Guidepost to Enhance Grazed-Forest Watersheds

E. William Anderson

Water is the most precious commodity derived from our rangelands and forests. All of these lands should be managed primarily as watersheds which, in turn, will enhance the production of forage, fiber, food, wildlife, social, and other commodity and non-commodity resource uses. Depleted watersheds cause serious widespread and long-lasting second- and third-order consequences, on-site and downstream, economically and socially. These adversities are intensified under prolonged drought conditions.

The basic ingredients of watershed management, i.e., managing for water efficiency, apply equally to rangelands (Anderson 1993) and grazed forests. These ingredients, which have been stated by Barrett (1990), are to **capture store**, and **safely release** water on watersheds. Several relatively old studies, mainly in the Pacific Northwest, are cited herein to emphasize that both early and more recent studies related to grazed-forest watersheds are prevalent. These studies illustrate the kinds of watershed-related inter-relationships that might be achieved by deliberately manipulating the tree cover. There is urgent need to include already available watershed management knowledge as basic ingredients of plans for management of all natural renewable resources.

Manipulation of vegetation to enhance grazed-forest watersheds focuses primarily on trees, which are predominant. Manipulations of tree cover have secondary effects on understory vegetation as well as on the previously mentioned basic ingredients of watershed management—Capture, Store and Safely Release water.

Soil Water

A study on pumice soils in central Oregon by Barrett and Youngberg (1965) shows that use of soil water increases significantly with increased density of sapling ponderosa pine. The effects of thinning the pine stand to 62, 125, 250, 500, and 1,000 trees per acre was measured in terms of water use. Total amount of water used by vegetation was 1.6 times greater on plots containing 1,000 trees per acre than on plots with 62 trees per acre. Where herbaceous vegetation was allowed to grow, water usage was 45% greater than where it was not allowed to grow.

A study in the Ochoco National Forest in Oregon (Swank 1969) reports that an acre of thinned trees will produce one sixth acre-foot of additional water, not all of which will be measurable at a weir placed at the outlet of the watershed because of recharge of underground aquifers. However, benefits derived from recharge of aquifers eventually will be noticeable in the amount and longevity of spring flows at lower elevations.

A study by Packer (1962) in northern Idaho showed that water content of the snow pack was affected uniformly by changes in the forest canopy regardless of elevation, aspect or magnitude of snowfall. Water content of the snowpack increased 4.2 inches with a change in tree canopy density from a completely closed canopy (100% tree canopy cover) to a completely open canopy (0% tree canopy cover). The significance of this is that thinning a 100% tree canopy cover to about 40% canopy theoretically can be expected to produce 2.5 inches more water in the snowpack (60% X 4.2 inches water).

Throughfall precipitation, that which falls directly through holes in the tree canopy, is an important factor. Intercepted precipitation fills the interception storage and the excess drips off leaves, trunks and branches or flows down the bole as stem-flow.

In a study in northern Wisconsin, Anderson, Loucks and Swain (1969) point out that understory vegetation can be limited in two ways by reduced availability of moisture as a result of tree canopy: (a) precipitation intercepted by the tree canopy and surface litter causes a reduction in total amount that reaches mineral soil; and (b) dominant species in the forest plant community, which are trees, compete with the herbaceous understory for moisture that does penetrate to mineral soil.

Their study of the relationships of throughfall precipitation

A selectively harvested grazed-forest watershed benefits tree growth, watershed health, wildlife habitat, and forage production.

E. William Anderson is a certified range management consultant, 1509 Hemlock Street, Lake Oswego, Oregon 97034. (503) 636-8017.

to tree canopy cover showed that, with tree canopy cover of 85% or more, throughfall precipitation during moderate storms would become so small as to be highly erratic. Conversely, throughfall precipitation for a tree canopy cover of 60% or less approaches 90%. They did not study canopies having less than 60% tree canopy cover. This study suggests that thinning to 60% or less tree canopy cover may improve effectiveness and efficiency of precipitation during the growing season and improve recharge of soil moisture during the rainy season.

Thick layers of litter under dense tree canopies tend to intercept significant amounts of throughfall precipitation before it reaches mineral soil. This accentuates the adverse effect that dense tree canopy has on the periodic recharge of soil moisture. The detrimental effect that a thick layer of litter can have on replenishing soil moisture might be a factor in considering the need for prescribed burning in some areas.

Understory Vegetation

In a pine-thinning study by McConnell and Smith (1965) in eastern Washington it was determined that when the thinned pine exceeds 45% canopy cover, forbs produced more dry matter than grasses. Below 45% tree canopy cover, grasses were superior producers. This study suggests that tree thinning should take into account the influence that density of tree canopy cover might have on the composition of grasses and forbs in the understory. Theoretically, thinning to approximately 45% tree canopy cover will favor the strongest composition of forbs and grasses, thereby benefitting wildlife and livestock forage conditions, as well as watershed qualities.

A study by Young, Hedrick and Keniston (1967) in the Blue Mountains of Oregon showed that percent shrub canopy cover was naturally greatest (about 35%) where tree canopy cover was between 20% and 65%. Under a tree canopy cover of less than 20%, shrub canopy cover decreased to about 22% where there were almost no trees. Under tree canopy cover greater than 65%, shrub canopy cover progressively decreased to less than 5% where the tree canopy cover was 90%.

Their study also cites a relationship between annual production of shrubs and tree canopy cover. The best annual production on shrubs was under a tree canopy cover of 6% to 35%. Under less than 6% tree canopy cover, annual production of shrubs dropped sharply. Annual production of shrubs also diminished with increasing tree canopy cover that exceeded 35%.

Natural recovery of understory vegetation following pine thinning was studied by McConnell and Smith (1970) in eastern Washington. After eight growing seasons, total understory yield ranged from 75 pounds per acre on unthinned to 417 pounds per acre under 26-foot pine spacing. The increase was made up of 51% grasses, 37% forbs and 12% shrubs.

From a watershed quality standpoint, natural understory recovery versus artificially reseeding the understory following thinning is a valid consideration. This study gives guidance for cost-benefit comparison between potential natural understory recovery in eight years as compared to potential establishment of a suitable understory in 2 to 3 years from seeded understory species.

Surface Runoff

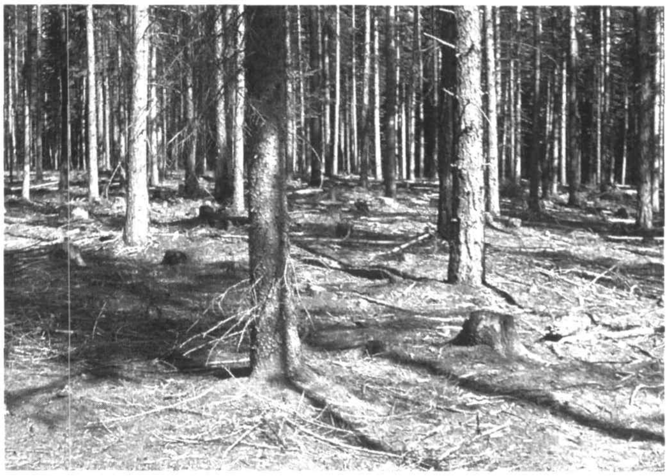
A study by Orr (1970) of a severely burned pine stand in the Black Hills of South Dakota showed that, as vegetational cover developed, summer runoff and erosion rates decelerated until total vegetal cover (live vegetation and litter) reached about 60%. As total vegetal cover increased beyond 60%, the rates of surface runoff and sediment production continued to decrease slowly and steadily. Orr postulated that total vegetal cover must equal or exceed about 60% for minimum tolerable runoff control and soil stability.

From a watershed quality standpoint, this study may help evaluate the effect that seeding of burned areas might have on achieving the desired 60% vegetal cover in a minimum length of time. This study also gives a basis for evaluating beneficial effects on vegetal cover from such measures as improved grazing management and tree thinning on non-burned forested watersheds that have excessive bare ground and much less than 60% total vegetal cover.

Trees

Barrett (1970) studied thinning of ponderosa pine on pumice soils near Bend, Oregon and concluded:

—Diameter and height growth of sapling ponderosa pine may be accelerated by increasing growing space per tree and removing competing understory vegetation.



A dog-hair stand of mixed coniferous species thinned to improve quality of wood production and increase solar energy for production of understory vegetation. Trees removed were processed through a chipper.

—Limbs of released trees also responded to increased growing space and removal of competing vegetation, which can be undesirable from a lumber-quality standpoint.

—Maximum benefits to tree growth from thinning will be gained by maintaining some suppression of understory vegetation development over at least part of the life of the stand.

—Thinning to a wide spacing and continued suppression of understory vegetation could appreciably increase water yield for domestic (and other) use. For example, when soil moisture use in a stand containing mature overstory, dense understory trees, and natural understory vegetation, primarily shrubs and grasses, was compared with soil moisture used in a stand thinned to 125 trees per acre and understory vegetation suppressed, the moisture left in storage at the end of the growing season increased during several years by almost 50%.

Thinning stimulated not only growth in diameter and height of trees but also growth of understory vegetation. In respect to the need for suppressing understory vegetation in order to obtain optimum wood fiber production and watershed quality, practical methods of suppression should include consideration of grazing by livestock and wildlife, as well as prescribed burning.

Edgerton and Smith (1971), in their study of elk and deer habitats in the Blue Mountains of Oregon, concluded that the greatest potential for habitat improvement was in the dense-forest areas through logging. Since these tree stands are important wildlife cover, particularly for elk, a pattern of untreated areas should be left as cover and escape routes, rather than apply wholesale area treatment.

Solar Energy

In 1964, Vezina and Pech reported on studies made in Quebec, Canada, which showed that, in very dense stands of balsam fir with full crown closure, only about 2% of total solar radiation reaches the forest floor. Such a low solar radiation ratio permits balsam fir seeds to germinate but does not allow seedlings to develop. Under these conditions, fir seedlings generally die within a year and are replaced by another crop of seedlings the following seed year. This process is repeated until the stands have opened up sufficiently to allow some seedlings to become established. It appears that on good sites, a minimum of 10% solar radiation ratio is required for balsam fir seedlings to develop satisfactorily. This corresponds to a 60% to 65% tree canopy cover for mature balsam fir.

Presumably, these balsam fir stands are comparable to the mixed Douglas-fir/white fir forest in the Pacific Northwest in terms of the effect tree canopy cover has on solar radiation ratio.

These studies also show that, under a 100% canopy cover of jack pine in eastern states, which closely resembles lodgepole pine in western states, the solar radiation ratio was 10% as compared to 2% under balsam fir. The authors did not predict how much solar radiation and corresponding tree canopy cover is required to obtain natural regeneration of jack pine. However, their graphs show that a 40% to 45% canopy cover of jack pine would result in about 35% to 40% solar radiation ratio under the pine.

Mountain stream draining a grazed-forest watershed in eastern Oregon.

There appears to be some correlation between these studies of jack pine and the study by McConnel and Smith (1965) that suggests about 45% tree canopy cover as a goal to favor the strongest composition of forbs and grasses under ponderosa pine in the Pacific Northwest.

In another similar study, Vezina (1965) estimated that thinnings which removed 12% and 36% of the original basal area of very dense balsam fir had the immediate effect of increasing solar energy radiation ratio by 25% and 50% respectively. These data might be useful for predicting the proportional increase in solar energy at the ground level that can be achieved by various degrees of tree canopy thinning in the Mixed Fir Forest ecological site in the Pacific Northwest.

Improving the efficiency of solar radiation for production of herbaceous vegetation and soil micro-organisms in dense tree-covered areas is important and worth special consideration. Production of herbaceous vegetation is increased under trees that have been thinned because of improved light and soil micro-organism conditions, and increased available moisture. Too often this is taken for granted without reasoning why it happens.

From the standpoint of watershed health, inefficiency in use of solar energy within a dog-hair stand of trees should be considered a critical situation in respect to the management of natural resources, of which solar energy is one of the most important. Wasted solar energy could be cited as a significant factor in helping establish the point that a critical biological situation exists. This, in turn, might help qualify a comprehensive watershed treatment program, including tree thinning, for public-funding approval.

Conclusion

Grazed-forest watershed health is largely a matter of desirable soil-plant relationships which can be manipulated, to a degree, by forestry and grazing treatments. Prescribing what is "desirable" requires application of basic knowledge about inter-relationships and interactions between such factors as soil water, overstory and understory vegetation, surface runoff, and solar energy. And these factors must be harmonized with such essential elements of success as feasibility and practicality.

References Cited

Anderson, E. William. 1993. Prescription grazing to enhance rangeland watersheds. Rangelands 15(1):31-35.

Anderson, R.C., O.L. Loucks, and A.M. Swain. 1969. Herbaceous response to canopy cover, light intensity and throughfall precipitation in coniferous forests. Ecology 50(2):255-263.

Barrett, Hugh. 1990. Direction: A range management need. Unpublished paper presented at North American Wildlife and Natural Resource Conference, Denver, Colo. March 20, 1990.

Barrett, James W. 1970. Ponderosa pine saplings respond to control of spacing and understory vegetation. USDA For. Serv. Res. Paper PNW-106.

Barrett, James W. and C.T. Youngberg. 1965. Effect of tree spacing and understory vegetation on water use on a pumice soil. *In*: Proceedings, Soil Sci. Soc. of America 29(4):472-475.

Edgerton, Paul J. and Justin G. Smith. 1971. Seasonal forage use by deer and elk on the Starkey Experimental Forest and Range, Oregon. USDA For. Serv. Res. Paper PNW-112.

McConnell, Burt R. and Justin C. Smith. 1965. Understory response three years after thinning pine. J. Range Manage 18(3):129-132.

McConnell, Burt R. and Justin C. Smith. 1970. Response of understory vegetation to ponderosa pine thinning in eastern Washington. USDA For. Serv. Res. Paper PNW-106.

Orr, Howard K. 1970. Runoff and erosion control by seeded and native vegetation on a forest burn: Black Hills, South Dakota. USDA For. Serv. Res. Paper RM-60.

Packer, Paul E. 1962. Elevation, aspects and cover effects on maximum snowpack water in a western white pine forest. Forest Sci. 8(3):225-235.

Swank, G. 1969. Water yield improvement potentials on National Forest lands tributary to the Ochoco reservoir. USDA For. Serv. Pac. NW Region, Portland, Oregon.

Vezina, P.E. 1965. Solar radiation available below thinned and unthinned balsam fir canopies. Canadian Dept Forestry Publ 1105.

Vezina, P.E. and G.Y. Pech. 1964. Solar radiation beneath conifer canopies in relation to crown closure. Forest Sci. 10(4):433-450.

Young, J.A., D.W. Hedrick, and R.F. Keniston. 1967. Forest cover and logging—herbaceous and browse production in the mixed coniferous forest of northeastern Oregon. J. Forestry November 1967.

(Continued from page 111).

Jim Chant, one of the cooperating ranchers, is quoted as saying that he believes that the Colorado River cutthroat trout is a barometer of how the range is functioning, and that if this fish can be reintroduced and live in Muddy Creek, it indicates his range is in good condition for cattle.

The folks involved in Muddy Creek have implemented many of the standard range improvement practices, but each practice was implemented with due consideration for all rangeland resources, and often with great innovation—reinforcing the CRM motto that none of us knows as much about something as all of us. Wyoming needs to be acknowledged for their important role in this effort. The State, including current Governor Jim Geringer has been a strong supporter of the CRM process as the method of choice for conducting natural resource management. The Governor's opening remarks reinforced his belief in the value of "communication, cooperation and commitment". Lastly, let me point out the importance of Larry Hicks, Little Snake River Conservation District and Andy Warren, Bureau of Land Managemet. These two resource conservatioists have provided sustained leadership to this project through their knowledge of the resources, the people involved and their communication, cooperation and commitment, lending great credence to the word professional.—**Bud Rumburg**, SRM EVP