Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

Reserve
1.9622
P2R31

RESEARCH PAPER 46
MARCH 1962

Noble Fir

A BIBLIOGRAPHY WITH ABSTRACTS

compiled by

JERRY F. FRANKLIN

U. S. DEPT. OF AGRICULTURE
LIBRARY
MAY 25 1962
CURRENT SERIAL RECORDS

PACIFIC NORTHWEST
FOREST AND RANGE EXPERIMENT STATION
U.S. DEPT. OF AGRICULTURE · FOREST SERVICE

An old-growth noble fir approximately 50 inches d. b. h. growing at an elevation of 2, 900 feet along the South Breitenbush River, Willamette National Forest, Oreg. Inset shows upper bole and crown of the same tree.

Research Paper 46

NOBLE FIR--

A BIBLIOGRAPHY WITH ABSTRACTS

Compiled by Jerry F. Franklin

March 1962

PACIFIC NORTHWEST
FOREST AND RANGE EXPERIMENT STATION
R. W. Cowlin, Director
Portland, Oregon

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

FOREWORD

This bibliography on noble fir (Abies procera Rehd.) includes both North American and European references. Its purpose is to list articles for those interested in the species; the most important references have been abstracted. An article concerning California red fir and one concerning Shasta red fir are included, as their silvical characteristics are similar to noble fir's and these studies were considered especially significant.

Articles are listed alphabetically by author. A subject index is given on pages 38-40, and a list of common and scientific names of tree species mentioned in the abstracts will be found on page 41.

Acknowledgment is made to Frank Ronco of the Rocky Mountain Forest and Range Experiment Station whose subject index from the "Bibliography of Engelmann Spruce and Subalpine Fir"[1/] served as a basis for the one included in this bibliography. The author would also like to thank Erna Jeppesen, past librarian, and Marie Gould, present librarian, at the Pacific Northwest Forest and Range Experiment Station, for considerable assistance in obtaining some of the references for examination.

1/ U.S. Forest Serv. Rocky Mt. Forest and Range Expt. Sta. Paper 57, 58 pp., illus. (Processed.)

BIBLIOGRAPHY

1. Abrams, LeRoy.
   1923. An illustrated flora of the Pacific States, Washington, Oregon and California. Vol. 1. Ophioglossaceae to Aristolochiaceae. 557 pp., illus. Stanford Univ.: Stanford Univ. Press.

2. Adams, Thomas C., and Syverson, Martin L.
   1958. Production and marketing of Christmas trees in the Pacific Northwest in 1957. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta., 20 pp., illus. (Processed.)

3. Aldhous, J. R.
   1959. Polythene bags for movements of forest nursery stock. Empire Forestry Rev. 38: 65-76.

   Noble fir transplants did not satisfactorily survive storage in polythene bags beyond 2 weeks.

4. Allen, G. S.
   1957. Storage behavior of conifer seeds in sealed containers held at 0° F., 32° F., and room temperature. Jour. Forestry 55: 278-281.

   Germination capacity of a single lot of noble fir seed dropped from 43 percent the year of collection to 33, 32, and 2 percent following 7 years of storage at 0° F., 32° F., and room temperature, respectively.

5. _____ and Bientjes, W.
   1954. Studies of coniferous tree seed at the University of British Columbia. Forestry Chron. 30: 183-196, illus.

   A 24- to 30-hour presoaking and 6-week stratification period is recommended when testing noble fir seed. Germination temperature should be 25° C. A 10-day period to determine germinative energy and a 14-day period to determine germination are suggested.

6. Aller, Alvin R.
   1956. A taxonomic and ecologic study of the flora of Monument Peak, Oregon. Amer. Midland Nat. 56: 454-472, illus.

   The highest forest community occurring on this 4,700-foot peak located in the western portion of the Cascade Range is dominated by an almost pure, dense, even-aged (46 to 47 years old) stand of noble fir located between 4,300- and 4,600-foot elevation. The boundary between this community and a Sitka alder–vine maple community lacks a transition zone and seems static. Its upper boundary with a rock-fell community does contain

a narrow ecotone with scattered specimens of Douglas-fir and western white pine. They apparently can establish themselves on soil too rocky for noble fir.

A noble fir–Pacific silver fir community is also found on this peak between 4,200- and 4,500-foot elevation. Taxonomic descriptions of both are included.

7. Anderson, Eric A.
1951. Tracheid length variation in conifers as related to distance from pith. Jour. Forestry 49: 38-42, illus.

A relationship between tracheid length and distance from the pith was found in four coniferous trees, including one noble fir. Shortest tracheids were found near the pith. Outward from the pith, tracheid length at first increased rapidly, then more slowly and with a tendency to level off.

8. Andrews, H. J., and Cowlin, R. W.
1940. Forest resources of the Douglas-fir region. U.S. Dept. Agr. Misc. Pub. 389, 169 pp., illus.

There was estimated to be 1,909.1 million cubic feet of noble fir and Shasta red fir in the region.

9. Annand, P. N.
1928. A contribution toward a monograph of the Adelginae (Phyloxeridae) of North America. 146 pp. Stanford Univ.: Stanford Univ. Press.

Reports an aggressive infestation of balsam woolly aphid on noble fir in California.

10. Anonymous.
1907. American forest trees—noble fir or Oregon larch. Hardwood Rec. 25(4): 16-17, illus.

11. Applegate, Elmer I.
1939. Plants of Crater Lake National Park. Amer. Midland Nat. 22: 225-314, illus.

Applegate states that although reports of noble fir in southern Oregon Cascades persist, he has never seen a specimen which he would recognize as noble fir. He distinguishes noble fir from Shasta red fir primarily on the basis of leaf characteristics. He considers Shasta red fir to be abundant in the Canadian and Hudsonian life zones of Crater Lake National Park.

12. Austin, R. C., and Strand, R. F.
1960. The use of slowly soluble fertilizers in forest planting in the Pacific Northwest. Jour. Forestry 58: 619-627, illus.

Fertilizer pellets (18.6 grams, 27.1 percent nitrogen as N, 5.5 percent phosphorus as P_2O_5) were ineffective in increasing first-year height growth or survival of noble fir seedlings. Noble fir did show a growth response the second growing season, however, suggesting it may be initially sensitive (negatively) to fertilizer applications. Removal of bracken fern greatly increased survival of noble fir seedlings but decreased height growth.

13. Bailey, Harold E., and Bailey, Virginia L.
1941. Forest and trees of the western national parks. U.S. Dept. Int. Natl. Park Serv. Conserv. Bul. 6, 129 pp., illus.

14. Bailey, L. H.
1934. The cultivated conifers in North America. 404 pp., illus. New York: The Macmillan Co.

15. Baker, Frederick S.
1949. A revised tolerance table. Jour. Forestry 47: 179-181.

Noble fir is rated "intolerant" in this five-class table, a classification second only to "very intolerant" in degree of intolerance. The table was developed from 55 published statements and questionnaires returned by queried foresters.

16. Balch, R. E.
1952. Studies of the balsam woolly aphid, Adelges piceae (Ratz.) (Homoptera: Phylloxeridae) and its effects on balsam fir, Abies balsamea (L.) Mill. Canada Dept. Agr. Pub. 867, 76 pp., illus.

Balch reared Adelges piceae on many species of Abies including noble fir.

17. Barnes, Irston R.
1955. Glacier Peak--wilderness wonderland. Mazama 37(13): 40-43, illus.

18. Barrett, D. K.
1958. Cracking in the main stem of noble fir at Lethen, Nairnshire. Scot. Forestry 12: 187-190, illus.

A large, windthrown noble fir, 70 years old and 120 inches in girth at breast height, contained numerous cracks developed periodically over 48 years. They were associated with periods of very dry weather accompanied by high temperatures.

19. Barton, Lela V.
1953. Seed storage and viability. Contrib. Boyce Thompson Inst. 17: 87-103.

An experiment was carried out to determine the effect of low temperature storage on the viability of noble fir, grand fir, and Shasta red fir seed at different moisture contents in sealed containers. Storage of noble fir seed for 16 years reduced percent of seedlings produced from approximately 60 to 30 percent.

20. Benson, Gilbert Thereon.
1930. The trees and shrubs of western Oregon. Contrib. Dudley Herb. Stanford Univ. Vol. 2, 170 pp., illus. Stanford Univ.: Stanford Univ. Press.

An annotated list with synonymy, type locality, range, and list of cited specimens. Benson felt further work was necessary to convince him that Shasta red fir and noble fir were entirely distinct. He felt leaf characteristics offered no assistance in this problem, and separation of California red fir from noble fir on the basis of number of vascular bundles in the leaf had not proved reliable.

21. Benson, R. B.
1945. Urocerus californicus (Norton) and some other interesting Siricidae (Hym., Symphyta) in Britain. Ent. Monthly Mag. 81: 67-68.

22. Betts, H. S.
1945. Noble fir. U.S. Dept. Agr. Amer. Woods, 5 pp., illus.

General information on distribution, habitat, life history, wood properties, and uses of noble fir.

23. Blackburn, Ben.
1944. Fir trees on the home grounds. Hort. 22: 27.

24. Bowers, Nathan A.
1942. Cone-bearing trees of the Pacific Coast. 169 pp., illus. New York, London: Whittlesey House, McGraw-Hill Book Co.

25. Boyce, J. S.
1930. Decay in Pacific Northwest conifers. Yale Univ. Osborn Bot. Lab. Bul. 1, 51 pp., illus.

26. Boyce, John S.
1943. Host relationships and distribution of conifer rusts in the United States and Canada. Conn. Acad. Sci. Trans. 35: 329-482.

Four rusts are known to attack noble fir.

27. Boyce, John S.
1948. Forest pathology. Ed. 2, 550 pp., illus. New York, London: McGraw-Hill Book Co.

Two trunk rots are listed as occurring on noble fir: red ring rot caused by Fomes pini, and brown stringy rot caused by Echinodontium tinctorium. At least one butt-rotting fungus and a number of needle casts may attack noble fir, but none are considered serious.

28. British Forestry Commission.
1957. Exotic forest trees in Great Britain. Bul. 30, 167 pp., illus.

Noble fir is one of three species of Abies planted extensively in Britain. Provenance attributes of the species have not been studied; most imported seed has been from the Cascade Range of Washington. Noble fir is usually planted as 2-2 stock and exhibits some intolerance to moving. Plantings are frequently established under partial oak or birch cover. Noble fir starts slowly and is sensitive to heather competition; growth is very good after initial establishment, however, with yields resembling those of the top two British quality classes of Douglas-fir. Nutrient requirements appear low, good growth having been experienced on poor tills, morainic deposits, and certain types of peat. Considerable variation in height and diameter growth requires close attention to the distribution of dominants.

No specific diseases of noble fir have been noted. A chalcid fly reduces seed yields. The tree may be above average in windfirmness and is very resistant to damage from snow and ice. Noble fir is hardy, although it may be damaged by spring frosts, and is tolerant to exposure, resisting crown deformation and seasonal defoliation very successfully.

Noble fir is the best seed producer of the Abies planted in Britain. Flowering begins between 25 and 30 years of age and good cone crops are produced at approximately 3-year intervals after 30 to 35 years of age.

29. _____
1957. Report on forest research for the year ended March, 1957. 176 pp., illus.

30. _____
1959. Report on forest research for the year ended March, 1958. 191 pp., illus.

31. British Forestry Commission.
1960. Report on forest research for the year ended March, 1959. 186 pp., illus.

Nursery investigations of noble fir are being conducted in an effort to improve germination and seedling yield of noble fir.

32. Britton, Nathaniel Lord, and Shafer, John Adolph.
1908. North American trees; being descriptions and illustrations of the trees growing independently of cultivation in North America, north of Mexico and the West Indies. 894 pp., illus. New York: Henry Holt and Co.

33. Brockman, C. Frank.
1933. The forests of Mt. Rainier. Nat. Hist. 33: 523-532, illus.

34. _____
1947. Flora of Mount Rainier National Park. U.S. Dept. Int., 170 pp., illus.

Brief botanical description of noble fir with excellent photographs of cones and foliage. Noble fir is considered a characteristic tree of the Canadian zone on Mount Rainier.

35. _____
1949. Trees of Mount Rainier National Park. 49 pp., illus. Seattle: Univ. Wash. Press.

36. Brown, H. P., and Panshin, A. J.
1934. Identification of the commercial timbers of the United States. 223 pp., illus. New York, London: McGraw-Hill Book Co. Inc.

37. _____ and Panshin, A. J.
1940. Commercial timbers of the United States. 554 pp., illus. New York, London: McGraw-Hill Book Co. Inc.

38. _____, Panshin, A. J., and Forsaith, C. C.
1949. Textbook of wood technology. Vol. 1, 652 pp., illus. New York, Toronto [etc.]: McGraw-Hill Book Co. Inc.

General characteristics and properties, minute anatomy, and uses of noble fir wood. Suggestions for distinguishing it from western hemlock.

39. Buckhorn, W. J., and Orr, P. W.
1959. Forest insect conditions in the Pacific Northwest during 1958. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta., 41 pp., illus. (Processed.)

Bark weevil (Pissodes piperi Hopk.) was reported attacking noble fir in the Molalla (Oreg.) River drainage. Weevils bred in a 90-year-old noble fir stand that had sustained rather extensive windbreak and snowbreak, then attacked surrounding green trees. Intermediate and suppressed trees were the preferred hosts.

40. Ching, Te May, and Parker, M. C.
1958. Hydrogen peroxide for rapid viability tests of some coniferous tree seeds. Forest Sci. 4: 128-134, illus.

Rapid viability tests of tree seed can be made by soaking the seed in a 1-percent solution of hydrogen peroxide after opening the seed to permit rapid absorption of this solution. When testing noble fir seed, 150 millileters of solution should be used per 50 seeds and the test carried on for 9 days at 20° to 30° C. Hydrogen peroxide and standard germination tests of three lots of noble fir seed showed 69- vs. 68-percent, 67- vs. 57-percent, and 36- vs. 43-percent germination, respectively. The standard germination tests required 49 to 70 days.

41. Christie, J. M., and Lewis, R. E. A.
1961. Provisional yield tables for Abies grandis and Abies nobilis. Brit. Forestry Comn. Forest Rec. 47, 48 pp., illus.

Presents yield tables and form height tables for noble fir and discusses its rate of growth and yield including comparisons with other conifers. Three quality classes are recognized for noble fir based on heights of 80 feet, 70 feet, and 60 feet at 50 years of age. Its rate of growth is comparable to Norway spruce. It grows more slowly than the spruce for the first 30 years but total volume production is greater at 50 years. The volume increment per 1 foot of height growth is higher than that of any other conifer for which the Forestry Commission has prepared yield tables. No single site factor (soil type, elevation, rainfall, exposure) appears to have a marked influence on its rate of growth.

42. Clark, Joe W.
1957. Comparative decay resistance of some common pines, hemlock, spruce, and true fir. Forest Sci. 3: 314-320, illus.

Noble fir was included in a decay-resistance study using the soil block technique. Weight losses incurred with Poria monticola, Lenzites sepiaria, and L. trabea indicate noble fir is 100 percent nonresistant. All test blocks had percentage weight losses exceeding 45 percent.

43. Clear, T.
1944. The role of mixed woods in Irish silviculture. Irish Forester 1: 41-46.

44. Collingwood, G. H.
1943. Noble fir, Abies nobilis Lindley. Amer. Forests 49: 126-127, illus.

45. _____ and Brush, Warren D.
1947. Knowing your trees. [Rev.] 312 pp., illus. Washington, D.C.: Amer. Forestry Assoc.

46. Colville, C. V.
1897. The Shasta fir (Abies shastensis). Garden and Forest 10(514): 516-517.

Discusses the range and botanical characteristics of Shasta red fir and noble fir and enumerates differences between them. Includes reports of noble fir on Mount Baker (Wash.) and at 500-foot elevation on the Grays River-Skamokawa River divide in southwestern Washington, about 4 miles from the Pacific Ocean.

46a. Cowlin, R. W., Briegleb, P. A., and Moravets, F. L.
1942. Forest resources of the ponderosa pine region of Washington and Oregon. U.S. Dept. Agr. Misc. Pub. 490, 99 pp., illus.

There was estimated to be 282.9 million cubic feet (1 billion 286.3 million board feet) of noble fir and Shasta red fir in the region.

47. Deffenbacher, Forrest W., and Wright, Ernest.
1954. Refrigerated storage of conifer seedlings in the Pacific Northwest. Jour. Forestry 52: 936-938.

Experiments indicate noble fir seedlings can be safely stored up to 12 months under proper cold storage conditions. Sphagnum moss and shingle tow were equally satisfactory as cold storage packing material.

48. Detling, LeRoy E.
1954. Significant features of the flora of Saddle Mountain, Clatsop County, Oregon. Northwest Sci. 28: 52-60.

Noble fir is one of the "boreal" species found on this peak in the Coast Ranges of northwest Oregon.

49. Dick, James.
1960. A direct seeding of Pacific silver fir. Weyerhaeuser Co. Forestry Res. Center Forestry Res. Note 33, 4 pp. (Processed.)

Dick reports that in the coastal forest of Oregon the preference of rodents for Douglas-fir seed was found to be extremely high in comparison with noble fir.

50. Dixon, Dorothy.
1961. These are the champs. Amer. Forests 67(1): 41-46, 48-50, illus.

The largest noble fir on record is 22 feet 8 inches d.b.h., 260 feet tall, and has a 35-foot spread. It is found in the Columbia (now Gifford Pinchot) National Forest.

51. Douglas-fir Second-Growth Management Committee.
1947. Management of second-growth forests of the Douglas-fir region. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta., 151 pp., illus. (Processed.)

Heavy partial cuts or small clear cuts are recommended to favor noble fir regeneration when cutting true fir stands. True firs should be planted, pure or in mixture with Douglas-fir, at elevations where noble fir or Pacific silver fir occur in mixture with Douglas-fir. They are considered more resistant than Douglas-fir to snowbreakage and winter injury.

52. Douglass, Bernard S.
1960. Collecting forest tree cones in the Pacific Northwest. U.S. Forest Serv. Region 6, 21 pp., illus. (Processed.)

A popular guide to cone collecting in the Northwest which includes identification of cones, collection period, cone testing, methods of collection, and care of cones after collecting. Cutting tests of noble fir cones should be made by slicing the cone lengthwise about one-half to one-fourth inch to one side of the cone. A good average seed count for cones so tested would be for 50 percent or more of exposed seed to be sound.

53. Eliot, Willard Ayres, and McLean, G. B.
1938. Forest trees of the Pacific Coast. 565 pp., illus. New York: G. P. Putnam's Sons.

54. Engelmann, George.
1878. A synopsis of the American firs. Acad. Sci. Trans. St. Louis 3: 593-602.

Engelmann divided the genus into four sections and used differences in leaf structure as the primary basis for distinguishing these sections and the species. Noble fir is in the section Nobiles, with California red fir. This section is characterized by "leaves of adult tree...quadrangular, short, curved, but scarcely twisted; resin ducts close to epidermis of lower side, and equidistant from edge and keel; fibrovascular bundles

single; . . . ." He includes nomenclature, range, and botanical characteristics of each species.

55. Engelmann, George.
1882. Notes on western conifers. Bot. Gaz. 7: 4-5.

56. Englerth, G. H., and Hansbrough, J. F.
1945. The significance of the discolorations in aircraft lumber; noble fir and western hemlock. U.S. Dept. Agr. Forest Path. Release 24, 10 pp., illus.

A survey of discoloration in noble fir and western hemlock wood in Oregon and Washington resulted in two classifications. The first did not indicate decay; the second indicated wood-staining or wood-destroying fungi.

57. English, Edith Hardin.
1958. Plant life of the area surrounding Glacier Peak. Mountaineer 51(4): 28-39.

58. Engstrom, W. H.
1953. Oregon cone crop, 1953. Oreg. State Bd. Forestry Res. Note 13, 6 pp., illus. (Processed.)

59. _____
1954. Oregon cone crop, 1954. Oreg. State Bd. Forestry Res. Note 16, 7 pp., illus. (Processed.)

60. Ferré, Y. de.
1952. Les formes de jeunesse des Abiétacées. Ontogénie-phylogénie. [Juvenile forms of the Abientineae. Ontogeny and phylogeny.] Trav. Lab. Forestier Toulouse, Tome II, Vol. III, Art. 1. 284 pp., illus.

Study of the characters of 103 conifers at different stages during juvenile development. Noble fir was included and these data are presented in tabular form (p. 65).

61. Forest Soils Committee of the Douglas-fir Region.
1957. An introduction to the forest soils of the Douglas-fir region of the Pacific Northwest. Various paging, illus. Seattle: Univ. Wash.

". . . [noble fir] is a splendid timber tree, forming pure or nearly pure stands in some localities or often mixed with Douglas-fir, western hemlock, and Pacific silver fir. It is found at scattered locations at medium to high elevations (2,000 to 5,000 ft.) in the Cascades of Oregon and Washington, and less often in the Oregon Coast Range and Willapa Hills of Washington. Early reports of its occurrence in the Olympic Mountains and in Canada have not been confirmed. . . ."

62. Francke-Grosman, Helene.
1938. Uber Dreyfusia piceae an auslandischen Tannenarten. Tharandter Forstl. Jahrb. 89: 35-49.

63. Franco, Joao do Amaral.
1941. Algunos abietos cultivados em Portugal. Agros 24: 45-63, illus.

64. _____
1950. Abetos. Anais Inst. Superior Agron. vol. 17, 260 pp., illus.

65. Franklin, Jerry F.
1961. Seedling identification guide for 25 conifers of the Pacific Northwest. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta., 65 pp., illus.

Information on the seedling characteristics of noble fir up to the age of 1 year.

66. Fulling, Edmund H.
1934. Identification, by leaf structure, of the species Abies cultivated in the United States. Torrey Bot. Club Bul. 61: 497-524, illus.

Discusses general anatomy of true fir leaves, particularly those features having taxonomic value. Noble fir is the only species of Abies studied in which the two strands of vascular tissue are fused. California red fir leaves approach this condition but are not quite fused. Pictures of the cross sections and a key are included.

67. Galoux, A.
1952. Etude des conditions de croissance des essences forestières américaines susceptibles d'intéresser la sylviculture européenme. Rev. de l'Agr. 5: 591-594.

68. Gannett, Henry.
1902. The forests of Oregon. U.S. Geol. Survey Prof. Paper 4, 36 pp., illus.

69. _____
1902. The forests of Washington. A revision of estimates. U.S. Geol. Survey Prof. Paper 5, 38 pp., illus.

70. Garman, E. H.
1949. Exotic trees in the coastal region of British Columbia. Brit. Columbia Forest Serv. Res. Notes 15, 14 pp. (Processed.)

A 34-year-old noble fir grown at Sidney in southern British Columbia was 47 feet tall and 14.8 inches d.b.h. Noble fir was also reported in 1915 as successful in the Fraser Valley.

71. Gibbs, R. Darnley.
1958. The Mäule reaction, lignins, and the relationships between woody plants. In The physiology of forest trees, ed. by Kenneth V. Thimann, pp. 269-312. New York: The Ronald Press Co.

72. Gilkey, Helen M.
1945. Northwestern American plants. Oreg. State Col. Monog. Studies in Bot. 9, 84 pp., illus.

73. _____ and Powell, Garland M.
1951. Handbook of Northwest flowering plants. Ed. 2, 412 pp., illus. Portland, Oreg.: Binfords & Mort.

74. Gill, L. S.
1935. Arceuthobium in the United States. Conn. Acad. Arts and Sci. Trans. 32: 111-245, illus.

Reports the examination of specimens of Arceuthobium campylopodum forma abietinum for which noble fir was the host. These were from Klamath County and Crater (now Rogue River) National Forest, Oreg.

75. Gorman, M. W.
1920. The flora of Mount Hood. Oreg. Out-of-Doors 1: 64-96.

76. Gratkowski, H. J.
1958. Natural reproduction of Shasta red fir on clear cuttings in southwestern Oregon. Northwest Sci. 32: 9-18, illus.

A detailed study of a 35-acre clearcut and surveys on nine additional clearcuts indicated that the staggered-setting pattern of clear cutting with natural reproduction should be a satisfactory silvicultural system for Shasta red fir in southwestern Oregon. However, cutting units should be limited to 15 to 20 acres to insure adequate dissemination of seed.

77. Hansen, Henry P.
1941. Paleoecology of a bog in the spruce-hemlock climax of the Olympic Peninsula. Amer. Midland Nat. 25: 290-297, illus.

The bog studied was 6 miles south of Forks, Wash., and 10 miles from the Pacific Ocean in spruce-hemlock climax forest. Noble fir pollen is best represented in the lower portions of the profile (1.4 to 2.5 meters depth) where it makes up from 1 to 4 percent of the total pollen examined. This may indicate the existence of noble fir in the past on the Olympic Peninsula.

78. Hansen, Henry P.
1941. Paleoecology of a montane peat deposit near Lake Wenatchee, Washington. Northwest Sci. 15: 53-65, illus.

79. _____
1941. Paleoecology of a peat deposit in west-central Oregon. Amer. Jour. Bot. 28: 206-212, illus.

80. _____
1941. Paleoecology of two peat deposits on the Oregon Coast. Oreg. State Col. Monog. Studies in Bot. 3, 31 pp., illus.

81. _____
1942. A pollen study of a montane peat deposit near Mount Adams, Washington. Lloydia 5: 305-313, illus.

82. _____
1942. A pollen study of lake sediments in the lower Willamette Valley of western Oregon. Torrey Bot. Club Bul. 69: 262-280, illus.

83. _____
1942. The influence of volcanic eruption upon post-Pleistocene forest succession in central Oregon. Amer. Jour. Bot. 29: 214-219, illus.

84. _____
1943. A pollen study of two bogs on Orcas Island, of the San Juan Islands, Washington. Torrey Bot. Club Bul. 70: 236-243, illus.

Noble fir pollen was found in the upper levels of the profiles from these bogs. It is presently not found on Orcas Island, although it may have existed there in the past. Other possible sources of this pollen might have been the other San Juan Islands, Vancouver Island, or the Olympic Peninsula, because of the prevailing westerly winds.

85. _____
1943. Paleoecology of two sand dune bogs on the southern Oregon coast. Amer. Jour. Bot. 30: 335-340, illus.

86. _____
1944. Further pollen studies of peat bogs on the Pacific coast of Oregon and Washington. Torrey Bot. Club Bul. 71: 627-636.

87. Hansen, Henry P.
1947. Postglacial forest succession, climate, and chronology in the Pacific Northwest. Amer. Phil. Soc. Trans. New Ser., vol. 37, part 1, 130 pp., illus.

Pollen grains of Pacific silver fir, grand fir, and noble fir cannot be separated in sediments because of similar size-frequency distributions. Noble fir is unimportant and adds nothing to the postglacial successional picture in the Puget Sound and Willamette Valley regions because of its poor representation in the profiles.

88. _____
1955. Postglacial forests in south central and central British Columbia. Amer. Jour. Sci. 253: 640-643, 647, 650-651, 654, 657, illus.

89. _____ and Mackin, J. Hoover.
1949. A pre-Wisconsin forest succession in the Puget lowland, Washington. Amer. Jour. Sci. 247: 833-855, illus.

90. Hanzlik, E. J.
1914. The distinguishing features of the true firs (Abies) of western Washington and Oregon. Soc. Amer. Foresters Proc. 9: 272-277, illus.

91. _____
1925. A preliminary study of the growth of noble fir. Jour. Agr. Res. 31: 929-934, illus.

A noble fir, Douglas-fir, and western hemlock stand located at an elevation of 3,000 to 3,500 feet on Larch Mountain in northern Oregon was studied. The area was site III for Douglas-fir but "good" for noble fir, which numbered 20 percent of the stand but contained 46 percent of the volume. Detailed growth data are presented in tabular form. Seedling growth rate was slower than either Douglas-fir or western hemlock. Hanzlik felt noble fir should be favored more than any other species, excepting possibly western white pine, in upper portions of the lower-slope forests and lower portions of the upper-slope forests.

92. Hanzlik, Edward John.
1928. Trees and forests of western United States. 128 pp., illus. Portland, Oreg.: Dunham Printing Co.

Interesting descriptive reference. Hanzlik felt that noble fir growing in second-growth stands would approximate the yields of Douglas-fir under similar conditions and that it should be a favored species for perpetuation in its range.

93. Harlow, W. M.
1945. Some comments on the new check list and other things nomenclatural. Jour. Forestry 43: 403-406.

94. Harlow, William M., and Harrar, Elwood S.
1958. Textbook of dendrology, covering the important forest trees of the United States and Canada. Ed. 4, 561 pp., illus. New York: McGraw-Hill Book Co. Inc.

95. Hartmann, F. K., Querengasser, F., and John, G.
1953. Unterlagen für den Ambau west amerikanisher Nadelholzarten in Deutschland. Allg. Forest-u. Jagdztg. 125: 25-47.

96. Hayes, G. L.
1959. Forest and forest-land problems of southwestern Oregon. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta., 54 pp., illus. (Processed.)

The true fir-mountain hemlock type occupies 1,200 square miles of the higher Cascades in southwestern Oregon, with either Shasta red fir or noble fir dominating in the area to the north of Crater Lake. The boundary or zone of mixing between these two species has not been satisfactorily identified and they probably hybridize. Their wood is superior to other true firs, stands are dense, and yields are high. Noble fir is considered commercially unimportant in southwestern Oregon because of limited quantity.

97. Hedgcock, George Grant.
1912. Notes on some diseases of trees in our national forests. II. Phytopath. 2: 78-80.

Notes noble fir is attacked by Trametes pini and Echinodontium tinctorum.

98. _____
1914. Notes on some diseases of trees in our national forests. IV. Phytopath. 4: 181-188.

Notes noble fir is attacked by Fomes pinicola and Polyporus schweinitzii.

99. Heusser, Calvin J.
1960. Late-Pleistocene environments of North Pacific North America. Amer. Geog. Soc. Spec. Pub. 35, 308 pp., illus.

100. Hofmann, J. V.
1925. Laboratory tests on effect of heat on seeds of noble and silver fir, western white pine, and Douglas fir. Jour. Agr. Res. 31: 197-199.

These tests were carried out to determine the ability of true fir seeds to withstand the effects of forest fires. Tests used dry and moist heat at various levels from 100° to 240°. Germination results are tabulated and discussed. The morphological effects of heating the seeds are described for each species.

101. Holmes, G. D., and Buszewicz, G.
1958. The storage of seed of temperate forest tree species. Forestry Abs. 19: 313-322, 455-476.

102. Holmsgaard, E., and Kjaer, A.
1951. Undersøgelse over spiring i laboratorium og planteskole af 4 Abies--og 2 Picea-arter. Dansk. Skovforen. Tidsskr. 36: 203-226.

103. Hopping, George.
1925. A key to the true firs of North America. In The Annual Cruise, Oreg. State Agr. Col. Forest Club, pp. 43-46, illus.

104. Hunter Blair, Sir J.
1946. Frost damage to woodlands on Blairquhan estate in April, 1945. Scot. Forestry Jour. 60(1): 38-43.

Noble fir appeared to be hardier than grand fir or Pacific silver fir.

105. Hussey, N. W., and Klinger, J.
1954. Variation in Megastigmus pinus Parfitt (Hum., Chalcidoidea, Torymidae). Ent. Monthly Mag. 90(1084): 198-201.

A study of this species (a seed chalcid) from material of six provenances of noble fir.

106. Hutt, P. A.
1956. The Dunemann nursery system. Quart. Jour. Forestry 50: 155-156.

107. Isaac, Leo A.
1930. Seed flight in the Douglas fir region. Jour. Forestry 28: 492-499, illus.

Noble fir seed was released from a box kite 200 feet in the air during an 11 m.p.h. wind. Greatest seed fall, 21 percent of the total, occurred at a distance of 1,400 feet from the point of release. Maximum

seed flight distance was 2,200 feet; however, 87 percent of the seed fell 1,600 feet or less from the point of release.

108. Isaac, Leo A.
1934. Cold storage prolongs the life of noble fir seed and apparently increases germinative power. Ecol. 15: 216-217.

Noble fir can be held in cold storage (15° F.) for a period of 5 years without appreciable loss of viability.

109. _____
1943. Reproductive habits of Douglas-fir. 107 pp., illus. Washington, D.C.: Charles Lathrop Pack Foundation.

Isaac studied the longevity of noble fir seed using the same technique he used with Douglas-fir. Fresh seed was collected and buried in three positions--just under the surface of the soil, and 1 inch and 2 inches below the surface. Normal germination was obtained the first season and none thereafter.

110. _____
1956. Where do we stand with Douglas-fir natural regeneration research. Soc. Amer. Foresters Proc. 1955: 70-72.

111. Jeffrey, Edward C.
1904. The comparative anatomy and phylogeny of the Coniferales. Part 2.--The Abietineae. Mem. Boston Nat. Hist. 6: 1-37, illus.

112. Johnson, F. A.
1955. Volume tables for Pacific Northwest trees. U.S. Dept. Agr. Handb. 92, 122 tables.

Included are two tables for noble fir: (1) board-foot volume with d.b.h. and number of 16-foot logs as variables, and (2) board-foot volume with d.b.h. and number of 32-foot logs as variables.

113. Johnson, Herman M.
1943. Recovery of aircraft lumber from noble fir logs. The Timberman 45(2): 38, 40, 42, illus.

The wood qualities of noble fir are noted briefly and results presented of a mill production study undertaken to obtain yield data for various sizes and grades of logs. Included is a tabulation of percentage lumber grade recoveries for various commercial log grades.

114. Johnson, Norman E., and Wright, Kenneth H.
1957. The balsam woolly aphid problem in Oregon and Washington. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta. Res. Paper 18, 34 pp., illus. (Processed.)

Describes and discusses the balsam woolly aphid (Adelges piceae) problem in the Northwest. Noble fir and Shasta red fir appear to have some degree of resistance to attack, only a few infested noble fir having been found. Aggressive infestations have been reported on noble fir in Europe and California, however. If noble fir does prove resistant, it may be possible to use it to replace Pacific silver fir and subalpine fir.

115. Jones, George Neville
1936. A botanical survey of the Olympic Peninsula, Washington. Univ. Wash. Pub. Biol. vol. 5, 286 pp., illus. Seattle: Univ. Wash.

There was no recent evidence of the occurrence of noble fir in the Olympic Mountains.

116. _____
1938. The flowering plants and ferns of Mount Rainier. Univ. Wash. Pub. Biol. vol. 7, 192 pp., illus. Seattle: Univ. Wash.

117. Keen, F. P.
1952. Insect enemies of western forests. U.S. Dept. Agr. Misc. Pub. 273 (rev.), 280 pp., illus.

Lists and discusses insects found infesting noble fir. These include Chermes piceae and Pseudohylesinus nobilis, the latter attacking only weakened trees.

118. _____
1958. Cone and seed insects of western forest trees. U.S. Dept. Agr. Tech. Bul. 1169, 168 pp., illus.

Only two collections have been made from noble fir and these do not indicate what insect damage might be expected. Cone moths (Dioryctria spp.), seed chalcids (Megastigmus pinus), and seed gall midges (Dasyneura abiesemia) were found in noble fir seed and cones. Much of the worthless seed found in other Abies species is sterile or "blighted" seed and this may be the case with noble fir.

119. Kurth, E. F.
1950. The chemical analysis of western woods. Part III. TAPPI 33: 507-508.

Includes an analysis of noble fir wood for ether, alcohol, and water extractives; holocellulose; lignin; methoxyl group; acetyl group; and ash content.

120. Lamb, William H.
1912. A synopsis of the red firs. Soc. Amer. Foresters Proc. 7: 184-186, illus.

A discussion emphasizing distinguishing characteristics of noble fir, California red fir, and Shasta red fir. Items of diagnostic character are: (1) presence or absence of a longitudinal groove on the upper surface of the leaf, (2) the relative length of the cone scale and cone bract, and (3) the shape of the cone bract. Noble fir lacks a groove on the upper surface of its needles which the other two red firs have. The bracts of noble fir are always longer than the cone scale while they are always shorter in California red fir and vary in Shasta red fir. The cone bracts of noble fir also have larger and stouter points than those of Shasta red fir.

121. _____
1914. A conspectus of North American firs (exclusive of Mexico). Soc. Amer. Foresters Proc. 9: 528-538, illus.

A taxonomic description of American Abies which places great emphasis on the form of the cone bract as a distinguishing characteristic. Species without exserted bracts are considered to have evolved from those with exserted bracts. Noble fir would be an older representative of the genus, Abies venusta being the most primitive surviving member. Arrangement of the leaves, position of the resin ducts in the leaf, and character of the upper surface of the leaf are also considered.

122. Langille, H. D., Plummer, Fred G., Dodwell, Arthur, and others.
1903. Forest conditions in the Cascade Range Forest Reserve, Oregon. U.S. Geol. Survey Prof. Paper 9, 298 pp., illus.

Almost 3,250 million board feet of noble fir timber were inventoried within this forest reserve which extended south along the Cascade Range from the Columbia River to Lake of the Woods. It comprised 6 percent of the timber on both the west and east sides of the Cascade summit. In the northern portion of the reserve--Mount Hood and vicinity--noble fir totaled about 7 percent of the timber stand. The examining officer noted a sparsity of noble fir seedlings and saplings and felt that the percentage of the species was decreasing. Farther south, between Clackamas Meadows and South Sister, noble fir volume was still 7 percent of the total and constituted an important tree in the middle altitudinal zone west of the

summit. The straight, clear trunk of mature noble fir throughout the area and its exceptional development around the middle fork of the Santiam River was noted. Altitudinal range of noble fir in this portion of the reserve is 1,500 to 6,000 feet. In the area between Tps. 18 and 20 S., noble fir constituted 5 percent of the total, but here it had an elevational range of 5,000 to 6,400 feet. A specimen cut at 6,000 feet was 125 feet tall and 53-1/2 inches in diameter at 163 years of age. Additional information on the quantity and distribution of noble fir is found in individual township reports included in the main report.

123. Lawrence, Donald B.
1939. Some features of the vegetation of the Columbia River Gorge with special reference to asymmetry in forest trees. Ecol. Monog. 9: 218-257, illus.

124. Leiberg, John B.
1900. Cascade Range and Ashland Forest Reserves and adjacent regions. U.S. Geol. Survey 21st Ann. Rpt., 1899-1900, Part 5, Forest Reserves: 209-498, illus.

Noble fir was an important tree in the forests of these reserves which are located in the southern Oregon Cascade Range and eastern Siskiyou Mountains. It was found chiefly at higher elevations, generally 5,200 to 8,800 feet, reaching maximum development at 5,800 to 6,800 feet. It occurred everywhere west of the Cascade summit and extended 2 to 6 miles from the summit on the eastern slope. It was absent from the ranges in the interior of the Upper Klamath Basin. Noble fir was most important in the lower levels of the "subalpine forests" where, in mixture with mountain hemlock, it formed mature stands which were "magnificent examples of forest growth but little inferior in timber volume to the best stands of the red-fir [Douglas-fir] type." Younger stands in this type were very dense with 4,000 to 10,000 trees per acre in 20- to 40-year-old stands. Reproduction was not good with regards to species ratios, noble fir and mountain hemlock giving way to lodgepole pine because of fires. Noble fir was considered intermediate between Douglas-fir and white fir in fire-resisting capability.

125. Lippe, F. v.d.
1949. Litt om edelgran. Tidsskr. Skogbruk 57: 169-173.

126. Little, Elbert L., Jr.
1949. Important forest trees of the United States. U.S. Dept. Agr. Yearbook 1949: 763-814, illus.

127. _____
1953. Check list of native and naturalized trees of the United States (including Alaska). U.S. Dept. Agr. Handb. 41, 472 pp.

Correct botanical name for noble fir is Abies procera Rehd. and approved common name is noble fir. Its range is western Washington from Cascade Range and high peaks of Coast Ranges southward to southwestern Oregon.

128. Lodewick, J. Elton.
1935. Noble fir for "larch." The Timberman 36(7): 16-17, illus.

129. Lumberman.
1955. Yule trees are special crop. Vol. 82(5): 82-84, illus.

130. Lunnum, Knut.
1953. Raising Christmas trees for profit. Pac. NW. Coop. Ext. Pub. 6, 20 pp., illus.

131. Luxford, R. F., and Krone, R. H.
1943. Chemical stain in noble fir as related to strength. U.S. Forest Serv. Forest Prod. Lab. Rpt. 1329, 6 pp., illus. (Processed.)

Colored materials present in noble fir wood are carried toward the surface during drying, resulting in chemical staining. Conditions that induce such movement may result in a slight decrease in the wood's resistance to impact loads.

132. MacDonald, J.
1952. The place of north-western American conifers in British forestry. Brit. Forestry Comn., 20 pp.

133. MacDonald, J. A. B.
1945. The Lon Mor: twenty years' research into wasteland peat afforestation in Scotland. Forestry 19: 67-73, illus.

134. MacDonald, J. M., and Lockhart, S. F. M.
1953. Some early observations on the natural regeneration of conifers in Scotland. Scot. Forestry 7(3): 79-82, 85.

Experience in Scotland indicates that equal mixtures of raw humus and moss make a good seedbed for noble fir.

135. McMinn, Howard E., and Maino, Evelyn.
1947. An illustrated manual of Pacific Coast trees. Ed. 2, 409 pp., illus. Berkeley: Univ. Calif. Press.

136. Macnab, James A.
1958. Biotic aspection in the Coast Range mountains of northwestern Oregon. Ecol. Monog. 28: 21-54, illus.

Occasional noble firs were found on the study area which was located at 1,400- to 1,500-foot elevation on Saddleback Mountain in extreme northeastern

Lincoln County. Ring counts showed they were the same age as the even-aged Douglas-firs which dominated the site. The 250-year-old Douglas-firs and noble firs formed a canopy 250 to 300 feet high and averaged about 4 feet in diameter.

137. McNaughton, G. C.
1944. Ignition and charring temperatures of wood. U.S. Forest Serv. Forest Prod. Lab. Rpt. 1464, 3 pp. (Processed.)

Results of tests to show the effect of temperature and time of exposure upon the ignition of various woods including noble fir.

138. Malcolm, D. C.
1958. The replacement of unhealthy larch stands in South Shropshire and North Herefordshire. Sylva [Edinb.] 1957-58(37): 15, 17.

139. Markwardt, L. J.
1930. Comparative strength properties of woods grown in the United States. U.S. Dept. Agr. Tech. Bul. 158, 38 pp.

140. _____ and Wilson, T. R. C.
1935. Strength and related properties of woods grown in the United States. U.S. Dept. Agr. Tech. Bul. 479, 99 pp. plus 14 tables, illus.

Tabulated data on the strength and other wood properties of noble fir from Multnomah County, Oreg.--rings per inch, summerwood percent, moisture content, specific gravity, weight, shrinkage, maximum tensile strength, and results of static bending, impact bending, compression, hardness, shear, and cleavage tests.

141. Martin, J. S.
1949. Sulphate pulping of logging and sawmill wastes of old-growth Douglas-fir and of certain associated species. TAPPI 32(12): 534-539.

In experiments carried out with Douglas-fir, noble fir, lodgepole pine, and mountain hemlock, logging and sawmill wastes of all species were pulped satisfactorily with normal amounts of chemicals. The three latter species produced pulp with excellent bursting and fair tearing strengths. Pulp from 70 percent Douglas-fir and 10 percent of each of the other three species had good bursting and excellent tear strength and was of higher quality than pulps from sound Douglas-fir alone. Includes information on chemical and physical tests of noble fir, mountain hemlock, and lodgepole pine woods. Noble fir has a high lignin content which offsets the advantage of little extractive material. (Also reported in U.S. Forest Serv. Forest Prod. Lab. Rpt. 1747.)

142. Masters, M. T.
1885. Abies nobilis. Gardeners' Chron. 24: 652-653, illus.

142a. Mergen, Francois, and Lester, Donald T.
1961. Colchicine-induced polyploidy in Abies. Forest Sci. 7: 314-319, illus.

Seed of noble fir was treated with aqueous colchicine solutions (0.05 to 0.04 percent) in an effort to obtain polyploid individuals. Results with noble fir and eight other Abies species indicates a low sensitivity to colchicine. Few polyploid Abies seedlings were produced, and these rapidly reverted to a diploid state. At the conclusion of the study (two growing seasons) no polyploid seedlings were alive.

143. Merkle, John.
1951. An analysis of the plant communities of Mary's Peak, western Oregon. Ecol. 32: 618-640, illus.

A western hemlock–noble fir–Douglas-fir community is found above 2,500-foot elevation on the north slope of this peak in the Coast Ranges. Noble fir forms an almost pure stand at 3,600- to 3,800-foot elevation, becomes scattered below 3,500 feet, and scarce below 2,500 feet. All size classes are represented from seedlings to trees 48 inches d.b.h. and 150 feet tall. Noble fir ranks second in abundance to western hemlock with 29 percent, but first in basal area with 39 percent of the total.

Noble fir is also present throughout a Douglas-fir–noble fir community found above 2,250-foot elevation on the east slope. Here noble fir has the same abundance ranking as Douglas-fir, but a smaller basal area. It is represented in all size classes and is reproducing readily above 3,400 feet, its area of greatest abundance.

Merkle concludes noble fir and western hemlock are codominant and climax above 2,500-foot elevation on the north slope. On the drier east slope, noble fir is codominant and climax with Douglas-fir above 3,300- to 3,400-foot elevation.

144. Mosher, Milton M., and Lunnum, Knut.
1953. Trees of Washington. State Col. Wash. Inst. Agr. Sci. Ext. Serv. Bul. 440 (rev.), 40 pp., illus.

145. Muenscher, W. C.
1941. The flora of Whatcom County, State of Washington. 134 pp., illus. Ithaca, N.Y.

Author reports he could not find any specimens of noble fir in this northern Washington county.

146. Munns, E. N.
1938. The distribution of important forest trees of the United States. U.S. Dept. Agr. Misc. Pub. 287, 176 pp., illus.

Includes range map for noble fir.

147. Neal, Carl B.
1924. Noble fir. The Timberman 25(5): 61, illus.

148. Neiland, Bonita J.
1958. Forest and adjacent burn in the Tillamook Burn area of northwestern Oregon. Ecol. 39: 660-671, illus.

A vegetational analysis of the remaining large, unburned forest stand in the center of the Tillamook Burn and of an adjacent area burned in 1945. Noble fir occurred over the elevational range studied (2,200 to 3,400 feet) in all size classes from seedlings and saplings to 60-inch-d.b.h. trees. It increased rapidly in abundance above 2,800 feet to the upper limit of the study area where it was dominant. One tree measured 87.2 inches d.b.h. and taller trees were estimated as 200 feet tall. The bases of their small, rounded crowns were somewhat above the main bulk of the canopy. Noble fir in the smaller size classes were not so numerous or vigorous as those of western hemlock. Local timberman confirmed that other unburned patches over 3,000-foot elevation in the Tillamook Burn area contain substantial amounts of noble fir.

149. Newlin, J. A., and Wilson, Thomas R. C.
1917. Mechanical properties of woods grown in the United States. U.S. Dept. Agr. Bul. 556, 47 pp., illus.

150. _____ and Wilson, T. R. C.
1919. The relation of the shrinkage and strength properties of wood to its specific gravity. U.S. Dept. Agr. Bul. 676, 35 pp., illus.

150a. Noelle, W.
1910. Studien zur vergleichenden Anatomie und Morphologie der Koniferenwurzeln mit Rücksicht auf die Systematik. Bot. Zeitung 68(pt. 1): 169-266, illus.

Information on the root anatomy and morphology of noble fir.

151. Northwest Forest Tree Seed Committee.
1959. Rules for service testing forest tree seed of the Pacific Northwest. Oreg. State Col. Agr. Expt. Sta. Misc. Paper 83, 27 pp. (Processed.)

Five ounces of noble fir seed are required for the standard tests--purity, germination, 1,000-seed count, and cutting. A weight of 100

grams is the minimum working sample which should be used for purity determination. Three procedures for testing noble fir germination are provided. Suggested standards for noble fir seed are 50 percent sound, 95 percent pure, and 35 percent viable by the peroxide test. Optimum moisture content for long-term cold storage is 9 to 12 percent.

152. Oosting, H. J., and Billings, W. D.
1943. The red fir forest of the Sierra Nevada: Abietum magnificae. Ecol. Monog. 13: 259-274, illus.

The authors conclude that the Abietum magnificae (California red fir) association is the Sierran example of the spruce-fir boreal forest and constitutes the true climax at medium-high elevations in the Sierra Nevada. Its vegetational constitution is adapted to wet winters with heavy snowfall and short, cool, dry growing seasons.

153. Ovington, J. D., and Madgwick, H. A. I.
1957. Afforestation and soil reaction. Jour. Soil Sci. 8: 141-149.

The pH of the leaves, litter, and rooting horizons were recorded under comparable conditions in 13 unplanted and 100 forest plots 17 to 50 years old. When arranged by species in order of increasing acidity of their underlying soils, noble fir ranks 12th among the 17 species studied, Douglas-fir, lodgepole pine, western hemlock, and European larch being associated with more acid conditions.

154. Pacific Northwest Forest Experiment Station.
1929. Cold storage prolongs the life of noble fir seed. In Forest Res. Notes 3, p. 8. (Processed.)

Experimental storage tests showed that noble fir seed stored at 15° F. loses its viability gradually and may be usable for 3 to 5 years. Seed stored at room temperature lost its viability in a single year.

155. Pacific Northwest Forest and Range Experiment Station.
1955. Annual report, 1954. 68 pp., illus. (Processed.)

156. _____
1959. Annual report, 1958. 94 pp., illus.

Treatment of planted noble fir seedlings with nitrogen fertilizer (45-0-0) or nitrogen and phosphorus fertilizer (16-20-0) caused a sharp reduction in survival; growth response of surviving seedlings was inconclusive.

157. Paul, Benson H.
1959. The effect of environmental factors on wood quality. U.S. Forest Serv. Forest Prod. Lab. Rpt. 2170, 48 pp. (Processed.)

Noble fir wood has an average specific gravity of 0.37 with a variation from 0.33 for wood with 0 to 10 rings per inch to 0.40 for wood with over 21 rings per inch. Specific gravity values overlap among sites and stands as well as among and within individual trees in a stand. Control of specific gravity can probably be obtained by close initial stocking followed by thinnings to maintain an even growth rate. The recommended growth rate for second-growth noble fir is eight rings per inch.

True firs are often subject to heavy snowloads and consequent bending when young. Compression wood is formed on the underside of bent trees, and trees which are unable to straighten themselves form this wood indefinitely. Removal of bent and leaning trees is therefore an important phase of stand improvement work with these species.

158. _____, Dohr, Alfred W., and Drow, John T.
1959. Some physical and mechanical properties of noble fir. U.S. Forest Serv. Forest Prod. Lab. Rpt. 2168, 14 pp., illus. (Processed.)

Results of tests made of specific gravity, shrinkage, toughness, and compression on wood specimens cut from noble fir trees grown in three locales in the Cascade Range of Oregon and Washington. Despite an effort to select sample trees standing as nearly vertical as possible, the wood collected contained considerable compression wood.

159. Peakes, L. V., Jr., Lloyd, R. A., Barnes, V. S., and others.
1945. Substitute woods for Port Orford white-cedar for storage battery separators. U.S. Forest Serv. Forest Prod. Lab. Rpt. 1476, 16 pp., illus. (Processed.)

160. Peattie, Donald Culross, ed.
1953. A natural history of western trees. 751 pp., illus. Boston: Houghton Mifflin Co.

161. Peavy, George W.
1929. Oregon's commercial forests. Oreg. State Bd. Forestry Bul. 2 (rev.), 94 pp., illus.

162. Peck, Morton Eaton.
1941. A manual of the higher plants of Oregon. 866 pp., illus. Portland, Oreg.: Binfords & Mort.

163. Penhallow, David Pearce.
1904. The anatomy of North American Coniferales. Amer. Nat. 38: 243-273, illus.

164. _____
1907. A manual of the North American gymnosperms. 374 pp., illus. Boston: Ginn & Co.

165. Piper, Charles V.
1906. Flora of the State of Washington. Contrib. U.S. Natl. Herb. vol. 11, 637 pp., illus.

The locale and collectors of noble fir specimens examined in the preparation of this article include Mount Baker by Johnson and Soleduck River, Olympic Mountains, by Sargent. Type locality for noble fir was near the "cascades of the Columbia" [Columbia River Gorge], where it was collected by Douglas.

166. _____ and Beattie, R. K.
1915. Flora of the northwest coast, including the area west of the summit of the Cascade Mountains, from the forty-ninth parallel south to the Calapooya Mountains on the south border of Lane County, Oregon. 418 pp. Lancaster, Pa.: Press of the New Era Printing Co.

167. Plummer, Fred G.
1900. Mount Rainier Forest Reserve, Washington. U.S. Geol. Survey 21st Ann. Rpt., 1899-1900, Part 5, Forest Reserves: 81-143, illus.

Noble fir was "...the finest timber tree in the forest..." of this southern Washington reserve. It was found at elevations of from 1,800 to 5,200 feet and "flourished" best at 3,000 feet. The largest trees found were 6 feet in diameter and 225 feet tall. Its short crown (one-third of total tree height) and straight, cylindrical trunk were noted. Age determinations of three trees--22-3/4, 17-1/2, and 33 inches in diameter--indicated they were 65, 67, and 174 years old.

168. _____
1902. Forest conditions in the Cascade Range, Washington, between the Washington and Mount Rainier Forest Reserves. U.S. Geol. Survey Prof. Paper 6, 42 pp., illus.

The area covered by this report lies in T. 19 N. to T. 28 N., R. 9 E., east to the Columbia River. An altitudinal range and development diagram indicated that noble fir occurred from about 2,300 to 4,850 feet in the area studied and reached maximum development between 3,800 and 4,800 feet. According to detailed reports on the various watersheds, noble fir was most prevalent in the Green and White River drainages.

169. Pope, Robert B.
1958. Final report, cooperative evaluation survey of Chermes damage, Mount St. Helens, Washington, 1957. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta., 25 pp., illus. (Processed.)

Damage from the balsam woolly aphid has been very severe near Mount St. Helens, Wash., and major landowners in this area cooperated in a survey to determine the total amount of dead and heavily damaged true firs. Within the 413,000-acre tract surveyed were 6 billion board feet of true fir timber. Noble fir constituted 10 percent of the timber volume of trees classed as lightly to moderately damaged by Chermes and 50 percent of the undamaged volume. No noble fir volume was classed as killed or heavily damaged.

170. Preston, Richard J., Jr.
1948. North American trees (exclusive of Mexico and tropical United States). 371 pp., illus. Ames, Iowa: Iowa State Col. Press.

171. Querengässer, F. A.
1958. Die pazifische Edeltanne Abies procera Rehd. (Abies nobilis Dougl.-Lind.). Holz.-Zbl. 84(114): 1453-1457.

A discussion of noble fir in Germany, including site and climatic requirements, provenances, suitable regions for introduction, silvicultural uses, planting and tending, utilization, and yield data from a 60-year trial plot at Diez, Rhineland.

172. Randall, Warren R.
1957. Manual of Oregon trees and shrubs. 234 pp. Corvallis, Oreg.: Oreg. State Col. Coop. Assoc.

173. Rave, D.
1952. Über den anbauwert einiger ausländischer holzarten. Forst u. Holz. 7: 311-314.

174. Redmond, J.
1950. Abies procera as a timber tree for exposed sites. Scot. Forestry 4: 87-93.

Noble fir has given good results when grown on high, dry, exposed sites in northern Ireland. It is best to grow it in pure stands because of its slow initial growth rate. If mixed planting is necessary, lodgepole pine is recommended.

175. Rehder, Alfred.
1940. Abies procera, a new name for A. nobilis Lindl. Rhodora 42: 522-524.

Noble fir is renamed because of an older homonym. Describes two varieties, glauca and prostrata, distinguished by glaucous foliage and a low spreading form, respectively. Another variety, robustifolia, is also discussed briefly.

176. Rehder, Alfred.
1940. Manual of cultivated trees and shrubs hardy in North America. Ed. 2, 996 pp., illus. New York: Macmillan Co.

177. Rhoads, Arthur S., Hedgcock, George G., Bethel, Ellsworth, and Hartley, Carl.
1918. Host relationships of the North American rusts, other than gymnosporangiums, which attack conifers. Phytopath. 8: 309-352.

Lists two leaf rusts and one stem and leaf rust which attack noble fir.

178. Ross, Charles R.
1957. Trees to know in Oregon. Oreg. State Col. Ext. Serv. Bul. 697 (rev.), 88 pp., illus. Corvallis, Oreg.: Oreg. State Col. Press.

179. Rudinsky, J. A.
1957. Notes on balsam woolly aphid. Weyerhaeuser Timber Co. Forestry Res. Center, 12 pp. (Processed.)

Rudinsky feels that noble fir is less susceptible to balsam woolly aphid than grand fir or Pacific silver fir, in the Northwest, at least.

180. _____ and Vité, J. P.
1959. Certain ecological and phylogenetic aspects of the pattern of water conduction in conifers. Forest Sci. 5: 259-266, illus.

Noble fir has a right-turning, spirally ascending water conducting system. This system results in greater water distribution than the four other systems detected in this study. A majority of the branches are connected with every root, decreasing the danger that loss of individual roots will decrease the water supply to entire tree sections, rendering them susceptible to secondary enemies. All of the Abies, Picea, Larix, and some of the Pinus species studied had the same type of water conducting system. Those with this type may respond quicker to environmental changes and thus be stronger in competition.

181. St. John, Harold, and Hardin, Edith.
1929. Flora of Mt. Baker. Mazama 11: 52-102, illus.

There is no mention of noble fir in this flora of the Mount Baker area.

182. St. John, Harold, and Warren, F. A.
1937. The plants at Mount Rainier National Park, Washington. Amer. Midland Nat. 18: 952-985.

183. Sargent, Charles S.
1898. The silva of North America. Vol. 12, 144 pp., illus. Boston, New York: Houghlin Mifflin Co.

An early dendrological reference. Excellent drawings of cones, foliage, etc. In 1896 Sargent identified a specimen of noble fir at an elevation of 3,000 feet above the Soleduc [sic] River in the Olympic Mountains. Dr. C. Hart Merriam made a similar observation the following year.

184. Sargent, Charles Sprague.
1922. Manual of the trees of North America (exclusive of Mexico). Ed. 2, 910 pp., illus. Boston, New York: Houghton Mifflin Co.

185. Schubert, G. H.
1952. Germination of various coniferous seeds after cold storage. U.S. Forest Serv. Calif. Forest and Range Expt. Sta. Res. Note 83, 7 pp. (Processed.)

Germination of noble fir seed stored in airtight containers at 41° F. dropped from 25 to 1 percent in 13 years. Another lot gave 2-percent germination after 11 to 20 years. (Reported in less detail in Jour. Forestry 52: 446-447.)

186. Schwenke, H. J.
1956. Einige Erfahrungen über die Anzucht von Abies nobilis (procera). Forsch. u. Berät. (Forstw.) Landesausach. tandw. Forsch. Landes Nordrhein-Westfalen 2, 1956: 116-127.

186a. _____
1961. Zur Anzucht von Abies procera (Rehd.). Forst-u. Holzw. 16: 263-264.

187. Seal, D. T.
1959. Collection of cones from standing trees. Brit. Forestry Comn. Forest Rec. 39, 33 pp., illus.

Good seed years occur every 4 to 5 years for noble fir. Normal months for collection are August and September. Cleaned seed yields approximately 2 pounds per bushel. Data on seedling and transplant yields in British nurseries are also included.

188. Shaw, Charles Gardner.
1958. Host fungus index for the Pacific Northwest. I. Hosts. Wash. Agr. Expt. Sta. Cir. 335, 127 pp.

Includes a complete listing of all fungi known to occur on noble fir.

189. Shaw, Charles Gardner.
1958. Host fungus index for the Pacific Northwest. II. Fungi. Wash. Agr. Expt. Sta. Cir. 336, 237 pp.

190. Silen, Roy R., and Woike, Leonard R.
1959. The Wind River Arboretum, 1912-1956. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta. Res. Paper 33, 50 pp., illus. (Processed.)

Two lots of noble fir were present in this southwestern Washington arboretum. Their growth rate was second only to grand fir among the 24 Abies species represented. Balsam woolly aphid had not attacked the noble fir and little climatic damage was found. The growth index of the species (using 1.00 for indigenous Douglas-fir) was 0.70.

191. Society of American Foresters.
1954. Forest cover types of North America (exclusive of Mexico). 67 pp., illus. Washington, D.C.: Soc. Amer. Foresters.

A noble fir type is considered too limited for recognition and is classified as a phase of the "Pacific silver fir-hemlock" type. Noble fir may also be a component of the "mountain hemlock-subalpine fir," "western hemlock," "Pacific Douglas-fir," and "Douglas-fir-western hemlock" types.

192. Staebler, George R.
1958. Silvical characteristics of noble fir. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta. Silvical Ser. 5, 12 pp., illus. (Processed.)

A summary of much of the available literature on the habitat and life history of noble fir. Includes some information on phenology and yield not published elsewhere.

193. Stein, William I.
1951. Germination of noble and silver fir seed on snow. Jour. Forestry 49: 448-449, illus.

Noble and Pacific silver fir seeds were observed germinating while still in the snowpack, and the resulting seedlings did not establish themselves in the soil. Broadcast sowing of true fir seed on snow might not be successful due to premature germination.

194. Stewart, D.
1945. Afforestation in Northern Ireland. Irish Forester 2: 54-56.

195. Sudworth, George B.
1908. Forest trees of the Pacific slope. Forest Serv. U.S. Dept. Agr., 441 pp., illus.

Information on botanical characteristics, general growth habits, and silvics of noble fir. Includes a general range description and notes on local observations of the species.

> Presence throughout range determined chiefly by abundant soil moisture, uniform, mild climate, and abundance of species competing with it. On gentle mountain slopes (of any aspect), depressions, benches, low ridges, and rolling plateaus. Vertical range increases from north to south and from coast eastward within a more or less fixed zone of heat and moisture. Latitude of range more restricted on east side of Cascades than on west, owing to lack of moisture and a severer climate. Thrives on moist, thin, rocky soils in cool situations, but best on deep, rich soils. Not so fastidious regarding quality of soil if abundant moisture is present...
>
> CLIMATIC CONDITIONS.--Not fully determined. In general, climate of range is mild, and mainly without extreme daily or seasonal temperatures. Precipitation, heavy; considerable snow, which does not remain late.

196. Suksdorf, William N., and Howell, Thomas.
1896. Flora of Mount Adams. Mazama 1: 68-97.

197. Taylor, Walter P.
1922. A distributional and ecological study of Mount Rainier, Washington. Ecol. 3: 214-236, illus.

198. Trappe, James M.
1961. Some probable mycorrhizal associations in the Pacific Northwest. III. Northwest Sci. 35: 91-94.

Reports a mycorrhizal association of Russula delica Fries with noble fir in Oregon and Washington.

199. U.S. Forest Service.
1948. Woody-plant seed manual. U.S. Dept. Agr. Misc. Pub. 654, 416 pp., illus.

Noble fir cones ripen in early September with seed dispersal occurring in October. Minimum commercial seed-bearing age is 50 to 60 years with ability to bear seed increasing to old age. Good cone crops are infrequent but some seed is produced every year. A bushel of cones produces

40 ounces of seed, and there are 11,200 to 19,300 cleaned seed per pound. Nine noble fir seed lots examined averaged 92 percent pure and 40 percent sound.

200. U.S. Forest Service.
1953. Density, fiber length, and yields of pulp for various species of wood. Forest Prod. Lab. Tech. Note 191, 2 pp. (Processed.)

201. _____
1955. Wood handbook. U.S. Dept. Agr. Handb. 72, 528 pp., illus.

Basic data on the wood characteristics, strength values, and related properties of noble fir--moisture content, shrinkage, stress values, toughness, and weight.

202. _____
1960. Cultural practices for growing Christmas trees in the Pacific Northwest. Pac. NW. Region Managing Your Woodland How To Do It Guides 5, 17 pp., illus. (Processed.)

203. _____
1960. Production and marketing of Christmas trees in the Pacific Northwest in 1959. Region 6, 21 pp., illus. (Processed.)

Noble fir and Shasta red fir accounted for 5.8 percent of the trees produced in Oregon, and noble fir and Pacific silver fir accounted for 0.6 percent of the trees produced in Washington. Noble fir brought the highest prices of any species, averaging $1.20 per lineal foot and ranging from $1 to $2. Noble fir boughs were the most popular item of decorative greenery sold, and some live noble fir trees, potted in gallon cans, were sold.

204. _____
1960. Selecting a good area for growing Christmas trees in the Pacific Northwest. Pac. NW. Region Managing Your Woodland How To Do It Guides 4, 11 pp., illus. (Processed.)

205. Varty, I. W.
1956. Adelges insects of silver firs. Brit. Forestry Comn. Bul. 26, 75 pp., illus.

Life histories of Adelges nusslini and A. piceae were studied on several species of Abies including noble fir in the laboratory and in the field. Reactions of noble fir to the attack of Adelges piceae included a pathological resin flow from small wounds on the bark (and even from areas where no apparent injury, except by the sistentes, was evident) and swellings of the buds and nodal areas. Noble fir appeared to show some resistance to both Adelges nusslini and A. piceae in the field but was fully susceptible to them in greenhouse tests. The nature of resistance mechanisms

is discussed briefly, late flushing being one factor discussed with particular reference to noble fir.

206. Viguié, Marie-Therese, and Gaussen, Henri.
1929. Revision du genre Abies. I. Historique. II. Description du genre. III. Monographie et iconographie des espéces. Trav. Lab. Forestier Toulouse, Tome 2, vol. 2, Art. I, 386 pp., illus.

207. Vité, J. P., and Rudinsky, J. A.
1959. The water-conducting systems in conifers and their importance to the distribution of trunk injecting chemicals. Contrib. Boyce Thompson Inst. 20: 27-38, illus.

208. Volbert, E.
1956. Holzeigenschaften von Gastbaumarten. Holz. Roh-u. Werkstoff 14: 81-86.

209. Vollmayer, H.
1955. Abies nobilis zur ertragssteigerung. Allg. Forstz. 10: 55.

210. Waterman, Alma M.
1945. Tip blight of species of Abies caused by a new species of Rehmiellopsis. Jour. Agr. Res. 70: 315-337, illus.

211. Weaver, John E., and Clements, F. E.
1938. Plant ecology. Ed. 2, 601 pp., illus. New York: McGraw-Hill Book Co. Inc.

212. Wells, Sidney D., and Rue, John D.
1927. The suitability of American woods for paper pulp. U.S. Dept. Agr. Bul. 1485, 102 pp., illus.

Presents data on the pulping of noble fir by sulphite, sulphate, and mechanical processes including cooking and strength data, yield, bleach requirements, and uses to which the pulp is suited.

213. West, W. I.
1949. A collection of Oregon woods. Oreg. State Col. School Forestry Cir. 1, 31 pp., illus.

214. Western Forestry and Conservation Association.
1950. Reports of the West Coast Forestry Procedures Committee on various recommended forest practices and techniques. 57 pp. Portland, Oreg.

215. Weyerhaeuser Timber Company.
1958. Annual report for 1957. Forestry Res. Center, 51 pp. (Processed.)

Test plantings of noble fir, Douglas-fir, grand fir, and Pacific silver fir were made on Chermes-infested cutovers. First-year development of noble fir and Douglas-fir contrasted sharply. Noble fir was 0.28 foot tall, less than half the height of the Douglas-fir; however, 18 percent of the noble fir was damaged versus 56 percent of the Douglas-fir. Two percent of the noble fir and 33 percent of the Douglas-fir were damaged by browsing.

Test applications of fertilizer were made to planted noble fir seedlings. Nitrogen, phosphorus, and potassium were applied at four levels each in the planting holes. No injury by fertilizer or wildlife was noted.

In a greenhouse test, noble fir and Pacific silver fir appeared to be equally susceptible to attack and damage by the balsam woolly aphid. Under forest conditions noble fir was infested, but larger trees were not seriously damaged.

216. Weyerhaeuser Timber Company.
1959. 1958 forestry research report. Forestry Res. Center, 39 pp., illus. (Processed.)

Seed processing equipment used by Weyerhaeuser Timber Co. may cause serious impact damage to noble fir seed, resulting in decreased germination rates. Germination tests made after the different processing stages showed a decrease in germination from the "after kiln" to "air lock in blower" stage which was statistically significant.

217. Whittaker, R. H.
1960. Vegetation of the Siskiyou Mountains, Oregon and California. Ecol. Monog. 30: 279-338, illus.

Noble fir and mountain hemlock dominate forests growing on soils of quartz diorite origin above 5,800-foot elevation in the central Siskiyou Mountains of Oregon. Their relative proportions were not strongly correlated with elevation or site, suggesting that stand composition was to some extent determined by chance. Noble fir tended to dominate on the more xeric sites and at lower elevations, however. Similar forests occupy the more mesic sites on soils derived from periodotite and serpentine above 5,800-foot elevation. At higher elevations on gabbro-derived soils, stands dominated by Brewer spruce and noble fir occur. Floral descriptions of the noble fir–mountain hemlock communities are included.

218. Wiesehuegel, E. G.
1932. Diagnostic characteristics of the xylem of the North American Abies. Bot. Gaz. 93: 55-70, illus.

A detailed wood anatomy study of 11 indigenous species of Abies including noble fir, California red fir, and Shasta red fir. Presents

tabulated data on wood tracheid measurements, ring widths, ray volumes, and other diagnostic characters. In a key the three red firs are separated immediately from the other Abies species on the basis of color and presence of resin cells in early springwood. Noble fir is separated from the other two red firs by several characteristics, including absence of crystals in ray parenchyma, partly biseriate rays, numerous resin cells, and high percent of summerwood.

219. Wilcox, Hugh.
1954. Primary organization of active and dormant roots of noble fir, Abies procera. Amer. Jour. Bot. 41: 812-821, illus.

The root system of noble fir is characterized by a slow-growing main root from which a few large, rapidly growing, and sparsely branched lateral roots of wide ramification arise. The 1- to 3-year-old noble fir seedling does not have a prominent tap root nor is the root fibrous in appearance.

220. _____
1955. Regeneration of injured root systems in noble fir. Bot. Gaz. 116: 221-234, illus.

Nearly all pruned roots of 1- to 3-year-old noble fir seedlings regenerated laterals within 20 to 30 days between June and September, the period of most active repair. Some seedlings also regenerated roots in February and March. Root regeneration has no relation to shoot growth or to the growth rate of the root system.

Root pruning of noble fir seedlings does not result in a compact fibrous root system. The severance of various roots results in the origin of replacement roots near the pruned surfaces rather than large numbers of laterals along the length of the roots. These replacement roots elongate rapidly and are as likely to be lost in transplanting as are the long laterals in the unpruned seedlings.

221. Williston, E. M.
1960. Proposed: New stress values for the coast white woods. Forest Prod. Jour. 10: 621-625, illus.

Compares presently published data on strength properties of the "coast white woods" (western hemlock, grand fir, Pacific silver fir, and noble fir) with new data from tests conducted by Weyerhaeuser Co. The author concludes present stress values are too conservative and recommends these woods be grouped at a higher level of stress values until more information is available. Noble fir accounts for the least volume of the species under discussion--8.4 billion board feet of a total of 189.3 billion.

222. Winkenwerder, Hugo, and Wangaard, Frederick F.
1939. Short keys to the native trees of Oregon and Washington. 19 pp. Seattle: Imperial Publishing Co.

223. Wodehouse, R. P.
1935. Pollen grains. 574 pp., illus. New York: McGraw-Hill Book Co. Inc.

224. Wyman, Donald.
1943. A simple foliage key to the firs. Arnoldia 3: 65-71, illus.

225. Wynd, F. Lyle.
1941. Life zones of Crater Lake. Amer. Midland Nat. 25: 324-342, illus.

Noble fir is listed as an important component of the mountain hemlock forests which occupy most of the Hudsonian Zone in Crater Lake National Park.

226. Youngberg, C. T.
1958. The uptake of nutrients by western conifers in forest nurseries. Jour. Forestry 56: 337-340.

Includes data on the dry weight production, nutrient content, and nutrient removal of noble fir seedlings at Greeley (Wash.) and Wind River (Wash.) Nurseries.

227. Zehetmayr, J. W. L.
1954. Experiments in tree planting on peat. Brit. Forestry Comn. Bul. 22, 110 pp., illus.

228. _____
1960. Afforestation of upland heaths. Brit. Forestry Comn. Bul. 32, 145 pp., illus.

LIST OF TREE SPECIES MENTIONED IN BIBLIOGRAPHY

Abies amabilis (Dougl.) Forbes	Pacific silver fir
Abies concolor (Gord. & Glend.) Lindl.	white fir
Abies grandis (Dougl.) Lindl.	grand fir
Abies lasiocarpa (Hook.) Nutt.	subalpine fir
Abies magnifica A. Murr.	California red fir
Abies magnifica var. shastensis Lemm.	Shasta red fir
Abies procera Rehd.	noble fir
Abies venusta now A. bracteata D. Don.	bristlecone fir
Acer circinatum Pursh.	vine maple
Alnus sinuata (Reg.) Rydb.	Sitka alder
Larix decidua Mill.	European larch
Picea abies (L.) Karst.	Norway spruce
Picea breweriana S. Wats.	Brewer spruce
Pinus contorta Dougl.	lodgepole pine
Pinus monticola Dougl.	western white pine
Pseudotsuga menziesii (Mirb.) Franco	Douglas-fir
Tsuga heterophylla (Raf.) Sarg.	western hemlock
Tsuga mertensiana (Bong.) Carr.	mountain hemlock

GPO 997444