AN ABSTRACT OF THE THESIS OF

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Title: SIMULATED STORM RUNOFF CHARACTERISTICS BETWEEN NATURAL AND ALTERED ECOSYSTEMS IN THE OREGON RANGE VALIDATION AREA

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John C. Buckhouse

During the summer of 1980 an infiltration/sedimentation study was conducted on the Oregon Range and Related Resource Validation Project Work Area in the Blue Mountains of east-central Oregon. A modified Rocky Mountain infiltrometer was used to simulate a 28 minute high intensity rainfall event to determine mean infiltration rates and average potential sediment losses on 19 improved resource units consisting of various combinations of productivity and condition classes. Such improvements included seedings, thinnings, herbicide spraying, mechanical brush control and certain combinations of 2 or more practices. Natural or unimproved resource units of similar soil type and ecological expression were sampled and used as controls.

On 4 of 9 seeded mountain grassland ecosystems sampled, the control had significantly higher infiltration rates for the entire run. On 2 others, no significant difference in infiltration rates occurred during the 3-8 time interval. Thereafter, the control had significantly higher infiltration rates. In another instance, the control had significantly higher infiltration rates only for the 3-8 minute time interval after which no significant differences were

found. In another case, significantly higher infiltration rates occurred only during the 3-8 and 23-28 minute time intervals for the treated and control areas, respectively. For the remaining site there were no significant differences in infiltration rates between the treated and control areas throughout the storm. The control had a significantly higher average potential sediment loss in all cases except 4. In 3 of these no significant differences in sediment loss was found. On the remaining site the treated area exhibited the significantly higher sediment loss.

On the sagebrush ecosystem sampled, where sagebrush was mechanically removed and the area seeded, the treated area had significantly lower infiltration rates than the control and a lower average potential sediment loss. The control for a thinned pine-mixed fir-sedge ecosystem in fair condition not only had a significantly higher average potential sediment loss but also had a significantly higher infiltration rate than the treated area for the 3-8 minute time interval after which no significant differences in infiltration rates occurred.

On a thinned and seeded pine mixed fir-sedge ecosystem in good condition, on which seeding establishment appeared unsuccessful, infiltration rates were significantly higher for the treated area for the entire storm. However, no significant differences in average potential sediment loss were found.

A thinned larch ecosystem was divided into a pinegrass, a seeded and a bareground area and each area was sampled separately. In all 3 cases, the control had significantly higher infiltration rates throughout the storm as well as a significantly lower average potential sediment loss.

On 1 of the 2 pine-sedge ecosystems the treated area had significantly higher infiltration rates for the entire storm as well as a significantly lower average potential sediment loss. On the other pine-sedge ecosystem, divided into non-vegetated and vegetated areas, the control of non-vegetated portion exhibited significantly higher infiltration rates and a lower average potential sediment loss than the treated area, whereas, no significant difference in infiltration rates or sediment loss was found beween the control and treated area on the vegetated portion.

On a thinned ponderosa pine-bunchgrass ecosystem although infiltration rates were significantly higher for the treated area during the entire run, no significant difference in average potential sediment loss was found.

SIMULATED STORM RUNOFF CHARACTERISTICS BETWEEN NATURAL AND ALTERED ECOSYSTEMS IN THE OREGON RANGE VALIDATION AREA

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INTRODUCTION

The high standard of living experienced by most Americans stems partially from the fact that they are living on a land rich in natural resources. Yet, until very recently, very little attention has been directed toward efficient management of these resources. As resource demands increase, their wise use and efficient management must also increase if present and future resource needs are to be satisfied. However, much of the information needed to make wise resource management plans and decisions is lacking, thereby constituting a major problem. In an effort to reduce the magnitude of this problem, the Oregon Range and Resource Validation Project was organized. This project reflects a cooperative effort among federal, state and local agencies, groups and individuals. The Validation project goals are to gather, assemble, develop and relate large amounts of forest and range land resource management information in a scientific and purposeful way that will allow more efficient management of such resources, as well as to attempt to validate existing information and management practices. Resource management decisions create an impact on the social, economical and environmental aspects of the resource dependent areas. Therefore, answers to resource questions are absolutely necessary.

Grant County, Oregon, is typical of many rural areas in Western United States. It's small, widely scattered population depends largely on the sale and export of beef for it's livelihood and has little to offer new industry. The Validation project resultantly provides the county's ranchers with three things: (1) it gives local managers more information which will help them to develop the county's resource base to its fullest potential, (2) helps determine the extent to which local economic development can be influenced by improved resource productivity, and (3) provides the rancher with a long term coordinated resource plan which offers them an opportunity to install management practices on their land at a reduced cost.

Objectives of the Validation Project

Five different resource management practices on the validation area have been designed to link range activities with the resources and to reduce potential problems which occur when numerous management systems are introduced (USDA 1972). These five original strategies were identified as A, B, C, D and E with the degree of grazing varying from no grazing under strategy A to maximization of animal production under strategy E. However, strategy E was eliminated because it did not consider multiple use as a constraint and therefore violated the Multiple Use Act. Strategies B, C and D consider various degrees of multiple use under various degrees of grazing (Validation Team 1976).

Nineteen resource outputs are being considered in the Validation Study. Determining the relationship between the nineteen monitored resource outputs and the four management strategies is the primary objective of the Validation Project.

Objectives of the Rangeland Resources Program Study

The objective of this research study was to monitor simulated storm runoff and sediment loss from resource units located within selected ecological site classifications and which have been subjected to various management strategies. Relationships between these hydrologic responses and the ecological potentials of the site modified by management have been investigated and established.

DESCRIPTION OF AREA

The Oregon Range Validation Area occupies portions of Grant, Umatilla, and Wheeler Counties in east-central Oregon (Fig. 1). At present there are a total of 625,717 ha within the study area: 616,170 ha in Grant County, 8,551 ha in Wheeler County, and 996 ha in Umatilla County. The maximum east-west distance is 113 km and the maximum north-south distance is 77 km. Elevations vary between 2,476 m and 556 m.

The John Day River system drains the entire area. This includes all of the Middle Fork of the John Day River, a portion of its North Fork from its mouth upstream to include the Desolation Creek sub-watershed and from the head waters of the John Day River to Kimberly.

All major kinds of land ownerships are included within the study area. These include federal, state, and private ownership. One hundred fifteen Bureau of Land Management (BLM) grazing leases and 60 Forest Service grazing permits have been issued to a portion of the 359 private land owners within the area. These permits and leases were issued to authorize grazing on federal lands in the area.

The area is primarily forest and rangeland. It is hilly to mountainous with the major streams deeply entrenched. Irrigated valley land occurs along the main stem of the John Day River, the lower North Fork, and to a lesser extent, on portions of the Middle Fork. The orthographic features of the area strongly control the North Fork, Middle Fork, and main stem of the John Day River, all of which have

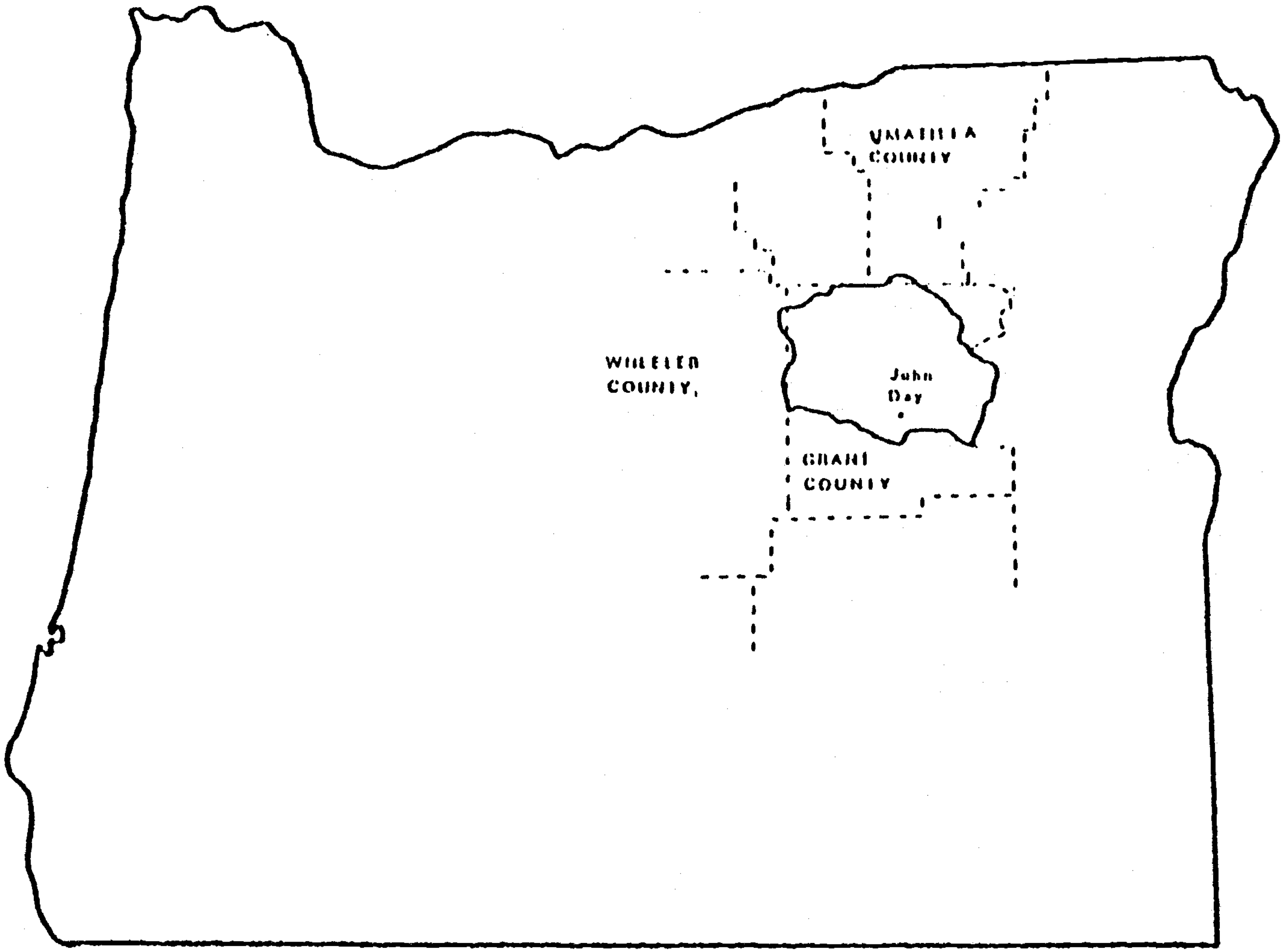

Figure 1. The Oregon Range and Related Resources Validation Project Work Area. (Gaither 1981)

their origins in the Strawberry, Aldrich and Greenhorn Mountain Ranges.

The Validation Work Area is characterized by a climate which ranges from semi-arid to cold, sub-humid. Precipitation ranges from 25 cm in the lower elevations, where it primarily occurs as rain, to 100 cm in the higher mountain elevations where it occurs mostly as snow between October and May. Elevation and coinciding climate regulate the growing season which ranges from 80 to 180 days. There are no frost free months at higher elevations. Summers are hot and dry with temperatures reaching 49°C. Cooler nighttime temperatures exist in the mountainous areas. Winters are cold and moist.

Snowmelt and occasional heavy rains cause peak discharge to occur within a six-week period from approximately the last week of March through the first week of May. Minimum discharge occurs between July and October. Yearly differences are related to variations in annual snowpack.

There are three major physiographic areas in the Validation Study Area. They are:

(1) High elevation uplands and open basins or mountain valleys

(2) Medium elevation uplands

(3) Alluvial fans and flood plains

High elevation uplands are presently forested areas on sedimentary or volcanic soils. Lands controlled by the National Forest System occupy most of this physiographic area. Included are deep, non-stony soils comprised of clay over sediments; silty clay loam over clay, silty clay loam and silt loam derived from loess; silt loam and loam from volcanic ash; and moderately deep, non-stony soils, mostly in mounds. Where volcanic rock exists, it is covered with moderately deep stony soils including reddish silty clay loam, brownish loam-clay loam, and brownish gravelly clay loam. Shallow, stony soils without forest cover also occur.

The medium elevation uplands are characterized by a grass-shrub vegetation growing on sediments and volcanic soils. They occupy the zone between the alluvial fans and flood plains and the high elevation uplands and mountain valleys. These soils are moderately deep and clayey when they occur over sediments. Included in these were dark, thick clay; dark clay; dark gray, fine clay; and dark red, fine clay. Where they occur over basalt or tuff, they are predominately silty, stony soils. Included here were very shallow silt loam; shallow, silty clay loam; moderately deep clay; and moderately deep, silty clay loam. Where they are derived from loess or ash, they are silty, non-stony soils. Included are moderately deep, silty clay loam and deep, ashy, silt loam. The medium elevational uplands are also characterized by glacial outwash terraces composed of gently sloping soils that are moderately deep to shallow over hardpan clay.

The arable alluvial fans and flood plains are primarily used for crops, hay, or improved pasture. They occur on nearly level to gently sloping fans and terraces as deep well-drained loam or clay loam soils and deep, somewhat poorly drained alkali silty clay loam or silty clay loam with a weak pan soils. On flood plains they occur as deep, well-drained silt loam or sandy loam soils, and moderately deep soils to gravel which are well-drained loams, somewhat poorly drained silt loam-sandy loam, or poorly drained silty clay loam.

Fox Valley constitutes the major mountain valley or open basin, characterized by wet meadows and grass-shrub vegetation. The soils are dark, silty, well-drained soils that are deep over old sediments; dark, clayey, well-drained soils that are shallow over tuff, or deep over old sediments; black poorly drained soils in alluvium that are silty clay, silty clay loam, or alkali affected silty clay loam (Validation Team 1976).

LITERATURE REVIEW

The impact of falling raindrops and subsequent sediment transportation is the primary cause of soil and plant nutrient movement on rangelands. Raindrops strike the soil surface with incredible force, dislodging soil particles and stirring up soluble plant nutrients into the surface water (Osborn 1950).

Where bare soil exists, raindrops beat on the soil surface and seal the pores or entrances necessary for initial infiltration. Water accumulates on the soil surface, providing a means for transport of loose soil particles. As crumbs of surface soil are broken down by raindrops, the soil particles mix with water, plugs and seals any soil openings or vacant channels. As rainfall continues, increasing amounts of soil transport is possible (Osborn 1950).

Dortignac and Love (1961) stated that vegetative factors, particularly above ground, dead organic materials, are the most influential regarding infiltration. Coleman (1953) and Kittredge (1948) found that surface litter aided in reducing surface runoff and increasing infiltration. "Litter accumulation on the surface soil breaks the impact of falling raindrops, impedes or slows down surface runoff by providing roughness of surface through miniature barriers, prevents concentration of surface flow, reduces the detrimental effects of soil compaction caused by trampling and tends to leave the soil surface porous, spongy, irregular and receptive to water intake" (Osborn 1954, as quoted by Dortignac and Love 1961, p. 17). Consequently, by reducing detrimental soil splash and overland flow, soil erosion and associated turbidity of runoff water is reduced (Dortignac and Love 1961).

Vegetation provides a "cushion" for the driving force of raindrops. The negative surfaces absorb the impact and break the large drops into a fine spray. Consequently, the tremendous energy of a storm is absorbed by the vegetation. Soil surface pores or entrances necessary for initial infiltration are not sealed, runoff is reduced and soil damage is minimal. When the vegetation on an area is removed faster than it is produced, this natural cushion is destroyed, thereby subjecting the soil to the driving forces of rain. The capacity of the soil to absorb water and supply nutrients necessary for plant growth is decreased, thereby reducing, through time, the capacity of the soil to produce enough cover for its own protection as well as forage for wildlife feed (Osborn 1950).

Contrary to what might normally be expected, sediment yields do not always increase with increasing rainfall (Fig. 2). Although soil erosion potential increases with increasing rainfall, erosion is increasingly inhibited because as rainfall increases, vegetation density increases and erosion pavement decreases correspondingly. However, one aspect should be noted: Areas receiving approximately 10"-14" of precipitation are areas which yield the most natural sediment production, because enough rain occurs to cause erosion, but not enough occurs to provide a continuous dense vegetational cover (Satterlund 1972).

Consequently, while forested mountains mainly provide streamflow in western United States, rangelands are mainly responsible for

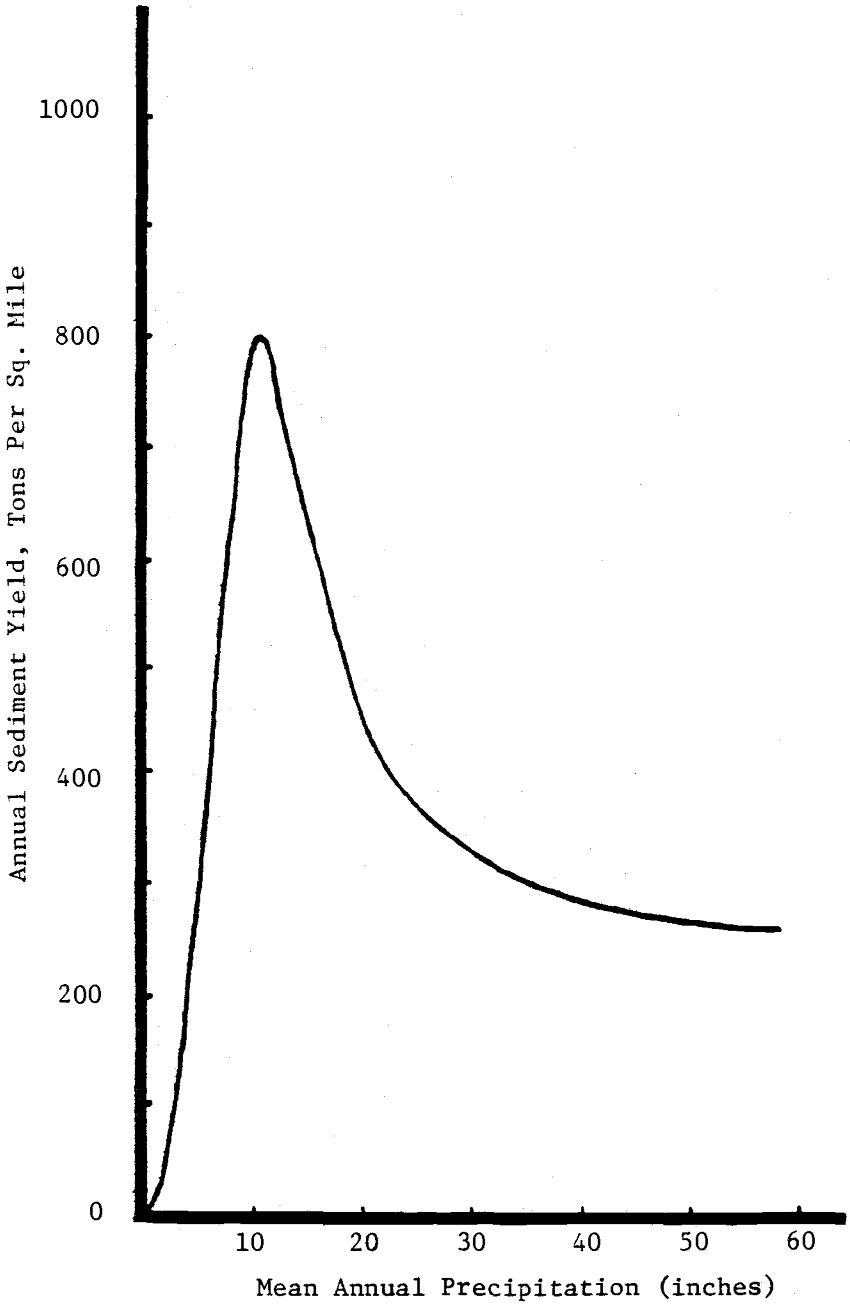

Figure 2. Relationship between natural (geologic) sediment yields and mean annual precipitation (Satterlund 1972).

sediment production (Branson et al. 1972). In four studies described by Branson et al. (1972), grazing was correlated with runoff on rangelands and they concluded that as grazing intensity increased, runoff increased accordingly. Lusby (1970) further showed that grazing and sediment yields were correlated and this was due to the fact that grazing caused an increase of rock and bare soil and a corresponding decrease in vegetative ground cover. Renner (1936) emphasized that overgrazing was the most important factor because of removal of plant cover and litter and due to the effects of trampling. In contrast, Dunford (1949) determined that while both heavy and moderate grazing resulted in increased runoff, heavy grazing resulted in a considerable increase in erosion while moderate grazing did not significantly increase the erosion in comparison to ungrazed plots.

When a vegetational conversion occurs on a watershed, it is primarily for the purpose of elimination of vegetation type of low value and replacing it with a vegetation type which is more beneficial (Branson et al. 1972). Pase and Ingebo (1965) investigated 2 watersheds which were burned. Subsequently, one was seeded to grass while the other was allowed a natural shrub recovery. By the end of 4 years, runoff from the naturally regenerated watershed was approaching pre-burn conditions.

However, on the watershed converted to grass, runoff increased from 1 inch per year to 6 inches per year. Hibbert (1971) noted that in areas receiving less than 16 inches of precipitation annually, increase in water yield resulting from land treatment is not likely to exceed 2 inches. Contrastingly, as annual precipitation amount increases up to 34 inches, vegetation conversions result in increased water yield. In the west, there have been vegetation conversions from low density chaparral (Brown 1970), pinyon-juniper types (Collings and Myrick 1966) and Utah juniper types (Wilm 1966) to grass with no statistically significant increase in water yield, pointing out that even Hibbert's model for water yields from low precipitation zones may have been optimistic.

Branson et al. (1972) state that although many conversions from sagebrush to grasslands have occurred in the past few hydrologic studies have been conducted to evaluate these conversions. Nevertheless, they speculate, it does not seem likely that increased streamflows would result because of the low precipitation zones in which sagebrush grows. Branson (1970) pointed out in a Colorado study, that such a conversion in a big sagebrush watershed actually decreased water yield compared to a big sagebrush watershed where the brush was not removed.

Therefore, for ample watershed protection, an understanding of the relationship of grazing and range improvements to erosion and runoff is essential prior to the development or implementation of any grazing management scheme designed to provide sustained high yields of forage and animal products (Rich and Reynolds 1963).

METHODS

On areas which had ecological classification, resource units, productivity classes, and condition classes identified by the U.S. Forest Service Validation Team, runoff and potential sediment losses were determined using a modified Rocky Mountain infiltrometer (Dortignac 1951). The simulated rainstorms from this infiltrometer were calibrated to a storm intensity of approximately 10 cm per hour. All sample plots were pre-wetted prior to application of simulated rainfall in order to eliminate antecedent moisture effects. The simulated rainfall lasted for 28 minutes with rainfall and runoff collected after 3 minutes and at 5 minute intervals thereafter. A wind screen was used at each plot to reduce the effects of wind disturbance when it was necessary.

The runoff samples were collected in glass jars. After allowing sufficient time for the sediment to settle, the clear water was decanted. The sediments remaining in the jars were oven dried at 105°C. Sediment loss was calculated as the difference in weight between the sediment-filled jar and the clean weight of the same bottle and converted into a kg/ha basis.

Resource units on which management practices (rangeland improvements) were conducted were also sampled in the same manner as previously stated. Such rangeland improvements included: seeding, thinning, herbicide spraying, mechanical brush control, and certain combinations of 2 or more practices. Natural or unimproved resource units of similar soil type and ecological expression were sampled and used as controls. Areas used as controls were previously sampled by Gaither (1981). Gaither's research investigated these ecosystems in a "natural" state, whereas this study compared his results to infiltration and sediment losses following range improvement practices.

Thinnings were sampled on the Wilburn, Hewett and Lane ranches; thinning and subsequent seeding on the Vaughn and Wilburn ranches; seedings on the Morgrass, Vaughn and Wilburn ranches; juniper and sagebrush removal and subsequent seeding on the Wilburn ranch; and herbicide spraying of sagebrush on the Cavender ranch.

Initial sampling consisted of 6 plots, each containing 3 subplots for a total of 18 observations per resource unit. An average infiltration rate was determined from the subplots for each time interval during the simulated rainstorm and plotted as a line graph. This plotting process was conducted for each resource unit and a family of curves was subsequently derived.

To determine whether significant relationships exist between resource units, an analysis of variance was used. An F-test was employed to determine significant differences. The LSD test to separate means was used on those resource units which were found to exhibit significant differences.

RESULTS AND DISCUSSION

Mountain Grassland Ecosystem - Moist Rolling Hills (36-III-PC)

This treatment involved a seeding on the Ferg unit which is located on the Jack Johns ranch. Prior to treatment, vegetational cover of the area was 45% grasses and forbs and with 15% litter and 40% bareground. Pretreatment sampling occurred in mid-July 1977. The area was disked using a tractor in October 1977. In early June 1978 the area was disked again in the same manner and the area was seeded with intermediate wheatgrass (*Agropyron intermedium*), Ladak alfalfa (*Medicago sativa*) and birdsfoot trefoil (*Lotus corniculatus*) at the rate of 9 kg/ha, 1.1 kg/ha and 1.1 kg/ha, respectively, using a rangeland drill. At sampling time in mid-July 1980 vegetational cover was 37% grasses and forbs with 48% bareground and 15% litter.

The treated site had a significantly higher infiltration rate ($p < 0.05$) for the 3-8 minute time interval while the reverse occurred during the last (23-28 minute) time interval (Fig. 3). No significant differences between infiltration rates were found during other portions of the storm.

In addition, the treated area exhibited a significantly less average potential sediment loss than the control ($p < 0.05$). The treated area lost an average of 190.8 kg/ha while the control area lost an average of 1118.7 kg/ha.

These results may indicate that in the 2 years following treatment the vegetational change had improved infiltration characteristics in those surface soil layers which caused an increase in infiltration

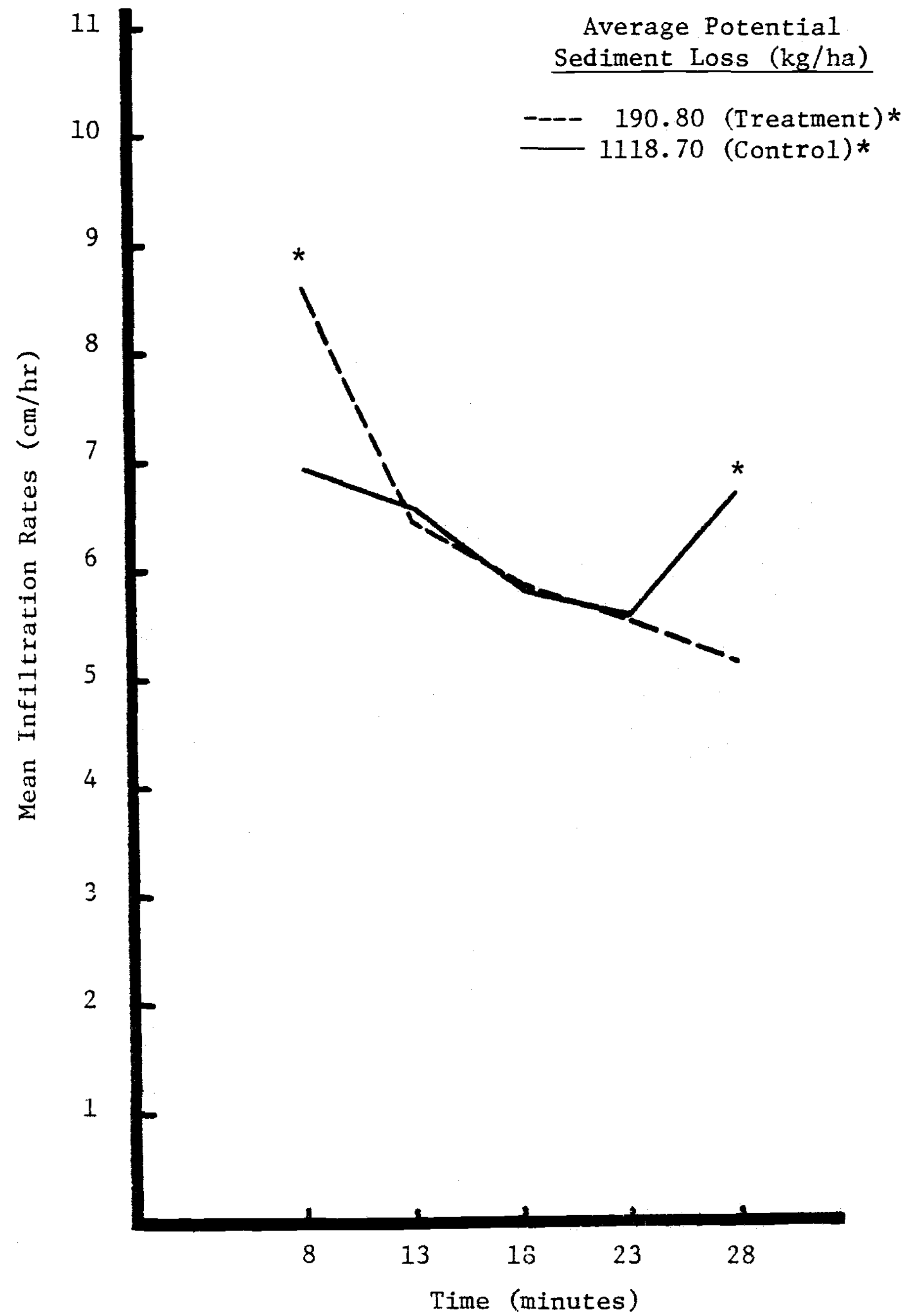

Figure 3. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered mountain grassland ecosystem - moist rolling hills (36-III-PC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

during the first 8 minutes of the run. However, such characteristics were not sufficient to permit such phenomena to last throughout the duration of the run. Results obtained during the last time interval indicate that 2 years post-treatment had not been sufficient time for the treated area to totally regain the original vegetative cover and correspondingly the infiltration characteristics of the control area. Also, despite the fact that the control had 8% more vegetative cover and, correspondingly, 8% less bareground it had a significantly higher average potential sediment loss.

Mountain Grassland Ecosystem - Shrubby Rolling Hills (36-III-PC)

This seeding took place on the Jack Johns ranch on a portion of land known as the Bowman place. Prior to treatment vegetational cover was 45% grasses and forbs with 40% bareground and 15% litter. The area was plowed and disked using a D2 cat in mid-October 1977. During the latter part of May 1978 the area was disked again using a rubber tired tractor and seeded to intermediate wheatgrass at 9.0 kg/ha using a rangeland drill. The area was sampled in late June 1980 at which time the vegetational cover was 27% intermediate wheatgrass with 61% bareground, 8% litter and 4% dung. The grass had been grazed to a stubble height of approximately 5 inches.

The control area had significantly higher infiltration rates ($p < 0.05$) during the entire storm (Fig. 4). In addition, the control area had a significantly lower average potential sediment loss of 1118.7 kg/ha, whereas an average sediment loss of 1978.6 kg/ha occurred on the treated area ($p < 0.05$).

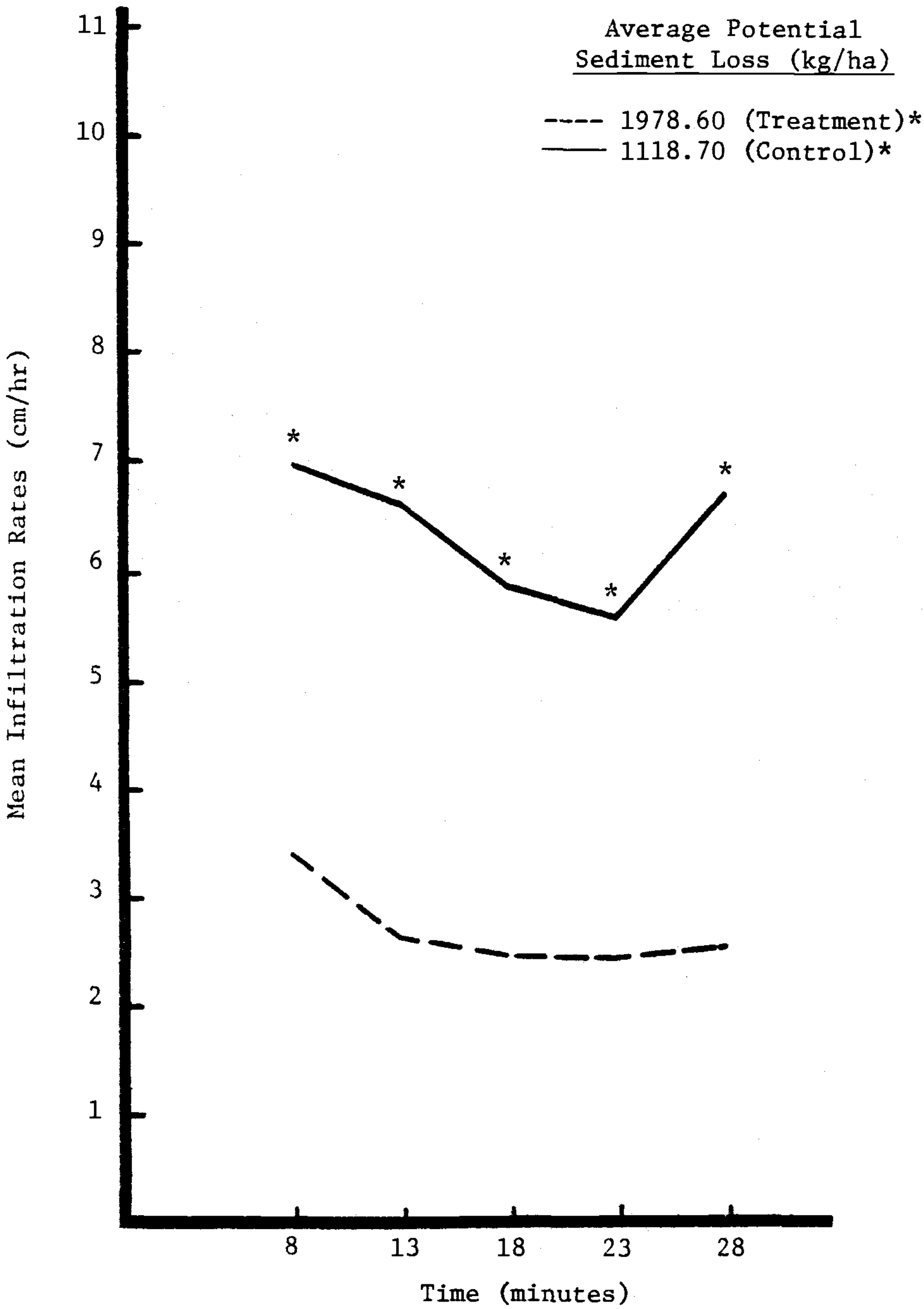

Figure 4. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered mountain grassland ecosystem - shrubby rolling hills (36-III-PC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

"Range improvement practices may influence infiltration rates in many ways. Mechanical disturbance of the surface soil or increased vegetational cover may increase or decrease infiltration rates" (Branson et al. 1972, p. 28). Rauzi et al. (1968) pointed out that a high correlation exists between soil water intake and soil structure of the first horizon. Soil structure obtained through time under natural ecological processes can be altered through plowing and can lead to poorer infiltration rates. In two big sagebrush studies, one by Gifford and Skau (1967) and another by Gifford (1972), infiltration rates following treatment were lowered by sagebrush plowing, the former having been seeded to crested wheatgrass.

The results of this trial were found to correspond with the above discussion as well as with the information found in the literature review. The treated area had only 60% of the pre-treatment vegetational cover, approximately one-half the litter cover and 20% less bareground, which lent itself to lower infiltration rates and higher sediment losses.

Mountain Grassland Ecosystem - Steep North (36-III-PC)

This site, located immediately north of the Cavender home, involved the spraying of big sagebrush (Artemisia tridenta) with 2,4-D. Prior to treatment vegetational cover was 40% grasses and forbs and 10% sagebrush with 35% bareground and 15% litter. During mid-May 1978 the area was sprayed using a helicopter. Infiltrometer sampling was done in mid-July 1980. A 100% kill of sagebrush was evidenced and the vegetational cover at that time was 85% dead cheatgrass (Bromus tectorum) and 3% bluebunch wheatgrass (Agropyron spicatum) with 3% bareground and 9% litter.

Infiltration rates on the control area were significantly higher ($p < 0.05$) than those of the treated area for all time intervals (Fig. 5). The control area also displayed a significantly higher average potential sediment loss of 1118.7 kg/ha whereas the treated area lost only an average of 174.4 kg/ha ($p < 0.05$).

The heavy invasion of cheatgrass on the treated area effectively decreased bareground by 27% while simultaneously increasing ground cover by the same amount. However, such a compositional change in vegetation was not sufficient in itself to promote the significantly higher pretreatment infiltration rates. This can be due to the fact that an invading annual like cheatgrass may lack the infiltration enhancement capabilities which may be found in other grass species. Furthermore, at the time of sampling, the cheatgrass was dead and this may have compounded reasons infiltration rates found on the treated area were significantly lower than the control. In conjunction, the control area, with its larger percentage of bare ground, lost a greater average amount of sediment.

Mountain Grassland Ecosystem - Bottomland Fan (36-III-PC)

This site is located on the Dogleg pasture of the Wilburn ranch. Prior to treatment vegetative cover was 45% grasses and forbs with 40% bareground and 15% litter. The area was drilled, without seed-bed preparation, with a rangeland drill (using a TD9 cat). The treatment

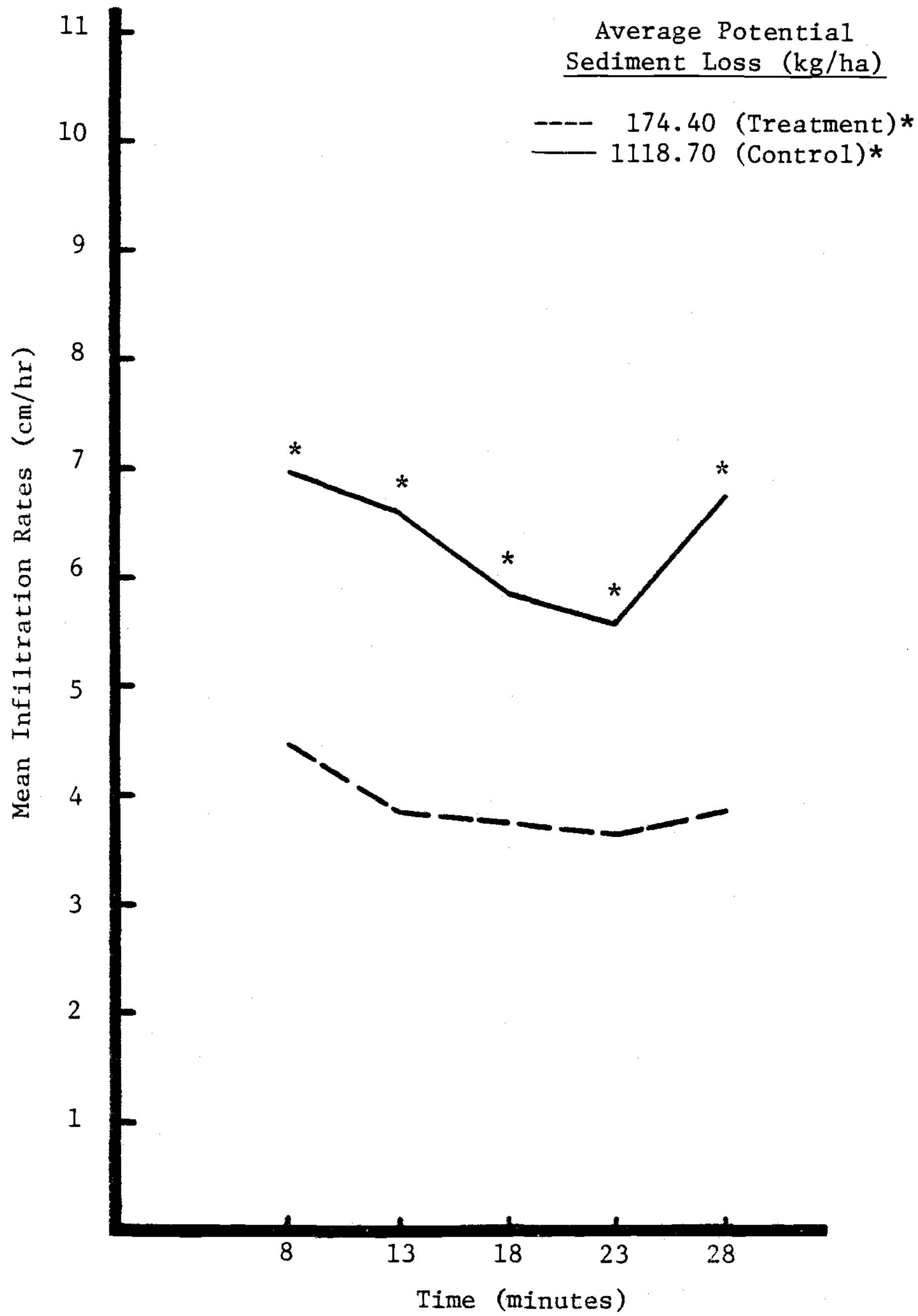

Figure 5. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered mountain grassland ecosystem - steep north (36-III-PC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

began in early December 1978 and was completed by mid-April 1979. A seeding mix of intermediate wheatgrass (9.0 kg/ha) and alfalfa (2.2 kg/ha) was planted. Sampling took place on the last day of July 1980 at which time vegetational cover consisted of 27% intermediate wheatgrass and smooth brome (*Bromus inermis*), 18% alfalfa and 15% forbs with 15% litter and 25% bareground.

The planted area had a significantly higher infiltration rate during the 3-8 minute time interval ($p < 0.05$) but no significant differences in infiltration rates existed during the remainder of the storm (Fig. 6). In addition, the planted area lost an average of 140.3 kg/ha of sediment whereas the control lost a significantly higher average of 1118.7 kg/ha ($p < 0.05$).

Slightly longer than 15 months time elapsed between treatment completion and post-treatment sampling. This apparently was sufficient time for the planted vegetation to improve those soil infiltration characteristics of the upper soils necessary for the higher infiltration rate that the treated area displayed during the 3-8 time interval. Evidently, the planted vegetation had not improved soil infiltration characteristics beyond that of the control in those lower soil levels which would result in higher infiltration rates for the treated area throughout the run.

Vegetational cover was increased and bareground decreased by 15% due to the treatment. This may account for the decrease in the potential average sediment loss on the treated area.

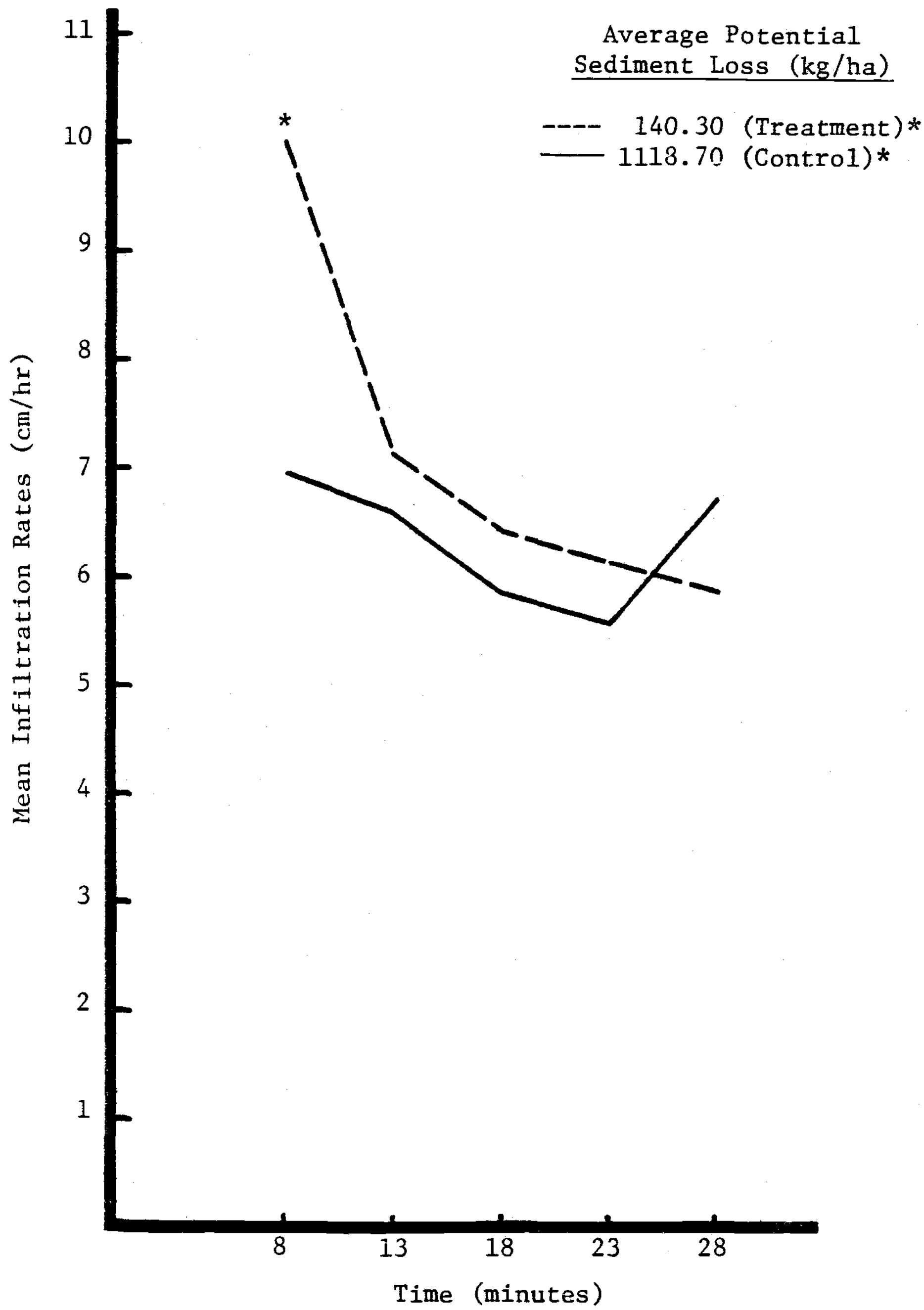

Figure 6. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered mountain grassland ecosystem - bottomland fan (36-III-PC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

Mountain Grassland Ecosystem - Bottomland Fan (36-III-PC)

This site is located on the John Porter pasture of the Morgrass ranch. Prior to treatment, vegetational cover was 45% grasses and forbs with 40% bareground and 15% litter. During early December 1976 the site was disked and harrowed using a D5 cat. In early May 1977 the site was harrowed again. In mid-May a rod weeder and packer using a D4 cat was used. The area was seeded in latter May, using a D6 cat and rangeland drill, to intermediate wheatgrass (11.2 kg/ha) and alfalfa (1.1 kg/ha). Vegetational cover at sampling which occurred in late August 1980, was 18% intermediate wheatgrass and 19% alfalfa with 15% bareground and 48% litter.

The control area had significantly higher infiltration rates ($p < 0.05$) through the entire storm (Fig. 7). In addition, the control area exhibited a lower average potential sediment loss of 1118.7 kg/ha compared to the treated area which lost an average of 1279.3 kg/ha. However, this difference in sediment loss was not found to be statistically significant ($p < 0.05$).

Mountain Grassland Ecosystem - Moist Rolling Hills (36-III-PC)

This site is located on the Broken Dam pasture of the Wilburn ranch. Prior to treatment vegetational cover was 45% grasses and forbs with 40% bareground and 15% litter. In mid-October 1977 the area was plowed, disked, packed and harrowed using a tractor.

In mid-November 1977 the area was planted, using a rangeland drill, to Manchar smooth brome and Cascade lotus (*Lotus corniculatus*)

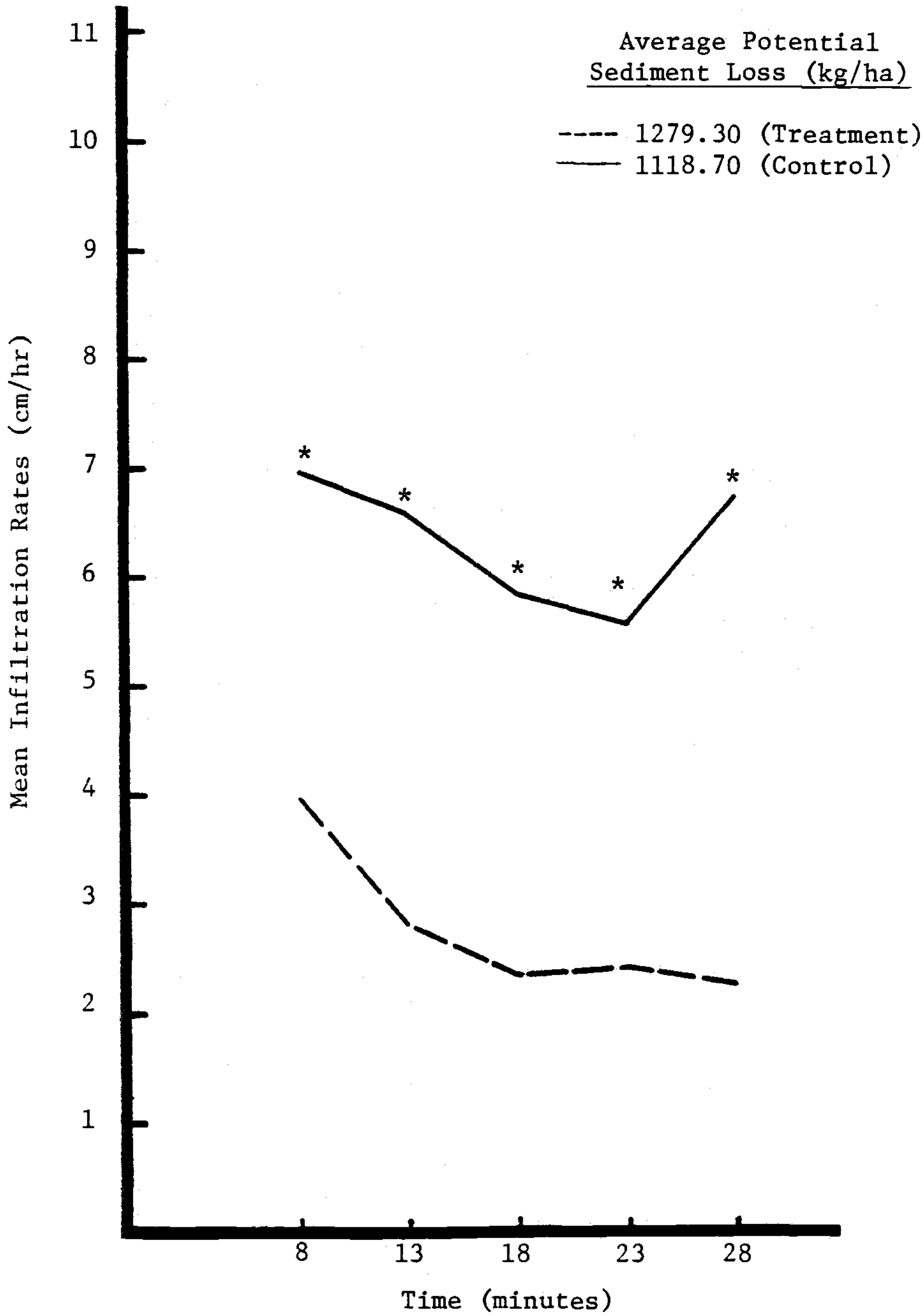

Figure 7. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered mountain grassland ecosystem - bottomland fan (36-III-PC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

at the rate of 11.2 kg/ha of seed of each. Sampling time occurred in mid-July 1980 at which time the vegetational cover was 72% with 13% bareground and 14% litter.

No significant difference existed between infiltration rates for the 3-8 time interval, however, infiltration rates were significantly higher ($p < 0.05$) for the control for the remainder of the storm (Fig. 8). The control area had an average potential sediment loss of 1118.7 kg/ha which was significantly higher than the treated area which lost an average of 211.3 kg/ha ($p < 0.05$).

The vegetational conversion increased cover and correspondingly decreased bareground by 27% but was inadequate in inducing significantly different infiltration rates for the first 8 minutes of the run.

Mountain Grassland Ecosystem - Shrubby Rolling Hills (36-III-PC)

This site is located on the Payne place of the Jack Johns ranch. Prior to treatment vegetational cover was 45% grasses and forbs with 40% bareground and 15% litter. In mid-November 1976 crested wheatgrass (*Agropyron cristatum*) was planted at a rate of 5.6 kg/ha with a rangeland drill. There was no seed bed preparation. At sampling time, in mid-July 1980, vegetational cover consisted of approximately 8% grasses (2% of which was crested wheatgrass), 60% pussy-toes (*Antennaria* spp.) and 2% forbs with 30% bareground. The crested wheatgrass was approximately 5-8 inches tall.

No significant differences between infiltration rates of the control and the treated area were demonstrated ($p < 0.05$) during the

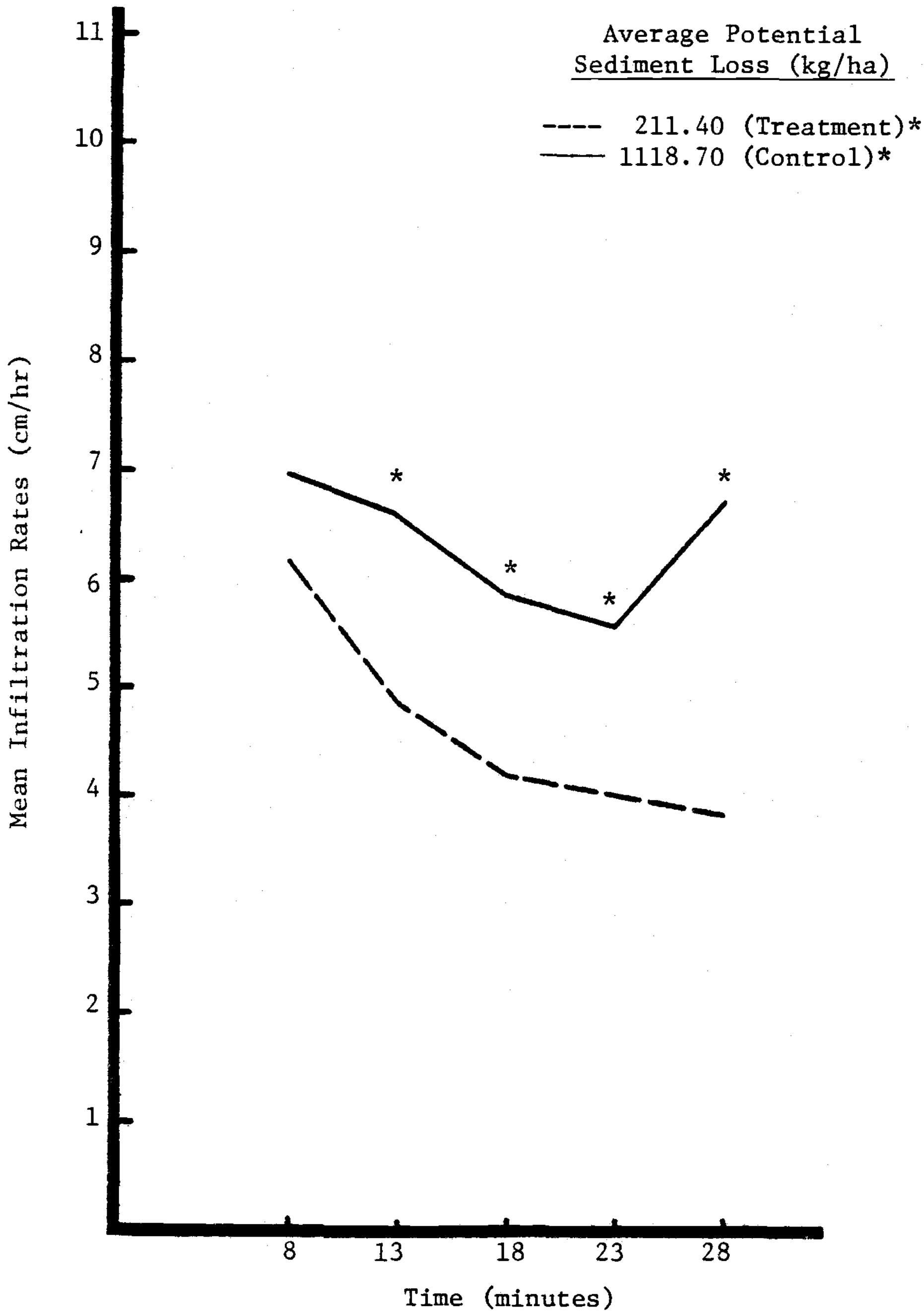

Figure 8. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered mountain grassland ecosystem - moist rolling hills (36-III-PC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

entire storm (Fig. 9). However, the control area had a significantly higher average potential sediment loss of 1118.7 kg/ha while the treated area lost an average of 248.0 kg/ha ($p < 0.05$).

The elapsed time between completion of treatment and post-treatment sampling was 3 years 8 months. Even though vegetational cover on the treated plot was 70% versus 45% on the control, 60% of it was pussy-toes, a very low growing and fragile forb. Very low amounts of crested wheatgrass (2%) were growing, indicating a poor seeding establishment. In addition, according to the results, rooting characteristics of pussy-toes do not appear to be conducive to improving infiltration rates. These factors may constitute the most likely reason why infiltration rates between the control and treated area showed no significant differences.

Mountain Grassland Ecosystem - Moist Rolling Hills (36-III-PC)

This seeding is located on the Clarence Porter unit of the Morgrass ranch. Prior to the treatment vegetational cover consisted of 45% grasses and forbs with 40% bareground and 15% litter. In late April 1977 seedbed preparation began. A D4 cat and rod weeder, then a D6 cat pulling a packer were used. In early May 1977 the area was seeded (using a D6 cat and a rangeland drill) to Nordan crested wheatgrass (*Agropyron cristatum*), Nomad alfalfa (*Medicago sativa*) and Alkar tall wheatgrass (*Agropyron elongatus*) at the rate of 11.2 kg/ha, 2.2 kg/ha and 0.6 kg/ha, respectively. At sampling time, in mid-August 1980, vegetational cover consisted of 17% tall and crested wheatgrass, 6% alfalfa and 3% other forbs with 46% bareground and 28% litter.

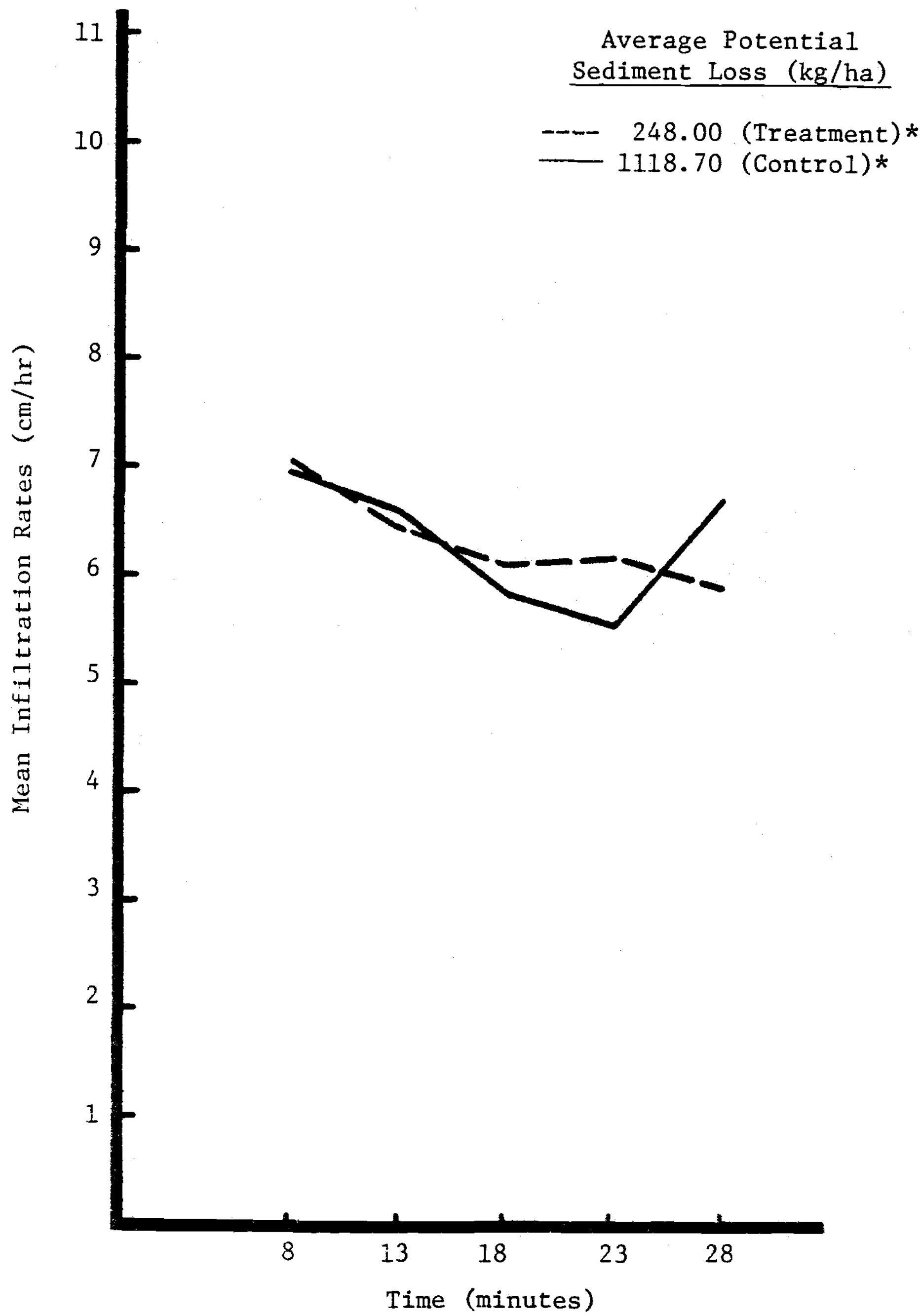

Figure 9. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered mountain grassland ecosystem - shrubby rolling hills (36-III-PC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

Differences in infiltration rates between the control and treated area were of no significance until after 8 minutes. Thereafter, the control showed significantly higher infiltration rates ($p < 0.05$) for the remaining portion of the storm (Fig. 10). The control showed an average potential sediment loss of 1118.7 kg/ha while the treated area lost an average of 1016.7 kg/ha. However, this was not found to be significantly different ($p < 0.05$).

Although live vegetative cover on the treated area was 19% lower than the control, indicating that 3 years following treatment had not been sufficient time for this site to regain the original vegetative cover and thus, infiltration rates characteristic of the control, this was slightly offset by a litter increase of 13%. In addition, despite a higher bareground percentage of 6% due to the application of the management practice, this was apparently insufficient to cause significant differences in sediment production between the two areas.

Mountain Grassland Ecosystem - Bottomland Fan (36-III-PC)

This site is located on the Clarance Porter unit of the Morgrass ranch. Vegetation cover prior to treatment was 45% grasses and forbs with 40% bareground and 15% litter. The same seedbed preparation was instrumented in the same manner, with the same equipment and at those dates which very closely correspond to those of the previously discussed seeding of the Clarance Porter unit occurring between late April and early May of 1977. Post-treatment vegetational cover consisted of 28% crested wheatgrass with 48% bareground and 24% litter when the site was sampled in mid-August 1980.

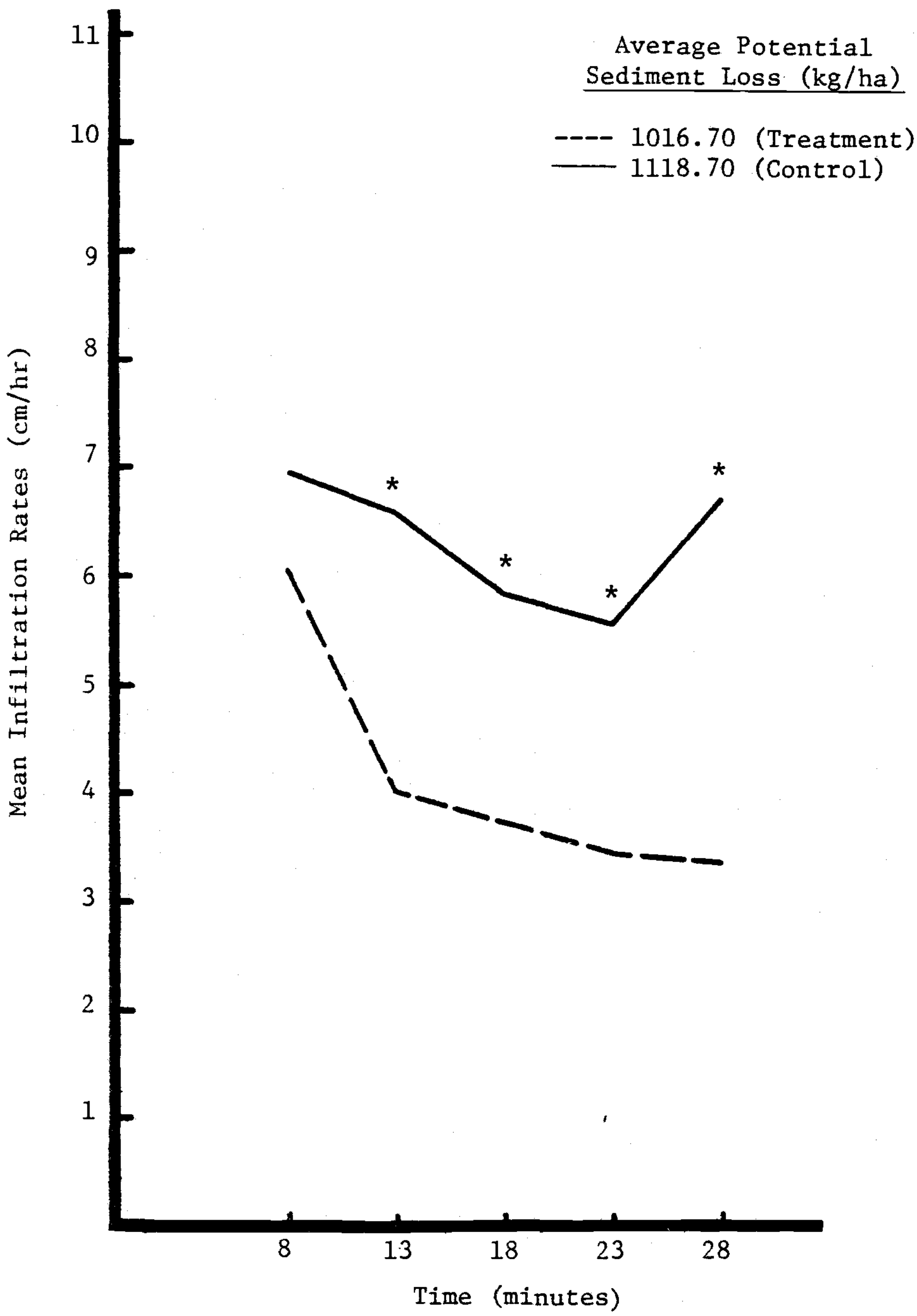

Figure 10. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered mountain grassland ecosystem - moist rolling hills (36-III-PC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

Infiltration rates were significantly higher ($p < 0.05$) for the control during the entire storm (Fig. 11). However, even though the control had an average sediment loss of 1118.7 kg/ha and the treated area lost only 563.9 kg/ha, this was not found to be statistically significant ($p < 0.05$).

Sagebrush Ecosystem - Clayey Terrace (29-III-PC)

This site is located on the Red Barn pasture of the Wilburn ranch. Pretreatment vegetation consisted of 15% grasses and forbs, 18% sagebrush (*Artemisia* spp.) and western juniper (*Juniperus occidentalis*) with 53% bareground and 14% litter. Mechanical removal of western juniper and low sagebrush (*Artemisia arbuscula*) occurred from mid-September to mid-October 1977. A D4 cat with brush blade was used to eliminate the sagebrush and some of the juniper trees. Other juniper trees were cut using a chain saw and stumps were left in place. Seeding of crested wheatgrass at the rate of 7.8 kg/ha was done using a tractor with a rangeland drill in late October and early November 1977. Vegetational cover at sampling time in late June 1980 was approximately 33% cheatgrass and 23% crested cheatgrass with 39% bareground and 5% litter.

Infiltration rates were significantly higher ($p < 0.05$) for the control area for the entire storm (Fig. 12). In addition, the control had a significantly higher average sediment loss of 3103.1 kg/ha compared to the treated area which lost an average of 1463.9 kg/ha ($p < 0.05$).

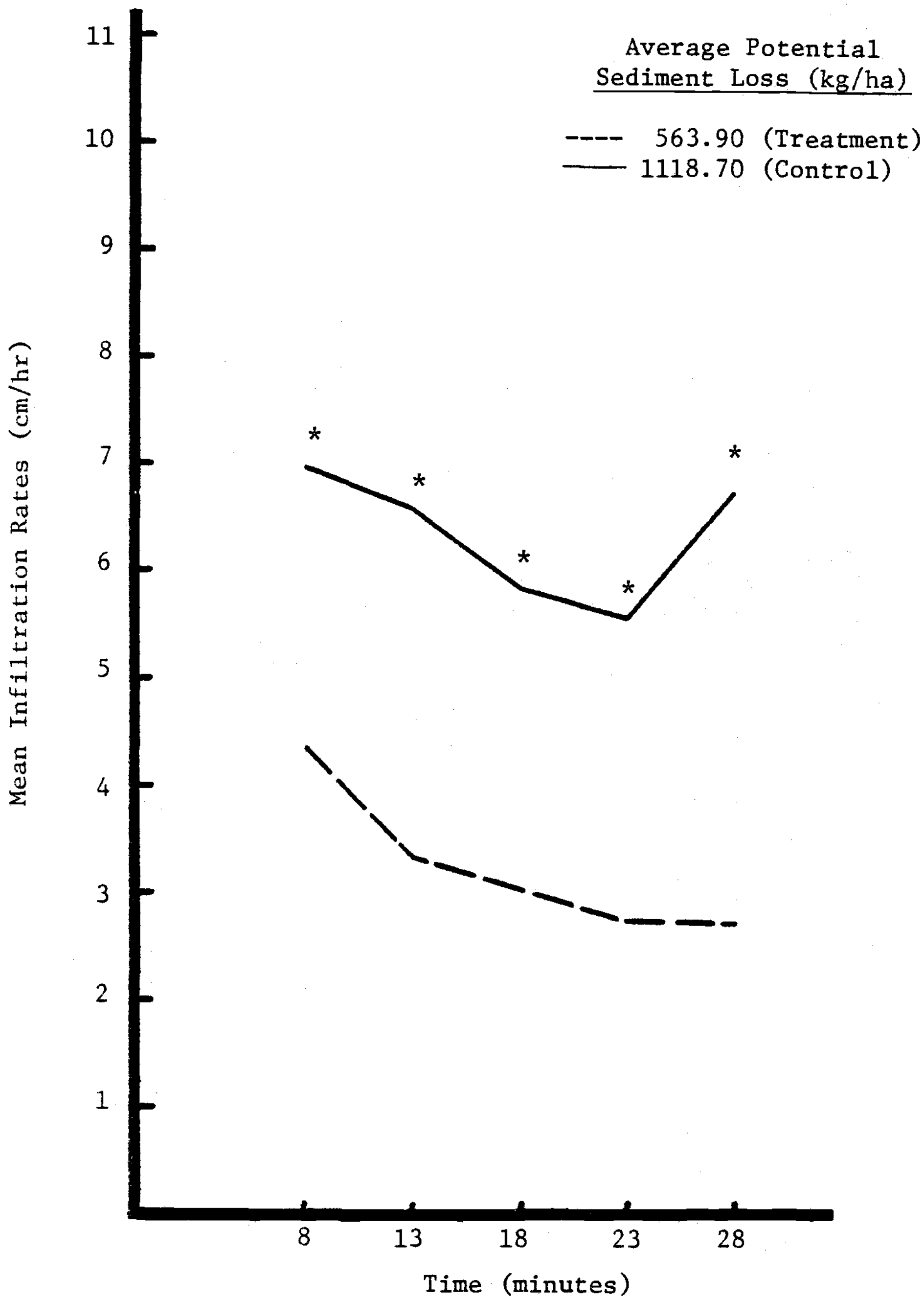

Figure 11. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered mountain grassland ecosystem - bottomland fan (36-III-PC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

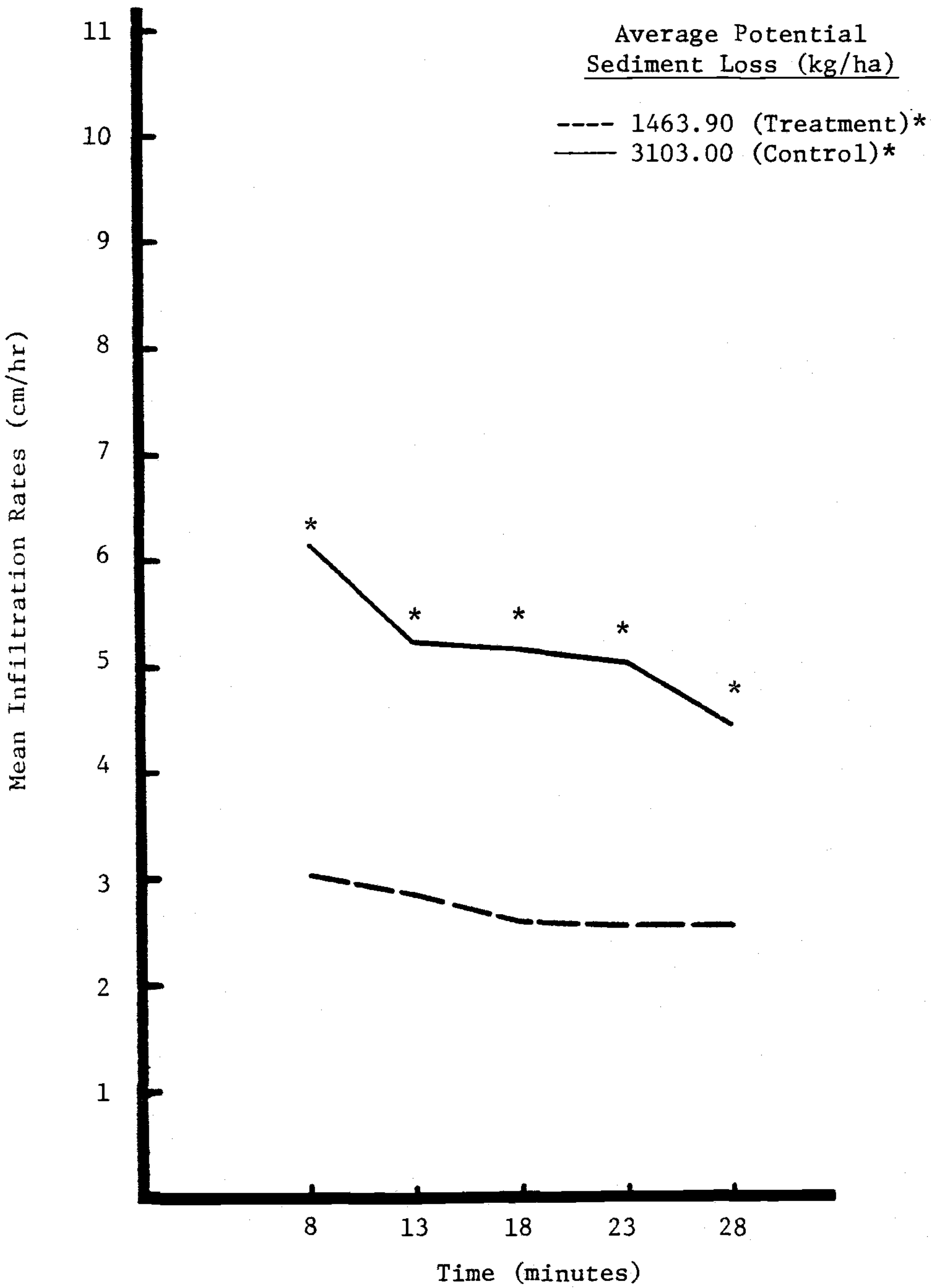

Figure 12. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered sagebrush ecosystem - clayey terrace (29-III-PC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

Douglas-fir Ecosystem - Pine-Mixed Fir-Sedge (20-IV-FC)

This site is located on pasture 1 of the Joe Lane ranch. Prior to treatment vegetational ground cover consisted of 26% grasses and forbs, 11% mosses and 10% grasslikes, with 8% bareground, 48% litter and 5% stone. Thinning of ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) occurred in early summer, 1979. Slash piling was also done in early summer using a cat. Post-treatment vegetational ground cover at sampling time in early August 1980 consisted of 1% forbs, 10% grasslikes and 1% shrubs with 88% litter, most of which was in the form of pine needles.

The control demonstrated significantly higher infiltration rates for the first 8 minutes of the storm, however, no significant difference ($p < 0.05$) between infiltration rates occurred for the rest of the storm (Fig. 13). In contrast, the control yielded a significantly higher average sediment loss of 130.0 kg/ha, whereas the treated area lost an average of only 33.7 kg/ha ($p < 0.05$).

Approximately 1 year elapsed between pre-treatment and post-treatment sampling. There was approximately 28% less live vegetation, 40% more litter cover and 8% less bareground on the treated area. Such a compositional change toward a lesser amount of rooted plants in ground cover plus some surface soil disturbance created by the cat may have been reasons why the control had significantly higher infiltration rates only for the first 8 minutes of the run and no significant differences existed for the remainder of the storm.

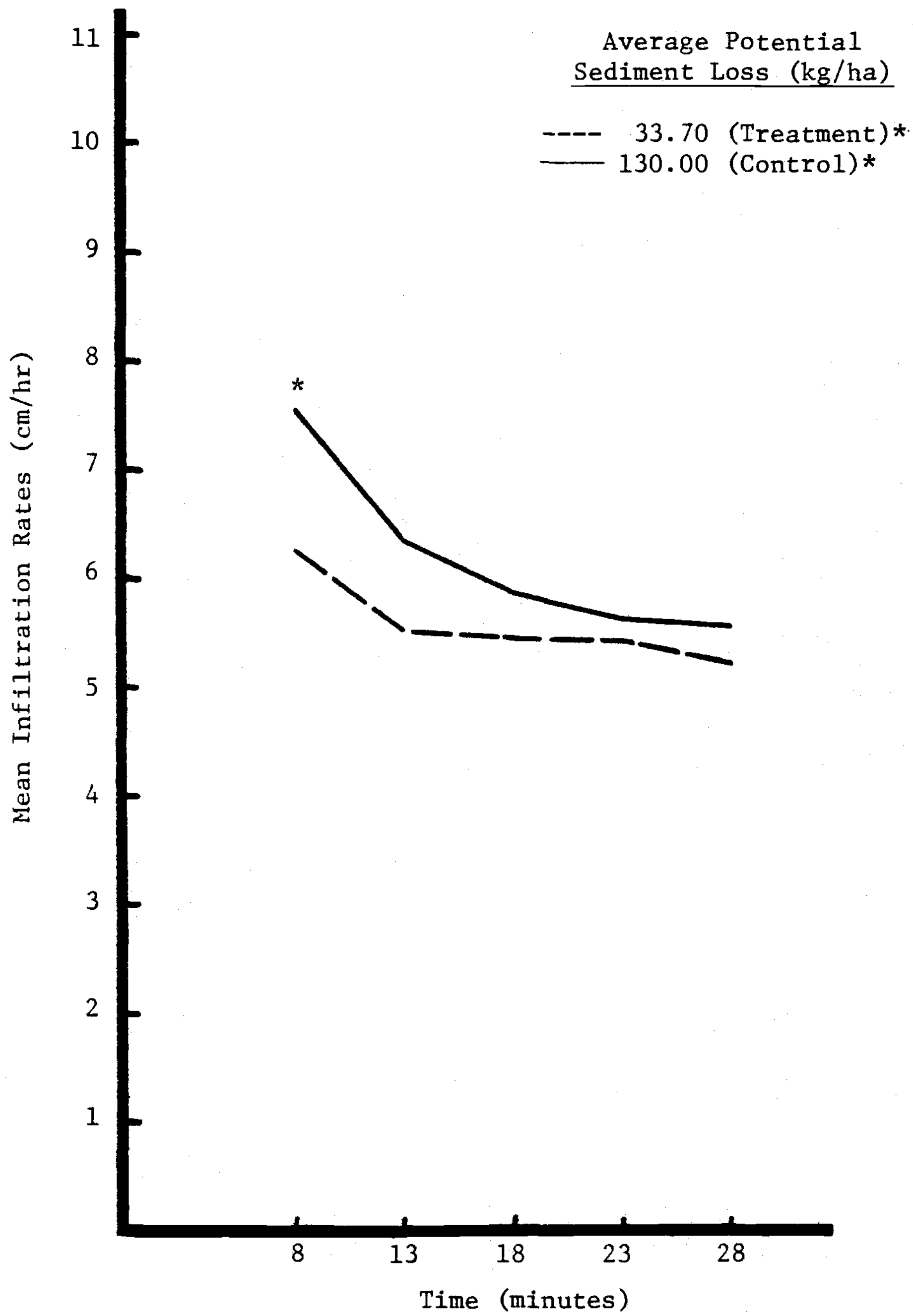

Figure 13. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered Douglas-fir ecosystem - pine-mixed fir-sedge (20-IV-FC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

Douglas-fir Ecosystem - Pine-Mixed Fir-Sedge (20-IV-GC)

This timber thinning is located on the Little Deer Creek pasture of the Wilburn ranch. Vegetational ground cover prior to treatment consisted of 5% mosses and lichens, 40% grasses and forbs, 7% grasslikes, 11% shrubs with 30% litter and 7% bareground. From early June until early July 1978 the stand was thinned. The entire month of August of that year was spent slash piling using a D4 cat with a blade and drum. During that same August month the area was seeded using a dribbler. Some debris disposal also occurred during early September 1978. The area was seeded with alfalfa, intermediate wheatgrass, orchard grass and brome (Bromus spp.) at the rate of 2.2 kg/ha, 4.5 kg/ha, 2.2 kg/ha and 2.2 kg/ha, respectively. Post-treatment vegetational cover at sampling time in late August 1980 consisted of 5% grasslikes and a trace of forbs, with 90% litter and 5% bareground.

Infiltration rates were found to be significantly higher ($p < 0.05$) for the treated area than for the control for the entire storm (Fig. 14). However, even though the treated area demonstrated an average potential sediment loss of 271.9 kg/ha compared to the control which lost an average of 133.4 kg/ha there was no significant difference ($p < 0.05$).

The percentage of bareground remained approximately the same, 7% and 5% for the pre-treated and post-treated areas, respectively. Despite the seeding attempt, litter cover, largely composed of pine needles, on the treated area was 60% higher and vegetational cover such as grasses, grasslikes, forbs and mosses was, compensatingly,

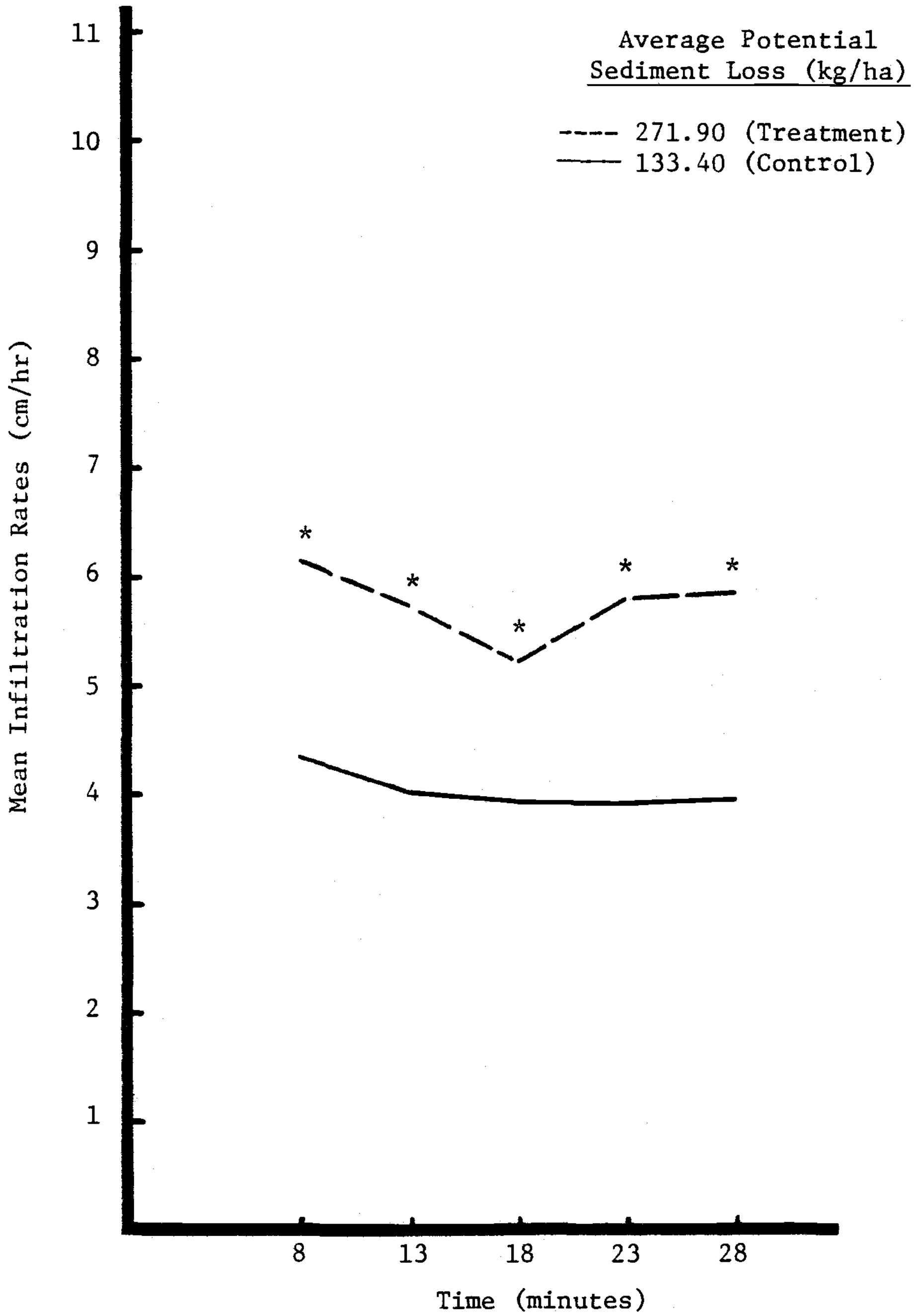

Figure 14. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered Douglas-fir ecosystem - pine-mixed fir-sedge (20-IV-GC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

58% lower than the control. Therefore even though infiltration rates on the treated area were significantly higher than for the control there was no significant difference in sediment production.

Larch Ecosystem - Mixed Fir-Pine Forest (25-III-FC)

This site is located on the Ferg unit of the Jack Johns ranch. Pretreatment vegetational ground cover consisted of 13% grasses and 16% shrubs with 71% litter. Between June 1 and August 10, 1978 the area was thinned. Piling was done using a D7 cat with a blade. Seeding of the thinned area using a tractor and broadcast seeder occurred during mid-September 1978. During late September of that year the area was also broadcast with seed using a hand seeder. On both seeding occasions there was no site preparation. A seeding mix of timothy (Phleum pratense), birdsfoot trefoil, orchardgrass and intermediate wheatgrass were used in seeding the site at the rate of 6.0 kg/ha, 0.8 kg/ha, 2.0 kg/ha and 8.4 kg/ha, respectively.

Inspection of the site in late July 1980, immediately prior to sampling, revealed that it could be divided into the following specific areas according to existing ground cover characteristics: a pinegrass (Calamagrostis rubescense) area, a seeded area, and a bareground area. Therefore, these 3 areas were sampled separately. The control which was contrasted to the 3 designated areas exhibited an average potential sediment loss of 2.1 kg/ha.

The pinegrass area was relatively undisturbed from machinery. It supported a duff layer of approximately 1" to 1.5". Post-treatment vegetational ground cover at sampling time consisted of approximately 17% grasses, 14% forbs and 1% mosses and lichens with 66% litter and 2% bareground which was somewhat crusted. Infiltration rates were found to be significantly higher ($p < 0.05$) for the control during the entire storm (Fig. 15). Correspondingly, the average potential sediment loss for the control was found to be significantly lower than for the treated area which lost an average of 41.9 kg/ha ($p < 0.05$).

Post-treatment vegetational ground cover at sampling time on the planted area consisted of approximately 28% grasses (10% orchard grass, 3% timothy), 8% forbs, and 9% lichens with 33% litter, 2% gravel or stone and 20% bare ground. Infiltration rates were found to be significantly higher ($p < 0.05$) for the control than the treated area (Fig. 16). In this case, also, the control had a significantly lower average potential sediment loss than the treated area which lost an average of 244.7 kg/ha ($p < 0.05$).

Post-treatment vegetational ground cover at sampling time on the bareground area consisted of approximately 1% forbs and 11% mosses and lichens with 62% litter and 26% bareground. Infiltration rates on the control were found to be significantly higher ($p < 0.05$) than those of the treated area (Fig. 17). The control again exhibited a significantly lower average potential sediment loss than the treated area which lost an average of 621.6 kg/ha ($p < 0.05$).

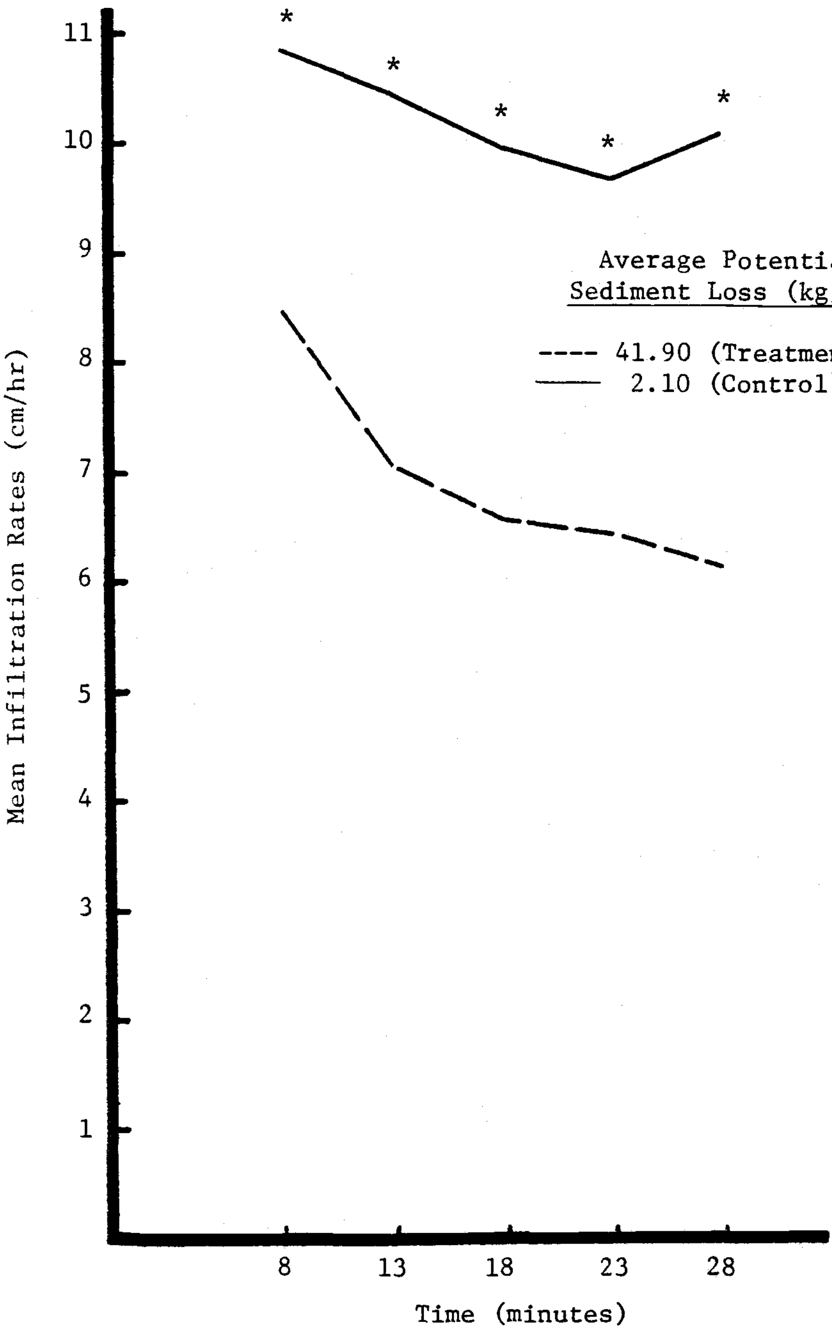

Figure 15. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered larch ecosystem - mixed fir-pine forest (25-III-FC) (pinegrass area). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

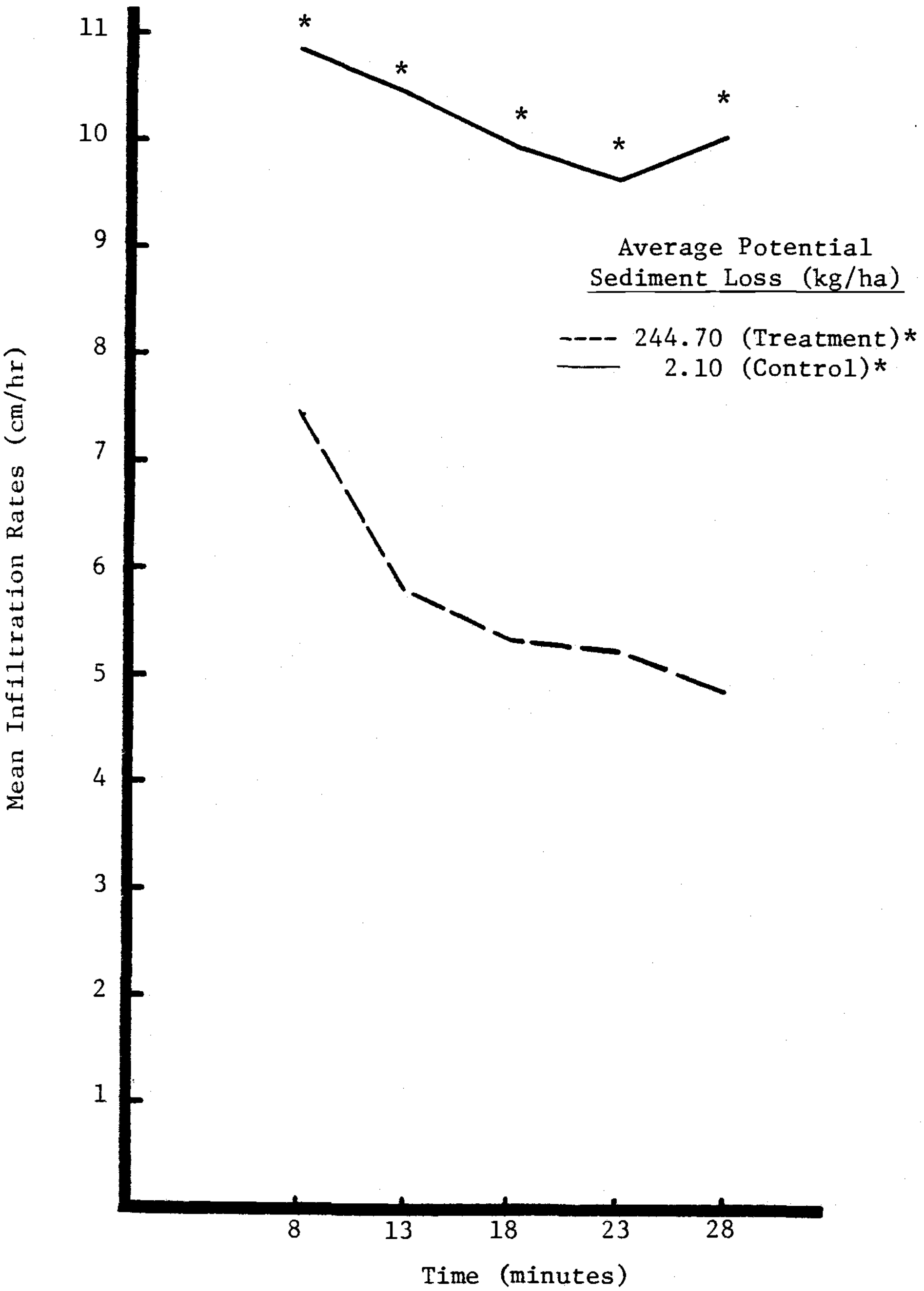

Figure 16. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered larch ecosystem - mixed fir-pine forest (25-III-FC) (seeded area). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

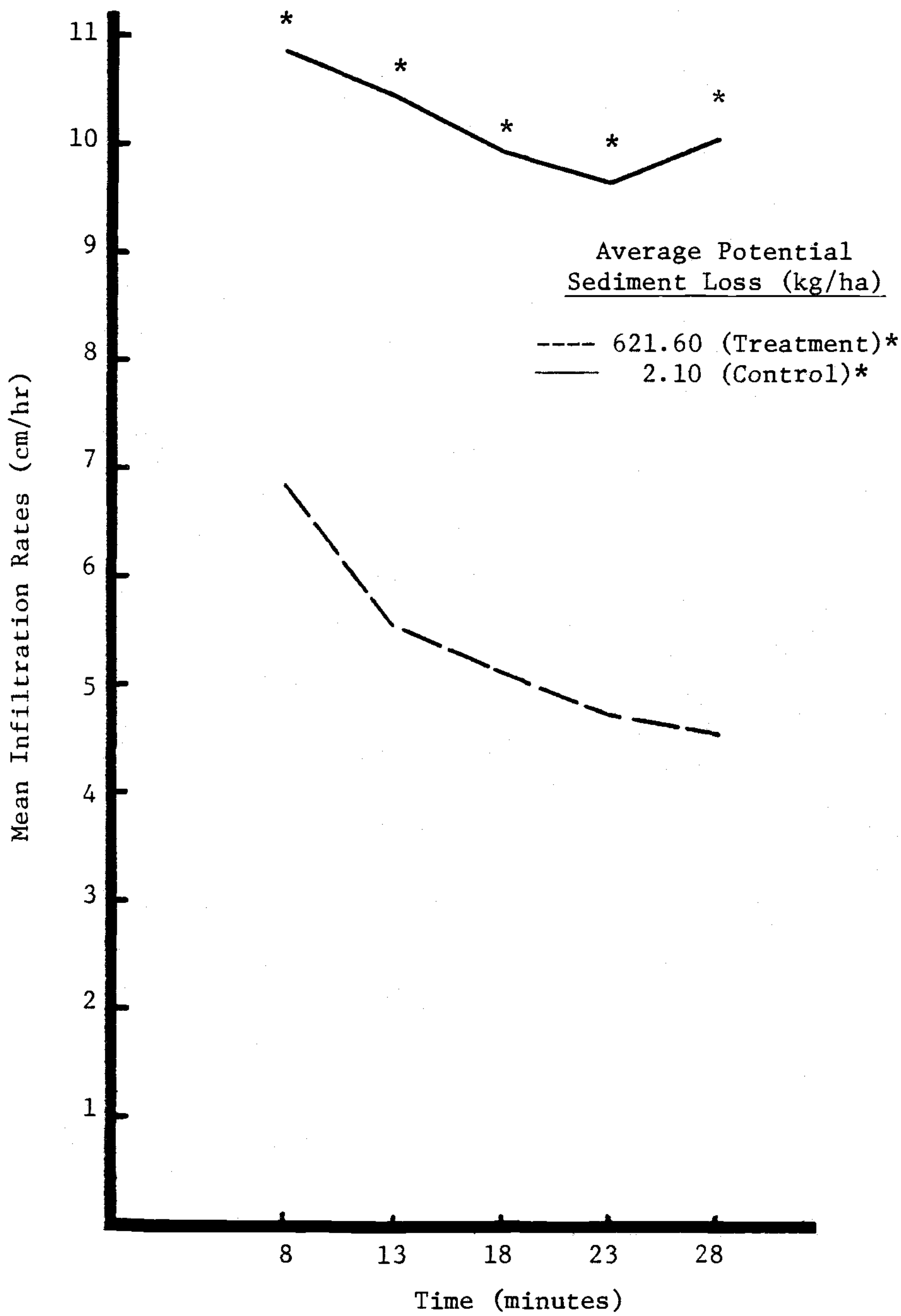

Figure 17. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered larch ecosystem - mixed fir-pine forest (25-III-FC) (bareground area). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

Ponderosa Pine Ecosystem - Pine-Sedge (21-IV-GC)

This site is located in the south pasture of the Paul Hewitt ranch. Vegetational ground cover prior to treatment was 9% grasses and forbs, 14% grasslikes, 3% mosses and lichens and 1% shrubs with 66% litter and 7% bareground. Timber thinning began in mid-February 1978 and was finished by the end of July of the same year. Debris disposal occurred during mid-May and again during the first half of the month of October 1978 using a D7 cat with a blade. Post-treatment vegetational cover at sampling time consisted of 52% grasses and forbs and 1% shrubs with 46% litter and 1% bareground.

Infiltration rates were found to be significantly higher ($p < 0.05$) during the entire storm for the treated area (Fig. 18). In addition, the treated showed a significantly lower average potential sediment loss of 49.2 kg/ha compared to the control which lost an average of 141.2 kg/ha ($p < 0.05$).

Ponderosa Pine Ecosystem - Pine-Sedge (21-IV-GC)

This thinning, located on the King allotment of the Wilburn ranch, was not a validation practice. Vegetational ground cover prior to treatment was 9% grasses and forbs, 14% grasslikes, 3% mosses and lichens and 1% shrubs with 66% litter and 7% bareground. The area was thinned in approximately 1977. Slash piling was done using a D4 cat.

After observation of the site, immediately prior to sampling in early June 1980, the decision was made to divide it into vegetated (relatively undisturbed) and non-vegetated (disturbance resulting

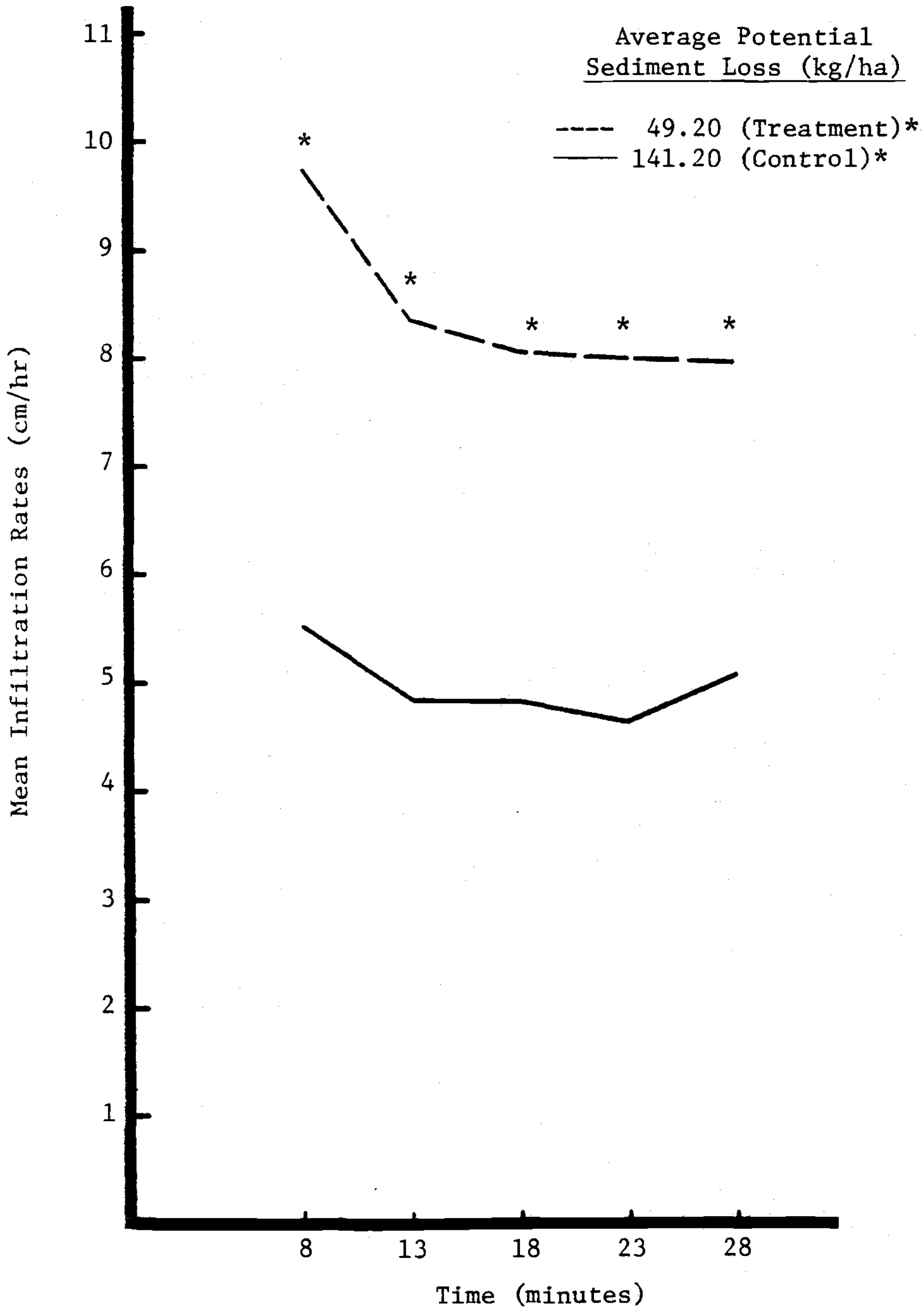

Figure 18. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered ponderosa pine ecosystem - pine-sedge (21-IV-GC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

from use of a crawler tractor) areas. These two classifications of the area were sampled separately. The control which was compared to these two areas displayed an average potential sediment loss of 141.2 kg/ha.

Post-treatment vegetational ground cover on the bareground area was 2% grasses and forbs and 1% shrubs with 7% litter and 90% bareground. Infiltration rates were found to be significantly higher ($p < 0.05$) for the control during the entire storm (Fig. 19). Coincidingly, the treated area had an average potential sediment loss of 11,330.8 kg/ha which was found to be significantly higher than for the control ($p < 0.05$).

Post-treatment vegetational ground cover for the vegetated area was 9% grasses and forbs, 14% grasslikes, 3% mosses and lichens and 1% shrubs with 66% litter and 7% bareground. Infiltration rates between the control and treated area (Fig. 20) were not found to be significantly different during any portion of the storm. In addition, even though the control had an average potential sediment loss of 141.2 kg/ha and the treated area lost 201.6 kg/ha, these differences were not found to be statistically significant ($p < 0.05$).

Ponderosa Pine Ecosystem - Pine-Bunchgrass (21-IV-FC)

This timber thinning was located on the north pasture (pasture #5) of the Hewitt ranch. Prior to treatment vegetational ground cover was 32% grasses and forbs and 6% shrubs with 58% litter and 4% bareground. Timber thinning occurred between January and April of 1978. Slash piling occurred during the same year. At sampling time

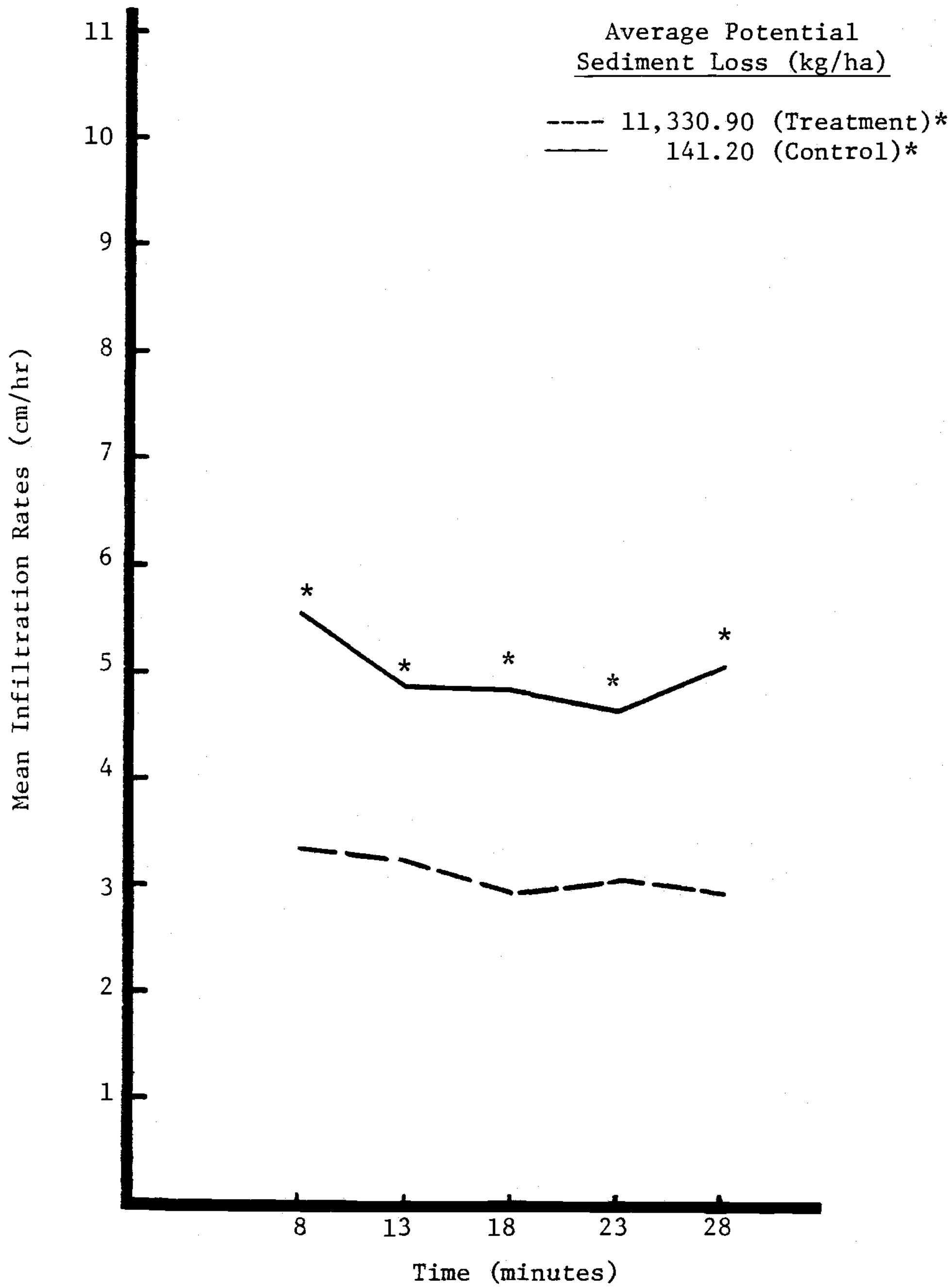

Figure 19. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered ponderosa pine ecosystem - pine-sedge (21-IV-GC) (bareground). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

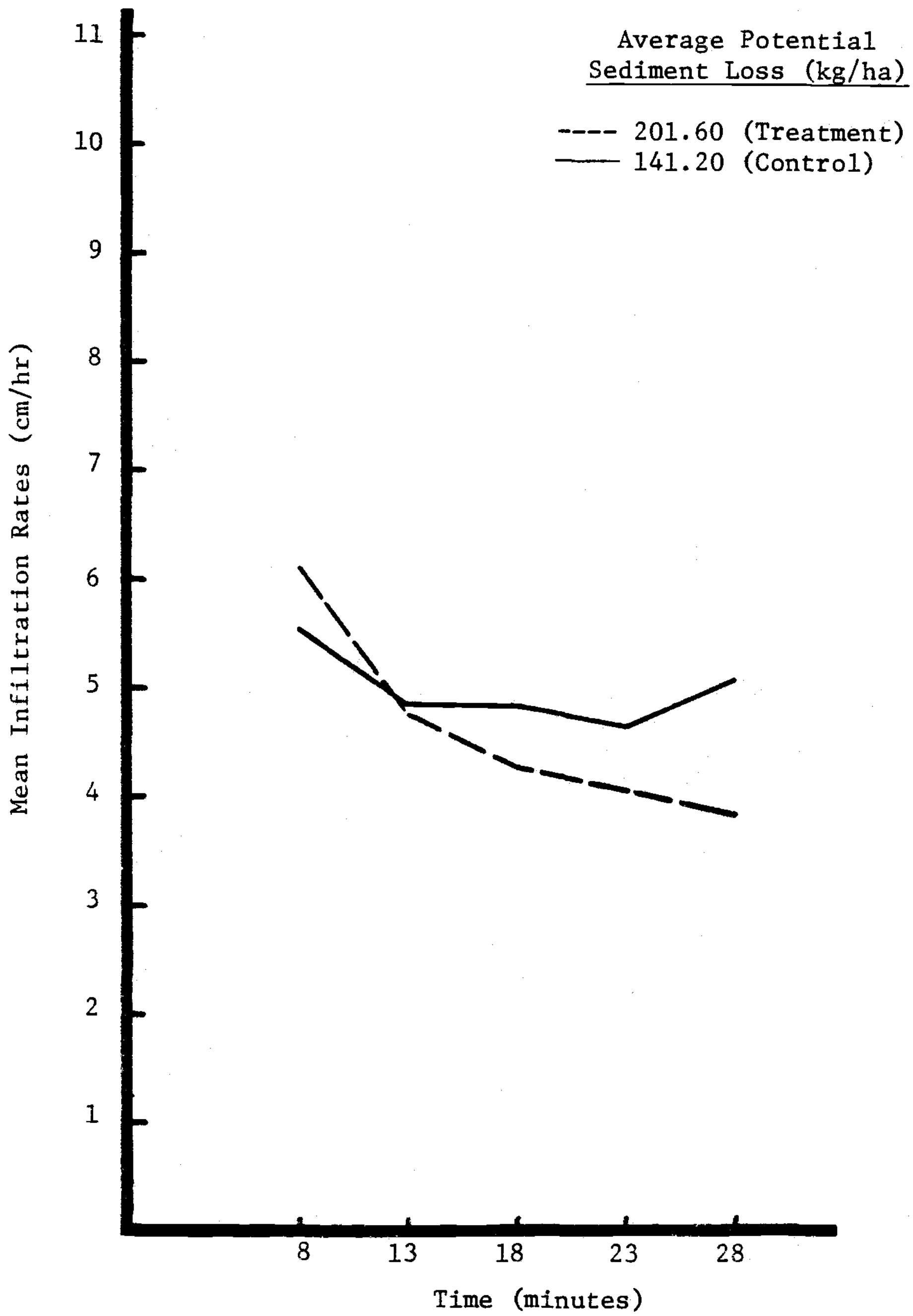

Figure 20. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered ponderosa pine ecosystem - pine-sedge (21-IV-GC) (vegetated). (Asterisks indicate significant differences, otherwise no differences occurred. $p < 0.05$.)

in mid-July 1980 vegetational ground cover was 26% grasses and forbs and 1% grasslikes with 62% litter and 1% bareground.

Infiltration rates were significantly higher ($p < 0.05$) for the treated area during the entire run (Fig. 21). However, even though the treated area showed a potential average sediment loss of 66.7 kg/ha, this was not found to be significantly larger ($p < 0.05$) than the control which lost an average of only 46.5 kg/ha.

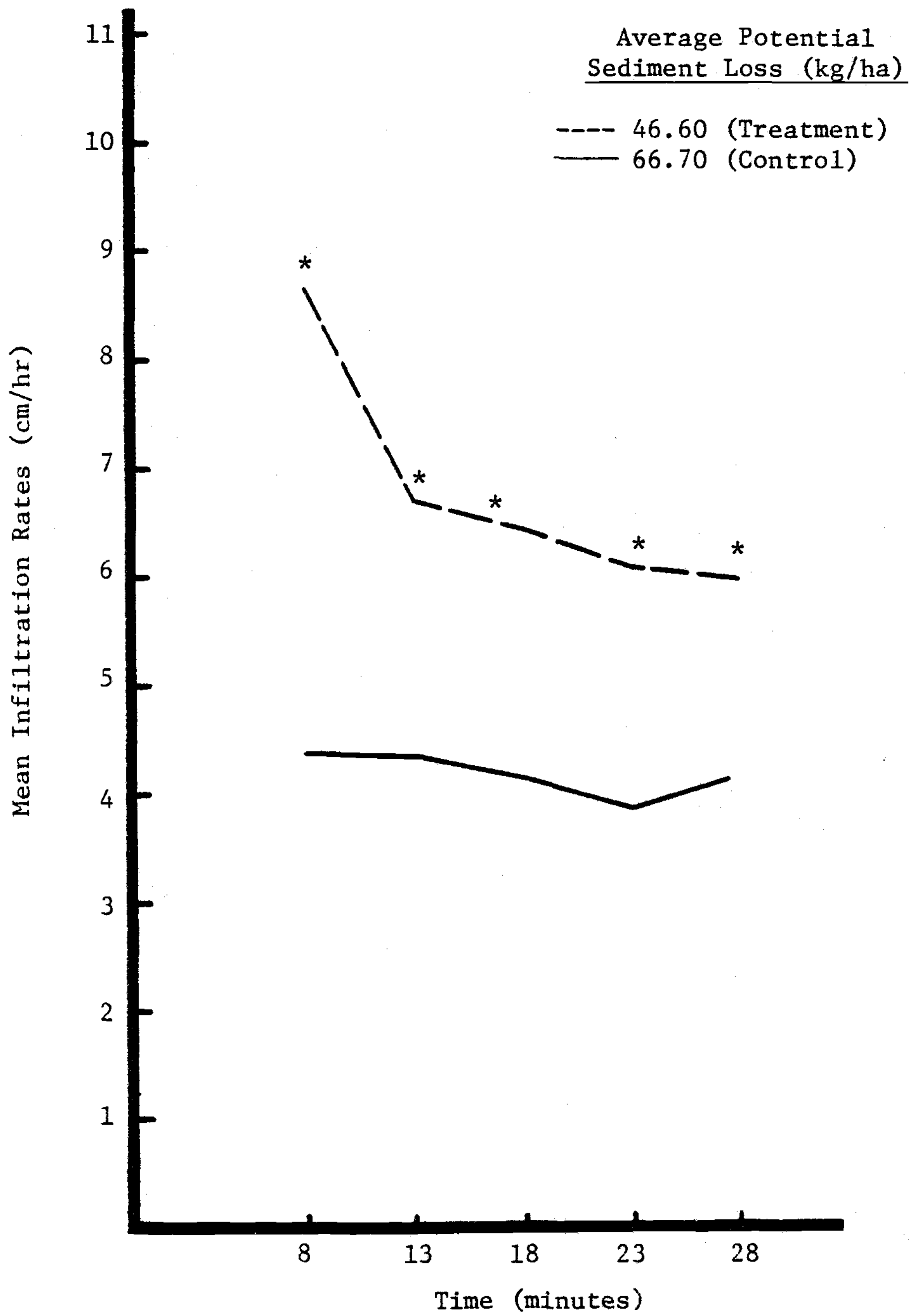

Figure 21. Comparison of mean infiltration rates and average potential sediment losses for a natural and vegetatively altered ponderosa pine ecosystem - pine-bunchgrass (21-IV-FC). (Asterisks indicate significant differences, otherwise no significant differences occurred. $p < 0.05$.)

SUMMARY AND CONCLUSIONS

Mountain Grassland Ecosystem (36-III-PC)

A total of 9 mountain grassland ecosystems was sampled. The control had significantly higher infiltration rates during the simulated rainfall storm for 4 of them. For 2 others the control had significantly higher infiltration rates for the entire storm with the exception of the 3-8 minute time interval during which there was no significant difference found. However, in contrast to this, in only one instance the control had significantly higher infiltration rates for the 3-8 minute time interval, after which no significant differences were found. In another case, the only significant differences in infiltration rates between the control and treatment occurred during the 3-8 and 23-28 minute time intervals. In this instance, infiltration rates on the treated area were higher during the early time period and infiltration rates on the control were higher during the latter one. On only 1 of the 9 were infiltration rates, between the control and treated area, found to exhibit no significant difference for the entire duration of the storm.

In this particular study, the relationship between infiltration rates and severity of ground disturbance did not appear to be evident. Many on-site variables may be responsible for this, among them being aspect, slope, vegetational type and soil packing. However, all other things being equal, the author speculates that such a relationship would have a high degree of correlation.

In regards to average potential sediment losses, the control had a significantly higher sediment loss in all cases except 4. In 3 out of these 4 cases there were no significant differences in sediment loss between the control and treated area. On the remaining site, the treated area exhibited the higher sediment loss.

The relationship between sediment loss and amount of vegetational cover appeared to be correlated. Where vegetational cover was low (i.e., < 35%), sediment loss was relatively high and when vegetational cover was high (i.e., > 60%) sediment loss was relatively low.

In addition, in this study a trend between infiltration rates and amount of sediment loss also appeared to be evident. As infiltration rates declined, the amount of sediment loss increased.

Sagebrush Ecosystem (29-III-PC)

Only 1 sagebrush resource unit was sampled. The treated area demonstrated significantly lower infiltration rates than the control during the entire run, but exhibited a lower average potential sediment loss. It was speculated that the lower sediment loss was being dictated by the higher percentage of vegetational ground cover which was found on the treated area.

Pine-Mixed Fir-Sedge Ecosystem (20-IV-FC and 20-IV-GC)

Two of these resource units were sampled. One was in good condition and one was in fair condition. The resource unit in fair condition was thinned and the slash piled with a crawler tractor. Only during the 3-8 minute time interval was infiltration rate for the control significantly higher than for the treated area. Thereafter, no significant differences in infiltration rates between the 2 areas existed. However, the control had a significantly higher average potential sediment loss due to the fact that the control also had a larger percentage of bareground.

The resource unit in good condition was thinned and piled with a crawler tractor also. However, the area was seeded with a dribbler at the time of treatment. This treatment did not appear to be successful in terms of seeding establishment. Infiltration rates were found to be significantly higher for the treated area than for the control for the entire storm. However, there was no significant difference in average potential sediment loss between the control and treated area, reflecting the fact that both areas possessed approximately the same amount of ground cover and bareground, even though ground cover was largely in the form of standing vegetation on the control but in the form of litter on the treated area.

Larch Ecosystem (25-III-FC)

This area was thinned and the slash piled with a crawler tractor. After a post-treatment inspection of the area the decision was made to divide it into the following 3 specific areas according to existing ground cover characteristics: a pinegrass area (relatively undisturbed from machinery), a planted area and a bareground area, all 3 of which were sampled separately.

For all 3 designated areas, not only did the control consistently demonstrate significantly higher infiltration rates, but it also exhibited a significantly lower average potential sediment loss.

Pine-Sedge Ecosystem (21-IV-GC)

Two thinned pine-sedge resource units were sampled. In both cases slash piling was done using a crawler tractor.

On 1 of the 2 resource units, the treated area had significantly higher infiltration rates for the entire storm as well as a significantly lower average potential sediment loss.

After post-treatment inspection of the other resource unit prior to sampling, the decision was made to divide it into vegetated and non-vegetated areas each of which were sampled separately. The vegetated area was relatively undisturbed while the non-vegetated area showed disturbance resulting from the use of the crawler tractor.

Concerning the non-vegetated areas, infiltration rates were significantly higher during the entire storm and average potential sediment loss was significantly lower for the control, thus reflecting the necessity of vegetation for soil protection.

Contrastingly, for the vegetated portions, not only was there no significant differences found between infiltration rates of the control and those of the treated area, but average potential sediment losses between the control and treated areas were also found to be of no statistical significance.

On both, the larch and the pine-sedge ecosystems, a trend was evident which indicated that as the percent of bareground increased, the mean infiltration rates declined and a greater average potential sediment loss resulted.

Ponderosa Pine-Bunchgrass Ecosystem (21-IV-FC)

This area was thinned and slash piling was also done using a crawler tractor. The amount of vegetative cover was approximately equal between the control and treated area. But even though the control had approximately 3% more bareground, no significant difference in average potential sediment loss was found. Infiltration rates, however, were significantly higher for the treated area during the entire run, possibly because of the lower percentage of bareground.

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