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LAND USE IN THE BASIN AND RANGE TOPOGRAPHIC PROVINCE OF TRANS-PECOS TEXAS

WILLIAM J. LLOYD and ROBERT H. SCHMIDT, JR.
Department of Geological Sciences
University of Texas at El Paso
El Paso, Texas 79968

INTRODUCTION

The Trans-Pecos region of far west Texas is probably the least known portion of the nation's second largest state. Although the more than 57,000 km² (22,002 mi²) area of the Trans-Pecos covers roughly one-twelfth of the area of Texas, its landscapes share little in common with the popular Texas images of vast plains and rolling hills. Yet, if the Trans-Pecos has been generally ignored in favor of regions farther east, it is not because the western corner of Texas is devoid of features of interest. The physical and cultural landscapes of the Trans-Pecos offer some of the most intriguing patterns of land use as well as some of the most varied and even spectacular scenery to be found anywhere in the state. In this paper we hope to promote a better understanding of Trans-Pecos, Texas by describing the manner in which people have come to settle upon and use the distinctive physical environments of the six westernmost counties of Texas: Hudspeth, Culberson, Jeff Davis, Presidio, Brewster and El Paso (fig. 1).

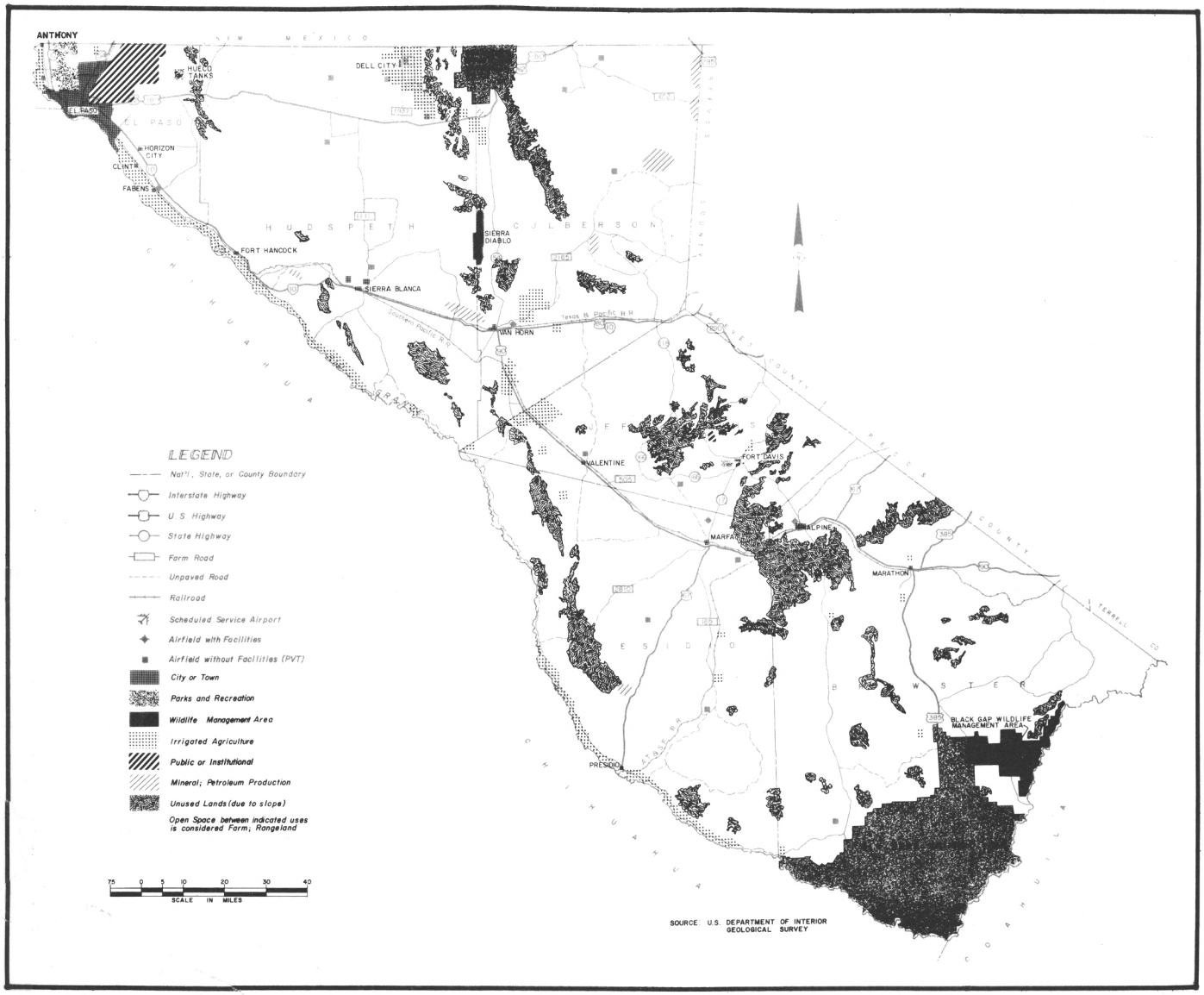


Figure 1. Land-use in the Trans-Pecos, 1975 (adapted from WTCOG, 1976).

THE PHYSICAL LANDSCAPE

Landforms

The Trans-Pecos region is here considered to be approximately synonymous with the Texas portion of the Basin and Range topographic province which extends far beyond the Texas boundary to the north, west and south. The Trans-Pecos is bounded by the Rio Grande (U.S.-Mexico boundary) to the south and west and the 32nd parallel (Texas-New Mexico boundary) to the north. Toward the east the region grades into the Great Plains province along the western margins of the Pecos River Valley and Stockton Plateau (Fenneman, 1931). The Basin and Range topography which characterizes the Trans-Pecos offers higher elevations and greater local relief than can be found anywhere else in Texas. While most of the state is relatively flat and less than 750 m (2460 ft) above sea level, the Trans-Pecos is at a rather consistent level of approximately 1200 m (3936 ft), with numerous widely spaced southeast-northwest trending mountain ranges rising an additional 600 m to 900 m (1968 ft to 2952 ft) above the lowlands. Some of the ranges such as the Sierra Diablo and Delaware Mountains are more plateau-like with gentle slopes even at higher elevations, while others such as the Davis Mountains are marked by considerable areas of steep slopes. The highest peak in Texas, Guadalupe Peak, elevation 2668 m (8751 ft), is located in the Trans-Pecos, as indeed are all Texas peaks higher than 1500 m (4920 ft). The lowest elevations in the Trans-Pecos occur in the narrow Rio Grande Valley where elevations reach below 600 m (1968 ft) in the vicinity of the Big Bend country, and on the plains that slope eastward to the Pecos River Valley where elevations reach below 900 m (2952 ft). The mean altitude of the region (based on planimeter calculations) is approximately 1280 m (4198 ft).

Climate

The Trans-Pecos corresponds closely with the Texas portion of the Chihuahuan Desert climatic province. Only the highest elevations and the extreme eastern margin of the region receive sufficient precipitation in relation to temperature to be considered semi-arid rather than true desert (Schmidt, 1979). In general, average annual precipitation decreases and annual variability of precipitation increases (Tucker and Griffiths, 1965) with increasing distance from the Gulf of Mexico, the principal source of moisture for the region, so that the average annual precipitation of 380 mm (15.0 in) at Marathon (elevation 1233 m [4043 ft]) decreases to 210 mm (8.3 in) at about the same elevation at El Paso, 350 km (217 mi) to the west (all precipitation data are from TWODB, [1976]). In addition to the east-west variability, precipitation also increases with increasing elevation with Mt. Locke receiving 485 mm (19.1 in) at 2070 m (6790 ft) (fig. 2).

Approximately three-fourths of the annual precipitation is received during the six warmest months of the year (Orton, 1969) (fig. 3). The maximum precipitation occurs during July, August and September when the northwestward circulation of moist unstable air around the western edge of the Bermuda subtropical anticyclone produces numerous convectional thunderstorms. The relative contribution of moisture derived from the Pacific Ocean to this seasonal maximum is a topic of some interest (Hales, 1974), but any definitive measure awaits further research. Better understood is the role of tropical revolving storms derived from either the Gulf of California or the Gulf of Mexico that occasionally bring widespread heavy rain to the region, inflating average annual precipitation figures and creating the greatest annual variability of precipitation. In September of 1974 a series of such storms over a period of 10 days brought as much as 300 mm (11.8 in) of precipitation to Toyah in the eastern Trans-Pecos, helping raise the annual total for that year to 556 mm (21.9 in) *vs* an average 252 mm (9.92 in). Other stations in the Trans-Pecos recorded more than 150 mm (5.9 in) during that month. The period of maximum precipitation during the warmest months is followed by a mild, dry winter during which the flow of air is generally from the west

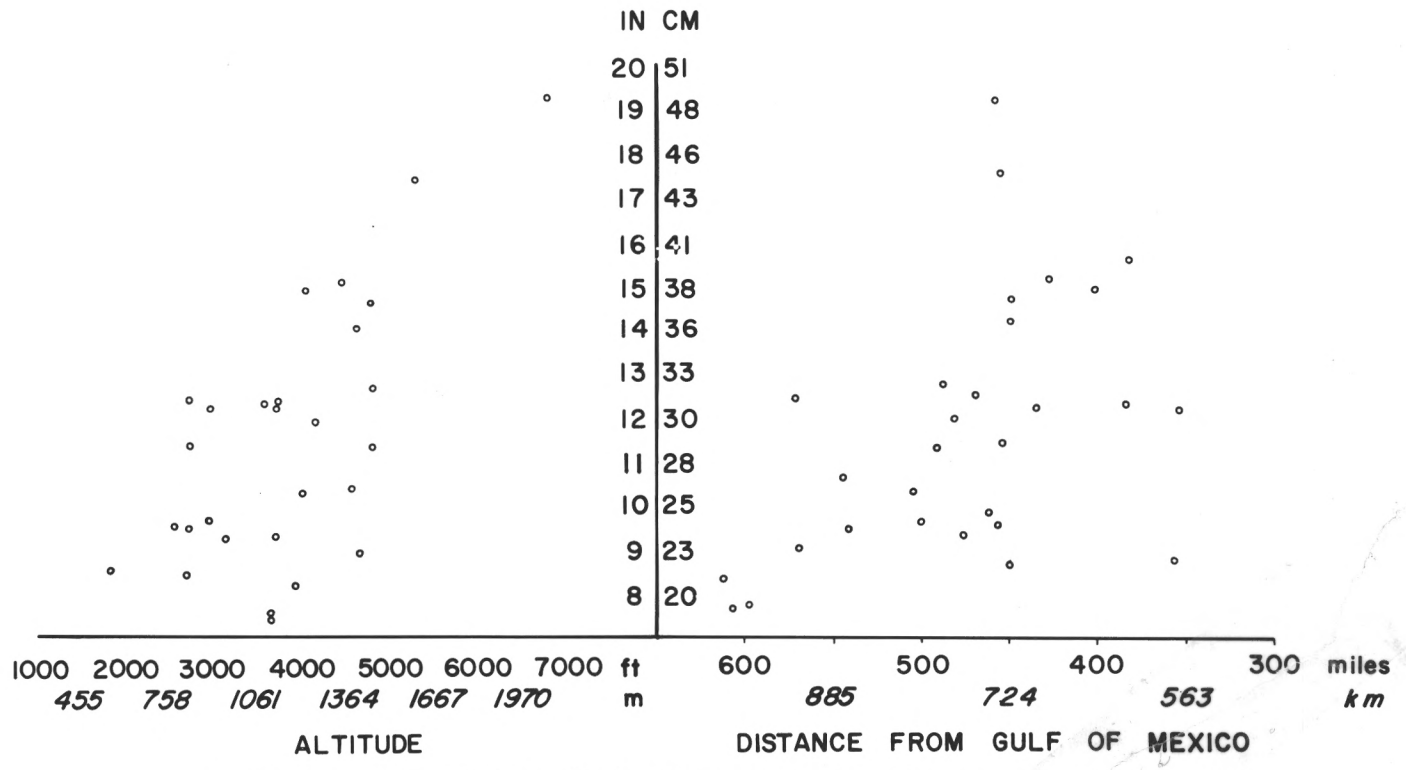


Figure 2. The relation of precipitation to altitude and distance from the Gulf of Mexico for Trans-Pecos stations.

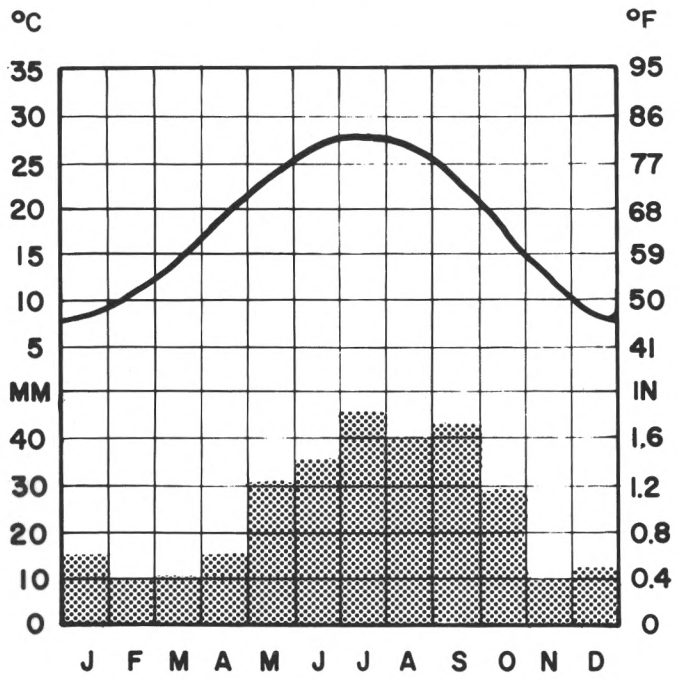


Figure 3. Average climatic characteristics for Alpine, Balmorhea, El Paso and Presidio.

where topographic barriers inhibit the movement of any significant amounts of moisture into the Trans-Pecos region.

The combination of clear skies, high altitudes and southerly location enable the Trans-Pecos to receive the highest mean annual solar radiation of any location within the United States (data from faulty sensors had previously placed the maximum in the Mojave Desert at China Lake, California) (Handy and Durrenberger, 1976). At lower elevations in the Rio Grande Valley below Candelaria some of the highest daytime temperatures in Texas (as well as the U.S.) are frequently recorded. In general, the Trans-Pecos is characterized by some of the highest average maximums found in Texas during the winter (second only to the Gulf Coast) and some of the lowest average minimums in summer (second only to the Panhandle). Large diurnal ranges are common in all seasons and frosts occur frequently in winter, even at the lowest elevations within the region (EDS, 1968).

Vegetation, Soils and Water

Aridity imposes a major constraint on vegetation and soils in the Trans-Pecos, with topography and associated temperature and precipitation variations imposing secondary controls which produce significant differences in vegetation from place to place within the region (WTCOG, 1976). Desert grassland is the most widespread vegetation type, occupying the lowlands between about 1100 m (3608 ft) and 1400 m (4592 ft). Desert shrub communities occupy the lowest elevations, and there are indications that this type of vegetation has been expanding upslope throughout the region as a result of grassland disturbance over the last 100 years. At higher elevations the desert grassland grades into open woodland, with truly dense woodland generally restricted to the higher elevations of the Davis and Guadalupe Mountains. Scattered throughout the region are smaller areas of riparian, halophytic, and other vegetation types adapted to specific site conditions. Upland soils are generally shallow and unproductive, while even the deeper alluvial soils of the basins are frequently too saline to be considered potentially productive (WTCOG, 1976).

The Rio Grande is the only significant surface stream in the region. Runoff from the mountains of Colorado and northern New Mexico is controlled by major storage dams in southern New Mexico from which water is released for heavy irrigation use in the valleys above and below El Paso. The average annual flow of 457,506,000 m^3 (370,580 acre/feet) at El Paso is reduced by agricultural diversions and infiltration to 134,195,000 m^3 (108,698 acre/feet) at Fort Quitman, with long periods of virtually no flow through the summer and fall (IBWC, 1977). The Rio Grande is replenished above Presidio by inflow from the Rio Conchos which drains the eastern slopes of the Sierra Madre Occidental in Mexico, producing average annual flows of 1,028,026,000 m^3 (832,701 acre/feet) through the Big Bend. By way of comparison, the flow past Rio Grande City in southern Texas averages 3,585,105,000 m^3 (2,903,125 acre/feet).

The remainder of the Trans-Pecos must rely on groundwater to satisfy water resource demands (Gates and others, 1978). Two major areas of groundwater are the structural basins of the Hueco Bolson west of the Hueco Mountains and the Salt Basin which stretches for a considerable distance west of the Guadalupe, Delaware and Davis Mountains. The groundwater resources of the region are limited by low recharge rates and high mineral contents.

THE CULTURAL LANDSCAPE

Population and Settlement

Although European settlers first came to the Rio Grande Valley in the vicinity of El Paso in the second half of the 17th century, the Trans-Pecos received essentially no modern settlement until it became part of the United States in the mid-19th century. Prior to the U.S. Civil War a small settlement was established on the Texas side of the river at El Paso and some mining activity was underway in Presidio County, but the combination of aridity, isolation, and roving bands of Indians discouraged any rural settlement of the region (Meinig, 1969). Jeff Davis and Brewster Counties were not effectively settled until the 1880's, while Hudspeth and Culberson Counties awaited the early decades of the 20th century before they began to attract settlers (Table 1). Presidio County reached its maximum population in 1920, Jeff Davis in 1940, Hudspeth in 1950, and Brewster in 1970 (Texas Almanac, 1977). Current population estimates suggest that only Culberson and El Paso Counties will record their maximum historic population in the current 1980 census (Rand McNally, 1980). As a region, the five rural counties (excluding metropolitan El Paso County) recorded a maximum population of 24,580 persons in 1940, thereafter declining to 19,613 persons by 1960, a decrease of 20%. Over the last two decades the population of the rural counties has risen slightly to an estimated 20,100 persons in 1980, a figure still well below the 1940 maximum.

The present population density of 0.4/km^2 (1.0/mi^2) (20,100 persons in 53,782/km^2 [20,760 mi^2]) in the five rural counties makes the Trans-Pecos the least densely populated rural area of Texas, a statistic that becomes even more impressive when it is realized that only about one-fourth of the five-county population is actually rural, the other three-fourths residing in the seven towns having populations of 500 or more. Only the long-term growth of metropolitan El Paso County (estimated population 457,600 in 1980), including some truly spectacular growth in recent decades, runs counter to the predominant theme of under-population found throughout most of the Trans-Pecos. The inclusion of El Paso in the regional totals raises the overall population density to 8.5/km^2 (21.9/mi^2), a figure that is less than one-half the Texas state average

Table 1. Population change and density in the Trans-Pecos, 1860–1980.
(Sources: Texas Almanac, 1977; Rand McNally, 1980)

County	1860	1870	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	Area km²	1980 Pop. Dens.
Hudspeth[1]							962	3728	3149	4298	3343	2392	2600	11798	0.2
Culberson[2]							912	1228	1653	1825	2794	3429	3800	9977	0.4
Jeff Davis[3]				1394	1150	1678	1445	1800	2375	2090	1582	1527	1600	5852	0.3
Presidio[3]	580	1636	2837	1698	3673	5218	12202	10154	10925	7354	5460	4842	4500	10083	0.4
Brewster[3]				710	2356	5220	4822	6624	6478	7309	6434	7780	7600	16072	0.5
Subtotal	580	1636	2837	3802	7179	12116	20343	23534	24580	22876	19613	19970	20100	53782	0.4
El Paso[1,2]	4051	3671	3845	15678	24886	52599	101877	131597	131067	194968	314070	359291	457600	2738	167.1
Total	4631	5307	6682	19480	32065	64715	122220	155131	155647	217844	333683	379261	477700	56520	8.5

1) Hudspeth created from El Paso, 1917.
2) Culberson created from El Paso, 1911.
3) Jeff Davis and Brewster created from Presidio, 1887.

of 19.4/km² (50.2/mi²). This pattern of extremely small rural population with small growth increments and a large, booming metropolitan El Paso population is expected to continue in the Trans-Pecos in the foreseeable future (WTCOG, 1976).

Livestock Ranching

Extensive grazing is the dominant commercial land use throughout the rural areas of the Trans-Pecos (WTCOG, 1976). Only small scattered areas of the region possess sufficient water resources for irrigated agriculture while at the other extreme, few areas are so steep or inaccessible that animals cannot reach them. Aridity and historic land tenure practices have combined to produce unusually large ranches and low animal densities in this region of predominantly private land ownership (an estimated 280,000 hectares [691,880 acres] of state-leased grazing land represents only about 7% of the total agricultural land in the region). The average ranch size in the five rural counties (using the census category of farms having $2500 or more sales) in 1974 was 8853 hectares (21,875 acres) compared to the Texas state average of 476 hectares (1176 acres) (U.S. Dept. Commerce, 1977). No region of Texas and only a small handful of individual counties contained ranch sizes as large as those of the Trans-Pecos. Market, range and historic factors favor cattle as the dominant livestock, though as recently as 1969 the 11,630,000 cattle in the region were joined by as many as 7,099,000 sheep and Angora goats, with the latter two concentrated in the southeast portion of the region (TCLRS, 1969). Since that time the number of cattle has risen moderately while the number of sheep and goats has declined by about 50 percent to the point where in 1978 there were 13,900,000 cattle *vs* only 3,465,000 sheep and goats (TCLRS, 1978). Rangeland throughout much of the region is characterized by serious deterioration because of past overgrazing, with the arid climate working to discourage efforts at improving conditions (WTCOG, 1976). Carrying capacities for the region have been estimated to be about 8 animals/km² (20 animals/mi²) or about 1 animal/13 hectares (1 animal/32 acres), compared with estimated densities of 494 animals/km² (1280 animals/mi²) or about 1 animal/.2 hectares (1 animal/.5 acres) in humid eastern Texas (TDHPT, 1975). Put another way, the 8.2% of all Texas land occupied by the Trans-Pecos contained only 1.6% of all Texas cattle at the end of 1978. It seems fair to conclude, therefore, that while cattle grazing is the dominant land use in the Trans-Pecos, the region as a whole does not rate very high in the overall Texas cattle industry. This conclusion is reflected in the 1974 average agricultural land values (including buildings) of $146/hectare ($59/acre) in the Trans-Pecos vs the Texas statewide average of $563/hectare ($228/acre) (U.S. Dept. Commerce, 1977).

Irrigated Agriculture

Aridity imposes severe limits on agricultural land-use in the Trans-Pecos (WTCOG, 1976). There is no rain-fed agriculture in the region and even irrigated agriculture is confined to a small fraction of the land area of the lowest basins. Flood plain irrigated agriculture based on stream runoff is found in the Rio Grande Valley, but even there the limited availability of water and land restricts agriculture to just two segments of the valley, a large strip extending from above El Paso to the Quitman Mountains, and a much smaller strip in the vicinity of Presidio, where water from the Rio Conchos replenishes the depleted Rio Grande. Irrigated agriculture based on ground-water pumping is essentially limited to the Salt Basin and its southward extension, and is concentrated in three favored areas: one around Dell City extending into northern Culberson County; one northeast of Van Horn; and one south and southeast of Van Horn. Elsewhere agriculture is confined to widely scattered favorable sites where small quantities of ground water are available.

Cotton, pecans, vegetables and alfalfa are the major crops of the region (TCLRS, 1969, 1978). The largest acreages in recent years have been devoted to cotton, including American-Pima grown in the flood plain around El Paso, and upland cotton grown in a number of parts of the region. In 1978, 23,432 hectares (57,900 acres) of cotton were harvested in El Paso, Culberson, and Hudspeth Counties, yielding 10,701 metric tons (49,150 bales) or 1.3 percent of the total Texas production. These figures represented declines from 1969 when 26,718 hectares (66,020 acres) yielded 60,500 bales, or 2.1 percent of Texas production. As cotton has declined in the region in the face of mounting costs and increased competition from other areas, pecans and vegetables have increased. The 11,800,000 kg (25,960,000 lbs) of pecans harvested in 1978 (primarily from the Rio Grande Valley) represented 11.2 percent of the total Texas production, an increase from 175,000 kg (385,000 lbs) and 1 percent, respectively, since 1969. Vegetable acreage including such crops as tomatoes, onions and chiles has increased from 1,052 hectares (2,600 acres) in 1969 to 1420 hectares (3510 acres) in 1978, with most of the expansion occurring in the Rio Grande Valley of Hudspeth County. Alfalfa is another important crop in the region, where warm temperatures and a sufficiently long growing season (particularly in the valley around Presidio) produce yields in excess of 14 metric tons/hectare (6.2 short

tons/acre), half again as large as the state average yield of 9 metric tons/hectare (4 short tons/acre). Altogether, 6475 hectares (16,000 acres) of alfalfa in the Trans-Pecos region yielded 7.8 percent of the total Texas production of the crop.

Viewed in a broad perspective, the Trans-Pecos crops which have a significant input into the overall Texas agricultural economy are essentially limited to American-Pima cotton, pecans and alfalfa. Agriculture in the region is obviously severely limited by the availability of water, a resource which may become even less abundant in the future because of the increasing depths from which water must be pumped and the increasing cost of energy to run the pumps. Agriculture in the region is also threatened by the on-going conversion of farmland to urban uses in the Rio Grande Valley above and below El Paso, the major agricultural districts of the region. Because of the presumed lack of significant untapped groundwater reserves of acceptable quality (Gates and others, 1978), no new major agricultural developments are anticipated.

Transportation and Towns

Although the sparse rural settlement of the Trans-Pecos generates very little demand for transportation, the position of the region astride the southernmost, east-west corridor of the United States results in large volumes of through traffic across the Trans-Pecos (TDHPT, 1975). I-10 traverses the center of the region, connecting El Paso and points west with San Antonio, Houston and the Gulf Coast, as well as with the Dallas-Fort Worth area via I-20 which branches off from I-10 near the eastern boundary of Culberson and Jeff Davis Counties. Other major highways include U.S. 90 which leaves I-10 at Van Horn to serve the southeastern part of the region including the Big Bend area, and U.S. 62-180 which crosses the northern Trans-Pecos from El Paso to Carlsbad, New Mexico and the Pecos River Valley.

Three railroads also cross the region, including the Southern Pacific connecting El Paso with the Gulf Coast, and the Missouri Pacific (formerly Texas and Pacific) from El Paso (via the Southern Pacific tracks to Sierra Blanca) to Dallas-Fort Worth. Among all the major transport links in the region, only the Santa Fe Railroad cuts across the east-west grain as it connects Kansas and Oklahoma to the northeast with Presidio (and a connection into Mexico) in the southwest portion of the Trans-Pecos. Both the highways and the rail lines are somewhat limited in their choice of routes by the availability of passes across the northwest-southeast trend of the Basin and Range topography. The highest passes along the major transportation routes lie above 1525 m (5002 ft). Although these elevations represent the highest points on the entire southern trans-continental route, the grades leading to them are not excessively steep.

The function of the railroads is supplemented by a number of major energy pipelines connecting the Midland-Odessa region with the West Coast. A contemplated west-to-east pipeline intended to carry Alaskan oil from southern California may be constructed across the region in the near future.

The vast rural areas of the Trans-Pecos contain only a few small towns. Alpine (pop. 6171), Van Horn (pop. 2913), and Marfa (pop. 2497) are the three largest towns in the five rural counties and together they account for more than 70 percent of the town-centered population and business activity of the rural region (Texas Almanac, 1977). All three towns function as rural service centers and county seats for their sparsely settled surroundings, but perhaps more important is their role as highway service centers (TDHPT, 1975). Alpine and Marfa stand at important junctions leading to the Rio Grande Valley and Big Bend country, while Van Horn is the largest town on I-10 between El Paso and Pecos, a distance of over 325 km (202 mi). Although metropolitan El Paso (SMSA estimated population: 457,600; Ciudad Juarez estimated population: 650,000) is the overwhelmingly dominant urban and economic location in the Trans-Pecos (Rand McNally, 1980), its location at the extreme western edge of a region of great distances permits the small rural towns to enjoy healthier service economies than might be the case if El Paso were more centrally located within the region.

Other Land Uses

The pattern of private land ownership in the Trans-Pecos is interrupted by three major areas of government control. Big Bend National Park and the adjacent Black Gap Wildlife Management Area form a large expanse of recreational land in the southeast portion of the region. Guadalupe Mountains National Park is a somewhat smaller recreational area located along the northern border of the region. Both of these areas are expected to make a major contribution to the long-term growth of the tourism component of the regional economy (WTCOG, 1974). The third major area of government land is the U.S. Army's Fort Bliss, which occupies a vast expanse of desert in El Paso County.

Although the Trans-Pecos is not especially noted for its mineral production, there are economically valuable deposits of various minerals scattered throughout the region. Sulphur, talc, fluorspar, silver and some petroleum are among the minerals that either are being worked at the present time or have been produced in significant quantities in the recent past (WTCOG, 1976). More detailed discussions of the economic geology of the Trans-Pecos appear elsewhere in this volume.

CONCLUSIONS

The Trans-Pecos is notable among all the regions of Texas for the unyielding qualities of its environment, the extreme sparsity of settlement, and the alternating Basin and Range topography which lends a distinctive pattern to the ranches, farms, and transportation lines. None of these are features commonly associated with the more typical image of Texas as a bountiful land of vast, unimpeded plains and gently rolling hills. It could be that the cultural landscapes of the region have more in common with other areas of arid Basin and Range topography in the Southwest than they do with those of Texas. Meinig (1969, 1971) has already argued that this is true for the El Paso district and the extreme western Trans-Pecos. Whether it is also true of the remainder of the Trans-Pecos or whether the region remains clearly Texan despite its obvious differences is an interesting topic for future research.

ACKNOWLEDGMENTS

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Long-tailed weasel, *Mustela frenata*.