NATIONAL FOREST WATER YIELD MANAGEMENT IN ALPINE AND SUB-ALPINE AREAS

By

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Introduction

The Lake Creek Water Yield Improvement Project, and several other projects in the United States, are to initiate a program of barometer watersheds for the Forest Service. This watershed program will provide the basis for: (1) determining the effect of management practices on hydrologic behavior, (2) developing and refining watershed prescriptions, (3) making water yield predictions, and (4) comparing predictions with actual performance. In addition, the barometer watershed is the proving ground for the application of the most recent research findings within the scope of multiple use management and a pilot project for appraising cost-benefit relationships.

The need for such watershed projects is apparent since the demand for water will increase greatly in the future. Transmountain water diversions have helped satisfy the need for water in critical areas. Cloud seeding projects may eventually aid water users by increasing precipitation. Saline water conversion will be economically feasible in the future.

The Forest Service feels that its place in the water yield picture is to provide for the efficient transmission of water from the time precipitation hits National Forest lands until it is off the National Forest. This includes provision for maintaining good water quality. Water yields will not be altered if water quality must be decreased. It also includes the improvement of late season flows for water users.

DESCRIPTION OF THE WATERSHED

Location

The Lake Creek watershed is in Lake and Chaffee Counties of Colorado on the Leadville District of the San Isabel National Forest. It is on State Highway 82 between Independence Pass and the town of Twin Lakes.

Description

The portion of the Lake Creek Drainage in the project area includes 42,077 acres. Elevation of the project area ranges from 9,350 feet above mean sea level to 14,340 feet above mean sea level. Forty seven percent of the watershed is higher than 12,000 feet above mean sea level.

About 64 percent of the project area is above timberline and only 20 percent is timbered.

The mean yearly water yield from Lake Creek is 78,391 acre-feet or about 1.86 acre-feet per acre. This is about 70 percent of the estimated average annual precipitation of 32 inches. Sixty to seventy percent of the precipitation in Lake Creek is snow.

HYDROLOGIC MEASUREMENTS

To determine the present hydrologic characteristics of the watershed several factors will be measured. These measurements will also be used to predict annual water yield. A series of predictions will be made and checked with the streamgaging stations. We will improve our predictions yearly and eventually use the Lake Creek data to predict water yields from similar alpine watersheds.

1/ U. S. Department of Agriculture Forest Service, San Isabel National Forest, Pueblo, Colorado, March 1965.

Wind Speed and Direction

During the winter of 1964-1965 wind run and wind direction equipment was installed and calibrated above timberline at the 12,200 foot elevation. Recently instantaneous recording of wind speed and wind direction was begun. It is hoped that a wind system can be installed which will sense variables in both the horizontal and vertical planes. Several wind measuring instruments will be placed throughout the watershed.

Temperature

Equipment to record this was installed and calibrated at the 12,200 foot elevation last winter. Eventually temperature will be recorded from several points on the watershed.

Relative Humidity

A dewcel will be installed next summer to give a record of dew point.

Radiation

Spot checks will be run with pyreheliometers to measure radiation. We will attempt to record radiation continuously, but this may be difficult to maintain.

Precipitation

Four storage precipitation gages were used this winter. Several recording rain gages will be used during the summer to determine precipitation intensities. A pressure pillow was installed in February, 1965. This pillow, along with three others to be installed next summer, will give winter precipitation intensities as well as the water content of the snowpack.

A system of snow depth markers will be set throughout the watershed. These will be read from airplanes. They will be used to supplement data from the storage gages and pressure pillows.

Streamflow

Two weirs will be constructed during the summer of 1965. Each will gage a main sub-watershed within the project. A flume will be installed below the first area where improvements will begin.

Seventeen years of streamflow records are available from a U. S. Geological Survey Station located at the lowest point on the project. This data has a 10 to 15 percent error, according to the Geological Survey.

WATER YIELD IMPROVEMENTS

The watershed will be treated to attain optimum water yields. The objectives of this treatment will be:

1. To improve or maintain water quality.
2. To decrease peak streamflow and delay water yields.
3. To increase annual water yields.

All improvements will be compatible with other land uses such as recreation, timber, range, and wildlife. We will determine what improvements are practical under the multiple use concept.

Water Quality

No increase or delay in water yields will be done if it will decrease water quality.

Within the project there are approximately seven miles of streams which will not support plant or animal life. During low flows these streams are high in sulphates and have a pH of 4.7 to 4.9. The sources of pollution are under two mountains. Water

leaches sulphide rocks and oxidation causes sulphates to form and pollute the streams.

We plan to try a series of stilling ponds partially filled with limestone and sulphur consuming bacteria to purify these streams. The details of this treatment must be worked out.

The watershed is sheep range and some adjustment in sheep numbers or the routes they graze may be necessary.

Water Yield Delay

Induced avalanching and induced snow drifting will be used to delay water yields. Induced Avalanching should cause avalanches to run more often than they would naturally. This would keep the accumulation zone free to collect snow. It would also pile the snow deep in the deposition zone. This would extend the snowmelt later into the summer.

The economic benefit of avalanching for water yield improvement is questionable. It is difficult to reach fracture lines in remote areas with explosives.

On March 18, 19, and 20 of 1965, Air Force, Federal Aviation Agency, and the Forest Service personnel tested the effect of sonic booms on avalanches. The results of these tests were inconclusive.

Snowfences are being used to cause snowdrifts. This will add depth to the snowpack and delay water yields. The snowfences are 11 feet tall. They will present a 50 percent solid barrier to the wind. The fence should cause a drift 176 feet long to lee of the fence. The drift should have an 11 foot maximum depth. An opening of three feet between the bottom of the barrier and the ground will allow the wind to clear the fence of snow.

The cost of these fences and the methods of constructing them are being studied to determine their feasibility as a management tool.

Snowpack may be deep enough behind some fences that it will not melt completely during the summer. Such areas will be used for storage until a year when the snowpack is small. The old snowpack from former years would then be melted with carbon black or other dark surface applicants.

Water Yield Increases

Vegetative Management will be used on the project. Only 18 percent of the watershed is covered with saw-timber or poletimber. Much of this timber cannot be clearcut because of its esthetic value along State Highway 82. We do not expect vegetative management to increase water yields noticeably on this project, but the timber will be cut to furnish a demonstration area.

The use of cable logging systems to preserve watershed values will also be investigated.

The modification of certain streamside vegetation will increase water yields, but we will not attempt this until the effect on fish and wildlife habitat and esthetics has been studied more thoroughly.

Snowpack Manipulation may also increase water yields. Snowfences will drift snow and have several possible effects.

1. A large volume of snow stored per unit of surface area. This can decrease evaporation.

2. Stop blowing snow which evaporates easily.

3. Provide a large volume of snow in one place. This will make the spreading of monomolecular films, evaporation retardants, more feasible.

Avalanches will also concentrate snow and possibly increase water yields. Rock dams in the deposition zones of avalanches will be investigated as a way to concentrate snow. Evaporation retarding monomolecular films such as hexadecanol and octadecanol will be

used to decrease evaporation. We will try to devise low cost application methods.

CONCLUSION

The Forest Service hopes to get answers from the barometer watershed program which will allow us to use water yield improvements within the scope of multiple land use management. We will also gain knowledge of construction methods and costs. The barometer watersheds should yield data from which we can draw analogies to use in planning water yield improvements on other similar watersheds.