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Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) roots in four plant communities--ocean spray (*Holodiscus discolor* (Pursh) Maxim.)/salal (*Gaultheria shallon* Pursh), vine maple (*Acer circinatum* Pursh)/salal, sword-fern (*Polystichum munitum* (Kaulf.) Presl. var. *munitum*) and sword-fern/oxalis (*Oxalis oregana* Nutt.)--were sampled for soluble nitrogen concentrations. Sampling prior to bud burst in the salal communities showed lower concentrations of soluble nitrogen than in the sword-fern communities. Summer samples showed no significant differences. Results suggest that salal community types experience minimum soluble nitrogen levels throughout the year while sword-fern community types experience higher nitrogen status during winter. Management practices that conserve or add nitrogen are more critical in salal community types.

Nitrogen Status in Oregon Coast Range Forest Communities

by

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

NITROGEN STATUS IN OREGON COAST RANGE FOREST COMMUNITIES

INTRODUCTION

Sensitive stewardship of forest resources requires an understanding of ecosystem characteristics and processes. In the Pacific Northwest, stratification of the forest into communities has been a useful approach to analyzing important characteristics and processes. A forest communitiy is a grouping of mutually compatible plants and animals living in a common location and interacting with each other and with their environment. Within the community, characteristics such as plant growth and species composition result from the plants' response to their operational environment (Mason and Langenheim 1957). This operational environment is made up of the environmental stimuli directly affecting the plant: moisture, temperature, light, chemical and mechanical factors (Waring _et al_ 1972). All interactions among community components affect individual plants through one or more of these phenomena. As a result, plants and communities are visible expressions of their environmental stimuli.

One way of defining environments is by identifying relationships between levels of environmental stimuli and physiological behavior in appropriate indicator species. Waring _et al_ (1972) proposed that response indices derived from such relationships allow a quantitative approach to evaluating the operational environment and resulting ecosystem characteristics such as community composition. After establishing a relationship between environmental stimuli and community composition (an ecosystem response), composition can be used to indicate environmental stimuli in related communities within the ecosystem. Recognizing important stimuli provides a framework within which management activities can be evaluated.

Careful selection of response indices and indicator species allows quantitative comparisons of communities and sites throughout the coniferous forest biome. Temperature and moisture response indices such as plant moisture stress (Waring and Cleary 1967) and temperature growth index (Cleary and Waring 1969) are valuable estimators of forest environments. Zobel _et al_ (1976) suggested that nutrient responses offer important additional information about environmental stimuli to plant communities, especially when community occurence is not explained well by moisture and temperature gradients.

Foliar total nitrogen concentration has been the conventional measurement used to characterize the interaction between nitrogen supply and plant nitrogen demand (Waring and Youngberg 1972; van den Driessche 1974; Powers 1974). Recently, van den Driessche and Webber (1975, 1977a, 1977b) have sampled other plant tissues and other forms of nitrogen to evaluate Douglas-fir (_Pseudotsuga menziesii_ (Mirb.) Franco) nitrogen status. They found soluble nitrogen concentrations to be much more sensitive than total nitrogen to differences in nitrogen status induced by different urea fertilizer treatments. Their work suggests that soluble nitrogen represents nitrogen readily available to the plant for high nitrogen demand processes such as primary growth. Of the tissues they examined--foliage, twigs, inner bark and roots--roots were both sensitive and easy to sample from large trees.

In order to characterize the relative nitrogen status of Douglas-fir in Oregon Coast Range forest communities, soluble nitrogen in roots was sampled in four Alsea River basin communities. The objective of the sampling was to provide baseline information about the relative nitrogen status of these communities. Such information will be useful in evaluating the impacts of management activities on nitrogen status when compared to similar measurements on disturbed sites and in young managed stands (Swank and Waide 1979). Additional information from young and mature and from managed and natural stands will allow greater predictibility of ecosystem responses to management practices.

METHODS

Three mature stands in each of four plant communities were selected for sampling: ocean spray (Holodiscus discolor (Pursh) Maxim.)/salal (Gaultheria shallon Pursh), vine maple (Acer circinatum Pursh))/salal, sword-fern (Polystichum munitum (Kaulf.) Presl. var. munitum) and sword-fern/oxalis (Oxalis oregana Nutt.). These communities were chosen because they represent climax associations that are relatively stable in species composition. Furthermore, they represent the full range of moisture status in the Alsea basin. The ocean spray/salal and the sword-fern/oxalis are dry and moist sites respectively, while the vine maple/salal and the sword-fern communities are intermediate (Corliss and Dyrness 1964, 1965; Franklin and Dyrness 1973). Because of their proximity to the Pacific Ocean, temperatures in these communities are moderate throughout the year and exhibit only small differences among communities.

All sampled stands are on Bohannon series soils. These soils are the most common in the Alsea basin, occuring on over 94,500 acres or 33 percent of the area. They exhibit an average Douglas-fir site index of 146 (Corliss and Dyrness 1964). Bohannon soils are shallow to moderately deep, well drained gravelly loams derived from fractured Tyee Formation sandstones. Detailed descriptions, including physical and chemical properties, are found in the Soil Survey of Alsea Area, Oregon (Corliss 1973). Stands were selected for sampling using the soil and vegetation mapping of Corliss and Dyrness (1964, 1965) and field checked to verify that species composition and surface soil characteristics fit their descriptions. Variations in soil depth and the presence of larger (8 cm to 20 cm) stones are noted in Table I. Such variations did not appear to be related to differences in community occurence. Also shown in Table I are percent cover of selected species in each stand and typical stands as described by Corliss and Dyrness (1964).

In each stand root samples between 1.0 cm and 1.5 cm in diameter were collected from five dominant or co-dominant trees by the method described by van den Driessche and Webber (1977b). Samples were collected in March-April and in August to provide a measure before and after bud burst and primary growth. Samples were frozen immediately after collection.

After freeze-drying and grinding, equal amounts of root tissue of the five trees per plot were combined for extraction. Soluble nitrogen was extracted using a chloroform-methanol-water mixture (van den Driessche and Webber 1977b). Extracts of each plot underwent Kjeldahl analysis to determine percent soluble nitrogen.

Analysis of variance and decomposition of sums of squares were used to test for differences in mean percent soluble nitrogen among the four plant communities and between the two community types.

TABLE I. VEGETATION AND SOIL CHARACTERISTICS OF SAMPLED STANDS AND TYPICAL COMMUNITIES.

PLOT NO.	ASPECT	ELEVATION meters	SOIL DEPTH cm	SOIL TEXTURE	SITE INDEX	STAND AGE	BASAL AREA m^2/ha	PERCENT COVER BY SPECIES DOUGLAS-FIR	OCEAN SPRAY	VINE MAPLE	SALAL	SWORD-FERN	OXALIS
OCEAN SPRAY/SALAL													
2	NW	525	70	gravelly loam	--	70	75	70	20	0	85	10	0
6	SE	375	90	gravelly loam	--	110	76	50	40	5	90	5	0
27	SE	525	80	gravelly loam	--	50	66	65	30	0	90	0	0
typical*-		--	--	--	135	200	--	65	15	1	40	6	1
VINE MAPLE/SALAL													
17	S	300	70	gravelly loam	--	110	69	60	0	40	70	10	0
19	SW	250	80	gravelly loam	--	110	65	60	0	50	80	5	0
20	SW	275	60	stoney	--	110	77	75	0	50	60	5	0
typical--		--	--	--	150	115	--	55	1	50	40	10	1
SWORD-FERN													
12	NW	625	80	gravelly loam	--	80	72	90	0	5	5	70	10
22	SW	500	90	gravelly loam	--	100	63	70	0	5	5	80	0
33	NW	525	80	gravelly loam	--	70	62	80	0	5	5	70	10
typical--		--	--	--	185	200	--	65	1	2	1	45	5
SWORD-FERN/OXALIS													
8	NE	375	90	gravelly loam	--	100	48	60	5	0	0	70	20
9	W	500	70	stoney	--	90	53	70	0	20	0	70	30
26	NE	450	70	stoney	--	100	62	90	0	0	0	40	40
typical--		--	--	--	185	100	--	70	0	3	1	40	30

*From Corliss and Dyrness 1964

RESULTS AND DISCUSSION

No differences in soluble nitrogen were found among the August samples. In the March-April samples differences between ocean spray/salal and vine maple/salal were insignificant as were those between sword-fern and sword-fern/oxalis (Table II and Figure 1). When comparing all plots with salal understories to all plots with sword-fern understories there is a significant difference in nitrogen status--0.028% versus 0.035%. Analysis of variance table is shown in Table III.

The pattern of soluble nitrogen in roots is the same as the nitrogen patterns identified by Youngberg (1966) and Tarnocai (1968) in Alsea basin communities. Youngberg measured percent total nitrogen in forest floors and Tarnocai measured percent total nitrogen in understory vegetation. Both found concentrations of total nitrogen to follow the order of ocean spray/salal less than vine maple/salal less than sword-fern/oxalis less than sword-fern. The sword-fern community types are much richer in nitrogen than the salal community types.

The April value of 0.028% soluble nitrogen in roots in the combined salal community types compares closely with the work of van den Driessche and Webber (1977b) who found values of 0.026% root soluble nitrogen in April in stands with salal understories. In urea fertilizer experiments they increased root soluble nitrogen by 0.004% with the addition of 224 kg N per ha and by 0.008% with 448 kg N per ha. Considering their findings, it appears that the higher nitrogen level in the Alsea basin sword-fern community

TABLE II. PERCENT SOLUBLE NITROGEN IN DOUGLAS-FIR ROOTS FROM FOUR COMMUNITIES SAMPLED IN MARCH-APRIL AND IN AUGUST.

COMMUNITY	PERCENT SOLUBLE N	
	MARCH-APRIL	AUGUST
OCEAN SPRAY/SALAL	0.027a*	0.029a
VINE MAPLE/SALAL	0.029a	0.032a
SWORD-FERN	0.037b	0.030a
SWORD-FERN/OXALIS	0.034ab	0.029a

*Values in a column followed by the same letter are not significantly different at $p \leq 0.05$.

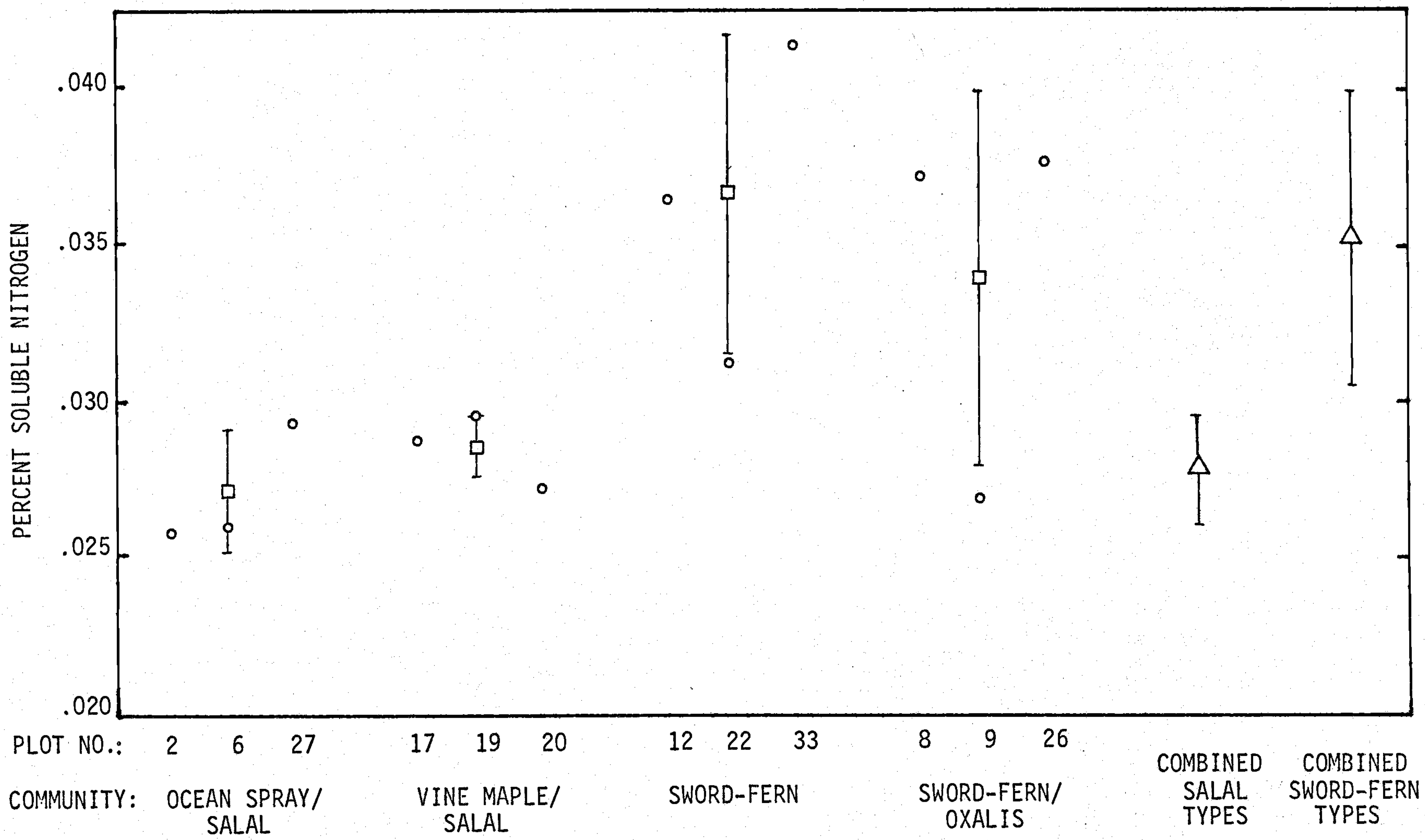

Figure 1. Percent soluble nitrogen in each plot (○), each community (□) and combined community types (△) for March-April samples of Douglas-fir roots. Bars show one standard deviation.

TABLE III. ANALYSIS OF VARIANCE TABLE FOR MARCH-APRIL SAMPLES OF PERCENT SOLUBLE NITROGEN IN DOUGLAS-FIR ROOTS.

SOURCE OF VARIATION	SS (1×10^{-4})	df	MS (1×10^{-4})
BETWEEN COMMUNITIES	1.7947	3	0.5984
BETWEEN TYPES	1.6618	1	1.6618
WITHIN SALAL TYPES	0.0296	1	0.0296
WITHIN SWORD-FERN TYPES	0.1033	1	0.1033
ERROR	1.3640	8	0.1705
TOTAL	3.1587	11	

types (0.035% soluble nitrogen in Douglas-fir roots) may be equivalent to nearly 448 kg per ha more nitrogen than in salal community types (0.028%).

The fact that measurements in the summer failed to show significant differences is consistent with the van den Driessche and Webber (1977b) work in which their mid-summer measurements did not differ according to fertilizer induced differences in nitrogen status. Soluble nitrogen in roots in the salal community types did not change significantly between winter and summer samples. In sword-fern community types, soluble nitrogen in roots decreased after bud burst to levels similar to the salal types. The difference between spring and summer values may represent nitrogen translocated for growth. The lower value, about 0.028%, appears to be a minimum level available to Alsea basin stands. Soluble nitrogen in roots in sword-fern types varied widely compared to the salal types (Figure 1). The lower values in this range were also about 0.028% and may be an additional indication of some minimum level of root soluble nitrogen in the Alsea basin.

The occurence of evergreen species on relatively dry, less fertile sites has been observed in other ecosystems (Monk 1966; Zobel et al 1976). Evergreen species appear to have low nutrient requirements, to conservatively use acquired nutrients and to be able to accumulate nutrients during cool, wet winters when nutrient availability is not summer drought limited (Waring and Franklin 1979). The occurence of evergreen shrub communities in the relatively moist, temperate Alsea River basin, including the coastal fog belt, suggests that nutrient status is as important as temperature and moisture when characterizing the environmental stimuli acting on those communities. Nutrient manipulations such as chemical and biological inputs of nitrogen or conservation of nitrogen by avoiding whole-tree harvesting or intensive slash burning may be appropriate in salal community types.

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