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LIFE ZONES OF NORTHEASTERN ARIZONA

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INTRODUCTION

In 1889 C. Hart Merriam (1890) of the United States Biological Survey studied the plants and animals found at different elevations in the San Francisco Peaks and the Grand Canyon areas and recognized the similarity between their vertical distribution and the north-south distribution of similiar plant and animal species from other areas. On the highest peaks he found species which were also found in Canada, and on the floor of the Canyon were species found in Mexico. He recognized the relationship between latitude and altitude and from these observations he formulated his ideas of life zones — a concept which has been expanded and adapted to different situations throughout the world.

For each 1000-foot increase in elevation there is a temperature decrease of about 3 ½° F. The same approximate temperature change can be expected for a 200-mile northward shift in latitude. The temperature differential from the bottom of the Grand Canyon to the top of San Francisco Peaks, a distance of about 50 miles, represents a latitude difference of approximately 1,800 miles. Superimposed on this decrease in temperature is a pattern of increasing rainfall and the two factors have conspired to produce a remarkable vertical zonation in the natural vegetation of this, the type area.

The moisture that reaches northeastern Arizona falls during two seasons. The rainfall maximum that occurs during late July, August, and September is seperated from the rainfall and snowfall maximum that occurs from December through March by the very dry months of May and June. Cool-season and warm-season moisture are about equal. The summer moisture is carried in aloft by southeasterly winds from tropical and subtropical areas and gives rise to a shower type of rainfall. Winter moisture is derived mainly from the Pacific polar front and results in a more steady type of precipitation.

Northeast of the Little Colorado River the annual rainfall averages less than 10 inches. This low rainfall combined with a nearly uniform elevation produces a monotonous vegetation. West and Southwest of the Little Colorado River the rainfall ranges from a few inches to 20-28 inches in the great highland moisture barrier formed by the Kaibab and Coconino Plateaus, the San Francisco group of volcanic peaks, the Mogollon Plateau, and the White Mountains. It is in this area that the life zones are best developed.

LIFE ZONES

In mountainous areas the temperature differential combined with the increase in rainfall with elevation produce a well-defined floral zonation. In fact it is sometimes possible for an ecologist to estimate elevation to within 500 feet by using the distribution of indicator species in the natural vegetation. These estimates, however, are made complicated by such factors as the direction of slope, latitude, direction of air currents, source of moisture, and the size of the mountain mass. Life zones are recognized from assemblages of plants, mammals, and birds. Plants are usually the most sensitive indicators and life zones are most often defined in terms of floral distribution. However, life zones are not clearly defined units and species are not necessarily restricted to any one zone. In this respect a life zone is similar to a "zone" in a biostratigraphic sense. Many species range between zones and a zone is most often identified from an assemblage.

Although zonation was well defined in the San Francisco Peaks and Grand Canyon areas, Merriam based his terminology on the latitudinal distribution of plant and animal species. For this reason his system became applicable over a wide area and such names as Canadian, Hudsonian, and Sonoran are used in the classification. Figure 1, from a map by Sumner (1945), shows the distribution of life zones in northeastern Arizona. The following table is a summary of information about life zones in this area:

Life Zone	Annual Rainfall (inches)	Elevation (feet)	Mean Annual Temperature (degrees F.)	Plant Indicators
Boreal	23-30		27-45	
Alpine		11,400		Above timberline, few small herbaceous species
Hudsonian		9000-11,400		Engelmann spruce
Canadian		8000-9000		White fir, blue spruce, Douglas fir
Transition	17-26	7000-8000	40-50	Ponderosa pine, Douglas fir, sagebrush
Upper Sonoran	12-18	4000-7000	50-65	Pinon pine, juniper, scrub oak, sagebrush
Lower Sonoran	8-12	Sea level-4000	51-74	Creosote bush, mesquite, acacia, century plant

Boreal Zone

The summit of the San Francisco Peaks is the only true alpine area in Arizona. The timberline ranges from 11,000 to 11,400 feet where only a few small herbaceous plants have established themselves among the loose volcanic cinders. Some of these alpine species range north to the Arctic Circle (Shreve, 1942).

The Hudsonian zone is typified by Engelmann spruce and alpine fir and is found on the San Francisco Peaks, the summit of the Kaibab Plateau north of the Grand Canyon, and in the White Mountains.

The Canadian zone is found above 8000 feet in the same areas and is composed of Douglas fir, white fir, blue spruce, dwarf juniper, aspen, and many other species.

Transition Zone

The Transition zone corresponds closely to the distribution of the ponderosa pine forests which are the source of most of the lumber in Arizona. Douglas fir extends below the Canadian zone into the Transition zone in some areas, and in areas of reduced moisture above 7000 feet oak chaparral or sagebrush ocassionally replace ponderosa pine. The Transition zone surrounds the Boreal zone in the Kaibab Plateau, the San Francisco Peaks area, the White Mountains, and the Chuska Mountains. It also covers the Mogollon Rim country, the Defiance uplift, and parts of the Coconino Plateau and Black Mesa.

Upper Sonoran Zone

The Upper Sonoran zone (4000-7000 feet) covers most of northeastern Arizona and is typified by the pinon pine-juniper association. South of the Mogollon Plateau oak brush replaces pinon pine and juniper in the foothills. In the northeast, sagebrush plains and parched wastelands cover extensive areas where there is insufficient moisture to support pinon and juniper. As late as 1857 grassland covered much of the barren wasteland that is now covered with semidesert shrubs.

Lower Sonoran Zone

The Lower Sonoran zone extends up the floor of the Grand Canyon as far as the Paria Valley on the Colorado River and as far as Cameron on the Little Colorado River. There is a good deal of mixing of the Upper and Lower Sonoran zones on the floor and sides of the Canyon. The most characteristic plant throughout most of the Lower Sonoran zone is the creosote bush. Other important indicators are mesquite, catclaw acacia, century plants, and a great variety of cacti.

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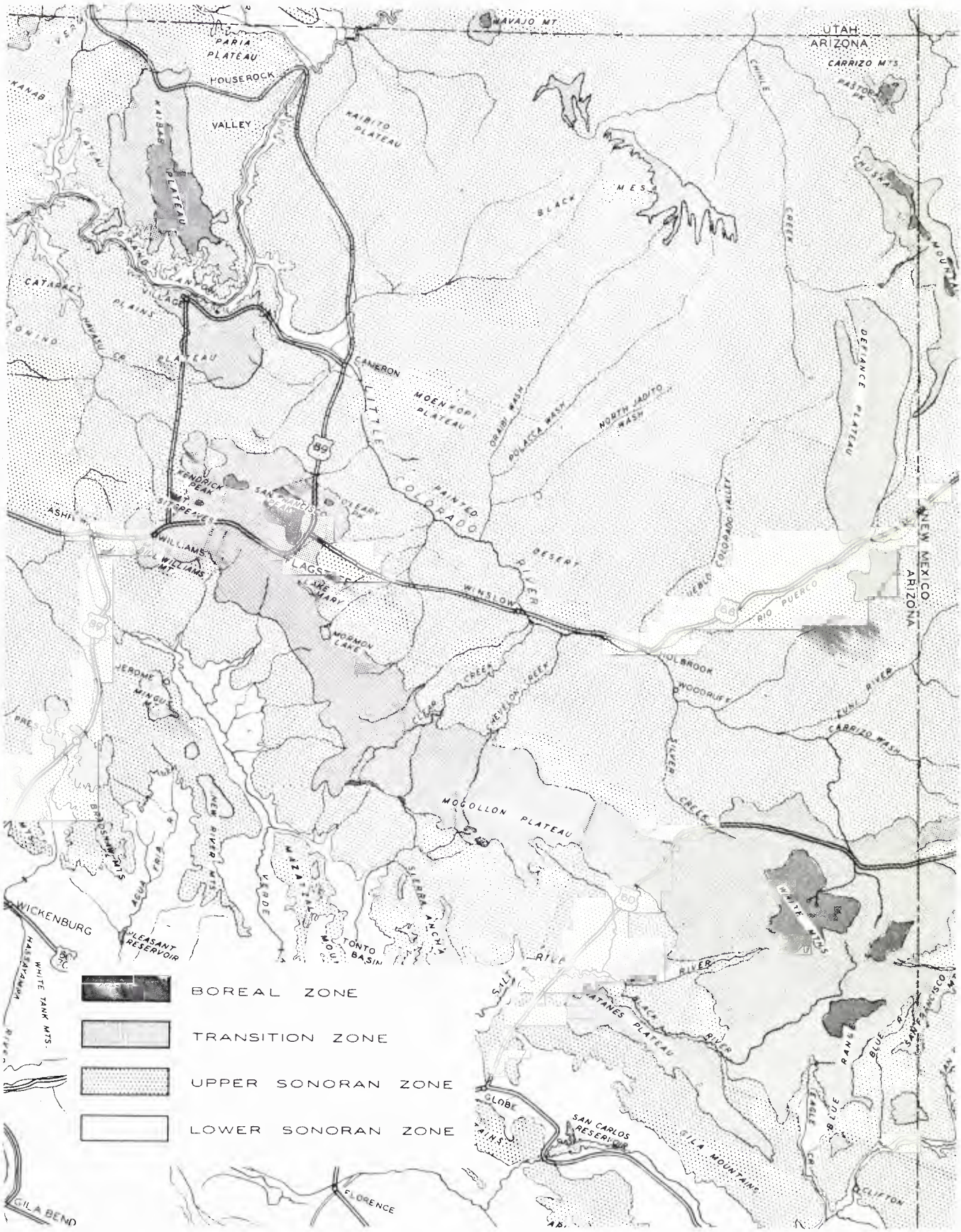

Figure 1. Life zones of northeastern Arizona.