



FIGURE 1. Clearcut blocks of forest near Jackson, Wyoming. Windrows of log trash can be seen in the cutover areas. When new trees in cutover areas grow to height of 10 feet, the timber areas now standing will be logged.

cut, even the most severe cutting left a residual stand to provide partial cover and to protect the soil."

This is a succinct description of selective logging practice which may be heavy or light but is not clearcut. Present practice in the same type of stand, Lodgepole Pine, is to remove all trees in blocks of 14 to 28 hectares (35-70 acres). The blocks were, until recently, rectangular or nearly so, but the aesthetic impact was so unfavorable that presently the blocks are made irregular and more natural in appearance. Skidding is done behind large caterpillar tractors, and loaded by machine. Discarded logs, stumps, and brush are either winnowed by bulldozer or piled in great mounds and burned by Forest Service personnel. I surveyed the percentage of soil on a clearcut area in Lodgepole Pine churned up to an average depth of one foot or more by tractor treads. In this sample 55 percent of the surface area was churned to depth, 29 percent disturbed, and only 16 percent undisturbed (see Figs 1-4).

This practice is based on the following reasoning:

- 1) Soil must be scarified so that seeds can contact mineral soil for germination.
- 2) Burning slash is needed to provide heat necessary for opening cones of Lodgepole Pine so the seeds can emerge.
- 3) Leaving some standing trees as in selective cutting exposes them to excessive wind throw.
- 4) In a mature stand the smaller trees not of merchantable size are the same age as the large trees and do not grow to loggable size. Regeneration on a clearcut area will give an even-age stand.



FIGURE 2. After logging is complete trash and discarded logs are piled for burning. Note soil churned by tractor treads.

5) Clearcutting controls dwarf mistletoe where the latter is prevalent.

Assuming these are facts which justify clearcutting on silvicultural and economic grounds, research questions emerge which are in need of study.

The most obvious concerns the difference in sediment production, in regeneration, and in economics of the older selective cutting and the new clearcutting practice. Considering the public criticism voiced against clearcutting by conservationists, it would be desirable to produce unassailable facts to defend the present practice. In my survey of the literature, the silvicultural argument, presumably the strongest, is equivocal (for example, see Boyd and Deitschman, 1969).

Clearcutting results in a large amount of organic debris which is not burned in the cleanup. This organic material can alter the cycling of dissolved materials, both organic and inorganic, and can therefore affect quality of the water leaving the area. The only study I have found concerned the effect of clearfelling (all trees cut, none removed) on the quality of the runoff water. It was concluded that "nitrate concentrations in the small stream from the cutover ecosystem have exceeded established pollution levels . . . for more than one year and algal blooms have appeared during the summer." (Bormann *et al.*, 1968). While this result may not be typical of western forest conditions it would be prudent to conduct research in western areas using typical logging practices.

My final point is that there is a growing need for tackling new problems and the accumulation of new data, toward both of which, use of instrumented watersheds can contribute as a research tool.



FIGURE 3. After trash is burned many charred and unburned logs remain on ground. Note evidence of sediment movement in minor channel. Horse Creek, Bridger Forest, Wyoming.

One of the subjects which is bound to increase in importance is the extent to which wilderness and primitive areas can be left in their natural condition without timber management but with protection from fire. Fire is a natural factor of the environment and plays an important role in maintaining a wide variety of plant communities. Extensive ecological changes have resulted from the exclusion of natural fires. Since widespread fire protection has been offered the plant communities in the Western States, marked changes have occurred. In many forest stands large amounts of burnable debris and litter have accumulated where formerly the same forests were open with only a moderate amount of understory. The ponderosa pine belt of southwestern United States had originally consisted of a savannah-like structure, an open woodland, with space between high-crowned pines, and understory which was more grass-like than brushy. This original condition apparently represented a fire climax resulting from frequent lightning-caused fires that burned quickly through the understory but seldom resulted in a crown fire. Ground fires served to clear out the organic fuel of the forest floor and to keep down the brush.

Fire protection of the last half century appears to have replaced grassy meadows with stunted young trees and greatly increased shrub and bush growth.



FIGURE 4. *Trucking road on moraine. Swath cut for road averages 30 m in width for a roadbed of only 5 m near Mosquito Lake. Teton Forest, Wyoming.*

Now that such a large amount of fuel has accumulated, continuing fire control is obligatory. When a fire, however caused, goes through such a brushy accumulation of fuel, a conflagration results.

Prescribed burning or use of fire as a management tool is widely used in southeastern United States. In many western forests which have had complete fire protection for several decades, the application of fire for management has become increasingly difficult and hazardous. It could be argued that complete fire protection now is cheaper and safer than the use of fire as a management tool or an attempt to reverse the trend and restore the forest to the former condition when fires were common and helpful rather than destructive. Research which has been carried on in recent years by the U.S. Forest Service appears to be directed primarily to the burning of cut-over slash rather than use as a tool in standing forests.

Here is a subject in which representative watersheds might serve a very useful purpose and one in which the results of such research are going to be needed primarily for the future rather than for the present.

There is a somewhat surprising lack of emphasis on the chemical and limnological quality of water. This subject has risen to prominence as pollution became more widespread in the last decade. This is merely one of the phases of hydrology in which the unplanned effects of man's activities have had a major impact. The growth of road networks, the production of pollutants and limnological alterations in streams, lakes, and estuaries, resulting from grazing, agriculture, pesticide use and recreation, the enlargement of stream channels due to upstream alterations, are among such unplanned effects. Problems of importance dealing with aesthetic values are emerging as a result of public awareness of the total environment.