

ARIZONA'S RENEWABLE NATURAL RESOURCES

By
Hollis S. Palmer

HD
211
-4646
Ariz.

Introduction

This short treatise dealing with Arizona's Renewable Natural Resources was prepared in cooperation with the Arizona State Teachers College of Tempe, and the Tonto National Forest, to meet the requests of a number of teachers in the public schools of Arizona.

It is very brief and written in terms meant to be understandable to the pupil of grammar and high school ages. It is felt that a word picture of the renewable resources and the areas producing them might be of some value to pupil and instructor.

The statistics cited are from compilations made by the Forest Service, and from the publication issued by the Salt River Valley Water Users' Association relative to the Salt River project.

It is hoped that the material contained herein may prove helpful to give you a better understanding of our state and what she naturally offers us as her residents.

Phoenix, Arizona

November 28, 1941

I. In General, What We Have and What Has Gone Before

Our state is the youngest in the Union. This at once brings out an important fact - that it is not yet fully developed insofar as its future possibilities are concerned. One of the most important requirements of progress is fertile, productive soil. Immediately, students who reside in such communities as Miami, Globe, Superior, Morenci, Bisbee, Ajo, and other mining communities may take issue that mineral deposit in sufficient quantity for the development of mines is the primary requirement.

Mines are indeed important; but without agriculture in nearby localities, such as the Gila, Salt River and Yuma Valleys, to supply the food necessary at a reasonable cost, for the people who work them, it would be impossible to put the products of the mines on the market cheaply enough to be used.

Early mining in Arizona experienced this. The Tip Top on the Black Canyon Highway, for instance, in the 1870s produced ore that contained as much as 5000 ounces of silver per ton, but the high cost of groceries, coupled with transportation of the ore, boosted the expenses so much that the owners made no profit due to the excessive cost of production.

It is very evident therefore that food to maintain a population is the first requirement of any state or nation. With this item available, man can proceed to develop other resources a state contains.

As the name indicates, Arizona is located in a zone of light rainfall. To grow crops, soil must have water. In areas where rainfall is not plentiful enough to supply the needs of agriculture, man has for untold centuries developed irrigation systems to make up for the lack of rainfall on desert areas. These man-made developments have resulted in the production of enormous crops on once desert areas. Mild climates such as we have in some of our broad valleys permit almost yearlong growth. Hence, contrary to the ideas of the Northern and Eastern farmer, the Arizona farmer has his land producing a crop for most of the year, while in colder climates the land is frozen and lying idle usually from mid-September to mid-May.

Intensive farming such as we do here may be carried on successfully as long as the soil is maintained through use of soil building crops on a crop rotation basis, and just as long as an ample supply of water for irrigation is maintained.

War has done much toward the fall of early civilizations in the near East and Northern Africa, the weakening of China, and other Asiatic countries that are today either only a name or a memory of "what once was." But the results of war are only a part of the reason for their downfall; loss of water supply from the drying up of streams, thus eliminating irrigation water, is the basic reason for the vanishing of these early civilizations.

Of the older civilizations, Egypt in the Valley of the Nile is all that remains in the sense of a modern inhabited area. The reason for this partial survival can be easily traced to the tremendous length of the Nile River and the great extent of its watershed. The watershed has survived the onslaught of civilization because it is located, particularly the headwaters, in the tropical zone of Africa that is not easily converted to use by man.

Unfortunately the other rivers of these early civilizations were located so that their headwaters had climates wherein man could easily survive. This resulted in the unwise use of the watersheds by people as the population increased and the natural agricultural valleys became crowded and failed to support the increase.

Acts of man and his conquests against others who opposed him fill the pages of our histories. To us, wars, their causes and results, have been important because they were spectacular and dealt with men. There is one war that has gone on continually, of which there is little written in the pages of history. That is the war between man and the balance established by Mother Nature.

Man has written little of this war because he has always lost; and Mother Nature - always the winner - has written the results very plainly on the surface of the earth where she won each of her wars. Each crumbled civilization is a chapter of her book.

It is not unusual that these closed chapters have been written in climates such as we enjoy in Arizona, for it was in this zone that it is presumed the cradle of our civilization was located. In less favorable climates, water is not an all important item due to its natural abundance.

Mother Nature has abundantly provided Arizona with a wealth not common to many states. The mild climate of her broad desert valleys makes them the most productive farm land on earth; her mountains hold a mineral wealth that is hard to equal or excel; these mountains are clothed with a cover of grasses, weeds and browse that makes the state ideal for the raising of cattle, sheep and goats; the loftier plateaus and mountain ranges are covered with forests of juniper, pines, fir and spruce in such variety and abundance that lumber, from our so-called desert state, finds its way to the markets of many other states in the nation, as well as filling the needs of our own agriculture, mines, industry and home building; the mountains and high plateaus constitute the watersheds of the rivers that furnish the water that makes farming possible; and aside from these essentials she has given us a range in temperature within our borders that is comparable in extent from the heat of the equator to the chill of the arctic, due to variety in elevation from near sea-level to over 12,000 feet, hence the climate of Arizona is outstanding, coupled with it the ruggedness and spectacular features of her surface make it outstanding in scenic grandeur, added to this is a healthy population of game animals and birds, and fish in her streams and lakes, which add a punch for sportsmen.

Of the natural resources contained in the state, all are renewable except the mineral. To maintain and further the development of Arizona it is necessary that these resources remain productive.

Farm lands retain their fertility by improved methods of agriculture developed through years of experience and public expenditure to increase production through education of farmers. Thus our farm lands generally are being cared for.

Water, range forage, forests, wildlife and scenic values are assets that naturally happened and are the vital resources that can, through improper use, overthrow the balance that can result in another victory for Mother Nature, or through wise use can aid in the development and maintenance of a civilization in our state that could endure and prosper indefinitely.

II. Water and Watersheds

As discussed in the preceding chapter, agriculture is the basis of our food supply and is, therefore, necessary for our existence. With the exception of relatively small areas, the bulk of our farm lands are found in the Salt River, Gila and Yuma Valleys, where the water for irrigation is furnished by the Salt, Gila and Colorado Rivers.

Man has no control over the amount of water that falls in the form of rain and snow. He can then only use water that is available on the earth. Water in running streams, flood waters collected in reservoirs and underground supplies obtained from wells are the main sources from which we can get this element for our needs.

Storage of water for use in times of inadequate streamflow and to insure a continual supply is practiced in Arizona probably more than in any other state.

Since early development of the United States, dams for storage of water to develop electricity have been in use. The Roosevelt Dam was the first of any major importance that was constructed to store water for irrigation purposes, as well as for electric power generation. Following the building of Roosevelt, Horse Mesa, Mormon Flat and Stewart Mountain Dams were constructed on Salt River, and in more recent times Bartlett Dam was constructed on the Verde River.

This system of storage reservoirs furnishes the Salt River Valley with its irrigation water and serves 240,000 acres of farm lands entirely with the water needed for irrigation, and an additional 95,000 acres with part of their needed water supply. Within this project are around 10,000 farms that raise crops 12 months of the year and support a population of nearly 200,000 people either directly or indirectly.

The use of this water in eight hydro-electric plants for generating power, with one Diesel plant, has a total capacity of 130,000 horse-power. Thus the community can be served with cheap electric power as long as the water holds out.

All of these dams, canals, power houses, power and telephone lines and other needs represent a total expenditure of over \$43,000,000 or \$215 per person dependent upon the area.

The Coolidge Dam on the Gila River, combined with well water, supplies the Casa Grande Valley with its water for irrigation purposes.

Gillespie Dam in the same river supplies the Gila Bend farm area with its irrigation needs.

The Carl Pleasant Dam on the Agua Fria furnishes water for an area near Peoria.

Lyman Dam on the Little Colorado supplies the irrigation water for St. Johns, and Daggs Reservoir on Silver Creek furnishes water to the Snowflake area.

Yuma Valley gets its water from the Colorado River.

In all there are 78 storage reservoirs in Arizona for irrigation water, with a total of 4000 miles of canals and 268 diversion dams.

It is readily seen that irrigation water and farming are inseparable as we know it here. This is further illustrated by the fact that irrigated farm land covers an area of nearly 665,000 acres, while dry farms cover only around 50,000 acres.

These facts illustrate that our entire structure here depends upon water. Hence the wise use of it and the proper handling of the areas producing it are very important indeed. The areas that produce water, either in the form of running streams or underground water, are commonly called watersheds. Practically all of the state comes in this class. More especially is this true of the higher mountainous portions where rain and snowfall is heavier.

The management of watersheds exerts a very decided influence on the water they produce. In their natural state - that is, the way they were before the coming of man to disrupt the conditions as Dame Nature made them - these watersheds were covered with vegetation of some form or other.

Vegetation exerts a great influence on the flow of water that falls in the form of rain. To illustrate this turn a hose on a patch of good sod on your lawn and notice that the water soaks in through the blades of grass and then settles in through the roots. Then turn the same hose on a spot of bare ground and watch what happens; immediately the falling water will disturb the soil and become muddy; soon it will start to flow, carrying the fertile top-soil with it. The difference in the action of the water illustrates what rainfall does on an area protected by vegetation and one that is bare.

The same action takes place on watersheds. Well covered areas absorb rainfall. The ground cover holds back the water and allows time for it to go into the ground. When the ground absorbs all the water it can hold it passes out into small streams as clear water from the lower layers of soil and is carried by the smaller streams to rivers and thence into our reservoirs for storage and eventually to our farm lands to irrigate the farmers' crops. This type of run-off is slow and steady and continues for a longer period of time. Further the ground cover in the form of grass, weeds, browse and timber, prevents evaporation of moisture by wind and sun, by keeping the earth shaded. By keeping evaporation low, in subsequent rains the soil takes less soaking to cause run-off and the dry channels of small streams, if shaded, absorb less water if their beds and banks are already well soaked or at least moist. Thus through reduced evaporation a greater discharge of water is had and consequently a better chance for more stored water.

On areas of watershed where vegetation is lacking or very sparse, the water from rains at once starts to rush toward stream channels, gouging out new gullies and enlarging those already there, taking the soil with it as it is joined by water from adjoining areas, developing into a flood that has sufficient power to move almost everything in its path. This is the case in most of Arizona's streams. Where once water passed down the streams slowly, through tree-lined meadows supporting lush grasses that held the productive soil in place, these meandering brooks have now been replaced by wide rock-strewn, usually dry, stream beds, with an occasional tree, and have steep, exposed banks that dry out rapidly after the passing of each flood. Following these floods the reservoirs are piled deeper with silt and trash that slowly but surely reduces the water holding capacity of them. Consequently each flood, with its deposit of silt and trash, reduces the value of the investment by shortening the useful life of the expensive dams that make the reservoirs.

By this process Mother Nature is starting her winning battle with man-made civilization that ignores the balance that she has established. Because Nature goes on and on and man's existence is so short by comparison, he is very short-sighted and accepts things as he finds them without regard to keeping or restoring the balance necessary for continued existence and progress of those to follow. It was this weakness of man that caused the fall of early empires in climates in Asia Minor and other areas that are similar to ours in climate, through the ruthless destruction of renewable natural resources found on the areas that furnished the water necessary for those early civilizations.

We have progressed far in the few centuries man has been on earth. Unfortunately our progress has been primarily in production of things that aid us in our short existence on earth. Each succeeding generation picks up from the preceding and makes further advances. In the case of our renewable natural resources efforts are being made to maintain them; however, a general public understanding is desirable.

The Forest Service, of the United States Department of Agriculture, is the oldest government bureau engaged in the management of government lands with the view of using all the products of the land for the benefit of the greatest number of people. After over 35 years of managing vast areas within the National Forests and findings made by experiment stations operated by this Service, much has been learned about watersheds and the proper managing of them in the light of the greatest good to the greatest number.

Although Arizona is the youngest state, it was settled and used many years before it became a state. The early pioneers were mostly stockmen and miners. Free, unrestricted and uncontrolled grazing of livestock on watershed areas, coupled with a mild climate and periodic drouths, had a damaging effect on the natural vegetation. Many areas were badly devastated as early as 1890. Resulting from this early use the placing of National Forests under administration in 1905 found much of the watershed areas badly out of balance as far as vegetative cover was concerned.

Regulation moves slowly under our democratic form of government. Laws and rules may be of the best, but the enforcing of them must be such as not to work great hardships on those affected.

As a result, since a large part of Arizona's citizenry at that early date was interested in the cattle and sheep that used the watersheds, enforcing the measures needed to get quick results were used sparingly to avoid human suffering and loss. Drastic changes are not easily accepted by any of us. Consequently education through demonstration of benefits derived from proper handling of these watersheds by stockmen has had to be the guiding factor in bringing about improvement of the vegetative cover, resulting in the restoring of the natural balance on these areas. This of necessity has been slow.

Farming and related occupations now represent the majority of Arizona's population. Other businesses, such as mining and lumbering, are dependent upon the farms for their needed foodstuffs. Thus the interests of our citizens as a whole are very different than they were when the first irrigation reservoir at Roosevelt was put into use in 1910. It is evident that at present our development and continued prosperity depends largely on maintaining our irrigated farms, since they directly or indirectly affect the large end of our population. Therefore public attention should be directed to the care and improvement of our watersheds which supply the needed water. This area is made up of all the state except the farm lands themselves. The values involved on this vast area vary according to the location of the various portions.

It is readily seen that areas, for instance around Yuma and Wellton, where the rainfall is less than ten inches a year, are not as important as areas of greater precipitation such as in the White Mountains near Greer, Springerville, Nutrioso and Alpine, where the rain and snowfall sometimes exceeds 30 inches, from the standpoint of water discharge. No matter how great or how little the rainfall on any of our watershed areas, they are important not only for the water they furnish but for what these areas produce in the way of usable products.

The renewable natural resources of these watershed areas vary with the amount of precipitation they receive. Generally speaking in Arizona the elevation of an area has a direct relationship to the amount of precipitation that falls.

The great changes in elevation in the state, from 137 feet above sea-level in the Yuma Valley to 12,611 feet on top of the San Francisco Peaks near Flagstaff, gives us a variety of vegetation within our borders not exceeded by many nations. These extremes brought about by changes in elevation, rainfall, and extremes in temperature from torrid to frigid, have caused five broad zones of vegetation. Simply expressed these are - (1) semi-desert; (2) open grassland; (3) chaparral or browse; (4) woodland; and (5) timberland.

The importance of these zones will be discussed in the light of their value as watersheds and what they produce.

III. Semi-desert

The area of this zone is the largest of the five in the state. It might well be defined as taking in that area of the state with elevations below 3500 feet and with an average annual rainfall below 15 inches.

This area includes all of Yuma County; the south and western part of Mohave; all but the higher portions of Maricopa and Pinal Counties; the northern and western part of Pima; a small portion of Cochise along the San Pedro River; a belt extending clear across Graham and into Greenlee County along the Gila River; a small area in Gila County is found along Salt River and Tonto Creek; and the southwest corner of Yavapai is covered by this zone.

Within the semi-desert area is found the principal farming district of the state. In addition are broad desert valleys which are potentially farm lands, all that is lacking is water. The temperature range is from a low of 20 degrees to a high of 120 degrees. Frost-free areas are found at the lower elevations. Many winters in this large area are often free from frost.

It is not unusual that this area supports plants common or similar to the Mediterranean area in southern Europe and North Africa, and also Asia Minor, Asia, portions of South America, Mexico, the Hawaiian Islands, and Australia, all having similar climatic conditions. This area in Arizona and its extension across the Colorado River into California is the only spot in the United States where such associations of plants common to so many places in the world may be found.

The importance of vegetative cover such as the low growing trees and shrubs that cover the semi-desert areas is not realized until they have been cleared off. Army officials engaged in airport construction complained of the dust, sometimes on heavily used areas knee-deep, that resulted from the clearing. It is surprising how these trees and shrubs keep the soil in place, thus keeping the eroding effect of wind to a minimum. Along river bottoms and dry washes these trees are more abundant due to the added moisture. This more abundant growth helps hold the river channels in place and across level valleys causes the water to spread out flooding the plains, thus giving them a good soaking and increasing the productiveness from the added moisture. Probably the best example of this action is the broad flood plain of the Santa Cruz River in northern Pima and southern Pinal Counties.

The Santa Cruz is not a live stream but floods occur frequently due to its length. Its source is in the Santa Rita and other mountains of southern Arizona and Sonora, Mexico. A heavy rain on the headwaters, even though a hundred or more miles away, may send a substantial stream of water clear down to Red Rock or vicinity. Enterprising ranchers living in this vicinity have learned that by turning the water out of the channel, flooding the broad flats, causes grass and weeds to grow less errantly. Many have learned that Johnson grass will withstand long periods without water and that it will grow and produce heavy stands resulting from flood waters. Further this grass is excellent feed for cattle, hence the areas flooded become highly valuable as a producer of this grass for forage. Man's ingenuity to make soil produce, utilizing flood waters originating miles away, and raising a crop to advantage, is necessary if he is to live in a semi-desert area.

This use of flood water by spreading from the Santa Cruz creates a beneficial effect for the farm lands in this valley. Many farms in the communities of Eloy and Casa Grande are dependent on well water for irrigation. The power-driven pumps that throw huge quantities of water into the irrigation ditches get their power from hydro-electric plants operated by water impounded behind the dams of irrigation projects in other parts of the state.

The supply of underground water must come from seepage of surface water into underground strata. The holding back of water, causing it to run slowly allowing it to go into the soil, should increase the underground supply. Further, the nearer to the surface the water is and the more shallow the wells are, the less the power required for pumping. The washing out of deep channels of rivers and washes causes drainage of water near the surface into them and its discharge through the streams to the ocean. This drainage naturally lowers the water-level of these all important wells, resulting in the need for drilling them deeper.

The natural vegetation found in this dry belt exerts a great influence in keeping erosive agents such as wind and flood from disturbing the soil. There are four distinct types of plant life:

1. Trees and large shrubs. 2. Half-shrub. 3. Annuals. 4. Cacti.

Trees and large shrubs are represented by a good many different groups. No doubt the most widespread of the groups is the mesquites. Among the most important are: Palo verde, crucifixion thorn, creosote bush, ironwood, catclaw, jujube or bluethorn, wolfberry, desert willow, coffeeberry or jojobe, cottonwood, tamarisk, desert hackberry, and others such as the Joshua tree of Mohave County, the native palms found in Yuma County, and the ocotilla, which is neither tree, shrub nor cactus.

The half-shrub group is so named because of the size of the plant and the fact that the plants are woody in appearance but questionable as to whether they are really wood. In some cases they are wood and others only stiff stems that resemble wood in appearance only. The number of this group of plants are many and include various *Eranterias* commonly called rabbit bush, false cocklebur, and green sage. Various species of salt bush are found, Mormon tea, and many others that take a botanist some time with which to become familiar.

The annual plants, those coming up from seed when moisture conditions are right, often convert the desert into a flower garden that knows no equal for the abundance and variety in its growth. Among the more common are the California poppy (the state flower of California), many lupines, mariposa lilies, alfileria, Indian wheat, and others far too many to attempt to enumerate. Also included are many annual grasses.

Various species of cacti are found all over the state, with the exception of the higher elevations. The semi-desert zone, however, is where they grow in the greatest abundance and variety. The giant sahuaro (the state flower of Arizona) is found only in this belt, as well as the organ pipe, south of Ajo. This is also true of the night blooming *Cereus*, one of the most beautiful cacti flowers produced in the area. Many other species, such as the cholla, pincushion, hedgehog, barrel, prickly pear, and others, are common.

Nature has provided well for these semi-desert plants. All are small-leaved. Even the cottonwood, generally with a large oval leaf, has in the native species a narrow leaf to cut down transpiration. The jujube, the wolfberry, the palo verde and crucifixion thorn have small leaves. During the hot months when rains are lacking, many of these species shed most of their leaves and become practically dormant. The mesquite, catclaw and ironwood all have small leaves, thereby restricting transpiration. The jojobe or coffeeberry has a thick, leathery leaf that keeps moisture loss from the surface to a minimum. The cacti have no leaves at all. In place of them are spines which act as protectors of the more fleshy, heavy-bodied portion of the plant that acts as a

central storehouse for water and stored food. With the exception of the mesquite and ironwood, which occur in more moist sites, practically all plant life in this area has shallow root systems that extend far out close to the surface to get the benefit of light rains.

Nature has planned well for the needs of plants that they might grow on this area. In so doing she has provided for animal life as well. There is a saying among the Indians native to this area that no month of the year passes without the production of some food. This seems well founded, for practically every shrub produces an edible fruit or bean. The mesquite, as one example, has furnished a bean in abundance for various uses. The Indian has made meal for tortillas and other uses we commonly have for flour. Soldiers have used this bean to feed their horses. In our time domestic livestock get fat from this valuable product. All these tree and shrub-produced beans have value as livestock forage. The wolfberry and hackberry produce berries that are edible and are used by the Indian as food, as well as by present day dwellers of the area for making of jelly and jam. The fruit of the casti is also valuable for food. A more modern use comes to the market in the form of cactus candy. The jojoba or coffeeberry produces a large, fleshy, edible berry that has qualities that might make it commercially important as a base for cosmetics instead of olive oil, because the oil from the jojoba does not become rancid.

Mesquite and ironwood have long served as fuel. Fence posts were and are still cut from these two native woods by the farmer and rancher. Mesquite flowers are excellent for honey, as is evidenced by many apiaries scattered about over the semi-desert areas. This is also true of practically all of the trees in this zone. The tamarisk produces a beautiful white wood that if quarter-sawed has a grain the beauty of which equals the birch and maple. Wood-workers using the woods of this area make some beautiful products. Some made of tamarisk trimmed with mesquite or ironwood are priceless. This semi-desert zone has long been renowned as a haven for healthseekers. One of the necessities to regain health is something to occupy the mind and time of the patient. Wood-working, producing novelties, has been developed by many of these people to advantage not only to their health but also financially.

The rank growth of annual weeds and grasses that occurs periodically, when rains occur in sufficient quantity, has a value as livestock forage that is astounding. Normally the dry desert floor is not a great attraction to livestock, but when these areas do produce forage the volume is tremendous. It works in well, since within these areas are located the feeding and meat packing centers which can put great numbers of stock on the ranges to great advantage.

Birds and game animals such as the mountain sheep in the Kofa and Superstition Mountains, the peccary and the white-tail deer are quite plentiful. This is the home of the quail, that are plentiful all over this vast area, the dove and whitewing, where man has not exterminated them. The many seeds and beans, along with the evergreen leaves common to the vegetation, furnish the food for the game and birds.

Thus is indicated that the plant life in this zone has a useful place in the pattern necessary for its occupancy by man, and this being the case, this use should be wisely executed so as to perpetuate these useful products.

IV. Open Grasslands

Large areas are found covered primarily with sod grasses above the semi-desert in many sections of the state in broad open valleys, on plateaus, and gentle slopes. Generally there are scattered stands of shrubs and trees within this zone; mesquites, catclaw, algerita and saltbush in the lower elevations, while oaks, pinon, juniper and others occur to a limited extent in the higher elevations. However, the general appearance is open and grassy.

Cochise County has a large area included in this zone. This is principally located in the San Bernardino, Sulphur Springs, San Simon and other valleys that cover a large percent of the county.

The lower reaches of Santa Cruz County including the Santa Cruz Valley and the broad mesas around Elgin are typical.

Pima County is covered by a large representation of open grassland between the semi-desert and the chaparral. The upper Altar and Santa Cruz drainages, and the country around Arivaca, are good representative areas, as well as a good portion of the Papago Indian Reservation.

Graham and Greenlee Counties are well represented in this type in their broad valleys draining into the Gila and the open mesas that are characteristic of the belt between the valleys and the sharp rise of mountain ranges that occur in these counties.

Small areas of open grasslands occur in Pinal and Maricopa Counties. Generally, where sharp changes in elevation, and rugged mountains resulting from this change occur, the vegetative transition is from semi-desert to chaparral.

Less extensive areas are found in Gila County. These are usually small tracts between the semi-desert and chaparral and woodland zones.

Mohave is essentially an open grassland and semi-desert county. The eastern part, south of the Colorado River, that has a higher elevation, falls generally in this zone. Some of the higher mountains and higher plateaus are more in the woodland type and some reach into the timber belt. North of the Colorado the large end of the area is open grassland with considerable sagebrush being found forming a second story over much of it. Considerable woodland occurs here and in small, higher, isolated tracts sawtimber occurs.

Wide, expansive areas of grassland are found in Yavapai County. Some of these areas are surrounded by woodland, others extend into other bordering counties.

Much of the lower stretches of Coconino County is covered by open grasslands; although this county is generally associated in thought with sawtimber, open grasslands fill an important place in her economy. Large open areas in the county within the sawtimber belt occur. However, the grasses found in these high parks are bunch grasses, not the sod grasses found in the general belt located at lower altitudes. Sagebrush occurs over much of the grasslands. The chopped up belt known as the painted desert on the Navajo and Hopi Indian Reservations represents geographic changes in an essentially open grassland zone.

Both Navajo and Apache Counties have vast areas below the woodland type that are essentially open grasslands. This is particularly true of the valley of the Little Colorado and its large tributaries. Like Coconino County, the painted desert extends across the northern portions.

Similar also to Coconino are the wide open bunch grass covered mountain parks and meadows in the White Mountains of Apache County. Open, relatively small wet and dry meadows in these counties producing lush grasses, sedges, rushes and weeds occur in the higher elevations within the sawtimber belt. This type of growth occurs along streams and on their headwaters and is extremely valuable due to the forage it produces.

Grass - and especially the perennial sod grasses - is the most important protective cover of these wild, hilly lands. Practically all such lands of the Southwest are used for grazing of livestock. Most of the areas are sloping in varying degrees. On a high percentage of these lands the top-soil is comparatively thin and is underlaid with a subsoil of clay, caliche, or rock. The subsoil and rock are good reservoirs for moisture but contain very little plant food since the greatest proportion of this is found in the thin layer of top-soil. This top-soil fertility has been built up over a period of hundreds and even thousands of years, during which nature was maintaining a balance between grazing animals, predatory animals, birds, insects, and other influencing factors, so that always at least a part of each season's growth of vegetation remained on the land. This, as it withered, dried, decayed and actually became a part of the soil, increased the organic matter and created or built up its fertility. Literally this performed the necessary function of "feeding the land." Soil produces grass and grass is the best plant grown to hold the soil and stabilize it on steep hillsides. This soil, if kept in place over the millions of acres of hilly, wild lands, has tremendous economic value for the growing of forage on which to produce livestock. It is calculated that approximately 62 million acres in Arizona are used as open range, and that the annual value of this forage on a sustained yield basis is at least $2\frac{1}{2}$ million dollars. The important consideration

here is regulated, conservative use, so that only a portion of each year's growth is grazed off and the remainder left on the land to replenish its organic content and maintain soil fertility. Closely tied in with this are two other important factors: (1) maintenance of plant vitality, and (2) maintenance of an adequate cover of protective vegetation of both live and humus or dry material on the ground. As to the first of these - plant vitality - this is as important to plants as it is to animals or human beings. In order to have vitality, grass must have adequate basal leafage. You have learned or will learn that the green parts of plants are the portions that produce plant food which causes growth and development. Consequently when the manufacturing plant is reduced before it has had a chance to produce the food necessary, naturally growth is only in proportion with the amount of leafage that serves to produce plant food. In use of grass as forage it is necessary, therefore, that enough of the plant be left to continue the production of plant food to cause continued growth in the following season. When this is not done, plants become weak and fail to grow and as a result nature has provided other types of growth, such as plants not used by livestock, that come in on the areas where grass has been killed out by overuse by livestock. In order to better understand this, students are asked to remember what happens to an orchard if, after leafing out, the leaves are suddenly removed by hail, grasshoppers, caterpillars, or by any other means. Most people have seen this happen and they know that shortly afterward many of the limbs will die on trees in such a predicament, and in some cases the trees themselves will completely die. Grass completely robbed of its basal leafage suffers in the same way, though it is hardier and the process requires much more time. The dangerous part about this is its insidiousness, as the changes occur very gradually over a long period of years and for that reason they frequently are not noticed even by people who have opportunity to continuously observe them. As the plant vitality suffers, the volume production of feed is reduced, causing stock to do more traveling and trampling to get forage, the plants themselves shrink in size, leaving more of the ground bare and exposed; and finally even the cover of dry humus disappears through wind and water erosion, so that finally a much greater proportion of these hilly areas is bare and exposed.

Then the rainfall flows off more rapidly and a smaller percentage of it soaks into the ground. Furthermore, evaporation is a tremendous factor, and on bare, exposed ground, even the limited amount of precipitation which does soak into the land is dried out more quickly after the storms cease and the sunshine and wind get in their work. A further harmful change which results from abusive use of range lands is vegetative transition from highly palatable to less palatable plant growth. Normally the perennial grasses are hardy and they can easily compete with any other vegetation if their vitality can be maintained; but, if these grasses are reduced in vitality by too heavy grazing, they cannot hold their own. Then the less palatable plant growth, such as snakeweed, prickly pear, cedars and others, have their chance to spread, with the result that eventually a substantial plant change takes place and frequently the unpalatable plant growth finally dominates. These factors must be taken into consideration and the use adjusted to them if the vitality of the better forage plants, the range productivity and the most

desirable plant composition is to be maintained. Those who have lived on farms know that in order for a cow to produce abundant milk, she must be well fed. A starved cow simply cannot give but very little milk. Likewise a starved plant cannot produce many blades and stalks of grass; and, in turn, a starved range cannot produce any worthwhile quantity of forage.

In earlier days, our people, - and in fact the people of every country, - have thought that the land was a fixed, unchanging thing, and that rain was the one controlling factor in producing crops of forage. The fact is that land is a very delicate thing, always changing - never remaining the same, and in order to maintain it we must study natural processes and cooperate with Nature.

People are just beginning to realize that range lands can be rendered useless through incorrect use. Much is yet to be learned about what is the best use to fit in with nature's scheme of things, and nearly every area is a problem all its own. Every rancher using any considerable area of range land should interest himself in the land as well as the livestock, because there are no new range lands to go to; therefore it behooves us to take better care of the ones we have and to restore, as far as possible, depletion which has already occurred. This will not mean a great deal to people of the older generation, because changes to either injure or help the lands cannot be brought about in time to affect them. But it is tremendously important to those of the younger generation, and to others yet unborn.

V. Chaparral or Browse

In the rougher portions of the state, particularly the central and southern, generally between the elevations of 3500 and 6500 feet, are found the chaparral or browse areas. The northern line is roughly the Mogollon Rim, which extends from the lower breaks of the Grand Canyon to the New Mexico line. Above this great fault are some browse areas, but they are not very extensive by comparison to those south of the Rim.

How much of the chaparral area has resulted from a transition due to plant succession and land abuse by improper use is not known. Old-timers in many parts of the browse areas of the state claim that when they first saw the country the now brushy slopes were open and grass-covered. There is a prevalence among stockmen to lament on the condition of their ranges. The reasons they bring out are drouths, fences, brush taking over the range, and many others, including the control of fire. However, many of these men do not consider that numbers of livestock had a bearing on the range conditions. Range-minded stockmen have proved to themselves that numbers in excess of the grazing capacity of their range is the real cause of the lamentable conditions that are so rampant on many ranges in the state.

Without regard to cause, there are large areas in the state covered by browse. The principal plants found are several species of scrub oak, Ceanothus, Algerita, buckthorn, manzanita, Rhus, cliffrose, mountain mahogany, and many others. In some parts of the country the term "chaparral" has become common usage to apply to combinations of shrubby plants.

Some pinon, junipers and cypress often occur on these areas. Sycamore trees are generally common along the creeks, as well as cottonwoods. Ash and alder are two other tree species found commonly in the more moist sites.

Sod grasses, weeds, half-shrubs such as wild buckwheat, snakeweed, and many others are common to these browse areas. As a whole these areas are very valuable. Generally they represent zones of greater rainfall and being often on very steep slopes this type of cover does very well in holding the soil in place. This is particularly true when a good understory of grass, weeds, and half-shrubs is in place. Litter formed by leaves and limbs, shed naturally, often forms a good protective ground cover in the more dense stands.

As forage for livestock these areas have a great value. However, grass found there is the greatest contributor to this value. The browse is eaten some and has a very decided value. Its greatest asset is as a reservoir of forage during drouths. When more palatable forage is not to be had stock can subsist on the shrubby cover and live; but generally speaking it is a "living diet" and not one conducive to producing good weight and growth on livestock.

The products of these shrubby slopes are particularly valuable for deer. These animals seem to prefer browse as food. Game animals also like ample cover in which to hide and to rear their young, and this zone is ideal for this purpose.

VI. Woodland

Yavapai, Coconino, Navajo and Apache Counties have extensive areas covered with a forest of pinon and juniper. Mohave, Gila, Greenlee, Graham, Cochise, Santa Cruz and Pima have considerable of the woodland forests but not so vast by comparison as the first four named. With the possible exception of Yuma, every county in the state has some juniper or pinon within its borders.

Woodland forests may be defined as areas producing trees that are larger than the average conception of browse but smaller than trees producing sawtimber. In the Southwest the juniper and pinon areas are generally due to first consideration as woodland forests, because of the vast areas they cover. However, many portions are covered with stands of oak, particularly in the central and southern portions of the state.

Another type of growth is the cypress forests or thickets as they are sometimes called. The cypress is found usually on small areas from the Mogollon Rim to the Mexican line. Cypress seems to grow on raw soils, often these soils seem unable to readily support other plant growth. The ability of cypress to thrive on poor soil has caused it to be used quite extensively on poor sites in other parts of the world. Much of the Arizona cypress is now planted in the Hawaiian Islands and the semi-arid portions of North Africa. As an ornamental tree it is used quite extensively in the Salt River Valley and other warm sections of the state; it has also found its way for such purposes into California.

The value of the state's woodland forests is hard to estimate. They have furnished huge amounts of fuelwood and posts for the people of the state ever since man's first arrival. The pinon furnishes a valuable crop in the pinon nut both for local and outside markets. In the past few years cypress posts have been used extensively in right-of-way fences of many of the state highways.

Juniper seems to be accepted as the most valuable species in the state, if not in the west, as fence post material. It reputedly has the longest life of any of our local woods in contact with the soil. This is of course one requirement that a wood must meet to be most valuable as a fence post.

The woodland forest areas are used extensively as range for livestock. Aside from the value of the forage, the protection afforded by the forest is of equal value to the livestock, since many of these areas are used as winter range. The woodland forests are excellent winter range for deer, elk, and turkey. These species drift down from the pine forests when snow gets deep in winter. Juniper berries and twigs, and the browse species on the area make up the forage for game and birds.

Antelope like the open grassland but usually live along the fringe of the woodland areas so that they can have the protection and shelter the forest affords them from their enemies.

The woodland forests occur generally between 3500 and 6500 feet elevation. At this elevation the watershed values are high because of the greater amount of moisture that falls. Consequently water delivery from the woodland forest areas might be classed next to the sawtimber type from a water discharge point of view.

VII. Sawtimber Belt

The average citizen of the metropolitan and farm section of Arizona doesn't know too much about the sawtimber area of the state. There is roughly 4,774,000 acres or 6.8% of the total area in the sawtimber type. It is estimated that 722,000 acres have been cut over. Some of the areas cut over at an early date have already produced a second crop of saw logs for lumber.

In the state as a whole, over 100 tree species are found. Four of this number make up 98% of the volume of the sawtimber. Ponderosa pine (*Pinus ponderosa*) accounts for 82%, Douglas fir (*Pseudotsuga taxifolia*) makes up 10%, white fir (*Abies concolor*) represents 3%, and Engelmann spruce (*Picea engelmannii*) accounts for another 3% of the volume. The balance consists of Mexican white pine (*Pinus strobiformis*), cork bark fir (*Abies arizonica*), limber pine (*Pinus flexilis*) and others.

Of interest to the student, there are about 100 tree species found on the continent of Europe as compared to over 100 in Arizona alone and more than 800 in North America. This difference in variety of vegetation is explained by the fact that mountain ranges in Europe generally extend east and west and during the glacial period change in elevation prohibited plant migration following the ice cap as it melted. In North America the mountain ranges extend north and south, consequently vegetation easily followed the ice cap's retreat without the handicap that existed in Europe.

A small portion of the timber area is not available for cutting due to its isolation or extreme value for other purposes. Due to this fact an area of 3,607,000 acres is estimated to be commercial forest area. The amount of timber on this commercial forest is estimated to be 19,492,000,000 board feet of lumber. The volume of timber on the inaccessible and areas set aside for other purposes is estimated to be 1,301,000,000 board feet. Thus the total volume of the sawtimber is estimated to be 20,793 million board feet, a very large amount of timber indeed.

Considering value on the stump at \$3.00 per thousand board feet, this would represent a monetary wealth of \$62,379,000. This is even more important when you consider that this timber handled as a crop is renewable. By improving on nature the volume on this forest area can be increased. The Forest Service in harvesting the timber on National Forests selects trees from the forest that are mature and leaves the younger, fast-growing trees for the next harvest. By selective cutting the forest area cut is disturbed the least and the cover of the crown is opened only partially so sun and wind action is not too severe on the soil, thus the young crop is not subjected to a too sudden change that might retard its growth and development.

Since ponderosa pine represents 82% of the volume of our stand of timber, it warrants some discussion. This species is naturally made up of a forest of all age classes from very young seedlings, very dense thickets of reproduction, pole stands, young, thrifty-growing trees, to overmature forest giants often exceeding 30 inches in diameter and extending well over 100 feet in height. By growing close together, competition for light seems to cause the individual trees to grow up straight. The result is that the lower limbs die and are shed while quite small, leaving clear, straight boles that are reasonably clear of limbs oftentimes for 20 to 40 feet. This portion of the tree results in clear logs that produce knot-free lumber that brings extremely high prices.

Naturally many trees in the younger stages die from competition for plant food and light. At present this loss through death goes back to form litter on the forest floor and eventually returns to the soil as humus. This soil building feature is beneficial. However, this natural thinning of the stand is beginning to find its place in our economic structure. These poles have a decided use. One is in mines as stulls, props and lagging. Mining companies have found that our native ponderosa pine takes preservatives well and, once treated against rot and moisture, will last as long in mines holding back the earth as more expensive timbers shipped in from elsewhere. It is not too much to expect that greater use of this pole crop will develop, with preservative treatment, in such uses as fence posts, grape sticks and many other tasks performed by wood on farms.

If a market develops for this forest product the lumber crop could be greatly improved by thinning the dense pole stands. However, it is not felt that sufficient benefit is derived to warrant expenditure for this purpose alone, but if a financial return can be realized through beneficial use of the product it would be very desirable, since then the poles would be another useful crop.

Young ponderosa pine trees are called black jacks, due to the dark bark, while with age the bark turns yellow. The black jack has a pointed crown, while as it ages the crown becomes more rounded and later becomes flat. The older trees have long been called yellow pine because of the appearance of the bark.

The ponderosa pine forest extends in a continuous belt from the New Mexico line to the Grand Canyon of the Colorado, from an elevation of around 6000 feet to about 8000 feet along the general route of the Mogollon Rim. This belt continues north of the Grand Canyon, covering the higher reaches of the Kaibab Plateau. This belt is from a few miles to many in width. It has been described as the most extensive continuous stand of pine in North America. Sargent's Manual of Trees of North America is the source of this information.

However, stands of ponderosa pine are found in other sections of the state. They occur in practically all the mountain ranges that extend above 7000 feet elevation.

The live waters of the sawtimber areas are the fishing streams of the state. Here in the cool climate this elevation affords, coupled with ample shade and quiet, majestic beauty of the surrounding scenery, are ideal summer vacation lands that are hard to excel.

The sawtimber areas make ideal homes for game. The deer, elk, turkey and bear abound here. Aspen, oak, locust, mountain mahogany and many other shrubs and trees furnish ideal game forage. Squirrels abound in these woods. The Kaibab squirrel is found only on the Kaibab Plateau.

By managing game as a crop it can be perpetuated as it is decidedly a renewable natural resource.

Douglas fir and other species are found at higher elevations.

The sawtimber areas are located in the zone of highest precipitation in the state, and make the greatest contribution of water, since it is here that all the live streams have their beginning or source. This feature makes it doubly desirable to handle the timber as a crop and harvest it selectively, since this system disturbs the ground cover the least.