DOE/GO/10363-Q

Quarterly Progress Report

For: The Effects of Fertilization and Competition Control on Carbon and Nutrient Allocation and Physiology in Loblolly Pine Plantations

Covering Period: January 1, 2000 to March 31, 2000

Date of Report: April 27, 2000

Recipient: University of Georgia, School of Forest Resources

Award Number: DE-FG36-98GO10363

Subcontractors: N/A

Other Partners: 11 Industry Cooperators

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Project Objective:

The objectives of this project are to:

1) Determine how forest management affects the availability and stand use of site resources, i.e., light, nutrients and water.

2) Determine how changes in the availability and stand use of site resources affect stand attributes that control growth and productivity. Stand attributes will include carbon and nutrient partitioning to foliage, stem and roots, rates of physiological processes such as net photosynthesis and respiration, and tree water status.

3) Develop process models that predict the effect of forest management on the growth and productivity of managed forests.

Background: The beneficial effects of intensive management (e.g. fertilization and competition control) on stand growth and yield must result from changes in the rates of physiological processes, changes in the pattern of carbon allocation or a combination of both. However, the biological mechanisms causing the large growth enhancements that occur with intensive forest management are unclear. For example, increased nutrient and water availability to crop trees that results from intensive forest management might increase net photosynthesis or decrease respiration rates, thus resulting in more carbon available for growth. Alternatively, increased resource availability associated with intensive forest management might increase root uptake

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efficiency or root longevity, and as a result, increase carbon allocation to aboveground growth. A shift in carbon allocation aboveground would increase stem growth and needle area which will fix more carbon and further increase tree growth.

Our work in past quarters has focused on monitoring site environmental conditions, making physiological measurements, quantifying stand biomass and nutrient pools, and quantifying canopy dynamics. We have made periodic measurements of photosynthetic rates, LAI, and regularly collect litterfall. We completed our destructive harvests for determining biomass and allometric relationships, and are in the process of completing mass and nutrient measurements. We are monitoring root growth using minirhizotrons (small plastic tubes in combination with a microvideo camera), and have collected samples for root biomass and nutrients. Standard environmental measurements (air and soil temp, RH, PAR, etc.) are made on an continuous basis.

Status:

Task 1.1. 1. Quantify biomass and nutrient (esp. N and P) allocation to leaf, stem and roots of individual loblolly pine within the plots.

Whole-tree harvests at the B.F. Grant sites were completed in February, and samples are currently being processed. 60% complete overall.

Task 1.2. Quantify how biomass and nutrient content of above and below ground components of loblolly pine stands change with time by examining the growth of different-aged stands.

Both the data previously collected at Waycross and currently being collected at the B.F. Grant site in association with the preceding task will be used for this purpose. 60% complete overall.

Task 1.3. Quantify rates of carbon flux, i.e. net photosynthesis, foliar respiration, root respiration and soil respiration.

Photosynthesis was measured in two blocks of each age at both Waycross and BF Grant. The first flush of 1998, 1999 and 2000 were measured on three trees in each plot. Measurements from the three trees were averaged and serve as the experimental unit. The needles used in the measurement of photosynthesis were collected and are partially prepared for chemical analysis.

There were no clear differences in Asat with regard to either treatment age class for any of the five completed sampling dates. Overall Completion: 60%.

Task 1.4. Determine allometric, phenological and temporal relationships between loblolly pine canopy and fine root dynamics.

Indirect measurements of leaf area index (LAI, total one-sided, leaf area per unit ground area, m^2/m^2) are being taken each month in the intensively managed plantations of loblolly pine at Athens, Eatonton, and Waycross, Georgia. The LAI-2000 plant canopy analyzer (Li-Cor, Inc., Lincoln, NB) is being used. The instrument measures diffuse radiation and uses these readings

to calculate LAI. A total of 12 readings are being taken on each of the 100 research plots. We will continue taking monthly measurements through February 2001, providing two full annual cycles of LAI development. This phase of the research is now 40% complete overall.

Task 1.5. Calculate photosynthetic nitrogen use efficiency and nitrogen productivity as well as growth efficiency on a per needle area and per unit intercepted radiation basis.

Measurements commenced June, 1999, and will incorporate the gas exchange and nutrient measurements being made under #1 and #3 above. 50%. complete

Task 1.6 Measure uptake, retranslocation, mineralization and immobilization of nutrients within stands of different ages.

Awaiting nutrient analyses and allometric equations for tree biomass. Completion: 80% for plants, 66% for litter and soil. (Waycross)

Task 1.7. Measure soil moisture and plant water status throughout the year.

Climate monitoring stations (radiation, temperature, RH, wind speed/direction): 100% set-up, 80% data collection. (1^{st} yr.), 60% collection (2^{nd} yr). Soil moisture/temperature: ongoing. Overall completion: 50%

Task 2.1. Identifying patterns of growth response in relation to resource limitation of individual stands.

This task represents the culmination of the tasks listed under Objective #1, and awaits their completion. Overall completion: 10%

Task 2.2. Developing new process models for growth and yield that incorporate the timing of resource availability associated with competition control and fertilization.

Model construction will commence after this coming field season once we have a full year's data and the biomass and nutrient samples have been completely analyzed. Overall completion: 0%

Task 2.3. Using (make available to industry) the process models to optimize scheduling of silvicultural treatments.

Iterative process performed in conjunction with task 2. Final version complete at termination of task 2. Overall completion: 0%

Task 2.4. Using data from the experimental portion of this study to help parameterize and calibrate existing regional assessment models in collaboration with Oakridge National Laboratory (Dr. Robert Luxmoore) and the University of Florida (Dr. Eric Jokela)

Will follow completion of task #2. Overall completion: 0%

Plans for Next Quarter:

Continue to monitor root growth and longevity; begin characterizing root architecture of pines and competitors; install and monitor zero tension lysimeters to measure ammonium and nitrate leaching through litter layer; collect and analyze canopy throughfall for ammonium and nitrate; continue litter collection and nutrient analyses; continue environmental monitoring.

Milestone Status Table:

ID Number	Task / Milestone Description	Planned Completion	Actual Completion	Comments
1.1	Biomass and Nutrient Allocation	8/31/01		
1.2	Time Effects on Allocation	8/31/01		
1.3	C Exchage (Photosyntheseis and Respiration)	8/31/01		
1.4	Canopy-Fine Root Relations	8/31/01		
1.5	NUE and N Productivity	6/30/01		
1.6	Nutrient Budget	7/31/01		
1.7	Soil and Plant Water Status	9/20/01		
2.1	Relate Growth Reposne to Resource Limit.	8/31/01		
2.2	Develop Process Model	9/30/01		
2.3	Process Model Available to Industry	9/30/01		
2.4	Regional Assessment Model	9/30/01		

Budget Data (as of date): The approved spending should not change from quarter to quarter. The actual spending should reflect the money actually spent on the project in the corresponding periods. A table such as the following could be used.

			Approved Spending Plan			Actual Spent to Date		
Phase / Budget Period			DOE Amount	Cost Share	Total	DOE Amount	Cost Share	Total
	From	To						
Year 1	10/1/98	9/30/99	113,086	25,000	138,086	113,086	25,000	138,086
Year 2	10/1/99	9/30/00	63,484	25,000	88,484	39,587	15,000	54,587
Year 3	10/1/9	9/30/01	17,310	25,000	42,310	0	0	0
		Totals	193,880	75,000	268,880	152,673	40,000	192,673