

SPECIES: Pinus strobiformis

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Photo by Chris Schnepf, University of Idaho, Bugwood.org

INTRODUCTORY

AUTHORSHIP AND CITATION :

Pavek, Diane S. 1993. Pinus strobiformis. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [2010, June 21].

ABBREVIATION :

PINSTO

SYNONYMS :

Pinus reflexa Engelm.
Pinus ayacahuite var. strobiformis Lemmon

SCS PLANT CODE :

PIST3

COMMON NAMES :

southwestern white pine
Mexican white pine
border white pine
pino enano

TAXONOMY :

The currently accepted scientific name of southwestern white pine is *Pinus strobiformis* Engelm. [6]. There are no recognized subspecies, varieties, or forms. Southwestern white pine hybridizes with limber pine (*P. flexilis* James) where their ranges overlap [6,17,53].

LIFE FORM :

Tree

FEDERAL LEGAL STATUS :

No special status

OTHER STATUS :

NO-ENTRY

DISTRIBUTION AND OCCURRENCE

SPECIES: Pinus strobiformis

GENERAL DISTRIBUTION :

Southwestern white pine has a limited distribution. It is found in the mountains of western Texas, New Mexico, Arizona, and southwestern Colorado [[15](#), [16](#), [50](#)]. It extends south along the mountains to central Mexico; most of its distribution is in Mexico [[44](#), [50](#), [65](#)].

ECOSYSTEMS :

FRES21 Ponderosa pine
FRES23 Fir - spruce

STATES :

AZ CO NM TX MEXICO

BLM PHYSIOGRAPHIC REGIONS :

7 Lower Basin and Range
11 Southern Rocky Mountains
12 Colorado Plateau
13 Rocky Mountain Piedmont

KUCHLER PLANT ASSOCIATIONS :

K018 Pine - Douglas-fir forest
K019 Arizona pine forest
K020 Spruce - fir - Douglas-fir forest
K021 Southwestern spruce - fir forest

SAF COVER TYPES :

206 Engelmann spruce - subalpine fir
210 Interior Douglas-fir
211 White fir
216 Blue spruce
217 Aspen
219 Limber pine
237 Interior ponderosa pine

SRM (RANGELAND) COVER TYPES :

NO-ENTRY

HABITAT TYPES AND PLANT COMMUNITIES :

Southwestern white pine normally occurs in low densities in southwestern pine, mixed-conifer, and spruce-fir forests [[67](#)]. It occurs as an associate in habitat type series of the major conifers in these forests [[3](#), [4](#), [5](#), [17](#), [26](#), [52](#)]. Southwestern white pine infrequently forms small pure stands; it is most likely to be dominant in high-elevation, cool habitats [[49](#), [51](#), [53](#)].

Southwestern white pine may be present as a minor component in riparian community types in south-central Arizona and in the montane riparian woodland zone of southwestern Colorado [[9](#), [70](#)].

Southwestern white pine is listed as an indicator species in the following publications:

- (1) Classification of the forest vegetation on the National Forests of Arizona and New Mexico [[5](#)]
- (2) A classification of forest habitat types of northern New Mexico and southern Colorado [[18](#)]
- (3) Forest habitat types in the Apache, Gila, and part of the Cibola National Forests, Arizona and New Mexico [[26](#)]
- (4) Forest and woodland habitat types (plant associations) of northern New Mexico and northern Arizona [[49](#)]
- (5) A classification of spruce-fir and mixed conifer habitat types of Arizona and New Mexico [[51](#)].

MANAGEMENT CONSIDERATIONS

SPECIES: Pinus strobiformis

WOOD PRODUCTS VALUE :

Southwestern white pine wood is soft, not resinous, and white with a slightly darker heartwood. It is used locally for cabinetry, doors, and window frames [53]. Crooked stems and coarse branches make it undesirable for lumber [41].

IMPORTANCE TO LIVESTOCK AND WILDLIFE :

Seeds of southwestern white pine are eaten by small mammals and birds. It is not generally browsed by game animals or livestock [41]. Southwestern white pine was seldom used by birds in either logged or unlogged forest areas [27].

Southwestern white pine is often found in mixed-conifer forests that are valuable summer habitat for big and small game animals, rodents, and game and nongame birds [19,25]. Since natural regeneration of clearcut mixed-conifer forests on south-facing slopes requires 50 to 100 years, these clearcut areas can be a valuable long-term forage resource for deer and elk [71].

PALATABILITY :

Southwestern white pine seeds are palatable to small mammals and birds [11,34].

NUTRITIONAL VALUE :

NO-ENTRY

COVER VALUE :

NO-ENTRY

VALUE FOR REHABILITATION OF DISTURBED SITES :

NO-ENTRY

OTHER USES AND VALUES :

Southwestern white pine is grown as an ornamental [73,78].

OTHER MANAGEMENT CONSIDERATIONS :

Silviculture: Various silviculture systems have been used in the mixed-conifer forests where southwestern white pine occurs.

The average annual growth of southwestern white pine was less than 0.1 inch (0.25 cm) per year in a virgin mixed-conifer stand in Arizona. The initial volume of southwestern white pine was 1,097 board feet per acre, and after 5 years, the volume was 1,163 board feet per acre [30].

Small patch clearcutting has been used for regeneration of southwestern white pine and associated conifers in old-growth mixed-conifer stands [24,32]. Regeneration density of southwestern white pine per acre was low after 10 years [24].

Gray [33] classified southwestern white pine as a suitable seed tree. Southwestern white pine regeneration by seed trees was not successful, however, in communities at 9,500 to 10,000 feet (2,896-3,048 m); revegetation was very slow [49].

Spot seeding yielded a low number of surviving southwestern white pine seedlings in east-central Arizona [39,43]. Rodents were controlled, but frost heaving and unsuitable tree ecotypes could have factored into the seedling mortality [39]. Heavy broadcast seeding of southwestern white pine should be used instead of spot seeding [43].

Planting southwestern white pine seedlings at different elevations and densities are discussed in detail [41].

Wildlife: Patch clearcuts were evaluated for forage production and utilization by ungulates. Understory production significantly ($p < 0.05$) increased on clearcut areas; however, utilization by ungulates did not differ significantly ($p > 0.05$) [23]. Equations are available for predicting forage production in mixed-conifer forests [22,48]. Patch clearcuts removed about 30 percent of the total basal area in an uneven-aged virgin Arizona mixed-conifer forest, which did not adversely affect the nesting or feeding of birds [62]. This method reduced southwestern

white pine basal area by 47 percent on northern aspects and by 13 percent on southern aspects.

Some of the mixed-conifer forests that southwestern white pine is in provide habitat for sensitive and threatened species such as Mexican spotted owl, northern goshawk, and Sacramento Mountain salamander [28,56,61].

Damaging agents: Southwestern white pine is the principal host of Apache dwarf mistletoe (*Arceuthobium apachecum*). Infected trees have reduced growth, increased susceptibility to other infections, insects, and mortality [35,75]. Southwestern white pine is infected by red ring rot and by root and butt rots [75]. Southwestern white pine seedlings received an average overall ranking of 8.8 in trials for resistance to white pine blister rust; a score of 11 was the lowest resistance [38].

Other factors: Various methods of weed suppression made no significant ($p=0.10$) difference in growth of southwestern white pine produced in containers [7].

Southwestern white pine has good potential for Christmas tree production in the eastern United States [36,78].

Southwestern white pine is planted along streets in urban areas. Its foliage has an intermediate susceptibility to salt spray; medium foliar injury with moderate growth reduction occurred [73].

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: *Pinus strobiformis*

GENERAL BOTANICAL CHARACTERISTICS :

Southwestern white pine is a native, evergreen conifer with an open, irregular crown. It can grow to 90 feet (27 m) tall with diameters to 3.2 feet (1 m) [15,53,64]. The bark is thin, rough, and furrowed [15,54]. Branches are long and horizontal to pendant [53]. Needles are 2.4 to 4 inches (6-10 cm) long in fascicles of five [53]. The cones are 2.8 to 9.8 inches (7-25 cm) long with reflexed, thick scales; cones are dehiscent when mature [15,46]. Seeds are essentially wingless and 0.4 to 0.5 inch (10-12 mm) long [15,53].

RAUNKIAER LIFE FORM :

Phanerophyte

REGENERATION PROCESSES :

Southwestern white pine reproduces sexually. It begins to produce cones when pole sized or about 15 years [39,44]. The interval between seed crops for any one tree is 3 to 4 years [44]. Seed traps were placed in clearcut mixed-conifer forest in Arizona to monitor regeneration over 3 years. No southwestern white pine seeds were found in the traps [39].

Southwestern white pine seeds require 2 weeks to 4 months stratification before germinating [43,44,78]. Germinability can vary between 52 and 95 percent [43,44]. Seed collection and germination methods are discussed in detail [36,44].

Seeds of the southwestern white pine ripen synchronously throughout a forest and overwhelm the harvesting efforts of predators [11,34]. Red squirrels clip entire cones and cache them [34]. The wingless seeds are dispersed by birds, primarily by the Steller's jay and [Clark's nutcracker](#) [11,47,72]. Animal caches result in clustered stands [72].

Southwestern white pine seedlings root deeply (to about 8 inches [20.3 cm]) the first year, which increases their survival under drought conditions [40,43]. All of the southwestern white pine seedlings died in a greenhouse experiment that assessed the drought resistance of conifers along an elevational gradient. Southwestern white pine died after significantly ($p<0.05$) fewer days than other conifer species from lower elevations [10].

With the initial deep root growth, southwestern white pine seedlings had the slowest top growth rate of four conifer species measured. At about 6 years of age, the average height of southwestern white pine seedlings

was 13.3 inches (33.8 cm) [40]. In another study, 2-year-old seedlings were between 4 and 8 inches (10.2-20.3 cm) tall [36].

SITE CHARACTERISTICS :

Southwestern white pine is widespread in mesic sites on ridges, slopes, and canyons of montane zones [15]. The best growth of this species occurs on moist, cool sites with deep soil [14,53]. The climate is semiarid, characterized by mild winters and warm summers. There are two wet seasons: July to September and December to March [2,10]. Average precipitation ranges from 19.2 to 45 inches (487-1,143 mm) per year [25,27,57].

Southwestern white pine occurs in ravines or on mesic lower slopes at 5,000 feet (1,525 m) in southeastern Arizona and goes up to timberline in southwestern Colorado [52,76]. It is typically found at elevations from 6,000 to 10,000 feet (1,830-3,048 m) [17,52]. Southwestern white pine often occurs on north- to east-facing slopes, but it has been reported on all aspects [1,11,17,57,71].

Southwestern white pine is found on sites with loamy soil textures ranging from shallow, gravelly loams to deep, sandy loams to stony silty clay loams [23,30,32,40].

Two to nine conifer species occur in the southwestern mixed-conifer forest type. Their proportions vary depending on site characteristics [37,48]. Some associated species not mentioned in Distribution and Occurrence are listed below. Associated tree species are New Mexico locust (*Robinia neomexicana*), Gambel oak (*Quercus gambelii*), and silverleaf oak (*Quercus hypoleucoides*) [14]. Associated shrubs are mountain snowberry (*Symphoricarpos oreophilus*), bush oceanspray (*Holodiscus dumosus*), Arizona honeysuckle (*Lonicera arizonica*), and Fendler ceanothus (*Ceanothus fendleri*) [8,14,23,57]. Other associated plants are Arizona fescue (*Festuca arizonica*), screwleaf muhly (*Muhlenbergia virescens*), pine dropseed (*Blepharoneuron tricholepsis*), Arizona wheatgrass (*Elymus arizonicus*), and western yarrow (*Achillea lanulosa*) [8,23,51].

SUCCESSIONAL STATUS :

Southwestern white pine is frequently a persistent, long-lived seral or climax species in mixed-conifer forests [4,26,51]. It has been classified as an early successional major tree [60]. Southwestern white pine infrequently is a climax dominant or codominant in open stands [4,51,69].

Southwestern white pine is relatively shade intolerant compared to other associated conifers in the southwestern mixed-conifer forests. It is relatively resistant to damage from full sunlight [41]. In 8 out of 12 sites in New Mexico, southwestern white pine was in the overstory, but in only 2 of those 12 sites was it in the understory. Ahlstrand [1] suggested that canopy closure prevented southwestern white pine replacement at these sites.

SEASONAL DEVELOPMENT :

Southwestern white pine flowers in June. Cones mature in September, and seeds are dispersed from September to October [44]. Southwestern white pine seeds germinate either in the spring or in the summer after the rains begin [40].

FIRE ECOLOGY

SPECIES: *Pinus strobiformis*

FIRE ECOLOGY OR ADAPTATIONS :

Southwestern white pine is not fire adapted; it does not have fire-induced sprouting, seed germination, or biomass increases [12]. Southwestern white pine is fire sensitive in young age classes. Older trees with somewhat thicker bark are relatively more fire resistant [20]. The thin bark and horizontal or drooping branches increase its susceptibility to fire.

Lightning-ignited fires occur in the southwestern forests during spring

or early summer before the rains begin [2]. Arizona and New Mexico mixed-conifer forests have the highest frequency of lightning fires in the United States [77].

Fire-scarred cross sections of living and dead southwestern white pine and other conifers were examined to determine the role of fire in southwestern forests. Over time spans of 288 and 426 years, the average intervals between fires in western Texas and east-central Arizona were 4.7 to 9 or 22 years [2,8,20]. These chronologies have been used with climatic data to develop fire hazard forecasting models [68].

POSTFIRE REGENERATION STRATEGY :

Tree without adventitious-bud root crown
Secondary colonizer - off-site seed

FIRE EFFECTS

SPECIES: Pinus strobiformis

IMMEDIATE FIRE EFFECT ON PLANT :

Fire damaged stems of young (less than 15 years) southwestern white pine usually die; older trees (more than 50 years) are susceptible to scarring [2].

No information was found in the literature about the fire susceptibility of southwestern white pine seeds stored in caches. It is possible that soil may sufficiently insulate cached seeds from fire damage.

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :

NO-ENTRY

PLANT RESPONSE TO FIRE :

Southwestern white pine may establish after fire through bird-dispersed seeds.

While southwestern white pine is known to be an important seral tree following fire, such as in white fir-Douglas-fir (*Abies concolor*-*Pseudotsuga menziesii*)/Gambel oak habitat types, no information was found in the literature about southwestern white pine rates of recovery after fire [51].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE :

NO-ENTRY

FIRE MANAGEMENT CONSIDERATIONS :

Prediction of natural fuel loadings in southwestern mixed-conifer forests is difficult; much variation exists within and between stands [58]. Sackett [59] reported average square diameter and specific gravity for southwestern white pine and other conifers in different size classes, making the planar intersect method of fuel evaluation applicable to southwestern forests.

Regeneration by prescribed fire of mixed-conifer series for wildlife has been discussed in detail [63].

REFERENCES

SPECIES: Pinus strobiformis

REFERENCES :

1. Ahlstrand, Gary M. 1979. Preliminary report on the ecology of fire study, Guadalupe Mountains and Carlsbad Caverns National Parks. In: Genoways, Hugh H.; Baker, Robert J., eds. Biological investigations in

- the Guadalupe Mountains National Park: Proceedings of a symposium; 1975 April 4-5; Lubbock, TX. Proceedings and Transactions Series No. 4. Washington, DC: U.S. Department of the Interior, National Park Service: 31-44. [16015]
2. Ahlstrand, Gary M. 1980. Fire history of a mixed conifer forest in Guadalupe Mountains National Park. In: Stokes, Marvin A.; Dieterich, John H., technical coordinators. Proceedings of the fire history workshop; 1980 October 20-24; Tucson, AZ. Gen. Tech. Rep. RM-81. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 4-7. [16035]
 3. Alexander, Billy G., Jr.; Ronco, Frank, Jr.; Fitzhugh, E. Lee; Ludwig, John A. 1984. A classification of forest habitat types of the Lincoln National Forest, New Mexico. Gen. Tech. Rep. RM-104. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 29 p. [300]
 4. Alexander, Billy G., Jr.; Ronco, Frank, Jr.; White, Alan S.; Ludwig, John A. 1984. Douglas-fir habitat types of northern Arizona. Gen. Tech. Rep. RM-108. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 13 p. [301]
 5. Alexander, Robert R.; Ronco, Frank, Jr. 1987. Classification of the forest vegetation on the National Forests of Arizona and New Mexico. Res. Note RM-469. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 p. [3515]
 6. Andresen, John W.; Steinhoff, Raphael J. 1971. The taxonomy of *Pinus flexilis* and *P. strobiformis*. *Phytologia*. 22(2): 57-70. [332]
 7. Appleton, Bonnie L.; Derr, Jeffrey F. 1990. Use of geotextile disks for container weed control. *HortScience*. 25(6): 666-668. [20642]
 8. Baisan, Christopher H.; Swetnam, Thomas W. 1990. Fire history on a desert mountain range: Rincon Mountain Wilderness, Arizona, U.S.A. *Canadian Journal of Forest Research*. 20: 1559-1569. [14986]
 9. Baker, William L. 1988. Size-class structure of contiguous riparian woodlands along a Rocky Mountain river. *Physical Geography*. 9(1): 1-14. [9269]
 10. Barton, Andrew M. 1992. Factors controlling lower elevational limits of plants: responses of pines to drought in the Chiricahua Mountains, Arizona. In: Ffolliott, Peter F.; Gottfried, Gerald J.; Bennett, Duane A.; [and others], technical coordinators. Ecology and management of oak and associated woodlands: perspectives in the sw United States & n Mexico: Proceedings; 1992 April 27-30; Sierra Vista, AZ. Gen. Tech. Rep. RM-218. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 191-194. [19764]
 11. Benkman, Craig W.; Balda, Russell P.; Smith, Christopher C. 1984. Adaptations for seed dispersal and the compromises due to seed predation in limber pine. *Ecology*. 65(2): 632-642. [429]
 12. Wright, T. W.; Will, G. M. 1958. The nutrient content of Scots and Corsican pines growing on sand dunes. *Forestry*. 31: 13-25. [18334]
 13. Bernard, Stephen R.; Brown, Kenneth F. 1977. Distribution of mammals, reptiles, and amphibians by BLM physiographic regions and A.W. Kuchler's associations for the eleven western states. Tech. Note 301. Denver, CO: U.S. Department of the Interior, Bureau of Land Management. 169 p. [434]
 14. Bowers, Janice E.; McLaughlin, Steven P. 1987. Flora and vegetation of the Rincon Mountains, Pima County, Arizona. *Desert Plants*. 8(2): 50-94. [495]
 15. Correll, Donovan S.; Johnston, Marshall C. 1970. Manual of the vascular plants of Texas. Renner, TX: Texas Research Foundation. 1881 p. [4003]
 16. Davila, Vidal, Jr. 1989. Tamarisk eradication efforts at Gaudalupe Mountains National Park, Texas. In: Kunzmann, Michael R.; Johnson, R. Roy; Bennett, Peter, technical coordinators. Tamarisk control in southwestern United States; 1987 September 2-3; Tucson, AZ. Special Report No. 9. Tucson, AZ: National Park Service, Cooperative National Park Resources Studies Unit, School of Renewable Natural Resources: 28-32. [11344]

17. DeVelice, Robert L.; Ludwig, John A. 1983. Forest habitat types south of the Mogollon Rim, Arizona and New Mexico. Final Report. Cooperative Agreement No. 28-K2-240 between U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station and New Mexico State University. Las Cruces, NM: New Mexico State University. 47 p. [780]
18. DeVelice, Robert L.; Ludwig, John A.; Moir, William H.; Ronco, Frank, Jr. 1986. A classification of forest habitat types of northern New Mexico and southern Colorado. Gen. Tech. Rep. RM-131. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 59 p. [781]
19. Diem, Kenneth L.; Zeveloff, Samuel I. 1980. Ponderosa pine bird communities. In: DeGraaf, Richard M., technical coordinator. Management of western forests and grasslands for nongame birds: Workshop proceedings; 1980 February 11-14; Salt Lake City, UT. Gen. Tech. Rep. INT-86. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 170-197. [17904]
20. Dieterich, John H. 1983. Fire history of southwestern mixed conifer: a case study. Forest Ecology. 6: 13-31. [5242]
21. Eyre, F. H., ed. 1980. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters. 148 p. [905]
22. Ffolliott, Peter F. 1983. Overstory-understory relationships: Southwestern ponderosa pine forests. In: Bartlett, E. T.; Betters, David R., eds. Overstory-understory relationships in western forests. Western Regional Research Publication No. 1. Fort Collins, CO: Colorado State University Experiment Station: 13-18. [3311]
23. Ffolliott, Peter F.; Gottfried, Gerald J. 1989. Production and utilization of herbaceous plants in small clearcuts in an Arizona mixed conifer forest. Res. Note RM-494. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 5 p. [10543]
24. Ffolliott, Peter F.; Gottfried, Gerald J. 1991. Mixed conifer and aspen regeneration in small clearcuts within a partially harvested Arizona mixed conifer forest. Res. Pap. RM-294. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 9 p. [14625]
25. Ffolliott, Peter F.; Thorud, David B. 1974. Vegetation for increased water yield in Arizona. Tech. Bull. 215. Tucson, AZ: University of Arizona, Agricultural Experiment Station. 38 p. [4448]
26. Fitzhugh, E. Lee; Moir, William H.; Ludwig, John A.; Ronco, Frank, Jr. 1987. Forest habitat types in the Apache, Gila, and part of the Cibola National Forests, Arizona and New Mexico. Gen. Tech. Rep. RM-145. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 116 p. [4206]
27. Franzreb, Kathleen E. 1977. Bird population changes after timber harvesting of a mixed conifer forest in Arizona. Res. Pap. RM-184. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 26 p. [19331]
28. Ganey, Joseph L.; Duncan, Russell B.; Block, William M. 1992. Use of oak and associated woodlands by Mexican spotted owls in Arizona. In: Ffolliott, Peter F.; Gottfried, Gerald J.; Bennett, Duane A.; [and others], technical coordinators. Ecology and management of oaks and associated woodlands: perspectives in the sw United States & n Mexico: Proceedings; 1992 April 27-30; Sierra Vista, AZ. Gen. Tech. Rep. RM-218. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 125-128. [19751]
29. Garrison, George A.; Bjugstad, Ardell J.; Duncan, Don A.; [and others]. 1977. Vegetation and environmental features of forest and range ecosystems. Agric. Handb. 475. Washington, DC: U.S. Department of Agriculture, Forest Service. 68 p. [998]
30. Gottfried, Gerald J. 1978. Five-year growth and development in a virgin Arizona mixed conifer stand. Res. Pap. RM-203. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 22 p. [15661]
31. Gottfried, Gerald J. 1983. Stand changes on a Southwestern mixed conifer watershed after timber harvesting. Journal of Forestry. 83(5): 311-316.

[10516]

32. Gottfried, Gerald J. 1992. Growth and development in an old-growth Arizona mixed conifer stand following initial harvesting. *Forest Ecology and Management*. 54: 1-26. [20231]
33. Gray, Susan E. 1991. Seed-tree regeneration method: Silvicultural considerations. In: Genetics/silviculture workshop proceedings; 1990 August 27-31; Wenatchee, WA. Washington, DC: U.S. Department of Agriculture, Forest Service, Timber Management Staff: 183-219. [16028]
34. Halvorson, Curtis H. 1986. Influence of vertebrates on conifer seed production. In: Shearer, Raymond C., compiler. Proceedings--conifer tree seed in the Inland Mountain West symposium; 1985 August 5-6; Missoula, MT. Gen. Tech. Rep. INT-203. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 201-222. [13115]
35. Hawksworth, Frank G. 1978. Biological factors of dwarf mistletoe in relation to control. In: Scharpf, Robert F.; Parmeter, John R., Jr., technical coordinators. Proceedings of the symposium on dwarf mistletoe control through forest management; 1978 April 11-13; Berkeley, CA. Gen. Tech. Rep. PSW-31. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 5-15. [14249]
36. Heit, C. E. 1973. Propagation from seed. Part 24. Testing and growing limber and Mexican border pines. *American Nurseryman*. 137: 8-9; 64-74. [20643]
37. Hermann, Richard K.; Lavender, Denis P. 1990. *Pseudotsuga menziesii* (Mirb.) Franco Douglas-fir. In: Burns, Russell M.; Honkala, Barbara H., technical coordinators. *Silvics of North America*. Volume 1. Conifers. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service: 527-540. [13413]
38. Hoff, R.; Bingham, R. T.; McDonald, G. I. 1980. Relative blister rust resistance of white pines. *European Journal of Forest Pathology*. 10(5): 307-316. [1177]
39. Jones, John R. 1967. Regeneration of mixed conifer clearcuttings on the Apache National Forest, Arizona. Res. Note RM-79. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p. [16082]
40. Jones, John R. 1971. Mixed conifer seedling growth in eastern Arizona. Res. Note RM-77. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 19 p. [16497]
41. Jones, John R. 1974. Silviculture of southwestern mixed conifers and aspen: The status of our knowledge. Res. Pap. RM-122. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 44 p. [16081]
42. Jones, John R. 1974. A spot seeding trial with southwestern white pine and blue spruce. Res. Note RM-265. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p. [20644]
43. Jones, John R. 1975. Regeneration on an aspen clearcut in Arizona. Res. Note RM-285. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p. [16484]
44. Krugman, Stanley L.; Jenkinson, James L. 1974. Pinaceae--pine family. In: Schopmeyer, C. S., technical coordinator. *Seeds of woody plants in the United States*. Agric. Handb. 450. Washington, DC: U.S. Department of Agriculture, Forest Service: 598-637. [1380]
45. Kuchler, A. W. 1964. Manual to accompany the map of potential vegetation of the conterminous United States. Special Publication No. 36. New York: American Geographical Society. 77 p. [1384]
46. Lanner, Ronald M. 1983. *Trees of the Great Basin: A natural history*. Reno, NV: University of Nevada Press. 215 p. [1401]
47. Lanner, Ronald M. 1990. Morphological differences between wind-dispersed and bird-dispersed pines of subgenus *Strobus*. In: Schmidt, Wyman C.; McDonald, Kathy J., compilers. Proceedings--symposium on whitebark pine ecosystems: ecology and management of a high-mountain resource; 1989 March 29-31; Bozeman, MT. Gen. Tech. Rep. INT-270. Ogden, UT: U.S.

Department of Agriculture, Forest Service, Intermountain Research
Station: 371-372. [11707]

48. Larson, Frederic R.; Wolters, Gale L. 1983. Overstory-understory relationships: mixed conifer forests. In: Bartlett, E. T.; Betters, David R., eds. Overstory-understory relationships in Western forests. Western Regional Res. Publ. No. 1. Fort Collins, CO: Colorado State University Experiment Station: 21-25. [3313]
49. Larson, Milo; Moir, W. H. 1987. Forest and woodland habitat types (plant associations) of northern New Mexico and northern Arizona. 2d ed. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 90 p. [8947]
50. Little, Elbert L., Jr. 1975. Rare and local conifers in the United States. Conservation Research Rep. No. 19. Washington, DC: U.S. Department of Agriculture, Forest Service. 25 p. [15691]
51. Moir, William H.; Ludwig, John A. 1979. A classification of spruce-fir and mixed conifer habitat types of Arizona and New Mexico. Res. Pap. RM-207. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 47 p. [1677]
52. Niering, William A.; Lowe, Charles H. 1984. Vegetation of the Santa Catalina Mountains: community types and dynamics. Vegetatio. 58: 3-28. [12037]
53. Perry, Jesse P., Jr. 1991. The pines of Mexico and Central America. Portland, OR: Timber Press. 231 p. [20328]
54. Powell, A. Michael. 1988. Trees & shrubs of Trans-Pecos Texas including Big Bend and Guadalupe Mountains National Parks. Big Bend National Park, TX: Big Bend Natural History Association. 536 p. [6130]
55. Raunkiaer, C. 1934. The life forms of plants and statistical plant geography. Oxford: Clarendon Press. 632 p. [2843]
56. Reynolds, Richard T.; Graham, Russell T.; Reiser, M. Hildegard; [and others]. 1992. Management recommendations for the northern goshawk in the southwestern United States. Gen. Tech. Rep. RM-217. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 90 p. [19721]
57. Romme, William H.; Jamieson, David W.; Redders, Jeffery S.; [and others]. 1992. Old-growth forests of the San Juan National Forest in southwestern Colorado. In: Kaufmann, Merrill R.; Moir, W. H.; Bassett, Richard L., technical coordinators. Old-growth forests in the southwest and Rocky Mountain regions: Proceedings of a workshop; 1992 March 9-13; Portal, AZ. Gen. Tech. Rep. RM-213. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 154-165. [19050]
58. Sackett, Stephen S. 1979. Natural fuel loadings in ponderosa pine and mixed conifer forests of the Southwest. Res. Pap. RM-213. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 p. [5665]
59. Sackett, Stephen S. 1980. Woody fuel particle size and specific gravity of southwestern tree species. Res. Note RM-389. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p. [13258]
60. Schmidt, Wyman C.; Larson, Milo. 1989. Silviculture of western inland conifers. In: Burns, Russell M., compiler. The scientific basis for silvicultural and management decisions in the National Forest System. Gen. Tech. Rep. WO-55. Washington, DC: U.S. Department of Agriculture, Forest Service: 40-58. [10245]
61. Scott, Norman J., Jr.; Ramotnik, Cynthia A. 1992. Does the Sacramento Mountain salamander require old-growth forests?. In: Kaufmann, Merrill R.; Moir, W. H.; Bassett, Richard L., technical coordinators. Old-growth forests in the southwest and Rocky Mountain regions: Proceedings of a workshop; 1992 March 9-13; Portal, AZ. Gen. Tech. Rep. RM-213. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 170-178. [19052]
62. Scott, Virgil E.; Gottfried, Gerald J. 1983. Bird response to timber harvest in a mixed conifer forest in Arizona. Res. Pap. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p. [19333]

63. Severson, Kieth E.; Rinne, John N. 1990. Increasing habitat diversity in Southwestern forests and woodlands via prescribed fire. In: Krammes, J. S., technical coordinator. Effects of fire management of Southwestern natural resources: Proceedings of the symposium; 1988 November 15-17; Tucson, AZ. Gen. Tech. Rep. RM-191. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 94-104. [11277]
64. Simpson, Benny J. 1988. A field guide to Texas trees. Austin, TX: Texas Monthly Press. 372 p. [11708]
65. Steinhoff, R. J.; Andresen, J. W. 1971. Geographic variation in *Pinus flexilis* and *Pinus strobiformis* and its bearing on their taxonomic status. *Silvae Genetica*. 20: 159-167. [2233]
66. Stickney, Peter F. 1989. Seral origin of species originating in northern Rocky Mountain forests. Unpublished draft on file at: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Fire Sciences Laboratory, Missoula, MT; RWU 4403 files. 7 p. [20090]
67. Stromberg, Julie C.; Patten, Duncan T. 1991. Dynamics of the spruce-fir forests on the Pinaleno Mountains, Graham Co., Arizona. *Southwestern Naturalist*. 36(1): 37-48. [14878]
68. Swetnam, Thomas W.; Betancourt, Julio L. 1990. Fire--southern oscillation relations in the southwestern United States. *Science*. 249: 1017-1020. [12106]
69. Swetnam, Thomas W.; Brown, Peter M. 1992. Oldest known conifers in the southwestern United States: temporal and spatial patterns of maximum age. In: Kaufmann, Merrill R.; Moir, W. H.; Bassett, Richard L., technical coordinators. Old-growth forests in the southwest and Rocky Mountain regions: Proceedings of a workshop; 1992 March 9-13; Portal, AZ. Gen. Tech. Rep. RM-213. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 24-38. [19039]
70. Szaro, Robert C.; King, Rudy M. 1990. Sampling intensity and species richness: effects on delineating Southwestern riparian plant communities. *Forest Ecology and Management*. 33/34: 335-349. [13783]
71. Thill, Ronald E.; Ffolliott, Peter F.; Patton, David R. 1983. Deer and elk forage production in Arizona mixed conifer forests. Res. Pap. RM-248. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 13 p. [14381]
72. Tomback, Diana F.; Linhart, Yan B. 1990. The evolution of bird-dispersed pines. *Evolutionary Ecology*. 4: 185-219. [17534]
73. Townsend, A. M. 1989. The search for salt tolerant trees. *Arboricultural Journal*. 13(1): 67-73. [13061]
74. U.S. Department of Agriculture, Soil Conservation Service. 1982. National list of scientific plant names. Vol. 1. List of plant names. SCS-TP-159. Washington, DC. 416 p. [11573]
75. Walters, James W. 1978. A guide to forest diseases of southwestern conifers. R3 78-9. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwest Region, State and Private Forestry, Forest Insect and Disease Management. 36 p. [16779]
76. Whittaker, R. H.; Niering, W. A. 1965. Vegetation of the Santa Catalina Mountains, Arizona: a gradient analysis of the south slope. *Ecology*. 46: 429-452. [9637]
77. Wright, Henry A. 1990. Role of fire in the management of southwestern ecosystems. In: Krammes, J. S., technical coordinator. Effects of fire management of Southwestern natural resources: Proceedings of the symposium; 1988 November 15-17; Tucson, AZ. Gen. Tech. Rep. RM-191. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 1-5. [11267]
78. Wright, J. W.; Kung, F. H.; Read, R. A.; [and others]. 1965. The Christmas tree possibilities of Southwestern white and limber pines. *American Christmas Tree Journal*. 14(4): 27-31. [2626]

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