United States
Department of
Agriculture

**Forest Service**

Pacific Northwest
Forest and Range
Experiment Station

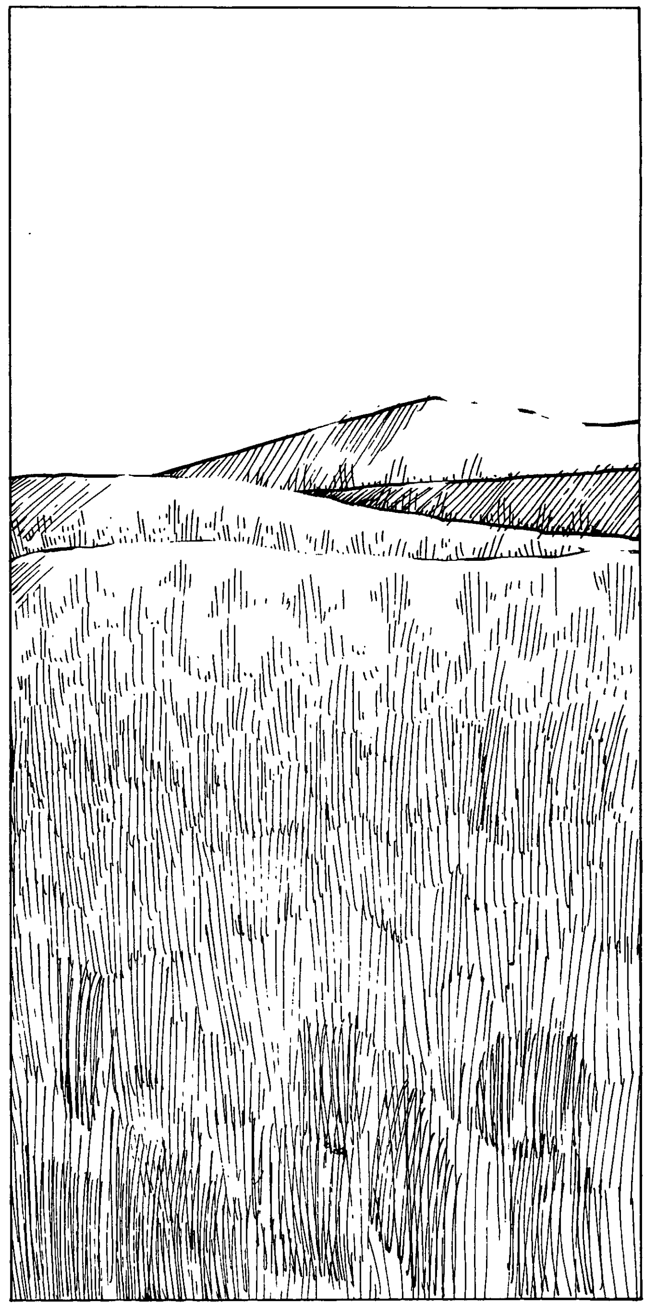
General Technical
Report
PNW-130

July 1981



# Research on Forest and Range Soils in Oregon and Washington:

## A Bibliography With Abstracts From 1975 Through 1979



# Research on Forest and Range Soils in Oregon and Washington: A Bibliography With Abstracts from 1975 through 1979

Compiled by

Glen O. Klock, Research Soil Scientist
Forestry Sciences Laboratory
Pacific Northwest Forest and Range Experiment Station
Wenatchee, Washington

and

Robert F. Tarrant, Professor
Department of Forest Science
Oregon State University
Corvallis, Oregon

Forest Service, **U.S.** Department of Agriculture
Pacific Northwest Forest and Range Experiment Station
Portland, Oregon
General Technical Report PNW-130
**July** 1981

## Abstract

Klock, Glen O., and Robert F. Tarrant.
1981. Research on forest and range soils in Oregon and Washington: A bibliography with abstracts from 1975 through 1979. USDA For. Serv. Gen. Tech. Rep. PNW-130, 23 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

An annotated bibliography on forest and range soils in Oregon and Washington supplementing three earlier bibliographies published by the Pacific Northwest Forest and Range Experiment Station.

Keywords: Soil (forest), soil (range), research, bibliographies (soils research).

## Preface

This is the fourth in a series of annotated bibliographies on forest and range soils research in Oregon and Washington. It includes the record of research findings for the years 1975 to 1979. Similar information for 1914 to 1974 is summarized in earlier papers.[1] Annotations enclosed in quotation marks are abstracts provided by the author of the publication cited.

Beginning in 1914 and extending through 1979, nearly 700 soil science publications have reported or discussed new information related to the management of Pacific Northwest forest and range lands. Most of this literature has appeared since World War II, when natural resource management research was substantially increased.

The forest soils research community, although small, has contributed forcefully and constructively to forest resource management in the Pacific Northwest. New knowledge, generated from research by public and private organizations, has been a key factor in widening sensitivity for the health of the soil-water-vegetation system.

Additional copies of this publication can be obtained from the compilers or the Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

---

[1] Published by the Pacific Northwest Forest and Range Experiment Station:

Tarrant, Robert F., compiler. 1964. Forest soils research in Oregon and Washington: A bibliography with abstracts through 1963. USDA For. Serv. Res. Pap. PNW-15, 29 p. (No longer available from Pacific Northwest Forest and Range Experiment Station.)

Klock, Glen O., compiler. 1969. Forest and range soils research in Oregon and Washington: A bibliography with abstracts from 1964 through 1968. USDA For. Sew. Res. Pap. PNW-90, 28 p.

Klock, Glen O., compiler. 1976. Forest and range soils research in Oregon and Washington: A bibliography with abstracts from 1969 through 1974. USDA For. Sew. Gen. Tech. Rep. PNW-47, 36 p.

# Bibliography


1. Atkinson, W. A., B. T. Bormann, and D. S. DeBell.
1979. Crop rotation of Douglas-fir and red alder: A preliminary biological and economic assessment. Bot. Gaz. 140(Suppl.):S102-S107.
"Four options for alternate cropping of red alder and Douglas-fir are described and compared to continuous cropping of Douglas-fir, with and without nitrogen fertilizer."

2. Atkinson, William A., and Willard I. Hamilton.
1978. The value of red alder as a source of nitrogen in Douglas-fir/alder mixed stands. *In* Utilization and management of alder. David G. Briggs, Dean S. DeBell, and William A. Atkinson, compilers. USDA For. Serv. Gen. Tech. Rep. PNW-70, p. 337-351, illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"A paper within a compendium covering all aspects of utilization and management of red alder."

3. Berg, Alan, and Allan Doerksen.
1975. Natural fertilization of heavily thinned Douglas-fir stand by understory red alder. For. Res. Lab. Res. Note 56, 3 p. Oreg. State Univ., Corvallis.
Red alder as a light understory added 200 pounds of nitrogen to the soil and 780 pounds as a heavy understory.

4. Berglund, Erwin R.
1976. Seeding to control erosion along forest roads. Oreg. State Univ. Ext. Serv. Ext. Circ. 885, 19 p., illus. Corvallis.
Summarizes techniques of revegetating disturbed soil along forest roads to control erosion.

5. Blake, John, and William K. Ferrell.
1977. The association between soil and xylem water potential, leaf resistance, and abscisic acid content in droughted seedlings of Douglas-fir ***(Pseudotsuga rnenziesii).*** Physiol. Plant. 39(2):106-108.
Soil matric potential appeared more closely associated with abscisic acid content of foliage than did plant water potential. Thus, the Douglas-fir root may be the drought-sensing organ.

6. Bockhelm, J. G., T. M. Ballard, and R. Willington.
1975. Soil disturbance associated with timber harvesting in southwestern British Columbia. Can. J. For. Res. 5(2):285-290.
Soil disturbance associated with logging was evaluated in five localities along transects away from main haulage roads and associated soil materials cast sideways from them. The data are compared with estimates of soil disturbances caused by logging in other regions of western North America.

7. Bollen, Walter B.
1977. Sulfur oxidation and respiration in 54-year-old soil samples. Soil Biol. and Biochem. 9:405-410.
Soil samples in dry storage for 54 years retained sulfur oxidizing power and respiration capacity.

8. Bollen, Walter B., and Logan A. Norris.
1979. Influence of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin on respiration in a forest floor and soil. Bull. Environ. Contam. and Toxicol. 22:648-652.
"TCDD, a contaminant of 2,4,5-T, did not significantly influence evolution of $CO_2$ from forest floor material in soil treated with TCDD at rates up to 5.2 times $10^5$ parts per million (equivalent to the amount of TCDD in 2,4,5-T applied at 44.8 kilograms per hectare)."

9. Bollen, W. B., Logan A. Norris, and Kathleen L. Stowers.
1977. Effect of cacodylic acid and MSMA on nitrogen transformation and in forest floor and soil. J. Environ. Qual. 6(1):1-3.
"Cacodylic acid and MSMA had minor effects on ammonification and nitrification in forest floor and soil from Douglas-fir, ponderosa pine, and mixed-fir forest types. These effects will not significantly influence nitrogen relations in young dense stands precommercially thinned with these chemicals."

10. Bowles, David S., J. Paul Riley, and George B. Shih.
1975. An application of the Utah State University watershed stimulation model to the Entiat experimental watershed, Washington State. Utah Water Res. Lab. PRWG:26-1, 50 p., illus. Utah State Univ., Logan.
"The Utah State University watershed stimulation model was applied to three small drainage areas in the Entiat experimental watershed located in central Washington. Reasonable agreement was achieved between observed and stimulated streamflow, both in terms of timing and quantity. The study illustrates the need for a better understanding of subsurface flow regime of the experimental watersheds."

11. Brown, T. H., B. L. McNeal, and G. O. Klock.
1976. Nutrient distribution at two forested eastern Washington locations. Northwest Sci. Assoc. Annu. Meet. Abstr. 110. 49th Meet.
"Studies initiated to enumerate the macronutrient distribution of two eastern Washington forest sites before harvest and after the application of several postharvest residue management techniques are described."

12. Buckhouse, J. C., and J. M. Skovlin.
1979. Streambank erosion in a Blue Mountain stringer meadow in response to livestock and big game grazing management. *In* 1979 progress report . . . Research in range land management. Agric. Exp. Stn. Spec. Rep. 549, p. 2-4. Oreg. State Univ., Corvallis.
Interim results from a study assessing the effects of management systems on streambank erosion show no real differences among grazing systems or between livestock grazing and no grazing. Apparently erosion in the winter masks the slight differences that grazing in the summer produces.

13. Campbell, G. S., and G. A. Harris.
1977. Water relations and water use patterns for ***Artemisia tridentata*** Nutt. in wet and dry years. Ecology 58(3):652-659.
"A simple model is proposed for predicting evaporation and transpiration from daily precipitation and potential evapotranspiration."

14. Cochran, P. H
1975. Response of pole-size lodgepole pine to fertilization. USDA For. Sew. Res. Note PNW-247, 10 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"N, P, and S fertilization increased volume growth and grass production in a lodgepole pine stand for a 4-year period after application. Measurements of annual radial wood growth indicate response will continue beyond 4 years."

15. Cochran, P. H.
1977. Forest regeneration of arid lands in the Pacific Northwest. ***In*** Forests for people: A challenge in world affairs. Proc. Soc. Am. For. Natl. Conv., p. 88-91. Soc. Am. For., Washington, D.C.
"Consistent success in regeneration on semi-arid sites hinges on commitment to do a correct job in every phase of the program from seed collection to plantation release from re-established competing vegetation."

16. Cochran, P. H.
1977. Response of ponderosa pine 8 years after fertilization. USDA For. Sew. Res. Note PNW-301, 7 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Diameter and volume growth of thinned ponderosa pine continue to respond to fertilization 8 years after application."

17. Cochran, P. H.
1978. Response of a pole-size ponderosa pine stand to nitrogen, phosphorus, and sulfur. USDA For. Serv. Res. Note PNW-319, 6 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Application of 200 pounds of nitrogen per acre increased ponderosa pine volume, basal area, and bole area growth for the first 4 years after application. One-hundred pounds of phosphorus per acre coupled with the nitrogen application increased basal area growth more than the other treatments."

18. Cochran, P. H.
1979. Response of thinned lodgepole pine after fertilization. USDA For. Serv. Res. Note PNW-335, 6 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Significant increase in volume growth continued during the second 4-year period after application of N, P, and S, height growth responded during the second 4-year period, but not during the first."

19. Cochran, P. H.
1979. Response of thinned ponderosa pine to fertilization. USDA For. Sew. Res. Note PNW-339, 8 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
Growth of thinned pole-size ponderosa pine was increased more than 50 percent by application of nitrogen, phosphorus, and sulfur.

20. Cole, Dale W., S. P. Gessel, and John Turner.
1978. Comparative mineral cycling in red alder and Douglas-fir. ***In*** Utilization and management of alder. David G. Briggs, Dean S. DeBell, and William A. Atkinson, compilers. USDA For. Sew. Gen. Tech. Rep. PNW-70, p. 327-336, illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

21. Cromack, K., Jr., P. Sollins, R. L. Todd, R. Fogel, A. W. Todd, W. H. Fender, H. E. Crossley, and D. A. Crossley, Jr.
1977. The role of oxalic acid and bicarbonate in calcium cycling by fungi and bacteria: Some possible implications for soil animals. Ecol. Bull. (Stockholm) 25:246-252.
"Oxalic acid production by fungi permits them to accumulate excess calcium as the sparingly soluble calcium oxalate compound. Bacteria can decompose the compound to recycle the calcium. These processes are important in soil weathering and release of phosphorus and iron."

22. Cromack, Kermit, Jr., Phillip Sollins, William C. Graustein, Karen Speidel, Allen W. Todd, Gody Spycher, C. Y. Li, and Robert L. Todd.
1979. Calcium oxalate accumulation and soil weathering in mats of the hypogeous fungus ***Hysterangium crassum.*** Soil Biol. and Biochem. 11:463-468.

23. Cromack, K. Jr., J. J. Swanson, and C. C. Grier.
1978. A comparison of harvesting methods and their impact on soils and environment in the Pacific Northwest. ***In*** Forest soils and land use. Proc. 5th North Am. For. Soils Conf., Aug. 6-9, 1978, Colo. State Univ., Fort Collins.

24. Dalton, David A., and Donald B. Zobel.
1977. Ecological aspects of nitrogen fixation by Purshia tridentata. Plant and Soil 48(1):57-80, illus.
"Bitterbrush root nodules fix nitrogen most rapidly at 20 degrees Celsius, but much slower at 15 degrees Celsius. Because soil temperatures are lower than optimum for fixation much of the time in the eastern Oregon pine forests where bitterbrush occurs, its contribution of nitrogen to the pine ecosystem is probably slight."

25. DeBell, D. S., and M. A. Radwan.
**1979.** Growth and nitrogen relations of coppiced black cottonwood and red alder in pure and mixed plantings. Bot. Gaz. **140(Suppl.):S97-S101.**
Growth and nitrogen status were assessed in pure and mixed plantings of black cottonwood and red alder. Annual dry-matter production of 2-year-old coppice (stump sprouting) in the mixed plots was higher than in pure cultures of cottonwood and alder. Twigs of cottonwood from mixed plantings contained **18** percent more nitrogen than twigs from pure plots. Soil in the mixed cottonwood-alder and pure alder cultures contained, **9** and **23** percent more nitrogen, respectively, than soil from the pure cottonwood planting. For the upper **15** cm of mineral soil, average annual nitrogen accretion under the mixed stand was **32** kglha and under pure alder, **80** kglha.

26. DeBell, Dean **S.**
**1979.** Future potential for use of symbiotic nitrogen in forest management. ***In*** Symbiotic nitrogen fixation in the management of temperate forests-proceedings of a workshop, April **2-5, 1979,** p. **451-466.** J. C. Gordon, C. T. Wheeler, and D. A. Perry, eds. For. Res. Lab., Sch. For., Oreg. State Univ., Corvallis.

27. Denison, **R.**, **B.** Caldwell, **B.** Bormann, L. Eldred, C. Swanberg, and S. Anderson.
**1977.** The effects of acid rain in nitrogen fixation in western Washington coniferous forests. Water, Air, and Soil Pollut. **8(1):21-34.**

28. Driessche, **R.** Van Den.
**1978.** Response of Douglas-fir seedlings to nitrate and ammonium nitrogen sources at different levels of pH and iron supply. Plant and Soil **49(3):607-623.**
"Relatively heavier roots and lighter shoots were found in seedlings supplied with $NO_3$-N rather than $NH_4$-N at pH 5. The relationship between Fe concentration and N nutrition is discussed."

29. Driessche, **R.** Van Den, and J. E. Webber.
**1977.** Variation in total and soluble nitrogen concentrations in response to fertilization of Douglas-fir. For. Sci. **23(2):134-142.**
"Total and soluble nitrogen (N) concentrations were high in current shoots after flushing in May and decreased rapidly until August. Soluble N concentration increased more than total N in all organs. Root analyses, in particular root concentration of arginine and guanidino compounds, together with stand age and basal area, could be used to predict growth and possibly the optimum timing of fertilization. Phloem analyses are suggested as more useful than root analyses in determining tree nutrient status since the former showed greater correlation with needle analyses."

30. Dyrness, C. T.
**1975.** Grass-legume mixtures for erosion control along forest roads in western Oregon. J. Soil and Water Conserv. **30(4):169-173.**
"Summarizes information collected over a 5-year period on the success of grass-legume seedlings, with and without straw mulch, in curtailing roadside soil erosion. Results indicate mulch is necessary to halt erosion during the **1st** year after construction, and refertilization may be needed to maintain a cover of vegetation."

31. Dyrness, C. T.
**1976.** Effect of wildfire on soil'wettability in the high cascades of Oregon. USDA For. Serv. Res. Pap. **PNW-202, 18** p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
Soil wettability and revegetation trends were studied for **6** years after wildfire. Burning caused an apparent increase in water repellency of the soil at depths of **1-9** inches, which persisted for 5 years after the fire. Application of a wetting agent had little discernible effect on soil wettability and rates of revegetation.

32. Edgerton, Paul J., and Burt **R.** McConnell.
**1979.** Recovery of bitterbrush following logging disturbance in a lodgepole pine forest. Soc. Range Manage. Annu. Meet. Abstr., p. **40.**
"Logging and slash disposal in lodgepole pine significantly damaged the bitterbrush understory. Increased growth of surviving shrubs and establishment of new shrubs, however, resulted in recovery of the forage resource 5 years after disturbance."

33. Edgerton, Paul J., Burt **R.** McConnell, and Justin G. Smith.
**1975.** Initial response of bitterbrush to disturbance by logging and slash disposal in a lodgepole pine forest. J. Range Manage. **28(2):112-114,** illus.
Logging and slash disposal in lodgepole pine caused significant damage to bitterbrush. Growth of twigs increased significantly on surviving shrubs, however, and many new plants were established on disturbed soils.

34. Edmonds, **R.** L.
**1976.** Survival of coliform bacteria in sewage sludge applied to a forest clearcut and potential movement into groundwater. Appl. and Environ. Microbiol. **32(4):537-546.**
"Groundwater contamination from vertical movements of potential pathogens is unlikely, but hazards may arise the first year from surface runoff and direct handling."

35. Flewelling, J. W., and Y. C. Yang.
1976. Tree volume table growth relationships possibly affected by fertilization. For. Sci. 22(1):58-60.

Thirty ***Pseudotsuga menziesii*** trees, 47 years old, were felled and sectioned in two adjoining plantations (one fertilized with 336 kg N/ha as urea and one control) in southwest Washington. Stem diameters were measured 5 years before fertilization, at fertilization, and 5 years later. Data are presented on the 5-year volume increments before and after fertilization.

36. Fogel, Robert, and Kermit Cromack, Jr.
1977. Effect of habitat and substrate quality on Douglas-fir litter decomposition in western Oregon. Can. J. Bot. 55(12):1632-1640, illus.

"Linear regression models were developed for decomposition of Douglas-fir litter in seven stands representing four mature vegetation types in western Oregon. The decomposition constant of needles had a negative linear correlation with maximum plant moisture stress and temperature growth index of the seven stands. In comparing substrate quality of needle and woody litter components, the decomposition constant was more closely correlated with lignin content than with carbon nitrogen ratio."

37. Foss, J. E., G. O. Klock, and M. S. Patterson.
1977. Distribution and characteristics of soils developed on tephra near Glacier Peak Washington. Argon. Abstr., p. 169. Am. Soc. Agron., Madison, Wis.

"Most of the glacier peak tephra is deposited to the east and southeast with the thickest deposits (greater than 300 centimeters) located along an axis E 10-15 degrees from the Peak. The sola of soils developed on this tephra are characterized by 2 to 86 percent (by weight) coarse pumice particles, bulk densities from 0.4 to 0.9 grams per cubic centimeter, and have pumiceous sandy loam textures."

38. Fowler, W. B., J. D. Helvey, and C. Johnson.
1979. Baseline climatic and hydrologic relationships for the High Ridge evaluation area. USDA For. Serv. Gen. Tech. Rep. PNW-91, 17 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

Summarizes the climatic and hydrologic measurements taken in the High Ridge evaluation area, a four-watershed complex within the Umatilla barometer watershed of eastern Oregon. Information on water yield, air, soil, and water temperatures; snow depth and density; and wind is presented to identify the pretreatment condition. The information is representative of environmental conditions in similar stands within the Blue Mountain area.

39. Fredriksen, R. L.
1976. Hydrology of a clearcut in western Oregon through the herb and shrub stages to the inception of dominance by Douglas-fir. Northwest Sci. Assoc. Annu. Meet. Abstr. 52.

"Summer streamflow has doubled in a 30-percent clearcut watershed. The increased flow has persisted for 12 years despite the fact that transpirational water losses are returned to pretreatment levels 4 years after harvest."

40. Fredriksen, R. L.
1977. Impacts of clearcutting and shelterwood cutting on soil and nitrogen balances of a mixed conifer forest. Northwest Sci. Assoc. Annu. Meet. Abstr. 100.

Soil and nitrogen (N) outflows from watersheds harvested by three methods — shelterwood, small clearcuts, and a total clearcut — are compared with a control. Important instream losses were noted only for the total clearcut where 4-year soil losses in kilograms per hectare were 11 200 compared with 2 **570** from the control. Outflows of N in streams from the clearcut and the control were, respectively, 3.4 and 0.7 times the input of precipitation.

41. Fredriksen, R. L.
1978. N balance after harvest of Douglas-fir stands — Cascade Range, Oregon. Agron. Abstr., p. 188. Am. Soc. Agron., Madison, Wis.

Nitrogen capital of forest stands is the difference between inputs by precipitation and by symbolic fixation and outflows by leaching, soil erosion, and volatilization. The largest outflows of N from volatilization by burning can be replaced by fixation. Outputs of N after clearcutting come from soil erosion rather than leaching, particularly in mountainous watersheds with high erosion potential.

42. Fredriksen, Richard L., and R. Dennis Harr.
1979. Soil, vegetation, and watershed management. *In* Forest soils of the Douglas-fir region, p. 231-259. Chapter 13. Wash. State Univ. Coop. Ext., Pullman.

"Covers hydrology, soil erosion, and nutrient balance of conifer forests of the Pacific Northwest and the effects of timber harvesting on forests and streams. Emphasis is on (1) soil erosion and nitrogen balance because of their known relationships to forest productivity, and (2) temperature and sediment transport in streams because of their impacts on habitat for native and anadromous fish."

43. Fredriksen, R. L., D. G. Moore, and L. A. Norris.
1975. The impact of timber harvest, fertilization, and herbicide treatment on streamwater quality in western Oregon and Washington. *In* Forest soils and forest land management. Proc. 4th North Am. For. Soils Conf., Laval Univ., Quebec, p. 283-313, illus.

Stream sedimentation caused by timber harvest was shown to increase with steeper slopes in Pacific Northwest watersheds. Nitrate nitrogen concentration in streams draining areas fertilized with nitrogen and areas clearcut harvested have been observed to remain below permissible health limits. Herbicide effects on quality of streamwater can be minimized by avoiding direct application and excessive drift of spray.

44. Fredriksen, R. L., D. N. Swanston, and F. J. Swanson.
1976. Sediment yield from soil erosion and channel storage after clearcutting and logging road construction, central western Cascade Range, Oregon. Agron. Abstr., p. 164. Am. Soc. Agron., Madison, Wis.

Although soil erosion loss caused by road construction was much greater than from clearcut harvest areas, losses from clearcut areas have been longer lasting. Mass wasting predominated on disturbed sites whereas streambank erosion was most active on undisturbed sites.

45. Froehliech, Henry A.
1978. Compaction of three forest soils by low ground-pressure, torsion-suspension logging vehicles. For. Res. Lab. Res. Pap. 36, 13 p. Oreg. State Univ., Corvallis.

"Soil compaction was largely confined to the upper 4 inches of soil. Most of the compaction occurred during the first few vehicle trips."

46. Geist, J. Michael.
1976. Forested range fertilization in eastern Oregon and Washington, Rangeman's J. 3(4):116-118.

"Discussed nutrient deficiencies, forage production, and ecological factors associated with fertilizer use in eastern Oregon and Washington."

47. Geist, J. Michael.
1976. Forested range fertilization-project checklist. Rangeman's J. 3(1):26.

"Lists items to be considered as part of an integrated resource management approach to forest fertilization."

48. Geist, J. Michael.
1976. Inorganic and available organic nitrogen supply in volcanic ash forest soils. Agron. Abstr., p. 184. Am. Soc. Agron., Madison, Wis.

Compares various methods of expressing,soil nitrogen supply and describes the relationship of these methods to plant growth and nitrogen uptake.

49. Geist, J. Michael.
1976. Orchardgrass growth on nitrogen and sulfur fertilized volcanic ash soil. J. Range Manage. 29(5):415-418.

"Orchardgrass response to N and S were faster and greater for N sources with soluble S than elemental S. Any one of four commercial fertilizers tested should effectively aid rapid establishment of new grass seedings on ash soils."

50. Geist, J. Michael.
1977. Nitrogen response relationships of some volcanic ash soils. Soil Sci. Soc. Am. J. 41(5):996-1000, illus.

A greenhouse study relating assessments of soil nitrogen to grass crop parameters attained polynomial regression correlation coefficient values of 0.97 and 0.80 for nitrogen uptake and yield of plant tops, respectively.

51. Geist, J. Michael.
1979. Toward improved understanding of N and S fertility status of upland volcanic ash soils of eastern Oregon and Washington. Agron. Abstr., p. 171. Am. Soc. Agron., Madison, Wis.

"Updates progress toward developing diagnostic capability of assessing soil fertility status of andepts."

52. Geist, J. Michael, and Lee Ehmer.
1977. Soil resource impacts from forest management in the Blue Mountains. *In* Integration of forest resource management in the Blue Mountains. Proc. Semin., Oreg. State Univ. Ext. Serv. and Soc. Am. For. Blue Mt. Chapter, p. 28-32, Mar. 1977, La Grande, Oreg.

"This expanded abstract discusses some of the fundamental properties of important Blue Mountain soils, and the implications certain management impacts have on subsequent plant growth."

53. Geist, J. Michael, and Lee Ehmer.
1978. Soil chemical properties and management implications for selected SRI sampling sites on the Umatilla National Forest. *In* Soil resource inventory, (Umatilla National Forest), p. 2-6. USDA For. Serv. Pac. Northwest Reg., Portland, Oreg.

"Soil Resource Inventory reference soils were sampled and analyzed for chemical properties. Data were grouped according to associated plant communities. Organic matter, total nitrogen, pH, available phosphorus, and extractable cation values are reported and discussed."

54. Geist, J. Michael, and John W. Hazard.
1975. Total nitrogen using a sodium hydroxide index and double sampling theory. Soil Sci. Soc. Am. Proc. 39(2):340-343, illus.

"A regression relationship was investigated between total kjeldahl soil N and an NAOH distillable fraction of soil N. The correlation coefficient "R" was 0.989 for 45 soil samples. A double sampling approach using both analyses to estimate total N was more efficient than kjeldahl analysis only. Example applications are presented under cost and precision limitations. The regression can also be used to obtain point values of total N for mapping or other non-statistical purposes."

**55.** Geist, J. Michael, and Gerald S. Strickler.
1978. Physical and chemical properties of some Blue Mountain soils in northeast Oregon. USDA For. Serv. Res. Pap. PNW-236, 19 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

"Soil properties of 57 forested locations were characterized and categorized by parent materials and vegetation. Properties were compared and interrelated, and their management implications were discussed. Data will serve as a basis for comparison with other soil-vegetation systems and for assessing environmental impacts."

56. Geist, **J.** Michael, John Wade, and Lee Ehmer.
1975. Soil analysis, fertility and management related to SRI landtypes from the Wallowa-Whitman and Umatilla National Forests. *In* Soil resource inventory, Wallowa-Whitman National Forest, appendix VIII, p. 206-214. USDA For. Serv. Pac. Northwest Reg., Portland, Oreg.

"Soil resource inventory (SRI) reference samples were analyzed to determine fertility status for management recommendations. Chemical properties, soil-site characteristics, and vegetative classification and reported and discussed."

57. Gessel, S. P., and J. Turner.
1976. Litter production in western Washington Douglas-fir stands. Forestry 49(1):63-72.

Litter production was measured by trapping for 1-9 years in 16 stands of ***Pseudotsuga rnenziesii*** aged 22-160 years in western Washington. Annual production of leaf litter increased to a maximum at age 30 years and then became stabilized at 2000-3000 kglha. Total litter continued to increase because of the production of wood litter but varied between stands.

58. Graustein, William C., Kermit Cromack, Jr., and Phillip Sollins.
1977. Calcium oxalate occurrence in soils and effect on nutrient and geochemical cycles. Science 198:1252-1254, illus.

"Whewellite and weddellite, calcium salts of oxalic acid, have been found in the litter layer of several different soils, indicating that oxalate is a major metabolic product of fungi in natural environment. The presence of oxalate in soil solution speeds weathering of soil minerals and increases the availability of nutrients to vegetation."

59. Gresswell, Stuart, David Heller, and Douglas N. Swanston.
1979. Mass movement response to forest management in the central Oregon Coast Ranges. USDA For. Serv. Resour. Bull. PNW-84, 26 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

"Timber management activities have clearly accelerated the number and frequency of soil mass movements on the Mapleton District, Siuslaw National Forest, as a result of the November 29-December 1, 1975, storm. Following roads, clearcutting is the next most damaging activity."

60. Grier, C. C.
1978. A ***Tsuga heterophylla-Picea sitchensis*** ecosystem of coastal Oregon: Decomposition and nutrient balances of fallen logs. Can. J. For. Res. 8(2):198-206.

Weight loss and changes in N, P, Ca, Mg, K, and Na content were determined for fallen ***T. heterophylla*** logs. After 38 years the average log had lost 34.5 percent of its original weight. Percentage N, Ca, and Mg content increased for about the first 20 years and declined thereafter. P and K percentage content decreased steadily, and Na increased. Except for Ca, nutrient input to log surfaces by litter fall and throughfall was greater than the amount lost by decomposition.

61. Grier, C. C., D. W. Cole, C. T. Dyrness, and R. L. Fredriksen.
1975. Nutrient cycling in 37- and 450-year-old Douglas-fir ecosystems. ***In*** Integrated research in the coniferous forest biome. Coniferous For. Biome, Ecosyst. Anal. Stud. U.S./Int. Biol. Program Bull. 5, p. 21-34.

"Biomass, nitrogen, phosphorus, potassium, and calcium distribution and geochemical and stand nitrogen, phosphorus, potassium, and calcium budgets were determined for 37- and 450-year-old Douglas-fir stands in the Pacific Northwest."

62. Grier, Charles C.
1975. Wildfire effects on nutrient distribution and leaching in a coniferous ecosystem. Can. J. For. Res. 5(4):599-607, illus.
"Nutrient losses during, and redistribution by leaching after, the Entiat fire in north-central Washington were determined."

63. Hansen, Everett.
1975. ***Phellinus*** (Poria) ***Weirii*** root rot in Douglas-fir-alder stands 10-17 years old. USDA For. Serv. Res. Note PNW-250, 5 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Red alder growing in even-aged mixture with Douglas-fir did not reduce initial losses to ***Phellinus weirii*** in 10- to 17-year-old Douglas-fir plantations. The ability of alder to reduce later losses from lateral spread within the stand was not examined."

64. Harr, R. D.
1977. Water flux in soil and subsoil on a steep forested slope. J. Hydrol. 33(½):37-58.
The movement of subsurface water was evaluated on a steep, forested slope in a small, headwater basin. Magnitude and direction of soil water movement during winter storms are compared with waterflow from a seep and from the basin and are related to soil properties. Dominance of subsurface flow and lack of overland flow in storm runoff are discussed.

65. Harr, R. Dennis.
1976. Forest practices and streamflow in western Oregon. USDA For. Serv. Gen. Tech. Rep. PNW-49, 18 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Clearcutting may increase annual water yield up to 62 centimeters, double minimum flows, and increase fall peak flows up to 200 percent. Roadbuilding and soil compaction may increase the size of larger peak flows. Under sustained yield forest management, such increases are masked in large, parent watersheds by unaltered streamflow from unlogged watersheds."

66. Harrington, Constance A., Dean S. DeBell, and Robert F. Strand.
1979. An experiment in biomass production: Results from three consecutive harvests of cottonwood and alder. ***In*** Proceedings of Solar 79 Northwest, p. 363-366. U.S. Dep. Energy, City Seattle, Bonneville Power Admin., Wash. State Off., and Oreg. Dep. Energy.
"Reports growth and yield data from three harvests of an experimental biomass farm growing black cottonwood and red alder. Plots were initially treated with pulpmill sludge and/or irrigation. Implications of the results and general considerations for biomass farming are discussed."

67. Harrington, Constance A., and Richard E. Miller.
1979. Response of a 110-year-old Douglas-fir stand to urea and ammonium nitrate fertilization. USDA For. Serv. Res. Note PNW-336, 7 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
Application of 150 pounds of nitrogen per acre as urea or ammonium nitrate significantly increased basal area growth in a recently thinned, 110-year-old, site II, Douglas-fir stand. "Response to ammonium nitrate was significantly greater than response to urea."

68. Heilman, P.
1975. Effect of added salts on nitrogen release and nitrate levels in forest soils of the Washington coastal area. Soil Sci. Soc. Am. 39(4):778-782.
Soil samples from 10 forested sites, supporting either ***Pseudotsuga menziesii*** or ***Tsuga heterophylla*** stands, were incubated with solutions of various salt concentrations for 21 days at 27°C. Release of N into solution increased with increasing salt concentration. The results are discussed in relation to work already reported on increased NO, concentration in soils after liming or burning.

69. Heilman, Paul E.
1979. Use of alders in coal spoil reclamation in the Pacific Northwest. (Abstr.) ***In*** Symbiotic nitrogen fixation in the management of temperate forests, p. 477. J. C. Gordon, C. T. Wheeler, and D. A. Perry, eds. Oreg. State Univ. Press, Corvallis.
Alder is being used for amelioration of coal mine spoils at Centralia, Washington; 40-year rotation of red alder followed by Douglas-fir, and ***Alnus sinuata*** interplanted with Douglas-fir.

**70.** Helvey, J. D.
1975. Soil moisture depletion and growth rates. USDA For. Serv. Res. Note PNW-245, 9 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Soil moisture depletion was reduced after a 40-year-old ponderosa pine stand was thinned. The treatment effect on soil moisture apparently lasted only 3 years."

71. Helvey, J. D., and W. B. Fowler.
1979. Grass seeding and soil erosion in a steep, logged area in northeastern Oregon. USDA For. Serv. Res. Note PNW-343, 11 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"This case study tested the common belief that grass seeding is needed to prevent erosion after areas are clearcut in the Blue Mountains. Changes in the soil surface height at about 500 points each in a seedbed and an unseeded area were measured on four dates covering a 20-month period. Average vertical displacement was not consistently related to seeding nor to degree of disturbance. Variability of vertical displacement within areas treated alike was almost as great as variability between treatments."

72. Helvey, J. D., W. B. Fowler, G. O. Klock, and A. R. Tiedemann.
1976. Climate and hydrology of the Entiat Experimental Forest watersheds under virgin forest cover. USDA For. Serv. Gen. Tech. Rep. PNW-42, 18 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Climatic and hydrologic measurements were made on three watersheds, each containing approximately 2 square miles (5.18 square kilometers) of drainage area, for 9 years under natural forested conditions. This paper describes the watersheds with respect to soils and geology, morphology, vegetation, precipitation, and other climatic parameters, and flow, sediment, temperature, and chemistry of streams during this period."

73. Helvey, J. D., C. Johnson, A. R. Tiedemann, and others.
1977. Climatic and hydrologic characteristics of four small watersheds in the Blue Mountains and some impacts of forest management on these characteristics. (Abstr.) ***In*** Integration of forest resource management in the Blue Mountains. Proc. Semin., Oreg. State Univ. Ext. Serv. and Soc. Am. For. Blue Mt. Chapter, p. 32-33, Mar. 1977, La Grande, Oreg.
"This expanded abstract discussed climatic and hydrologic data collected from small, undisturbed watersheds in the Blue Mountains of northeastern Oregon."

74. Helvey, J. D., and A. R. Tiedemann.
1976. Amounts and chemistry of gross rainfall, throughfall, and stemflow in a mixed fir stand growing in central Washington. Northwest Sci. Assoc. Annu. Meet. Abstr. 112.
"Amounts of throughfall and stemflow are predictable from measurements of gross rainfall. Concentrations of most chemical constituents are least in gross rainfall and highest in stemflow."

75. Helvey, J. D., A. R. Tiedemann, and W. B. Fowler.
1976. Some climatic and hydrologic effects of wildfire in Washington State. Proc. Annu. Tall Timber Fire Ecol. Conf., 15:201-222. Tall Timber Res. Stn., Tallahassee, Fla.
"Total water yield, water temperature, losses of nitrogen and losses of total cations all increased after a severe wildfire. Suspected changes in air temperature could not be verified because of limited data."

76. Ho, Iwan.
1979. Acid phosphatase in forest soil. For. Sci. 25(4):567-568.
Acid phosphatase activity in soil was higher in a red alder stand and in a red alder-Douglas-fir stand than in pure stands of Douglas-fir, ponderosa pine, lodgepole pine, or western juniper.

77. Holbo, H. R., R. D. Harr, and J. D. Hyde.
1975. A multiple-well, water-level measuring and recording system. J. Hydrol. 27(3):199-286, illus.
An electronic measuring and recording system was designed to make periodic measurements of water level simultaneouslyin 16 small-diameter piezometers. The system can operate from battery power in remote areas for 2 to 4 weeks unattended. Output data are easily read and readily adaptable to computer entry for analysis and plotting.

78. Hoyer, Gerald, Walter Fergerson, Michael Newton, and David R. M. Scott.
1978. A comparison of red alder, Douglas-fir, and western hemlock productivities as related to site —a panel discussion. ***In*** Utilization and management of alder. David G. Briggs, Dean S. DeBell, and William A. Atkinson, compilers. USDA For. Serv. Gen. Tech. Rep. PNW-70, p. 175-182, illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
A paper in a compendium covering all aspects of utilization and management of red alder.

79. Jeppesen, Darwin J.
1978. Competitive moisture consumption by the western juniper ***(Juniperus occidentalis)***. ***In*** Proceedings of the western juniper ecology and management workshop, Bend, Oregon, Jan. 1977. Robert E. Martin, J. Edward Dealy, and David L. Caraher, eds. USDA For. Serv. Gen. Tech. Rep. PNW-74, p. 83-90, illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Western junipers are not only strong competition for soil moisture, but they also appear to utilize much of the winter-accumulated soil moisture before herbaceous plant competition for soil moisture begins."

80. Johnson, D. W., and D. W. Cole.
1977. Sulfate mobility in an outwash soil in western Washington. Water, Air, and Soil Pollut. 7(4):489-495.
High rates of $H_2SO_4$ were applied to the forest floor and to lysimeter plates in a second-growth Douglas-fir ecosystem. Movement of the acid in the soil was slight, probably because of sulphate absorption onto soil sesquioxides. The isotherms describing sulphate adsorption suggest that it is affected by two mechanisms.

81. Johnson, D. W., D. W. Cole, S. P. Gessel, M. J. Singer, and R. V. Minden.
1977. Carbonic acid leaching in a tropical, temperate, subalpine and northern forest soil. Arctic and Alpine Res. 9(4):329-343.
It is hypothesized that the carbonic acid leaching mechanism in each ecosystem is adjusted to suit its rate of nutrient cycling and to minimize leaching losses.

82. Keener, Quentin R., and J. R. Bell.
1973. An investigation of the feasibility of a cut-bank slope design method based on the analysis of natural slopes. Proc. 11th Annu. Eng. Geol. and Soils Eng. Symp., Pocatello, Idaho, April 1973, p. 131-155, illus. Idaho Dep. Highw., Univ. Idaho, and Idaho State Univ.
"Data were collected on 79 slides along forest access roads cut in residual volcanic soils of the Umpqua National Forest located in the western Cascades of Oregon. These data were compared with a theory developed for failures in cuts made into natural slopes of such soils. The theory was substantiated by the field data and was used to develop design curves which could, in turn, be used to predict the percentage that failures may be reduced from those occurring at present."

83. Klock, G. O.
1976. Long span skyline logging reduces soil disturbances. *In* Long span skyline logging in intermountain forests, p. 41-42. Coop. Ext. Serv., Coll. Agric., Wash. State Univ., Pullman. [Wenatchee, Wash., June 1975.]
"Research has shown that logging with a long span skyline system can minimize serious soil surface disturbance, particularly on steep, unstable slopes."

84. Klock, G. O.
1976. Response of *Penstemon* fruticosus to fertilization. USDA For. Serv. Res. Note PNW-271, 4 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Greenhouse testing showed that 50 to 100 ppm nitrogen fertilization with adequate soil moisture was sufficient to provide nearly maximum growth response of bush penstemon seedlings."

85. Klock, G. O.
1979. Some effects of soil erosion on forest and range soil productivity. Agron. Abstr., p. 206. Am. Soc. Agron., Madison, Wis.
"The biological significance of erosion which can be estimated by bioassay analyses is highly dependent upon its effects on the soil-related growth factors influencing site productivity."

86. Klock, G. O.
1979. Some engineering aspects of forest soils of the Douglas-fir region. *In* Forest soils of the Douglas-fir region. Chapter 15, p. 269-277. Wash. State Univ. Coop. Ext., Pullman. (Copies of entire book for sale by Conference Office, Cooperative Extension, Washington State University, Pullman, Washington 99164.)
"Some of the basic factors involved in the engineering aspects of forest soils—including geologic, soil, and water relationships—are described."

87. Klock, G. O.
1977. Some implications of factors in soil formation on silvicultural practices. Northwest Sci. Assoc. Annu. Meet. Abstr. 93.
"Important differences in factors influencing soil formation could possibly dictate the use of different silvicultural practices in various physiographic regions."

88. Klock, G. O., and N. R. Benson.
1975. An increase in conifer seedling survival and vigor on an east Cascade slope with a soil fumigant. USDA For. Serv. Res. Note PNW-251, 5 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"In small experimental field plantings on the Wenatchee National Forest, the survival of Douglas-fir 2-0 seedlings increased from 45 to 91.9 percent after soil fumigation with methyl bromide. The vigor of both Douglas-fir and ponderosa pine seedlings also improved after fumigation. Biotic factor(s) may be restricting conifer seedling development on some east Cascade slope soils."

89. Klock, G. O., J. M. Geist, and A. R. Tiedemann.
1975. Response of orchardgrass to sulphur in sulphur-coated urea. Sulphur Inst. J. 11(3-4):4-5, illus.
"The sulphur in sulphur-coated urea, a slow release nitrogen fertilizer, was found to be available in a sufficient amount within an acceptable time period to be of value on three sulphur-deficient forest and range soils."

90. Klock, G. O., and J. D. Helvey.
1975. Some evaporation and drainage characteristics of a cindery, frigid family of typic vitrandepts. Agron. Abstr., p. 162. Am. Soc. Agron., Madison, Wis.

91. Klock, G. O., and J. D. Helvey.
1976. Debris flows following wildfire in north central Washington. *In* Proceedings of the third Federal inter-agency sedimentation conference, sedimentation committee, Denver, Colo., March 1976.
"Debris torrents during 1972 in the Entiat Experimental Forest and two adjacent watersheds are summarized by location, soil type, topography, and land use history."

92. Klock, G. O., and J. D. Helvey.
1976. Soil-water trends following wildfire on the Entiat Experimental Forest. Proc. Annu. Tall Timbers Fire Ecol. Conf. 15:193-200. Tall Timbers Res. Stn., Tallahassee, Fla.
"The autumnal soil-water content was increased by 11.6, 11.2, and 8.6 centimeters in 1971, 1972, and 1973, respectively, in the upper 120 centimeters of the soil profile with the removal of vegetation by the August 1970 wildfire on the Entiat Experimental Forest."

93. Klock, G. O., and C. Huang.
1977. Some early effects of conifer defoliation on microclimate. Agron. Abstr., p. 181. Am. Soc. Agron., Madison, Wis.

94. Klock, G. O., and T. L. Jones.
1976. Physical disturbance of soil by salvage logging in the Oregon Blue Mountains. Northwest Sci. Assoc. Annu. Meet. Abstr. 113.
A survey of the physical disturbance of soil by tractor logging salvage from Douglas-fir tussock moth-killed timber showed 17 percent of the logged area slightly disturbed, 25 percent seriously disturbed, and the remaining 58 percent undisturbed.

95. Klock, G. O., and P. D. McColley.
1979. Soil factors influencing the quality of wilderness recreation impact. *In* Proc. Recreat. Impact on Wildlands Conf., Seattle, Wash., p. 66-69.
Four dominant soil factors influencing.recreational use impact are discussed and evaluated in terms of trail location and waste disposal.

96. Klock, G. O., G. E. Warrington, and R. S. Beasley.
1978. An approach to indexing sediment delivery of forestry lands. Agron. Abstr., p. 193. Am. Soc. Agron., Madison, Wis.

97. Klock, Glen O.
1975. Impact of five postfire salvage logging systems on soils and vegetation. J. Soil and Water Conserv. 30(2):78-81, illus.
"The impact of cable skidding, tractor skidding over both bare ground and snow, skyline, and helicopter logging methods on soils and vegetation in a post-fire timber salvage operation is reported."

98. Klock, Glen O.
1976. Estimating the indirect logging costs caused by accelerated erosion. USDA For. Serv. Gen. Tech. Rep. PNW-44, 9 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"In forest areas where high soil erosion potential exists, a comparative yarding cost estimate, including the indirect costs determined by methods proposed in this report, shows that the total cost of using 'advanced' logging methods may be less than that of 'traditional' systems."

99. Klock, Glen O.
1976. Forest and range soils research in Oregon and Washington—A bibliography with abstracts from 1969 through 1974. USDA For. Serv. Gen. Tech. Rep. PNW-47, 36 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"A bibliography with annotations supplementing bibliographies by Tarrant for 1956 through 1963 and by Klock for 1969 through 1974."

100. Klock, Glen O., Arthur R. Tiedemann, and William Lopushinsky.
1975. Seeding recommendations for disturbed mountain slopes in north central Washington. USDA For. Serv. Res. Note PNW-244, 8 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Many native and introduced plant species were tested for their ability to become established on highly disturbed soils on upper elevation slopes in north central Washington. Latar orchardgrass, drummond timothy, perennial ryegrass, manchar smooth brome, and tall fescue proved to be the best adapted species. A starter fertilizer treatment is essential for successful plantings."

101. Klock, Glen O., and Boyd E. Wickman.
1978. Ecosystem effects. *In* the Douglas-fir tussock moth: A synthesis. U.S. Dep. Agric. Tech. Bull. 1585, p. 90-95. Washington, D.C.
A state of knowledge review on the effects of Douglas-fir tussock moth impacts on the hydrology, nutrient distribution, and vegetative structure and composition of forest stands.

102. Li, C. Y.
1978. Soil fatty acids under alder, conifer, and mixed alder-conifer stands of coastal Oregon. Soil Sci. 125(2):92-94.
"Total soil lipid contents among alder, conifer, and mixed alder-conifer stands near the Oregon coast did not differ significantly. The lipids contained a number of fatty acids ranging in carbon-chain length from 12 (lauric acid) to 24 (lignoceric acid). Concentration levels of several fatty acids differed significantly among stands. Lignoceric acid was highest in conifer soil, palmitic acid in alder soil, and lauric acid in mixed alder-conifer soil.

103. Lopushinsky, W.
1975. Water relations and photosynthesis in lodgepole pine. *In* Management of lodgepole pine ecosystems symposium proceedings, p. 135-153, illus. David H. Baumgartner, ed. Wash. State Univ. Coop. Ext. Serv., Pullman.
"Transpiration rate in lodgepole pine seedlings is moderate to high, decreases greatly with soil drought, and is very low at night. Stomata close at a relatively high leaf water potential, and closure is complete at night. Resistance to drought is moderate, and tolerance to saturation is high. Lodgepole has been reported to have a higher rate of photosynthesis than Engelmann spruce, Austrian pine, and mountain beech, but a lower rate than monterey pine. Light saturation occurs at high light intensities, and photosynthesis reportedly ceases at a root zone osmotic potential of − 9 atmospheres."

104. Lopushinsky, W., and T. Beebe.
**1976.** Effect of black polyethylene mulch on survival of Douglas-fir seedlings, soil moisture content, and soil temperature. Tree Plant. Notes **27(3):7-8.**
"Black polyethylene mulch around **2-0** Douglas-fir seedlings planted on pumice soils in eastern Washington increased first-year survival **14** percent. No consistent differences in soil moisture content were found in mulched and unmulched planting spots. Soil temperature under mulch at a depth of **6** inches **(15.2** cm) was **2.7** degrees F **(1.5** degrees C) higher than at the same depth at unmulched spots."

**105.** Lopushinsky, William.
**1978.** Effects of low soil temperature on water relations of Douglas-fir seedlings. (Abstr.) Proc. 5th North Am. For. Biol. Workshop, p. **416-417.** Soc. Am. For. in coop. with Sch. For. Resour., Univ. Fla., and USDA For. Serv. Southeast. For. Exp. Stn.

**106.** McCorison, **F.** M., D. G. Moore, and L. F. Glenn.
**1976.** Dissolved nutrients in throughfall precipitation and litter leachate in a Douglas-fir forest ecosystem. Agron. Abstr., p. **186.** Am. Soc. Agron., Madison, Wis.
"Transfer of the dissolved nutrients, N, P, Ca, Mg, Na, and K, between compartments is examined for two ecological habitat types on a small experimental watershed. Data were collected for three compartments, incident precipitation, throughfall precipitation, and forest floor leachate over a 30-month period. Even though the sites were separated by less than **300** meters horizontally and **70** meters vertically, statistically significant differences were found for nearly all variables."

**107.** McNabb, D. **H.**
**1979.** Correlation of soil plasticity with amorphous clay constituents. Soil Sci. Soc. Am. Jour. **43(3):613-616.**
"The percentage of amorphous constituents removed from the clay size fraction of western Oregon soils by kinetic dissolution was significantly correlated with soil plasticity."

**108.** McNabb, D. **H.,** and J. M. Geist.
**1979.** Acetylene reduction assay of symbiotic $N_2$ fixation under field conditions. Ecology **60(5):1070-1072.**
"Describes field methodology for estimating nitrogen fixation rates using acetylene reduction assay where acetylene is used as an internal standard."

**109.** McNabb, D. **H.,** and J. M. Geist.
**1979.** Nitrogen fixation potential of native lupines in western conifer ecosystems. Agron. Abstr., p. **217.** Am. Soc. Agron., Madison, Wis.
"This paper addresses effects of nodule biomass persistence and quantity, moisture supply, temperature, and length of growing season on annual fixation potential of four lupine species."

**110.** McNabb, D. **H.,** J. M. Geist, and C. T. Youngberg.
**1977.** Nitrogen fixation by Ceanothus velutinus in northeastern Oregon. Agron. Abstr., p. **127-128.** Am. Soc. Agron., Madison, Wis.
Periodic measurements of acetylene reduction by *ceanothus* root nodules were made in an **11**-year-old stand. The annual contribution to the nitrogen budget was estimated to be **32** kilograms N per hectare. Late season acetylene reduction rate was significantly correlated with plant moisture stress **($R^2$ = 0.66).**

**111.** McNabb, D. **H.,** J. M. Geist, and C. T. Youngberg.
**1979.** Nitrogen fixation by Ceanothus velutinus in northern Oregon. (Abstr.) In Symbiotic nitrogen fixation in the management of temperate forests, p. **481-482.** For. Res. Lab., Oreg. State Univ., Corvallis.
"Research on the nitrogen fixing potential of snowbrush in northeastern Oregon showed an annual addition of **32** kilograms N per hectare. The shrub stand had an estimated above ground biomass of **6 560** kilograms per hectare and a nodule biomass of **147** kilograms per hectare."

**112.** Mallonee, **E. H.,** and R. F. Strand.
**1976.** Seven-year growth response of young Douglas-fir plantations following thinning and urea fertilization. For. Res. Note **6, 8** p. Crown Zellerbach, Camas, Wash.
"Describes a study of the effects of chemical thinning, and rate of N application in relation to site quality in two Pseudotsuga rnenziesii plantations, **15** and **24** years old. The basal area increment response averaged **42%** over the 7-year study. It was greater per lb of N at applications of **200** lb urea N/acre than at **400** lb urea N/acre. The response to fertilizer was greater on the better sites and in the older plantation."

**113.** Miller, R. E., and H. W. Anderson.
**1978.** Urea and biuret stimulate growth of Douglas-fir and western hemlock seedlings. Agron. Abstr., p. **191.** Am. Soc. Agron., Madison, Wis.
"Two experiments were conducted in a glasshouse to support or allay a concern that biuret in urea fertilizer may reduce growth of Douglas-fir or western hemlock. The results indicate that biuret is unlikely to reduce growth of seedlings of either species—and probably not of older stands under field conditions—even when heavily contaminated urea is applied at high dosage."

114. Miller, Richard E.
1976. Effects of fertilization on mortality in western hemlock and Douglas-fir stands. Proc. West. Hemlock Conf., p. 253-265. Coll. For. Resour., Univ. Wash., Seattle.
"Reviews published and unpublished data to determine if fertilizer could be a tool for thinning pure or mixed stands of hemlock and Douglas-fir. Concludes the main potential benefit from conventional fertilizer dosages is increased stand growth. The increased rate of suppression mortality which is likely to accompany accelerated growth is a contributing benefit."

115. Miller, Richard E.
1978. The effects of red alder on growth of Douglas-fir. *In* Utilization and management of alder. David G. Briggs, Dean S. DeBell, and William A. Atkinson, compilers. USDA For. Serv. Gen. Tech. Rep. PNW-70, p. 283-306. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
Maintaining red alder in Douglas-fir stands can increase merchantable yields on nitrogen-deficient sites.

116. Miller, Richard E., and Roger D. Fight.
1979. Analyzing forest fertilization: Study evaluates costs, benefits. For. Ind. (Sept.), p. 60-62.
"Factors affecting the costs of and revenues from forest fertilization are discussed. The present net worth and benefit/cost ratios for fertilizing immature and mature stands of Douglas-fir are estimated."

117. Miller, Richard E., and Roger D. Fight.
1979. Fertilizing Douglas-fir forests. USDA For. Serv. Gen. Tech. Rep. PNW-83, 29 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Part I of the report describes the current practice of fertilizing Douglas-fir forests in western Washington and Oregon and the effects of this nitrogen fertilization on tree growth and water quality. Part II discusses factors that affect costs and revenues from investment in forest fertilization. The appended tables, figures, and worksheets enable the user to prepare a break-even economic anlaysis for fertilization projects."

118. Miller, Richard E., and Constance A. Harrington.
1979. Response to urea and ammonium nitrate fertilization in an 80-year-old Douglas-fir stand. USDA For. Serv. Res. Note PNW-330, 5 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Volume growth response to 200 pounds of nitrogen per acre applied as urea or ammonium nitrate was monitored for 4 years in an 80-year-old, site 1, Douglas-fir stand. Fertilization increased gross total cubic growth by 20 percent over the controls. Response to urea and to ammonium nitrate was similar."

119. Miller, Richard E., Denis P. Lavender, and Charles C. Grier.
1976. Nutrient cycling in the Douglas-fir type-silvicultural implications. Proc. Soc. Am. For. 1975:359-399, illus.
"Nutrient cycling in a young- and an old-growth forest is described. Rapid decomposition of forest residues is desirable because recycled nutrients supply a large portion of the stands requirements. Silvicultural practices can affect nutrient cycling by removing or adding nutrients or by altering rates of organic matter decomposition through changes in soil environment or quantity and quality of organic matter returned to the soil."

120. Miller, Richard E., and Marshall D. Murray.
1979. Fertilizer versus red alder for adding nitrogen to Douglas-fir forests of the Pacific Northwest. *In* Symbiotic nitrogen fixation in the management of temperate forests—proceedings of a workshop, April 2-5, 1979, p. 356-373. J. C. Gordon, C. T. Wheeler, and D. A. Perry, eds. Oreg. State Univ., Corvallis.
"Seven possible silvicultural options for supplying additional nitrogen to intensively managed Douglas-fir forests are described. Conventional fertilization with repeated applications of urea is compared to several crop rotation and mixed stand options using red alder. Our preliminary analysis indicates that using red alder in some options may be a practical silvicultural alternative to urea fertilizer. Specific research studies are suggested to clarify or improve the feasibility of using $N_2$- fixing plants to increase amounts of available N in Northwest forests."

121. Miller, Richard E., and Donald Reukema.
1977. Urea fertilizer increases growth of 20-year-old, thinned Douglas-fir on a poor quality site. USDA For. Serv. Res. Note PNW-291, 8 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"In 20-year-old, site V Douglas-fir in southwest Washington, fertilizing with nitrogen increased average 5-year diameter and height growth of concurrently released dominant trees by about 85 percent. Thinning alone in this moderately stocked plantation reduced height by about 25 percent."

122. Miller, Richard E., and Steve Wert.
1979. Effects of soil and foliar applications of nitrogen fertilizers on a 20-year-old Douglas-fir stand. USDA For. Serv. Res. Note PNW-329, 12 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

Comparisons were made between growth and cone production of Douglas-fir treated 4 years earlier with 150 pounds N per acre applied as urea prill by hand and as a 32-percent N solution applied by helicopter. "Nitrogen fertilization increased growth by 88 cubic feet per acre during the 4 years after treatment; this 35-percent gain was similar for both soil (prill) and foliar (solution) applications. Although cone production on the prill-treated plots averaged twofold to fourfold greater than on the control plots, these differences were not statistically significant."

123. Miller, Richard E., and Donald C. Young.
1976. Forest fertilization: Foliar application of nitrogen solutions proves efficient. Fert. Solutions 20(2):36, 40, 42, 44, 46, 59-60, illus. Natl. Fert. Solutions Assoc., Peoria, Ill.

"Forest fertilization in the United States, with particular emphasis in the Pacific Northwest, is reviewed."

124. Miller, Richard E., and Ray Zalunardo.
1979. Long-term growth of eight legumes introduced at three forest locations in southwest Oregon. USDA For. Serv. Res. Pap. PNW-255, 12 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

"Eight nitrogen-fixing legume cultivars were screened for suitability in Douglas-fir forests of southwest Oregon. The legumes were sown on concurrently fertilized and unfertilized plots within deer exclosures in three logged and burned clearcuts. Percent cover after the first and during the ninth growing season was clearly greater on 2- by 2-meter plots sown with alfalfa, crownvetch, and birdsfoot deervetch (trefoil) than with wetland deervetch, perennial lupine, annual lupine, flatpea, or hairy vetch."

125. Minore, Don.
1975. Comparative intolerance of lodgepole pine and thin-leaved huckleberry to boron and manganese. USDA For. Serv. Res. Note PNW-253, 6 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

"Lodgepole pine and thin-leaved huckleberry seedlings were treated with several levels of boron and manganese in the greenhouse. Huckleberry was less tolerant of excess boron than was lodgepole pine. Both species tolerated excess manganese. Further testing of these micronutrients to favor huckleberry and eliminate lodgepole pine is not recommended."

126. Minore, Don, and Richard E. Carkin.
1978. Vegetative indicators, soils, overstory canopy, and natural regeneration after partial cutting on the Dead Indian Plateau of southwestern Oregon. USDA For. Serv. Res. Note PNW-316, 9 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

"Natural regeneration in partially cut stands on the dead Indian Plateau east of Ashland, Oregon, varies with soil nitrogen. Overstory canopy and associated vegetation were used to calculate a predictive equation to identify problem areas before logging. Management recommendations are listed.".

127. Molina, Randy.
1979. Pure culture synthesis and host specificity of red alder mycorrhizae. Can. J. Bot. 57(11):1223-1228.

'Cultures of 28 ectomycorrhizal fungi were tested in pure culture syntheses for mycorrhiza formation with red alder. Only 4 of the 28 fungi tested formed characteristic ectomycorrhizae: ***Alpova diplophloeus, Paxillus involutus, Astraeus pteridis,*** and ***Scleroderma hypogaeum.*** These mycorrhizae are briefly described, and the specialization of alder mycorrhizae is discussed."

128. Moore, D. G., F. M. McCorison, and L. F. Glenn.
1976. Extractable soil nutrients in the rooting zone of a Douglas-fir forest ecosystem. Agron. Abstr., p. 188. Am. Soc. Agron.

"Soil core samples were collected at 3-week intervals for 2 years from two sites representative of the extreme environmental watershed in terms of moisture and temperature gradients. Observed differences in nutrient cycling patterns were small. The same soil processes are active on both sites, but they proceed at different rates due to relatively slight differences in moisture, temperature, and vegetation."

129. Moore, D. G., L. A. Norris, and B. R. Loper.
1977. DDT residues on vegetation and forest floor materials in eastern Oregon and Washington and northern Idaho—1974-1975. Northwest Sci. Assoc. Annu. Meet. Abstr. 83.

"Dissipation of DDT residues from the forest was monitored on five spray project units in Oregon, Washington, and Idaho following the 1974 Douglas-fir tussock moth control project. Residues decreased at varying rates to approximately 1 percent, 9 percent, and 36 percent of the initial concentrations in the subvegetation, crown foliage, and forest floor 1 year after application."

130. Moore, Duane G.
1975. Effects of forest fertilization with urea on stream water quality—Quilcene Ranger District, Washington. USDA For. Serv. Res. Note PNW-241, 9 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Aerial fertilization of forested watershed with urea at 224 kilograms nitrogen per hectare (200 pounds nitrogen per acre) resulted in some fertilizer nitrogen entering surface streams. However, maximum concentrations measured were well below established permissible limits for public water supplies. Because quantities of nitrogen entering affected streams were small, significant impacts on the aquatic environment are unlikely."

131. Moore, Duane G.
1975. Impact of forest fertilization on water quality in the Douglas-fir region—a summary of monitoring studies. *In* Forestry issues in urban America. Proc. Soc. Am. For. 1974:209-219, illus.
"Federal and state agencies and private industry have conducted a number of monitoring studies to measure nitrogen residues in forest streams after operational forest fertilization in the Pacific Northwest. These studies, covering a wide range of environmental conditions, indicate that while some nitrogen is carried away in streamflow, maximum concentrations do not approach unacceptable levels."

132. Moore, Duane G., and Logan A. Norris.
1979. Forest chemicals in watershed management. *In* Forest soils of the Douglas-fir region. Chapter 14, p. 261-268. Wash. State Univ. Coop. Ext., Pullman. (Copies of entire book for sale by Conference Office, Cooperative Extension, Washington State University, Pullman, Washington 99164.)
Discusses factors influencing chemical behavior in forest soils and the movement, persistence, fate and impact of introduced chemicals on the environment.

133. Mosher, M. M.
1975. Irrigation and fertilization of 90-year-old ponderosa pine in northeastern Washington. Coll. Agric. Res. Cent. Wash. State Univ. Bull. 807, 9 p.
The diameter of ponderosa pine was significantly increased by the annual application of 12 inches of water during the growing season for a period of 10 years. Cone production was significantly increased by fertilization and by irrigation plus fertilization, but not by irrigation alone.

134. Mullen, V. J., R. E. Pacha, and R. F. Lapen.
1976. Effect of livestock on the microbiological quality of forest surface water. Northwest Sci. Assoc. Annu. Meet. Abstr. 108.
"The effect of cattle grazing on the microbiological quality of mountain streams was studied by weekly summer monitoring of grazed and ungrazed watersheds."

135. Munson, K. R., J. M. Trappe, and B. Zak.
1978. Mycorrhizal response of conifer seedlings to medium pretreatment, fertilizer and fungal inoculation. Agron. Abstr., p. 191. Am. Soc. Agron., Madison, Wis.
"Steam treatment of container mix prior to mycorrhizal inoculation and low fertility levels produced the best mycorrhiza formation on Douglas-fir, ponderosa pine, and western hemlock seedlings. Of four fungi inoculated, *Hebeloma crustuliniforme* was most effective in colonizing root systems."

136. Nelson, E. E.
1975. Survival of *Poria weirii* in wood buried in urea-amended forest soil. Phytopathology 65(4):501-502.
"*Poris weirii* failed to survive in buried wood cubes when urea was mixed with the surrounding soil or broadcast on the soil surface. Survival was closely associated with zone lines formed inside the cubes. If urea similarly can reduce survival of the fungus in colonized roots of stumps and dead trees, it could be an effective control of *P. weirii* on harvested forest lands."

137. Nelson, E. E.
1976. Effect of urea on *Poria weirii* and soil microbes in an artificial system. Soil Biol. and Biochem. 8(1):51-53, illus.
"Survival of *Phellinus (Poria) weirii* in buried wood was reduced when urea was mixed with soil. Populations of *Trichoderma* increased rapidly after 8 weeks with urea and usually replaced *P. weirii* in the wood. Populations of soil microbes and nitrogen levels were also compared to amount of applied urea."

138. Nelson, Earl E.
1975. Survival of *Poria weirii* on paired plots in alder and conifer stands. Microbios 12:155-158, illus.
"Survival of *Poria weirii* in wood cubes, and chemical and biological soil factors were compared on 12 paired plots in pure alder and pure conifer stands. Survival was not significantly different, but nitrate content was significantly higher and pH significantly lower on alder plots."

139. Nnyamah, J. U., T. A. Black, and C. S. Tan. Resistance to water uptake in a Douglas-fir forest. Soil Sci. 126(2):63-76.
Comparative measurement of soil water potential, root xylem water potential, twig xylem pressure potential, root density and transpiration rates were made between thinned and unthinned stands of Douglas-fir on Vancouver Island, British Columbia.

140. Norris, L. A., M. L. Montgomery, and Fred Gross. 1976. The behavior of picloram and 2,4-D in soil on western powerline rights-of-way. Weed Sci. Soc. Am. Annu. Meet. Abstr. p. 9-10.
"Picloram and 2,4-D show a rapid decline in concentration in soil after their application to powerline rights-of-way in Oregon and Washington. Biologically significant residues were seldom present for more than 12 months after application."

141. Norris, L. A., M. L. Montgomery, and E. R. Johnson. 1975. Residues of 2,4,5-T in the forest. Weed Sci. Soc. Am. Annu. Meet. Abstr., p. 23.
"Samples of vegetation, forest floor material, and soil were examined for 2,4,5-T residues after aerial application of this herbicide to forest land. Highest concentrations in all portions of the environment occurred immediately after application. Residue levels fell sharply in the first 30 days after application. Only negligible residues persisted 1 year after application."

142. Norris, L. A., M. L. Montgomery, and E. R. Johnson. 1977. The persistence of 2,4,5-T in a Pacific Northwest forest. Weed Sci. 25:417-422.
"Concentrations of 2,4,5-T in four species of vegetation varied from 11 to 115 ppm by weight immediately after application at 2.24 kglha but were less than **0.5** ppm after 1 year. The 2,4,5-T level in forest floor declined 90 percent during the first 6 months after application and less than 0.02 kglha remained after 1 year. There was little leaching of 2,4,5-T from the forest floor into soil and no residues were found deeper than 15 cm. Maximum soil residues did not exceed 0.1 ppm. Residues levels and dissipation rates of 2,4,5-T were similar after one and two successive annual applications."

143. Norris, L. A., M. L. Montgomery, and G. D. Savelle. 1976. Behavior of triclopyr in soil and stream water on a small watershed, southeast Oregon. Weed Sci. Soc. Am. Annu. Meet. Abstr., p. 36.
"Less than 0.1 percent of the triclopyr applied to a small watershed was recovered in stream water in the 1st year after application. Virtually the entire discharge occurred in the first 4 months after application. Triclopyr residues were largely confined to the top 15 cm of soil with close to 90 percent in the top **5** cm."

144. Norris, L. A., M. L. Montgomery, and L. E. Warren. 1976. Leaching and persistence characteristics of picloram and 2,4-D on a small watershed in southwest Oregon. Weed Sci. Soc. Am. Annu. Meet. Abstr., p. 35-36.
"Herbicide residues in soil decline steadily with time after application. About 0.3 percent of the picloram applied to the watershed was lost in streamflow but virtually no loss of 2,4-D occurred."

145. Norris, Logan A., Paul R. Canutt, and John F. Neuman. 1977. Arsenic in the forest after chemical thinning. Weed Sci. Soc. Am. Annu. Meet. Abstr. 117.
"Arsenic concentrations increased in vegetation but were not toxicologically important. Arsenic residues increased and then decreased with little change occurring in the arsenic content of underlying mineral soil. Stream water did not contain detectable concentrations of arsenic."

146. Olson, John, William Atkinson, and Michael Rineheart.
1980. Radial increment response of western hemlock to nitrogen fertilization and thinning. Reg. For. Nutr. Res. Proj. Inst. For. Resour. Tech. Rep., 9 p., Univ. Wash.
Average response of western hemlock to N fertilization is low over a wide range of geographical and environmental conditions.

147. Paustian, Steven J., and Robert L. Beschta. 1979. The suspended sediment regime of an Oregon Coast Range stream. Water Resour. Bull. 15(1): 144-154.
Armored stream sediments may affect the suspended sediment regime of small mountain streams in western Oregon by the release of fine sediments stored in the bed gravels.

148. Radwan, M. A., and D. S. DeBell. 1977. Growth and foliar nitrogen and chlorophyll contents of western hemlock in relation to site index. Agron. Abstr., p. 183. Am. Soc. Agron., Madison, Wis.
Site productivity may be improved by cultural treatments that enhance N and chlorophyll content of needles.

149. Radwan, M. A., and D. S. DeBell. 1978. Effects of fertilizer in source on growth and nutrition of western hemlock seedlings. Northwest Sci. Assoc. Annu. Meet. Abstr., p. 30.
Fertilization greatly increased chlorophyll level and more than doubled total N content in the foliage. Ca and **P** concentrations were lower in the fertilized than in untreated seedlings.

150. Radwan, M. A., and D. S. DeBell.
1978. Foliar mineral content of western hemlock in relation to growth and site index. (Abstr.) Proc. 5th North Am. For. Biol. Workshop. p. 419-420. Soc. Am. For. in coop. with Sch. For. Resour., Univ. Fla., and USDA For. Serv. Southeast. For. Exp. Stn.

151. Radwan, M. A., and D. S. DeBell.
1978. Relationships between site index, growth and foliar chemical composition of western hemlock. Northwest Sci. Assoc. Annu. Meet. Abstr., p. 35.

152. Radwan, M. A., John S. Shumway, and Dean S. DeBell.
1979. Effects of manganese and manganese-nitrogen applications on growth and nutrition of Douglas-fir seedlings. USDA For. Serv. Res. Pap. PNW-265, 12 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Effects of manganese (Mn) on Douglas-fir grown in soil, with and without urea, and in nutrient solution was investigated. In addition, Mn sorption by forest soils was evaluated. Results show that Dougls-fir does not respond to added Mn and is quite tolerant to high Mn levels. Moreover, Mn sorption by soils is high."

153. Rains, D. W., and C. S. Bledsoe.
1976. The effects of Douglas-fir seedlings on the transfer of nutrients through soil columns. Plant and Soil 44(1):97-112.
"Describes laboratory studies in Washington on the movement of ions through soil columns fitted with suction lysimeter plates and either planted with three 6-month-old *Pseudotsuga menziesii* seedlings or unplanted. The pH, alkalinity, conductivity and cation composition of the leachates were determined as a function of time under two temperature regimes and estimates were made of nutrient uptake and water loss. It is suggested that comparison of values derived by this model with field data should clarify the process of nutrient cycling in coniferous ecosystems."

154. Rickard, W. H.
1975. Litterfall in a Douglas-fir forest near the Trojan nuclear power station, Oregon. Northwest Sci. 49(4):183-189.
"Tabulates the weight, mineral nutrient content and seasonal incidence of the litter fall (totaling 3.43 t/ha/year) by litter type (needles, broad leaves, cones, twigs, and miscellaneous) in a second-growth stand dominated by *Pseudotsuga menziesii,* with a few *Acer macrophyllum* and *Quercus garryana* and an understory mainly of deciduous shrubs, from May 1972 to Dec. 1973."

155. Riekerk, H.
1977. Utilization of a root pressure chamber for nutrient uptake studies. Plant and Soil 46(1):279-282.
"A root-pressure chamber is described which causes exudation of xylem sap from soil/root systems at relatively high moisture tensions (over 0.5 atm)."

156. Shumway, J. S., and W. A. Atkinson.
1977. Measuring and predicting growth response in unthinned stands of Douglas-fir by paired tree analysis and soil testing. Dep. Nat. Resour. CNR Notes 15, 10 p. Olympia, Wash.
Growth was compared between trees of the same diameter in different treatments. Fertilizer application resulted in a significant growth response in 4 of the 6 plots. Growth response was significantly correlated with ammonium production and ammonium content (after anaerobic incubation) in soil samples from 0-30 cm but not in samples from 30-60 cm and when ammonium content was less than 46 ug/g or ammonium production less than 36 uglg. Both variables appear to predict growth response better than total N.

157. Singer, M. J., and F. C. Ugolini.
1976. Hydrophobicity in the soil of Findley Lake, Washington. For. Sci. 22(1):54-58.
"Reports studies on sub-alpine soils from a 260-ha unmanaged catchment area of Washington, unburned for 200 years and supporting old-growth *Tsuga heterophylla, T. mertensiana* and *Abies amabilis.*"

158. Smith, R. B., and E. F. Wass.
1976. Soil disturbance, vegetative cover and regeneration on clearcuts in the Nelson forest district, British Columbia. Pac. For. Res. Cent. Can. Rep. BC-X-151, 37 p.
"Summer ground skidding caused the greatest amount of soil disturbance, most of which was related to road construction; ground skidding on snow, high-lead cable systems and grapple yarding caused about half as much disturbance. The skyline clearcut sampled caused the least soil disturbance. Severe disturbances were associated mainly with road systems."

159. Smith, R. M., B. L. McNeal, and G. O. Klock.
1978. Effects of conifer defoliation on levels of extractable nutrients in forest floor and underlying soil. Agron. Abstr., p. 193. Am. Soc. Agron., Madison, Wis.
"Immediate increases in N, P, K, Ca, and Mg contents of the forest floor were measured after defoliation."

160. Sorensen, Frank C., and Robert K. Campbell.
1978. Comparative roles of soil and air temperatures in the timing of spring bud flush in seedling Douglas-fir. Can. J. Bot. 56(18):2307-2308.
"Outdoor cold frame tests in which air and soil temperatures were modified showed both to be involved in the timing of spring bud flush. Warming the soil advanced the date of growth initiation and warming the air increased the rate of bud development once initiated. The latter had a 5.70:9.45 greater effect per degree celsius change in temperature."

161. Swanson, F. J., and C. T. Dyrness.
1975. Impact of clear-cutting and road construction on soil erosion by landslides in the western Cascade Range, Oregon. Geology 3(7):393-396, illus.
"H. J. Andrews Experimental Forest can be divided into two zones of erosion by rapid soil mass movements. A stable zone above the 1000-m level, underlain by lava flow bedrock, has had two small road-related slides, while in the unstable zone located at elevations below 1000 m and underlain by altered volcaniclastic rock, 139 road-related slides have occurred. Combined management impacts in the unstable zone appear to have increased slide activity on roads of clearcut sites about five times relative to forested area over a 20-year period."

162. Swanson, F. J., C. T. Dyrness, and R. L. Fredriksen.
1975. Landslides in the H. J. Andrews Experimental Forest, western Cascades, Oregon. Northwest Sci. Annu. Meet. Abstr. 75.
"The H. J. Andrews Experimental Forest can be divided into two zones of strikingly different susceptibility to rapid soil mass movements. Clearcut logging and road construction in the unstable zone appear to have increased slide activity by nearly five times."

163. Swanson, F. J., D. N. Swanston, and F. M. McCorison.
1976. Mass erosion processes in forested western Oregon watersheds. Cordilleran Sect. 72d Annu. Meet., Abstr. Prog. 8(3):414. Geol. Soc. Am.
"The interrelated mass movement processes of creep, earthflow, and debris avalanches have been the dominant landscape forming processes in the recent history of mountainous terrain in western Oregon. Periodic deforestation of a landscape, whether it be a man-influenced change or a natural event such as wildfire, appears to temporarily accelerate the rate of creep and earthflow movement and the frequency of debris avalanches. Different types and intensities of forest disturbance accelerate the erosion to varying degrees."

164. Swanson, Frederick J., and Michael E. James.
1975. Geology and geomorphology of the H. J. Andrews Experimental Forest, western Cascades, Oregon. USDA For. Serv. Res. Pap. PNW-188, 14 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"The geology of the H. J. Andrews Experimental Forest is essentially comprised of upper miocene and pliocene lava flows overlying older, altered volcanic rocks. The present landscape has been carved during the past 4 million years by glacial, fluvial, and mass movement processes. The occurrence of both deep-seated and shallow mass movements is controlled by bedrock geology."

165. Swanson, Frederick J., and Douglas N. Swanston.
1977. Complex mass-movement terrains in the western Cascade range, Oregon. Rev. Eng. Geol. 3:113-124. Geol. Soc. Am.
"Creep rates range from nearly imperceptible to 15 millimeters per year. Relative movement between earthflow blocks ranges up to 10 centimeters per year. Movement is regulated by moisture availability; bedrock determines the distribution and morphology of mass movement landforms. Mass movement terrains supply large quantities of sediment and large organic debris to streams and may substantially alter channel geometry. Such impacts are long term. Individual inputs of sediment into a stream may occur as infrequent pulses during major storm events. But the total history of most mass movement terrains has spanned centuries and possibly millennia."

166. Swanston,. D. N.
1975. Interpreting stability problems for the land manager. *In* New requirements in forest road construction, p. 147-176. Proc., Symp. sponsored by B.C. Prof. For. and Univ. B.C.
"Understanding mass wasting processes and controlling and contributing factors is essential to effective identification, prediction, and control of soil mass movements on forest lands. Soil processes are the product of the interaction between slope gradient, soil water content, basic soil properties, and the modifying influences provided by vegetation cover and rooting distribution. Once the land manager understands these interactions he can identify and avoid problem areas or attempt to control operational effects."

167. Swanston, Douglas N.
1975. Guidelines for characterizing naturally unstable or potentially unstable slopes on western National Forest. *In* New requirements in forest road construction, p. 122-136. Proc., Symp. sponsored by B. C. Prof. For. and Univ. B.C.
"Six environmental qualities should be given careful consideration in judging stability of natural slopes in terms of surface erosion and mass soil movement. Each of these qualities encompasses a group of factors which control stability conditions on the slope and determine or identify the type of processes and movements which are most likely to occur."

168. Swanston, Douglas N.
1976. Erosion processes and control methods in North America. Proc., 16th IUFRO World Congr., Div. 1, p. 251-285, illus.
"The primary links in the natural transport of soil material to streams from steep forested slopes are described and monitored rates of movement reported. The impacts of forest operations on these processes are summarized and viable control techniques available to the land manager are discussed."

169. Swanston, Douglas N.
1977. Prediction, prevention, and control of landslides on mountainous forest lands. Proc. Semin. Watershed Manage., Pakistan, Sept. 1977, p. 226-249, illus.
"Soil creep, slump-earthflows, debris avalanches, and debris torrents are the major erosion processes operating on mountainous forest land and function as primary links in the natural transport of soil material to streams. Timber harvest and road construction accelerate these processes by destroying the stabilizing influence of vegetation cover, altering the hydrologic regime of the site, and interrupting the balanced strength-stress relationships existing under natural conditions."

170. Swanston, Douglas N.
1978. Effect of geology on soil mass movement activity in the Pacific Northwest. *In* Forest soils and land use, p. 89-115. Chester T. Youngberg, ed. Proc. 5th North Am. For. Soils Conf., Colo. State Univ., Fort Collins.
"The effects of bedrock type, structure, and geomorphic process on soil mass movement occurrence in the Pacific Northwest are major. Knowledge of these effects and their impact provide a means of estimating the probable failure mechanisms, the engineering properties of soils, and the general hazard from proposed activities. These effects and their use for land management decisionmaking are discussed."

171. Swanston, Douglas N., and Frederick J. Swanson.
1976. Timber harvesting, mass erosion, and steepland forest geomorphology in the Pacific Northwest. *In* Geomorphology and engineering, p. 119-221. Donald R. Coates, ed. Dowden, Hutchinson L. Ross, Inc., Stroudsburg, Pa.
"Creep, slump-earthflows, debris avalanches, and debris torrent function as primary links in the natural transport of soil material to streams in the Pacific Northwest. Forest operations accelerate these processes resulting in reduced productivity of forest soils, damage to roads, bridges, and other structures and adverse impacts on the stream environment for many kilometers downstream."

172. Tasky, R. D., M. E. Harward, and C. T. Youngberg.
1978. Relationship of clay mineralogy to landscape stability. *In* Forest soils and land use, p. 140-164. C.T. Youngberg, ed. Proc. 5th North Am. For. Soils Conf., Colo. State Univ., Fort Collins.

173. Tiedemann, A. R., J. D. Helvey, and T. D. Anderson.
1976. Nutrient economy of three watersheds after wildfire and erosion control fertilization. Northwest Sci. Assoc. Annu. Meet. Abstr. 111.
"Results from 4 years of study after a wildfire and fertilization with ammonium sulfate and urea indicate that fire and fertilization exerted negligible effects on chemical water quality and potential site productivity."

174. Tiedemann, A. R., J. D. Helvey, and T. D. Anderson.
1978. Stream chemistry and watershed nutrient economy following wildfire and fertilization in eastern Washington. J. Environ. Qual. 7(4):580-588.
"During 5 years following wildfire in 1970, fertilization with ammonium sulfate and urea increased maximum nitrate-N in streamflow from prefire levels of 3.829 to 1.47 mg/liter. Average N loss in solution increased from 0.07 kglha per year in 1970 to 3.35 kglha per year in 1972. By 1975, maximum nitrate-N concentration was 0.34 mg/liter and average loss was 0.90 kglha per year. Average combined concentration of Ca, Mg, N, and K decrease from 14 mg/liter in 1970 to 9 mg/liter in 1972, but average solution losses increased from 19.5 to 60.6 kglha per year. In 1975, concentration of the four cations was 11 mg/liter and losses were 42.6 kglha per year. Average inputs of total-N and the four cations in precipitation were 1.38 and 4.62 kglha per year, respectively."

175. Tiedemann, A. R., and Glen O. Klock.
1976. Development of vegetation after fire, seeding, and fertilization on the Entiat Experimental Forest. Proc. Annu. Tall Timbers Fire Ecol. Conf. 15:171-192. Tall Timbers Res. Stn., Tallahassee, Fla.
"By the end of the 4th year of study on four watersheds burned by wildfire, 31 percent of the ground was covered by foliage. Seeding improved vegetative cover by one-fourth to one-third. Fertilizer did not improve vegetal cover but increased height growth and improved vigor of seeded species. These plants should thus be more effective in soil binding and nutrient recapture."

176. Tiedemann, A. R., W. Lopushinsky, and H. J. Larsen, Jr.
1978. Plant' and soil responses to a commercial algae inoculant. Am. Assoc. Advance. Sci. Annu. Meet., Pac. Div., Abstr., p. 27.

177. Tiedemann, Arthur R., and Glen O. Klock.
1977. Meeks Table Research Natural Area—reference sampling and habitat classification. USDA For. Serv. Res. Pap. PNW-223, 19 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Studies of vegetation cover and composition and physical and chemical characteristics of soil indicate the presence of three shrub-grass and two forested communities on Meeks Table Research Natural Area. Development of these communities appears to be linked to depth of volcanic ash."

178. Tiedemann, Arthur R., Glen O. Klock, L. L. Mason, and D. E. Sears.
1976. Shrub plantings for erosion control in eastern Washington—progress and research needs. USDA For. Serv. Res. Note PNW-279, 11 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Evaluation of survival and vigor of native shrubs planted in eastern Washington showed that blue elderberry, bush penstemon, wild rose, and serviceberry can be recommended for operational plantings. Also, bitterbrush, squaw carpet ceanothus, and snowbrush ceanothus can be used for road fill-slope situations where ravelling does not cover plants."

179. Trappe, James M., and Walter B. Bollen.
1979. Forest soil biology. *In* Forest soils of the Douglas-fir region. Chapter 8. p. 145-155. Wash. State Univ. Coop. Ext., Pullman. (Copies of entire book for sale by Conference Office, Cooperative Extension, Washington State University, Pullman, Washington 99164.)

180. Tripp, L. N., D. F. Bezdicek, and P. E. Heilman.
1979. Seasonal and diurnal patterns and rates of nitrogen fixation by young red alder. For. Sci. 25(2):371-380.
Rates of N fixation were monitored in entire root systems of 2- to 4-year-old red alder ***(Alnus rubra)*** which had naturally seeded on coal mine spoil materials near Centralia, Washington. Average total N fixed in each season was 7.7 g/tree, and represented approximately 70 percent of the total N accumulated per season. At the stand density of the most dense sample area (8000 trees/ha), annual N fixed was 62 kglha.

181. Triska, F. J. and J. R. Sedell.
1976. Decomposition of four species of leaf litter in response to nitrate manipulation. Ecology 57(4):783-792.
Decomposition rate of leaf debris in the water did not increase when nitrate level of stream waters was increased 3-4 times.

182. Turner, J.
1977. Effect of nitrogen availability on nitrogen cycling in a Douglas-fir stand. For. Sci. 23(3):307-316.
"N abundance and deficiency were simulated in a &year-old N-deficient Douglas-fir stand in Washington, by applications respectively of (a) 220 or 880 kglha N (as urea), and (b) carbohydrate (8 000 kglha sucrose + 10 000 kglha red-cedar sawdust) which reduces N availability."

183. Turner, J., D. W. Cole, and S. P. Gessel.
1976. Mineral nutrient accumulation and cycling in a stand of red alder ***(Alnus rubra).*** J. Ecol. 64(3):965-974.
Distribution of organic matter and mineral nutrients (N, P, K, Ca, Mg, Mn) in a 34-year-old stand of red alder is described, together with annual nutrient transfer between vegetation component.

184. Turner, J., M. J. Lambert, and S. P. Gessel.
1977. Use of foliage sulphate concentrations to predict response to urea application by Douglas-fir. Can. J. For. Res. 7(3):476-480.
Foliar sulphate S reserves were positively correlated with response to N fertilizer, and were a better indicator of N requirement than foliar N concentration.

185. Turner, J., and M. J. Singer.
1976. Nutrient distribution and cycling in a subalpine coniferous forest ecosystem. J. Appl. Ecol. 13(1):295-301.
"Reports studies in 1972-73 in a 0.045-ha plot at 1200 m altitude at Findley Lake, Washington, dominating by 175-year-old ***Abies amabilis.*** Data are tabulated on the biomass and nutrient content (N, P, K, Ca, Mg, and Mn) of separate components of the stand and of the forest floor and soil, and on nutrient exchanges within the system. Results are compared with data for typical Pacific Northwest coniferous forests."

186. Wagle, R. F.., and Thomas W. Eakle.
1979. A controlled burn reduces the impact of a subsequent wildfire in a ponderosa pine vegetation type. For. Sci. 25(1):123-129.
"A controlled burn 1 year prior to the advent of wildfire effectively reduces the impact on the wildfire on a ponderosa pine forest overstory, the surface vegetation, and the organic layers of the soil characteristic of an adjacent area on the same slope and in the same vegetation type not control burned. Changes in the surface vegetation and soil organic layers caused by wildfire on the area not control burned were greatest on the steepest slope and least on the level. Soil fertility levels varied with fire history."

187. Webster, S. R., D. S. DeBell, K. N. Wiley, and W. A. Atkinson.
1976. Fertilization of western hemlock. Proc. West. Hemlock Conf., p. 247-252. Coll. For. Resour., Univ. Wash., Seattle.
"Growth response of hemlock to urea application has been highly inconsistent. Inland stands and thinned stands respond better than stands which have not been thinned or grow on coastal sites."

188. Wells, Carol G., Ralph E. Campbell, Leonard F. Debano, Clifford E. Lewis, Richard L. Fredriksen, E. Carlyle Franklin, Ronald C. Froelich, and Paul H. Dunn.
1979. Effects of fire on soil: A state-of-knowledge review. USDA For. Serv. Gen. Tech. Rep. WO-7, 34 p.
"Includes sections on soil heating, chemical properties and nutrient cycles, physical properties, erosion, a special section on range soils, and research needs and priorities."

189. Will, G. M., and C. T. Youngberg.
1978. Sulfur status of some central Oregon pumice soils. Soil Sci. Soc. Am. J. 42(1):132-134.
Results of a fertilizer field trial indicate that in the central Oregon pumice region, tree growth can be increased by applying S.

190. Will, G. M., and C. T. Youngberg.
1979. Some foliage nutrient levels in tree and brush species growing on pumice soils in central Oregon. Northwest Sci. 53(4):274-276.
Soil nutrient levels differed between tree and brush species but not between sites. Tree foliage nutrient levels indicated inadequate supply of S.

191. Yee, C. S., and R. D. Harr.
1975. Soil factors influencing the slope stability of two cohesionless soils of the central Coast Range of Oregon. Northwest Sci. Assoc. Annu. Meet. Abstr. 121.
"Physical properties, hydraulic characteristics, and shear strengths for two major soils of the central Coast Ranges of Oregon are described. Each soil exhibits a high degree of aggregation which markedly influences its subsurface hydraulic response to precipitation."

192. Yee, Carlton S., and R. Dennis Harr.
1977. Effect of wetting mode on shear strength of two aggregated soils. USDA For. Serv. Res. Note PNW-303, 9 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.
"Soil aggregation and wetting by immersion during shear tests caused angles of internal friction of saturated soil to be atypically 9.5 degrees to 11 degrees smaller than angles of internal friction of dry soil. Amounts of water-stable aggregates were 26 to 35 percent less after saturation by immersion of soil than after saturation by wetting under tension."

193. Yee, Carlton S., and R. Dennis Harr.
1977. Influence of soil aggregation on slope stability in the Coast Ranges. Environ. Geol. 1(6):367-377.
"Soil aggregation in two major cohesionless soils of the central Coast Ranges of Oregon was found to be the most important soil property influencing shear strength and movement of subsurface water. Mode of wetting significantly affected angle of internal friction of both soils. Considering the large area covered by the two soils, aggregation appears to be an important slope stability property of regional significance."

194. Youngberg, C. T.
1975. Effects of fertilization and thinning on the growth of ponderosa pine. Soil Sci. Soc. Am. Proc. 39(1):137-139.
Growth of thinned and unthinned stands of young ponderosa pine was increased when soil was fertilized with N, P, and K. Thinning effects were greater than those of fertilizer. The combination of thinning and fertilizer gave the best growth increase.

**195.** Youngberg, C. T.
**1978.** Nitrogen mineralization and uptake from Douglas-fir forest floors. Soil Sci. Soc. Am. J. **42(3):499-502.**
Initial N mobilization rates were generally related to total N content of forest floor materials. Materials with the highest sustained N mobilization rates come from the highest site quality Douglas-fir types.

**196.** Youngberg, C. T., and A. G. Wollum II.
**1976.** Nitrogen accretion in developing ***Ceanothus velutinus*** stands. Soil Sci. Soc. Am. **J. 40(3):109-112.**
N accretion in biomass, litter, and soil over **10** years was **715** kglha for a ponderosa pine site and **1**080 kglha for a Douglas-fir site.

**197.** Youngberg, C. T., A. G. Wollum, and **W.** Scott.
**1979.** ***Ceanothus*** in Douglas-fir clearcuts: Nitrogen accretion and impact on regeneration. ***In*** Symbiotic nitrogen fixation in the management of temperate forests, p. **224-233.** Oreg. State Univ., Corvallis. J.C. Gordon, C. T. Wheeler, and D. A. Perry, eds.
Douglas-fir seedlings growing under ***Ceanothus*** did not experience N stress during the growing season, and had higher foliage N concentration than did those in the open.

## Theses


198. Anderson, Steven.
1979. Assessment of conifer growth and nutrition on two coastal Washington forest soils. Univ. Wash., Seattle.

199. Brown, Terry Henry.
1977. Nutrient distribution of two eastern Washington forested sites. Wash. State Univ., Pullman.

200. Flewelling, James W.
1977. Uptake of ammonium by *Pinus radiata* seedlings in low concentration solutions. Univ. Wash., Seattle.

201. Fredriksen, Richard Lee.
1975. Nitrogen, phosphorus, and particulate matter budgets of five coniferous forest ecosystems in the western Cascades Range, Oregon. Oreg. State Univ., Corvallis.

202. Johnson, Dale W.
1975. Processes of elemental transfer in some tropical, temperate, and northern forest soils: Factors influencing the availability and mobility of major leaching agents. Univ. Wash., Seattle.

203. Knight, Robert William.
1977. Streamside erosional response to animal grazing practices on Meadow Creek in northeastern Oregon. Oreg. State Univ., Corvallis.

204. Kurtz, Ronald.
1978. Litterfall dynamics and forest structure at a subalpine forest-lake interface in the western Cascades of Washington. Univ. Wash., Seattle.

205. Larson, Arthur.
1979. Origin of the chemical composition of undisturbed forested streams, western Olympic Peninsula, Washington State. Univ. Wash., Seattle.

206. Levine, Paul.
1975. Sorption of zinc, lead, and cadmium on glacial outwash soil. Univ. Wash., Seattle.

207. Nissley, Steven.
1978. Nutrient changes after prescribed burning of Oregon ponderosa pine stands. Univ. Wash., Seattle.

208. Pierson, Thomas Charles.
1977. Factors controlling debris-flow initiation on forested hillslopes in the Oregon Coast Range. Univ. Wash., Seattle.

209. Riggan, Philip.
1979. Simulation modeling of growth and nitrogen dynamics in a young Douglas-fir ecosystem. Univ. Wash., Seattle.

210. Schiess, Peter.
1975. The energy balance of dewatered sludge. Univ. Wash., Seattle.

211. Smith, Ronald Martin.
1977. Changes in levels of extractable nutrients of a forest floor and soil accompanying defoliation. Wash. State Univ., Pullman.

212. Stednick, John.
1979. Nitrogen, phosphorus, and sulfur cycling in Douglas-fir stands irrigated with sludge and water. Univ. Wash., Seattle.

213. Swain, Walter C.
1975. Coal spoil characteristics and natural revegetation on a western Washington strip mine: An investigation ten years after mining. Univ. Wash., Seattle.

214. Turner, John.
1975. Nutrient cycling in a Douglas-fir ecosystem with respect to age and nutrient status. Univ. Wash., Seattle.

215. Turner, Suzanne.
1975. A method for investigating equilibrium and increment redistribution in fertilized Douglas-fir stands. Univ. Wash., Seattle.

216. Wallace, Michael.
1976. The effects of fire on nutrient conditions in the *Pinus ponderosa* zone of central Oregon. Univ. Wash., Seattle.

217. Warner, Susan Ann.
1976. Cation exchange properties of forest litter as influenced by vegetation type and decomposition. Oreg. State Univ., Corvallis.

218. Yee, Carlton Stratton.
1975. Soil and hydrologic factors affecting stability of natural slopes in the Oregon Coast Range. Oreg. State Univ., Corvallis.

# Index

Subject — Citation Number

Klock, Glen O., and Robert F. Tarrant.
1981. Research on forest and range soils in Oregon and Washington: A bibliography with abstracts from 1975 through 1979. USDA For. Serv. Gen. Tech. Rep. PNW-130, 23 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

An annotated bibliography on forest and range soils in Oregon and Washington supplementing three earlier bibliographies published by the Pacific Northwest Forest and Range Experiment Station.

Keywords: Soil (forest), soil (range), research, bibliographies (soils research).

The **Forest Service** of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.



Pacific Northwest Forest and Range
Experiment Station
809 NE Sixth Avenue
Portland, Oregon 97232