2012

Campus Biomass: It's a Good Thing!

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2012 MSTA

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University of Southern Mississippi

THE GLOBE PROGRAM

CONNECTING THE NEXT GENERATION OF SCIENTISTS

Global Learning and Observations to Benefit the Environment

- Began on Earth Day 1995
- Currently, there are
  - 112 participating countries
  - 58,000 GLOBE-trained teachers
  - > 25,000 schools
  - > 1.5 million students
  - > 23 million measurements

Tupelo Middle School

Calculating tree height, tree circumference, canopy cover, and ground cover on the campus.



Kate Wheeler and George Patterson measure and record the size of a sycamore outside of the school. Below, Shelia Brown assists Tupelo Middle School students, from left, Wyatt Herring, Marcus Lewis, Lucas Hartigan and Jason Garrett with their recording of scientific data. (C. Todd Sherman)

Tupelo Middle School students measure trees, collect water samples
by Chris Kieffer/NEMS Daily Journal Nems360.Com

TUPELO – Science proved to be more work than Tupelo Middle School eighth-grader Kimya Jamasbi expected.

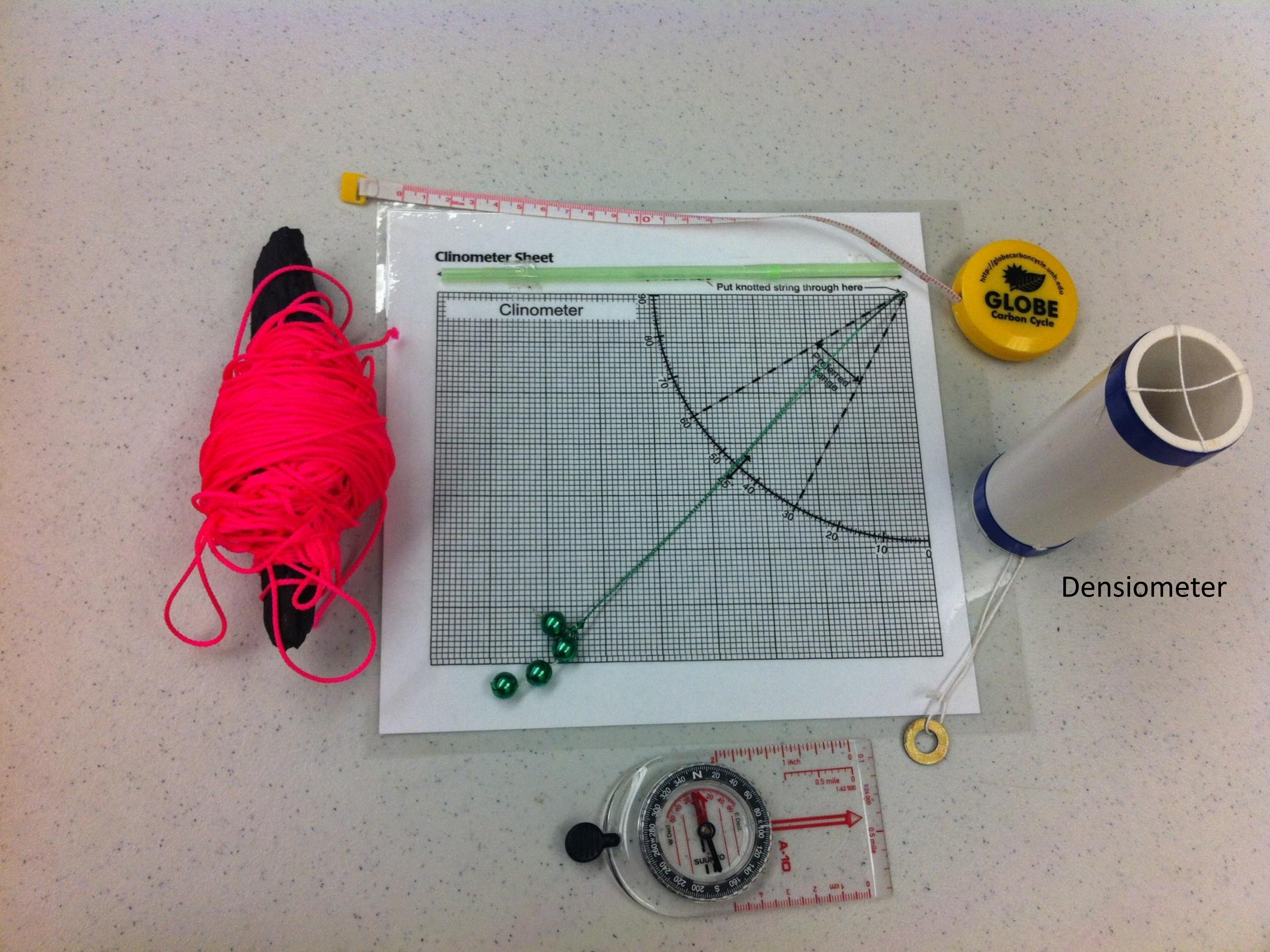
After spending a class period measuring the trees on the school's athletic field, Kimya said she was surprised to be ducking under branches and getting poked by limbs. "It was a good experience," she said, "but I didn't like climbing through the trees."

Kimya was among about 300 students participating in a hands-on activity Wednesday with science educators from the University of Southern Mississippi. The students, from Holly Bailey's seventh-grade science class and Judy Harden's eighth-grade science class, peered at the trees through a tube-shaped instrument called a densiometer; used measuring tape to determine circumferences of trunks; and carried clipboards to record data.

They will log that information throughout the year and record it in an online database that allows scientists to use the results throughout the world.

"Hopefully they will gain an awareness of how science works and what scientists do," said Sherry Herron, professor and director of the Center for Science and Mathematics Education at USM.

Herron joined Shelia Brown at the school Wednesday to give the students a lesson on collecting data. Brown is an educator/ biologist at Gulf Coast Research Laboratory Marine Education Center in Ocean Springs, part of USM.



Densiometer

N.R. Burger Middle School

Calculating tree height and circumference on the campus.

Sherwood Forest Middle Magnet School

Walking a block to do GLOBE Land Cover and Hydrology

Hancock North Elementary

Calculating tree height, tree circumference, canopy cover, and ground cover on campus.

THE GLOBE PROGRAM

CONNECTING THE NEXT GENERATION OF SCIENTISTS

http://globecarboncycle.unh.edu/

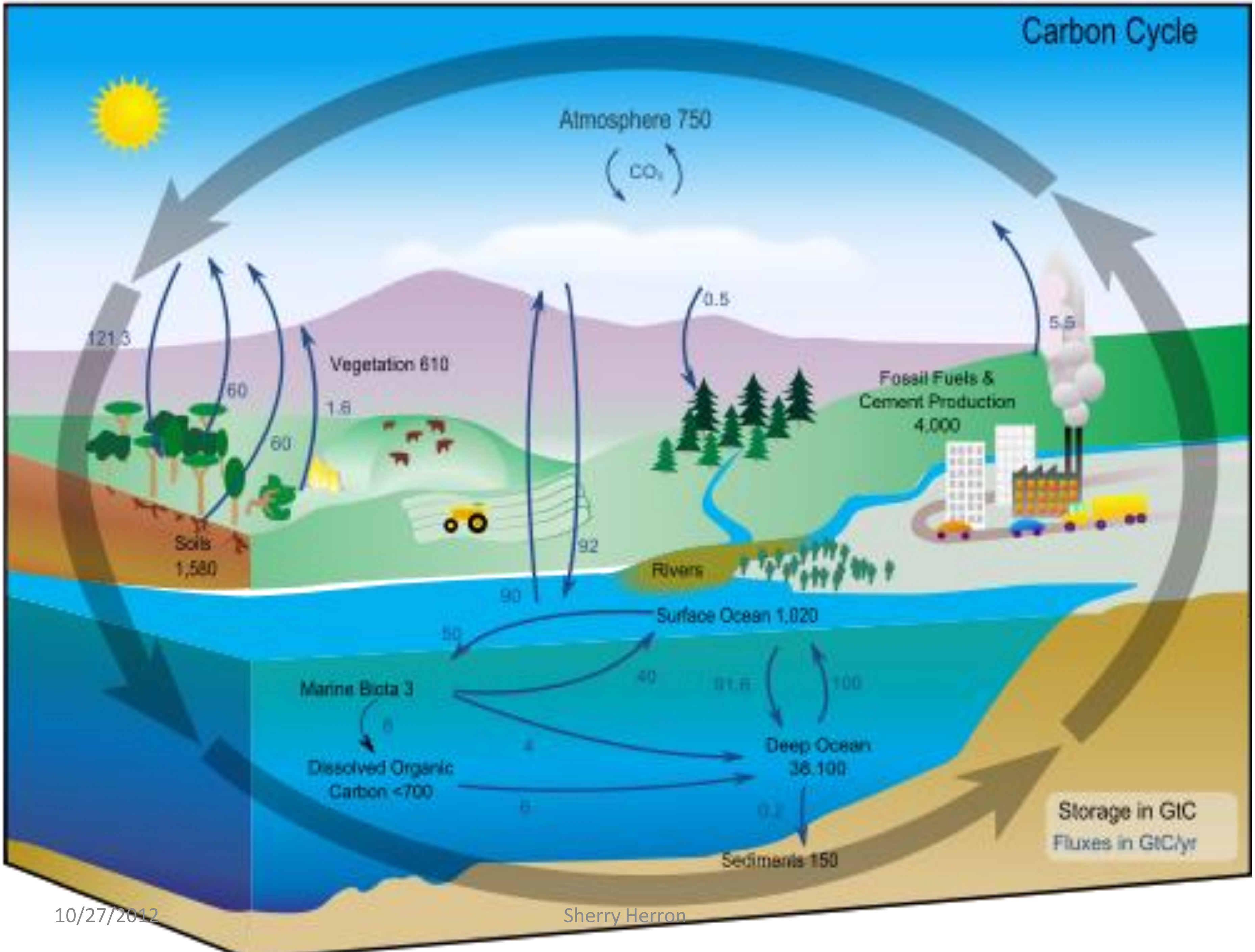
NSF

NASA

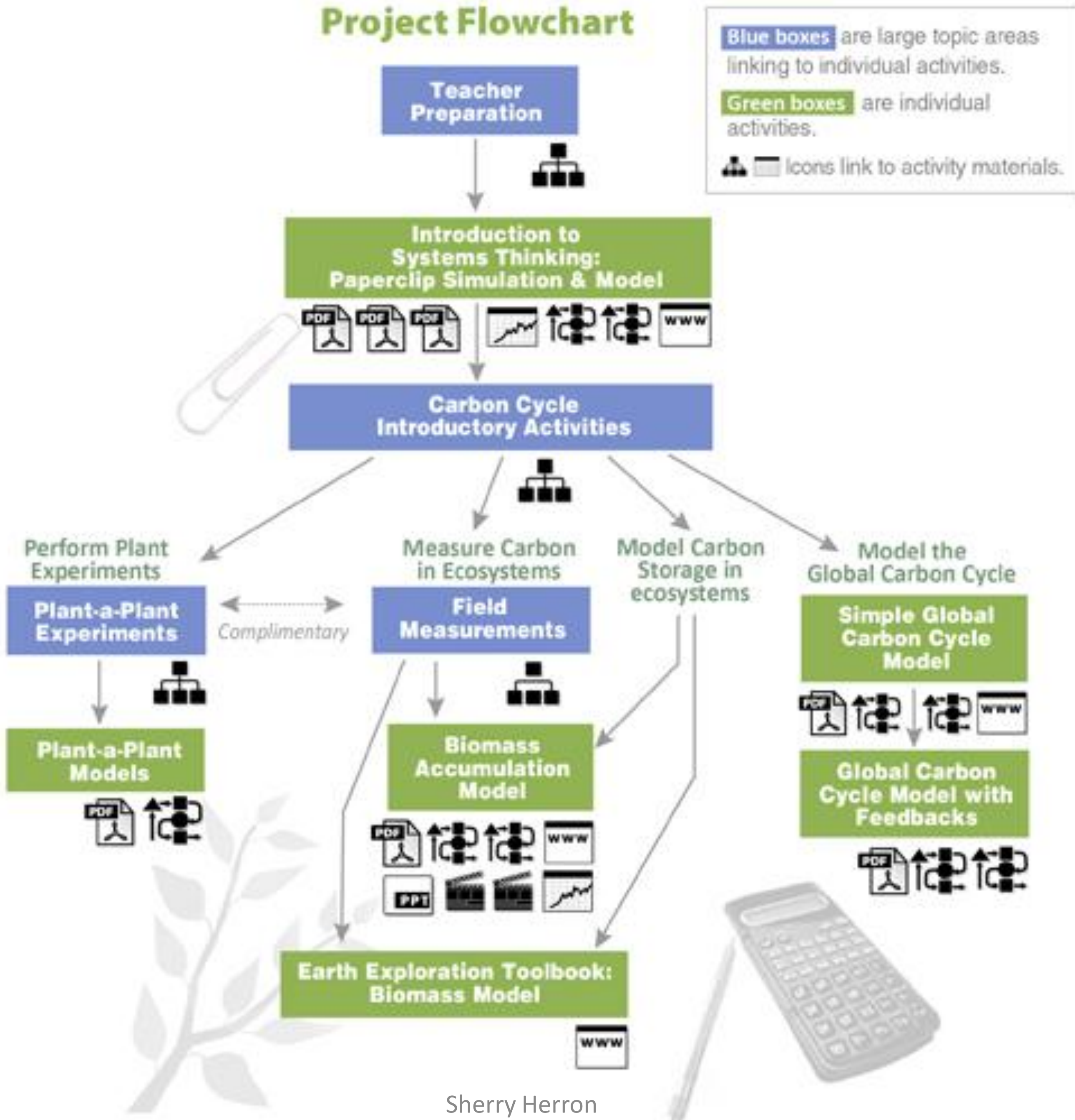
UNIVERSITY of NEW HAMPSHIRE

Investigating the Carbon Cycle in Terrestrial Ecosystems

Carbon Cycle



Carbon Cycle
Atmosphere 750
CO₂
121.3
60
60
1.6
Vegetation 610
0.5
5.5
Fossil Fuels &
Cement Production
4,000
Soils
1,580
92
90
Rivers
Surface Ocean 1,020
50
40
91.6
100
Marine Biota 3
Deep Ocean
38,100
Dissolved Organic
Carbon <700
6
0.2
Sediments 150
Storage in GtC
Fluxes in GtC/yr


Project Flowchart
Blue boxes are large topic areas linking to individual activities.
Green boxes are individual activities.
Icons link to activity materials.
Teacher Preparation
Introduction to Systems Thinking: Paperclip Simulation & Model
Carbon Cycle Introductory Activities
Perform Plant Experiments
Measure Carbon in Ecosystems
Model Carbon Storage in ecosystems
Model the Global Carbon Cycle
Plant-a-Plant Experiments
Complimentary
Field Measurements
Simple Global Carbon Cycle Model
Plant-a-Plant Models
Biomass Accumulation Model
Global Carbon Cycle Model with Feedbacks
Earth Exploration Toolbook: Biomass Model

Goals

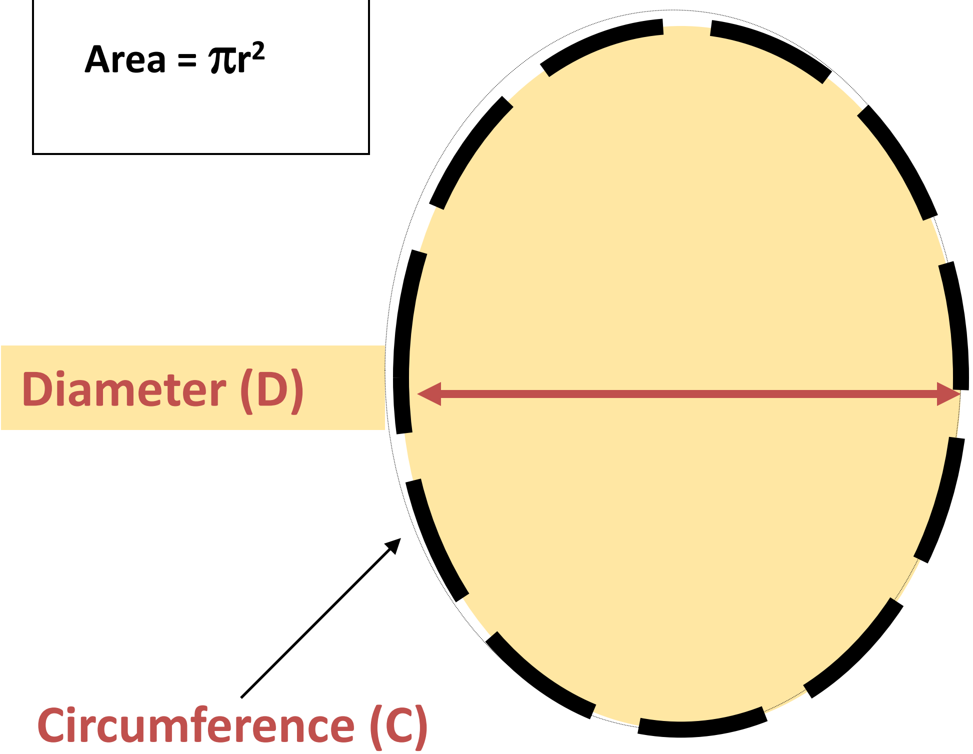
- Increase environmental awareness in students.
- Increase students' appreciation for and importance of the trees in their own neighborhoods and at school.
- Increase students' abilities to engage in scientific studies.
- Increase students' understanding of how climate change data is collected.

Diameter at Breast Height (DBH)

$\pi = 3.14$

$D = C/\pi$

$\text{Area} = \pi r^2$



John Banks

Excel Spreadsheet with automatic calculations

Tab 1: Instructions
Tab 2: Plot Size

Plot Size

In order to compare your data to data collected by others, our calculation of biomass per plot will be converted to biomass per square meter. This conversion requires some information that you will enter here about your plot size. **Enter data into either 1 or 2 below in meters**:

1. If your plot is rectangular, enter the LENGTH of a SHORT and LONG side
2. If your plot is circular, enter the plot RADIUS
3. If you have an odd sized plot (for instance you've sampled your entire schoolyard, calculate the entire area in m^2, and add it here)

Calculated plot size in m^2 0

Tab 3. Field Data Entry

School Name: ____________________ **Site:** ____________________

Date/Time: ____

Year Month Day

		Collection Year #:
Tree #	**Species Group**	**Circumference/ CBH (cm)**

Tab 4: Tree Biomass & Carbon Storage Calculations

Biomass & Carbon Storage Calculations

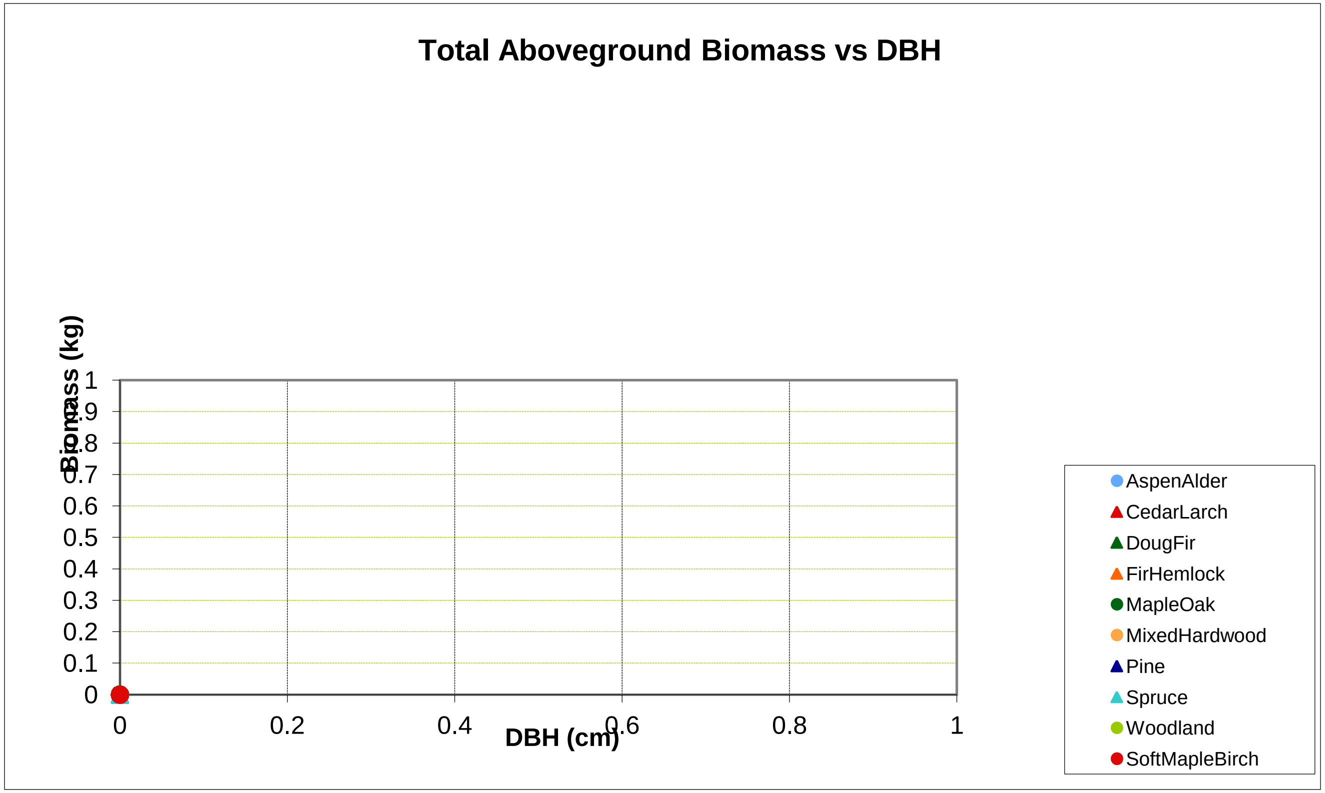
Note: Do not edit this sheet. The information on this sheet in the blue sections will **automatically** be imported from other sheets in this file. To add/change/delete trees, make all of your changes to the FieldDataEntry worksheet. Biomass and carbon storage values for each tree are calculated in the white block, and summarized in the yellow table (read column and row headers to identify cell contents).

If you would like to sort the data (i.e. by species group, by circumference, etc.) to help you answer questions or create new graphs, go to the FieldDataEntry worksheet to use the Data: SORT function.

Table summarizing the tree data below	
	Total Aboveground
Plot Biomass (g/plot)	0
Plot Carbon Storage (g C/plot)	0
Biomass (g/m2)	0
Carbon (g C/m2)	0

Data imported from FieldDataEntry tab			Calculated Tree Values				Coefficients imported from Species Group Allomentry tab	
Tree #	Species Group	Circumference/ CBH (cm)	Diameter/ DBH (cm)	Total Aboveground Biomass(kg)	Total Aboveground Biomass (g)	AbovegrounddCarbon Storage (g C)	Coefficients for Aboveground Biomass	
#	Group	Circ	Dia	TotAboveBio	TotAboveBio-g	Carbon	B0	B1
0	0	0.0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
0	0	0.0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
0	0	0.0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
0	0	0.0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
0	0	0.0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
0	0	0.0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A

Tab 5: Graphs



AspenAlder		CedarLarch		DougFir		FirHemlock		MapleOak		MixedHardwood		Pine		SoftMapleBirch		Spruce		Woodland	
DBH	TotBio	DBH	TotBio	DBH	TotBio	DBH	TotBio	DBH	TotBio	DBH	TotBio	DBH	TotBio	DBH	TotBio	DBH	TotBio	DBH	TotBio
FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Tab 6: Allometric Equations (convert tree DBH to biomass)

Allomentric Equations (convert tree DBH to biomass)

1. The allometric equations for total aboveground biomass are given for 10 species groups, where individual species are classed into the 10 groups in Appendix A of Jenkins et al. 2003. See the Species Groups Tab if your species has not yet been assigned to a group.

2. The allometric equations are of the form: ***biomass = Exp(** B_0 **+** B_1 **ln dbh)***, where ln = log base e (or 2.718282), and dbh is in cm.

3. EXTENSION: A second set of equations determines the ratio of tree "components" - foliage, bark, stem and roots, to the total aboveground biomass. These equations are in the form ***ratio = Exp(** B_0 **+ (** B_1 **/dbh)).*** *To see a breakdown of biomass by components, view the Biomass Components and Biomass Summary Tabs.*

4. These equations are built into the spreadsheet and will automatically calculate biomass in the *TreeBiomass&CarbonStorage* as well as the *BiomassComponents* Tabs.

5. To see the how this works view the *EquationExamples* tab for more details.

	Coefficients for Aboveground Biomass		Coefficients for Foliage Fraction		Coefficients for Stem Wood		Coefficients for Stem Bark		Coefficients for Coarse Roots	
SpeciesGroup	**B0**	**B1**	**B0**	**B1**	**B0**	**B1**	**B0**	**B1**	**B0**	**B1**
AspenAlder	-2.2094	2.3867	-4.0813	5.8816	-0.3065	-5.4240	-2.0129	-1.6805	-1.6911	0.816
CedarLarch	-2.0336	2.2592	-2.9584	4.4766	-0.3737	-1.8055	-2.0980	-1.1432	-1.5619	0.6614
DougFir	-2.2304	2.4435	-2.9584	4.4766	-0.3737	-1.8055	-2.0980	-1.1432	-1.5619	0.6614
FirHemlock	-2.5384	2.4814	-2.9584	4.4766	-0.3737	-1.8055	-2.0980	-1.1432	-1.5619	0.6614
MapleOak	-2.0127	2.4342	-4.0813	5.8816	-0.3065	-5.4240	-2.0129	-1.6805	-1.6911	0.816
MixedHardwood	-2.4800	2.4835	-4.0813	5.8816	-0.3065	-5.4240	-2.0129	-1.6805	-1.6911	0.816
Pine	-2.5356	2.4349	-2.9584	4.4766	-0.3737	-1.8055	-2.0980	-1.1432	-1.5619	0.6614
SoftMapleBirch	-1.9123	2.3651	-4.0813	5.8816	-0.3065	-5.4240	-2.0129	-1.6805	-1.6911	0.816
Spruce	-2.0773	2.3323	-2.9584	4.4766	-0.3737	-1.8055	-2.0980	-1.1432	-1.5619	0.6614
Woodland	-0.7152	1.7029	-4.0813	5.8816	-0.3065	-5.4240	-2.0129	-1.6805	-1.6911	0.816
LowWoodDensitySpecies	-2.5356	2.4349	-2.9584	4.4766	-0.3737	-1.8055	-2.0980	-1.1432	-1.5619	0.6614
MediumWoodDensitySpecies	-2.4800	2.4835	-4.0813	5.8816	-0.3065	-5.4240	-2.0129	-1.6805	-1.6911	0.816
HighWoodDensitySpecies	-2.0127	2.4342	-4.0813	5.8816	-0.3065	-5.4240	-2.0129	-1.6805	-1.6911	0.816

* note: we have calculated woodland component fractions as in hardwood.

Jenkins et al. 2003 "National Scale Biomass Estimators for United States Tree Species", Forest Science 49:12-35.

Tab 8: Species Groups

Species Group name used in FieldDataEntry worksheet	Species Group name from Jenkins paper	Species Group Code
AspenAlder	aspen/alder/cottonwood/willow	aa
CedarLarch	cedar/larch	cl
DougFir	Douglas-fir	df
FirHemlock	true fir/hemlock	tf
MapleOak	maple/oak/hickory/beech	mo
MixedHardwood	mixed hardwood	mh
Pine	pine	pi
SoftMapleBirch	soft maple/birch	mb
Spruce	spruce	sp
Woodland	woodland	wo
LowWoodDensitySpecies		
MediumWoodDensitySpecies		
HighWoodDensitySpecies		

Pine	Apache pine	Pinus	engelmannii
Pine	Arizona pine	Pinus	arizonica
Pine	Austrian pine	Pinus	nigra
Pine	Bishop pine	Pinus	muricata
Pine	Border pinyon	Pinus	discolor
Pine	Bristlecone pine	Pinus	aristata
Pine	California foothill pine	Pinus	sabiniana
Pine	Chihuahuan pine	Pinus	leiophylla
Pine	Coulter pine	Pinus	coulteri
Pine	Eastern white pine	Pinus	strobus
Pine	Foxtail pine	Pinus	balfouriana
Pine	Jack pine	Pinus	banksiana
Pine	Jeffrey pine	Pinus	jeffreyi
Pine	Knobcone pine	Pinus	attenuata
Pine	Limber pine	Pinus	flexilis
Pine	Loblolly pine	Pinus	taeda
Pine	Lodgepole pine	Pinus	contorta
Pine	Longleaf pine	Pinus	palustris
Pine	Monterey pine	Pinus	radiata
Pine	Pinyon pine	Pinus	edulis
Pine	Pitch pine	Pinus	rigida
Pine	Pond pine	Pinus	serotina
Pine	Ponderosa pine	Pinus	ponderosa
Pine	Red pine	Pinus	resinosa
Pine	Sand pine	Pinus	clausa
Pine	Scotch pine	Pinus	sylvestris
Pine	Shortleaf pine	Pinus	echinata
Pine	Singleleaf pinyon	Pinus	monophylla
Pine	Slash pine	Pinus	elliottii
Pine	Southwestern white pine	Pinus	strobiformis
Pine	Spruce pine	Pinus	glabra
Pine	Sugar pine	Pinus	lambertiana
Pine	Table Mountain pine	Pinus	pungens
Pine	Virginia pine	Pinus	virginiana
Pine	Western white pine	Pinus	monticola
Pine	Whitebark pine	Pinus	albicaulis

Tab 9: Biomass Components

EXTENSION: Biomass Components

Note: Do not edit this sheet. The information on this sheet in the blue sections will **automatically** be imported from other sheets in this file. To add/change/delete trees, make all of your changes to the FieldDataEntry worksheet. Biomass values for each tree are calculated in the white center block, and summarized in the yellow table (read column and row headers to identify cell contents).

Keep in Mind: "We hypothesize that C allocation strategies may differ among individuals belonging to the same species (or species groups). The proportion of biomass in foliage, for example, might be different for an open-grown tree versus a tree growing in a dense stand, and the proportion of biomass in the stem might change with variables such as wind exposure or water availability". (Jenkins et al. 2003, pages 24-25)

Table summarizing the tree data below					
	Total Aboveground	**Foliage**	**Stem**	**Branch**	**Roots**
Plot Biomass (kg/plot)	0	0	0	0	0
Biomass (g/m2)	0	0	0	0	0
Carbon (g C/m2)	0	0	0	0	0

Data imported from FieldDataEntry tab			**Calculated Biomass Values By Compartment**						**Allometric equation coefficients imported from Species Group Allomentry tab**									
Tree Tag #	Species Group	Circumference (cm)	Diameter (cm)	Total Aboveground Biomass(kg)	Foliage Biomass (kg)	Stem Biomass (kg)	Branch Biomass (kg)	Coarse Root Biomass	Coefficients for Aboveground Biomass		Coefficients for Foliage Fraction		Coefficients for Stem Wood		Coefficients for Stem Bark		Coefficients for Coarse Roots	
Tag	Group	Circ	Dia	TotAboveBio	FolBio	StemBio	BranchBio	RootBio	B0	B1	B0	B1	B0	B1	B0	B1	B0	B1
0	0	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
0	0	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
0	0	0	0.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

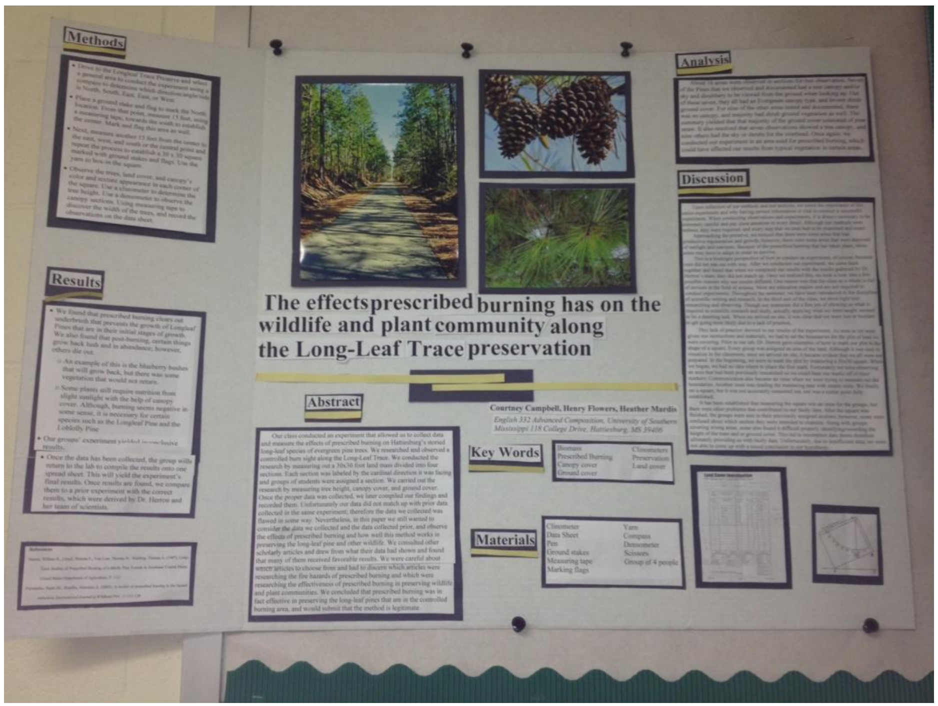
Results from Long Leaf Preserve

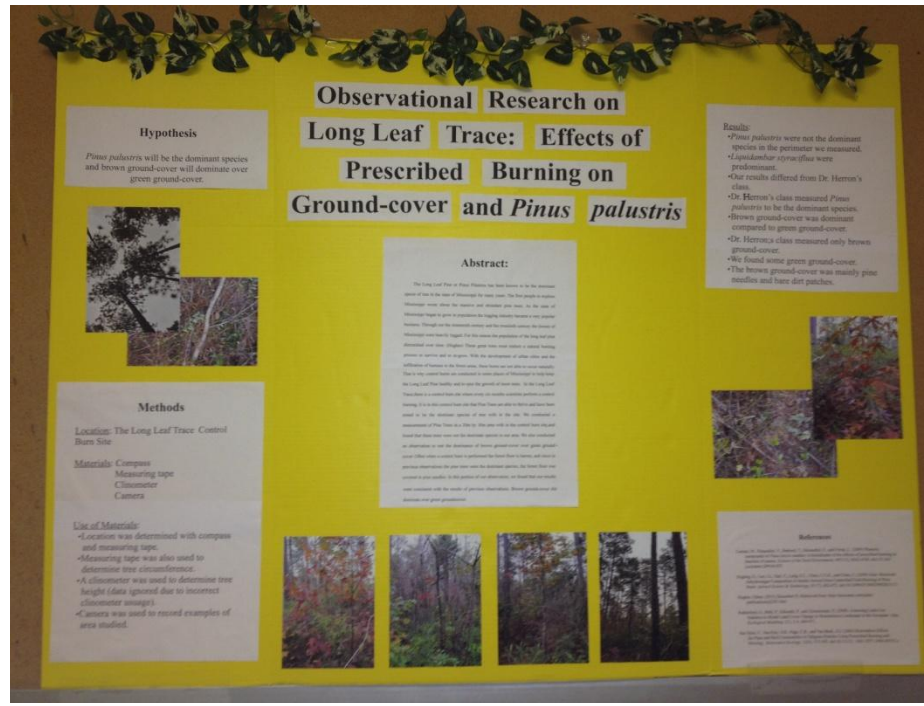
Tree #	Species Group	Circumference/ CBH (cm)
1	Pinus palustris	132.91
2	Pinus palustris	138.92
3	Pinus palustris	148.84
4	Pinus palustris	159.83
5	Pinus palustris	76.93
6	Pinus palustris	159.83
7	Pinus palustris	171.76
8	Pinus palustris	127.8
9	Pinus palustris	86.98
10	Pinus palustris	70.97
11	Pinus palustris	113.04

Table summarizing the tree data	
	Total Aboveground
Plot Biomass (g/plot)	7,842,711
Plot Carbon Storage (g C/plot)	3,921,356
Biomass (g/m2)	8,714
Carbon (g C/m2)	4,357

Table summarizing the tree data					
	Total Aboveground	Foliage	Stem	Branch	Roots
Plot Biomass (kg/plot)	7843	451	6118	1274	1670
Biomass (g/m2)	8714	501	6798	1415	1855
Carbon (g C/m2)	4357	250	3399	708	928

Student Posters





Results from Mixed Hardwoods

Data imported from FieldDataEntry tab			Calculated Tree Values				Coefficients imported from Species Group Allomentry tab	
Tree #	Species Group	Circumference/ CBH (cm)	Diameter/ DBH (cm)	Total Aboveground Biomass(kg)	Total Aboveground Biomass (g)	AbovegroundCarbon Storage (g C)	Coefficients for Aboveground Biomass	
#	Group	Circ	Dia	TotAboveBio	TotAboveBio-g	Carbon	B0	B1
0	Sweet gum	89.9	28.62	312.67	312,673.56	156,336.78	-2.0773	2.3323
0	magnolia	22.0	7.00	9.89	9,886.60	4,943.30	-2.5384	2.4814
0	oak	125.2	39.85	790.09	790,093.21	395,046.60	-2.48	2.4835
0	oak	41.5	13.21	50.90	50,897.97	25,448.98	-2.48	2.4835
0	magnolia	40.3	12.83	44.40	44,397.97	22,198.99	-2.5384	2.4814
0	hackberry	24.5	7.80	12.91	12,913.26	6,456.63	-2.5384	2.4814
0	magnolia	27.0	8.59	16.43	16,434.07	8,217.04	-2.5384	2.4814
0	hackberry	43.4	13.81	53.36	53,361.28	26,680.64	-2.5384	2.4814
0	magnolia	124.5	39.63	729.31	729,310.43	364,655.21	-2.5384	2.4814
0	magnolia	14.5	4.62	3.51	3,513.81	1,756.90	-2.5384	2.4814
0	hackberry	53.5	17.03	89.68	89,680.14	44,840.07	-2.5384	2.4814
0	Sweet gum	112.1	35.68	523.16	523,157.67	261,578.83	-2.0773	2.3323
0	magnolia	23.0	7.32	11.04	11,039.53	5,519.77	-2.5384	2.4814
0	live oak	8.0	2.55	0.80	803.32	401.66	-2.5384	2.4814
0	sweet gum	33.0	10.50	30.20	30,197.26	15,098.63	-2.0773	2.3323
0	hackberry	56.0	17.83	100.44	100,441.45	50,220.72	-2.5384	2.4814
0	sassfras	31.0	9.87	20.87	20,874.17	10,437.09	-2.5356	2.4349
0	white oak	69.0	21.96	168.69	168,688.38	84,344.19	-2.0773	2.3323
0	hackberry	57.0	18.14	104.95	104,951.12	52,475.56	-2.5384	2.4814
0	oak	120.0	38.20	711.09	711,090.05	355,545.02	-2.48	2.4835
0	hackberry	17.0	5.41	5.21	5,214.29	2,607.14	-2.5384	2.4814
0	hackberry	16.0	5.09	4.49	4,486.03	2,243.02	-2.5384	2.4814
0	magnolia	29.0	9.23	19.62	19,622.47	9,811.23	-2.5384	2.4814
0	sweet gum	12.0	3.82	2.85	2,853.07	1,426.53	-2.0773	2.3323

Table summarizing the tree data below	
	Total Aboveground
Plot Biomass (g/plot)	3,816,581
Plot Carbon Storage (g C/plot)	1,908,291
Biomass (g/m2)	16,963
Carbon (g C/m2)	8,481

Table summarizing the tree data below					
	Total Above ground	Foliage	Stem	Branch	Roots
Plot Biomass (kg/plot)	3817	173	2899	745	781
Biomass (g/m2)	16963	770	12882	3310	3469
Carbon (g C/m2)	8481	385	6441	1655	1735

Modified UNESCO Classification "MUC"

United Nations
Educational, Scientific and
Cultural Organization

QUESTION		MUC CODE	CONCLUSION
Is the site natural?	Yes		Natural (closed forest, woodland, shrubland, dwarf shrub land, herbaceous, herbaceous vegetation, wetland or barren land or open water.)
Is more than 40% of the site covered by the canopy of trees that are at least 5 meters tall?	Yes		Trees (closed forest or woodland)
Are the crowns of the tees greater than 5 meters tall interlocking?	Yes	MUC 0	Closed
Are at least 50% of the trees that reach the canopy evergreen?	No	MUC 02	Deciduous (87% of the site is covered with deciduous trees and 10% with evergreen trees).
Do the deciduous trees lose their leaves because there is a dry season?	Yes	MUC 021	Tropical and Subtropical Drought-Deciduous. (Lowland, Submontane)
Is your site located in a lowland or submontane area?	Yes	MUC 0211	Closed , Mainly Deciduous, Tropical and Subtropical, Drought –Deciduous, Broad Leaved Lowland and Submontane

Acknowledgements

- Dr. Shelia Brown
- EPA Gulf of Mexico Alliance
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- Sherwood Middle Academy Magnet – Baton Rouge, LA: Sheila Stagnoli and Misti Segura
- Tupelo Middle: Holly Bailey, Judy Harden, Connie Gusmus
- N.R. Burger Middle: Jessica Johnson
- Hancock North Elementary: Teresa Merwin
- Laila Ali
- Chad Garrick
- Monica Moss-Watkins
- Jennifer Robertson
- My students