Monitoring Urban Impacts on Tree Growth

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Abstract - Our team studied the possible impacts of urban development on tree growth during the Watershed Watch Program. We focused on the science of dendrochronology and the effect of environmental factors on the trees. Tree cores and foliar samples were collected at the ECSU (Elizabeth City State University) campus, fig. 2, and compared with the same species from the Great Dismal Swamp (GDS) in Virginia, fig. 2. The main targets of this experiment are one aquatic tree, the bald cypress (*Taxodium distichum*) fig. 1, and a land based tree, the loblolly pine (*Pinus taeda*) fig. 3. This allowed us to compare an urbanized area with a more natural setting to determine factors impacting tree growth. This experiment did show us harmful impacts with the data that at ECSU. The growth rings of the ECSU campus tree cores are noticeably narrower, especially in the loblolly pine from the ECSU outdoor classroom, and multiple fluctuations in more recent tree rings of the bald cypress in the ECUS campus. VIRIS data provided evidence of chlorophyll disturbances that reflect the differences of the ECSU campus and the GDS and demonstrated greater abnormalities in the ECSU foliage samples of the chlorophyll due to much ground level ozone damage.


Fig.1- Bald cypress tree at Lake Drummond

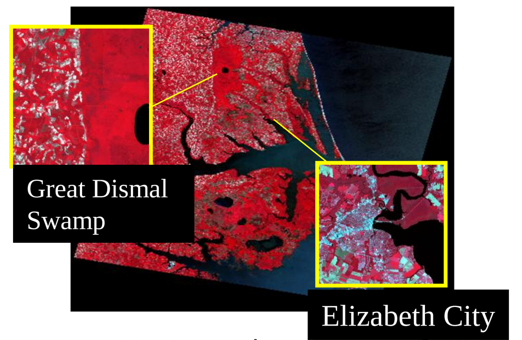

Fig.2-Landsat image of ECSU and Dismal Swamp

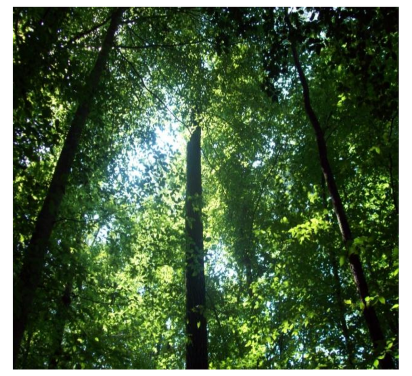
Fig.3-Canopy of loblolly pines at GDS


Fig.4-Anna coring a loblolly pine

Introduction - To help understand the subject of dendrochronology and other measurements, our team used the help of Dr. Rock, Mr. Gagnon, and published documents (Rock et al. 1986; Lauten and Rock, 1994; Spencer and Rock, 1998; Gagnon and Rock, 2009). Wood core samples of the Loblolly pine and Bald Cypress will be our team's main focus. With the use of the microscopes, these tree cores will show us variations growth rings (Spencer and Rock, 1998). The study of these rings is called dendrochronology, which should be able to tell us the age of individual trees and growth rate. Multiple factors affect the growth rate of the trees, such as water quality, temperature, and ozone intake demonstrated in the tree rings. The smaller the rings the harder it was for the tree to obtain what was need for that year.

Also, our team had preformed thin sections of the foliage to better understand the leaf anatomy (Gagnon and Rock, 2009) and the location of chlorophyll. This was to better understand the path of photosynthesis and the ETS (Electromagnetic Transport System). Reflectance levels had been taken with the VIRIS (Lauten and Rock, 1994) during the Watershed Watch Program to show multiples levels and outcomes photosynthetic growth patterns. These patterns show multiple ETS and chlorophyll problems in the ECSU foliage of the bald cypress and loblolly pine.

We did follow the basic scientific methods to gather data on the Loblolly Pine and Bald Cypress to help present impacts of the human disturbances at ECSU campus and compare it to the natural settings of the Great Dismal Swamp. In addition, we did determine if ground-level ozone damage had been involved in the health of the trees due to urbanization of ECSU in comparison to the potentially "healthier" settings of the Great Dismal Swamp.

Hypothesis- We hypothesize that urban development will have multiple impacts on tree growth.

Methods, Materials, and Objectives -

We collected nine wood cores, figure 7, total following the methods of Spencer and Rock (1998). Four from the loblolly pine, two from the outdoor classroom at ECSU campus and the two others in the Washington Ditch parking lot at the Great Dismal Swamp. Five from the bald cypress, two of which were close to the outdoor classroom of ECSU campus, two from the Big Tree area of the GSD, and the last one from the Washington Ditch parking lot. These core samples were glued to wood trays and sanded down and later studied under dissecting microscopes to count and measure the growth rings in millimeters.

Foliage from ECSU campus and the GDS was also collected using pruning poles during the tree coring process. We then placed our foliage in plastic zip lock bags with wet paper towels and put into coolers and later used to VIRIS and to cut into microscope slides using the carrot method (ex. Figure 6).

Our team also scanned multiple foliage samples with the VIRIS, figure 5, using the methods of Lauten and Rock (1994) to obtain chlorophyll reflectance and other measurements of dryness, maturity, amount of chlorophyll, and biomass. This was to determine how healthy the chlorophyll levels in the tree foliagewere and it helps to determine if there was abnormal photosynthesis due to a malfunction in the ETS (Electron Transport System).

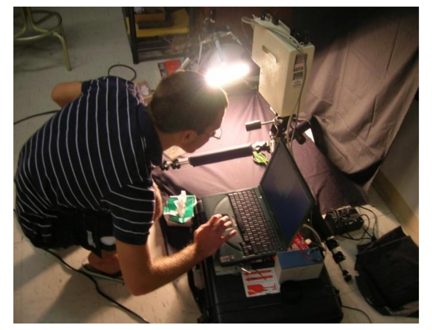
Fig.5-Jason using VIRIS

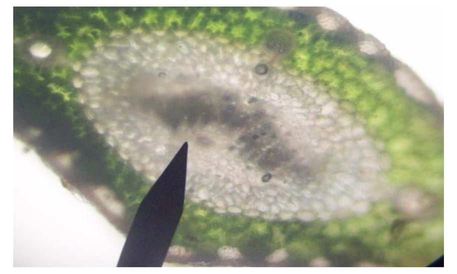
Fig.6-Thin section of loblolly pine needle


Fig.7-ECSU Cypress core

Results –

The growth rings of the loblolly pine tree cores from the GDS show a slight decrease in ring size between the years of 1915 and 2009. Compared with the loblolly pines of the ECSU outdoor campus (figure 8), the ECSU cores show a much larger decrease in size of the growth rings. The data shown in figure 8 suggests that ECSU loblolly pines are growing less and may have been effected during 1956 when ECSU dorms were placed in next to the outdoor classroom, growing due to campus development (Bischoff, 2009).

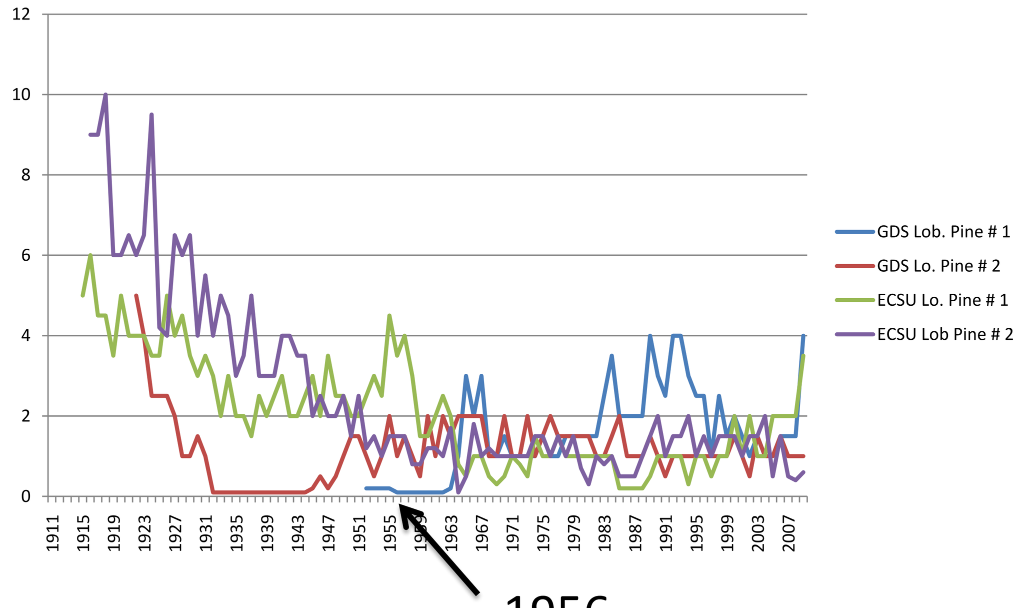

Fig.8-Loblolly pine graph

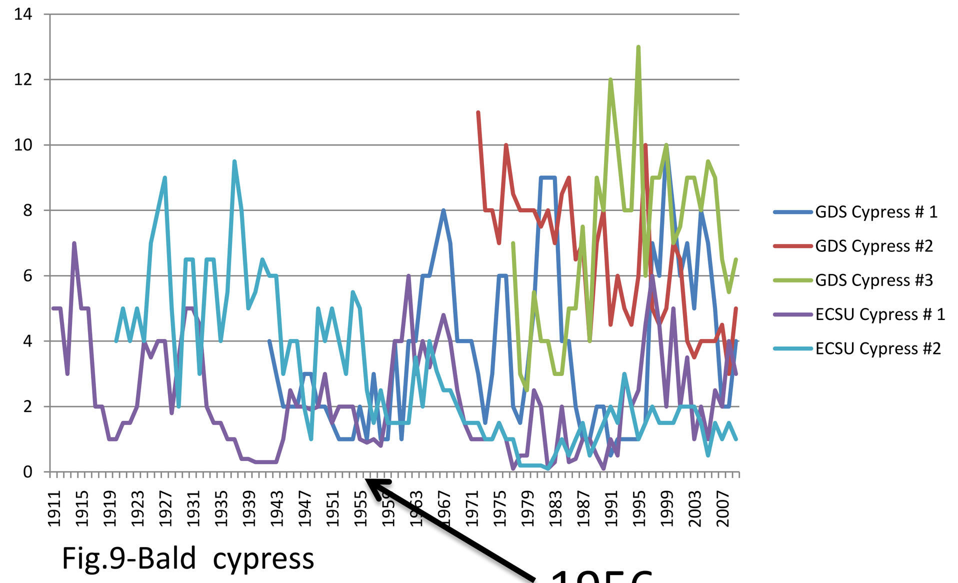

Fig.9-Bald cypress graph

The growth rings of the three GDS bald cypress tree cores show multiple fluctuations of wood growth, but exhibit more of a consistent pattern of growth between the years of 1911 and 2009. Noticeably, the two ECSU bald cypress are older than the GDS bald cypress. We are able to see many narrow rings (droughts?) in figure 9 but improved growth before 1956 when the dorms were placed constructed near the outdoor class room. As growth progresses in bald cypress at the ECSU campus, the data shows that the urban development and construction has caused reduced growth for the bald cypress.

Comparing both figures 8 and 9 together gives further evidence of unnatural tree growth about the time of the expanded construction at ECSU and further development to the present day of 2009.

In addition, the VIRIS was able to show multiple abnormalities in the chlorophyll levels and the photosynthesis process of the ECSU campus foliage due to urban development (see figure 10; table 1). There are levels at which concentrations of the chlorophyll (REIP) are recorded and if it's at a higher concentration it is at better health. Also, the VIRIS is able to determine correlations of total water content (TM 5/4 Ratio) and indicate foliar maturation over the year (NIR 3/1). In the figure 10 and table 1, our foliage samples from the ECSU campus clearly show lower values in the TM5/4 ratio and NIR3/1compared to the GDS samples. This is further evidence that urban development has and will reduce annual tree health. In the REIP, the ECSU samples are actually larger but the NIR shoulder is flattened. The trees may be producing more chlorophyll to adapt to malfuntioning photosynthesis in the ETS (electromagnetic transport system).

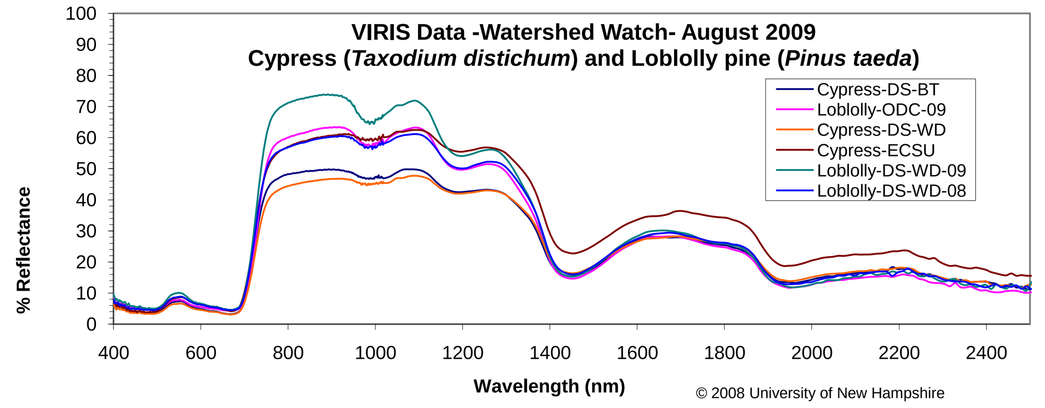

Fig.10-Reflectance graph of foliage samples

VIRIS Data – Watershed Watch 2009

Tree	Cypress-DS-BT	Cypress-DS-WD	Cypress-ECSU	Loblolly-DS-WD-09	Loblolly-DS-WD-08	Loblolly-ODC-09	Loblolly-ODC-08
REIP	723.9	723.9	725.4	725.4	725.4	731.6	725.4
NDVI	0.863	0.858	0.848	0.869	0.846	0.861	0.804
TM54	0.555	0.597	0.592	0.395	0.479	0.439	0.663
NIR31	0.845	0.907	0.929	0.731	0.855	0.791	1.038

Table.1-Table of reflectance indications

References

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