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A Provisional Tree Seed-Zone And Cone-Crop Rating System For Arizona And New Mexico

USDA Forest Service
Research Paper RM-105

April 1973

By Gilbert H. Schubert and John A. Pitcher

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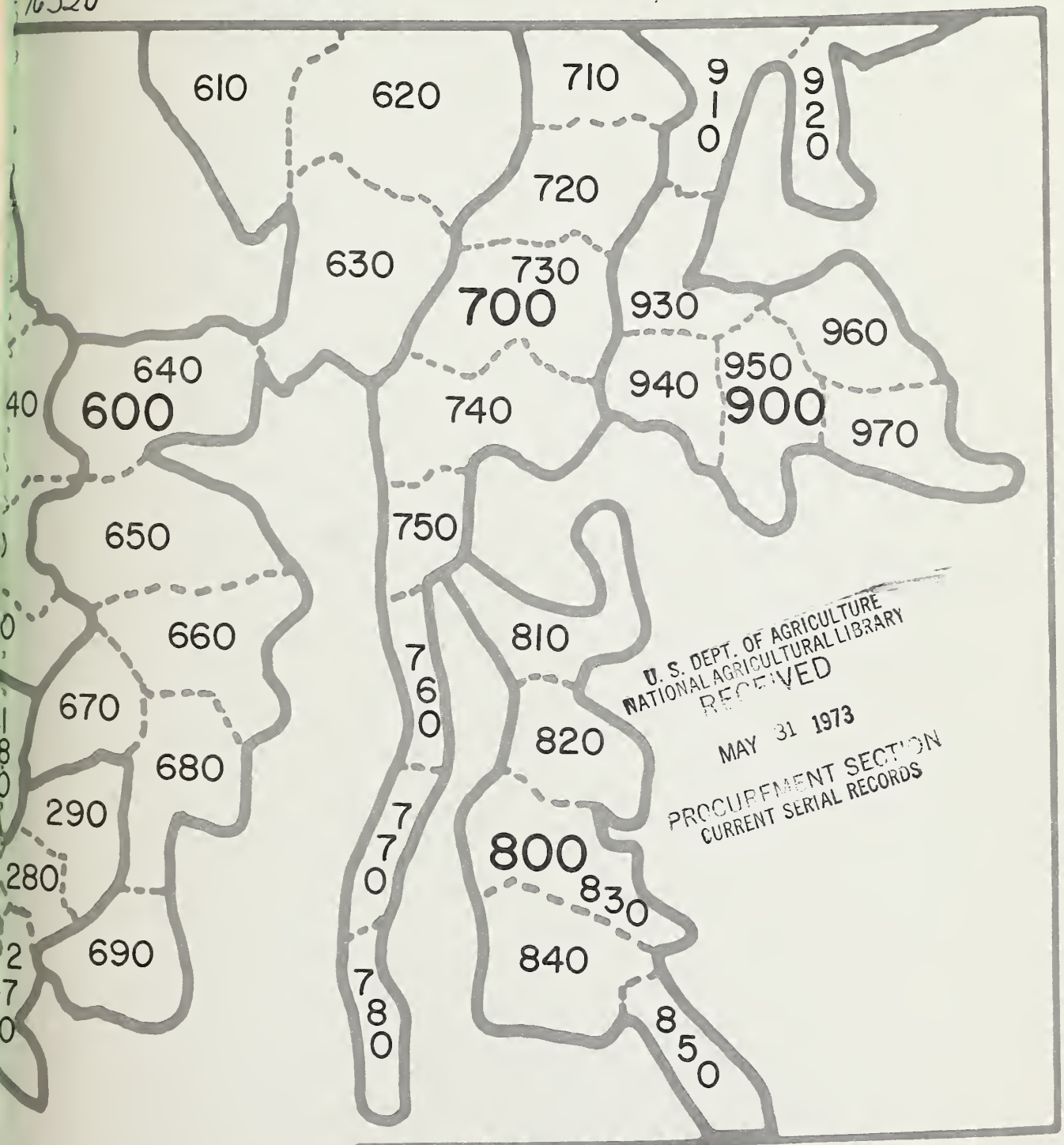

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Rocky Mountain Forest and Range Experiment Station
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Abstract

The forested areas of Arizona and New Mexico were divided into 10 physiographic-climatic regions. These regions were then subdivided into five to nine seed collection zones about 50 miles wide. Provenance tests will be conducted to determine variation and need for adjustments. Seed used for reforestation should be limited to that collected within the local zone. A 10-unit classification system for rating cone crops is included.

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A Provisional Tree Seed-Zone and Cone-Crop Rating System for Arizona and New Mexico

[☆reforestation]

by

Gilbert H. Schubert [1] and John A. Pitcher [2]

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Contents

A Provisional Tree Seed-Zone and Cone-Crop Rating System for Arizona and New Mexico

Gilbert H. Schubert and John A. Pitcher

Forest tree species occur over a wide range of climatic and physiographic conditions in the Southwest. Thousands of possible genotypes are represented in seed crops collected from wild stands. These stands have probably maintained a broad range of genetic variability, even in rather local areas. The trees growing in a particular environmental niche represent the progeny of a small proportion of each seed crop. Those genotypes that were adapted to the specific conditions survived, while the others failed.

Many studies in other regions have shown that seed origin affects both survival and growth of the progeny (Baron and Schubert 1963, Callaham and Hasel 1963, Dawson and Rudolf 1966, Shoulders 1965, Squillace and Bingham 1958, Squillace and Silen 1962).

The microclimate is most severe during the first few years after seedlings are planted. Temperature and moisture, either alone or in combination, are the two most critical factors affecting survival. Even small differences in these two factors may be highly significant. In large openings, there is little or no protective cover to shield the young seedlings from desiccating winds, high temperatures, or sudden freezes. Seedlings from a cooler climatic region start growth earlier to take advantage of a shorter growing season. These seedlings are frequently killed by a late spring freeze.

In Arizona, Larson (1966) reported that ponderosa pine[3] from eastern and southeastern seed sources survived at Fort Valley, whereas trees of northern and western sources failed. Early, hard fall freezes killed all the Angeles and Klamath and nearly all the Tahoe seedlings in the Fort Valley nursery. A severe fall drought eliminated 6 of the 14 sources planted in the study area the preceding spring. The larvae of May beetles killed many seedlings during the first few years. Seedlings from sources nearest the study area survived best, grew fastest, and developed into trees with the best form.

[3]*Common and scientific names are listed in table 1.*

The Need for Tree Seed Zones

Reforestation on National Forests in the Southwest is expected to expand greatly in the future. With this expansion, we cannot afford to make costly errors in seeding or planting trees from seed sources that are not adapted to the site. Seedlings that are not adapted to local conditions may be killed by frost or drought the first year, or succumb to other conditions at some later date before the trees mature. We have many examples of plantation failures, but we are often unsure of the reasons why the seedlings failed to survive, or why the trees failed to develop good quality characteristics. Frequently, the seed source of unsuccessful plantations is unknown.

In addition to National Forest reforestation needs, there are many thousand acres of unstocked land in other ownerships that should be reforested. The use of seed or planting stock from seed collected within these zones should also be followed in their reforestation efforts.

Seed-zone maps have helped managers use local seed in other forest regions. We need to set provisional seed zones for Arizona and New Mexico now, and begin tests of their adequacy. The maps in this Paper represent our best judgment of desirable limits of seed sources for the existing ecological and environmental conditions in the Southwest. Hopefully, they will hasten the time when only local seeds are used for reforestation in Arizona and New Mexico.

We also need a clearly defined system for rating current cone crops, to be used in conjunction with the seed-zone maps. We propose a cone-crop rating system based on the relative number of cones produced on a proportion of the seed trees at each sampling area.

Criteria for and Limitations of the Tree Seed Zones

To establish provisional seed zones, we divided the forested areas into 10 broad physiographic-climatic regions, each with five to nine

seed-collection zones (see map). Maps of the major forest types (Choate 1966, Spencer 1966) and of the topographic features were used as the basis for division into regions.

Boundaries of the seed-collection zones within these regions were drawn along recognizable land features. These zones are approximately 50 miles wide. While we consider it most desirable to use seed within the zone collected, use of nearby seed from an adjacent zone within the same physiographic-climatic region is permissible for locations near the boundary of the zone. Seeds from an adjacent zone may be used on an emergency basis; however, the use should be cleared first through the Office of the Regional Forester, Southwestern Region, Albuquerque, New Mexico.

Some zones have elevational differences greater than 1,000 feet, have several forest types, and have differences in aspect. Since these differences within a zone may be as critical as the difference between regions, seed collections must be labeled to identify elevation, forest type, and aspect. These seeds should then be used in areas which most nearly match the local environment.

Most of our seed zones are dissected by deep, narrow canyons. The climate in these canyons may be vastly different from that at the top of the plateaus. For example, spruce and other species which normally do best on high mountain slopes can be found growing several thousand feet lower in these moist, cool canyons. Seedlings of these species would have a difficult time becoming established on the hotter and drier plateaus above the canyons.

The forest type maps reflect the environmental requirements of the various species found in the Southwest. We did not delineate the seed-collection zones along type boundaries. Therefore, many species will be found within each zone (table 1). Although the tabulation indicates up to 15 species growing in some zones, the species may be found in rather restricted locales in some zones.

Land supporting the pinyon-juniper type has been included in the seed-collection zones presented here. At present, there are some forest plantings contemplated in this type. Future markets for Christmas trees and other special products may make it desirable to grow these species on a commercial basis, however. Also, each year we receive requests for pinyon, Arizona cypress, and juniper seeds for the international seed exchange program. Identification by seed zones would be useful along with the other requested information.

Seed-Zone Regions

The 10 physiographic-climatic seed-zone regions for the Southwest are identified on the map.

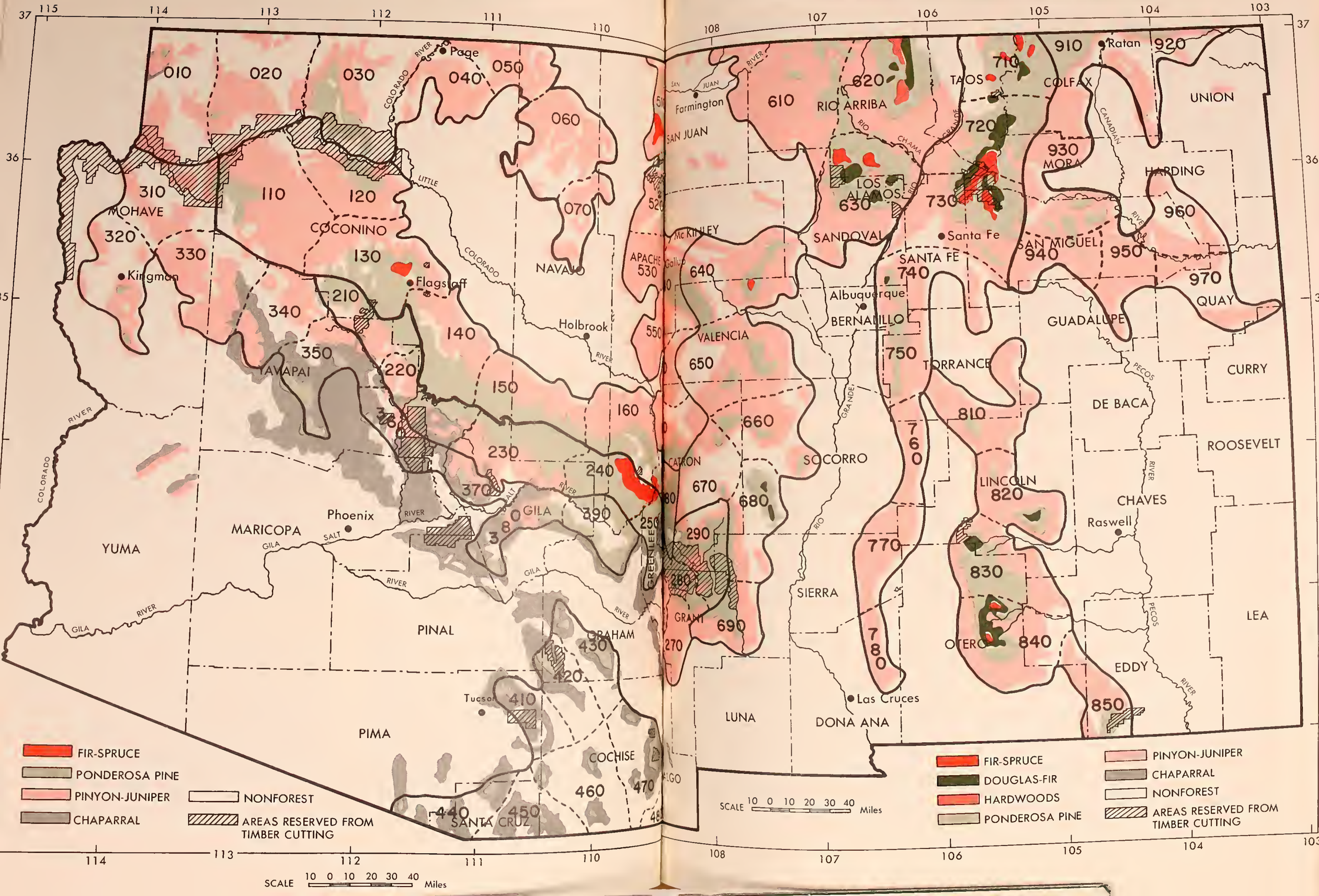
Seed collections were made in 1971 to evaluate the physiographic-climatic variation and to adjust the provisional seed-collection zones. In the interim, foresters should use seed for reforestation from the zone in which it was collected. Since the zone boundaries were located at roughly 50-mile intervals within the physiographic-climatic regions, seeds collected within 50 miles of the reforestation site could be used provided they came from the same physiographic-climatic region. Considerable variation exists within a seed zone; therefore, it would be advisable to plan seed collections which most closely match local conditions.

000 Northwest Plateaus (Seed Zones 010-070). —This region is composed primarily of the Shivwits, Uinkaret, Kaibab, Paria, Kaibito, and Black Mesa plateaus north of the Colorado and Little Colorado Rivers in northwestern and north-central Arizona. Differences in elevation and precipitation are great. Main species present in this region are the pinyons and junipers. Ponderosa pine, spruces, Douglas-fir, and the true firs occur mainly on the Virgin Mountains, Mount Trumbull, Kaibab Plateau, and Navajo Mountain. Stringers of ponderosa pine and Douglas-fir are scattered in the more moist canyons of the other plateaus, but cannot be considered as important forest components.

100 Central Plateaus (Seed Zones 110-180). —This region consists primarily of the Coconino and Mogollon Plateaus and associated mountains extending from the South Rim of the Grand Canyon in northwestern Arizona to the Continental Divide in New Mexico. Drainage in the region is primarily northward into the Colorado and Little Colorado Rivers. The Coconino Plateau is covered primarily by the pinyon-juniper type on the lower, drier sites, while ponderosa pine occurs on the higher, more moist sites. The Mogollon Plateau is about equally occupied by pinyon-juniper and the ponderosa pine types. Most of the ponderosa pine type is covered by nearly pure stands. Douglas-fir, Engelmann spruce, the true firs, and southwestern white pine are found on the mountains and in some of the moist, cool canyons along the Mogollon Rim. Elevation and aspect determine species composition on these mountains. A prominent feature of this region is the San

Table 1.--Occurrence of conifer species by physiographic-climatic regions (code number) in Arizona and New Mexico with approximate range in precipitation and elevation (Little 1950, 1971)

Scientific name	Common name	Physiographic-climatic regions										Precip-itation	Elevation
		000	100	200	300	400	500	600	700	800	900		
												Inches	Feet
Abies concolor (Gord. & Glend.) Lindl.	White fir	x	x	x	x	x	x	x	x	x		25-30	5,000-10,000
A. lasiocarpa (Hook.) Nutt.	Subalpine fir	x	x	x		x	x	x	x			30-35	8,000-12,000
A. lasiocarpa var. *arizonica* (Merriam) Lemm.	Corkbark fir	x	x	x		x	x	x	x			30-35	8,000-12,000
Cupressus arizonica Greene	Arizona cypress			x	x	x						12-20	3,500- 7,200
Juniperus californica Carr.	California juniper				x							10-20	2,000- 4,000
J. communis L.	Common juniper	x	x				x	x	x			25-30	8,000-11,500
J. deppeana Steud.	Alligator juniper		x	x	x	x	x	x	x	x		12-20	4,500- 8,000
J. monosperma (Engelm.) Sarg.	One-seed juniper		x	x	x	x	x	x	x	x	x	12-20	3,000- 7,000
J. osteosperma (Torr.) Little	Utah juniper	x	x	x	x		x	x				12-20	3,000- 7,500
J. pinchotii Sudw.	Pinchot juniper									x		12-20	3,000- 4,000
J. scopulorum Sarg.	Rocky Mountain juniper	x	x	x			x	x	x	x	x	12-20	5,000- 9,000
Picea engelmannii Parry	Engelmann spruce	x	x	x		x		x	x	x		30-35	9,000-12,000
P. pungens Engelm.	Blue spruce	x		x			x	x	x	x		30-35	7,000-11,000
Pinus aristata Engelm.	Bristlecone pine		x						x			30-35	9,000-11,500
P. cembroides Zucc.	Mexican pinyon			x		x						12-20	5,000- 7,500
P. edulis Engelm.	Pinyon	x	x	x	x		x	x	x	x	x	12-20	5,000- 7,000
P. engelmannii Carr.	Apache pine					x						19-25	5,000- 8,200
P. flexilis James	Limber pine		x						x			25-30	7,000-10,000
P. leiophylla var. *chihuahuana* (Engelm.) Shaw	Chihuahua pine			x	x	x						20-25	5,000- 7,800
P. monophylla Torr. & Frém	Singleleaf pinyon	x			x							12-20	4,500- 6,500
P. ponderosa Laws.	Ponderosa pine	x	x	x	x	x	x	x	x	x	x	19-25	5,500- 8,500
P. ponderosa var. *arizonica* (Engelm.) Shaw	Arizona pine					x						19-25	5,500- 8,500
P. strobiformis Engelm.	Southwestern white pine		x	x	x	x		x	x	x		25-30	7,000-10,000
Pseudotsuga menziesii (Mirb.) Franco.	Douglas-fir	x	x	x	x	x	x	x	x	x		25-30	6,500-10,000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GREENLEE
GRAHAM
COCHISE
SANTA CRUZ
PIMA
PINAL
GILA
YUMA
MARICOPA
YAVAPAI
LITTLE COLORADO RIVER
GILA RIVER
SALT RIVER
RIO CHAMA
RIO GRANDE
CANADIAN RIVER
PECOS RIVER
FIR-SPRUCE
PONDEROSA PINE
PINYON-JUNIPER
CHAPARRAL
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AREAS RESERVED FROM TIMBER CUTTING
DOUGLAS-FIR
HARDWOODS
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Francisco Peaks, with rather distinct species zonation from ponderosa pine at the base to Engelmann spruce at timberline. At the upper levels of the Peaks are found subalpine fir and bristlecone pine. The latter species is found in only one other area in the Southwest.

200 Mogollon Slope and Highlands (Seed Zones 210-290).—This region starts near Ashfork, Arizona, and extends along the south slope of the Mogollon Rim to the Continental Divide in New Mexico. This region, also known as the Transition Zone, divides the Mogollon Rim from the Tonto Basin, Sierra Ancha, and Natanes Plateau. It includes the White, Mogollon, Big Burro, and Pinos Altos Mountains. Below the Mogollon Rim the area slopes primarily southward. Further east, the numerous mountain ranges provide all aspects and pronounced elevational differences. Seed zones within this region are divided along major water drainages, highways, and the Continental Divide. The ponderosa pine and pinyon-juniper are the main species types. Douglas-fir, true fir, and southwestern white pine are found on the moist, cool sites. The White Mountains support mostly spruces and firs at the higher elevations.

300 Central Highlands (Seed Zones 310-390).—This region extends in a southeasterly direction from Lake Mead in Mohave County to the Natanes Plateau in Graham County, Arizona. A considerable portion of this region is covered with grass and chaparral. Ponderosa pine is restricted primarily to the mountains and plateaus, while pinyon-juniper occurs at the lower elevations in a more continuous belt. The best stands of ponderosa pine occur on the Hualapai, Mingus, Bradshaw, Mazatzal, and Sierra Ancha Mountains and Natanes Plateau. Douglas-fir, Chihuahua and southwestern white pines, and the true firs also occur on the higher mountains.

400 Southeast Desert Highlands (Seed Zones 410-480).—This region is composed primarily of rather widely separated mountains. The individual seed zones within this region divide the mountain ranges into separate groups, so each zone has great elevational and aspect differences. Tree species range from the pinyons and junipers at the lower dry elevations through ponderosa pine and Douglas-firs to spruce and fir at the higher, moist elevations. Other pines in this region are Apache, Arizona, limber, Chihuahua, and southwestern white pine.

500 Chuska-Zuni-Gallo Highlands (Seed Zones 510-570).—This region extends from the Four Corners south to the ridge of the Gallo Mountains in west central New Mexico. The most extensive stands of ponderosa pine occur in the Chuska and Zuni Mountains. Pinyons and junipers occupy most of the low-elevation dry sites. White and subalpine firs and blue spruce occur above the ponderosa pines in the northern end of the Chuska Mountains.

600 East Continental Highlands (Seed Zones 610-690).—This region extends from the San Juan Mountains at the Colorado border to the Mimbres in southeastern New Mexico. It lies between the Continental Divide and the Rio Grande except for seed zone 610, which is west of the Continental Divide in the Jicarilla Indian Reservation. Pinyon-juniper type covers an extensive part of this region, mainly at lower elevations and on the drier sites. The ponderosa pine type is found at higher elevations in the San Juan, Jemez, San Mateo, Cebolleta, Datil, Gallinas, Black Range, and Mimbres Mountains. Good stands of spruce, true fir, and Douglas-fir also occur in the San Juan, Jemez, and San Mateo Mountains with lesser amounts on some of the other high mountains. Water drainage in this region is almost entirely into the Rio Grande except for seed zone 610, which is drained by the San Juan River into the Colorado.

700 East Rio Grande Highlands (Seed Zones 710-780).—This region includes the southern Rocky Mountains bordering on the Rio Grande. The best ponderosa pines, along with the other high-elevation conifers, occur in the Sangre de Cristo Mountains in northern New Mexico. Ponderosa pine and Douglas-fir also occur in the Manzano Mountains south of Albuquerque. The lower three seed zones in this region are occupied mainly by the pinyon-juniper type. Bristlecone pine occurs at high elevation in seed zones 710, 720, and 730 of the Sangre de Cristo Mountains in New Mexico.

800 Sacramento-Guadalupe Range (Seed Zones 810-850).—This region lies in south central New Mexico east of Tularosa Valley, from Torrance County to the Mexican border. Major land features include the Juames Mesa and the Gallinas, Carrizo, Capitan, Sacramento, and Guadalupe Mountains. Species composition includes pinyon and junipers at lower elevations through ponderosa pine with Douglas-fir, true firs, and spruces at the higher elevations on Carrizo, Capitan, and Sacramento Mountains. The Pinchot juniper occurs only at the lower end of seed zone 850 near the Mexican border.

900 Northeast Plains (Seed Zones 910-970). —This region includes the plains and associated mountains in northeastern New Mexico. One-seed and Rocky Mountain junipers and pinyons are the most common species. Ponderosa pine is found only at high elevations in Colfax, Union, Mora, and San Miguel Counties.

Interim Cone-Crop Rating System

What do we mean by a "light", "medium", or "heavy" cone crop? In California, cone crop ratings are based on the number of cones per dominant tree larger than 19.5 inches d.b.h. (Fowells and Schubert 1956) and by the 5-unit classification system which relates cone abundance on an area basis (Schubert and Baron 1960).

We have some information on cone production on ponderosa pines, but none on the other conifers. Large, vigorous, isolated ponderosa pines are the best cone producers in terms of seed quantity, quality, and frequency of bearing in the Southwest (Larson and Schubert 1970). Ponderosa pines 28 inches in diameter may produce from 200 to 450 cones per year, while trees under 12 inches usually produce very few cones. Therefore, until information is available for the other species, we have elected to use an interim cone-crop rating system employing a 10-unit classification system (table 2).

The cone-crop rating is based on the relative number of cones produced on a proportion of the seed trees at each sampling area. A seed tree is defined as a dominant tree over 12 inches in diameter with a full, vigorous crown. These specifications are adequate for ponderosa pines, but not necessarily for all species. For example, the firs, spruces, junipers, Arizona cypress, and other pines produce excellent crops on smaller trees. These size differences will need to be recognized in rating the cone crops by species.

This 10-unit system provides the forester with intermediate ratings between those set for California, and provides recognition of bumper cone crops. An exact cone count is not required for a reasonable evaluation of the cone-crop rating. The ratings are subjective and should improve with practice.

Identification of Collected Cones

All seed collections must be properly labeled. Each sack of cones must have two labels, one to be placed inside the sack and the other tied

Table 2.--The 10-unit classification for rating cone crops on conifers in Arizona and New Mexico

Classification		Description[1]
1	None	No cones on any seed tree.
2	Very light	Few cones on less than one-fourth of the seed trees.
3	Very light to light	Few cones on one-fourth to one-half of the seed trees.
4	Light	Few cones on more than one-half of the seed trees.
5	Light to medium	Few cones on more than one-half any many cones on less than one-fourth of the seed trees.
6	Medium	Many cones on one-fourth to one-half of the seed trees.
7	Medium to heavy	Many cones on more than one-half of the seed trees.
8	Heavy	Many cones on more than one-half of the seed trees, with less than one-fourth to one-half of them loaded with cones.
9	Heavy to very heavy	Many cones on more than one-half of the seed trees, with one-fourth to one-half of them loaded with cones.
10	Very heavy	Many cones on more than one-half of the seed trees, with more than half of them loaded with cones.

[1]Cones per tree: few = 1 to 20; many = 21 to 160; loaded = 161 or more.

on the outside. The minimum data recorded on each label should include:

1. Species (common and scientific name).
2. Seed collection zone, elevation, and aspect.
3. Forest, District, township, range and section.
4. Stand density, site index, associated species.
5. Cone-crop rating.
6. Collected from felled or standing trees.
7. Day, month, and year of collection.
8. Collector's name.

Frequently it is necessary to have more data on special seed lots. For example, the following additional data are needed for seed exchange and testing provenances:

9. Latitude, longitude, and county.
10. General soil classification and associated rocks.
11. Tree size (diameter, height, and age).
12. Tree characteristics (bole, crown, branching, growth rate, and disease).
13. Number of trees from which cones were collected.
14. Whether trees can be relocated for future collections.
15. Map with pin prick to show location of collection area (the hole on reverse side should be circled and dated).

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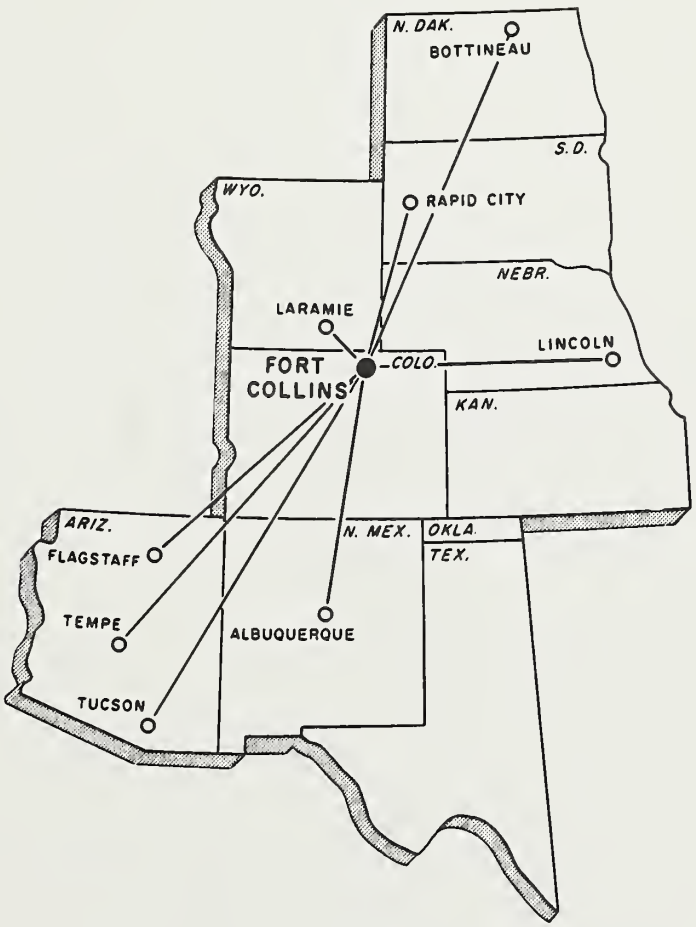
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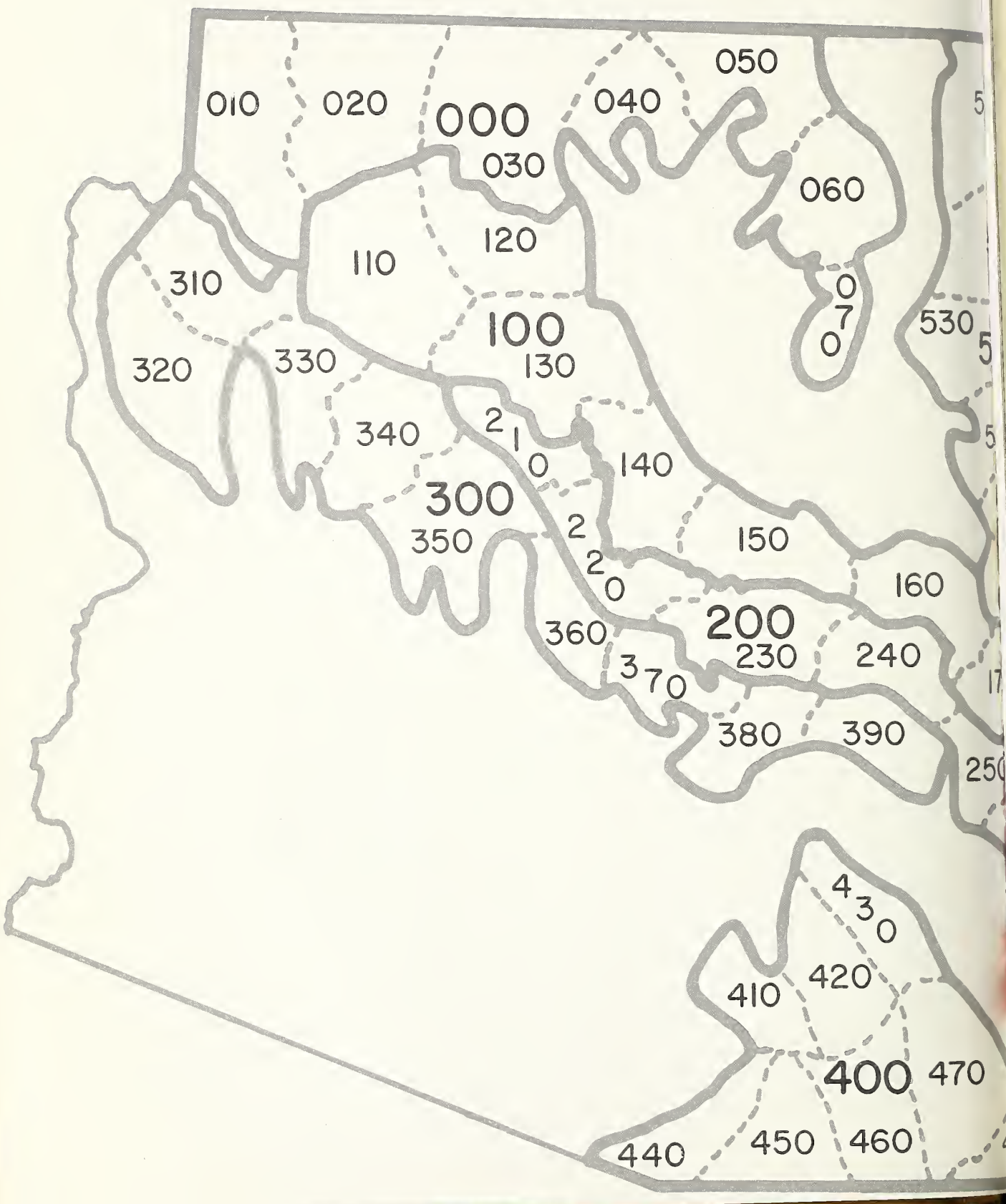
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