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GRAZING AND REFORESTATION

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Grazing in its relation to forest regrowth presents a problem which is just beginning to be appreciated by American foresters and is almost unheard of by the public. Until recently it has been regarded as a local matter peculiar to the Southwest; but as more information comes from other regions, it grows more and more evident that we have to deal with a condition of widespread occurrence. Although nearly all forest lands are concerned, this discussion will deal primarily with the timbered areas of the national forests, because the time is ripe for meeting the situation on the national forests, and because grazing interests are now striving to obtain concessions from Congress which, if granted, would seriously hamper forest management.

That browsing by livestock is capable of destroying or seriously injuring young forest growth is no longer questioned by foresters. Yet there is wide difference of opinion within the profession as to the gravity of the situation and as to what remedies are needed and economically justified. The dictum of European forestry that grazing and timber culture are incompatible has been directly challenged. In the administration of the national forests there has grown up a new school which teaches that, contrary to European experience, grazing and forestry may go hand in hand without endangering the latter. It is natural that this idea should appeal to forest administrators in the West, where most of the permittees are graziers, especially in the pioneer days of forestry when it was believed that the very existence of the Forest Service depended upon maintaining the good will of forest users.

The wide divergence between the two schools, one of which sees antagonism and the other harmony between grazing and forestry, may be accounted for partly by the interests and associations of individuals, and partly by actual differences in the conditions encountered.

The attitude of the individual forest officer is likely to depend much upon whether his experience has brought him more closely in contact with timber growing or with stock growing. What a man observes for himself, his reaction toward what he sees and hears, and the natural trend of his reasoning are influenced by his immediate interests and general background of personal experience. When it is

considered that of the entire Forest Service personnel those whose major duties are in grazing or general administration are more numerous than those directly concerned with timber growing, it is easy to understand why there should develop a point of view at variance with that of the dyed-in-the-wool silviculturist.

Grazing damage is influenced by many local conditions such as the character of the range, number of stock, and conditions affecting the growth of trees. It is now generally conceded that when there is an abundance of good forage for all stock on the range, young trees are less likely to be browsed than when the feed is short. Another important factor is the density and growth of tree seedlings. With a stand of 50,000 seedlings per acre the chances that 2,000 may survive are better than if we start with only 5,000. If appreciable numbers spring up every two or three years, the chances are better than if the interval is twice as long. If seedlings make an average annual height growth of six inches during the first ten years, a greater number are likely to get beyond the reach of stock than if the growth is only two inches a year.

THE STRUGGLE BETWEEN THE FOREST AND GRAZING

With such a variety of conditions as are encountered in the United States, generalizations must be used with caution; yet in the maze of apparently conflicting observations one fact stands out as a basic principle. Full crops of timber and forage can not grow on the same ground at the same time. The two may thrive side by side for a few years, but sooner or later one or the other must decline. Wherever there are forests and grazing animals there is conflict. The fact that this conflict assumes different aspects in different regions does not alter the essential facts. Where conditions of climate and soil are favorable for tree growth, it is usually the forest that prevails. Very little forage can grow under a stand of trees which approaches full stocking. This is the reason why little is heard about grazing damage in the most heavily timbered sections of the country. It is only with the aid of fire or lumbering that grazing can gain a foothold in these forests, and without these allies it can seldom maintain itself long. But go to regions of less vigorous forest growth, and the tables are turned. Even under these conditions the forest undisturbed by fire and logging may hold its own, but with the aid of these agencies grazing gains the upper hand and holds it.

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GRAZING DAMAGE IS USUALLY UNDERESTIMATED

The areas subject to damage by grazing are more extensive and widespread than is generally supposed. In the writer's opinion much damage is taking place which is not recognized or is not given due weight. The reason for this is that foresters generally, to say nothing of the public, are not trained to detect damage to very young seedlings, and they have a faulty conception of what constitutes satisfactory reproduction. Coniferous seedlings bitten off during the first two years of their life usually disappear entirely and, unless detailed examinations have been made, there will be no record of their having existed. What is often taken for good stocking of young timber is in reality understocking. Mature stands are often used as a standard of density for reproduction, disregarding the well known fact that young trees must be closely spaced in order to produce the straight, clean stems needed for saw timber.

The real test of reproduction comes after logging. Fortunately, many of our mature stands have "advance" reproduction or young growth in the open spaces between the old trees. When this condition prevails the problem is much simpler than when there is little or no advance reproduction. Even under the former conditions, however, there will be considerable bare spaces after the old trees are removed, because seedlings seldom grow directly under a dense canopy, and besides the young growth will be broken down by logging on large portions of the area. Except under unusual conditions, as where large quantities of seed are stored in the leaf litter, or where a large number of seed trees are left, reproduction after cutting is slow. In the Southwest, yellow pine, Douglas fir, and Engelmann spruce require from 15 to 20 years on the average to restock after cutting. In more favorable regions the period is shorter, but even there grazing needs to be closely guarded.

Although the need for reproduction is most apparent directly after logging, it may be almost as great in virgin stands. Because of the slowness with which western yellow pine restocks, advance reproduction of this species is now advocated throughout most of its range. Advance reproduction not only facilitates restocking after cutting, but it is needed in order to utilize idle land and build up the younger age-classes in mature stands some of which will not be cut for fifty years or more. Our virgin forests throughout the country are generally far understocked. In Arizona where average stands of yellow pine on good sites yield only from 8,000 to 15,000 board feet per acre, fully stocked

plots carry from 40,000 to 50,000 board feet per acre. Shaw has found a similar relation in California, with the difference that there the volumes run much higher than in Arizona. The light stocking of mature stands is generally due to the failure of young growth to replace the old trees which are continually dropping out from various causes. Normally, the space given up when a tree dies is promptly occupied by the expansion of its neighbors, or by young trees. But if fires run over the ground every few years there may be no young trees to fill the gaps. Where fires have occurred periodically for a hundred years or more, we usually find open spaces from 50 to 200 feet in diameter between groups of trees. In many forests these openings occupy more than half of the total area. In California and in parts of Arizona and New Mexico they have restocked following the exclusion of fire during the last twenty years; but on extensive areas in the latter two states reproduction is still lacking. Recent investigations have shown that in most cases these failures are due to grazing damage.

INVESTIGATION OF THE GRAZING SITUATION

Because of the fact that the grazing problem has been more exhaustively investigated in the Southwest than elsewhere in this country, it is believed worthwhile to present some of the findings in that region. While it is realized that conditions may be vastly different in other regions, yet there are certain relationships which are likely to be the same wherever stock graze in the forest. What has happened in the Southwest can happen elsewhere unless the situation is kept well in hand. Whether or not grazing is a problem in any locality need not be a matter of conjecture, for it can readily be determined by investigation.

Annual seedling counts on the Coconino and Tusayan National Forests, supplemented by general observations on other forests in Arizona and New Mexico, give a fairly complete history of yellow pine reproduction in this region since 1907. In the following accounts cattle range refers to areas grazed by cattle and a few horses, but no sheep; sheep range refers to areas grazed by sheep and also by cattle and horses. There are practically no ranges in this region which are grazed by sheep exclusively.

Examinations on the Coconino and Tusayan in 1908 showed fine stands of seedlings and saplings on considerable areas. These were mostly either ten or twenty-six years old, the result of unusually high germination, about 1898 and 1882. Remnants of these age-classes,

usually damaged, were found on most of the unstocked and poorly stocked areas, indicating that they were once of widespread occurrence. Making due allowance for fire, it is estimated that these two age-classes were more or less completely destroyed by livestock on approximately one-third of the area originally covered. The same classes have since been identified on the Prescott, Sitgreaves, and Apache Forests, but no estimate has been made of the damage. Scattering seedlings of younger ages were also found in 1908. These were generally damaged and have since disappeared, except in a few localities.

In 1910 considerable numbers of 1907 and 1909 germination appeared in places. There were heavy losses from natural causes, but a few survived and they were practically all eaten by stock.

In 1914 stands varying from light to heavy sprang up pretty much all over Arizona and New Mexico. Some excellent reproduction of this age-class remains on the Santa Fe and Sitgreaves. On much of the sheep range on the Coconino, Tusayan, Apache, and Sitgreaves, it was practically wiped out. In the midst of the worst damage, fenced areas grazed only by cattle and horses are now well stocked. This is also generally true of open cattle ranges.

A light stand started in 1917. It was exterminated on sheep ranges, but a few survive on cattle ranges and on ungrazed plots.

The year 1919 brought what was probably the best and most extensive seedling crop on the Colorado Plateau since 1882. On sheep ranges at least half is gone, and most of the remainder is severely damaged. On cattle ranges from which sheep are excluded there is considerable damage in certain localities, but on the whole it is much less than where sheep are permitted. Very few seedlings have started on the Coconino and Tusayan since 1919.

From the foregoing it appears that sheep are the worst offenders, although the situation is complicated by the fact that we have no ranges grazed by sheep alone. Damage by cattle is usually confined to areas of heavy overgrazing, especially in the vicinity of water holes and other places of concentration. Next to proper stocking on the range as a whole, the problem with cattle is to obtain proper distribution. Cattle should not be allowed in the forest between late fall and spring, especially when the ground is covered with snow.

Grazing may be beneficial in checking the growth of herbaceous vegetation which competes with young seedlings for moisture and light. Unless excessive browsing can be avoided, however, forest reproduction

is better off with no grazing, because it will usually succeed in spite of competition with herbaceous vegetation.

The benefits from grazing in reducing fire hazard in the Southwest have been generally over-rated. Cattle grazing does remove a large amount of inflammable material; but sheep grazing is much less effective because sheep do not eat the tall bunchgrasses. To remove enough of the ground cover to prevent rapid spread of fires usually requires overgrazing with its attendant ill effects on forest reproduction and soil. Moreover, the worst fire danger is in logging slash or in young stands of trees where the ground is covered with leaf litter.

Grazing does not appreciably favor germination by trampling seeds into the soil, as is commonly supposed. Nature takes care of this by the checking and heaving of the soil. Tramping by stock is decidedly detrimental in wet weather, in that it packs and puddles the soil. At such times seedlings are also destroyed by tramping, although ordinarily they are very resistant to this form of abuse.

According to grazing specialists, excessive damage to forest reproduction is usually associated with overgrazing. This apparently applies to cattle grazing, but does not promise a practical solution to the sheep problem in the Southwest. The theory that stock do not eat forest seedlings unless starved to it assumes that seedlings are distasteful or at least are not relished. There is much evidence to indicate that not infrequently sheep prefer seedlings to grass. It is a common observation that pine seedlings are defoliated when the coarser bunchgrasses, such as *Festuca arizonica*, are practically untouched, and the better bunchgrasses, such as *Muhlenbergia gracilis* and *Blepharoneuron tricholepis*, are but lightly grazed. Severe damage has been found even where the leaves of such excellent short grasses as blue grama (*Bouteloua gracilis*) and black sporobolus (*Sporobolus interruptus*) stand two inches high and many seed stalks remain. White fir (*Abies concolor*) is eaten in preference to yellow pine. The only coniferous species which have been found to be immune in the Southwest are the junipers and in less degree the blue spruce.

It should be added that the liking of sheep for pine and fir seedlings is not always evident. Sometimes, even where the better forage is short, the seedlings are almost ignored and again under similar or better forage conditions they are stripped of needles. Perhaps there is something in the suggestion often made that sheep crave a certain amount of "browse" which is absent from many of the southwestern ranges. It is also probable that their appetite varies from time to time.

On the whole their behavior has been such that they are not to be trusted. No doubt a reduction in numbers to a point where only the very choicest forage is demanded would decrease the damage. This does not mean that the appetite for pine would disappear, but rather that one sheep would eat fewer seedlings than three or four. With a stocking of about one sheep to 30-40 acres, perhaps the damage would not be intolerable. Where reproduction has taken place on sheep range in the past, it apparently has been with this kind of stocking combined with unusually favorable conditions as to seed supply and moisture. Whether the adoption of such a standard of forage utilization would be effective and acceptable to stockmen remains to be determined. From the forester's point of view exclusion of sheep, together with rigid control of cattle, offers the only safe remedy. It is not my desire to discourage investigations, but it seems questionable whether natural reproduction on millions of acres of pine land should be left at the mercy of sheep, pending the results of further experiments which may have to run another twenty years.

THE INCOMPATIBILITY OF FORESTRY AND GRAZING

There is no good reason to believe that the problem of adjusting grazing to silviculture can be more successfully solved in this country than it has been in Europe. Contrary to the usual impression, grazing is not prohibited in all European forests. This is because of the existence of ancient grazing rights and mixed ownership of land, which often render the forest administration powerless to exclude stock. It is not likely that European foresters who have struggled with this problem for centuries have overlooked any opportunities to obtain relief by proper management of stock. Their conclusion that grazing and forestry are fundamentally antagonistic is not a mere dogma but a conviction based on generations of experience. European literature on this subject shows some disposition to tolerate cattle grazing under rigid restrictions, but sheep and goat grazing are universally condemned. In Sweden it is considered better to sacrifice timber growth entirely on certain areas than to allow livestock the run of the forests. For this reason selected areas well adapted to forage production are set aside for this purpose, and subjected to very intensive grazing management including proper stocking, reseeding, and even fertilizing.

The idea prevailing in this country that grazing and forestry can flourish side by side without conflict has probably grown out of the fact that the forests in which grazing is important are of an open character,

and it has been assumed that this is a natural condition. As has already been explained, this is usually an artificial condition brought about by fire and often perpetuated by grazing. In the Southwest there are many thousand acres of open spaces which have lain vacant for fifty years or more, but which under real protection against fire and grazing damage are now restocking. This of course does not apply to areas unadapted to timber growth, such as the large prairies, parks, and wet meadows, but it does apply to nearly all of the small open spaces within stands. It is legitimate to utilize the forage which grows in these openings so long as it does not seriously interfere with forest reproduction. But the success of the livestock industry in the forest depends upon preventing reproduction, because when trees take possession of the soil there can be but little grazing. As foresters it should be our aim to stock every acre of potential timberland so completely that it will produce a minimum amount of forage.

RELATIVE RETURNS FROM FORESTRY AND GRAZING

There is a deep-seated notion among foresters as well as grazing men that where grazing is an established industry forestry must not interfere lest it cause economic upheaval. Curiously enough, this idea prevails in some communities where the lumber industry contributes far more to local business than does the stock industry. In the yellow pine type of the Coconino National Forest the fees received from grazing are about two cents an acre annually, whereas the annual increment in a fairly stocked cut-over stand of yellow pine at average current stumpage rates is worth 30 cents an acre. Translating annual growth of forage and timber into returns to the community, as represented by the f. o. b. selling price of cattle, sheep and wool on one hand, and lumber on the other, the values are less than \$1.00 an acre for the forage crop, and \$3.00 an acre for the timber crop. In regions where timber grows more rapidly, the differential in favor of the timber crop is still greater. The Coconino National Forest has about 600,000 acres of productive and accessible timberland. Under a crude system of forestry which does little but practice conservative cutting and provide effective protection against fire and grazing, this land is capable of a sustained annual yield of at least fifty million board feet of timber, which will support a permanent lumber industry worth a million and a half dollars a year. The livestock industry on this same land, under present conditions, can yield less than half a million dollars a year. If the forest were clear cut and the land devoted entirely to grazing, it

might, under proper management, be capable of twice its present return; but under intensive management the yield of the forest could also be doubled, and a still further increase will doubtless come from rising timber prices.

According to figures by the Arizona Industrial Congress, the value of the lumber industry in Arizona in 1925 was about five million dollars, and corresponding value of the cattle and sheep industry was a little less than fifteen millions. The saw-timber lands occupy about seven per cent of the total area of the state. Nearly all of this area, including timber lands, is grazed, the only notable exception being farm lands and portions of the lower desert, both classes totaling perhaps fifteen per cent. In other words, seven per cent of the land devoted to timber crops is producing one-third as much wealth as twelve times this area devoted to grazing. The forests of the state are capable, under intensive management, of supporting a lumber industry worth nine millions of dollars a year, without taking into account a probable rise in lumber prices. Because of the overgrazed condition of nearly all grazing lands in the state, the range livestock industry is bound to decline. It is not improbable that the present generation will live to see the lumber industry of Arizona surpass the grazing industry in point of wealth produced.

These comparisons between grazing and forestry are made, not with the idea of belittling the stock industry, but in order to show that if grazing is permitted to damage the forests, a major resource is being subordinated to a minor one. The situation on the Coconino National Forest differs from that on many others in the West mainly in that transportation facilities favor more immediate exploitation of timber resources on the Coconino. Where logging can not be advantageously practiced at present or in the near future, there may be justification for favoring reasonable grazing as a temporary measure; but there can be no justification for grazing conducted in such a manner that it destroys the future forest, undergrowth, and soil.

The indirect values of a forest cover are often greater than both the timber and grazing resources. This is clearly recognized in the case of watersheds. Recreational values are rapidly coming to the front, and in many localities they already exceed the grazing values. Let it not be supposed that a forest can long be overgrazed, the undergrowth destroyed or mutilated, the lakes, streams and springs disfigured and polluted, and still retain the natural charm which each summer lures millions of people from the cities into the woods.

Abuse of the forests by grazing is all the more indefensible when we consider the relatively small amount of forage produced by real timber lands. The usual plea is that the forests are needed for summer grazing. How much they are needed throughout the West, the writer is not prepared to say. In Arizona, however, contrary to the common belief, the woodlands below the true timber zone and the so-called "desert" down to an altitude of 3,000 feet are capable, under proper use, of producing more palatable forage acre for acre than the timber lands. This is true for every month of the year, except possibly May and June. The trouble with the lower ranges in the Southwest is that they have been ruined by overgrazing. If these lands were revegetated and used conservatively, they alone would carry more livestock than is now carried by pasturing both timber and grass lands.

CONTROL OF GRAZING

Control of grazing is essentially an administrative problem. If the timber crop is given primary consideration, the research aspects of grazing become relatively simple. If timber production is truly the major objective, forage production *on timber lands* can scarcely be even a secondary objective for then whatever grazing is afforded must be regarded as purely incidental and temporary. Grazing must be subordinated to such an extent that there will always be a substantial margin of safety on the side of the forest. This will usually result in incomplete utilization of forage. If we attempt to graze to a dead line beyond which forest reproduction can not take place, there will be no end of research problems, because the amount of grazing which can be tolerated is seldom the same in two localities, nor does it remain constant in the same locality from year to year. The inevitable consequence will be too much grazing for the good of the forest.

Where control measures involve large reductions in the number of stock, decades may be required to make the necessary adjustments without undue hardship to the stock owners and disturbance of local economic conditions. For this reason it is usually better to plan reductions and exclusions far in advance instead of waiting until an emergency exists and then attempting to remove large numbers at one stroke. In regions where good seedling crops come at long intervals deferment of action until serious damage becomes evident usually means that, before remedial measures can be put into effect, the seedlings will be destroyed and reproduction will be delayed another twenty years. Wherever the forage in an understocked forest is fully utilized, it is

inevitable that the stock industry must face drastic reductions sooner or later. If forest reproduction is being injured, silviculture will demand a decrease in the number of animals; if forest reproduction is not being injured, the young trees will shade out the forage and a decrease in the number of stock must follow automatically.

The regulation of grazing in the National Forests should be absolutely in the hands of the Forest Service. When damage is found to be taking place, it should be within the power of forest officers to act promptly. The usual procedure of consulting with stock owners and, after a year or two of delay, adopting some compromise measure, may promote harmony but it is poor forestry. If grazing is permitted at all on areas in the process of regeneration, arbitrary action on the part of forest officers is often going to be necessary. Permits to graze on such areas should be granted only on the condition that they are subject to reduction or cancellation on short notice. No doubt this will result in depreciating the value of forest range. The answer is that grazing on a large scale can not be made permanently attractive on lands dedicated to the growing of timber. In view of these circumstances one must look with apprehension upon measures designed to stabilize grazing in the National Forests. By the very nature of things, grazing can not be stabilized on a basis satisfactory to stockmen if timber, soil, and water resources are to be properly safeguarded.

There appears to be only one way to avoid arbitrary and perhaps confiscatory action, and that is to carry enough surplus range so that when it becomes necessary to reduce or eliminate grazing on any area, the permittee can be moved to another allotment. In order to make such a plan workable it would probably be necessary for the Forest Service to acquire ownership of permanent improvements such as fences and water developments. When we consider the low carrying capacity of many forest ranges during the reproduction period and after reproduction is established, it becomes doubtful whether this would be a sound investment, especially in regions where water development is expensive.

In pointing out some of the shortcomings of the grazing administration in the National Forests, the writer is not unmindful that they are to a large extent the result of circumstances beyond the control of forest administrators. Grazing was an established industry in practically all the forest regions before American forestry came into being. Communities in remote timber regions are even now, in the absence of transportation facilities necessary for timber exploitation, dependent

upon the grazing industry, and will be so for years to come. It has not been wholly through disregard of forestry that timber growing has been set aside in the interest of stock growing. The great danger which foresters must avoid lies in mistaking artificial and temporary conditions for the natural and permanent, and in allowing their vision to be distorted by false standards. Economic conditions make it impossible to practice forestry in this country today as it is practiced in Europe. But we must not forget that certain economic and physical laws are the same the world over. One of these is that the permanent prosperity of a nation demands that its land be put to the highest use; another is that full crops of trees and grass can not grow on the same soil.

The solution of the grazing problem should follow constructive lines. Distinction must be made between true timber lands and lands chiefly valuable for grazing. On the latter, range management should be developed to a high degree, with due consideration of soil and water resources. Ordinarily the area of such lands within National Forests should be small. On the former there should be no attempt to increase grazing capacity, but rather to decrease it by replacing grass with trees. Reforestation may require many years, in which event the forage crop will be considerable. To what extent this may be utilized without retarding reforestation will depend upon many circumstances, and should be made the subject of investigation in every region. Where the demand for grazing land is great, there will be a tendency to overgraze. There should always be a substantial factor of safety on the side of forest reproduction, regardless of whether the forage is fully utilized. In regions where reproduction comes easily, or where, perchance, seedlings are not eaten to a great extent, these conditions should be known so that grazing may not be unnecessarily curtailed. Moreover, there are possibilities of employing grazing as an aid to reproduction. Except in extreme cases, the problem can not be dismissed by deciding that grazing is destructive and must be eliminated, or that it does no damage and therefore requires no attention. We shall probably always have some grazing on timber lands. The day of the large outfit in the forest is passing, but there will always be the farmer with a few head of cattle, and possibly other small owners whose living in the woods is to be encouraged. The solution is to begin now and work steadily on reductions or class exclusion as circumstances require, with a view toward doing away with overgrazing. Understocking rather than full stocking should be the aim, and the criterion of proper stocking should be elimination of damage to reproduction and soil rather than utilization

of forage. Having reached this goal, there will still be cases of local damage. To handle these effectively, forest officers must be constantly on the alert, trained to detect damage in its incipency, and clothed with authority to act without delay.