8) After all the measurements are taken, rinse probe and return it to the KCl storage bottle. Reference: G:\Data\FL Carbon\Original data\LabData\Protocols\pH Protocol.doc
Litter	Decimal	kg litter m^{-2}	Mass of litter (kg litter m^{-2})