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Comparison of vegetation in adjacent alder, conifer, and mixed alder-conifer communities. I. Understory vegetation and stand structure

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Abstract

Vegetational analyses of adjacent 40-year-old coastal Oregon stands of red alder, conifers, and mixed alder-conifer showed marked differences in coverage and richness of understory. Shrubby species were confined mainly to the pure alder stand, where they formed a dense layer. Herbaceous plants were best developed in the alder and mixed stands and ground-dwelling cryptogams in the mixed and conifer stands. Differences in canopy density and, perhaps, in nutrition probably accounted for most of the contrasts. Although current regeneration of trees was uniformly absent, supressed Sitka spruce saplings persisting in the alder and mixed stands could, by responding to future release, partially replace a deteriorating alder overstory.

A variety of biological studies are being conducted in three adjacent 40-year-old stands of red alder (*Alnus rubra*), conifer (mainly Douglas-fir (*Pseudotsuga menziesii*)), and mixed alder and conifer growing on the Oregon coast (Berntsen, 1961; Franklin et al., 1968; Bollen and Lu, 1968; and Lu, Chen, and Bollen, 1968). A quantitative vegetational analysis of these stands was deemed not only interesting in itself but was also needed as an aid in interpretation of other studies.

In the spring of 1966 we made such an analysis. Our data on stand structure and composition of the understory vegetation, including ground-dwelling cryptogams, are presented in this paper. Data on epiphytic, epixylic, and epilithic cryptogams are presented elsewhere (Pechanec and Franklin, 1968).

ENVIRONMENT

The stands studied are located in the Cascade Head Experimental Forest about 2 miles north of Otis, Oregon. They lie within the mild, wet coastal

climatic zone sometimes called the "fog belt" (Madison, 1957). Average annual rainfall in the study area is between 90 and 100 inches, and temperatures below freezing or in excess of 80 F are uncommon. The stands occupy a relatively uniform, gentle (about 15 percent) southwesterly facing slope about 6 miles from the ocean. Soils are deep Astoria-like Sols Bruns Acides which have been fully described by Franklin et al. (1968). All are moderately fine textured and derived from deeply weathered Eocene siltstone.

HISTORY OF STANDS

The 40-year-old stands occupy a site which was once cleared for agriculture but was abandoned about 1925. A well-stocked stand of alder and conifer reproduction developed. Between 1935 and 1937, three long-term silvicultural study plots, which constitute the three stands employed in the present study, were established. On one 1-acre plot, all conifers were removed and the remaining alders thinned to a spacing of 8 by 8 feet, leaving 733 trees per acre. On another 1/2-acre plot, all alders were removed and conifers were thinned to 1,148 trees per acre. A third 1-acre plot containing about 3,000 trees per acre, of which 40 percent were alder and 60 percent conifer, was left untouched. Berntsen (1961) described the subsequent development of the stands up to 1957. The three plots constitute our alder, conifer, and mixed stands.

Methods

A 15- by 25-meter macroplot in the center of each stand was used to obtain data on understory vegetation and forest structure and composition. Each macroplot was outlined on the ground with cloth tapes, the long axis across the slope. Each macroplot was then divided into three 5- by 25-meter segments with two more tapes. Frequency and coverage of all shrubs, herbs, and ground mosses and liverworts were determined on fifty 20- by 50-cm plots systematically placed at 1-meter intervals along the inside boundaries of the center 5- by 25-meter segment. Daubenmire's (1959) procedures for estimating and calculating canopy coverage were used. The remainder of the macroplot and stand was examined for additional species.

All trees on each macroplot were tallied by species and size class.

Results

Understory Community

Understory vegetation was much better developed under pure red alder than under conifer, with the mixed stand intermediate (Table 1). A total of 40 species of shrubs, herbs, and ground cryptogams were recorded – 36 in the alder stand, 23 in the mixed stand, and 19 in the conifer stand. Sixteen of the 40 species were observed in only one of the three stands, 13 of these 16 occurring only under pure alder; most were minor components, however.

Coverage by the different understory layers differed dramatically. The alder stand was the only one with a significant coverage by the shrub layer,

mostly of *Sambucus melanocarpa* and *Rubus spectabilis* (Table 1). Only 2 percent and a trace of shrub coverage were recorded in the mixed and conifer stands, respectively. The alder and mixed stands had comparable coverage within the herb layer, but the conifer stand herb coverage was again significantly lower, having less than half as much. Coverage by ground cryptogams was considerably higher in the conifer and mixed stands than in the pure alder stand; proportionately high coverage of *Eurhynchium oreganum* accounted for most of this difference.

Most of the important herbs occurred in all three stands although there were some shifts in dominance (Table 1). *Maianthemum bifolium* and *Polystichum munitum* were consistently important. On the other hand, *Montia sibirica,* which had high frequency and coverage in the pure alder and mixed stands, was nearly absent from the conifer stand. *Stachys mexicana* was the only major herbaceous species confined to a single stand condition, pure alder.

Stand Structure

Regeneration of tree species was not yet taking place in significant numbers (Table 2). A very few western hemlock seedlings (<3 feet tall) were

TABLE 1.–Frequency and canopy cover of understory species in adjacent red alder, conifer, and mixed alder-conifer stands based on 50 systematically placed 20- by 50-cm plots in each stand.[1]

Layer and species	Alder		Mixed		Conifer	
	Freq.	Cover	Freq.	Cover	Freq.	Cover
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Shrub layer:						
Rubus spectabilis	80	58	4	2		
Sambucus melanocarpa	52	43	2	< .5		
Rubus parviflorus	10	4				
Acer circinatum	10	9		+		+
Holodiscus discolor	2	1				
Menziesia ferruginea		+				+
Vaccinium parvifolium		+		+		+
Sum of coverage by species in shrub layer		115		2		
Herb layer:						
Maianthemum bifolium	98	24	70	38	82	19
Montia sibirica	94	37	82	42		+
Polystichum munitum	26	14	24	14	20	11
Rubus ursinus	22	3	10	1	8	< .5

Table 1.–Frequency and canopy cover of understory species. . . (Continued)

Layer and species	Alder		Mixed		Conifer	
	Freq.	Cover	Freq.	Cover	Freq.	Cover
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Disporum smithii	16	3	6	1	10	< .5
Pteridium aquilinum	4	2	2	1	2	2
Carex leptopoda	4	2	2	< .5		+
Trillium ovatum	4	1		+	6	1
Galium triflorum		+	2	< .5	4	1
Luzula parviflora		+		+	2	1
Trisetum cernuum	4	1		+		
Stachys mexicana	28	6				
Viola sempervirens			2	< .5	4	< .5
Oxalis oregana		+				+
Osmorhiza chilensis	2	< .5				
Melica subulata	2			+		
Dryopteris spinulosa dilatata		+		+		
Athyrium filixfemina		+		+		
Poa marcida		+				
Streptopus amplexifolius		+				
Polypodium vulgare		+				
Tiarella trifoliata						+
Sum of coverage by species in herb layer		93		97		35
Moss layer:						
Eurhynchium oreganum	56	8	98	54	100	55
Isothecium spiculiferum	10	< .5	18	1	6	< .5
Eurhynchium stokesii	60	4	2	< .5		
Mnium insigne	16	1				
Plagiothecium denticulatum	14	1				
Rhytidiadelphus loreus	12	1				
Plagiothecium undulatum	8	< .5				
Campylium sp.	4	< .5				
Mnium punctatum	2	< .5				
Neckera			2	< .5		
Scapania bolanderi					2	< .5
Sum of coverage by mosses and liverworts		15		55		55
Sum of coverage, all understory species		223		154		90

[1] *A "+" indicates that the species was present in the stand but was not observed on a plot.*

found in the conifer stand; no seedlings of any tree species were found in the other stands. A number of suppressed Sitka spruce saplings (>3 feet tall and <4 inches dbh) were found in the alder and mixed stands. A check of comparable saplings growing just outside plot boundaries revealed most of these had persisted since establishment 25 to 35 years earlier.

Discussion

The relative richness of understory vegetation under stands of alder has frequently been noted. For example, Sharpe[1] found red alder stands on alluvial sites on the Olympic Peninsula had a greater abundance of herbs, grasses, grasslike plants, and ground cryptogams than most conifer stands. Smirnova and Sorogovets (1966) contrasted the abundance of herbs in *Alnus incana* stands with conditions under stands of aspen and birch growing on similar sites. They also mention that herbage is reduced under an admixture of *Picea excelsa* and suggest alder preservation for improvement of herbage quality.

Why was the understory more lush under pure alder and mixed stands than under the pure conifer stand at Cascade Head? We suggest that this primarily reflected greater amounts of light passing through the more open and season-

[1] *Sharpe, Grant William. A taxonomical-ecological study of the vegetation by habitats in eight forest types of the Olympic rain forest, Olympic National Park, Washington. 335 p. 1956. Ph.D. thesis on file at Univ. Wash.*

TABLE 2.–Stand structure in adjacent 40-year-old red alder, conifer, and mixed alder-conifer stands.[1]

Stand and species	Diameter at breast height							
	<2 in.		2-4 in.	4-8 in.	8-12 in.	12-16 in.	16-20 in.	20-24 in.
	<3 ft. tall	>3 ft. tall						
	Number of trees							
Red alder stand:								
Red alder			1	10	17	2		
Sitka spruce		6	8					
Mixed stand:								
Red alder			2	7	11	3		
Sitka spruce		14	23	15				
Douglas-fir				1	6	5	1	
Conifer stand:								
Douglas-fir				1	2	9	5	2
Western hemlock	8	2		2	1			
Sitka spruce			2	1				
Red alder				1				

[1] Tally of trees on 15- by 25-m macroplot in the middle of each stand.

ally leafless alder canopy. Many shrub and herb species abundant in the alder stand are known to be relatively intolerant, light-demanding species, e.g., *Rubus spectabilis.* Also, as Vēzina and Grandtner (1965) have shown, species of herbs may leaf out and flower or even complete their entire life cycle prior to development of a deciduous tree canopy in the spring. Several species present at Cascade Head were well along in development prior to red alder bud burst, *Montia sibirica* being a notable example. Higher nitrogen content of the soil under red alder (Franklin et al., 1968) may also promote greater development of understory vegetation. Some Russians have emphasized this factor (Gel'tman and Parfenov, 1966).

Lower coverage of cryptogams under the alder stand probably resulted from low light levels under the dense herb and shrub layers as well as greater quantities of smothering broad-leaved litter. Low-lying ground mosses and liverworts were not well adapted to meet competition of this type. Ground cryptogams did best in the conifer stand where competing vascular understory plants were largely absent.

No successional trends in tree species were evident after 40 years, as neither alder nor conifers were reproducing. Relative sizes of red alder and Douglas-fir in the mixed stand suggest alder was beginning to drop behind in the growth race. Since red alder is a relatively short-lived species (Fowells, 1965), the Douglas-firs, now occupying a dominant crown position, will take over more and more growing space.

Some suppressed Sitka spruce saplings were present in the mixed and pure alder stands. It appears many of these will persist until the alder overstory breaks up. If they then respond to release, an understocked stand of Sitka spruce could be expected to succeed the alder. Sitka spruce regeneration has commonly been observed in other stands of red alder in the fog belt region along the Oregon coast. Sitka spruce forest is known to succeed thickets of *Alnus sinuata* in coastal Alaska (Cooper, 1931). Gel'tman and Parfenov (1966) have described successional replacement of *Alnus incana* stands by those of spruce in Belorussia beginning, in many cases, with simultaneous establishment of alder and spruce and involving extended periods of spruce suppression by alder.

We have observed regeneration of western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*) growing in red alder stands elsewhere in the region, particularly in western Washington. Since both are relatively tolerant species, a successional sequence similar to that suggested for alder stands with Sitka spruce might be expected.

The successional sequence proposed here differs somewhat from that described for other western Oregon red alder stands by Newton, El Hassan, and Zavitkovski (1968). In most of their stands, seedlings and saplings of all tree species were absent from the understory; Douglas-firs suppressed in early stages of stand development did not persist. They suggest that alder stands of this type deteriorate into nonforested areas of brush species, such as salmonberry, which are only slowly reclaimed by conifers.

Literature Cited

Berntsen, Carl M. 1961. Growth and development of red alder compared with conifers in 30-year-old stands. U.S. Forest Serv. Pacific Northwest Forest & Range Exp. Sta. Res. Pap. 38. 20 p.

Bollen, W. B., and K. C. Lu. 1968. Nitrogen transformations in soils beneath red alder and conifers, p. 141-148. *In* J. M. Trappe, J. F. Franklin, R. F. Tarrant, and G. M. Hansen [ed.], Biology of alder. Pacific Northwest Forest & Range Exp. Sta., Portland, Oregon.

Cooper, W. S. 1931. A third expedition to Glacier Bay, Alaska. Ecology 12:61-95.

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Sci. 33:43-64.

Fowells, H. A. [ed.] 1965. Silvics of forest trees of the United States. U.S. Dep. Agr. Agr. Handbook 271. 762 p.

Franklin, J. F., C. T. Dyrness, D. G. Moore, and R. F. Tarrant. 1968. Chemical soil properties under coastal Oregon stands of alder and conifers, p. 157-172. *In* J. M. Trappe, J. F. Franklin, R. F. Tarrant, and G. M. Hansen [ed.], Biology of alder. Pacific Northwest Forest & Range Exp. Sta., Portland, Oregon.

Gel'tman, V. S., and V. I. Parfenov. 1966. The forming of speckled alder phytocoenoses and their succession by spruce. Israel Program for Sci. Transl. Cat. No. 1566. 9 p.

Lu, K. C., C. S. Chen, and W. B. Bollen. 1968. Comparison of microbial populations between red alder and conifer soils, p. 173-178. *In* J. M. Trappe, J. F. Franklin, R. F. Tarrant, and G. M. Hansen [ed.], Biology of alder. Pacific Northwest Forest & Range Exp. Sta., Portland, Oregon.

Madison, R. W. 1957. A guide to the Cascade Head Experimental Forest. U.S. Forest Serv., Pacific Northwest Forest & Range Exp. Sta., 14 p.

Newton, M., B. A. El Hassan, and J. Zavitkovski. 1968. Role of red alder in western Oregon forest succession, p. 73-84. *In* J. M. Trappe, J. F. Franklin, R. F. Tarrant, and G. M. Hansen [ed.], Biology of alder. Pacific Northwest Forest & Range Exp. Sta., Portland, Oregon.

Pechanec, Anna A., and J. F. Franklin. 1968. A vegetational comparison of adjacent alder, conifer, and mixed alder-conifer communities. II. Epiphytic, epixylic, and epilithic cryptogams, p. 85-98. *In* J. M. Trappe, J. F. Franklin, R. F. Tarrant, and G. M. Hansen [ed.], Biology of alder. Pacific Northwest Forest & Range Exp. Sta., Portland, Oregon.

Smirnova, V. A., and P. E. Sorogovets. 1966. The effect of grey alder on herbaceous vegetation. Israel Program for Sci. Transl. Cat. No. 1585. 4 p.

Vēzina, P. E., and M. M. Grandtner. 1965. Phenological observations of spring geophytes in Quebec. Ecology 46:869-872.