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Description of the Ecoregions of the United States

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Description of the Ecoregions of the United States

Compiled by Robert G. Bailey

Formerly Regional geographer, Intermountain Region; currently geographer, Rocky Mountain Forest and Range Experiment Station

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In April 1979, the Agency leaders of the Bureau of Land Management, Forest Service, Fish and Wildlife Service, Geological Survey, and Soil Conservation Service endorsed the concept of a national classification system developed by the Resources Evaluation Techniques Program at the Rocky Mountain Forest and Range Experiment Station, to be used for renewable resources evaluation. The classification system consists of four components (vegetation, soil, landform, and water), a proposed procedure for integrating the components into ecological response units, and a programmed procedure for integrating the ecological response units into ecosystem associations.

The classification system described here is the result of literature synthesis and limited field testing and evaluation. It presents one procedure for defining, describing, and displaying ecosystems with respect to geographical distribution. The system and others are undergoing rigorous evaluation to determine the most appropriate procedure for defining and describing ecosystem associations.

Bailey, Robert G.
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This publication briefly describes and illustrates the Nation's ecosystem regions as shown in the 1976 map, "Ecoregions of the United States." A copy of this map, described in the Introduction, can be found between the last page and the back cover of this publication. The description of each region includes a discussion of land-surface form, climate, vegetation, soils, and fauna.

Contents

Introduction

Public land management agencies are increasingly involved in regional and national long-range planning and in efforts to classify all lands according to their capabilities and availability to produce goods and services in a balanced national program. During the past few years, these agencies have generally recognized the need for a comprehensive system for classifying ecosystems as an aid to achieving quality land management.

Regional variations in climate, vegetation, and landform are important in the development of ecosystems; and, often, different regions have very different management problems. For this reason, it is important to recognize regional differences at the highest level in the classification. This regionalization facilitates (1) planning at the national level, where it is necessary to study management problems and potential solutions on a regional basis; (2) organization and retrieval of data gathered in a resource inventory; and (3) interpretation of inventory data, including differences in indicator plants and animals among regions.

A map titled "Ecoregions of the United States," published in 1976, shows an initial attempt to systematically divide the country into ecosystem regions. This map, along with a brief narrative that described the approach and development of the system, was prepared by the Forest Service for the Interior Department's Fish and Wildlife Service as an aid in its National Wetlands Inventory. This map is now being used in making assessments required by the 1980 Resources Planning Act and in the Roadless Area Review and Evaluation (RARE II) program.

The supporting descriptions of the areas shown on the map are first published here. They make the meaning of the map clearer and further explain the principles of the classification system. The objective

has been to provide a broad synthesis of our current knowledge about the ecosystem geography of the country that may be a useful reference for persons who desire an overview on a comparable basis.

This publication gives, for each province, a brief description of the dominant physical and biological characteristics, under five headings: land-surface form, climate, vegetation, soils, and fauna. The descriptions are based on information compiled from many sources. The principal ones are listed in Selected References. Land-surface form is described using the terminology and classification of E. H. Hammond (1964). Climate descriptions are based largely on Köppen's classification, summarized in Appendix 1. Soil information is given by naming the principal soil orders of the Soil Taxonomy (Soil Survey Staff 1975).

The approximate area of each province and section, and the proportionate extent of each in the United States are listed in Appendix 2. The Yukon Parkland Province (1310) has been deleted because it was felt to be an unrealistic and arbitrary division of interior Alaska. All land formerly shown on the map as being in the Yukon Parkland is now shown in the Yukon Forest Province.

1000 Polar Domain

Climates of the polar group, located at high latitude, are controlled chiefly by polar and arctic air masses. As a group, these climates have low temperatures, a severe winter season, and only small amounts of precipitation. Maximum precipitation in all the polar climates comes in summer. In areas where summers are short and temperatures are generally low throughout the year, temperature efficiency rather than effectiveness of precipitation becomes critical in influencing plant distribution and soil development. Two major divisions have been recognized and delimited in terms of temperature efficiency — the tundra and the subarctic (taiga).

1200 Tundra Division

The northern continental fringes of North America from the Arctic Circle northward to about the 75th parallel lie within the outer zone of control of arctic-type air masses. These conditions produce the tundra climate, that Köppen designated by symbol *ET*. Average temperature of the warmest month is colder than 50°F. (10°C.) but warmer than 32°F. (0°C.).

The tundra climate has a very short, cool summer and a long, severe winter. At most only 188 days in the year have a mean temperature warmer than 0°C., and sometimes these are as few as 55. Precipitation is light, often less than 8 in. (200 mm.), but since the potential evaporation is also very low, the climate is humid.

Vegetation on the tundra consists of grasses, sedges, and lichens, with willow shrubs. Traced southward the vegetation changes into birch-lichen woodland, then into the needleleaf forest. In some places, a distinct tree line separates the forest from tundra. Köppen used this line, which coincides approximately with the 50°F. (10°C.) isotherm of the warmest month, as a boundary between subarctic and tundra climates.

The soil particles of tundra are produced almost entirely by mechanical breakup of the parent rock and have suffered little or no chemical alteration. Inceptisols with weakly differentiated horizons are dominant. Continual freezing and thawing of soil moisture has disintegrated the soil particles. Like the soils of the northern continental interior, soils of the tundra are affected by the permanently frozen condition called permafrost. The permafrost layer is more than 1,000 ft. (300 m.) thick over most of this region; seasonal thaw reaches only 4 to 24 in. (10-60 cm.) below the surface.

Geomorphic processes have a distinctive pattern in the tundra regions, and a variety of curious landforms results. Under a protective sod of small plants, the soil water melts in summer producing a thick mud which may flow downslope to create bulges and terraces and lobes on slopes. The freeze and thaw of water in the soil sorts the coarse particles and gives rise to patterned ground with such features as stone rings, stone polygons and stone stripes. The coastal plains have numerous lakes of thermokarst origin, formed by melting of ground ice.

1210 Arctic Tundra Province

Northern Arctic coastal plain, 68,900 sq. mi. (178,500 sq. km.)

Land-surface form. — The north coast of Alaska is a broad, level plain, generally less than 1,000 ft. (300 m.) in elevation. Rolling foothills rise near the Colville River and gain altitude southward into the Brooks Range. The entire province is under continuous permafrost to depths of 2,000 ft. (600 m.) in some areas. In summer, thousands of lakes and marshes dot the plain.

Climate. — The severe Arctic climate reaches temperatures of -60°F. (-51°C.) in winter. Average annual temperature is only 10°F. (-12°C.) to 20°F. (-6°C.). Precipitation is very low throughout the year; average annual precipitation is only 7 in. (180 mm.). The extremely northern location of this province subjects it to great differences in amount of sunlight received at various times of the year. In summer the sun remains above the horizon from only 2 to as many as 85 days depending on the latitude; in winter it can remain below the horizon for as long as 67 consecutive days. All sunlight is received at oblique angles that average 41°. The growing season averages only 2 weeks per year.

Vegetation. — Permafrost limits the rooting depth of plants and forces surface water drainage; this creates extensive marshes and lakes. Cottongrass-tussock, the most widespread vegetation system in the Arctic, is associated with sedges, dwarf shrubs, lichens, mosses, dwarf

Watersedge tundra of the Arctic Tundra Province on the Arctic coastal plain of Alaska. (U.S. Fish and Wildlife Service.)

birch, Labrador-tea, and cinquefoil. These highly productive systems produce 500-1,000 (227-454 kg.) pounds/acre, and are important sources of food for caribou and waterfowl. Several forbs flower brightly in the short summer.

Soils. — The soils are wet, cold Inceptisols that have weakly differentiated horizons. Soils occupying south slopes and low moraines are well drained and loamy with permafrost and ice features. They are underlain by coarse outwash and till. Localized areas of poorly drained clayey soils occupy uplands. Soils of the lowlands are deep, wet, and silty. There is no surface water in winter and only moderate flows in the summer. Supplies of ground water are very limited.

Fauna. — Mammals of the Arctic include brown bear, wolf, wolverine, caribou, Arctic hare, mink, weasel, and lemming. Ptarmigans, ravens, hawks, and open country owls are common. Shore and lake areas are rich habitat for millions of migrating waterfowl and shorebirds during the summer months. Polar bear, walrus, and Arctic fox are common on the ice pack and coastal areas during the winter. Gyrfalcon have also been seen on sea ice.

1220 Bering Tundra Province

Seward Peninsula, Bering Sea and Bristol Bay coastal plains, 86,700 sq. mi. (224,600 sq. km.)

Land-surface form. — The Bering Tundra is a western extension of the Arctic coastal plain, a broad lowland area rising gradually to the eastward. General topography is less than 1,000 ft. (300 m.) in elevation, broken in places by small mountain groups that rise 2,500-3,500 ft. (800-1,100 m.). Standing water is present in thousands of shallow lakes and marshes along the coast. Two large braided rivers, the lower Yukon and Kuskokwim, flow out of the province to the southwest.

Climate. — The Bering Tundra climate is less severe than that on the Arctic slope but it also has cold winters and warm summers. Annual precipitation averages 17 in. (430 mm.). Temperatures range from 90°F. (32°C.) to -70°F. (-57°C.). Permafrost is continuous under most of the area.

Vegetation. — Vegetation along the wet coastal areas is chiefly sedge and cottongrass; woody plants grow on higher sites. Birch-willow-alder thickets interspersed with alpine tundra vegetation are extensive on the Seward Peninsula and in transition zones between the beach and forest. The lower Yukon and Kuskokwim valleys are dominated by white spruce, mixed with cottonwood and balsam poplar. It is a tall, relatively dense growth, with dense undergrowth of thinleaf alder, willow, rose, dogwood, and various species of berry bushes.

Soils. — Coastal soils are wet, cool, Inceptisols over silt, sand, and marine sediments. The lower Yukon and Kuskokwim valley bottoms have pockets of Entisols with no soil horizons. Ground water throughout the area is limited, but some is available in the major river valleys. Surface water ceases to flow in winter on the Seward Peninsula, but flows continuously further south.

Fauna. — River bottom lands provide excellent habitat for furbearers, game birds, and moose. Upland and coastal areas support brown and black bear, wolf, wolverine, coyote, caribou, reindeer, snowshoe hare, red fox, lynx, beaver, moose, squirrels, mice, weasel, mink, and marten. Along the northern Bering Sea coast, polar bear, walrus, and Arctic fox are occasionally found. The coastal areas provide extensive and excellent habitat for migrating waterfowl and shorebirds. Other bird species in the area include ospreys, falcons, grouse, ravens, golden eagles, and various hawks and owls.

Highland Provinces

M1210 Brooks Range Province

Northern Alaska, 53,300 sq. mi. (138,000 sq. km.)

Land-surface form. — The Brooks Range is a northern extension of the Rocky Mountain system and extends 600 mi. (970 km.) westward from Canada to the Chukchi Sea. Its rugged mountains reach elevations of 9,000 ft. (2,700 m.) in the east and decrease to 3,000 ft. (900 m.) in the west. Broad U-shaped valleys and morainal topography show evidence of glaciation. A series of rolling plateaus and low mountains, the Arctic foothills, borders the coastal plain to the north.

Climate. — The climate of the Brooks Range is similar to that of the Arctic coastal plain, but precipitation increases at the higher altitudes and at the east end of the range. Precipitation averages 7 to 15 in. (180-390 mm.), but drainage is rapid because soils have low holding capacity and steep slopes. Summer temperatures reach 90° to 100°F. (32° to 38°C.), but winter temperatures drop as low as -75°F. (-60°C.). Since the province lies above the Arctic Circle, it experiences several days of 24-hr. sunlight in June, and several sunless days in December.

Vegetation. — In the higher alpine areas, plant cover is discontinuous over barren rock. It consists chiefly of low mats of such herbaceous and shrubby species as dwarf arctic birch, crowberry, Labrador-tea, arctic willow, resin birch, and dwarf blueberry. Lower elevations may be covered by a very productive mat of sedge and shrub that is valuable as forage for caribou. Cottongrass, bluejoint, mosses, dwarf willow, dwarf birch, Labrador-tea, and bistort are common. Regeneration of most species is extremely slow; some mosses require more than 60 years to recover from disturbance.

Soils. — The mountains are underlain by folded and faulted limestone, the foothills by various sediments. Soils are rocky and poorly developed. Inceptisols cover the lower slopes. Glacial and alluvial deposits occur in the valleys and at the base of the mountain slopes. Permafrost is continuous under the entire area.

Fauna. — The Brooks Range is an important big game area in Alaska and supports brown and black bear, wolf, wolverine, caribou, and Dall sheep. Smaller mammals include marmot, red and Arctic fox, ground squirrel, lemming, and pika. Raptors prominent in many areas include golden eagles, marsh hawks, gyrfalcons, snowy and other open country owls. Brooks Range is an important resting area for migrating waterfowl and songbirds during the summer.

1300 Subarctic Division

The source region for the continental polar air masses is south of the tundra zone between lat. 50° and 70° N. This climate type shows very great seasonal range in temperature; winters are severe and the small annual precipitation is concentrated in the three warm months. This climate, called here the continental subarctic climate, is classified as *Dfc* by Köppen. This cold, snowy forest climate is moist all year, and summers are cool and short. Less than 4 months of the year have average temperatures warmer than 50°F. (10°C.).

Winter is the dominant season of this continental subarctic climate. Because monthly average subfreezing temperatures continue through 6 to 7 consecutive months, all moisture in the soil and subsoil freeze solidly to depths of many feet. Summer warmth is insufficient to thaw more than a few surface feet; so permafrost prevails under large areas. Seasonal thaw penetrates from 2 to 14 ft. (0.6 to 4 m.) depending on latitude, aspect, and kind of ground.

The subarctic climate zone coincides with a great belt of needleleaf forest, often referred to as boreal forest, and open lichen woodland, called the taiga. Most trees are small and have less value for lumber than for pulpwood.

Inceptisols with pockets of wet, organic Histosols are associated with the arctic needleleaf forest. These light gray soils are wet, strongly leached, and acid; they have a very distinct layer beneath the uppermost layer of humus and forest litter. Agricultural potential is poor. Added to the natural infertility of soils is the prevalence of swamps and lakes left by the departed ice sheets. Ice scoured some rock surfaces and stripped off the overburden entirely. Elsewhere rock basins were formed and stream courses dammed; this made countless lakes.

1320 Yukon Forest Province

Interior Alaska, 185,500 sq. mi. (480,600 sq. km.)

Land-surface form. — A series of broad valleys, dissected uplands, and lowland basins covered by alluvial deposits extends across interior Alaska between the Brooks and Alaska Ranges. Five major rivers provide the outstanding hydrologic features of the area: the upper Yukon, Porcupine, Tanana, Koyukuk, and upper Kuskokwim. River valleys are wide and channels extensively braided; in some areas they contain hundreds of small lakes and marshes. Elevations are generally less than 2,000 ft. (600 m.). Small mountain groups and isolated peaks, mostly near the Canadian border, rise to heights of 5,500-6,000 ft. (1,700-1,800 m.).

Boreal forest of stunted black spruce in the Yukon Forest Province, Kuskokwim River, Alaska.

Climate. — The semiarid climate has extreme temperatures. Summers are short and hot, up to 100°F. (38°C.); winters are long and severe, and temperatures fall as low as -75°F. (-60°C.). Average annual precipitation is only 17 in. (430 mm.). Permafrost is discontinuous in the major river valleys, but continuous on north-facing slopes and in the higher elevations of the province. Temperature inversions, frequent in upland areas in winters, result in warmer temperatures on lower slopes than in bottom lands.

Vegetation. — The major river bottoms support dense white spruce-cottonwood-poplar forest on the flood plains and south-facing slopes up to about 1,000 ft. (300 m.) elevation. Undergrowth is dense shrubbery, including green and thinleaf alder, willow, dogwood, and berries. The outer valley edges support evergreen and coniferous forests, often with pure stands of black spruce. Undergrowth is willow, dwarf birch, crowberry, fern, blueberry, lichens, and mosses. Upland areas are generally covered by a rather dense white spruce-birch-aspen-poplar forest. Pure stands of white spruce grow near streams. Typical undergrowth includes willow, alder, fern, berries, grasses, and mosses. Root systems are shallow. Water balance is likely the factor limiting growth in most of these areas because of the hot, dry summer climate. Scattered but extensive bogs occupy old river terraces, ponds, and sloughs. Their vegetation is chiefly sphagnum and other mosses, sedges, bog rosemary, and Labrador-tea. Marginal areas may support willow and alder. Alpine tundra covers isolated areas above 3,000 ft. (900 m.).

Soils. — River bottom and lower slope soils have generally deep, well drained Inceptisols, with underlying sands, silts, and gravels that are only slightly weathered. Soils on north-facing slopes are shallow and poorly developed and have continuous permafrost. Upland soils that support spruce-hardwood forests are well drained, shallow Inceptisols. Bog soils are Histosols.

Fauna. — The spruce-hardwood forests provide excellent habitat for furbearers, woodland game birds, and mammals. Brush zones and immature forests recovering from fires furnish especially good browse for moose. Black and brown bear, wolf, wolverine, caribou, and moose are common game species. Smaller mammals include red fox, beaver, mink, muskrat, weasel, land otter, marten, squirrels, and mice. Upland birds include sharptail, spruce and ruffed grouse, ptarmigan, hawks, woodland owls, and ravens. Cliffs along the Yukon and Porcupine Rivers support several raptor species: osprey, gyrfalcon, hawks, and the endangered American peregrine falcon.

Highland Provinces

M1310 Alaska Range Province

Alaska Range, Alaska Peninsula, Aleutian Islands
102,200 sq. mi. (264,700 sq. km.)

Land-surface form. — The Alaska and Aleutian Ranges are a continuation of the Pacific Coast Mountains in an arc across the northern Pacific. The high rugged and glaciated peaks of the Alaska Range, which include Mt. McKinley at 20,320 ft. (6,193.5 m.), and the 2,000-mi. (3,219 km.) volcanic arc of the Aleutian Mountains and Islands, typify the ruggedness of the area. The only major rivers are the Susitna and upper Copper River; several large lakes are on the Alaska Peninsula. Coastlines are dissected, steep sloped, and rocky.

Climate. — The Alaska Range and north Alaska Peninsula have a transitional climate of severe winters and hot, dry summers. Temperatures range from 90°F. (32°C.) to -70°F. (-56°C.). Precipitation averages only 16 in. (420 mm.) annually. The south Alaska Peninsula and Aleutian Islands fall in the maritime zone. Their temperatures are slightly less severe in winter, down to -40°F. (-40°C.); but precipitation is as much as 65 in. (1,650 mm.). Winds are often a severe problem on the islands. Permafrost is discontinuous on south-facing mountain slopes and is generally absent from the southern Alaska Peninsula and Aleutian Islands.

Vegetation. — Vertical vegetative zonation in the Alaska and Aleutian Ranges extends from dense bottom land stands of white spruce and cottonwood on the Copper and Susitna River flood plains and low terraces, and black spruce stands on poorly drained areas up to 1,000 ft. (300 m.) elevation. Upland spruce-hardwood forests of white spruce, birch, aspen, and poplar with a moss, fern, grass, and berry undergrowth extend to timberline at about 2,500-3,500 ft. (760-1,100 m.). Tundra systems lie above timberline ending upward at the permanent ice caps. Low shrubs and herbaceous plants form discontinuous mats among rock and rubble. White mountain-avens may cover entire ridges in the Alaska Range and are associated with moss-campion, black oxytrope, arctic sandwort, lichens, grasses, and sedges.

The low-lying north shore of the Alaska Peninsula is an area of standing water, sedges, and cottongrass; the south shore has more of a brush system centered around alder thickets, devilsclub, willow, mountain ash, and berries.

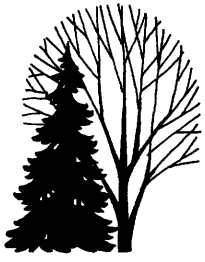
In the Aleutians, dominant plants are low heath shrubs, crowberry, bog blueberry, mountain cranberry, alpine-azalea, and dwarf willow. Moist, low elevation areas are often tall grass meadows interspersed with dense low heath shrubs.

Soils. — Bottom land and terrace soils of the Copper and Susitna Rivers are stratified, well drained Entisols. The Entisols have no pedogenic horizons. Upland hardwood forest soils are mostly shallow, well drained Inceptisols. North-facing slopes have continuous permafrost. Soils that support the moister tundra areas range from wet Inceptisols to Histosols. Alpine Inceptisols are generally shallow and poorly developed, with discontinuous to continuous permafrost.

The Aleutian soils are poorly developed Inceptisols and Histosols and rock areas.

Fauna. — The Aleutian Islands support no large mammals. Foxes, bald eagles, and hawks are the primary predators on the millions of seabirds that use the islands and rocks for rookeries. Such marine mammals as seal, sea lion, and sea otter are abundant and use the islands for hauling out and rookeries.

The Alaska Peninsula and Alaska Range support large big game populations of moose, Dall sheep, black and brown bear, wolf, caribou, and wolverine. Smaller mammals include beaver, red fox, lynx, otter, marten, squirrels, weasel, and various rodents. Migrating waterfowl and shorebirds use the coastal areas extensively in the summer. Golden eagles, ptarmigan, ravens, and hawks inhabit the uplands; the rich fish resources support bald eagles and osprey on the coastline.



2000 Humid Temperate Domain

The climates of the humid temperate group are those of midlatitudes (30° to 60°) occupying the zone in which both tropical and polar air masses are important climatic factors. The midlatitudes are a belt subject to cyclones; much of the precipitation in this belt comes from lifting of moist air along fronts within those cyclones. Strong climatic seasons are characteristic of the midlatitude climates — seasons in which temperatures as well as precipitation show strong annual cycles. In these environments, the seasonal fluctuation of energy and temperature is greater than the diurnal. The midlatitude climates have a distinctive winter season, which the tropical climates do not.

The humid temperature domain comprises the humid midlatitude forests of broadleaf deciduous and needleleaf evergreen trees. The variable importance of winter frost determines six divisions: warm continental, hot continental, subtropical, marine, prairie, and Mediterranean.

2100 Warm Continental Division

South of the eastern area of the subarctic climate, between latitudes 40° and 55° N. and extending from the continental interior to the east coast, lies the humid warm-summer continental climate. Its location is intermediate between the source regions of polar continental air masses to the north and maritime or continental tropical air masses to the south. Alternations of these air masses create strong seasonal contrasts in temperature.

In the Köppen system this area lies in the *Dfb,* described as a cold, snowy, winter climate that has a warm summer. The *Dfb* climate has 4 to 8 months when temperatures exceed 50°F. (10°C.) with no dry season. The warm summer specified by the letter *b* is one in which the average temperature of the warmest month is colder than 72°F. (22°C.). Precipitation is ample all year but is substantially greater during the summer.

Needleleaf and mixed needleleaf-deciduous forest extends along the entire length of the colder northern parts of the humid continental climate zone. To this may be added the mountain region of the Adirondacks and northern New England. Here soils are Spodosols. The Spodosols have a low supply of bases and a horizon in which organic matter and iron and aluminum have accumulated. They are strongly leached but have an upper layer of humus. Cool temperatures inhibit bacterial activity that would destroy this organic matter in tropical regions. Soils are deficient in calcium, potassium, and magnesium, and are generally acid. Thus, they are not highly productive for crop farming even though adequate rainfall is generally assured; but they are well suited to growing conifers.

2110 Laurentian Mixed Forest Province

North-Central Lake-Swamp-Morainic Plains, Adirondack-New England Highlands
224,700 sq. mi. (582,000 sq. km.)

Land-surface form. — Most of this province has low relief, but rolling hills and low mountains occur in many places. The Adirondack-New England Highlands have relief of between 1,000 and 3,000 ft. (300 and 900 m.). Lakes, poorly drained depressions, morainic hills, drumlins, eskers, outwash plains, and other glacial features are characteristic, for glaciers covered the entire area during parts of the Pleistocene. Elevations range from sea level to 4,000 ft. (1,200 m.); a few isolated peaks are higher than 5,000 ft. (1,500 m.).

Climate. — Winters are moderately long and somewhat severe, but more than 120 days have temperatures above 50°F. (10°C.). Average annual temperatures range from 35° to 50°F. (2° to 10°C.). Snow usually stays on the ground all winter. During winter, the province lies north of the main cyclonic belt; but during summer it lies within this belt and the weather is changeable. The moderate precipitation ranges from 24 to 45 in. (600 to 1,150 mm.); maximum precipitation comes in summer. A short growing season imposes severe restrictions on agriculture; the frost-free season lasts from 100 to 140 days.

Vegetation. — This province lies between the boreal forest and the deciduous forest zones and therefore is transitional. It consists of either mixed stands of a few coniferous species (mainly pine) and a few deciduous species, or of a macromosaic-like arrangement with pure deciduous forest on favorable habitats with good soil, and pure coniferous forest on less favorable habitats that have poor soils. Several species of pine represent the conifers in the mixed stands, mainly northern white pine in the Great Lakes region; but eastern hemlock is also present here, and eastern redcedar is in the southeast. Pine trees are often the pioneer woody species following forest fires or on abandoned arable land. Since they grow more rapidly than deciduous species on poor soils, they constitute the upper tree stratum; but their regeneration in such mixed stands is problematic if the deciduous undergrowth is dense. For this reason, pine trees are successful only where fire is recurrent. Fires started by lightning occur commonly in such forests, particularly where soils are sandy and where there is a layer of dry litter in summer.

This stand of beech and hemlock in the Allegheny National Forest, Pennsylvania, illustrates mixed deciduous-coniferous forest in the Laurentian Mixed Forest Province.

Soils. — Soils vary greatly from place to place and include peat, muck, marl, clay, silt, sand, gravel, and boulders, in various combinations. Spodosols are dominant in New England and along the Great Lakes coast; Inceptisols and Alfisols dominate farther inland. The Alfisols are medium to high in bases and have gray to brown surface horizons and subsurface horizons of clay accumulation.

Fauna. — In winter the ptarmigan, weasel, and snowshoe hare turn white, as they do in the polar provinces. The black bear, striped skunk, marmot, chipmunk, and the two genera of jumping mice pass the winter in hibernation. So do badger and the striped ground squirrel that live in the western parts of the province. Many birds, especially the insectivorous species, migrate south in winter. Beaver and muskrat remain active all winter but work beneath the ice that covers the lakes and streams.

Sections. — Four sections are recognized in this province: Spruce-Fir Forest (2111), Northern Hardwoods-Fir Forest (2112), Northern Hardwoods Forest (2113), and the Northern Hardwoods-Spruce Forest (2114).

Highland Provinces

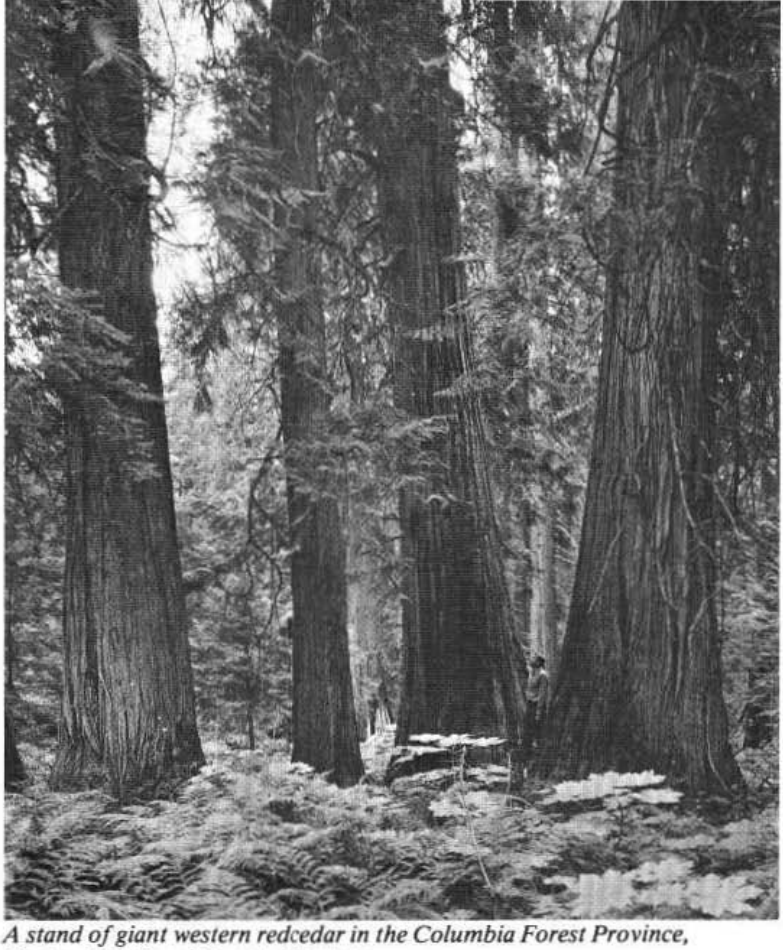
M2110 Columbia Forest Province

Northern Idaho, western Montana, eastern Washington
45,300 sq. mi. (11,700 sq. km.)

Land-surface form. — The Columbia Forest consists of high, rugged mountains, rising to more than 9,000 ft. (2,700 m.) with local relief in excess of 3,000 ft. (900 m.). Most of the region has been glaciated. In the several Rocky Mountain trenches, there are flat or nearly flat valleys, some of which are several miles wide.

Climate. — Severe winters are usual. The average temperature of the coldest month is lower than 32°F. (0°C.) and the warmest is lower than 72°F. (22°C.). Summer days are often hot, the nights cool. Precipitation average 20 to 40 in. (500-1,000 mm.) per year, mainly in the fall, winter, and spring. Summers are usually dry because westerly air masses draw the dry climate of the Pacific coast across the area. As a result, there is a distinct climatic gradient from north to south and east to west. Snowfall in winter is heavy, but permanent snowfields and glaciers cover only rather small areas.

Vegetation. — Mixed coniferous-deciduous forest predominates; Douglas-fir forest and cedar-hemlock-Douglas-fir forest are the two major types.



A stand of giant western redcedar in the Columbia Forest Province, Kootenai National Forest, Montana.

Well marked life belts are a striking feature. The uppermost belt is the alpine, where trees are absent. Next below is the subalpine belt, dominated in most places by Engelmann spruce and subalpine fir. In the Bitterroot Range, mountain hemlock is said to be the climax tree of the subalpine belt. Western redcedar and western hemlock are characteristic of the montane belt. Associated trees include Douglas-fir, which has a general distribution, and, in the southern parts, western white pine, western larch, grand fir, and western ponderosa pine. At the lower edge of the montane belt, depending on latitude, there may be a belt of grass and sagebrush.

Soils. — Soils are mostly cool, moist Inceptisols. A variety of igneous, sedimentary, and metamorphic rocks forms mountain masses. In comparison with other parts of the Rocky Mountains, however, shallowness and stoniness of soils play a relatively minor part in forest distribution. In the foothills of the Rockies and to the south of the glacial border, loess and volcanic ash have been deposited on the slopes and have helped to form excellent soils.

Fauna. — Large mammals in this province are black bear, deer, elk, mountain lion, and bobcat. Smaller mammals include mice, squirrels, martens, chipmunks, and wood rats. Some familiar birds are hawks and owls, jays, chestnut-backed chickadees, red-breasted nuthatches, and great gray owls. Blue and ruffed grouse are the most common game birds.

Sections. — Two sections are recognized in this province: Douglas-fir Forest (M2111), and Cedar-Hemlock-Douglas-fir Forest (M2112).

2200 Hot Continental Division

South of the warm continental climate lies the humid, hot-summer continental climate. It has the same characteristics as the warm continental except that it is more moderate and has hot summers and cool winters. The boundary between the two is the isotherm of 72°F. (22°C.) for the warmest month. In the warmer sections the frost-free or growing season continues for 5 to 6 months, in the colder sections only 3 to 5 months. Snow cover is deeper and lasts longer in the northerly areas.

In the Köppen system, these areas are classified as *Dfa.* The letter *a* specifies the hot summer. We are including here under hot continental climate the northern part of Köopen's *Cf* climate region in the eastern United States. Köppen uses as the *C* - *D* boundary the isotherm of 26.6°F. (-3°C.) for the coldest month. Thus, for example, Köppen places New Haven and Cleveland in the same climatic region as New Orleans and Tampa despite obvious contrasts in January mean temperatures, soil groups, and natural vegetation between these northern and southern zones. Trewartha redefined the boundary between *C* and *D* climates as the isotherm of 32°F. (0°C.) of the coldest month; he thus pushed the *C* - *D* boundary in the United States southward to a line extending roughly from St. Louis to New York City. Trewartha's *C* - *D* climate boundary is adopted here in distinguishing between humid continental and humid subtropical climates.

Natural vegetation is winter deciduous forest, dominated by tall, broadlead trees that provide a continuous dense canopy in summer but shed their leaves completely in the winter. Lower layers of small trees and shrubs are weakly developed. In spring, a luxuriant low layer of herbs quickly develops, but this is greatly reduced after trees reach full foliage and shade the ground.

Soils are chiefly Inceptisols, Ultisols, and Alfisols, rich in humus and moderately leached so as to have a distinct light colored leached zone under the upper dark layer. The Ultisols have a low supply of bases and a horizon in which clay has accumulated. Where topography is favorable, diversified farming and dairying are the most successful uses of the land.

2210 Eastern Deciduous Forest Province

East-Central Drift and Lake-bed Flats, Ozark-Ouachita Highlands, Eastern Interior Uplands and Basins, Appalachian Highlands
367,800 sq. mi. (952,600 sq. km.)

Land-surface form. — Most of the area is rolling, but some parts are nearly flat and in the Appalachian Mountains the relief is high (up to 3,000 ft. [900m.]). The northern parts of the province have been glaciated but not the southern. Elevations range from sea level to 2,500 ft. (760 m.); a few isolated peaks are higher than 4,500 ft. (1,370 m.).

Gently rounded slopes of the southern Appalachian Mountains, Pisgah National Forest, North Carolina.

Climate. — The Eastern Deciduous Forest represents a response to a continental climatic regime that receives adequate precipitation in all months. Average annual precipitation is from 35 to 60 in. (900-1,500 mm.). Precipitation is markedly greater in the summer months when evapotranspiration is great and moisture demands are high. Only a small water deficit is incurred in the summer, whereas a large surplus normally develops in spring. A strong annual temperature cycle brings cold winters and warm summers. The average annual temperature is 40°-60°F. (4°-15°C.).

Vegetation. — Winter deciduous forest, sometimes called temperate deciduous forest, is characteristic of this province. It is dominated by tall, broadleaf trees that provide a continuous and dense canopy in summer but shed their leaves completely in winter. Lower layers of small trees and shrubs develop weakly. In spring, a luxuriant low layer of herbs quickly develops, but this is greatly reduced after the trees reach full foliage and shade the ground.

Common trees of the deciduous forests of eastern North America are oak, beech, birch, hickory, walnut, maple, basswood, elm, ash, tulip tree, sweet chestnut, and hornbean. In poorly drained habitats, the deciduous forest consists of alder, willow, ash, elm, and many hygrophytic shrubs. Where forests have been cleared by logging, pines develop readily as second-growth vegetation.

Soils. — The pedogenic process associated with deciduous forest is podzolization, moderated by the warm wet winters. As a result, soils are characteristically Alfisols. Toward lower latitudes, the tendency to laterization becomes stronger and Ultisols are encountered. Toward the continental interior, the tendency to calcification sets in and the deciduous forest extends into the darker soils of the grasslands (Mollisols). In the deciduous forests, a thick layer of leaves covers the ground and humus is abundant.

Fauna. — Important mammals include the white-tailed deer, black bear, bobcat, gray fox, raccoon, gray squirrel, fox squirrel, eastern chipmunk, white-footed mouse, pine vole, short-tailed shrew, and cotton mouse.

Bird populations are large. The turkey, ruffed grouse, bobwhite, and morning dove are game birds in various parts of the province. Breeding bird populations average about 225 pairs per 100 acres and include some 25 species. The most abundant breeding birds include the cardinal, tufted titmouse, wood thrush, summer tanager, red-eyed vireo, blue-gray gnatcatcher, hooded warbler, and Carolina wren. The box turtle, common garter snake, and timber rattlesnake are characteristic reptiles.

Sections. — The province includes five principal plant associations, which are the basis for five sections: Mixed Mesophytic Forest (2211), Beech-Maple Forest (2212), Maple-Basswood Forest and Oak Savanna (2213), Appalachian Oak Forest (2214), and Oak-Hickory Forest (2215).

Upper photo — Rolling surface of a glaciated plain in central Minnesota. (Soil Conservation Service.)

Lower photo — A grove of yellow-poplar in the Eastern Deciduous Forest, Chattahoochee National Forest, Georgia.

2300 Subtropical Division

The humid subtropical climate, a general pattern characterized by absence of really cold winters, and presence of high humidity, especially in summer, prevails throughout the southern Atlantic and Gulf Coast states of the United States.

In the Köppen system, this area lies within the *Cfa* climate, described as temperate and rainy and having hot summers. The *Cfa* climate has no dry season, and even the driest summer month receives at least 1.2 in. (30 mm.) of rain. The hot summer specified by the letter *a* is one in which the average temperature of the warmest month is warmer than 72°F. (22°C.). Rainfall is ample all year, but is markedly greater during summer. Thunderstorms are especially frequent in summer; they may be of thermal or squall-line or cold front origin. A tropical cyclone or hurricane may strike the coastal area occasionally, always bringing very heavy rains. Winter precipitation, some in the form of snow, is of frontal type. Temperatures show a moderately wide range, of much the same magnitude as those in tropical deserts, but without the extreme heat in summer.

Soils of the moister, warmer parts of the humid subtropical regions are strongly leached Ultisols related to those of the humid tropical and equatorial climates. Rich in oxides of both iron and aluminum, these soils are poor in many of the plant nutrients essential for successful agricultural production.

Forest is the natural vegetation of most areas that have the humid subtropical climate. Much of the sandy coastal region of the southeastern United States today is covered by a second growth forest of longleaf, loblolly, and slash pines, whereas the inland region is deciduous forest.

2310 Outer Coastal Plain Forest Province

Gulf of Mexico coastal plain, Florida, 150,100 sq. mi. (388,800 sq. km.)

Land-surface form. — This region is restricted to flat and irregular southern Gulf Coastal Plains. Well over 50 percent of the area is gently sloping. Local relief is less than 300 ft. (90 m.) plus some gently rolling areas. Most of its numerous streams are sluggish; and marshes, swamps, and lakes are numerous.

Climate. — The climate regime is equable; the annual range of temperature is small to moderate. Average annual temperature is 60° to 70°F. (15° to 21°C.). Rainfall is abundant and well distributed throughout the year; precipitation ranges from 40 to 60 in. (1,000 to 1,525 mm.).

A forest of live oaks draped with Spanish moss in the Outer Coastal Plain Forest region.

Vegetation. — Temperate rainforest, also called temperate evergreen forest and laurel forest, is characteristic. It differs from the equatorial and tropical rainforest by having fewer species of trees and hence large populations of individual single species. Trees are not as tall here as in the low-latitude rainforest; leaves usually are smaller and more leathery, and the leaf canopy is less dense. The trees commonly found in the southeastern United States are evergreen oaks and members of the laurel and magnolia families. These forests usually have a well developed lower stratum of vegetation that, in different places, may include tree ferns, small palms, shrubs, and herbaceous plants. Lianas and ephiphytes are abundant. Particularly striking at higher elevations where fog and clouds persist is the sheathing of trees' trunks and branches by mosses. An example of conspicuous epiphyte accumulation at low elevations is the Spanish "moss" that festoons the Evangeline oak, baldcypress, and other trees of the eastern Gulf Coast.

A word about the vegetation of the coastal region of the southeastern United States may prevent some misunderstanding. On forest maps of the United States and on numerous maps of world vegetation, this coastal zone is shown as having needleleaf evergreen or coniferous forest. It is true that large areas of sandy upland bear forests of loblolly and slash pine and that baldcypress is a dominant tree in swamps, but such vegetation represents xerophytic and hydrophytic forms in excessively dry or wet habitats, or the second growth forest following fire and deforestation. The climax vegetation of mesophytic habitats is the evergreen-oak and magnolia forest.

Soils. — Temperate rainforest grows on a wide variety of upland soils, but most tend to be wet, acidic, and low in the major plant nutrients. The soils are derived mainly from Coastal Plain sediments, ranging from heavy clay to gravel, but sandy materials predominate. Silty soils occur mainly on expansive level areas. Sands are prevalent in hilly sections, but they also cover broad flats in central Florida.

The soils are mainly of three orders: Ultisols, Spodosols, and Entisols.

Fauna. — This region provides habitat for a wide variety of animals. Except for a few isolated areas where black bear or the endangered Florida panther may be encountered rarely, the white-tailed deer is the only large indigenous mammal. Common small mammals include raccoons, opossums, tree squirrels, rabbits, and numerous species of ground-dwelling rodents. The bobwhite and wild turkey are the principal game birds. Resident and migratory nongame bird species are numerous, as are migratory waterfowl. The red-cockaded woodpecker is an endangered species. Of the numerous species of reptiles, the endangered American alligator is the largest.

Sections. — This region is divided into two distinct sections: the Beech-Sweetgum-Magnolia-Pine-Oak Forest (2311), and the Southern Flood Plain Forest (2312).

2320 Southeastern Mixed Forest Province

Southeastern United States, 257,900 sq. mi. (668,000 sq. km.)

Land-surface form. — This region generally occurs on the irregular Gulf Coastal Plains and the Piedmont, where 50 to 80 percent of the area slopes gently. Local relief is 100 to 600 ft. (30 to 180 m.) on the Gulf Coastal Plains and 300 to 1,000 ft. (90 to 300 m.) on the Piedmont. The flat Coastal Plains have gentle slopes and local relief of less than 100 ft. (30 m.). Most of the numerous streams are sluggish; and marshes, lakes, and swamps are numerous.

Climate. — The climate is approximately uniform throughout the region. Mild winters and hot humid summers are the rule; average annual temperature is 60° to 70°F. (15° to 21°C.). Precipitation averages 40 to 60 in. (1,000 to 1,500 mm.) annually. It is rather evenly distributed throughout the year, but peaks slightly in midsummer or early spring when it falls mostly during thunderstorms. Precipitation exceeds evaporation, but summer droughts occur. The growing season is long (200 to 300 days), but frost occurs nearly every winter. Snow falls rarely but melts almost immediately.

Vegetation. — The climax vegetation is medium tall to tall forests of broadleaf deciduous and needleleaf evergreen trees. At least 50 percent of the stands are loblolly pine, shortleaf pine, or other southern yellow pines, singly or in combination. Common associates include oak, hickory, sweetgum, blackgum, red maple, and winged elm. The main grasses are bluestem, panicums, and longleaf uniola. Dogwood, viburnum, haw, blueberry, American beautyberry, youpon, and numerous woody vines are common.

Along the Altantic Coast, the extensive coastal marshes and interior swamps are dominated by gums and cypress. Most upland areas are covered by subclimax pine forest, which has an understory of grasses and sedges called savannas. Undrained shallow depressions in savannas form upland bogs or pocosins in which evergreen shrubs predominate.

Soils. — Ultisols dominate throughout the region and Vertisols formed from marls or soft limestones are conspicuous locally. The Vertisols are clayey soils that have wide, deep cracks when dry. Inceptisols on flood plains of the major streams are among the better soils for crops.

A stand of oak and pine in the Southeastern Mixed Forest.

Fauna. — The fauna vary with the age and stocking of the timber stand, the percent of deciduous trees, proximity to openings, and presence of bottom land forest types. The white-tailed deer is widespread, as is the cottontail. When deciduous trees are present on uplands, the fox squirrel is common. Gray squirrels live along intersecting drainages. Raccoon and fox inhabit the whole region and are hunted in many areas.

The eastern wild turkey, bobwhite, and mourning dove are widespread. In mature forests the density of breeding birds is about 240 pairs per 100 acres. Of the 20-odd species present, the most common are the pine warbler, cardinal, summer tanager, Carolina wren, ruby-throated hummingbird, blue jay, hooded warbler, eastern towhee, and tufted titmouse. The red-cockaded woodpecker is an endangered species.

Forest snakes include cottonmouth moccasin, copperhead, rough green snake, rat snake, coachwhip, and speckled kingsnake. Other reptiles present are lizards and slimy salamanders.

2400 Marine Division

Situated on the Pacific west coast between latitudes 40° and 60° N. is a zone that receives abundant rainfall from maritime polar air masses and has a rather narrow range of temperature because it fronts on the ocean.

Köppen classified the marine west coast climate as *Cfb* — temperate and rainy, with warm summers. The average temperature of the warmest month is cooler than 72°F. (22°C.), but at least 4 months average 50°F. (10°C.). Precipitation is abundant throughout the year but is markedly reduced during the summer months. Although total rainfall is not great by tropical standards, the cooler air temperatures reduce evaporation and produce a very damp, humid climate with much cloud cover. Mild winters and relatively cool summers are characteristic. The coast ranges influence precipitation markedly in these middle latitudes. The mountainous coasts of British Columbia and Alaska annually receive 60 to 80 in. (1,525-2,032 mm.) and more. This heavy precipitation has been a major factor in the development of fiords along the coast. Heavy snows in the glacial period fed vigorous valley glaciers that descended to the seas, scouring deep troughs below sea level at their lower ends.

Natural vegetation of the marine west coast climate of North America is needleleaf forest. In the coast ranges of the Pacific Northwest, Douglas-fir, redcedar, and spruce grow in magnificent forests. These are some of the densest of all coniferous forests and have some of the world's largest trees.

Soils are strongly leached Inceptisols and Ultisols and are acid. Under cool temperatures, bacterial activity is slow in contrast to that in the warm tropics; so vegetative matter is not consumed and forms a heavy surface deposit. Organic acids from the decomposing vegetation react with the soil compounds and remove such bases as calcium, sodium and potassium.

2410 Willamette-Pudget Forest Province

Oregon and Washington, 13,000 sq. mi. (33,700 sq. km.)

Land-surface form. — The Willamette-Puget Forest occupies a north-south depression between the Coast Ranges and the Cascade Mountains. Elevations range from sea level to 1,500 ft. (460 m.). The Willamette Valley has nearly level to gently sloping flood plains bordered by dissected high terraces and hills. The Puget Sound Valley is a moderately dissected tableland covered by glacial till, glacial outwash, and lacustrine deposits. This province includes isolated hills and low mountains.

Climate. — Because this province is close to the Pacific Ocean, its climate is generally mild throughout the year. Annual temperatures average 48° to 55°F. (9° to 13°C.). The moderate rainfall reaches its maximum in winter; summer has a slight moisture deficit. Average annual rainfall ranges from 15 to 60 in. (380 to 1,525 mm.); but in much of the area, the range is from 30 to 45 in. (760 to 1,120 mm.). Coastal mountains are responsible for the drier and less muted climate. Fog partially compensates for the summer drought.

Vegetation. — Before cultivation, dense coniferous forest dominated the vegetation. The principal trees are western redcedar, western hemlock, and Douglas-fir. In interior valleys, the coniferous forest is less dense than along the coast and often contains deciduous trees including big-leaf maple, Oregon ash, and black cottonwood. Some prairies support open stands of oaks or are broken by groves of Douglas-fir and other trees. Poorly drained sites with swamp or bog communities are abundant.

Soils. — Alfisols, Inceptisols, and Ultisols are the principal soil orders. Inceptisols dominate in Puget Sound Valley.

Fauna. — The fauna are closely related to those of the surrounding Pacific Forest province. Mule deer are the most common large mammal. Chief mammalian predators are the mountain lion and bobcat. The western gray squirrel frequents oak trees, and the bushy-tailed wood rat builds nests in shrub-covered stream margins and at forest edges. Isolated thickets are inhabited by brush rabbit, gray fox, and ruffed grouse. The Dusky Canada goose winters exclusively in the Willamette Valley in Oregon.

Highland Provinces

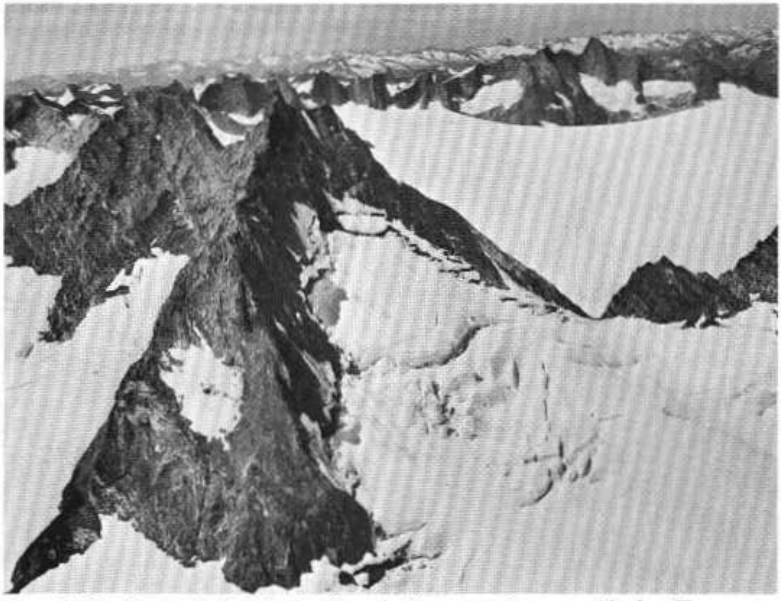
M2410 Pacific Forest Province

Southeast Alaska, Pacific Northwest and northern California
129,700 sq. mi. (335,900 sq. km.)

Land-surface form. — The Pacific Forest covers a series of steep, rugged mountains, fronted in places by a narrow coastal plain. Mountains along the coast rise 5,000 ft. (1,500 m.) above sea level and have local relief of 1,000 to 3,000 ft. (300 to 900 m.). The interior Cascade Range has mountains 8,000 to 9,000 ft. (2,400 to 2,700 m.) in altitude, dominated every 5 to 85 mi. (8 to 135 km.) by a volcano of much higher elevation. Mt. Rainier, for example, rises more than 14,000 ft. (4,300 m.) above sea level. Much of the province, especially the northern portion, has been glaciated.

Climate. — Because this province fronts on the Pacific Ocean, its climate is characterized by generally mild temperatures averaging 35° to 50°F. (2° to 10°C.) throughout the year. Rainfall is heavy, 30 to 150 in. (750 to 3,800 mm.); maximum rainfall comes in winter. Humidity is always high and produces an extremely favorable precipitation/evaporation ratio. The southern part of this province is winter-wet with no snow; fog partially compensates for the summer drought. Northward, the summer dry season shortens until, in Alaska, there is none. Northward, too, the proportion of precipitation falling as snow increases. On the high mountains all precipitation may be snow, as deep as 50 to 65 ft. (15 to 20 m.).

Mountain slopes along the coast of the Pacific Forest Province. Prince of Wales Island, Tongass National Forest, Alaska.



Snowfields above the head of valley glaciers near Juneau, Alaska. Tongass National Forest.

Vegetation. — The Pacific Forest Province is primarily montane, but it ranges from sea level to altitudes above 5,000 ft. (1,500 m.). Only in the Cascades and for a short distance into British Columbia does it become a subalpine forest. Northward this zone becomes fragmentary or disappears completely.

The principal trees of the dense conifer forest are Douglas-fir, western redcedar, western hemlock, grand fir, silver fir, Sitka spruce, and Alaska-cedar. Numerous species of shrubs grow exceptionally well in the forest and around its margins. In many places this vegetation is practically impenetrable.

Although Douglas-fir is the most abundant tree in most of the forest, it is not a member of the climax. Western hemlock and several other species of fir are more tolerant of shade than Douglas-fir, and in the mature forest, Douglas-fir cannot reproduce itself. On the western and southern slopes of the Olympic Mountains in Washington, hemlock is eventually displaced by the more shade-tolerant silver fir.

In the humid conifer forest in southwestern Oregon, Alaska-cedar is replaced by silver fir and redwood. In the fog belt along the coast of northwestern California, redwood is the characteristic tree. Douglas-fir and some other conifers associate with it to form perhaps the densest of all coniferous forests, with the world's largest trees. Individual redwoods attain heights more than 325 ft. (99 m.) and girths of more than 65 ft. (19.8 m.).

Western hemlock and Sitka spruce in the Pacific Forest Province, Washington. Olympic National Forest.

The high snowcapped mountains have a well marked subalpine belt. Important trees here are mountain hemlock, subalpine fir, whitebark pine, and Alaska-cedar.

The alpine zone has a rich flora of shrubs and herbs. Timberline is at a low elevation (about 1,500 ft.) in the northern part of the province. Many upper mountain areas are covered by perpetual snow and ice. In southeastern Alaska, timberline is between 1,000 and 2,000 ft. (300 and 600 m.). Farther south all but the highest peaks are covered by forest; perpetual snow is confined to small patches. In the Cascade Mountains in Oregon, timberline varies from 7,700 to 10,000 ft. (2,350 to 3,050 m.).

Soils. — Soils occur in three broad patterns from south to north. A climatic transect from south to north shows precipitation increasing (with an increasing percent as snowfall) and temperatures decreasing sufficiently to induce changes in vegetation. The combined effect of these changing environmental factors causes departure from Ultisols to Inceptisols, even though elevation decreases slightly in the more northerly latitudes. Limited areas in the northern latitudes are associated with changes in the sequence of great soil groups crossed by the west-east transects that ascend the mountain slopes.

Fauna. — In the Pacific Northwest and northern California, common large mammals include elk, deer, mountain lion, bobcat, and black bear. Additionally, brown bear and moose are in Alaska. The most important game birds are blue and ruffed grouse, but hawks and owls also are in the northwestern part of the province. Small mammals include mice, squirrels, martens, chipmunks, and bushy-tailed wood rats. The more common birds are the chestnut-backed chickadee, red-breasted nuthatch, gray jay, and Steller's jay.

Sections. — This province includes five distinct sections: Sitka Spruce-Cedar-Hemlock Forest (M2411), Redwood Forest (M2412), Cedar-Hemlock-Douglas-fir Forest (M2413), California Mixed Evergreen Forest (M2414), and the Silver Fir-Douglas-fir Forest (M2415).

2500 Prairie Division

Prairies are typically associated with continental, middle-latitude climates designated as *subhumid,* that is, in which evapotranspiration and precipitation almost balance on an average yearly basis and range between 20 and 40 in. (500 and 1,000 mm.). In summer, temperatures of air and soil are high; soil moisture in the uplands is not adequate for tree growth, and deeper sources of water are beyond the reach of tree roots. The North American prairies are in a broad belt extending from Texas northward to southern Alberta and Saskatchewan. Forest and prairie mix in a transitional belt on the eastern border of the division.

The prairie climate is not designated as a separate variety in the Köppen system. Geographers' recognition of the prairie climate (Thornthwaite 1931, Borchert 1950) has been incorporated into the system presented here. Prairies lie on the arid western side of the humid continental climate and with decreasing latitude extend into the subtropical climate. Temperature characteristics correspond to those of the adjacent humid climates.

The dominant natural vegetation of the prairie is tall grasses associated with subdominant broad-leaved herbs. Trees and shrubs are almost totally absent but a few may grow as woodland patches in valleys and other depressions. Grasses are deeply rooted and form a continuous cover. They flower in spring and early summer; the forbs in late summer. In Iowa, a representative region of tall-grass prairie, typical grasses are big bluestem and little bluestem; a typical forb is black-eyed Susan.

Since there is less rainfall in the grasslands than in forest, there is also less leaching of the soil. The pedogenic process associated with prairie vegetation is calcification; i.e., accumulation of carbonates in the lower layers. Soils of the prairies are Mollisols, which have black, friable, organic surface horizons and a high content of bases. Grass roots penetrate these soils deeply. Bases brought to the surface by plant growth are released on the surface and restored to the soil, perpetuating fertility. These soils are the most productive of the great soil groups.

2510 Prairie Parkland Province

Central Lowlands, West Gulf Coastal Plain
204,600 sq. mi. (529,900 sq. km.)

Land-surface form. — The Prairie Parkland Province covers an extensive area from Illinois to the Gulf Coast over which prairie and deciduous forest alternate. The topography is mostly gently rolling plains, but steep bluffs border a number of the valleys. Some areas are nearly flat; others have high rounded hills. Elevations range from sea level to 1,200 ft. (370 m.). The far northern portion of the province has been glaciated.

Climate. — Average annual precipitation ranges from 23 to 40 in. (600-1,000 mm.), and falls mainly in the growing season. Summers usually are hot, and winters, especially in the northern part of the province, are cold. Average annual temperatures may be as high as 55 °F. (13 °C.) in the north and 70 °F. (21 °C.) in the south. In the south, winters are short and relatively mild. The frost-free season ranges from 140 days along the northern fringe to 280 days in the south.

Floodplain forest of cottonwood in Nebraska.

Vegetation. — Vegetation in this province is forest-steppe, characterized by the intermingling of prairie, groves, and strips of deciduous trees. The alternating of forest and prairie in the western part of the province results chiefly from local soil conditions and slope exposure. Here trees grow most commonly near streams and on north-facing slopes. Very few trees grow on the thin soils on the tops of the limestone hills. In the eastern part of the province, on the other hand, trees often cover the highest hills. The prairies seem to be areas that have not yet become forested either because of frequent fires or because the last glaciation was too recent for the final stages in succession to have been reached.

Grasses are the dominant plants in prairie vegetation. Most are moderately tall and usually grow in bunches. The most prevalent type is bluestem prairie. In many places where grazing and fire are controlled, deciduous forest is encroaching on the prairies.

The upland forest in this province is dominated by oak and hickory and forms part of the oak-hickory forest. On flood plains and moist hillsides, there is a richer forest of deciduous trees. In the southwestern part of the province, these include elm, sycamore, bur oak, eastern cottonwood, hackberry, redbud, and buckeye.

In Texas the trees are chiefly oaks and hickories, of which the most important are post oak, blackjack oak, and Texas hickory.

An extensive border of marshes stretches inland 5 to 10 miles, sometimes farther, from the Gulf Coast of Texas.

Soils. — Mollisols dominate throughout the province north of Texas. Alfisols are in the Mississippi valley and east Texas. East Texas is dominated by north-south bands of Alfisols and Vertisols.

Fauna. — The fauna include many prairie animals that are completely independent of the need for woody vegetation. In addition, many deciduous-forest animals inhabit the timber along the valleys westward across the province. Accordingly, the fauna, like the flora, are a mixture of prairie and forest species. Few forms have been identified as being peculiar to this region.

Sections. — Two sections are recognized: the Oak-Hickory-Bluestem Parkland (2511), and the Oak-Bluestem Parkland (2512).

2520 Prairie Brushland Province

Texas, 83,600 sq. mi. (216,500 sq. km.)

Land-surface form. — This province is a region of rolling plains and plateaus occasionally dissected by canyons at the western end of the Gulf Coastal Plain and the southern end of the Great Plains. Elevations range from sea level to 3,600 ft. (1,100 m.) on the Edwards Plateau. A mesa and butte landscape is characteristic of certain parts.

Climate. — The summers are long and hot and the winters short and mild. Annual temperatures average 60° to 70°F. (15° to 21°C.). The frost-free season ranges from about 250 to considerably more than 300 days. Precipitation, which falls mostly during the growing season, ranges from 20 to 30 in. (500 to 750 mm.). Annual evaporation is 71 to 79 in. (1,800-2,000 mm.). From May to October, potential evaporation is about twice the precipitation.

Vegetation. — This province is characterized by arid grasslands in which shrubs and low trees grow singly or in bunches. On the plains in northwestern Texas, xerophytic grasses (bluestem, three-awn, buffalograss, grama) are the characteristic vegetation. However, in much of this area mesquite grows in open stands among the grasses. On the Edwards Plateau, oak and juniper are often mixed with the grass and mesquite, and on steep rocky slopes these trees may form closed stands. They rarely grow higher than 20 ft. (6.1 m.). Over much of the Plateau the characteristic vegetation is grass; trees and shrubs are present only in very open stands.

Soils. — Soils in this region are varied, but the different orders are well correlated with the different plant communities. The mesquite-live oak savanna, for example, is the only Entisol area within the region. Soils of the mesquite-buffalograss and the juniper-oak savanna are almost entirely Mollisols; an island of Alfisols within the area corresponds with the boundaries of the mesquite-oak savanna. In the mesquite-acacia savanna, Mollisols, Alfisols, and Vertisols occur.

Fauna. — The northern limit of distribution of several mammals coincides generally with the northern boundary of this province. The Mexican ground squirrel and gray fox live here and to the south, but not to the north. White-tailed deer and wild turkey are abundant and armadillo are present. The fox squirrel is hunted in wooded areas along streams. Chief furbearers are the ringtail and the raccoon.

The golden-cheeked warbler is a threatened species. Mourning dove, scaled quail, and bobwhite are common game birds and several species of hawks and owls are present.

Sections. — The sections recognized are: Mesquite-Buffalograss (2521), Juniper-Oak Mesquite Savanna (2522), and Mesquite-Acacia-Savanna (2523).

2530 Tall-Grass Prairie Province

High plains and central lowlands between the deciduous forest and the 100th meridian from the Canadian border through Oklahoma
223,000 sq. mi. (577,500 sq. km.)

Land-surface form. — This region is characterized by flat and rolling plains with relief of less than 300 ft. (90 m.). Elevations range from 2,500 ft. (760 m.) near the western edge of the province to 1,000 ft. (300 m.) at the eastern edge. Most of the lands, excluding those south of the Missouri River, are young glacial drifts and dissected till plains. Water covers much of the surface. Loess and sand deposits cover the area south of the Missouri River. This flat to rolling hill land has well developed drainage systems.

Climate. — Along its eastern boundary from Oklahoma to Iowa, annual precipitation in this province approaches 40 in. (1,000 mm.) but drops to about 20 in. (500 mm.) in North Dakota. Along the western limit of the region, precipitation ranges from 20 in. (500 mm.) in Oklahoma to 25 in. (600 mm.) in Nebraska, and 15 in. (380 mm.) in the extreme northwest. Drought periods are less frequent and less severe near the forest than in the more westerly areas. Average annual temperatures range from 40°F. (4°C.) in the north to 55°F. (13°C.) in the east, 60°F. (15°C.) in the west, and 65°F. (18°C.) in the south.

The irregular surface of the Tall-grass Prairie in northeastern Kansas. Proposed Prairie National Park. (National Park Service.)

Vegetation. — This region includes the tall-grass and mixed grasslands extending from the deciduous forest to about long. 104° W. Bunch grasses are conspicuous, for many of them grow taller than 6 ft. (1.8 m.), but sod-forming species are also dominant. Woody vegetation is rare, except on the cottonwood flood plains. Because of the generally favorable conditions of climate and soil, most of the area is cultivated and little of the original vegetation remains.

Dominant plants are porcupine grass, prairie dropseed, little bluestem, side-oats grama, Junegrass, western wheatgrass, plains muhly, panic grass, and the sedge *Carex pennsylvanica.* In mixed prairie, additional species include green needlegrass, needle-and-thread grass, sand dropseed, slender wheatgrass, galleta, and purple three-awn. There are numerous species of forbs throughout. Match weed or broomweed, scurf-pea, sunflowers, goldenrods, and ragweed occur from Texas into Canada.

During protracted dry periods, the short grasses increase at the expense of phreatophytic tall grasses; but during a series of years when supplies of moisture are normal, recovery of original vegetation is assured. Thus, the western boundaries of this region are not static and are represented by a wide transition zone.

Soils. — The soils of the tall-grass prairie are primarily Mollisols. There are smaller areas of Entisols and one small area of Vertisols. Most of the soils have dark upper horizons.

Fauna. — Bison once grazed the western margin of the tall-grass prairie. Pronghorn antelope and coyotes are still present. Jackrabbits are numerous on the prairie, and cottontails are present where there are streams and cover. Burrowing rodents include ground squirrels, prairie dogs, pocket gophers, and many smaller species. Burrowing predators include the badger and the black-footed ferret, now classified as an endangered species. The red wolf also is classed as an endangered species.

The northern portion of this region is an important breeding area for migrating waterfowl. Mourning doves have become abundant in shelterbelt plantings. The sharp-tailed grouse, greater prairie chicken, and bobwhite are present in fair numbers; however, the Northern greater prairie chicken is classified as threatened.

Sections. — The sections recognized are: Bluestem Prairie (2531), Wheatgrass-Bluestem-Needlegrass (2532), and Bluestem-Grama Prairie (2533).

2600 Mediterranean Division

Situated on the Pacific coast between latitudes 30° and 45° N. is a zone subject to alternate wet and dry seasons. It is in the transition zone between the dry west coast desert and the wet west coast.

Köppen classified the climate of the Mediterranean lands of *Csa,* a temperate rainy climate with dry, hot summers. Occurrence of a wet winter followed by a dry summer is unique among climate types and produces a distinctive natural vegetation of hardleaved evergreen trees and shrubs called sclerophyll forest. Various forms of sclerophyll woodland and scrub are also typical. Trees and shrubs must withstand the severe summer drought — 2 to 4 rainless months — and severe evaporation.

Soils of this Mediterranean climate are not susceptible to simple classification. Alfisols and Mollisols typical of semiarid climates are generally present.

2610 California Grassland Province

California, 20,200 sq. mi. (52,300 sq. km.)

Land-surface form. — This province lies within the Central Valley of California — a flat alluvial plain between the Sierra Nevada and the Coast Ranges. Elevations range from sea level to 500 ft. (150 m.). This area has broad, nearly level valleys bordered by sloping alluvial fans, slightly dissected terraces and the lower foothills of the surrounding uplands. Large undrained basins are in the south.

Climate. — The precipitation of this climate is characterized by winter rainfall; the maximum amount falls in December, January, and February. Except near the coast, summers are hot and the winters mild — often foggy with little or no snow. Annual rainfall ranges from approximately 6 in. (150 mm.) in the upper san Joaquin Valley to nearly 30 in. (750 mm.) along the coast. Potential evaporation during the warmest months is often much greater than the precipitation. Low rainfall and small streamflow result in water scarcity in many parts of the area. Annual temperatures average 60° to 67°F. (15° to 19°C.) but can fall as low as 55°F. (13°C.) in the north.

Vegetation. — Evidence indicates that the Central Valley of California was once dominated by natural grasses that the plow, fire, and grazing have eliminated except as relief stands. These stands suggest that the dominants were bunch grasses, which produced grasslands similar in appearance to mixed prairie. Apparently, needlegrass was the principal species except near the coast. Today, introduced annual grasses, such as various species of avens, brome, fescue, and barley, occupy most of the remaining grassland areas.

The rivers flow through alkaline flats where greasewood, picklewood, salt grass, and shadscale are the chief cover. Tule marshes border the lower reaches of the San Joaquin and Sacramento Rivers.

Soils. — The soils of this region are mostly Entisols and Alfisols. The Entisols usually are at the lower elevations and the Alfisols at slightly higher elevations, away from the valley floor. A small area of Aridisols occurs in the more arid southern portions of the San Joaquin Valley.

Fauna. — Intensive agricultural development has changed the fauna of the annual grasslands. Larger species, such as the California grizzly, wolf, and pronghorn antelope, have been eliminated or have "moved up in the hills." The San Joaquin kit fox is classified as an endangered species. Several species of mule deer live in brush areas. Common mammals include the Beechy ground squirrel, cottontail, black-tailed jackrabbit, mice, and kangaroo rats. Other species, e.g., coyote and bobcat, live in, or enter from the adjacent woodlands.

Common birds are the mourning dove, horned lark, western meadowlark, western kingbird, mockingbird, loggerhead shrike, house finch, lesser goldfinch, red-shafted flicker, and scrub jay. The roadrunner feeds on reptiles and insects. The California quail is numerous in areas where brush or rock outcrops provide cover. Avian predators include the golden eagle, red-tailed hawk, and Cooper's hawk. Several species of snakes and lizards are present; rattlesnakes are important predators on rodents.

Highland Provinces

M2610 Sierran Forest Province

California, 32,600 sq. mi. (84,400 sq. km.)

Land-surface form. — This province covers the southernmost portion of the Cascade Mountains and the Sierra Nevada. Most of the area is steeply sloping to precipitous mountains crossed by many valleys having steep gradients. The long west slope of the Sierra Nevada rises gradually from 2,000 ft. (600 m.) to higher than 14,000 ft. (4,300 m.); the east slope drops abruptly to the floor of the Great Basin, about 4,000 ft. (1,200 m.). Much of this region has been glaciated.

Climate. — The base of the west slope receives only about 10 to 15 in. (250 to 380 mm.) of rainfall and has a long, unbroken, dry summer. At higher elevations, precipitation increases to as much as 70 in. (1,800 mm.), temperatures decrease, the dry summer season shortens, and a larger portion of precipitation falls as snow. Prevailing west winds influence climatic conditions for the whole region. East slopes are much drier than west slopes. Winter precipitation makes up 80 to 85 percent of the total; at high elevations, most of this falls as snow. The greatest total precipitation reported has been on slopes between 3,000 and 7,000 ft. (900 and 2,100 m.), which support the luxuriant mixed conifer forests of the montane zone. The subalpine zone coincides with the altitude of greatest snowfall, where precipitation is 40 to 50 in. (1,000 to 1,270 mm.) a year. Temperatures average 35° to 52°F. (2° to 11°C.) but decrease as elevation increases.

Vegetation. — Vegetation zones are exceptionally well marked. The lower slopes and foothills, from about 1,500 to 4,000 ft. (457 to 1,219 m.), are covered by coniferous and shrub association. On higher slopes, digger pine and blue oak dominate and form typical open or woodland stands. Most of the low hills are covered by close-growing, evergreen scrub, or chaparral, in which buckbrush and manzanita predominate. Several oaks are common associates.

Lateral moraines of Green Creek, 10 miles south of Bridgeport, California. View is westward up the east front of the Sierra Nevada. (John S. Shelton.)

The montane zone lies between about 2,000 and 6,000 ft. (600 and 1,800 m.) in the Cascades, 4,000 and 7,000 ft. (1,200 and 2,100 m.) in the Central Sierras, and 5,000 to 8,000 ft. (1,500 and 2,400 m.) or more in the south. The most important trees are western yellow pine (Jeffrey), Douglas-fir, sugar pine, white fir, and incense cedar; but several other conifers are also present. The giant sequoia is one of the most spectacular species, but it grows in only a few groves on the western slope. Dense chaparral communities of manzanita, buckbrush, and buckthorn may appear after fire and sometimes persist for years.

The subalpine zone, between 6,500 ft. (1,980 m.) and 9,500 ft. (2,900 m.), depending on latitude and exposure, extends through a vertical range of 1,000 ft. (300 m.). Mountain hemlock, California red fir, lodgepole pine, western white pine, and whitebark pine are important. Conditions are severe and timberline varies from about 7,000 ft. (2,100 m.) in the north to 10,000 ft. (3,000 m.) in the south. Lodgepole pine is said to have climax characteristics near the upper limits of this zone.

The alpine zone covers the treeless areas above timberline.

Soils. — Ultisols are extensive on mountain slopes where air is humid; dry Alfisols predominate at lower elevations. Entisols occupy the narrow flood plains and alluvial fans of the valleys.

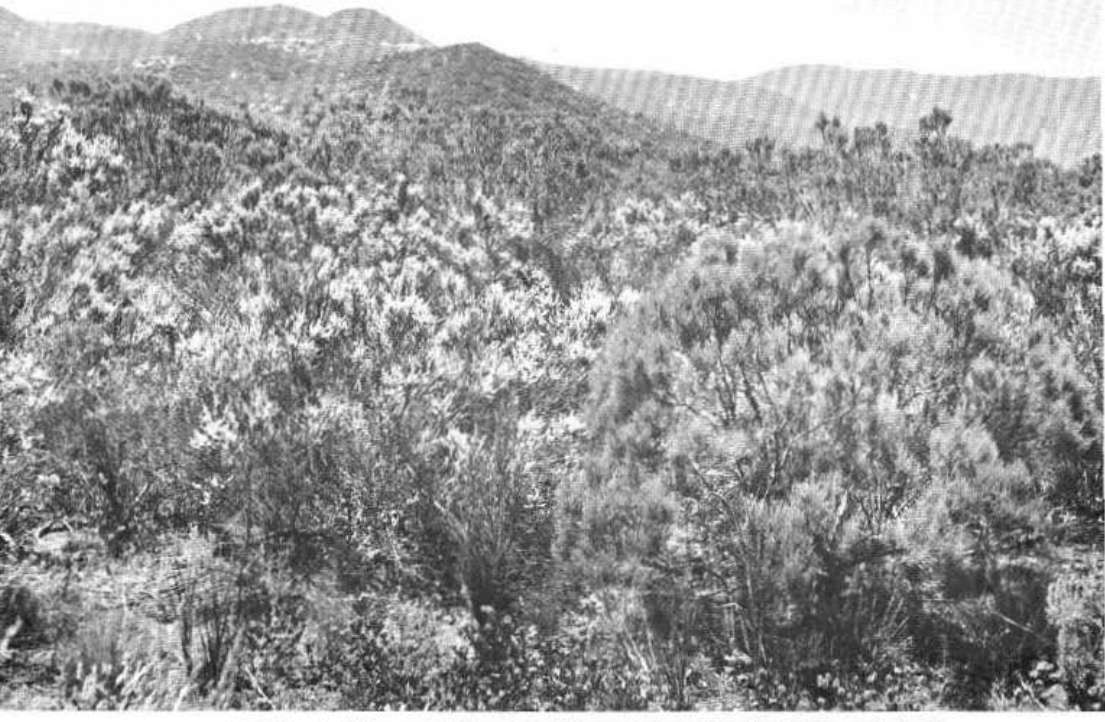
Characteristic open oak woodland of the Sierran foothills, Sequoia National Forest, California.

Fauna. — Common large mammals include mule deer, mountain lion, coyote, and black bear. Smaller mammals include bushy-tailed wood rat, flying squirrel, red fox, fisher, yellow-haired porcupine, long-eared chipmunk, and Trowbridge's shrew. Common birds are mountain quail, Lincoln's sparrow, Audubon's warbler, pine siskin, Oregon junco, blue goose, Williamson's sapsucker, and mountain chickadee. Predator birds include the common nighthawk, pygmy owl, and great gray owl. The bark beetles *Ips emarginatus* and *I. integer* infest ponderosa and lodgepole pine. The California mountain kingsnake also lives here.

M2620 California Chaparral Province

California, 33,500 sq. mi. (86,800 sq. km.)

Land-surface form. — The California Chaparral Province occupies the central part of the California Coast Ranges and the mountains of southern California. The Coast Ranges are gently to steeply sloping low mountains underlain by shale, sandstone, and igneous and volcanic rocks. Elevations range from sea level to 2,500 ft. (760 m.); some peaks rise to 5,000 ft. (1,500 m.). Coastal plains are narrow and discontinuous. Stream valleys are narrow and widely spaced. The mountains of southern California are steeply sloping to precipitous; high mountains have unstable slopes and sharp crests; valleys are narrow. Elevations range from 2,000 to 8,000 ft. (600 to 2,400 m.); some peaks reach 12,000 ft. (3,700 m.). There is a large coastal plain.



California Chaparral Province: Chaparral predominated by red shank, ceanothus, and sage, with Mt. Palomar in background, Cleveland National Forest, California.

Climate. — The climate is characterized by hot, dry summers and rainy, mild winters. Precipitation ranges from 12 to 40 in. (300 to 1,000 mm.) evenly distributed through fall, winter, and spring; precipitation increases with elevation. Most of this is rain; the little snow that falls in winter melts quickly. Frost and short periods of freezing weather occur occasionally in the winter. Coastal areas have a more moderate climate than the interior and receive some moisture from fog in summer. Temperatures average 53° to 65°F. (13° to 18°C.) in the Coast Range, but are only 32° to 60°F. (0° to 15°C.) in the mountains of southern California, always decreasing at progressively higher altitudes.

Vegetation. — The montane vegetation of this region consists of species having thick, hard, evergreen leaves. One climax, dominated by trees, is called sclerophyll forest. The other, called chaparral, is a shrub climax. These two climaxes appear in alternating patches in almost any part of the region, but chaparral occupies the greater area. The forest consistently appears on north-facing slopes and the wetter sites, chaparral on south-facing slopes and drier sites.

The most important evergreen trees of the sclerophyll forest are California live oak, canyon live oak, interior live oak, tanoak, California laurel, Pacific madrone, golden chinquapin, and Pacific bayberry. Several deciduous trees, shrubs, and herb associates are also characteristic.

The chaparral community extends over a wide area and a diversity of habitats. It includes at least 40 species of evergreen shrubs that have varying degrees of dominance and importance. Some are so dense that they practically eliminate understory vegetation; other types support a highly productive understory. The most important species are chamiso and manzanita. Other common species are Christmasberry, California scrub oak, and mountain mahogany. Often at higher elevations and near the ocean, chaparral is interspersed with, or alternates with, coniferous forests.

The coastal plains and interior valleys have sagebrush and grassland communities. A riparian forest, containing many broadleaf species, grows along streams.

Soils. — The pattern of Alfisols, Entisols, and Mollisols in this region is complex. Mollisols are usually found along the coast; Alfisols occur in the north, and the south consists mostly of Entisols.

Fauna. — Mule deer are the most important large mammal. Other large mammals include the coyote, mountain lion, California bobcat, gray fox, wood rat, and spotted and striped skunks. Small mammals peculiar to chaparral include the Merriam chipmunk, California mouse, and five-toed kangaroo rat.

The most common birds seen in the dry summer season are wrentit, common bushtit, and rufous-sided towhee. In October, white- and golden-crowned sparrows, several races of fox sparrows, hermit thrushes, rubycrowned kinglets, and Audubon's warblers are present. The California condor is classified as a treatened species.

Reptiles are numerous in all vegetation types. Amphibians appear to be scarce except for the tree frog.

3000 Dry Domain

The essential feature of a dry climate is that annual losses of water through evaporation at the earth's surface exceed annual water gains from precipitation. This creates a deficiency of water. Since evaporation, which depends chiefly on temperature, varies greatly from one part of the earth to another, no specific value for precipitation can be used as the boundary for all dry climates. Thus while 25 in. (610 mm.) of annual precipitation may produce a humid climate and forest cover in cool northwestern Europe, this same amount falling in the hot tropics produces semiarid conditions.

Two divisions of dry climates are commonly recognized: the arid desert, and the semiarid steppe. Generally, the steppe is a transitional belt surrounding the desert and separating it from the humid climates beyond. The boundary between arid and semiarid climates is arbitrary but commonly is defined as one-half the amount of precipitation separating steppe from humid climates.

Of all the climatic groups, dry climates are the most extensive; they occupy a quarter or more of the earth's land surface.

3100 Steppe Division

Steppes are areas that have a semiarid continental climatic regime in which, despite maximum summer rainfall, evaporation usually exceeds precipitation. Köppen classified the climate as *BSk*. Winters are cold and dry, summers warm to hot. The vegetation is steppe, sometimes called shortgrass prairie, and semidesert. Typical steppe vegetation consists of numerous species of short grasses that usually grow in bunches that are sparsely distributed. Scattered shrubs and low trees sometimes grow in the steppe and all gradations of cover into semi-desert and woodland classes are present. Since ground cover is sparse,

much soil is exposed. Many species of grasses and other herbs occur. Buffalograss is typical grass of the American steppe; other typical plants are the sunflower and locoweed.

The semidesert cover is a xerophytic shrub vegetation accompanied by a poorly developed herbaceous layer. Trees are generally absent. An example of semidesert cover is the sagebrush vegetation of the middle and southern Rocky Mountain region and the Colorado Plateau.

In this climatic regime, the dominant pedogenic process is calcification, with salinization on poorly drained sites. Soils contain a large excess of precipitated calcium carbonate and are very rich in bases. Mollisols are typical in steppe lands. The soils of the semidesert shrub are Aridisols, which have pedogenic horizons, are low in content of organic matter, have a clay horizon in some places, and have accumulations of various salts in some places. Humus content is small because the vegetation is so sparse.

3110 Great Plains-Shortgrass Prairie Province

Rocky Mountain Piedmont and Upper Missouri Basin Broken Lands
317,600 sq. mi. (822,600 sq. km.)

Land-surface form. — This region is characterized by rolling plains and tablelands of moderate relief. They are in a broad belt that slopes gradually eastward down from an altitude of 5,500 ft. (1,520 m.) near the foot of the Rocky Mountains to 2,500 ft. (760 m.) in the Central States. The plains are notably flat, but there are occasional valleys, canyons, and buttes. In the northern section, badlands and isolated mountains break the continuity of the plains.

Climate. — The climate is a semiarid continental regime in which maximum rainfall comes in summer, but the total supply of moisture is low. Evaporation usually exceeds precipitation. The average annual temperature is 45 °F. (8 °C.) throughout most of the region but can reach 60 °F. (15 °C.) in the south. Winters are cold and dry; the summers warm to hot. The frost-free season ranges from fewer than 100 days in the north to more than 200 days in Texas. Precipitation ranges from 10 in. (250 mm.) in the north to more than 25 in. (620 mm.) in the south.

Vegetation. — Steppe, sometimes called shortgrass prairie, is a formation class of short grasses usually bunched and sparsely distributed, and is characteristic of this province. Scattered trees and shrubs occasionally appear in the steppe, and exist all gradations of cover into semidesert and woodland formations. Since ground cover is scarce, much soil is exposed. Many species of grasses and herbs grow in this province; a typical grass is buffalograss; sunflower and locoweed are typical plants.

Shortgrass prairie and badland topography along Little Missouri River, North Dakota.

Soil. — In this climatic regime, the dominant pedogenic process is calcification; salinization is dominant in poorly drained sites. Soils contain a large excess of precipitated calcium carbonate and are rich in bases. Mollisols are typical. Humus content is small because vegetation is sparse.

Fauna. — Large herds of buffalo migrated with the seasons across the steppe plains. Now the pronghorn antelope is probably the most abundant large mammal, but mule deer and white-tailed deer are often abundant where brush cover is available along stream courses. The white-tailed jackrabbit occupies the northern part of the province and the black-tailed jackrabbit, the area south of Nebraska. The desert cottontail is widespread. The lagomorphs, the prairie dogs, and several other small rodents are preyed upon by the coyote and several other mammalian and avian predators; one of these, the black-footed ferret, is classed as an endangered species.

The lesser prairie chicken, formerly abundant, is now classed as threatened. Sage grouse, greater prairie chickens, and sharp-tailed grouse are present in the area. Among the many smaller birds are the horned lark, lark bunting, and western meadowlark. The threatened golden-cheeked warbler inhabits the southeastern portion where the Ashe juniper is present. Construction of stock ponds has created an important "duck factory" in the northern Great Plains.

Sections. — This province includes the following sections: Grama-Needlegrass-Wheatgrass (3111), Wheatgrass-Needlegrass (3112), and Grama-Buffalograss (3113).

3120 Palouse Grassland Province

Washington and Oregon, 12,400 sq. mi. (32,100 sq. km.)

Land-surface form. — The Palouse Grassland occupies a series of loess-covered basalt tablelands that have moderate to high relief. Elevations range from 600 ft. (180 m.) along the major streams to as high as 4,000 ft. (1,200 m.) over most of the uplands. These uplands are moderately to strongly dissected; slopes are mostly hilly and steep. Major streams have cut deep canyons.

Climate. — The climate is characterized by hot, nearly rainless summers and moderately cool, foggy, and rainy winters. The average annual precipitation is from 18 to 23 in. (450 to 600 mm.). Average annual temperature is 45° to 55°F. (7° to 13°C.). The frost-free period ranges from 120 to 170 days.

Vegetation. — This province was dominated by prairie grasses before it was cultivated for wheat production. Although numerous species characteristic of other grassland regions are present, the major dominants are distinctive; they include bluebunch wheatgrass, fescue, and bluegrass. Possibly much of the sagebrush dominance in this region results from grazing; certainly the dominance of such annuals as brome results from fire and grazing.

Small wooded areas on steep slopes cover about 10 percent of the area.

Soils. — Soils are formed mainly in loess containing a small amount of volcanic ash. Mollisols dominate.

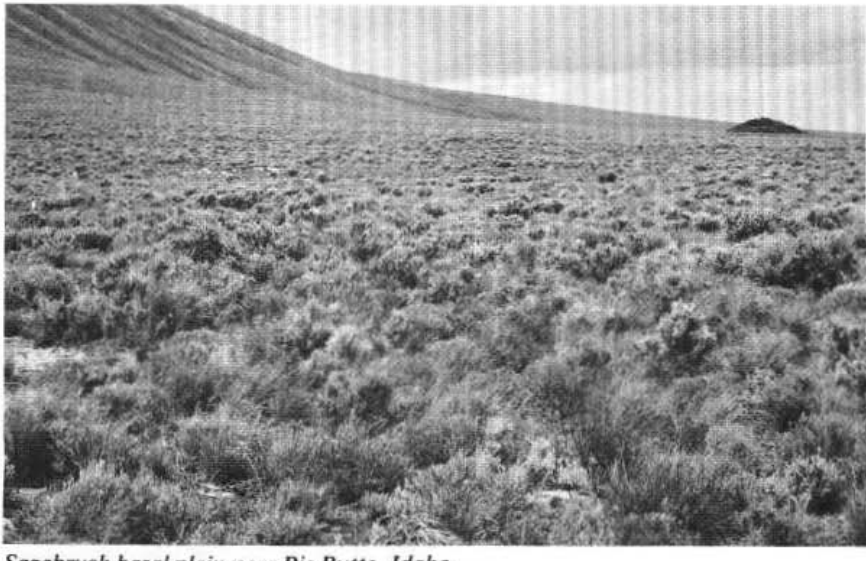
Fauna. — Pronghorn antelope are the largest permanent residents. Deer come down from the mountains and enter the region locally in the winter. The Washington ground squirrel inhabits large areas at low to medium elevations, and the Columbia ground squirrel is at higher elevations. The bobcat sometimes chases pronghorns. The coyote is present, and the badger is seen occasionally.

The sharp-tailed grouse and sage grouse were formerly important game birds. The most common birds, Brewer's sparrow, lazuli bunting, Tolmie warbler, song sparrow, and little flycatcher all inhabit sagebrush cover. The short-eared owl and marsh hawk are the most common carnivorous birds.

3130 Intermountain Sagebrush Province

Nevada, Utah, southern Idaho, southern Oregon
203,400 sq. mi. (526,806 sq. km.)

Land-surface form. — The Intermountain Sagebrush Province occupies the physiographic section called the Great Basin. Much of this area is numerous separate interior basins and only a small share of it drains to the sea. The lower parts of many of the basins have a heavy accumulation of alkaline and saline salts. Streams are rare and few are permanent. Many mountains rise steeply from the semiarid, sagebrush-covered plains. These mountains are generally well covered by vegetation, and their upper elevations usually bear sparse conifer forests.



Sagebrush basal plain near Big Butte, Idaho.

Climate. — Summers are hot, but winters are only moderately cold. The average annual temperature is 40° to 55°F. (4° to 13°C.). Spring comes early except at the higher elevations. Total annual precipitation averages only 5 to 20 in. (125 to 500 mm.); almost no rain falls during the summer months except in the mountains.

Vegetation. — Sagebrush dominates the vegetation of the lower elevations of the province. Other important plants in this sagebrush belt are shadscale, fourwing saltbush, rubber rabbitbrush, spiny hopsage, and horsebrush. All these shrubs tolerate alkali, but in varying degrees; this tolerance is essential to their survival on the poorly drained soils that are widespread in the region. In areas where salt concentration is very high, even these shrubs are unable to grow; in their stead communities dominated by greasewood or saltgrass appear.

Although sagebrush is now the characteristic plant, it may not be the climax vegetation, but only a disclimax produced by overgrazing. In plots protected from fire, grasses of Palouse or mixed-prairie type gradually become dominant.

In the montane belt, ponderosa pine generally occupies the lower and more exposed slopes and Douglas-fir the higher and more sheltered ones. In the subalpine belt, the characteristic trees are subalpine fir and Engelmann spruce. Only a few mountains rise high enough to support an alpine belt.

Soils. — Aridisols dominate all basin and lowland areas in eastern Oregon; Mollisols are at higher elevations. Narrow bands of Entisols lie in stream flood plains. Salt flats and playas without soils are extensive in the lower parts of the basins that have interior drainage.

Fauna. — Few large mammals live in this province, but mule deer, mountain lion, bobcat, and badger occasionally penetrate it. The most common species are such small mammals as ground squirrels, jackrabbits, kangaroo mice, wood rats, and kit fox. Some ground squirrels that inhabit the lower life belts, especially the Belding and Townsend ground squirrel, became dormant during the hot dry summer.

Sections. — The Intermountain Sagebrush Province has five sections: Sagebrush-Wheatgrass (3131), Lahontan Saltbush-Greasewood (3132), Great Basin Sagebrush (3133), Bonneville Saltbush-Greasewood (3134), and Ponderosa Shrub Forest (3135).

3140 Mexican Highlands Shrub Steppe Province

Southeastern Arizona, southwestern New Mexico
17,500 sq. mi. (45,325 sq. km.)

Land-surface form. — The province covers the grassy high plains and the mountains included in them between the American Desert on the west and the Chihuahuan Desert on the east. The plains range in elevation from about 4,000 ft. (1,200 m.) to more than 7,000 ft. (2,100 m.). Above them rise many isolated hills and mountains, some of which reach elevations higher than 9,000 ft. (2,700 m.).

Climate. — The climate is semiarid. Most of the precipitation comes in convectional storms during the summer months; rains fall occasionally in winter. The most arid season is late spring and early summer. Because of the high elevation, mean temperatures are moderate, but the summer days are hot. The average annual temperature range is from 55° to 70°F. (13° to 21°C.). Periods of extremely cold weather may occur in winter.

Vegetation. — Four life belts are distinct in this province. The lowest is the desert belt, which extends from the American Desert upward along the San Pedro Wash for a number of miles, north of the Santa Catalina Mountains. Characteristic plants in this belt are the giant cactus or saguaro, paloverde, and creosote bush. The extensive arid grassland belt covers most of the high plains of the province. Short grasses, such as grama, are abundant, but taller grasses are also present.

Mesquite, yucca, and other shrubs, as well as cacti, particularly the arborescent choyas, frequently grow in open stands. The submontane belt covers most of the hills and the lower slopes of the mountains. Several species of oaks dominate this belt but some juniper also grow in it. A montane belt, generally dominated by pines, appears only on the upper parts of the higher mountains. Oaks sometimes grow among the pines and may form thickets. Douglas-fir and white fir occupy a few sheltered upper slopes on the Santa Catalina Mountains.

Soils. — The soils are Aridisols.

Fauna. — Large mammals are rare, but pronghorn antelope and mule deer are present. Scaled quail and Gambel's quail inhabit most of the region. The white-winged dove is locally important in Arizona, as is the more widespread mourning dove. Jackrabbits, cottontails, kangaroo rats, wood rats, and other small rodents are preyed on by coyotes, golden eagles, great horned owls, and hawks. Reptiles include Gila monsters, various species of rattlesnakes, and lizards.

Highland Provinces

M3110 Rocky Mountain Forest Province

Blue Mountains, Central Rocky Mountains, 187,300 sq. mi. (485,100 sq. km.)

Land-surface form. — The Rocky Mountains are rugged glaciated mountains as high as 14,000 ft. (4,300 m.). Local relief is between 3,000 ft. (900 m.) and 7,000 ft. (2,100 m.). Several sections have intermontane depressions of "parks" that have floors less than 6,000 ft. (1,800 m.) in altitude. Many high-elevation plateaus composed of dissected, horizontally layered rocks are in Wyoming, Oregon, and Utah.

Climate. — The climate is a semiarid steppe regime in which, despite considerable variation with altitude, precipitation falls in winter. Total precipitation is moderate but is greater than on the plains to the west and the east. In the highest mountains, a considerable part of the annual precipitation is snow; however, permanent snowfields and glaciers cover only relatively small areas. Bases of these mountains

receive only 10 to 20 in. (250 to 500 mm.) of rainfall. Upward, precipitation increases to 40 in. (1,000 mm.) and temperatures decrease.

Climate is influenced by the prevailing west winds and the general north-south orientation of the mountain ranges. East slopes are much drier than west slopes. Within this region, the individual mountain ranges have similar east-west slope differences. Average annual temperatures are mainly 35° to 45°F. (2° to 7°C.) but reach 50°F. (10°C.) in lower valleys.

Vegetation — Well marked vegetational zones are a striking feature. Their distribution is controlled mostly by a combination of altitude, latitude, direction of prevailing winds, and slope exposure. Generally, the various zones are at higher altitudes in the southern part of the province than in the northern. The uppermost zone, the alpine, is characterized by alpine tundra and the absence of trees. Next below is the subalpine zone, dominated in most places by Engelmann spruce and subalpine fir. The montane zone, immediately below the subalpine, is characterized by the dominance of ponderosa pine and Douglas-fir. Frequently there is alternation in the occurrence of these two trees; ponderosa pine is dominant on the lower, drier, more exposed slopes, and Douglas-fir on the higher, moister, and more sheltered ones.

After fire in the subalpine zone and in the upper part of the montane zone, the original forest trees are usually replaced by aspen or lodgepole pine.

Altitudinal zonation in the Sawtooth Mountains of Idaho. Semidesert shrubs in foreground, coniferous forests on the lower slopes of the mountains, and alpine tundra toward the top.

Grass, often mixed with sagebrush, regularly covers the ground under open ponderosa pine forests and some treeless areas. These treeless openings usually are small, and they often alternate, according to slope exposure, with ponderosa pine forest. At the lower edge of the montane zone, they may be continuous with the adjacent grass and sagebrush belt.

Below the montane belt is the foothill (woodland) zone. Dry rocky slopes in this zone often have a growth of shrubs in which mountain-mahogany and several kinds of scrub oak are conspicuous. Along the border of the Colorado Plateau Province, the ponderosa pine and pinyon-juniper associations frequently alternate extensively according to exposure of the slopes.

Unforested parks are a conspicuous feature of this province. Many are dominated by grasses, but some are covered largely by sagebrush and other shrubs.

Soils. — In the Rocky Mountains, soil orders occur in zones corresponding to the vegetation zones. These range from Mollisols and Alfisols in the montane zone to Aridisols in the foothill zone. In addition, because of steep slopes and recent glaciation, there are areas of Inceptisols.

Fauna. — Common large mammals include elk, deer, mountain lion, bobcat, and black bear. Grizzly bear and moose are in the northern portions. Small mammals include mice, squirrels, martens, chipmunks, and bushy-tailed rats. Hawks and owls inhabit most of the region. The numerous, more common birds are the chestnut-backed chickadee, red-breasted nuthatch, gray jay, and Steller's jay. Blue and ruffed grouse are the most common upland game birds.

Sections. — In the northwestern part of the province, in the Blue Mountains and the Salmon River Mountains, grand fir is commonly associated with Douglas-fir. In the southeastern part, in Colorado and New Mexico, ponderosa pine is associated with Douglas-fir in the montane zone. These areas thus form distinct sections and are separated from the central Douglas-fir section. The three sections are accordingly named: Grand Fir-Douglas-fir Forest (M3111), Douglas-fir Forest (M3112), Ponderosa Pine-Douglas-fir Forest (M3113).

M3120 Upper Gila Mountains Forest Province

Arizona, New Mexico, 36,100 sq. mi. (93,500 sq. km.)

Land-surface form. — This area consists mostly of steep foothills and mountains, but includes some deeply dissected high plateaus. Eleva-

tions range from 4,500 to 10,000 ft. (1,370 to 3,000 m.) with some mountain peaks 12,600 ft. (3,840 m.). In many areas, the relief is higher than 3,000 ft. (900 m.). Isolated volcanic peaks that rise to considerable heights are in the northwest. The Grand Canyon of the Colorado River, which crosses the northern part of the province, rims the only large stream. Many other streams flow year-round, but the volume of water fluctuates considerably.

Climate. — Climate varies considerably with altitude. Average annual precipitation ranges from 10 to 35 in. (250 to 875 mm.) and increases with rising elevations. Summer rains are of the thunderstorm type; rains also come in early autumn and winter. In the mountains, most of the precipitation is snow. During the late spring, there is a moisture deficit until the summer rains come. Average annual temperature is about 55 °F. (13 °C.) in the lower foothills and 40 °F. (5 °C.) on the upper mountain slopes.

Vegetation. — The zones of the Gila Mountains are similar to those of the Rocky Mountains except that they occur at higher elevations. Up to 7,000 ft. (2,100 m.), the foothill zone has mixed grasses, chaparral brush, oak-juniper woodland, and pinyon-juniper woodland. At about 7,000 ft. (2,100 m.), open forests of ponderosa pine are found with pinyon-juniper on south-facing slopes. This zone extends upward to about 8,000 ft. (2,400 m.), where it is replaced, first on the north-facing slopes and a little higher on all slopes, by Douglas-fir. Aspen is common in this zone; limber pine grows on rockier and drier places.

At about 9,000 ft. (2,700 m.), the Douglas-fir zone merges into a zone of Engelmann spruce and corkbark fir. Limber pines and bristlecone pines grow in rockier places. The alpine belt covers relatively small areas above 11,000 ft. (3,400 m.).

Soils. — Detailed information about orders of soils is lacking for much of this area. The Colorado River Valley is composed mostly of Entisols. Mollisols and Aridisols dominate upland areas. Stony land and rock outcrops occupy large areas on both mountains and foothills.

Fauna. — The most common large mammal is the mule deer. Mammalian predators include mountain lions, coyotes, and bobcats. Small mammals are the deer mouse, long-tailed weasel, porcupine, golden-mantled ground squirrel, Colorado chipmunk, red squirrel, wood rat, pocket gopher, long-tailed vole, Kaibab (Abert) squirrel, and cottontail. Some of the more common birds are the mountain bluebird, pygmy nuthatch, white-breasted nuthatch, Mexican Junco, Steller's jay, red-shafted flicker and the Rocky Mountain sapsucker. Goshawks and red-tailed hawks are present. The only common, widely distributed reptile is the shorthorned lizard.

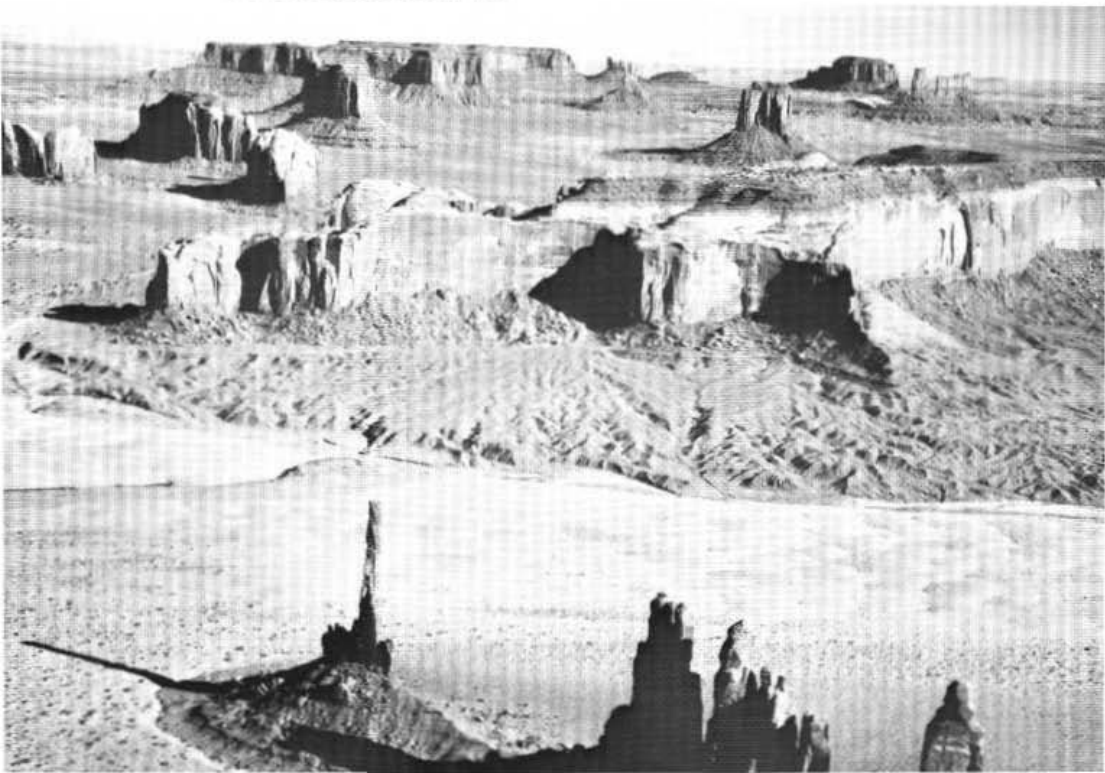
P3130 Colorado Plateau Province

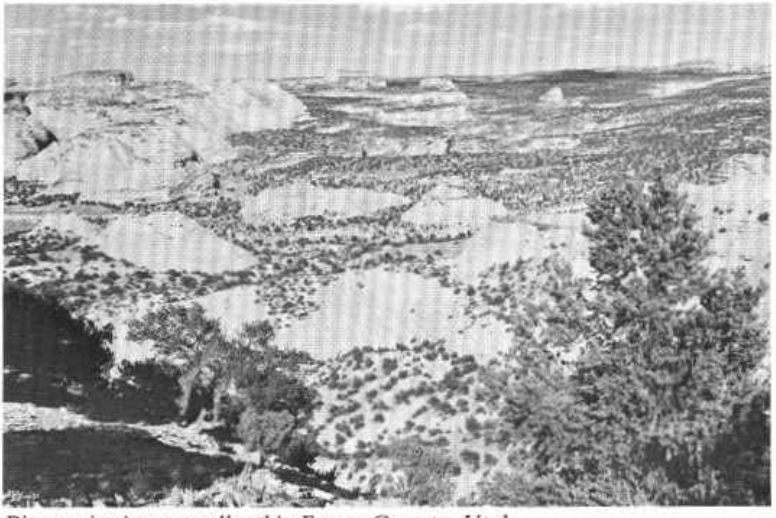
Colorado River Plateau, Utah, Arizona, New Mexico
94,700 sq. mi. (245,300 sq. km.)

Land-surface form. — The Colorado Plateau Province consists of tablelands having moderate to considerable relief in Arizona, New Mexico, and Utah. Elevations of the plateau tops range from 5,000 to 7,000 ft. (1,500 to 2,100 m.). Local relief is from 500 to more than 3,000 ft. (150 to 900 m.) in some of the deeper canyons that dissect these surfaces. In some sections, volcanic mountains rise 1,000 to 3,000 ft. (300 to 900 m.) above the plateau surface. Stream valleys are narrow and widely spaced.

Climate. — The climate is characterized, because of its generally high altitude, by cold winters. Summer days are usually hot, but nights are cool; accordingly, the diurnal variation in temperature is considerable. Annual average temperatures are 40° to 55°F. (4° to 13°C.) and decrease as altitude increases. Average annual precipitation is about 20 in. (500 mm.), except on the higher mountains; some parts of the province receive less than 10 in. (250 mm.). Summer rains are thunderstorms but ordinary rains come in winter. Thus, this province differs from the Intermountain Sagebrush Province, which generally lacks summer rains.

Monument Valley, Arizona, a well defined tableland in the Colorado Plateau. (John S. Shelton.)





Pinyon-juniper woodland in Emery County, Utah.

Vegetation. — Vegetational zones are conspicuous but are not uniform over the whole province, nor even in adjacent areas. The lowest zone is covered by arid grasslands. Here the shortgrass sod seldom covers the ground completely; there are many bare areas. Xeric shrubs often grow in open stands among the grasses. Sagebrush is dominant over extensive areas. A profusion of annuals and perennials blooms during the summer rainy season. At low elevations in the south, several kinds of cacti and yucca are common. Cottonwoods and, more rarely, other trees grow along some of the permanent streams.

The woodland zone is the most extensive. It is dominated by open stands of pinyon pine and several species of juniper. Between the trees the ground is sparsely covered by grama, other grasses, herbs, and various shrubs.

The montane zone extends over considerable areas on the high plateaus and mountains, but it is a much smaller area than the pinyon-juniper zone. Vegetation in the montane zone varies considerably over the different parts of the province. In the southern part, especially in Arizona, ponderosa pine is the dominant forest tree. Douglas-fir either is associated with ponderosa pine or grows in more sheltered locations or at higher elevations. In Utah, by contrast, lodgepole pine and aspen are dominant.

The subalpine zone is characterized by abundance of Engelmann spruce and subalpine fir. On San Francisco Mountain in northern Arizona the bristlecone pine is often associated with the spruce. Since only a few isolated mountains rise above timberline, the alpine zone is not extensive.

Soils. — Entisols occur along the flood plains of major streams. Aridisols occupy the plateau tops, older terraces, and alluvial fans. Badlands of rough broken land are extensive in the mountains and on plateaus.

Fauna. — Major mammals are the mule deer, mountain lion, coyote, and bobcat; elk are locally important. Pronghorn antelope are the primary large mammal in the arid grasslands. Smaller species include the wood rat, white-footed mouse, cliff chipmunk, jackrabbit, cottontail, rock squirrel, porcupine, and gray fox. The ring-tailed cat and spotted skunk occur rarely.

The most abundant resident birds are the plain titmouse, Woodhouse's jay, red-tailed hawk, golden eagle, red-shafted flicker, pinyon jay, lead-colored bushtit, and rock wren. Summer residents include the chipping sparrow, night hawk, black-throated gray warbler, northern cliff swallow, lark sparrow, and mourning dove. Common winter residents are the pink-sided junco, Shufeldt's junco, gray-headed junco, red-backed junco, Rocky Mountain nuthatch, mountain bluebird, robin, and Steller's jay. Turkeys are locally abundant during the winter.

Reptiles include the horned lizard, collared lizard, and rattlesnake.

Sections. — This province is divided into two sections: Juniper-Pinyon Woodland + Sagebrush-Saltbush Mosaic (P3131), and Grama-Galleta Steppe + Juniper-Pinyon Woodland Mosaic (P3132).

A3140 Wyoming Basin Province

Wyoming Basin, 42,300 sq. mi. (109,600 sq. km.)

Land-surface form. — The Wyoming Basin consists of plains interrupted by isolated hills and low mountains. Altitudes are mostly between 6,000 ft. (1,800 m.) and 8,000 ft. (2,400 m.); the few mountains are 1,000 to 2,000 ft. (300 to 600 m.) higher. Broad intermountain basins and a few isolated small mountain ranges merge into a dissected plateau in the south. Sloping alluvial fans at the edges of the basins merge into flat plains in the center. Badlands are typical of the dissected parts along the outer edges.

Climate. — The overall high altitude of this basin gives it a climate characterized by cold winters. Both temperature and precipitation average slightly lower than in the Colorado Plateau. Summers are short and hot. Annual temperature averages range from 40° to 52°F. (4° to 11°C.). The average growing season is fewer than 100 days in the south and fewer than 140 days in the north and east. Average

annual precipitation ranges from 5 to 14 in. (125 to 350 mm.) fairly evenly distributed throughout the year.

Vegetation. — The chief vegetation is sagebrush or shadscale, with a mixture of short grasses. Moist alkaline flats support alkali-tolerant greasewood. Along streams in and near the mountains, where the water is good, valley bottoms are lined by willows and sedges, but farther from the mountains this vegetation gives way to greasewood and other alkali-tolerant plants.

Soils. — This province has extensive alluvial deposits in stream flood plains and in fans at the foot of mountains. Dry lake beds are numerous, and there are extensive eolian deposits including both dune sand and loess.

Soils in the Wyoming Basin are alkaline Aridisols. Subsoils contain a layer enriched with lime and/or gypsum, which may develop into a caliche hardpan. Because the Wyoming Basin is semiarid and weathering is correspondingly slight, soil texture and composition are dominated by the parent materials.

Fauna. — Because of its wilderness character, this region supports a great variety of wildlife species. Seasonal changes in climate force many animals to move from the surrounding mountains onto the desert during the winter. In addition to providing for its resident animals, the sagebrush desert furnishes range for a seasonal influx of migratory birds and mammals from life zones at higher elevations.

Major mammals are coyote, pronghorn antelope, mountain lion, and bobcat. Smaller species include Wyoming ground squirrel, white-tailed prairie dog, deer mouse, white-tailed jackrabbit, and porcupine. During severe winters, elk and mule deer move onto the desert. Moose are locally important in the dense willow thickets along desert watercourses.

This region is an important breeding and resting ground for migrating waterfowl. Mallards, pintails, green-winged teal, and gadwalls are most common. Canada geese are locally important. Sage grouse are the most abundant upland game bird. The numerous raptors here include Swainson's hawk, ferruginous roughlegged hawk, red-tailed hawk, marsh hawk, prairie falcon, great horned owl, and burrowing owl.

Reptiles include sagebrush lizard, horned lizard, and prairie rattlesnake.

Sections. — This province is divided into two sections: Wheatgrass-Needlegrass-Sagebrush (A3141), and Sagebrush-Wheatgrass (A3142).

3200 Desert Division

South of the Rocky Mountains are the continental desert climates, which have not only extreme aridity but also extremely high air and soil temperatures. Direct sun radiation is very strong; similarly strong is the outgoing radiation during the night. This causes extreme variations between day and night temperatures and results in a rare nocturnal frost. Annual precipitation is less than 8 in. (200 mm.) and in extreme deserts is less than 4 in. (100 mm.). These areas are Köppen's *BW* climates.

The vegetation is dry-desert, a class of xerophytic plants widely dispersed and providing almost negligible ground cover. In dry periods the visible vegetation is only small hard-leaved or spiny shrubs, cacti, or hard grasses. Many species of small annuals may be present, but they appear only after a rare but heavy rain has saturated the soil.

In the Mojave-Sonoran Deserts, plants are often so large that some places have a near-woodland appearance. Well known are the treelike saguaro cactus, the pricklypear cactus, the ocotillo, creosote bush, and smoke tree. Much of the desert of the southwestern United States is in fact scrub, thorn scrub, savanna, or steppe grassland. Some of the area in this region has no visible plants; it is shifting dune sand or almost sterile salt flats.

A dominant pedogenic process is salinization, which produces areas of salt crust where only salt-loving (halophytic) plants can survive. Calcification is conspicuous on well drained uplands; encrustations and deposits of calcium carbonate (caliche) are common. Humus is lacking and soils are mostly Aridisols and dry Entisols.

3210 Chihuahuan Desert Province

Southern New Mexico, western Texas, 64,100 sq. mi. (166,000 sq. km.)

Land-surface form. — This province is mostly desert. Practically the only permanent streams are a few large rivers that originate in humid provinces. The Rio Grande and the Pecos Rivers and a few of their larger tributaries are the only perennial streams. The area has undulating plains with elevations near 4,000 ft. (1,200 m.), from which somewhat isolated mountains rise 2,000 to 5,000 ft. (600 to 1,500 m.). Washes, dry most of the year, fill with water following a rain. Basins that have no outlet drain into shallow playa lakes that dry up during rainless periods. Small whirlwinds constantly play over these dry playas when they are heated by the summer sun. Extensive dunes of silica sand cover parts of the province. In a few places there are dunes

of gypsum sand, the most notable being the White Sands near Alamogordo in southern New Mexico. In scattered areas small beds and isolated buttes of blackish lava occur.

Climate. — The climate is distinctly arid; spring and early summer are extremely dry. During July the summer rains usually begin, and they continue through October. The summer rains are torrential storms, mostly local. The northern part of the province also receives winter rains; these are more gentle and more widespread. Average annual temperature ranges from 50° to 65 °F. (10° to 18 °C.). Summers are long and hot. Winters are short but may include brief periods when temperatures fall below freezing.

Vegetation. — The characteristic vegetation of the Chihuahuan Desert is a number of shrubs, most of them thorny. These shrubs frequently grow in open stands, but sometimes form low closed thickets. Short grass grows in association with the shrubs in many places. On deep soils, mesquite is often the dominant plant. A few cottonwoods and other trees grow beside the widely separated rivers. Creosote bush covers great areas in its characteristic open stand and is especially common on gravel fans. On rocky slopes the ocotillo is conspicuous; on the slopes leading down to the Rio Grande the ceniza shrub dominates. Juniper and pinyons, which are limited to rocky outcrops, are prominent around the Stockton Plateau in western Texas.

Some isolated mountains in the Chihuahuan Province rise high enough to carry a belt of oak and juniper woodland. On a few of the highest mountains pines grow among the oaks, but locally they sometimes grow in nearly pure stands.

Soils. — In the western and northern portions, the soils are primarily Aridisols but both Aridisols and Entisols are present in the south.

Fauna. — Pronghorn antelope and mule deer are the most widely distributed large game animals. The common white-tailed deer is in Texas. The collared peccary or javelina is common in the southern part of the region. Scaled quail and Gambel's quail are present in most of the area, and the bobwhite reaches the eastern portion. The black-tailed jackrabbit, desert cottontail, kangaroo rat, wood rat, and numerous smaller rodents compete with domestic and wild herbivores for available forage and are preyed upon by the coyote, bobcat, golden eagle, great horned owl, red-tailed hawk, and ferruginous hawk.

Sections. — Two sections are recognized: the Grama-Tobosa (3211), and the Tarbush-Creosote Bush (3212).

Deeply eroded ranges alternate with smooth basin floors in the Mojave Desert of southern Nevada. Note playa in middleground. (John S. Shelton.)

3220 American Desert Province

California, Arizona, Nevada, and Utah
77,500 sq. mi. (200,700 sq. km.)

Land-surface form. — The American Desert includes the Mojave, Colorado, and Sonoran Deserts. Its topography is characterized by extensive plains, most gently undulating, from which isolated low mountains and buttes rise abruptly. Elevations range from 280 ft. (85 m.) below sea level to 4,000 ft. (1,200 m.) above in valleys and basins, to 11,000 ft. (3,400 m.) in some mountain ranges. The mountains are rocky and rise abruptly from their outwash aprons and alluvial faces. Included are some areas of interior drainage, such as the Salton Trough; but a large part of the province drains to the sea through washes that are dry most of the year, or by underground seepage. The Colorado River, which crosses the eastern part of the province, is the only large stream.

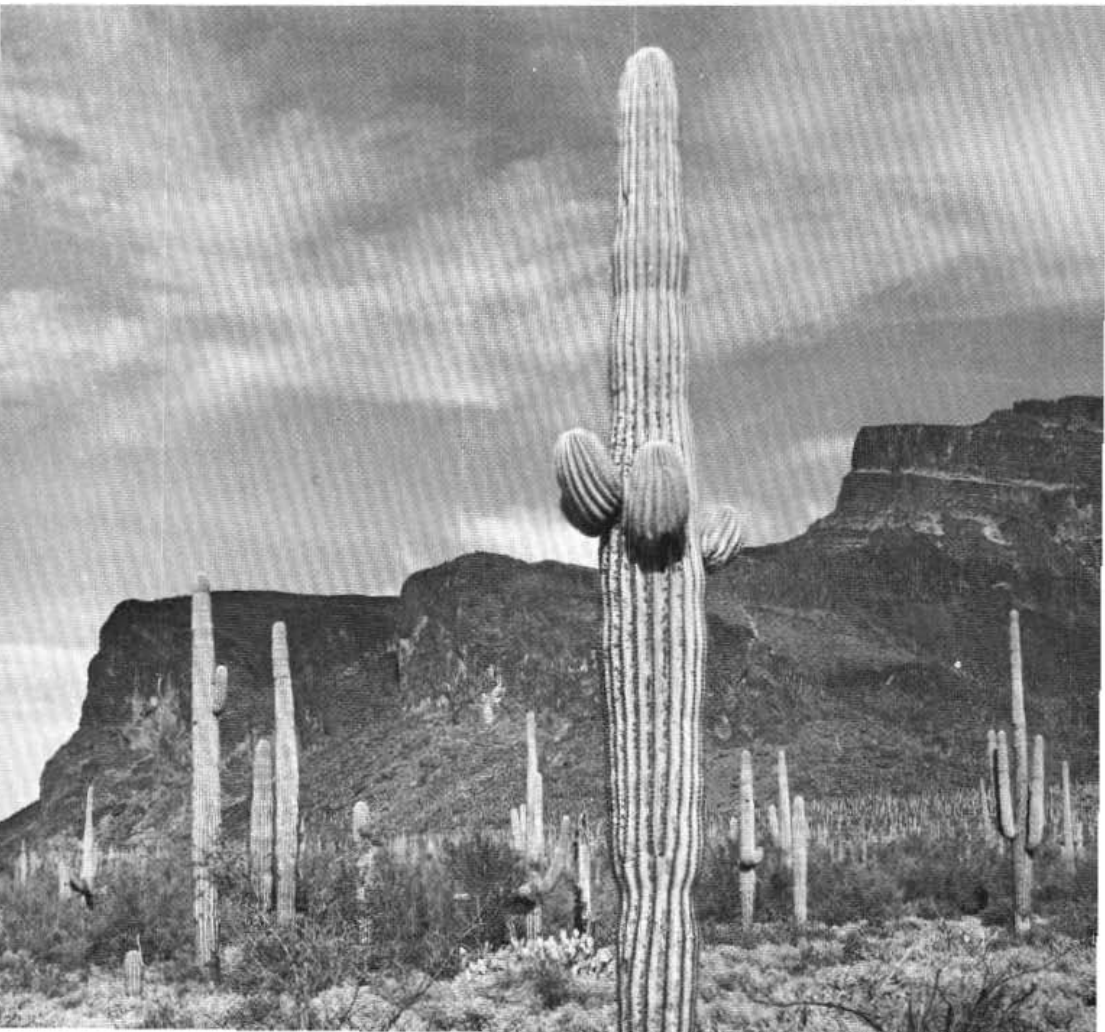
Climate. — Summers are long and high temperatures prevail. The highest temperature ever observed in the United States was 134°F. (57°C.) in 1913 at Death Valley. The average annual temperature is 60° to 75°F. (15° to 24°C.). Though the winters are moderate, the entire province is subject to occasional frosts. In winter the rains are widespread and usually gentle, but in summer they are the thunderstorm type. In the Colorado and Mojave Deserts of southeastern California there are virtually no summer rains. Rains do not

occur regularly in any part of the province, and, especially in the western part, a year or more may pass without measurable rainfall. Average annual precipitation is 2 to 10 in. (50 to 250 mm.) in valleys but as much as 25 in. (610 mm.) on mountain slopes. The evaporation rate in summer is very high.

Vegetation. — Vegetation is usually very sparse, with bare ground between individual plants. Cacti and thorny shrubs are conspicuous, but many thornless shrubs and herbs are also present.

On the Sonoran Desert plains the most widely distributed plant is the creosote bush, which covers extensive areas in nearly pure stands. On some parts of the plains the arborescent cacti, cholla, are also common. Mesquite is less widespread and grows only along washes and watercourses.

American Desert Province: Saguaro cactus and desert shrub near the Superstition Mountains in Arizona. (Soil Conservation Service.)



On the steep rocky slopes of the mountains, vegetation is dominated by paloverde, ocotillo, and saguaro, but bitterbrush is also a common shrub. Vegetation below 3,000 ft. (914 m.) in the Mojave Desert is mostly creosote bush and chamiso. The desert mountains are exceptionally barren, and many are almost devoid of vegetation.

Along the higher northern edge of the province is a belt where the Joshua tree is prominent. At a still higher level is a belt of junipers and pinyons.

Interior basins characterized by ephemeral shallow playa lakes are a conspicuous feature of the Mojave Desert. Soils near these plavas contain alkali; the quantity varies with the distance from the eɑɟe of the lake. This results in a zonation of vegetation dependent upon the tolerance of the several species for salts.

Soils. — Gravel or bare rock appears on the surface near the bases of some mountains and much bare rock is exposed on the mountains because the heavy, violent desert rainstorms allow little soil to accumulate on the steep slopes. Entisols occur on the older alluvial fans and terraces and in the better drained basins. Aridisols dominate throughout the rest of the province.

Fauna. — Large ungulates are almost absent from the desert. Carnivores are small and usually nocturnal. Nocturnal burrowers, particularly kangaroo rats and pocket mice, dominate. Merriam's kangaroo rat is closely associated with creosote bush. Other important species are the long-tailed pocket mouse and antelope ground squirrel.

Common larger mammals of the region are the desert kit fox, coyote, and western spotted skunk. Desert mule deer and peccary live chiefly in the paloverde-cactus shrub community. Many desert birds are very selective in their type of habitat. Greasewood may furnish a permanent residence for the loggerhead shrike. Areas where tall cacti are plentiful furnish homes for many birds, including the Gila woodpecker, several species of owl, and the purple marten. Gambel's quail, the cactus wren, and the roadrunner are common in the southern part of the region. Reptiles include numerous species of snakes and lizards, including the Gila monster, which lives in areas where cacti grow tall. The Sonoran pronghorn is classed as an endangered species; few of these animals are left in southern Arizona. The mashed bobwhite quail is also an endangered species.

Sections. — Two sections are recognized: the Creosote Bush (3221), and the Creosote Bush-Bur Sage (3222).

4000 Humid Tropical Domain

The humid tropical group of climates is at low latitudes and is controlled largely by equatorial and tropical air masses. The average temperature of every month is warmer than 65 °F. (18 °C.). There is no winter season. Average annual rainfall is heavy and exceeds annual evaporation; however, it varies in amount and in seasonal and areal distribution.

Two types of climates are differentiated on the basis of the seasonal distribution of precipitation. Tropical wet or rainforest has ample rainfall throughout 10 or more months of the year. Tropical wet-and-dry, or savanna, has a dry season lasting longer than 2 months.

4100 Savanna Division

The latitude belt between 10° and 30° N. is intermediate between the equatorial and middle latitude climates. This produces the tropical wet-dry savanna climate, which has a wet season controlled by moist, warm, maritime tropical air masses at times of high sun, and a dry season controlled by the continental tropical masses at times of low sun. Köppen classified the tropical wet-dry climate as *Aw*, the letter *w* signifying a dry winter.

Alternation of wet and dry seasons results in the growth of a distinctive vegetation known generally as tropical savanna. This is characterized by open expanses of tall grasses, interspersed with hardy, drought-resistant shrubs and trees. Other areas have savanna woodland, monsoon forest, thornbush, and tropical scrub. Grasses are dried to straw and many tree species shed their leaves in the dry season. Other trees and shrubs have thorns and small or hard, leathery leaves that resist loss of water.

Soils are mostly Histosols and Inceptisols. Excessive leaching results from heavy rainfall and high temperatures. Streamflow in these regions contrasts greatly with that in the rainforest climates, which have a very strong seasonal fluctuation. In the rainy season, extensive low-lying areas are under water. In the dry season, there is little or no flow; channel bottoms of sand and gravel are exposed and mud flats dry out.

North American Savanna areas are typified by southern Florida, where habitats and fauna are strongly influenced by water levels. Large numbers of birds are especially characteristic.

The flat, marshy surface of the Florida Everglades. (National Park Service.)

4110 Everglades Province

Southern Florida, 7,800 sq. mi. (20,200 sq. km.)

Land-surface form. — The Everglades occupy an extensive, almost flat, marl and limestone shelf generally covered with a few feet of muck and a little sand. Elevation ranges from sea level to 25 ft. (7.6 m.). The level low coastal plain contains large areas of swamps and marshes. Poorly defined broad streams, canals, and ditches drain to the ocean. In the interior, hammocks rise a few feet above the general level. Low beach ridges and dunes rise several feet above adjoining swamps and marshes.

Climate. — The tropical climate has 50 to 65 in. (1,270 to 1,650 mm.) of rain; the greatest amount falls from late spring through mid-autumn. The average annual temperature is 70° to 75°F. (21° to 24°C.) October through February. The area is frost-free practically all year.

Vegetation. — About one-fifth of the area is covered by tropical moist hardwood forest. Cypress forests are most extensive, but mangrove is widespread along the eastern and southern coasts. Much of the area is open marsh covered by phreatophytic grasses, reeds, sedges, and other aquatic herbaceous plants. Several areas covered by dense grasses are classed as medium-tall grasslands. The major plants are sawgrass and three-awns. Within the grassland are mesic habitats, termed "hammocks," raised above surrounding, usually wetter, areas. These hammocks contain groves of low to medium-tall broadleaf evergreen trees and shrubs. Mahogany, redbay, and several palmettos are common trees. One also finds strangler fig along with abundant epihpytes.

Soils. — Histosols are the principal soils. In areas slightly less wet, Inceptisols occupy extensive areas in the south part of the Everglades.

Fauna. — The Everglades has a wide variety of influent species from adjacent palmetto prairie, cypress swamp, magnolia forest, and mangrove areas. A slight change in water level changes the habitat and the fauna markedly. Among the many mammals are the white-tailed deer, Florida panther, black bear, raccoon, bobcat, opossum, skunk, various bats, marsh and swamp rabbits, cotton rat, and fox squirrel. Numerous species of birds live in this province. Before the water level in much of the Everglades was lowered by drainage, the area was the home of large numbers of herons, egrets, limpkins, mottled ducks, Florida Everglade kites, and other birds. Now the Florida great white heron and the Florida Everglade kite are classified as threatened.

Characteristic lizards are the Caroline anole and the brown red-tailed skink. Snakes include the rough green snake, key rat snake, and the southern Florida coral snake. The endangered American alligator is a yearlong resident.

4200 Rainforest Division

Between the equator and latitude 10° N. lies a region classified as wet equatorial or rainforest. Average annual temperatures are close to 80°F. (27°C.); the seasonal range is virtually imperceptible. Rainfall is heavy during the entire year, but the monthly averages differ considerably because of the seasonal shifting of the equatorial convergence zone and a consequent variation in air mass characteristics. According to Köppen's definition of this *Af* climate, no month averages less than 2.4 in. (60 mm.) of rainfall.

The equatorial region is characterized by growth of a rainforest, or selva vegetation type unexcelled for luxuriance of tree growth and number of species. Broadleaf trees rise 100 to 150 ft. (30 to 45 m.), forming a dense leaf canopy through which little sunlight can reach the ground. Giant lianas (woody vines) hang from the trees. The forest is evergreen but individual species have a rhythm of leaf-shedding.

Rainforest is the home of the small forest animals that take advantage of the continuous forest canopy for living and traveling. The species of birds are numerous and spectacularly plumaged.

The copious rainfall and high temperatures combine to keep chemical processes continuous on the rocks and soils. Leaching of all soluble elements of the deeply decayed rock produces Ultisols and Oxisols that are often especially rich in hydroxides of iron, magnesium, and aluminum.

Streamflow is fairly constant because a large water surplus exists throughout the year and allow ample runoff. River channels are lined with dense vegetation. Sand bars and sand banks are less conspicuous than in drier regions. Flood plains have meanders and many swampy sloughs where river channels have shifted their courses. Although water is abundant, river systems carry relatively little material in chemical solution. Thorough leaching of soils has already removed most soluble mineral matter.

Not all equatorial rainforest areas have low topographic relief. Hilly or mountainous belts have very steep slopes on which flows, slides, and avalanches of soil and rock frequently occur, stripping away all vegetation and soil down to bedrock.

Highland Provinces

M4210 Hawaiian Islands Province

Hawaiian Islands, 6,700 sq. mi. (17,400 sq. km.)

Land-surface form. — Hawaii occupies a tropical oceanic position just south of the Tropic of Cancer (23½° N.). The five principal islands and four smaller ones are all volcanoes in various stages of erosion. The islands are hilly and mountainous, especially toward the east. About a fourth of the area rises less than 650 ft. (198 m.); half is between 650 and 2,000 ft. (198 and 600 m.), and a fourth higher than 2,000 ft. (600 m.). Hawaii, the most easterly and the largest of the islands, has peaks higher than 13,000 ft. (3,900 m.), and some active volcanoes. Coastlines are mostly rocky and rough. Only Oahu and Niihau have much coastal plain. Surface streams are not abundant, because the ground, being composed of lavas, is highly porous.

Climate. — Hawaii has a tropical climate. The surrounding ocean and the highly persistent northeast trade winds maintain almost uniform climate throughout the year. At any given location, temperature and precipitation remain nearly constant, but both vary greatly with altitude and exposure. At sea level, average January temperature is about 70 °F. (21 °C.); average July temperature is about 75 °F. (24 °C.). Frost is rare below 4,000 ft. (1,200 m.) and has never been recorded below 2,500 ft. (760 m.). On the very high peaks, however, snow may fall in any month of the year. Precipitation is heaviest on the windward side of all the islands; lee slopes are semiarid. For example, the trade winds, blowing from the northeast, first reach the peaks on the northeast side of Oahu, and annual rainfall there averages more than 200 in. (5,000 mm.). Leeward is a rain shadow. Annual rainfall at Honolulu averages about 20 in. (500 mm.).

Vegetation. — Because the Hawaiian Islands are isolated, their flora are unique; before man's arrival, many species were endemic. Stands of native plants on the islands include shrub, forest, bog, and moss-lichen.

Dense rainforest in Hawaii Volcanoes National Park. (National Park Service.)

Most of the shrub land is along the coastal lowlands, on the lee sides of the mountains; but it extends to considerable altitudes where rainfall is slight.

Forests grow above the shrub land on the lee sides of mountains but extend to sea level on the windward sides. There are at least four kinds of native forest, reflecting differences in availability of moisture. One occurs on the dry, lee sides of mountains up to about 2,500 ft. (760 m). Wetter areas, up to about 6,000 ft. (1,800 m.), support a forest that includes one of the principal lumber trees, the ohia. With it are tree-like ferns. A third forest grows above the ohia forests on Maui and Hawaii up to 9,500 ft. (2,900 m.). A fourth is characterized by the koa tree, the largest Hawaiian tree, which grows up to 60 ft. (18 m.) high and has diameter that may be as large as 12 ft. (3.7 m.).

Shrubs mixed with scattered trees grow on the upper slopes of the high mountains. Bogs are common in areas of heavy rainfall. Mosses and lichens grow above timberline, where rainfall is low and frost is frequent.

Soils. — Soils of the islands are a complex pattern of leached Ultisols and Oxisols, Inceptisols, and rocky highlands and coastlines. Deep Ultisols are widespread on old lavas that form the older islands; young lavas on the younger islands are still rock.

Fauna. — Because of their detachment, the Hawaiian Islands have a meager but unique fauna. They have no snakes and few other reptiles. The Islands support large populations of such water birds as terns, tropicbirds, boobies, shearwaters, and petrels. The major islands have such special species as the white-tailed tropicbird, the rare Manx (Newell's) shearwater, and dark-rumped petrel, all of which seek crater walls for nesting. Native land birds include hawks, owls, crows, warblers, and thrushes. Several species, including the crested honey-creeper and ou, are near extinction. Many species of birds have been introduced. Introduced mammals include the axis deer, Hawaiian wild boar, feral sheep, and goats.

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Appendix 1:

Regional climates, based on the Köppen system of classification (1931), as modified by G. T. Trewartha (1943, 1967).

Köppen *Groups and Types*	*Ecoregion Equivalents*
A— **Tropical Humid Climates**	**Humid Tropical Domain** (4000)
Tropical rainforest (Af)	Rainforest Division (4200)
Tropical savanna (Aw)	Savanna Division (4100)
B— **Dry Climates**	**Dry Domain** (3000)
Steppe (BSk)	Steppe Division (3100)
Desert (BWh, BWk)	Desert Division (3200)
C— **Subtropical Climates**	**Humid Temperate Domain** (2000)
Mediterranean (Csa)	Mediterranean Division (2600)
Humid subtropical (Cfa)	Subtropical Division (2300)
	Prairie Division (2500)*
Marine west coast (Cfb)	Marine Division (2400)
D— **Temperate Climates**	
Humid continental, warm summer (Dfa)	Hot Continental Division (2200)
	Prairie Division (2500)*
Humid continental, cool summer (Dfb)	Warm Continental Division (2100)
	Prairie Division (2500)*
	Polar Domain (1000)
Subarctic (Dfc, Dfd)	Subarctic Division (1300)
E— **Polar Climates**	
Tundra (ET)	Tundra Division (1200)
Ice cap (EF)	

*Köppen did not recognize the Prairie as a distinct climatic type. The ecoregion classification system represents it at the arid sides of the Cfa, Dfa, and Dfb types.

Definitions and Boundaries of Köppen System

A Tropical forest climates; without frost. Coolest month warmer than 65°F. (18°C.).

B Dry climates; evaporation exceeds precipitation.
BS — Steppe or semiarid climate.
BW — Desert or arid climate.

C Subtropical climates; eight months or more warmer than 50°F. (10°C.); coolest month warmer than 32°F. (0°C.) but colder than 65°F. (18°C.).

D Temperate forest climates; four to eight months warmer than 50°F. (10°C.); coldest month cooler than 32°F. (0°C.).

E Polar climates, warmest month colder than 50°F. (10°C.).
ET — Tundra climate; warmest month colder than 50°F. but warmer than 32°F.
EF — Perpetual frost; all months colder than 32°F.

a - average temperature of warmest month warmer than 72°F. (22°C.)
b - average temperature of warmest month colder than 72°F. (22°C.)
c - fewer than four months warmer than 50°F. (10°C.)
d - same as "c," but coldest month cooler than -36°F. (-38°C.)
f - no dry season; rainfall throughout the year
h - hot and dry; all months warmer than 32°F. (0°C.)
k - cold and dry; at least one month colder than 32°F. (0°C.)
s - dry season in summer
w - dry season in winter

Appendix 2:

Approximate area and proportionate extent of ecoregions at the province and section level in the United States (Area given in nearest 100 square miles and percent to nearest tenth.)

Province and Section	Area	Extent in Province	Extent in U.S.
	Square Miles	*Percent*	*Percent*
1210 Arctic Tundra	68,900		2.2
1220 Bering Tundra	86,700		2.6
1320 Yukon Forest	185,500		5.7
M1210 Brooks Range	53,300		1.6
M1310 Alaska Range	102,200		3.1
2110 Laurentian Mixed Forest	204,700		6.2
2111 Spruce-Fir Forest	35,900	17.5	1.0
2112 Northern Hardwoods-Fir Forest	18,000	8.8	0.6
2113 Northern Hardwoods Forest	91,600	44.8	2.8
2114 Northern Hardwoods-Spruce Forest	59,200	28.9	1.8
M2110 Columbia Forest	45,300		1.4
M2111 Douglas-fir Forest	11,400	25.2	0.4
M2112 Cedar-Hemlock-Douglas-fir Forest	33,900	74.8	1.0
2210 Eastern Deciduous Forest	367,800		11.1
2211 Mixed Mesophytic Forest	38,400	10.4	1.1
2212 Beech-Maple Forest	58,300	15.9	1.9
2213 Maple-Basswood Forest + Oak Savanna	44,300	12.0	1.3
2214 Appalachian Oak Forest	103,400	28.1	3.1
2215 Oak-Hickory Forest	123,400	33.6	3.7

Province and Section	Area	Extent in Province	Extent in U.S.
	Square Miles	*Percent*	*Percent*
2310 Outer Coastal Plain Forest	150,100		4.6
2311 Beech-Sweetgum-Magnolia-Pine-Oak	107,500	71.6	3.2
2312 Southern Floodplain Forest	42,600	28.4	1.4
2320 Southeastern Mixed Forest	257,900		7.7
2410 Willamette-Puget Forest	13,000		0.4
M2410 Pacific Forest (in conterminous U.S.)	63,000		2.1
M2411 Sitka Spruce-Cedar-Hemlock Forest	6,300	10.0	0.2
M2412 Redwood Forest	5,100	8.1	0.2
M2413 Cedar-Hemlock-Douglas-fir Forest	22,000	34.9	0.8
M2414 California Mixed Evergreen Forest	4,300	6.8	0.1
M2415 Silver Fir-Douglas-fir Forest	25,300	40.2	0.8
M2410 Pacific Forest (in Alaska)	66,700		0.2
2510 Prairie Parkland	204,600		6.2
2511 Oak-Hickory-Bluestem Parkland	124,200	60.7	3.8
2512 Oak + Bluestem Parkland	80,400	39.3	2.4
2520 Prairie Brushland	83,600		2.6
2521 Mesquite-Buffalo Grass	32,200	38.5	1.0
2522 Juniper-Oak-Mesquite	24,100	28.8	0.7
2523 Mesquite-Acacia	27,300	32.7	0.9
2530 Tall-Grass Prairie	223,000		6.8
2531 Bluestem Prairie	111,600	50.0	3.3
2532 Wheatgrass-Bluestem-Needlegrass	49,400	22.2	1.5
2533 Bluestem-Grama Prairie	62,000	27.8	2.0
2610 California Grassland	20,200		0.6
M2610 Sierran Forest	32,600		1.1
M2620 California Chaparral	33,500		1.0
3110 Great Plains-Shortgrass Prairie	317,600		9.6
3111 Grama-Needlegrass-Wheatgrass	83,800	26.4	2.6
3112 Wheatgrass-Needlegrass	102,800	32.4	3.1
3113 Grama-Buffalo Grass	131,000	41.2	3.9

Province and Section	Area	Extent in Province	Extent in U.S.
	Square Miles	*Percent*	*Percent*
M3110 Rocky Mountain Forest	187,300		5.7
M3111 Grand Fir-Douglas-fir Forest	32,600	17.4	1.1
M3112 Douglas-fir Forest	94,500	50.4	2.8
M3113 Ponderosa Pine-Douglas-fir Forest	60,200	32.2	1.8
3120 Palouse Grassland	12,400		0.5
M3120 Upper Gila Mountains Forest	36,100		1.1
3130 Intermountain Sagebrush	203,400		6.2
3131 Sagebrush-Wheatgrass	89,800	44.1	2.8
3132 Lahontan Saltbush-Greasewood	33,300	16.4	1.0
3133 Great Basin Sagebrush	46,900	23.1	1.4
3134 Bonneville Saltbush-Greasewood	22,200	10.9	0.7
3135 Ponderosa Shrub Forest	11,200	5.5	0.3
P 3130 Colorado Plateau	94,700		2.8
P3131 Juniper-Pinyon Woodland + Sagebrush Saltbush Mosaic	39,600	41.8	1.2
P3132 Grama-Galleta Steppe + Juniper-Pinyon Woodland Mosaic	55,100	58.2	1.6
3140 Mexican Highland Shrub Steppe	17,500		0.6
A 3140 Wyoming Basin	42,300		1.4
A3141 Wheatgrass-Needlegrass-Sagebrush	13,100	31.0	0.4
A3142 Sagebrush-Wheatgrass	29,200	69.0	1.0
3210 Chihuahuan Desert	64,100		2.0
3211 Grama-Tobosa	18,200	28.3	0.5
3212 Tarbush-Creosote Bush	45,900	71.7	1.5
3220 American Desert	77,500		2.4
3221 Creosote Bush	36,700	47.4	1.2
3222 Creosote Bush-Bur Sage	40,800	52.6	1.2
4110 Everglades	7,800		0.2
M4210 Hawaiian Islands	6,700		0.3
TOTAL SQUARE MILES	3,330,000		