Forest Fertilization to Increase Biofuel Feedstock and Soil C Sequestration in Coastal PNW Forests

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Abstract

We examined whether N fertilization of Douglas-fir (Psuedotsuga menziesii [Mirb.]) plantations in western Washington and Oregon State could affect C sequestration in trees and soil. Nine unthinned and six thinned sites of the Pacific Northwest Stand Managment Cooperative (SMC), which received 1000 kg N/ha over a 16-y period, were compared with adjacent unfertilized control sites. Carbon contained in the live trees was estimated using biomass equations and average carbon concentrations. There was more C estimated to be stored in live trees of the fertilized vs. control plots. On average, fertilized trees contained 10.5 percent more C (average 24 Mg/ha) than the control plots in the unthinned and 22.5 percent more C (average 38 Mg/ha) than the control plots for the live trees in the thinned stands. In two studies of six stands, an additional 19.1 Mg C/ha accumulated in the soil and other non-live-tree stand components. This study suggests that N fertilization of commercial forests in western Washington could substantially increase C stored in these forest ecosystems. Considering that there are approximately 20.9 million hectares of forest land in the states of Washington and Oregon, fertilization could result in an additional 1.19 Pg of additional carbon sequestrated during a single rotation of forestland, a period of approximately 40 years, for an average of 0.03 Pg/year. How much of this C would offset fossil fuel use in the long-term is unclear.

Helicopter application of urea is the most common fertilization method in the mountainous PNW. Applications can be made very precisely, minimizing potential for runoff and maximizing fertilizer response.

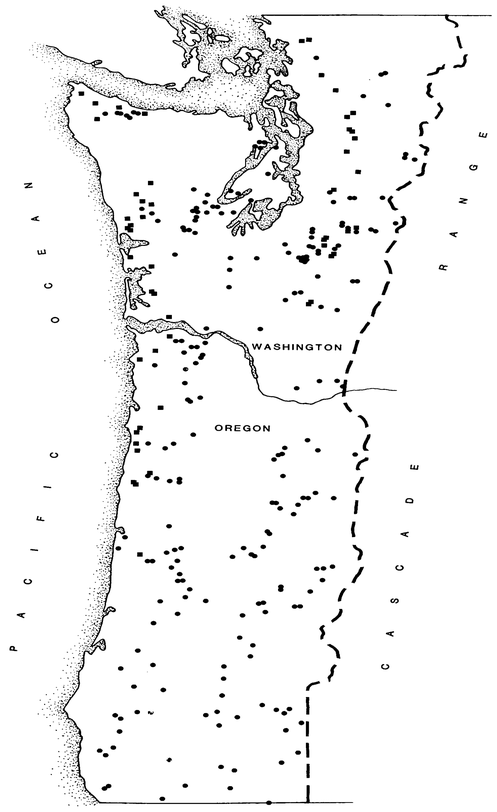

Figure 1. Location of SMC study sites in WA and OR.

Table 1. Average Tree C contents for unthinned SMC plots.

Installation ID	Age at last measurement	total biomass 0 N	total biomass 1000 N	difference	% difference
		kg/ha			
5	64	246,498	292,404	45,906	18.6
53	54	347,720	431,212	83,493	24.0
54	63	167,447	196,777	29,330	17.5
57	61	397,649	439,254	41,606	10.5
76	60	220,032	316,104	96,072	43.7
77	42	172,062	132,327	-39,735	-23.1
95	52	204,651	199,246	-5,405	-2.6
101	54	179,941	163,248	-16,693	-9.3
113	50	155,247	140,399	-14,848	-9.6
	average	**232,361**	**256,775**	**24,414**	**10.5**

Table 2. Average Tree C contents for thinned SMC plots.

Installation ID	Age at last measurement	total biomass 0 N	total biomass 1000 N	difference	% difference
		kg/ha			
118	57	143,436	238,999	95,564	66.6
120	42	124,141	140,662	16,520	13.3
128	50	220,950	256,501	35,550	16.1
136	49	259,471	270,458	10,987	4.2
139	45	133,134	163,589	30,456	22.9
159	51	120,458	156,976	36,518	30.3
	average	**166,932**	**204,531**	**37,599**	**22.5**

Table 3. Potential tree C sequestration

If all commercial forest land in PNW was fertilized	
37.6	Mg C/ha increase over 40 y rotation
20,900,000	hectares manageable forest land in WA and OR
785,840,000	Mg C 40 y rotation
0.786	Pg C
0.020	Pg C/year
Currently only about 25,000 ha fertilized/y in PNW	
37.6	Mg C/ha increase over 40 y rotation
1,200,000	hectares manageable forest land in WA and OR
45,120,000	Mg C 40 y rotation
0.045	Pg C
0.001	Pg C/year

Table 4. Potential soil C sequestration

If all commercial forest land in PNW was fertilized	
19.1	Mg C/ha increase over 40 y rotation
20,900,000	hectares manageable forest land in WA and OR
399,190,000	Mg C 40 y rotation
0.399	Pg C
0.010	Pg C/year
Currently only about 25,000 ha fertilized/y in PNW	
19.1	Mg C/ha increase over 40 y rotation
1,200,000	hectares manageable forest land in WA and OR
22,920,000	Mg C 40 y rotation
0.023	Pg C
0.0006	Pg C/year

Results and Discussion

The C contents of nine fertilized, unthinned and six fertilized, thinned stands were estimated using stand measurements and estimation equations (Gholz et al., 1979). Tables 1 and 2 show results. There was 24 Mg C/ha (10.5%) more in the fertilized, unthinned, and 38 Mg C/ha (22.5%) in the fertilized, thinned sites. The estimate for increases in the overall biomass that could be achieved with fertilization of all forest land is 0.79 Pg over 40 years for trees and 0.40 Pg for soils, or about 0.02 Pg/year in tree biomass and 0.01 in soil (Table 3 and 4).

Impacts of N fertilization on soil in this region have proven to be highly variable, particularly with regard to soil mineralogy. Canary *et al*. (2001) found an average of 8 Mg C/ha additional C 16 years following fertilization in three glacial-origin soils, while Adams *et al*. (2005) found much more variable results, with an average of 30.1 Mg C/ha in two glacial-origin and one volcanic-origin soils. For this poster, we used an average of the two studies, 19.1 Mg C/ha for calculating the impacts of large additions of N (about 1000 Mg N/ha) on soil C sequestration.

Conclusions

There exists a substantial potential for additional C sequestration through N fertilization in the PNW region. If all commercial land was fertilized as in the studies of Canary et al (2001) and Adams et al. (2005), the effect could be > 1 Pg C over a 40-y period or 0.03 Pg C/y. However, currently a much smaller potential C sequestration is being realized because only a small fraction of forest land (about 25,000 ha/y) is being fertilized, and a smaller C sequestration being realized.

References

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NARA
Northwest Advanced Renewables Alliance

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