Multiple Use of Forest Land in Arizona particularly on the Sitgreaves and Apache National Forests and the Ft. Apache Indian Reservation of Northeastern Arizona by GILBERT A. GARDNER

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Approved: [Signature]
Professor of Forestry
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The forests of Arizona are truly Everyman’s Empire. One sixth of the area of the state is enclosed within eight national forests, extending over a domain of 11,420,278 acres. During 1946, the forests of Arizona produced over forty-four million board feet of lumber, taken from a stand estimated at over fourteen billion board-feet. Within these forests are watersheds, fabulous grazing lands, and limitless opportunities for recreation. Thousands of people go into our national forests each year to enjoy hunting, fishing, vacationing in God’s great out-of-doors.
INTRODUCTION

Statement of Study and General Information on Area Studied:

Probably no other region in America is so inextricably dependent upon the protective benefits of forests as the state of Arizona. It is unequivocally true that the rich agricultural, mining, recreational, and industrial economy of the state would become inoperative without the water which comes from the 19,538,000 acres of forests of various types.

Arizona is chiefly a range state, 62,000,000 acres of a total 73,000,000 acres being used for grazing. (1)

Elevation variations are wide, the optimum range conditions being on land between 3,000 to 5,000 feet, with the bulk of the lands being used on a yearlong basis. (1) However, as the vast differences in topography and elevation are more marked in Arizona than any other state except California (2), the resultant differences in vegetation from sub-tropical to cold northland types makes impossible the support of static numbers of range animals on some areas.

A large portion of the state's range is within the watershed areas. (1) Erosion, water run-off, silting, and conditions of forage are all partially controllable by proper livestock management of forest areas devoted to grazing.

Revenues in 1945 from livestock production included
$29,000,000 from beef cattle and $3,000,000 from sheep, considerably more than from any other single product obtained from the land except that from cultivated crops.

More than one-quarter of the land area of Arizona is classed as forest land. Practically all of this land is publicly owned, about 1% being private property. The arc of forest lands runs through the state from the northwest to the southeast borders.

Woodlands compose about 80% of the forest, mostly several species of juniper, Arizona cypress, pinon and oak occupying the foothills and lower mesas at elevations of from 4,500 feet in the case of the evergreen oak type of southern Arizona to 7,000 feet altitude. The principal type is juniper and pinon occurring between 5,000 and 7,000 feet where annual precipitation approximates 14 to 19 inches per year. (3)

The woodlands support mostly fuel, fence posts, and a growing pinon nut business along with grazing, recreation, and other related uses.

Sawtimber, predominately ponderosa pine with Douglas-fir, white fir, and Engelmann spruce as associates, grows on approximately 5,000,000 acres. The best sites are above 7,000 feet, the maximum elevation for best growth being near 9,000 feet. There are some 40 sawmills in Arizona which produce an average of 116,000 M. feet board measure of lumber per year. The sawmilling industry is the major support for Flagstaff and McNary.
Following is a table showing ownership and volume of sawtimber available for commercial use: (3)

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
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<tbody>
<tr>
<td>National Forests</td>
<td>3,072,000</td>
<td>13,842,000 M.ft.,B.M.</td>
</tr>
<tr>
<td>Indian Reservation</td>
<td>1,455,000</td>
<td>5,500,000 &quot;</td>
</tr>
<tr>
<td>State</td>
<td>31,000</td>
<td>32,000 &quot;</td>
</tr>
<tr>
<td>Private</td>
<td>62,000</td>
<td>68,000 &quot;</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>4,620,000</strong></td>
<td><strong>19,492,000 M.ft.,B.M.</strong></td>
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</tbody>
</table>

600,000 recreationists and 2,000,000 travelers visited forests in Arizona in 1940. (1) Many villages and towns are almost wholly supported by recreationists, being dormant during the off-seasons.

Many varieties of game are found in Arizona’s forests. There are 10,000,000 acres of National Forest lands open to hunting. Indian lands, although not as freely open to vacationists and sportsmen as National Forest lands, serve the double purpose of a game refuge for adjoining lands and are also open under special permit privileges, seasonally, to hunting and fishing. These resources are a large factor in contributing to the social and economic welfare of the state.

Irrigated lands, such as those in the Salt River valley, one of the richest crop producing localities in the United States, are held in extremely delicate balance by water and protective vegetation sustained by water from the higher levels. The desert literally reverts to its previous and natural condition overnight. 800,000 acres (1) are irrigated in Arizona on land that was formerly desert waste. $160,000,000 worth of cash crops, including lettuce and other truck crops, citrus
fruits, cotton, small grains, and seed crops mostly marketed outside the state, were produced in 1946. (3)

Land ownership in Arizona may be roughly divided into seven parts, of which two parts are Indian reservations. Another two parts are public domain under control of the Federal government, part of which are divided into four grazing districts. The remaining three parts are state-owned lands, National Forests, and privately-owned lands, one part comprising each. (3)

The scope of this study is, admittedly, broad, but the forest lands of Arizona must be conceived as an integrated whole. No single forest produces sufficiently numerous or valuable products to make it of outstanding merit. Together they control to a large extent the returns already mentioned. These returns in order of outstanding value would probably be: (1) water-shed protection for agriculture and grazing and for municipal uses; (2) timber production for local use and export; (3) recreational facilities in easy access to all parts of the state, including 728,000 acres of wilderness; (4) miscellaneous and intangible benefits common to all forest areas.

AREA STUDIED

This report is primarily concerned with the multiple benefits received from forests centered at McNary on the Apache Indian Reservation. The Sitgreaves and Apache National Forests, which adjoin it, with the Apache Indian
Reservation, have supplied the Southwest Lumber mills at McNary with volumes of timber approaching 200 M. ft., B.M. per day for many years. This timber is all on a continuous use program. Several small mills with capacities of production averaging 10 to 20 M. ft., B.M. per day are sustained on the two National Forests. Indian needs are mostly self-supplied by the agency-operated mill at Whiteriver.

In addition to timber products, much has been added to the local economy by recreationists and small land-owners, ranchers, and stockmen, all in varying ways dependent on the forest.

**REASONS FOR MAKING STUDY**

The reasons for the reporting of the typical pine forest economy are two-fold. First, Arizona's forest use is not generally well-known. Secondly, it is an opportunity to write from personal observation, and to analyze the worth and possibilities of a forest of many uses.

**METHODS OF MAKING STUDY**

All information obtained in this thesis has been obtained through correspondence with the various Forest Service headquarters, Southwestern Forest and Range Experiment Station and the Agricultural Experiment Station at Tucson, Arizona Game and Fish Commission at Phoenix, and from published information obtainable in the libraries here at Oregon State College. Occasion-
al expansion and additions have been made from personal observations and experience of several years spent in that locality in forestry work.

WOODS OPERATIONS

Use Standards:

All woods operations of any size are under supervision of and responsible to the control of the Forest Service, or other Federal agency, policies. Although much better utilization of inferior species such as white fir was instituted in the war years, and subsequently held over because of good marketability, the policy has been to mark only those trees which could be handled at a profit to the manufacturer.

Ninety percent of all timber cut is ponderosa pine. Following is a table showing the average grades that can be obtained from ponderosa pine in that region. (3)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
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<tr>
<td>Clears and Selects</td>
<td>8 percent</td>
</tr>
<tr>
<td>Shop</td>
<td>9 percent</td>
</tr>
<tr>
<td>No. 1 &amp; 2 Common Boards and Dimension</td>
<td>14 percent</td>
</tr>
<tr>
<td>No. 3, 4 and 5 Common</td>
<td>29 percent</td>
</tr>
<tr>
<td>Ties and Timbers</td>
<td>16 percent</td>
</tr>
<tr>
<td>Box</td>
<td>24 percent</td>
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Improvement Techniques:

George W. Kimball, acting regional forester at Albuquerque, N.M., in a memorandum for forest supervisors, "Markets for minor products are available on several forests, and potential markets on others. Minor
forest products can be cut and are being cut from trees in the pole stage. Sales of minor products provide a way to accomplish real stand improvement by disposing of material not desirable for retention in the stand through commercial sales and through uses, thus improving the stand and at a saving of cost." (4)

Many summer homes and cabins for tourists are being constructed from pole size crop trees up to 11 inches d.b.h. In addition, stand improvement techniques are employed in logging operations wherever possible. (4)

Most of the stand improvement work has been done on a project basis, using men employed by the emergency appropriations administrations, examples being thinnings and prunings done by the Civilian Conservation Corps and the Indian Emergency Conservation Works. Local demand, sales under Forest Regulation S-22, and other commercial sales afford opportunities to secure similar results if economically good business from the buyer's standpoint.

Crop tree selection is the basis for stand improvement when working areas in the pole stage. Future cutting plans determine the number of stems to leave. That is, a heavier residual stand is left when mine props, stulls, or hewn ties are to be cut than when sawtimber is the final crop. Provision is also made for losses from natural causes.

Pruning of trees below 11 inches aims to increase the quality of the final crop and to protect the portion of the tree pruned from future red rot (polyporus ellis-
Pruning may often be done in conjunction with pole sales or as part of the job of working other stands on the same area. It is, "a relatively cheap operation and offers a big return on investment in labor." The aim is to prune the first log; however, the length pruned is determined by the portion of the stem covered by dead, dying, or diseased limbs, or those having the appearance of shading out. Green limbs which, if pruned, will reduce the living crown and thus retard growth should not be removed.

The principle of improvement selection cutting as outlined by G.A. Pearson (5) has as its goal the creation of a better growing stock with every successive cutting. This flexible method of marking trees for cutting considers the existing growing stock as forest capital, volume and capital increment of all the growing stock being the basis for removal of individual trees. Inferior trees because of disease, form, vigor, or competition from other, more desirable boles are removed wherever practicable.

Ownership:

Because the timber of the southwest is all slow growing and sparsely stocked, economic returns per acre are low compared to other forested areas such as the Pacific Northwest and South.

The public, rather than any individual, is the large recipient of most of the capital returns. This condition makes public ownership the best practical foundation for forestry in this region. (6)
Large buyers of timber who own extensive transportation systems such as those of the Southwest Lumber Mills at McNary are alone financially capable of carrying on continuous production of forest products.

It is often necessary to traverse poorly stocked stands at a financial loss in order to reach merchantable timber that will return a profit on the large investment in railroads, rolling stock, and other logging equipment and roads.

5,000 ft., B.M. per acre is considered a minimum average volume to make operations economically practical.

**Equipment and Logging Methods:**

The pine and pine-Douglas-fir types of northern Arizona are particularly well-adapted to the use of cat-skidding and arching. The stands are open and little damage is done to reproduction if skid trails and landings are well-located.

Skidding of all logs lying within 300 to 400 feet of roads and arching logs up to 2,000 feet has proven to be the most practical method in operations of sufficient size to pay for the investment and depreciation of equipment.

From landings located at regular intervals along truck roads, self-propelled, tracked loaders of the gasoline-powered shovel, single-tongs type systematically follow road construction from one cutting area to another. Trucks haul logs either directly to the mill or to a railroad cold-deck.
At present, Southwest, only large lumber mill in Arizona, is operating trains on more than fifty miles of track and is continuously expanding to reach hither-to inaccessible stands of virgin timber.

Small mills use a variety of combinations of equipment which usually and most practically consist of small tractors for skidding and loading and trucks on a contract basis for hauling to the mills. Horses are also used for skidding small logs.

Recently gasoline power saws of the chain type have been used to very good advantage for felling and bucking on the larger operations. Their value is greatly enhanced by providing instructions to fellers in their use and by employing a good overseer to give advice in use technique and to maintain the saws in good mechanical condition.

**Slash Disposal:**

The fundamental factors determining slash disposal methods and degree of slash disposal in ponderosa pine forests are, "volume and distribution of slash, degree of fire danger, silvicultural influences, economic aspects of disposal, and aesthetic values involved." (7)

Fire danger, along with the silvicultural effects caused by slash burning are the primary factors to consider in deciding upon the method and degree of disposal.

Fire danger, in a particular area, will vary with
the climate, quantity and character of inflammable material with the slash, accessibility of the area, presence of logging operations, and proximity of timberlands not protected from fire. (7)

Where old roads, gullies, or other openings in the forest floor afford an opportunity, scattering of slash is recommended. The material left in this manner promotes absorption of water and inhibits erosion and heavy run-offs. The scattering of slash has only a temporary effect, however, and can not be considered a substitute for proper silvicultural procedure along with good management of grazing and restriction of cutting.

Most slash disposal work, especially in the area with which this paper is concerned, is done on a contract basis. Navajo Indian crews, supervised by a contractor, pile brush after logging at a set pay scale per top. The slash is then burned in winter months or in the wet summer season as conditions dictate. Local conditions and variations in requirements for slash disposal control the degree and method of slash disposal.

Fire Protection:

The necessity for a coordinated program of fire protection work is self-evident. Lumber company woods crews cooperate with forest officials in providing fire-tool boxes, available man-power for suppression work, special fire-fighting equipment, and in prevention and detection work. It is necessary, if woods operations
continue throughout hazardous seasons, for private employers to take all necessary precautions at work and in public relations in order to insure continuous production. The sawmills depend for most of the winter's output of lumber on logs hauled during the dry, hazardous months of summer.

**Road Construction and Maintenance:**

Logging roads in this area require careful planning before construction begins. Length of roads is comparatively greater than those needed in the dense stands of the Northwest. The public road systems are of small use to loggers, being relatively few and missing the obstructive character of the forested localities. Disregarding the temporary, emergency measure of access roads built at Federal expense, the large hindrance to logging is the cost of building and maintaining extensive truck and rail transportation systems. Marketing centers are also reached at much expense in transportation.

The use of aerial photographs has proven to be a valuable aid to road location, mostly by showing inaccessible, poorly stocked areas, thus obviating the difficulty of making intensive ground surveys in those tracts.

Land surveys in the forest regions are, at best, incomplete. No topographic maps accurate enough for complete road planning are available. This necessit-
ates much field examination to obtain sufficient accurate information for logging plans. Typically, two to four engineering crews performing the variety of tasks necessary for good road building are employed by Southwest in order to log 150,000 to 200,000 ft., B.M. per day.

The compensating feature of road building is that much level ground with few obstructions is traversed.

Good foundation for roads is nearly always to be found, and cinders for fills and surfacing are easily obtained in this soil of volcanic origin.

It is of utmost importance to keep roads in good condition. Long truck hauls of twenty to thirty miles, all on company-built roads, prevent making more than three to four round trips per day with optimum road conditions. Costs of logging are very greatly reduced by preparing and also maintaining smooth, hard road-beds. To insure a continuous flow of logs to the mill auto patrols, cinder trucks, and labor crews under competent supervision must constantly give attention to surfacing, culverts, bridges, cattle guards, and general condition of the roads.

MILLING

Utilization:

In normal manufacturing, utilization standards for pine lumber and minor products, box shook, lath, molding, etc., are largely determined by demand.

Kiln-dried and yard-dried lumber stock piles are
kept in balance with orders for finished products thus supplying a continuous flow of stock to meet a diversified demand.

With planing, molding, and box departments well-coordinated, the only waste material is that placed in "hogs" to be burned for power.

Small mills, having no remanufacture machines, sell clear material to those companies set up to handle finishing work. Where milling is done on a close cost margin, grading must be carefully supervised to obtain the best possible price.

The good utilization of timber which varies so widely in quality, often being knotty and defective, begins with proper felling and bucking in the woods. Reaching sawing, edging, and trimming processes on the green-chain, good techniques and knowledge of possible end products can greatly enhance the value of seemingly valueless logs.

Waste Disposal:

Sawdust and most slab material and trimmings has usually been burned as fuel for steam power to run mills and to power electrical plants.

There has been very little market for hogged fuel, sawdust or slab wood except that used by company employees.

Generally, excess sawdust is burned or merely allowed to deteriorate in piles or after spreading.
Fire hazard from burning waste material is a constant source of fire danger to mills. One owner of a small mill has, during a period of twenty years, survived the loss of three mills through careless use of fire in the burning of waste. Surrounding areas are also susceptible to loss from fire started in refuse piles.

Many experiments in search of a logical use for sawdust have resulted in little or no progress. Fuel supplies are adequate for small communities without installation of sawdust burners, and transportation and handling costs to large communities are prohibitive.

One recent building-block development uses a considerable amount of sawdust mixed with adobe clay and cement but may hardly be considered a large factor in waste disposal.

Some attempt has been made to use first-grade slabbing material for log-cabin siding. Insufficient demand and poor quality makes its use insignificant.

Utilization of dead material from snags for building purposes has met with increasing favor. Its best adaptation has been in laying walls of 3" by 6" material, followed by stuccoing.

Installation of plants to utilize waste would be met with a ready and adequate supply of wood left after logging and milling.
General Milling Methods—Southwest Lumber Mills:

Power comes from steam produced by burning mill waste. Head saws and heavy trimmers, edgers, and the green chains are powered by steam directly.

An adequate electric power plant, also run by steam, furnishes a steady source of power for molding machines, planers, and other small finishing machines.

The town of McNary with a population of approximately 1,000 persons, all dependent on work in lumber production, also receives power from the mill, only adequate and steady source of electricity in this isolated section of the state.

For continuous winter sawing of lumber, a large mill pond is a necessity. Winters are severely cold and wet at altitudes over 7,000 feet. Snow and soft ground often halt woods operations for several weeks during the winter months. Logs are frequently completely frozen, thus making sawing impossible. A large mill pond serves the double purpose of storing the excess logs hauled in good weather and of keeping stored logs from freezing during the winter operations.

For the same reason large lumber yards are important in keeping stock on hand for remanufacturing and marketing continuity.

SMALL MILLS

Personnel:

Small mills are often manned by fewer than ten men,
ordinarily averaging a cut of 10,000 ft., B.M. of structural lumber, ties, and timbers per day.

Transient workers and local, seasonal labor are usually available to supplement regular personnel which is largely made up of family-owners of the mill.

**Stability and Economic Responsibility:**

Availability of Forest Service or Indian timber is the main factor in keeping small mills on a continuous basis. Long distances of transporting logs after an original circle surrounding the mills has been cut often causes such large overhead expenses that mills must be moved or shut down.

This condition, arising from the fact that timber stands are sparsely stocked, is the main deterrent to any but small, portable mills.

A relatively large investment in equipment for logging, sawing, and transportation is a hazard to good economic security for small mills. Markets are distant for trucks and rail communications are not conveniently available. Some alleviation of these difficulties is possible with closer cooperation between small owners.

Regular, cooperative marketing, transportation of lumber to markets, and the establishment of remanufacturing plants to supply local demand would all have a beneficial effect.

**Future of Mills--Comparison of Small and Large Mills:**

From the present lumber manufacture will become
an increasingly difficult venture. Virgin stands of timber are few and of minor importance compared to the volume of timber and acreage already cut.

Small mills, allowed to encroach upon timber during the war which was originally reserved under a longer cutting cycle, are being forced to stop operating or to move to new locations. Even with optimum economic conditions small operators have been very restricted. Only the most efficient, cooperative, well-planned lumber producers will be capable of surviving dwindling timber supplies and keener competition.

A large mill such as Southwest will be in a better position to continue operations since options on large tracts of timber and established railroad systems for logging, marketing, and hauling mill and woods supplies have been established.

The outstanding difficulty to the practice of forestry and manufacture of wood products has been the low volume of timber available in reach of well-situated mills. Since approximately fifty percent of the original stand is removed in this first cut, and since the timber grows at a slow rate, the problem will become increasingly critical until only the best competitors remain.

The use of small, efficient, portable sawmills might possibly provide a means of reaching remote stands, previously considered inaccessible to logging. Better public roads to markets will also be an aid in
reducing costs.

GRAZING

In a short distance the vegetation of Arizona's range will change from creosotebrush or other typical desert shrubs, and with increasing altitude, to juniper, pinon, ponderosa pine, aspen, Douglas-fir, and white fir types.

Rainfall increases, in general, directly with altitude. Thus desert range is limited in use by lack of water, and the higher elevations, being wet enough, are subject to low temperatures and a short growing season. The balance exists in moving stock with climatic changes.

The forest areas, because of climatic conditions, are grazed only during the summer and early fall, usually 90 to 120 days.

Conditions for grazing vary from very good to poor, often on the same area. The key to proper livestock management is in determining the proper number of animals to graze on any particular area with varying year to year conditions.

RECREATION

Recreationists find many opportunities to pursue a variety of interesting and pleasing diversions in the forests here.

Following are a few outstanding recreational values:

To escape hot summer weather, always a factor of
discomfort in the desert, requires only short trips to forested areas. Forest outings have a health-saving value of great importance to southern Arizonans.

Wilderness areas, 728,000 acres in Arizona, are set aside to perpetuate primitive forest conditions for recreationists and research. (8)

There are 500 miles of fishing streams on these National Forests, along with many lakes and reservoirs restocked from state and Federally operated fish hatcheries each year.

Common sense protection of game has built up a fine range for deer, elk, antelope, javelina, bear, and wild turkey, an estimated 11,000 of the latter in Arizona comprising one of the last vestiges of a once common game bird. (9)

Recreational facilities and opportunities are generally equally good on all National Forests in this locale. Indian Reservations are, of course, somewhat more restricted to vacationists.

**SUMMARY & RECOMMENDATIONS**

Water is of first importance in management of any forested area in Arizona. The balance of vegetation and soil must be maintained and, wherever possible, increased.

Timber production, while of importance, will decrease as original virgin stands of ponderosa pine are cut. The more efficient mills will be able to
to continue operations, but "shoe-string" operators will probably be forced out of business.

With the advent of good roads and accommodations for the tourist, recreation will continue to increase, possibly until it is of first importance to forest management policies. Resorts, sanatoriums, guest ranches, and general tourist business have already gained a place of major significance in Arizona's economy. More and more people will find their way to the splendid vacationland of the forest.

In concluding I would make the following recommendations as a guide to future forest management in this area:

1. Continued and increased protection of watershed which would include the building up of denuded grazing ranges through good livestock management and the construction of check dams in eroding drainages; the restriction of timber cutting on all but the better more fully-stocked stands which would reduce the number of economically unsound lumber producers, permit better utilization of the other plus values of the area, and control water run-off better; establishment of better public relations contacts with lumbermen, stockmen, farmers, and tourists to reduce man-made fires and generally improve cooperation.

2. Construction of many more camp sites, opening
of parks, and general betterment of facilities for
tourists, summer camps for young people, and facil-
itation of recreation in all its phases.
3. The further opening of forested lands to home
owners or small operators of tourist accommodations
to raise the generally poor standard of living in
those communities on an almost exclusive forest
economy. This would also include the provision for
equitable use of grazing lands for small ranchers and
farmers.
4. Fuller utilization of woods waste and the favor-
ing on all sales of those operators who add most to
the local economy and who can most efficiently util-
ize the resources of the forest.

Finally, with a multiple-use pattern in exist-
ence on a forest, the analysis of the best method of ob-
taining all the benefits possible from any given condit-
ion requires careful consideration. Each area contains
specific problems which must be solved in order to prom-
ote the fuller, more productive, continuous well-being
of the people involved and of the over-all economy.
(1) Barr, George W. Arizona’s Agricultural Wealth. Agricultural Experiment Station Bul. 205, Oct., 1946.

(2) Cooperrider, C.K. The Relationship of Stream Flow to Precipitation on the Salt River Above Roosevelt Dam.


Fig. 1 Log Pond & Sawmill Southwest Lumber Mills, Inc.
Fig. 2. Typical Pine Stand in Arizona
Fig. 3. Cut-over land at 8,500 ft. elev. Aspen, Douglas-fir, & pine are often associates.