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An Economic Analysis of Range Improvements on Saddle Creek Allotment and Curlew National Grasslands--With Special Consideration on the Effects of Improvements on Wildlife Management

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AN ECONOMIC ANALYSIS OF RANGE IMPROVEMENTS ON SADDLE CREEK ALLOTMENT AND CURLEW NATIONAL GRASSLANDS--WITH SPECIAL CONSIDERATION ON THE EFFECTS OF IMPROVEMENTS ON WILDLIFE MANAGEMENT

by

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by

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Range improvements for livestock were analyzed for the Curlew National Grassland and Saddle Creek Allotment. Increases in aum's which were a result of range improvements were calculated and valued at $4.00 each. Internal rates of return for both study areas were computed with a 15-year project life span for estimated grazing capacity and permitted grazing. Rate of return was then set at 10 percent to calculate project life span for both permitted grazing and estimated grazing capacity for the two areas.

Effects of range improvements for livestock on wildlife habitat were studied. Due to a lack of quantitative data, values could not be placed upon benefits and detriments which improvements for livestock had on wildlife. Positive and negative effects which range improvements for livestock had on wildlife are given for both study areas.

An alternative grazing policy is suggested for both study areas. Internal rates of return for permitted grazing are calculated for a 15-year project life span. Internal rate of return was then set at 10 percent to calculate project life span necessary to provide that rate of return.

(88 pages)

INTRODUCTION

The United States Government owns 359 million acres of land in the 11 Western States. This acreage accounts for 65 percent of the total land in these states. This enormous acreage is used by many people for numerous activities. Stockmen annually graze thousands of livestock on federal ranges. Lumbermen harvest millions of board-feet of timber each year. Prospectors have discovered vast mineral deposits which are being mined. Recreationists and sportsmen take advantage of opportunities to be found on these federal lands. Water from high mountain watersheds is used by farmers for irrigation, by industry for consumption, and various forms of water base recreation. Many times users of these resources react as if they were competing against each other, i.e., one use can only be increased at the expense of another use. Improvements to benefit one resource use damages the position of another. Many types of improvements for one resource use are actually complementary or at least supplementary to other resource uses; however, there are areas in which there may be competition. One area where there is controversy is between livestock grazing and wildlife when range improvements are made. This study is concerned with this problem.

Public agencies which control the public lands attempt to allocate resources for multiple-use. The Department of Agriculture and Department of the Interior have control of 95 percent of this vast public domain. The Bureau of Land Management (BLM) administers over 88 percent of land controlled by the Department of the Interior. The United States Forest

Service (USFS) manages 99 percent of the land administered by the Department of Agriculture (Caton, n.d.).

At the beginning of the 18th century there was essentially very little demand for resources found on what would later become national forest and national grassland. At that time the main use for these lands came from wildlife and Indians who lived in these areas. The only white men who were present in the Western States were a few missionaries and trappers.

Cattle were first introduced to the West by Spaniards who brought them from Mexico, Cuba, and Florida (Clawson, 1960). The first cattle in Utah came from the Escalante Exploration Party on their way to Oregon (Walker, 1964). These early stockmen could see no limit to the amount of forage available for their cattle; consequently, as soon as one range was depleted and overgrazed they would move to another area. The majority of ranges were unfenced and were used by the stockman who arrived first and was powerful enough to keep them. These grazing practices resulted in damage to many areas. Local stockmen and the public became concerned about the condition of ranges and began pressing for legislation which would protect federal lands.

As early as 1897, legislation was passed to start some method of protection. In that year power was given to the President to set aside certain areas of public domain for forest reserves (Parkins and Whitaker, 1939). The Forest Reserve Act of 1897 gave the federal government power to administer grazing policies concerning livestock on these lands (US Department of Agriculture, Forest Service, 1960). Although a start was made, many problems still existed in the management of this natural resource. Land was still being overgrazed in many areas, causing

grasses to be destroyed and allowing sagebrush and other undesirable plants an excellent opportunity to take over the ranges.

In 1934, Congress passed the Taylor Grazing Act, which overcame many problems associated with management of public domain lands. The Taylor Grazing Act primarily affected the land remaining in the public domain. A few years after the Taylor Grazing Act was passed the BLM was formed in the Department of the Interior. The purpose of the Taylor Grazing Act was:

> To stop injury to the public grazing lands by preventing overgrazing and soil deterioration, to provide for their orderly use, improvement, and development, and to stabilize the livestock purposes. (US Department of the Interior, BLM, 1955, p. 14)

Grazing policies adopted by the USFS and BLM were a start toward better management of public rangelands; however, problems still existed that congressmen did not consider when drafting this important legislation. For example, early management policies mention in their purposes that they are designed for better management of public ranges for the livestock industry. They do not say anything about wildlife habitat management; consequently, little thought was given to this aspect of multiple use until sportsmen and recreationists believed that wildlife habitat was being altered enough by range improvements for livestock to damage wildlife populations. If their statements are valid then studies should be undertaken to evaluate social benefits and costs as a result of range improvements for livestock grazing.

OBJECTIVES OF STUDY

The first objective of this study was to analyze benefits and costs of range improvements specifically for livestock grazing. The second objective was to ascertain if recreationists and sportsmen's claims can be substantiated that range improvement practices such as brush control, seeding, and fencing are detrimental to wildlife. The third objective was to review present range improvement investment policies of the USFS and determine if economic returns could be increased under an alternative policy.

REVIEW OF LITERATURE

Advantages of Control

An economical, yet effective means of brush control and revegetation has been the objective of researchers. In Southeastern Idaho, carrying capacity had increased 69 percent by the end of the third year after a program of burning and reseeding. On a plowing and reseeding project in Elko County, Nevada, the carrying capacity increased 800 percent. The greatest increase reported was from an area in California which was sprayed and reseeded. Their range increased its grazing capacity by 25 times (Pechanec, Stewart, and Blaisdell, 1954). Another advantage of range improvements on many ranges is greater gains in weight made by livestock. Grazing on better quality and quantity forage has resulted in cows gaining 4.34 pounds per day compared to 2.87 pounds per day on the same range prior to improvements. Calves gained twice as much--2.2 pounds per day compared to 1.1 pounds per day on the native ranges (Pingrey and Dortignac, 1959). Ranchers in a New Mexico study desired to market their calves at 400 pounds after 205 days. They reported that they could reach their goal easier on the created wheatgrass ranges, which they were able to graze from May 1 until November 1, than on the native ranges (Pingrey and Dortignac, 1959). Better ranges also gave them a 7.5 percent increase in calf crop (Pingrey and Dortignac, 1959).

Methods of Brush Control

Several methods of brush control have been tested in the intermountain area which give excellent results if done properly. Burning is perhaps the cheapest method available--$0.50 to $2.50 an acre (Plummer et al., 1954)--and will provide effective brush control if conditions are right when burning is done. There must be a sufficient amount of grass understory to carry the fire through the brush. Sagebrush should be dense enough to give off a large amount of heat. To obtain best results atmospheric temperature should be high with a low humidity level. Best sagebrush kills from burning are expected in the fall. Portions of Benmore Valley in Utah were burned both in fall and in spring. Fall burning resulted in a sagebrush kill of 93 percent while the spring efforts only produced a 72 percent kill (Cook, 1958). Burning is one of the most effective methods of controlling young sagebrush.

Another method available to control these undesirable plants is by machine. Several kinds of machines are available. The choice is regulated by terrain, types of vegetation to control, and other factors peculiar to the area.

The wheatland plow and other one-way disks are common means for control. If done correctly, kills from 50 percent to 99 percent of the non-sprouting brush species can be obtained (Plummer et al., 1954). Rabbit brush and other associated plants may be killed only if the disks are set low enough to cut below the root crowns. The depth of these crowns will vary from 5 to 7 inches (Plummer et al., 1954). Cost of plowing varies, but will usually be between $3 and $5 per acre (Plummer et al., 1954; Caton and Beringer, 1960). This method of control is

usually limited to areas that are relatively rock free with a slight or moderate slope.

Railing is an inexpensive method of control but is also limited in effectiveness. Between 50 and 80 percent of the old, brittle sagebrush plants will be killed using this method (Plummer et al., 1954). If plants are young and flexible, results are disappointing. Sagebrush will just bend under the weight of the heavy rail rather than breaking off. Only 10 to 50 percent of the brush will be destroyed (Plummer et al., 1954). Other undesirables such as cheat grass are not affected and will continue to use the available soil moisture. The rail will also leave piles of debris, which make drilling the seed quite difficult.

In recent years, chemicals have become an effective and popular means of eradication. The USFS uses 2-4D butyl ester for brush control. The average reported kill for 1959 was 83.5 percent (Krenz, 1962). Costs vary due to size of the site to be sprayed and distance to a suitable landing strip. Competitive bidding on a large project will result in prices close to $2.50 per acre for material and application, but may vary from $2.00 to $4.50 an acre (Nielsen, 1967).

Revegetation

After action has been taken to control the brush, a decision must be made concerning the revegetation of an area. A choice must be made to either seed the area to new grasses or allow native perennials to revegetate it. Native perennial grasses trying to revegetate the area are in competition with cheat grass and other undesirables for moisture which limit the number of plants and amount of seed available

to reseed the area. It may be a matter of years before the ranges are at their maximum carrying capacity. The need for seeding can readily be determined by the amount of desirable forage available prior to action taken to control brush. It has been recommended that seeding be done if there is less than 2-4 square feet of good forage available per 100 square feet. On meadow lands seeding should be done if there is less than 5-6 square feet of desirable plants for each 100 square feet (Rummell and Holscher, 1955).

Seedbed is very important for a good stand for grass. The ground should be firm, not of a dry powdery nature. If necessary it may have to be rolled or cultipacked to arrive at the desired texture (Rummell and Holscher, 1955). It should be in an area of at least 10 to 12 inches of annual precipitation for the best plant growth (Vallentine, Cook, and Stoddart, 1963). An area which previously was infested with large sagebrush is a good indication that the seeding venture will be successful if it is properly done (Cook and Lloyd, 1960).

Season of planting is very crucial in obtaining a good stand of grass. The best time to drill is in late fall--preferably in October. This will allow the seed to take advantage of all winter and spring moisture. Impassable roads and muddy soils would delay the growing season for two or three weeks if the seed were to be planted in the spring. Planting in early fall is also not recommended since the seed would have time to germinate. The harsh winter conditions would then take their toll of new seedlings and only a few would survive (Rummell and Holscher, 1955).

Drilling the seed is the most successful method of planting. The most desirable depth to plant for greatest germination and growth is 0.5

to 1.0 inch. This alleviates the problem of covering it and getting it evenly spaced. Average cost of seeding 22 areas in Utah was $3.68 per acre (Cook and Lloyd, 1960). Drilling is limited to areas which are relatively free of rocks and have moderate slopes.

Another method of planting that is quite effective, if done properly, is broadcasting seed either by hand or machine. The chief objection to this method is the amount of extra seed required. Broadcasting requires 33 to 50 percent more seed than drilling (Vallentine, Cook, and Stoddart, 1963). A problem often encountered with broadcasting is getting the seed covered except in deeply plowed ground or in areas that have been burned. In these places the seed easily sinks either into the soil or ash with the precipitation that falls (Love and Jones, 1952).

Many species of grasses have been tested to determine the best forage for a particular area. In California alone 200 species have been tested to determine the best forage (Love and Jones, 1952). Wheatgrasses have proven to be most hardy and drought resistant throughout the Intermountain area. They provide abundant forage which grows rapidly in the spring, often attaining a growth of 4 to 6 inches by May 1. Tests have been run on wheatgrasses which show that in May they have 24 percent more digestable protein than alfalfa. By fall the digestable protein falls as crude fiber and celluloses increase. This continues until wheatgrass only contains 33 percent as much digestable protein as alfalfa. Similarly, crested wheatgrass is higher in total digestable nutrients in the spring than alfalfa, but in the fall total digestable nutrient level falls to 92 percent of alfalfa (Pingrey and Dortignac, 1959).

Four types of wheatgrasses have been found to be most suitable for western ranges. These species are: tall wheatgrass (Agropyron elongatum),

intermediate wheatgrass (Agropyron intermedium), pubescent wheatgrass (Agropyron Trichophorum), and crested wheatgrass (Agropyron desertorum), (Cook, 1958). Tall wheatgrass requires a site with 12 or more inches of annual precipitation and is valuable for seeding moist saline soils where other plants have trouble growing. Intermediate and pubescent wheatgrass usually require 12 inches or more annual precipitation but are more susceptible to intermittent drought periods than crested wheatgrass (Cook, 1958).

Good management is recommended after grasses have begun to grow to gain the maximum benefits. Cattle should not be permitted to trail across newly seeded areas or the new grass (Plummer et al., 1954). This will help to get the grass well established. Livestock should not be allowed to consume more than 40 percent of each year's growth thereafter to obtain maximum results and avoid overgrazing (Vallentine, Cook, and Stoddart, 1963).

A system of rotation grazing has been quite effective in gaining greater benefits from the improved ranges (Love and Jones, 1952). New fences may have to be constructed to separate the areas. Costs for construction of these fences will vary according to area and type. Estimates vary from $964.00 per mile for a four-strand barbed wire fence with juniper and steel posts set at 1 rod intervals to $2,400 per mile for a four-strand barbed wire let-down type fence (Cook and Lloyd, 1960; Campbell, 1969). A rotation grazing system will retard growth of undesirable annuals if the area is subjected to heavy grazing just before the undesirables head out. Cattle are then moved before the perennials have produced their seed. Thus, the perennials will dominate the area

after a short period of time (Love and Jones, 1952). Livestock will also be able to utilize the grass more evenly with a rotation grazing system.

Evaluating Returns

Methods have been devised by agricultural economists to measure the benefits derived from range improvement projects. The usual procedure is to compare the initial investment costs with the sum of the discounted future net returns resulting from the investment. One formula used to compute the sum of discounted future returns may be expressed mathematically as follows (Caton and Beringer, 1960):

$$V_o = \sum_{t=1}^{n} \frac{R_t - C_t}{(1 + r)^t}$$

V_o = the sum of discounted net returns (present value)

R_t = gross receipts resulting from investment

C_t = annual costs of investment (not costs of investment itself)

r = rate of discount

t = (1.....n) year from date of investment to termination life of investment

$$r_r = \frac{V_o - K_o}{K_o}$$

r_r = rate of return of investment

V_o = present value

K_o = total cost of investment

Another method of determining the internal rate of return is given as follows (Gardner, 1963):

$$I = R \left[\frac{1-(1 + i)^{-n}}{i}\right]$$

I = initial investment

R = net annual additional return

$\left[\frac{1-(1 + i)^{-n}}{i}\right]$ = discounting factor

n = number of years

$$i = \frac{I}{R}$$

i = rate of return of investment

I = initial investment

R = net annual additional return

Improved quantity and quality of forage may result in a greater carrying capacity per acre, higher rate of gain by livestock, increased calf or lamb crops, and increased wool yields. All or any combinations of these benefits should be considered when computing the additional returns from range improvement projects (Cook and Lloyd, 1960).

Effects of Range Improvements on Wildlife

Researchers have tried to determine the effects of range improvements for stockmen on wildlife habitat and population numbers. Sportsmen have been concerned by declining numbers of certain species of upland game birds, particularly the sage grouse. One of the most extensive and complete studies on the sage grouse has been done in Wyoming (Patterson, 1952). He reports:

> The pattern of decline in sage grouse numbers has been little different from that exhibited by numerous other game animals in the West. Destruction of habitat and inadequate

> protection, whatever their nature, have been the basic cause of sage grouse decreases throughout the West as a whole. . . . The oft mentioned factors of unfavorable weather, increased predation, and disease may have been of significance in localized areas but were relatively unimportant in the over-all decline in sage grouse numbers. (Patterson, 1952, p. 257).

Destruction of habitat (sagebrush) is the goal of range improvements. Without sagebrush habitat, sage grouse will decline for several reasons. They need sagebrush or other suitable cover for nesting purposes. The sage grouse need brush for protection in winter and also use it exclusively for their diet during this season. Due to the structure of their digestive system, sage grouse cannot digest hard grains coming from wheatgrasses (Trueblood, 1954). He found that all of these factors had an effect upon the numbers of sage grouse in the Pines Area of Utah. Studies conducted in the Pines Area two years after Trueblood completed his work showed at least one more major effect which would be considered a detriment. Prior to improvements several strutting grounds were noticed in the area. After improvements sage grouse abandoned these mating areas. Attempts to establish new strutting grounds on reseeded areas were not successful. When seeding interferes with the strutting grounds and causes mating to be difficult, the sage grouse are being adversely affected at the beginning of their life cycle. This problem will cause a decrease in populations (Enyeart, 1956).

Some work has been done determining the effects which fences have upon wildlife movement. The majority of studies were done determining the effects upon pronghorn antelope. Recommendations have been made concerning the optimum fences for antelope movement and livestock control (Spillett, Low, and Sill, 1967). The areas this study is concerned with contain such a negligible amount of antelope that they will not be

considered.

Research evaluating the effects of range improvements upon wildlife populations could not be found. Very little, if any, work has been done in this area.

METHODOLOGY

Collection of Data

Data for this research were made available through a cooperative agreement between Utah State University and the USFS. The majority of information was collected from records kept by the USFS. Some data were obtained by personal interview with USFS and Idaho Fish and Game personnel.

Saddle Creek Cattle Allotment improvement project costs were obtained from the Cache National Forest supervisor's office in Logan, Utah. Grazing analysis reports, from which returns could be computed, were also available in the supervisor's office. Data concerning fencing costs and results were obtained from the district USFS office in Randolph, Utah. Information concerning the effects of fencing on wildlife habitat and populations was obtained from personal interviews with USFS wildlife biologists and rangers in Logan and Randolph.

Data concerning the Curlew National Grassland were obtained from several locations. The supervisor's office for the Caribou National Forest, which has jurisdiction over the Curlew National Grassland, is located in Pocatello, Idaho. Some grazing reports and costs of improvements were obtained from the supervisor's office. The majority of improvement costs for livestock and wildlife were obtained from the district USFS office in Malad, Idaho. Grazing reports from which annual animal unit month (AUM) increases could be computed were obtained from

the district office in Malad and USFS Region 4 offices in Ogden, Utah. Data concerning livestock improvements and their resulting effects upon wildlife populations were obtained from interviews with USFS wildlife biologists and Idaho Fish and Game personnel.

Analyzing the Data

Data were classified according to the improvement project from which it was obtained. The Curlew National Grassland and Saddle Creek Allotment areas were analyzed separately.

Information concerning the Curlew National Grassland was separated into two main categories--livestock and wildlife. Livestock information was further classified by type of improvement. These improvements consisted of spraying, plowing, brush-beating, reseeding, fencing, and water development. Costs for each type of improvement were tabulated and then added to obtain the total for each type of project. Costs for each type of improvement were also added to obtain the total amount spent on all livestock improvements for each year from 1954 to 1968. Benefits from improvements were obtained by analyzing annual grazing reports. These reports provide estimated aum's as well as the number of aum's of livestock permitted to graze.

Annual increases in aum's due to range improvements were computed by subtracting the number of aum's used in 1954, prior to USFS improvement projects, from the number of aum's estimated and permitted to graze each year after 1954 until 1968. Private lease rates are between $3.50 and $5.00 per acre in most areas of the West (Nielsen, 1967). In this study each aum is valued at $4.00. The annual increase in estimated aum's and permitted to graze aum's are each multiplied by $4.00 to

arrive at gross annual benefit from livestock improvements.

Annual operating costs were computed as follows. Each acre has an annual operating cost of $0.05. Of the $0.05, fence maintenance used $0.03 and water development and use costs resulted in $0.02 (Nielsen, 1967). Annual operating costs were computed for each year of project life and then subtracted from gross annual returns, giving net annual return per year for improvement projects.

Attention was then focused on the effects of range improvement projects benefiting livestock forage on wildlife habitat and populations. Information from interviews with USFS personnel and Idaho Fish and Game biologists was analyzed to show the effects of improvements benefiting livestock grazing on predation, habitat, population numbers, and food supplies of wildlife. Results could not be quantified due to a lack of records concerning population numbers from the beginning of the improvement projects to the present time.

Data for the Saddle Creek Allotment area were analyzed in the same manner as the Curlew National Grassland information. Costs were obtained for fencing, water developments, and spraying projects, which were the main types of improvement. Costs for each project were tabulated and added to find the total cost of each type of improvement. Costs for each type of improvement were added to obtain the total amount spent on each improvement for each year from 1961 to 1968. Benefits from improvements were obtained by analyzing annual grazing reports. Monetary returns from improvement projects were computed using the same method as the Curlew National Grassland.

Effects of livestock improvements on wildlife populations were analyzed in relation of the fences to big game movements.

Discounting Returns to Present Value

Discounting--making revenues and costs occurred in different planning intervals comparable in time--was the process used in determining rate of return on investments for the Curlew National Grassland and Saddle Creek Allotment areas. Any investment in range improvements has to be made at the present time, but returns will accrue over the life of the project. The return of a dollar each year for 10 years is not worth $10.00 today; the income stream expected over 10 years has to be put in terms of the present. The process by which the flow of future returns are brought to their present value is called discounting (Nielsen, 1967).

Two procedures were used to discount returns to present value. The first method follows a guideline set in a memo from the Secretary of the Department of Agriculture to the Chief of the USFS on May 29, 1969. The memo suggests that range technicians should be able to foresee a rate of return of 10 percent to justify money spent on range improvements. Using the first method, the length of the life of the project necessary to yield a 10 percent return on investment was computed. Since net annual returns were different each year due to non-use incurred as a result of improvement projects, future net annual returns were each discounted by the 10 percent rate to the beginning year of the study period. Net annual discounted returns for each year were added until the discounted returns were equal to investment costs of the project. The number of years required to make the total discounted returns equal to the investment gave the "necessary" life of the project.

The second method uses a specific time period for project life, based on the biological aspects of the improvement project. Project life spans vary due to differing reinvasion rates of undesirable plants which occur in most improvement projects unless controlled. Estimates of project life spans range from 8 to 12 years for brush control programs in some areas to 5 to 30 years for other areas (Vallentine, Cook, and Stoddart, 1963; Nielsen, 1967). The project life used in this study was 15 years. Net annual returns for the two study areas were discounted at various discount rates. Net annual discounted returns, at each discount rate, were added together for 15 years. If the total of the net annual discounted returns did not equal the initial investment costs, that rate of interest was rejected as the internal rate of return for the project. A new discount rate was then selected. Costs and returns were discounted with this rate for 15 years. If discounted costs and returns were approximately equal, then this discount rate was considered the internal rate of return for the project.

An Alternative Investment Policy

The USFS allocates improvement funds over a large number of range improvement projects in an effort to satisfy demands of stockmen who graze livestock on these public lands. This practice requires proposed improvement programs to be carried over a number of years before enough funds have been made available to complete improvement projects. Economic justification of expenditures invested in this manner is becoming more difficult each year; thus, economic efficiency is becoming more important and someday may be considered as the sole criterion for funding of public investment projects. This study has analyzed the economic

returns that would have occurred if all costs for improvement projects would have been incurred in one year.

Costs of various improvement practices throughout the study period were computed and added together to arrive at the total amount spent for livestock improvements. Annual operating costs were not included in this figure. Annual increase in aum's due to range improvements were computed from annual grazing reports. The number of aum's reported in the first year of the study was subtracted from the number of aum's reported in 1968. This figure, when multiplied by the value assigned to each aum, gave gross annual benefit per year. Annual operating costs were subtracted from gross annual benefits, giving net returns due to livestock improvements. Net annual returns were discounted for 15 years--the assumed life of the project--at various discounts until the rate was found where discounted net annual returns were equal to initial investment costs. The discount rate at which these figures were equal was the internal rate of return from the project. Returns from both study areas were computed using this method.

PRESENTATION OF DATA AND RESULTS

Curlew National Grassland

Description of study area

The Curlew National Grassland consists of 47,600 acres of federal land located in Oneida and Power Counties in Southern Idaho. The area, under the administration of the Caribou National Forest, was designated a national grassland on June 20, 1960, by the United States Department of Agriculture. The Curlew National Grassland is part of the former Southeastern Idaho Land Utilization Project, purchased by the federal government between 1934-1942 from private landowners because it was marginal for cultivation and subject to drought. These lands were administered by the Soil Conservation Service from the time they were purchased until 1954, at which time they were placed under the control of the USFS.

The Curlew National Grassland is grazed by approximately 2,700 head of cattle licensed under term permits and 637 head under temporary permits. Differences exist between these two permit types. Term permits are issued to eligible ranchers for a 10-year period and temporary permits are issued to eligible ranchers for a one-year period. To obtain a term permit the rancher has to meet a commensurate property requirement. Commensurate property ownership is not required for a temporary permit. The USFS Manual states that for a permittee to meet commensurability requirements he "must be able to fully care for the permitted livestock during that time such livestock are not on National

Forest Service lands" (Forest Service Manual, 1960, p. 10).

The cattle are owned by 61 permittees, who, with few exceptions, live in Oneida County. There are two separate grazing units, the Curlew Unit and Buist Field Unit, consisting of 40,000 and 7,600 acres respectively.

Curlew Unit is grazed for an 8.5 month season on a deferred-rotation system of management. A temporary increase of 350 head of cattle was issued to the Curlew Cattle and Horse Association in October of 1965. The increased number will be carried on a temperary permit for a five-year period. An additional 287-head temporary permit was issued for the 1968 grazing season. This permit was also to be administered on a five-year trial basis.

Buist Field cattle and horse allotment has an established season of 3.5 months for 862 cattle. Estimated capacity is 6,000 cow months. Management, reseeding, and spraying have made additional forage available, which has enabled the USFS to extend early summer use to July 31. During good forage years, fall grazing has been allowed. It is anticipated that approximately 1,000 aum's can be grazed during the winter months.

Grazing season on the two units usually begins between April 20 and April 28. The elevation is from 4,500 to 5,000 feet. Soils are varied but are primarily lake-laid silt loams with some rock present. Annual precipitation is 10 to 14 inches. The growing season is approximately 45 days with extended seasons up to 70 days.

The Curlew National Grassland was originally established to improve the soil and vegetation and to promote agriculture. From 1954 to 1968, approximately 29,840 acres were seeded to crested wheatgrass and 1,220

acres were planted to pubescent wheatgrass. Approximately 6,000 acres were aerial sprayed and 1,600 acres were beaten with brush beaters for sagebrush control. The area has been fenced into 49 separate pastures both prior to and during the administration of the USFS. Much of the work has been accomplished cooperatively with Curlew and Buist Field permittees. Future development plans call for a continued seeding and brush control program. A project has also been proposed which would try to enhance wildlife habitat on a controlled basis.

Range management policy

The USFS has initiated a range management policy which calls for range improvement projects which will increase the amount of forage available for livestock. During each year since the USFS has had control of the land, they have tried to either control sagebrush by spraying, plowing, beating, and burning, or seeding some of the various fields to some type of wheatgrass. The rate at which the USFS has proceeded with projects has been determined by funds available for range improvements on the Curlew National Grassland.

Fields which were seeded were watched closely by USFS personnel to see that the new grass had an opportunity to establish itself prior to grazing. Each field that had been seeded was not used for a two-year period. During this period of non-use, livestock were grazed in other fields in the two units. Fields in which sagebrush control projects were conducted without new seedings were not given such long periods of non-use.

Description of range improvements

Range improvement projects for the Curlew National Grassland were divided into two main categories. The first type of improvement is termed non-structural. Non-structural improvements are plowing, burning, spraying or beating the sagebrush, and seeding projects. The other category is structural range improvements. Fencing projects and water developments would fall into this classification. Structural improvements would include all of those projects for which some improvements were actually constructed.

Non-structural range improvements were further classified together according to the type (plowing, spraying, seeding, etc.) and the year in which they were carried out. The costs and a description of each project were taken from project work plans filed at the district USFS office in Malad, Idaho. Costs and a description of each non-structural range improvement project for the Curlew National Grassland are found in Table 1.

Structural range improvements consisted of either fences or water developments. Almost all fencing projects were on a cooperative basis with permittees. The USFS would supply all materials and permittees would provide the labor. A description of fences and the costs incurred by the USFS for Curlew National Grassland was obtained at the district USFS office in Malad, Idaho and is given in Table 2.

Water developments for the Curlew National Grassland were also a cooperative effort between permittees and the USFS. The USFS furnished all materials, with the exception of redrilling Bierly Well, and permittees provided labor to install the developments. The entire costs of redrilling and casing Bierly Well were borne by the USFS, which hired a

Table 1. Description and costs of non-structural range improvements for Curlew National Grassland

Field	Description of improvement	Year	Cost
North Canyon	640 acres plowed and seeded to crested wheatgrass and Ladak alfalfa	1954	$3,520.00
West Carter[a]	657 acres plowed and seeded to Whitman and Ladak alfalfa	1954	3,163.50
West Grandine	357 acres plowed and seeded to crested wheatgrass	1956	1,963.50
North Carter[b]	750 acres aerial sprayed	1956	2,325.00
East Grandine	720 acres plowed and seeded to crested wheatgrass	1957	3,960.00
West Hurd[a]	520 acres plowed and seeded to crested wheatgrass	1958	2,860.00
Vanderhoff	320 acres beaten with Servis Brush Beater	1959-1960	1,410.02
East Jacobsen	920 acres aerial sprayed	1961	3,205.00
West 13	400 acres beaten with Gyro Brush Beater	1961	690.00
North 13	400 acres beaten with Gyro Brush Beater	1961	668.50
Vanderhoff	320 acres sprayed with ground rig	1961	600.00
East Vanderhoff	77 acres beaten with Gyro Brush Beater	1961	127.05
East Hess B	600 acres aerial sprayed	1961	1,700.00
North 13	1,050 acres plowed and seeded to crested wheatgrass	1962	7,036.00
South Hess-Haws	720 acres aerial sprayed	1962	2,132.00
Richards' Bull Pasture	60 acres plowed and seeded to crested wheatgrass	1962	330.00
West Hunsaker	50 acres plowed and seeded to crested wheatgrass	1962	275.00

Table 1. Continued

Field	Description of improvement	Year	Cost
Grandine	40 acres plowed, 200 acres seeded to crested wheatgrass and Ladak alfalfa	1962	1,327.00
West Jacobsen	800 acres aerial sprayed, 320 acres beaten with Servis Brush Beater	1963	3,075.00
West Huffman	1,400 acres aerial sprayed with crested wheatgrass seedings	1963	3,601.00
East Huffman	2,097 acres aerial sprayed with crested wheatgrass seedings	1963	7,422.00
Jacobsen Exchange	325 acres plowed and seeded to pubescent wheatgrass	1963	2,762.40
Vanderhoff	480 acres plowed and seeded to crested wheatgrass	1963	2,493.00
Vanderhoff	70 acres sprayed with ground rig	1963	266.00
Vanderhoff	750 acres plowed and seeded to crested wheatgrass	1963	3,989.00
Strong[b]	320 acres aerial sprayed	1964	992.00
Vanderhoff	240 acres plowed and seeded to crested wheatgrass	1964	406.00
North Carter	160 acres aerial sprayed	1964	506.00
North Kurtz	900 acres plowed and seeded to pubescent wheatgrass, intermediate wheatgrass, bitterbrush, and snowberry	1965	3,989.88
South Kurtz[a]	1,360 acres seeded to crested wheatgrass	1965	2,040.00
Thompson Bull Pasture	160 acres sprayed with ground rig	1965	244.00
Funk Bull Pasture	132 acres sprayed with ground rig	1965	400.00

Table 1. Continued

Field	Description of improvement	Year	Cost
East Hurd	460 acres plowed and seeded to crested wheatgrass, Ladak alfalfa, and yellow sweet clover	1966	3,479.00
North Hess-Haws	1,200 acres aerial sprayed	1966	5,174.00
Total			$78,291.45

[a]Costs estimated from project work plans: $4.00/acre for plowing, $1.50/acre for seeding.

[b]Costs are estimated from an average of other aerial spraying costs--$3.10/acre.

Table 2. Description and cost of fences for Curlew National Grassland

Field	Description of fence	Year	Cost
No. 13	1.50 miles of division fence	1959	$ 900.00
South Hess-Haws	.625 mile of fence for water lane	1961	718.75
East Jacobsen	1.50 miles of division fence	1961	1,370.00
North Carter	.50 mile of range improvement protection fence	1962	571.00
Jacobsen Exchange	2.0 miles of division fence	1963	1,740.00
East 13	Tagging and marking corral	1963	466.07
Kurtz	1.75 miles of cross fences	1965	2,012.50
South Funk	1.50 miles of division fence	1966	1,725.00
Zollinger-Funk	1.25 miles of division fence	1967	1,423.00
East Huffman	1.50 miles of division fence	1967	1,595.00
East Huffman	1.50 miles of division fence	1967	1,725.00
Total			$14,242.32

well driller to accomplish the project. Data concerning water developments were taken from project work plans on file in the district USFS office in Malad, Idaho. A description of water developments and their costs is found in Table 3.

Costs incurred each year were computed after being classified as either structural or non-structural. Costs for each type of improvement were taken from Tables 1, 2, and 3 and added together to arrive at both costs of improvements per year and total amount spent for range improvements on the Curlew National Grassland. These costs are given in Table 4.

Table 3. Description and cost of water developments for Curlew National Grassland

Field	Description of water development	Year	Cost
Curlew Unit	Redrill Bierly Well	1960	$ 794.00
Peterson-Lonigan	Tile spring, 60 ft. of 1 1/4 in. pipe, and install 500 gallon trough	1964	222.68
Kurtz	Install water troughs	1965	460.00
East Jacobsen	Drill 150 ft. and case with 6 in. pipe	1965	1,281.76
Salyar	Install 1.75 miles of 1 in. plastic pipe	1967	554.40
Total			$3,312.84

Table 4. Costs of range improvements for Curlew National Grassland

Year	Annual cost	Cumulative cost
1954	$ 6,683.35	$ 6,683.35
1955	0	6,683.35
1956	4,288.50	10,971.85
1957	3,960.00	14,931.85
1958	2,860.00	17,791.85
1959	2,310.02	20,101.87
1960	794.00	20,895.87
1961	9,079.30	29,975.15
1962	11,826.75	40,801.92
1963	25,814.47	67,616.39
1964	2,126.68	69,743.07
1965	10,428.14	80,171.21
1966	10,378.00	90,549.21
1967	5,297.40	95,846.61

Evaluation of range improvements

The effectiveness of range improvement projects was found by analyzing annual grazing reports obtained from USFS Region 4 offices in Ogden, Utah, and Caribou National Forest Supervisor's office at Pocatello, Idaho. These annual grazing reports gave both estimated grazing capacity in aum's and number of aum's which livestock were permitted to graze. Estimated grazing capacity is the number of aum's which USFS personnel estimate are available for grazing. Permitted grazing is the number of aum's which livestock are allowed to graze. A complete year by year description is given in Table 5.

This study is concerned with the number of aum's for both estimated grazing capacity and the number of aum's of livestock grazing that were actually permitted. The base year from which all calculations were made was 1954 since this was the year the USFS took the Curlew National

Table 5. Number of aum's which USFS personnel estimated were present and number of aum's which livestock were allowed to graze from 1954-1968 on Curlew National Grassland[a]

Year	Estimated grazing in aum's	Permitted grazing in aum's
1954	14,273	14,273
1955	16,388	11,823
1956	14,749	13,495
1957	14,749	12,236
1958	14,749	13,751
1959	14,749	13,115
1960	13,600	13,215
1961	13,600	13,299
1962	13,600	13,370
1963	15,400	16,156
1964	15,400	16,072
1965	17,000	16,273
1966	17,358	16,747
1967	17,423	16,711
1968	26,065	24,320

[a]Data summarized from annual grazing reports for Curlew National Grassland.

Grassland under its administration and began a range improvement program.

Number of aum's for both estimated and permitted-to-graze categories is subtracted from the number of aum's grazed in 1954. The resulting figures are the increase in production due to range improvements for that year. Since the number of aum's varied in each category (estimated and permitted), each year, the calculation was performed on a year to year basis from 1955 to 1968 to arrive at annual benefits for a project life of 15 years. Number of aum's of grazing produced in 1954 was not considered as a benefit due to range improvements; consequently, the value of these aum's were not shown in further calculations.

Current private lease rates in most areas of the West are between $3.50 and $5.00 per aum. In the following analysis the value of each aum will be arbitrarily set at $4.00, which is not unreasonable in view of current private lease rates. Number of aum's produced in the years from 1955 to 1968 subtracted from those produced in 1954 gave the annual benefit due to range improvements in aum's. To find the dollar value of these aum's, they were multiplied by $4.00. This value is the gross return for range improvement projects each year, Table 6.

Annual maintenance costs are computed and subtracted from gross annual returns to arrive at the net annual return. Annual maintenance costs were computed using the following method (Nielsen, 1967):

1. Fence maintenance	$0.03/acre
2. Water development maintenance	0.02/acre
Total annual cost	$0.05/acre

Annual operating costs subtracted from gross annual return for the number of aum's which permittees were allowed to graze are given in Table 7.

Attention is pointed to the years from 1955 to 1962 in Table 7. Gross returns were less than zero during this period of time due to non-use of grazing lands as a result of range improvement projects. Although costs per year for improvements were less than in the years from 1962 to 1967, effects of non-use of several pastures were felt more than in the later years. Even though non-use of pastures was occurring during the 1963-1967 period, the number of aum's resulting from improvements during the 1954-1962 period were large enough to counterbalance the non-use incurred as a result of improvements from 1963-1967.

Table 6. Gross returns from range improvement projects for Curlew National Grassland

Year	Estimated grazing capacity		Permitted to graze	
	Aum's[a]	Gross value	Aum's[a]	Gross value
1954	0	0	0	0
1955	2,065	$ 8,260.00	-2,450	$-9,800.00
1956	476	1,904.00	-778	-3,112.00
1957	476	1,904.00	-2,037	-8,148.00
1958	476	1,904.00	-522	-2,088.00
1959	476	1,904.00	-1,158	-4,632.00
1960	-673	-2,692.00	-1,058	-4,232.00
1961	-673	-2,692.00	-974	-3,896.00
1962	-673	-2,692.00	-903	-3,612.00
1963	1,127	4,508.00	1,883	7,532.00
1964	1,127	4,508.00	1,799	7,196.00
1965	2,727	10,980.00	1,990	7,960.00
1966	3,085	12,340.00	2,474	9,896.00
1967	3,150	12,600.00	2,438	9,752.00
1968	11,792	47,168.00	10,944	43,776.00

[a]Difference between aums of the current year and those in 1954.

Table 7. Net annual returns for Curlew National Grassland from aum's which livestock were permitted to graze with annual operating costs of $0.05/acre (47,600 acres)

Year	Gross return	Annual operating cost	Net annual return
1954	0	0	0
1955	$-9,800.00	$2,380.00	$-12,180.00
1956	-3,112.00	2,380.00	-5,492.00
1957	-8,148.00	2,380.00	-10,528.00
1958	-2,088.00	2,380.00	-4,468.00
1959	-4,632.00	2,380.00	-7,012.00
1960	-4,232.00	2,380.00	-6,612.00
1961	-3,896.00	2,380.00	-6,276.00
1962	-3,612.00	2,380.00	-5,992.00
1963	7,532.00	2,380.00	5,152.00
1964	7,196.00	2,380.00	4,816.00
1965	7,960.00	2,380.00	5,580.00
1966	9,896.00	2,380.00	7,516.00
1967	9,752.00	2,380.00	7,372.00
1968	43,776.00	2,380.00	41,396.00

Benefits of these earlier improvements were larger than non-use being imposed as a result of later improvements. The large amount spent in 1963 begins to produce returns during the 1965 grazing season. Returns for the 1968 grazing season are an accumulated effect of all range improvement investment costs during the previous 14 years. Non-use effects were not being suffered by any of the pastures in the Curlew National Grassland during 1968. Those pastures which had been improved during 1966 were returned to grazing by 1968. All improvements in 1967 were either water developments or fencing, which did not have a detrimental effect upon grazing capacity.

Gross annual returns minus annual operating costs for the amount of forage which USFS personnel estimated to exist are shown in Table 8.

Discounting costs and returns

Investment costs and returns for the Curlew National Grassland were spread over a number of years. Since the return of a dollar each year for 15 years is not worth 15 dollars today, the future income stream for the 15-year period has to be put in terms of the present. A similar situation exists with costs incurred in the future; they are not equal to the same amount at the present time.

Two procedures were used to discount costs and returns to the year 1954. The first method uses a 10 percent discount rate as suggested by the Secretary of the Department of Agriculture in a memo to the Chief of the USFS on May 29, 1969. Using this method, the length of life of a project required to return 10 percent on the investment for both estimated grazing capacity and number of aum's which livestock were actually permitted to graze was computed. The permitted-to-graze analysis is

Table 8. Net annual returns for Curlew National Grassland from estimated grazing capacity with annual operating costs of $0.05/acre (47,600 acres)

Year	Gross return	Annual operating cost	Net annual return
1954	0	0	0
1955	$ 8,260.00	$2,380.00	$ 5,880.00
1956	1,904.00	2,380.00	-476.00
1957	1,904.00	2,380.00	-476.00
1958	1,904.00	2,380.00	-476.00
1959	1,904.00	2,380.00	-476.00
1960	-2,692.00	2,380.00	-5,072.00
1961	-2,692.00	2,380.00	-5,072.00
1962	-2,692.00	2,380.00	-5,072.00
1963	4,508.00	2,380.00	2,128.00
1964	4,508.00	2,380.00	2,128.00
1965	10,980.00	2,380.00	8,600.00
1966	12,340.00	2,380.00	9,960.00
1967	12,600.00	2,380.00	10,220.00
1968	47,168.00	2,380.00	44,788.00

presented first with the estimated grazing capacity analysis following.

Costs of improvements per year were shown in Table 4. Since the entire $95,846.61 was not invested in 1954, the costs must be discounted to 1954 to make them equal in time to each other. They are discounted using the 10 percent rate in Table 9.

To find the length of project life necessary to yield an internal rate of return of 10 percent, discounted costs must be equated to discounted net returns. Internal rate of return is defined as that discount rate which makes the sum of discounted net returns for N years equal to the discounted cost of obtaining the income stream (Nielsen, 1967). Since the discount rate or internal rate of return is known, the number of years which returns must be discounted to equal discounted costs will be calculated. The number of years necessary for discounted

Table 9. Range improvement costs from 1954-1967 for Curlew National Grassland, discounted at 10 percent

Year	Cost	Discounting factor	Discounted cost
1954	$ 6,683.35	.909	$ 6,075.17
1955	0	.826	0
1956	4,288.50	.751	3,220.66
1957	3,960.00	.683	2,704.68
1958	2,860.00	.620	1,773.20
1959	2,310.02	.564	1,302.85
1960	794.00	.513	407.95
1961	9,079.30	.466	4,230.95
1962	11,826.75	.424	5,014.54
1963	25,814.47	.385	9,938.57
1964	2,126.68	.350	744.34
1965	10,428.14	.318	3,316.15
1966	10,378.00	.289	2,999.24
1967	5,297.40	.263	1,393.22
Total discounted costs			$43,120.89

costs and returns to be equal is the project life span required to yield a 10 percent return. Discounted net returns for the number of aum's which permittees were allowed to graze are given in Table 10.

The number of years before discounted net returns equal discounted costs, as given in Table 9, is 25; therefore, the life of the project necessary for a 10 percent return is 25 years (Table 10). A 25-year project life for the Curlew National Grassland is an overoptimistic figure due to the rate of reinvasion of undesirable brush. A more realistic project life span might be 15 years (Vallentine, Cook, and Stoddart, 1963; Nielsen, 1967).

Returns from estimated grazing capacity were larger than returns from forage which USFS personnel allowed livestock to graze; consequently, project life will be shorter for estimated grazing than the

Table 10. Net annual returns for aum's which USFS personnel allowed livestock to graze on Curlew National Grassland, discounted at 10 percent

	Net annual return	Discounting factor	Discounted net annual return
1	0	.909	0
2	$-12,180.00	.826	$-10,060.68
3	-5,492.00	.751	-4,124.49
4	-10,528.00	.683	-7,190.62
5	-4,468.00	.620	-2,770.16
6	-7,012.00	.564	-3,954.77
7	-6,612.00	.513	-3,391.96
8	-6,276.00	.466	-2,924.62
9	-5,992.00	.424	-2,540.61
10	5,152.00	.385	1,983.52
11	4,816.00	.350	1,685.60
12	5,580.00	.318	1,774.44
13	7,516.00	.289	2,172.12
14	7,372.00	.263	1,938.84
15	41,396.00	.239	9,893.64
16	41,396.00	.217	8,982.93
17	41,396.00	.197	8,155.01
18	41,396.00	.179	7,409.88
19	41,396.00	.163	6,747.54
20	41,396.00	.148	6,126.61
21	41,396.00	.135	5,588.46
22	41,396.00	.122	5,050.31
23	41,396.00	.111	4,594.96
24	41,396.00	.101	4,180.10
25	41,396.00	.092	3,808.43

25 years which were necessary to realize a 10 percent return from permitted grazing. From Table 11, it can be seen that 18 years are necessary for discounted net returns to equal discounted costs; thus, 18 years would be required to realize a 10 percent return on investments for estimated grazing capacity. See Table 11.

An 18-year project life would also be hard to attain due to rapid reinvasion of undesirable plants. When brush control projects are initiated, a complete kill of existing brush is economically difficult to

Table 11. Net annual returns for estimated grazing capacity on Curlew National Grassland, discounted at 10 percent

Year	Net annual return	Discounting factor	Discounted net annual return
1954	0	.909	0
1955	$ 5,880.00	.826	$ 4,856.88
1956	-476.00	.751	-357.48
1957	-476.00	.683	-325.10
1958	-476.00	.620	-295.12
1959	-476.00	.564	-268.46
1960	-5,072.00	.513	-2,601.94
1961	-5,072.00	.466	-2,363.55
1962	-5,072.00	.424	-2,150.53
1963	2,128.00	.385	819.28
1964	2,128.00	.350	744.80
1965	8,600.00	.318	2,734.80
1966	9,960.00	.289	2,878.44
1967	10,220.00	.263	2,687.86
1968	44,788.00	.239	10,704.33
1969	44,788.00	.217	9,718.99
1970	44,788.00	.197	8,823.24
1971	44,788.00	.179	8,017.05
Total discounted net returns			$43,623.49

attain and brush seeds seem to be relatively unaffected by the eradication methods (plowing, spraying, and beating). These plants and seeds immediately begin to reinvade the area, especially since there are few other deep-rooted plants competing for water. In most cases, 18 years is too long to expect a project to last without reinvasion of brush species that would reduce yields.

The second method by which costs and returns are discounted assumes a 15-year project life. The discount rate which makes the discounted net returns for 15 years equal to the discounted costs of obtaining the income stream is computed. The discount rate which makes these two sums equal is called the internal rate of return. The internal rate

of return is the objective of the following calculations.

Costs and returns were discounted for both estimated grazing and permitted grazing capacities for 15 years at different rates until the internal rate of return was found. The rate at which the two figures were equal was not determined exactly; however, the rate of return at which the two figures were almost equal for permitted grazing was found to be less than 1.0 percent. This figure would then be the internal rate of return for money spent by the USFS for range improvement projects on the Curlew National Grassland. Costs discounted at 1.0 percent are given in Table 12. Net annual returns for the number of aum's which livestock were permitted to graze are shown in Table 13.

Using a 1.0 percent discount rate on the number of aum's which livestock were permitted to graze, discounted net returns were found to be much less in 15 years than discounted costs--$6,917.73 in discounted returns compared to $87,636.38 in discounted costs. This shows that the internal rate of return is much lower than 1.0 percent. The project life must be extended to 18 years before a 1.0 percent internal rate of return was received for benefits from those range improvements which livestock were actually permitted to graze.

Discounting returns for the estimated grazing capacity brought the internal rate of return to 1.0 percent after 15 and a fraction years. Discounted net returns for estimated grazing capacity are given in Table 14.

When discounted returns after 15 years are compared to discounted costs from Table 12, the difference is found to be $30,056.12. After 16 years, returns exceed costs by $8,103.12; thus, discounted costs and

Table 12. Costs of range improvements for Curlew National Grassland, discounted at 1.0 percent

Year	Cost	Discounting factor	Discounted cost
1954	$ 6,683.35	.990	$ 6,616.52
1955	0	.980	0
1956	4,288.50	.970	4,159.85
1957	3,960.00	.960	3,801.60
1958	2,860.00	.951	2,719.86
1959	2,310.02	.942	2,176.02
1960	794.00	.932	740.00
1961	9,079.30	.923	8,380.19
1962	11,826.75	.914	10,809.65
1963	25,814.47	.905	23,362.10
1964	2,126.68	.896	1,905.51
1965	10,428.14	.887	9,249.76
1966	10,378.00	.878	9,111.88
1967	5,297.40	.869	4,603.44
Total discounted costs			$87,636.38

Table 13. Net annual returns for aum's which USFS personnel allowed livestock to graze on Curlew National Grassland discounted at 1.0 percent

Year	Net annual return	Discounting factor	Discounted net annual return
1954	0	.990	0
1955	$-12,180.00	.980	$-11,936.40
1956	-5,492.00	.970	-5,327.24
1957	-10,528.00	.960	-10,106.88
1958	-4,468.00	.951	-4,249.07
1959	-7,012.00	.942	-6,605.30
1960	-6,612.00	.932	-6,162.38
1961	-6,276.00	.923	-5,792.75
1962	-5,992.00	.914	-5,476.69
1963	5,152.00	.905	4,662.56
1964	4,816.00	.896	4,315.14
1965	5,580.00	.887	4,949.46
1966	7,516.00	.878	6,599.05
1967	7,372.00	.869	6,406.27
1968[a]	41,396.00	.861	35,641.96
1969	41,396.00	.852	35,269.39
1970	41,396.00	.844	34,938.22
1971[b]	41,396.00	.836	34,607.06

[a]Total discounted returns for 15 years--$6,917.73.

[b]Total discounted returns for 18 years--$111,732.40.

Table 14. Net annual returns for estimated grazing capacity on Curlew National Grassland, discounted at 1.0 percent

Year	Net annual return	Discounting factor	Discounted net annual return
1954	0	0	0
1955	$ 5,880.00	.980	$ 5,762.40
1956	-476.00	.970	-461.72
1957	-476.00	.960	-456.96
1958	-476.00	.951	-452.68
1959	-476.00	.942	-448.39
1960	-5,072.00	.932	-4,727.10
1961	-5,072.00	.923	-4,681.45
1962	-5,072.00	.914	-4,635.80
1963	2,128.00	.905	1,958.40
1964	2,128.00	.896	1,906.69
1965	8,600.00	.887	7,628.20
1966	9,960.00	.878	8,744.88
1967	10,220.00	.869	8,881.18
1968[a]	44,788.00	.861	38,562.47
1969[b]	44,788.00	.852	38,159.38

[a]Total discounted net annual return at 15 years--$57,580.12.

[b]Total discounted net annual return at 16 years--$95,739.50.

returns are equal somewhere between 15 and 16 years of project life.

Alternative method of range improvement investments

Present USFS range improvement investment policy requires several years before enough funds are made available to complete all of the proposed improvement projects for an area. Funds spent in such a manner are hard to justify as was seen in the previous section of this study. Results of investment policies of this type are found on the Curlew National Grassland. Costs and returns have been spread over a large number of years, causing project life to expire prior to realization of returns that could have been received earlier. This following

analysis shows the results which could have been obtained if the entire amount spent on improvement projects, $95,846.61, could have been invested in 1954 rather than being spread over a 14-year period.

Results for improvement projects can be obtained from Table 5. In Table 5, under aum's in the permitted-to-graze section, the total number of aum's is 24,320. This amount represents both the beginning number of aum's prior to range improvements, 14,273, and the number of aum's resulting from range improvements, 10,047. Multiplying the result of range improvements, 10,047, aum's by the value of each aum, $4.00, gives a gross annual return for range improvements of $40,188.00. Annual maintenance costs of $2,380.00 (47,600 acres multiplied by $0.05), subtracted from gross annual return of $40,188.00, equal a net annual return of $37,808.00. This net return could be expected for 13 years with project life set at 15 years (see Table 15).

If the entire Curlew National Grassland would have been treated in 1954, non-use would have been necessary for two years to allow the newly seeded wheatgrasses to establish themselves. Such a non-use would have cost stockmen $57,092.00 each year for losing the initial number of aum's, 14,273, valued at $4.00 apiece. Net annual returns for the 15-year project life are given in Table 15.

Returns must be discounted to 1954 values to compare with costs incurred at that time. This study will first discount net returns at 10 percent to determine life of the project. Project life will be that year in which discounted net returns equal initial investment costs.

Net annual returns are taken from Table 15. These net annual returns are discounted using a 10 percent discounting factor in Table 16. From Table 16 it is found that after 11 years, discounted net

Table 15. Investment cost, annual costs, and net annual returns of alternative investment policy for Curlew National Grassland

Year	Investment	Increase in aum's from 1954	Gross annual benefit	Annual cost	Net annual benefit
1954	$95,846.61	-14,273	$-57,092.00	0	$-57,092.00
1955		-14,273	-57,092.00	0	-57,092.00
1956		10,047	40,188.00	$2,380.00	37,808.00
1957		10,047	40,188.00	2,380.00	37,808.00
1958		10,047	40,188.00	2,380.00	37,808.00
1959		10,047	40,188.00	2,380.00	37,808.00
1960		10,047	40,188.00	2,380.00	37,808.00
1961		10,047	40,188.00	2,380.00	37,808.00
1962		10,047	40,188.00	2,380.00	37,808.00
1963		10,047	40,188.00	2,380.00	37,808.00
1964		10,047	40,188.00	2,380.00	37,808.00
1965		10,047	40,188.00	2,380.00	37,808.00
1966		10,047	40,188.00	2,380.00	37,808.00
1967		10,047	40,188.00	2,380.00	37,808.00
1968		10,047	40,188.00	2,380.00	37,808.00

Table 16. Net annual returns for alternative investment policy from Curlew National Grassland, discounted at 10 percent

Year	Net annual return	Discounting factor	Discounted net annual return
1954	$-57,092.00	.909	$-51,896.00
1955	-57,092.00	.826	-47,158.00
1956	37,808.00	.751	28,394.00
1957	37,808.00	.683	25,823.00
1958	37,808.00	.620	23,441.00
1959	37,808.00	.564	21,324.00
1960	37,808.00	.513	19,396.00
1961	37,808.00	.466	17,619.00
1962	37,808.00	.424	16,031.00
1963	37,808.00	.385	14,556.00
1964[a]	37,808.00	.350	13,233.00
1965	37,808.00	.318	12,023.00
1966	37,808.00	.289	10,927.00
1967	37,808.00	.263	9,944.00
1968[b]	37,808.00	.239	9,036.00

[a]Total discounted net annual returns after 11 years equal $98,382.00.

[b]Total discounted net annual returns after 15 years equal $140,312.00.

annual returns are $98,382.00. This figure is $2,535.39 more than initial investment costs of $95,846.61; thus, project life span for an internal rate of return of 10 percent is between 10 and 11 years.

Net annual returns are discounted at various interest rates to determine the internal rate of return with a 15-year project life. The discount rate at which discounted net annual returns are approximately equal to initial investment costs is found to be 12 percent. Net annual returns are discounted for 15 years using the 12-percent discounting factor in Table 17. Total discounted net annual returns from Table 17 are $96,883.94. Initial investment costs are $95,846.61. This amount is $1,037.33 less than discounted returns; thus, internal rate of return is between 12 and 13 percent for the alternative investment policy.

Table 17. Net annual returns for alternative investment policy from Curlew National Grassland, discounted at 12 percent for 15 years

Year	Net annual return	Discounting factor	Discounted net annual return
1954	$-57,092.00	.892	$-50,926.06
1955	-57,092.00	.797	-45,502.32
1956	37,808.00	.711	26,881.49
1957	37,808.00	.635	24,008.08
1958	37,808.00	.567	21,437.13
1959	37,808.00	.506	19,130.85
1960	37,808.00	.452	17,089.22
1961	37,808.00	.403	15,236.62
1962	37,808.00	.360	13,610.88
1963	37,808.00	.321	12,136.37
1964	37,808.00	.287	10,850.90
1965	37,808.00	.256	9,678.85
1966	37,808.00	.229	8,658.03
1967	37,808.00	.204	7,712.83
1968	37,808.00	.182	6,881.07
Total discounted net annual returns			$ 96,883.94

Sage grouse and the Curlew

National Grassland

Early residents of Curlew Valley reported that large numbers of sage grouse existed on the Curlew National Grassland area during the 1920's and 1930's. These people tell of many evenings when the horizon would be blackened by sage grouse flying to watering places in the valley. These same "old-timers" have reported populations to be greatly decreased today from those numbers of sage grouse that existed in the 1920's and 1930's.

Sage grouse are some of the most difficult game birds to sample quantitatively due to their migratory nature and gregarious habits, which tend to vary by day and by season. Small remnant flocks located on the Curlew National Grassland have been found in Hess Haws pasture, Hurd pasture, Jacobsen pasture, Peterson-Lonigan pasture and Huffman pasture. All of these pastures have a history of being areas where good populations of sage grouse once existed.

Variances in sage grouse populations have been caused by livestock management of the fields. Livestock had heavily grazed the fields killing valuable forage. Fields were overgrown with sagebrush and forbs. This situation resulted in a favorable habitat for sage grouse. They had sagebrush for cover, food in winter, and nesting purposes. Forbs such as wild lettuce, sunflowers, and other annuals made valuable food for sage grouse in spring, summer, and fall. It was during this era of private ownership when large populations of sage grouse existed on the Curlew National Grassland.

The federal government purchased the land comprising the Curlew National Grassland from private owners from 1934 to 1942 because the

land was unsuitable for cultivation and subject to drought. These public lands were administered by the Soil Conservation Service (SCS) until 1954, at which time they were placed under the auspices of the USFS. The SCS began a program of range improvements during their administration of the area. They knew that desirable forage had to be increased to enable them to raise the limit on the number of cattle which would be allowed to graze. The area showed great potential for range improvement programs. These improvements were initiated by the SCS and are still being continued by the USFS. Their efforts to produce better grazing in the fields have damaged sage grouse populations.

The first step taken by federal agencies to increase aum's on the Curlew National Grassland was directed toward sagebrush control. Various fields have had 9,534 acres sprayed, 1,517 acres have been plowed, and 160 acres have been burned. Controlling sagebrush has injured sage grouse populations and habitat in several ways.

The majority of brush control projects are carried out in the spring to be most effective. This is a critical time of the year for sage grouse reproduction. Sage grouse begin their process of reproduction with a procedure known as booming. Males and females gather in an area which is open but has sagebrush nearby for cover. The males then do a strutting-like movement and produce sounds by rubbing their wings against the stiff, white feathers on the cape, which has been blown up with air. Females appear on the booming grounds and show their willingness to mate with a particular male by squatting in front of him. Breeding occurs on the booming grounds. Evidence indicates that sage grouse return to the same booming ground year after year. They show a reluctance to move to new areas. When surrounding cover is destroyed,

sage grouse abandon the booming ground. Early residents give reports of seeing thousands of sage grouse booming in many of the fields on the Curlew National Grassland. In 1967 the only booming ground which could be located was in South 13 pasture. This pasture was watched throughout March, April and May. Booming activity reached its peak on May 9 when 21 cocks were counted.

Sagebrush control projects carried out in early spring undoubtedly destroyed many nests. Sage grouse nest under sagebrush plants to gain the cover and protection it gives them from predators. When a field is plowed, burned, or beaten, the nest is destroyed as well as the sagebrush. Male sage grouse are only fertile for 60 to 80 days while they are on the booming grounds. Sage grouse do not have the tendency to renest even if the male is still fertile. Thus, a year's crop of sage grouse are destroyed. Yearling hens that fail to breed and nest their first year have been found to be unsuccessful in breeding the remainder of their life. When a disturbance occurs like plowing, burning, or brush beating near a booming ground, yearling hens may fail to breed. In this situation the range improvement projects accomplished that spring have a long range detrimental effect on sage grouse populations.

Range technicians, in considering an area for sagebrush control, will look at the amount of soil moisture available for either native grasses or grasses which will be seeded. The best areas are along creeks and meadows. Sagebrush along creeks and on meadows on the Curlew National Grassland was quite thick and provided excellent protection from predators for sage grouse and their little chicks. The maximum distance from water to nests was found to be 800 yards. Sagebrush near water is the major limiting factor for sage grouse on the

Curlew National Grassland at the present time.

Loss of spring habitat may also affect sage grouse in other ways. Small chicks are vulnerable to attacks from predators. Without good cover they are subject to death every time they move to their water supply to drink. With sagebrush for protection their chances of being killed are reduced.

Sagebrush along creeks and meadows contains many more insects and ants than either wheatgrass fields or sagebrush in dry, arid areas. Eighty percent of a two-week-old chick's diet consists of insects and ants. They are not able to survive on the type of diet on which mature sage grouse live. Young chicks are very specific in their needs. Without proper cover and diet, their numbers are limited. Wheatgrasses which were planted in these areas neither provide the cover nor diet needed for a large population of sage grouse.

Sagebrush is the major source of protection from weather and for food during the winter season. Sage grouse require an area which has 2,000 to 3,000 plants per acre. This gives them cover and will provide a food supply. Sage grouse have a soft crop and are not able to digest hard grains produced by wheatgrasses which have been planted where sagebrush lived prior to the control projects. Without a supply of food during the winter, sage grouse either die or migrate to the surrounding hills.

Wheatgrasses which have been planted in the fields have had a detrimental influence on sage grouse populations. This forage--much to the delight of stockmen--will kill other types of plants in areas where it grows. Wheatgrasses have killed wild lettuce, sunflowers, and other

forbs which are necessary to the diet of sage grouse. As previously mentioned, these birds are not able to digest hard grains. The diets of sage grouse consist of sagebrush, insects and ants which live on sagebrush, and leaves and bud capsules of forbs. The forb which sage grouse seem to prefer most on the Curlew National Grassland is wild lettuce (Lactuca Serriola). Since 31,060 acres of the Curlew National Grassland have been seeded to crested and pubescent wheatgrass, the amount of food which sage grouse can digest has become limited.

Sage grouse are migratory birds. Rather than to die in a certain area due to lack of habitat or food they will migrate limited distances. Some sage grouse have been followed 35 miles from Locomotive Springs in Northern Utah to the Curlew National Grassland in Southern Idaho. Small flocks have been noticed in the various pastures during one season and will move to a different pasture during another season. They will fly from foothills surrounding the valley to the valley floor as their needs change with the seasons. The most critical time and limiting factor on the Curlew National Grassland for sage grouse is late spring and early summer. During this period they need a habitat consisting of sagebrush near creeks and meadows, which provide food and protection for mature birds and young chicks. Pastures with water and brush, for the most part, have been planted to grasses. Control projects have done away with sagebrush needed for protection. Without such areas, sage grouse populations will be restricted or have to migrate to areas which are more suitable to their needs than can be found on the Curlew National Grassland. Wildlife biologists are confident that they would have noticed any great increase in sage grouse populations of areas surrounding the Curlew National Grassland if sage grouse had migrated rather

than died over the period of years when range improvements for livestock were being carried out.

Hungarian partridges and the Curlew National Grassland

Hungarian partridges were introduced to the Curlew Valley during the early part of the 20th century. They have increased in number, until now partridges are found scattered throughout all of the pastures. Their habitat requirements are quite different than those of sage grouse. Partridges thrive on wheatgrasses and their hard seeds. They are able to digest hard seeds without any trouble.

Habitat conducive to partridge production is quite different than that required by sage grouse. Partridges prefer a habitat which has tall grasses and some sagebrush. A habitat of this type provides the cover they desire. Sage grouse prefer areas which give them large areas of "seeing room" and do not have tall grasses. Sage grouse get their cover from sagebrush. Improvements for livestock have altered pastures to make habitat more desirable for partridges than sage grouse.

Pheasants and the Curlew National Grassland

Pheasants were transplanted into the Curlew Valley in the early 1900's. They are now considered to be the main upland game bird hunted by sportsmen on the Curlew National Grassland. They are found in all of the pastures.

Requirements of pheasants are not as restrictive as those of sage grouse. They adapt to wheatgrass areas well. They are able to eat and digest hard grain seeds. Improvements on the pastures have helped

pheasant populations by providing more food for them.

Migratory waterfowl on the Curlew National Grassland

Range improvements have neither been detrimental nor beneficial to ducks and wild geese on the Curlew National Grassland. The large populations which arrive each fall restrict their movements to Stone Reservoir and wheat fields located on farms throughout the valley. These birds have not been seen feeding in the sagebrush or crested wheatgrass fields.

Over-all effects of range improvements for livestock on upland game birds

Due to a lack of quantitative data, it is impossible to state that range improvements for livestock have reduced or increased upland game bird populations by X number of birds. From interviews conducted with Idaho Fish and Game Department biologists and USFS wildlife biologists, it is possible to state that range improvements for livestock have been detrimental to sage grouse populations and beneficial to partridge and pheasant populations.

If data concerning the number of birds which were gained or lost and the value of said birds were available, the value of the hunting resource gained or lost by society would have been considered when computing total return from range improvement projects. If net return to society for sage grouse is negative, then this value must be subtracted from total returns. If net benefits to sportsmen are positive for the increase in pheasant and partridge populations, then this value would

be added to total net benefit.

Negative and positive returns for each type of upland game bird, in addition to net returns for livestock, would have to be considered in determining total benefit for range improvements. Due to a lack of quantitative data, it is impossible to make accurate statements concerning economic values of these birds.

Saddle Creek Allotment

Description of study area

The Saddle Creek cattle-grazing allotment is located in Rich and Cache Counties of Northeastern Utah and is under the administration of Cache National Forest, Randolph District. This allotment was formed in 1961 by a separation from Willow Springs allotment, Mill Hollow sheep allotment, and Laketown cattle allotment. In 1962, Lower Saddle Creek unit was added; it too had been separated from Laketown cattle allotment in 1961. Saddle Creek allotment carried 560 head of livestock during the 1969 grazing season. There are three permittees on this allotment. The grazing season usually lasts from June 15 to September 26; however, variances of one week in beginning and ending dates have occurred.

Saddle Creek allotment contains 3,986 acres which have been further subdivided by let-down fences into four fields. These four fields are often referred to by several different names. To avoid confusion, the names of these pastures are as follows: (1) Red Banks, Northwest, or West; (2) Lower; (3) Deer Lock, Middle, or Southeast; and (4) Mahogany, Big, or Northeast. They will be referred to as Red Banks, Lower, Deer Lock, and Mahogany in this study. These pastures were set up so that a planned rotation grazing system could be initiated.

Range improvements have consisted of 2,500 acres being sprayed to control undesirable plant growth, 15 reservoirs have been constructed to provide water for livestock, and approximately 13 miles of let-down fences have been constructed. In addition to dividing the unit into pastures for a rest-rotation grazing system, the fences were constructed to be an aid to movement of big game. These fences are lowered to the ground during the seasons when cattle are not present in the pastures. During this period of time, big game are able to migrate without their movement being hindered by fences.

The area is characterized by mountains with elevations reaching nearly 9,000 feet. Portions of the area are classified as unusable except for limited grazing and aesthetic value.

Range management policy

The USFS initiated a range management policy in 1961 that calls for improvement projects which will increase amount of forage available for livestock consumption. The basic requirement for meeting this objective is to achieve and maintain a plant cover adequate to provide soil stability. These requirements have been met by spraying undesirable brush and providing a rest-rotation grazing system which resulted in better establishment and utilization of desirable forage. The rate at which structural and non-structural range improvement projects are completed has been determined by funds available for improvement projects on the Saddle Creek allotment.

Rest rotation grazing plans for the four pastures were proposed in 1962 for the period beginning in 1962 and ending in 1970. In 1970 present plans will be analyzed and changes, if necessary, will be

proposed.

Range condition analyses was conducted each year by the USFS personnel from Randolph District. Recommendations were drawn from the analyses and made to supervisory personnel who determined the number of cattle which would be permitted to graze each year.

Description of range improvements

Range improvement projects for the Saddle Creek allotment were divided into the same categories as the Curlew National Grassland improvements--structural and non-structural.

Non-structural range improvements were further classified according to pasture and the year in which improvements were accomplished. A complete description of non-structural range improvement projects for the Saddle Creek allotment and their costs are given in Table 18.

All structural range improvements for Saddle Creek allotment were either fences or water developments. Fencing projects were constructed

Table 18. Description and costs of non-structural range improvements for Saddle Creek allotment

Pasture	Description of improvement	Year	Cost
Lower	450 acres aerial sprayed	1961	$ 2,025.00
Deer Lick	600 acres aerial sprayed	1961	2,700.00
Mahogany	1,000 acres aerial sprayed	1963	4,500.00
Red Banks	460 acres aerial sprayed	1965	2,188.00
Total			$11,413.00

on a cooperative basis with permittees. The USFS supplied all materials and the permittees provided labor in constructing the fences. A description of fences and costs incurred by the USFS is given in Table 19.

Water developments were also a cooperative effort between permittees and the USFS. These developments have consisted of small reservoirs designed to hold water from spring run-off to provide drinking water for the cattle. They are not used to any extent for irrigation purposes although they do provide small benefits for forage immediately surrounding the reservoirs. A description of water developments is provided in Table 20.

Total costs for range improvements for each year were computed after being classified into their respective categories of spraying,

Table 19. Description and costs of fences for Saddle Creek allotment

Pasture	Description of fence	Year	Cost
Deer Lick	2.0 miles let-down fence	1961	$ 3,600.00
Deer Lick	2.0 miles let-down fence	1961	3,600.00
North Boundary	3.25 miles let-down fence	1961	5,850.00
East Boundary	2.0 miles let-down fence	1961	3,600.00
South Boundary	2.0 miles let-down fence	1961	4,500.00
Lower Pasture	1.0 mile let-down fence	1962	1,800.00
West Boundary	0.5 mile let-down fence	1962	900.00
Total			$23,850.00

Table 20. Description and costs of water developments for Saddle Creek allotment

Pasture	Description of improvement	Year	Cost
Red Banks No. 1	2 reservoirs	1961	$ 41.67
Red Banks No. 1	1 reservoir	1962	41.67
Red Banks	1 reservoir	1962	41.67
Mahogany No. 2	1 reservoir	1962	41.67
Mahogany No. 1	1 reservoir	1962	41.67
Mahogany No. 1	1 reservoir	1962	41.67
Mahogany No. 3	1 reservoir	1962	41.67
Mahogany No. 4	1 reservoir	1962	41.67
Deer Lick No. 1	1 reservoir	1962	41.67
Deer Lick No. 2	1 reservoir	1962	41.67
Deer Lick No. 3	1 reservoir	1962	41.67
Mahogany No. 2	1 reservoir	1964	42.00
Mahogany No. 3	1 reservoir	1964	42.00
Mahogany No. 3	1 reservoir	1964	42.00
Total			$584.37

fences, and water developments. Costs for each type of improvement as shown in Tables 18, 19 and 20 were added together to arrive at both costs of improvement per year and total amount spent for range improvement projects on the Saddle Creek allotment. These costs are given in Table 21.

Table 21. Costs of range improvements for Saddle Creek allotment

Year	Annual cost	Cumulative cost
1961	$25,916.67	$25,916.67
1962	3,116.70	29,033.37
1963	4,500.00	33,533.37
1964	126.00	33,659.37
1965	2,188.00	35,847.37

Evaluation of range improvements

The effectiveness of range improvement projects was determined by analyzing range allotment records obtained from Region 4 USFS offices in Ogden, Utah, and Cache National Forest Supervisor's Office in Logan, Utah. These records stated both estimated grazing capacity in aum's and the number of aum's which livestock were actually allowed to grace. These figures are shown in Table 22.

The year from which this study bases all calculations is 1961, the year USFS personnel began their range improvement program. The number of aum's for both estimated and permitted-to-graze categories was subtracted from the starting amount of aum's in 1961. The figures resulting from this calculation are the benefit due to range improvements in aum's for one year. Since the number of aum's varied in each category each year, the calculation was performed on a year-to-year basis from 1962 to 1975 to arrive at annual benefit for a project life of 15 years. The number of aum's in 1961, when range improvements were started and project life commenced, were not considered as a benefit due to range improvements; consequently, the value of these aum's will not be counted in further calculations. Although data is not available for aum's present from

Table 22. Number of aum's which USFS personnel estimated was present and number of aum's which livestock were allowed to graze on Saddle Creek allotment[a]

Year	Estimated grazing capacity (aum)	Permitted to graze (aum)
1961	778	778
1962	1,874	1,122
1963	1,874	1,186
1964	2,628	1,186
1965	2,628	1,300
1966	2,876	1,332
1967	2,876	1,325
1968	2,876	1,651
1969	2,876	1,960
1970[b]	2,876	1,960
1971	2,876	1,960
1972	2,876	1,960
1973	2,876	1,960
1974	2,876	1,960
1975	2,876	1,960

[a]Data summarized from range allotment record and analysis for Saddle Creek allotment.

[b]Projected number of aum's, actual number not available from 1970 to 1975.

1970 to 1975, it is not unreasonable to project that there will be at least as many aum's present for this period as were available in 1969. The number of aum's projected for 1970 to 1975 is a conservative estimate which will result in a conservative dollar return for range improvements in the analyses to be shown in later sections of this study. Gross value of annual benefit is determined by multiplying each aum by $4.00, the same value used in Curlew National Grassland calculations. Table 23 shows annual results of range improvement projects in aum's and gross value.

To arrive at actual benefits for range improvement projects, net annual returns must be calculated. Annual maintenance costs must be

Table 23. Gross returns for range improvement projects for Saddle Creek allotment

Year	Estimated grazing capacity		Permitted to graze	
	Aum's[a]	Gross value	Aum's[a]	Gross value
1961	0	0	0	0
1962	778	$4,384.00	344	$1,376.00
1963	1,874	4,384.00	408	1,632.00
1964	1,874	7,400.00	408	1,632.00
1965	2,628	7,400.00	522	2,088.00
1966	2,628	8,392.00	554	2,216.00
1967	2,876	8,392.00	547	2,188.00
1968	2,876	8,392.00	873	3,492.00
1969	2,876	8,392.00	1,182	4,728.00
1970	2,876	8,392.00	1,182	4,728.00
1971	2,876	8,392.00	1,182	4,728.00
1972	2,876	8,392.00	1,182	4,728.00
1973	2,876	8,392.00	1,182	4,728.00
1974	2,876	8,392.00	1,182	4,728.00
1975	2,876	8,392.00	1,182	4,728.00

[a]Difference between aum's of the current year and those in 1961.

computed and subtracted from gross annual return to arrive at net annual return. Annual maintenance costs for the Saddle Creek allotment area are computed by the same procedure as they were for the Curlew National Grassland:

1. fence maintenance	$0.03/acre
2. water development maintenance	0.02/acre
	$0.05/acre

Annual operating costs, gross annual returns, and net annual returns are given in Table 24 for permitted-to-graze benefits.

Gross annual return, annual maintenance costs, and net annual returns for the estimated number of aum's, which were the result of range improvement projects, are given in Table 25.

Table 24. Net annual returns for Saddle Creek allotment from aum's which livestock were permitted to graze with annual operating costs of $0.05/acre (3,986 acres)

Year	Gross return	Annual operating cost	Net annual return
1961	0	0	0
1962	$1,376.00	$199.30	$1,176.70
1963	1,632.00	199.30	1,432.70
1964	1,632.00	199.30	1,432.70
1965	2,088.00	199.30	1,888.70
1966	2,216.00	199.30	2,016.70
1967	2,188.00	199.30	1,988.70
1968	3,492.00	199.30	3,292.70
1969	4,728.00	199.30	4,528.70
1970	4,728.00	199.30	4,528.70
1971	4,728.00	199.30	4,528.70
1972	4,728.00	199.30	4,528.70
1973	4,728.00	199.30	4,528.70
1974	4,728.00	199.30	4,528.70
1975	4,728.00	199.30	4,528.70

Table 25. Net annual returns for Saddle Creek allotment for estimated grazing capacity with annual operating costs of $0.05/acre (3,986 acres)

Year	Gross return	Annual operating cost	Net annual return
1961	0	0	0
1962	$4,384.00	$199.30	$4,184.70
1963	4,384.00	199.30	4,184.70
1964	7,400.00	199.30	7,200.70
1965	7,400.00	199.30	7,200.70
1966	8,392.00	199.30	8,192.70
1967	8,392.00	199.30	8,192.70
1968	8,392.00	199.30	8,192.70
1969	8,392.00	199.30	8,192.70
1970	8,392.00	199.30	8,192.70
1971	8,392.00	199.30	8,192.70
1972	8,392.00	199.30	8,192.70
1973	8,392.00	199.30	8,192.70
1974	8,392.00	199.30	8,192.70
1975	8,392.00	199.30	8,192.70

Discounting costs and returns

Since investment costs and returns for the Saddle Creek allotment are spread over a period of years and the value of a dollar each year for 15 years is not equal to 15 dollars today, future costs and returns must be discounted to present value. Saddle Creek allotment returns and costs are handled with a procedure similar to that used with the Curlew National Grassland.

Two methods are used to discount costs and returns to 1961 values. The first method again uses the 10 percent discount rate as suggested by the Secretary of the Department of Agriculture to the Chief of the USFS. Project life span required to return 10 percent on investment for both estimated grazing capacity and number of aum's which livestock were actually allowed to graze was computed. The permitted-to-graze analysis is presented first. It will be followed by analysis of estimated grazing capacity.

Costs of range improvements each year are taken from Table 19. Since the $35,847.37 was not all invested in 1961, it is necessary to discount the cost incurred each year to 1961. The discounting procedure will make the costs equal in time to each other. They are discounted using the 10 percent rate in Table 26.

From Table 26 it is seen that discounted costs are equal to $30,954.70. To find the length of project life necessary to yield a 10 percent internal rate of return, discounted net returns must be equal to discounted costs. The number of years necessary for discounted costs to equal discounted returns is the project life span. Total discounted net returns in the year 2032 are only $28,839.23. This amount is $2,115.47 short of recovering investment costs of $30,954.70.

Table 26. Range improvement costs for Saddle Creek allotment, discounted at 10 percent

Year	Cost	Discounting factor	Discounted cost
1961	$25,916.27	.909	$23,558.25
1962	3,116.70	.826	2,574.39
1963	4,500.00	.751	3,379.50
1964	126.00	.683	86.00
1965	2,188.00	.620	1,356.56
Total discounted cost			$30,954.70

It is biologically impossible for project life to be 72-plus years due to reinvasion of undesirable plants after 12-15 years. Therefore, this project is not feasible at a 10 percent discount rate.

With estimated grazing capacity, the length of project life necessary to yield a 10 percent internal rate of return for estimated grazing capacity is found by equating discounted net annual returns and discounted costs. Net annual returns discounted with the 10 percent rate for estimated grazing capacity are given in Table 27.

When discounted net returns of eight years, $31,503.18, are compared to discounted costs from Table 24, $30,954.70, the difference is found to be $548.48; thus, project life for estimated grazing capacity on the Saddle Creek allotment is eight years with a discount rate of 10 percent.

The second method by which costs and returns are discounted uses a project life of 15 years. Costs and returns for both estimated grazing and permitted grazing capacities were discounted for 15 years at different rates until the internal rate of return was found for each.

Table 27. Net annual returns for estimated grazing capacity on Saddle Creek allotment, discounted at 10 percent

Year	Net annual return	Discounting factor	Discounted net annual return
1961	0	.909	0
1962	$4,184.70	.826	$ 3,456.56
1963	7,200.70	.751	5,407.73
1964	7,200.70	.683	4,918.08
1965	8,192.70	.620	5,079.47
1966	8,192.70	.564	4,620.68
1967	8,192.70	.513	4,202.86
1968	8,192.70	.466	3,817.80
Total discounted net annual return			$31,503.18

The internal rate of return for aum's which the USFS allowed livestock to graze was found to be 3 percent. Costs discounted at 3 percent equaled $34,198.92; returns were found to be $33,480.98. Although the exact rate at which the two figures could not be determined, the internal rate of return is between 2 and 3 percent. Discounted costs are given in Table 28. Returns discounted at 3 percent are shown in Table 29.

Although internal rate of return was found to be approximately 3 percent for aum's which the USFS allowed cattle to graze, the internal rate of return is much greater when returns are discounted using the number of aum's which USFS personnel estimated were present. The internal rate of return for estimated grazing capacity on Saddle Creek allotment is between 20 and 21 percent with a 15-year project life. Costs discounted by 20 percent are shown in Table 30. Returns discounted by 20 percent are presented in Table 31.

Table 28. Costs of range improvements for Saddle Creek allotment, discounted at 3 percent

Year	Cost	Discounting factor	Discounted cost
1961	$25,916.67	.970	$25,139.17
1962	3,116.70	.942	2,935.93
1963	4,500.00	.915	4,125.87
1964	126.00	.888	111.89
1965	2,188.00	.862	1,886.06
Total discounted annual costs			$34,198.92

Table 29. Net annual returns for aum's which USFS personnel allowed livestock to graze on Saddle Creek allotment, discounted at 3 percent

Year	Net annual return	Discounting factor	Discounted net return
1961	0	.970	0
1962	$1,176.70	.942	$ 1,108.45
1963	1,432.70	.915	1,310.92
1964	1,432.70	.888	1,272.24
1965	1,888.70	.862	1,628.06
1966	2,016.70	.837	1,687.98
1967	1,988.70	.813	1,616.83
1968	3,292.70	.789	2,597.94
1969	4,528.70	.766	3,468.98
1970	4,528.70	.744	3,369.35
1971	4,528.70	.722	3,269.72
1972	4,528.70	.701	3,174.62
1973	4,528.70	.680	3,079.52
1974	4,528.70	.661	2,993.47
1975	4,528.70	.641	2,902.90
Total discounted net annual returns			$33,480.98

Table 30. Costs of range improvements for Saddle Creek allotment, discounted at 20 percent

Year	Cost	Discounting factor	Discounted cost
1961	$25,916.67	.833	$21,588.59
1962	3,116.70	.694	2,162.99
1963	4,500.00	.578	2,601.00
1964	126.00	.482	60.73
1965	2,188.00	.401	877.39
Total discounted costs			$27,290.70

Table 31. Net annual returns for estimated grazing on Saddle Creek allotment, discounted at 20 percent

Year	Net annual return	Discounting factor	Discounted net annual return
1961	0	.833	0
1962	$4,184.70	.694	$ 2,904.18
1963	7,200.70	.578	4,162.00
1964	7,200.70	.482	3,470.74
1965	8,192.70	.401	3,285.27
1966	8,192.70	.334	2,737.14
1967	8,192.70	.279	2,285.76
1968	8,192.70	.232	1,900.71
1969	8,192.70	.193	1,581.19
1970	8,182.70	.161	1,319.02
1971	8,192.70	.134	1,097.82
1972	8,192.70	.112	917.58
1973	8,192.70	.093	761.92
1974	8,192.70	.077	630.83
1975	8,192.70	.064	524.33
Total discounted net annual returns			$27,938.49

Alternative Method of Range Improvement Investments

Benefits received from range improvements for the Saddle Creek Allotment area are analyzed according to the procedure explained in the Curlew National Grassland section of this thesis.

The analysis will show the results that would have been attained if the entire cost of range improvements, $35,947.37, could have been invested in 1961 rather than being spread over a five-year period.

Results of range improvement projects for Saddle Creek Allotment are obtained from Table 22, under the permit to graze column. From this column, total number of aum's in 1975 are found to be 1,960. This figure represents number of aum's prior to improvements 778, and number available as a result of improvements, 1,182. Gross annual returns, $4,728.00, are calculated by multiplying the result of range improvements, 1,182 aum's by the value of each aum, $4.00. Annual maintenance costs of $0.05/acre for 3,986 acres equal $199.30. Gross annual return of $4,728.00 minus annual maintenance costs of $199.30 gives a net annual return of $4,528.70. This net annual return would be expected 13 years out of the 15 year project life span.

If the entire Saddle Creek Allotment area would have been treated in 1961, two years of non-use would have been required to allow native grasses to establish themselves. Non-use of grazing lands would have cost the three permittees $3,112.00 each year for losing 778 aum's, number of aum's present in 1961 valued at $4.00 each, for the 2 year non-use period. Net annual returns for the entire 15 year project life span are given in Table 32.

Table 32. Investment cost, annual costs, and net annual returns of alternative investment policy for Saddle Creek allotment

Year	Investment	Increase in aum's from 1961	Gross an. bene.	Annual operating costs	Net annual return
1961	$35,847.37	778[a]	$-3,112.00		$-3,112.00
1962		778[a]	-3,112.00		-3,112.00
1963		1,182	4,728.00	$199.30	4,528.70
1964		1,182	4,728.00	199.30	4,528.70
1965		1,182	4,728.00	199.30	4,528.70
1966		1,182	4,728.00	199.30	4,528.70
1967		1,182	4,728.00	199.30	4,528.70
1968		1,182	4,728.00	199.30	4,528.70
1969		1,182	4,728.00	199.30	4,528.70
1970		1,182	4,728.00	199.30	4,528.70
1971		1,182	4,728.00	199.30	4,528.70
1972		1,182	4,728.00	199.30	4,528.70
1973		1,182	4,728.00	199.30	4,528.70
1974		1,182	4,728.00	199.30	4,528.70
1975		1,182	4,728.00	199.30	4,528.70

[a]Loss of aum's resulting from non-use.

Net annual returns must be discounted to 1961 values for comparison with costs which were incurred at that time. An attempt to discount net annual returns at 10 percent to determine project life span was made. It was found that the project would not yield a 10 percent internal rate of return even after 70 years, which would be biologically impossible to attain.

Net annual returns are then discounted at various interest rates to determine the internal rate of return for a 15-year project life. The discounting factor which brings discounted net annual returns closest to initial investment costs is 4 percent. See Table 33. Total discounted net annual returns are $35,887.17. Initial investment costs are

Table 33. Net annual returns for alternative investment policy from Saddle Creek allotment discounted at 4 percent for 15 years

Year	Net annual return	Discounting factor	Discounted net annual return
1961	$-3,112.00	.961	$-2,990.63
1962	-3,112.00	.924	-2,875.49
1963	4,528.70	.888	4,021.49
1964	4,528.70	.854	3,867.51
1965	4,528.70	.821	3,718.62
1966	4,528.70	.790	3,577.67
1967	4,528.70	.759	3,437.28
1968	4,528.70	.730	3,305.95
1969	4,528.70	.702	3,179.15
1970	4,528.70	.675	3,056.87
1971	4,528.70	.649	2,939.13
1972	4,528.70	.624	2,825.91
1973	4,528.70	.600	2,717.22
1974	4,528.70	.577	2,613.06
1975	4,528.70	.555	2,513.43
Total discounted net annual returns			$35,887.17

$35,847.37 which is $39.80 less than discounted net annual returns. Internal rate of return for the alternative investment policy after 15 years of project life is 4 percent.

Big Game and the Saddle Creek Allotment Area

Deer and elk are the primary game sought by sportsmen on the Saddle Creek Allotment. Hunters were concerned about what effect range improvement programs primarily for livestock would have on big game numbers. Beginning in 1961, the USFS started a range improvement program which consisted of spraying undesirable brush and constructing fences to make pastures for a rotation grazing system. Recreationists were concerned with the number of deer and young elk that were caught on the barbed wire fences and died each year. Deaths of big game during the summer grazing season of June 15 to September 15, when cattle were in the pastures, seemed to be the lowest of all the seasons. USFS wildlife personnel contended that fences which could be lowered to ground level after the June 15 to September 15 grazing season would help reduce the amount of big game animals which were caught and died on the fences each year.

Description of fences

USFS regulations require that all fences constructed on USFS lands be no higher than 42 inches except for special projects. This regulation is not always followed; consequently many fences on public ranges are higher than regulations permit. Young deer and elk seem to be able to negotiate their way through or over fences that conform to the regulation.

The taller fences are the ones which cause most of the deaths and are more prevalent on public grazing area than those conforming to regulations.

Both let-down fences and USFS standard four-wire fences are found on the Saddle Creek Allotment. Let-down fences are located in areas which are subject to big-game migration and heavy snowfall. After the cattle are removed from the pastures each fall, USFS personnel lower the fences to ground level. This action occurs prior to game migration and heavy snowfall.

Maintenance costs

Let-down fences have not only decreased the number of deaths of big game animals, but are also less expensive to maintain over a period of several years. Both recreationists and USFS range managers believe the heavier initial investment cost of let-down fences is justified. Let-down fences constructed in 1968 on the Cache National Forest cost approximately $2,400 per mile, USFS standard four-wire fences were approximately $1,400 per mile. High maintenance costs were incurred with the standard four-wire fences due to heavy accumulation of snow in drifts on the Saddle Creek Allotment area. These heavy drifts broke the barbed wire in many places. If the staples were not pulled out of the posts by the heavy, sliding snow drifts, entire sections of fences were tipped over with the posts being pulled out of the ground. With no support, it was only a matter of time until the wires were broken by great strains placed upon them by sliding snow. Maintenance crews spent several weeks each spring repairing broken wires and replacing posts to have the fences ready to hold cattle when the grazing season began.

USFS range managers report that let-down fences have saved them money in this area. In the fall prior to heavy snowstorms and big game migrations, one or two men are sent to the Saddle Creek Allotment and pull the staples which hold the fences upright. This allows the fence to lay flat on the ground, permitting big game to cross with no problem and not catching the heavy, drifting snow. Although a few posts are still pushed over by heavy snow and some wires are broken, maintenance crews have been able to place the fences upright and repair the broken areas in the period of a few days; thus saving money in materials and time spent maintaining the fences.

Effects of Range Improvements on Big Game

Although quantitative data are not available concerning the actual number of wildlife deaths, interviews with Fish and Game Department personnel and USFS wildlife specialists indicate that let-down fences have lowered the number of big game deaths. Prior to let-down fences the majority of wildlife deaths occurred during the fall and spring months when wildlife were migrating. Let-down fences are lowered to the ground during these seasons; consequently death rates of big game have been lowered.

Fish and Game Department and USFS wildlife personnel stated that improvements for livestock had an effect on amount of forage available for big game animals. Prior to improvements for livestock, cattle were forced to eat a certain amount of forbs and browse. This situation resulted in less being available for big game. After spraying projects eliminated a large portion of sagebrush, grasses were able to establish

themselves in the pastures. Since livestock prefer grasses, more forbs and browse were available for big game consumption.

Quantitative data are not available to economically evaluate benefits big game have received as a result of range improvements for livestock. If it were possible to arrive at returns for wildlife, the monetary value received each year would be added to net annual returns and discounted to arrive at total discounted benefits. Data received from interviews indicate that with proper planning and management by Fish and Game Department personnel, USFS range management technicians, and USFS wildlife biologists range improvements for livestock have been at least supplementary for big game and livestock on Saddle Creek Allotment.

SUMMARY AND CONCLUSIONS

The first objective of this study was to determine benefits of range improvements designed specifically to increase livestock grazing capacity. The second objective was to determine what effect range improvements for livestock grazing had upon wildlife. The final objective was to determine if an increased internal rate of return could be obtained from an alternative range improvement investment policy.

Curlew National Grassland in southeastern Idaho and Saddle Creek Allotment in northeastern Utah were chosen for the analysis. Preliminary investigation and conversations with USFS personnel had shown these two areas to be typical of ranges grazed by permittees which could be further developed to increase carrying capacity.

Costs and returns for Curlew National Grassland were determined on an annual basis and discounted to 1954 values, the beginning year of the project. Costs and returns were discounted at 10 percent to find number of years necessary to realize a 10 percent internal rate of return. Project life spans of 18 and 25 years would be difficult to attain biologically due to rapid re-invasion of undesirable brush species. Therefore, one would have to conclude that these improvement projects as currently managed are uneconomical at a 10 percent discount rate.

Project life span was next set at 15 years. Costs and returns were discounted at various rates until that rate was found for both permitted and estimated grazing capacities where discounted costs were

equal to discounted returns. For permitted grazing the internal rate of return was found to be less than 1.0 percent. Internal rate of return for estimated grazing capacity was 1.0 percent.

Costs and returns from Saddle Creek Allotment were analyzed by the same method as the Curlew National Grassland investments and benefits. Project life spans were computed for permitted and estimated grazing capacities by discounting net returns at 10 percent until they were equal to costs discounted at the same rate. The permitted-to-graze analysis showed that an internal rate of return of 10 percent was impossible to attain even after 72 years. Estimated grazing capacity yielded an internal rate of return of 10 percent after 8 years.

After project life span was set at 15 years, the internal rate of return for permitted grazing was found to be 3 percent. Estimated grazing capacity gave an internal rate of return of 20 percent for a 15 year project life.

From society's point of view, economic returns from range improvements cannot be realized until forage is actually consumed. USFS personnel estimate enough forage to be available on Saddle Creek Allotment to realize an internal rate of return of 10 percent after 8 years; however they did not permit enough livestock to graze the forage to yield a 10 percent internal rate of return. Since forage is a renewable resource which realizes no return to users unless consumed, USFS personnel should increase the number of aum's which livestock are permitted to graze to actually receive benefits and justify money spent for improvements. Number of aum's which USFS personnel permit to be grazed could be increased considerably without endangering rangelands with overgrazing problems.

A proposed alternative investment policy is to make the entire investment in range improvements the first year of project life instead of stringing costs out over a number of years. Discounted costs for non-use suffered the first 2 years of project life were subtracted from total discounted net returns with project life set at 15 years. This analysis was applied to benefits which the USFS allowed permittees to receive rather than estimated grazing which was available.

Internal rate of return was set at 10 percent for the first analysis to determine project life span for Curlew National Grassland. Returns were discounted until they were equal to initial investment costs. After 11 years, discounted net returns equalled initial costs.

The second analysis of costs and returns for Curlew National Grassland set project life span at 15 years. Returns were discounted at various rates until they were equal to initial investment. Internal rate of return using this method was found to be 12 percent.

Results from the proposed investment policy for Saddle Creek Allotment did not produce returns as large as those found on the Curlew National Grassland. It was discovered that an internal rate of return of 10 percent could not be attained with a reasonable project life. Project life was then set at 15 years to determine internal rate of return. Returns were discounted at several rates until the rate was found where discounted returns were equal to initial costs. Internal rate of return on estimated grazing capacities using this method was found to be 4 percent.

Range improvements for livestock were found to have both beneficial and detrimental effects on wildlife within the two study areas. At the

Curlew National Grassland brush control measures and reseeding projects were detrimental to sage grouse populations. Improvements for livestock destroyed sagebrush which was used for cover from predators, food for adults during winter months, provided a favorable habitat for insects which young chicks must have for their diet, and destroyed booming grounds which are essential for reproduction. Wheatgrasses which were seeded in the pastures killed the forbs which sage grouse consumed. The digestive system of sage grouse is not able to utilize hard grain seeds which wheatgrasses produce; thus, food has also become a limiting factor.

The habitat produced by range improvements is favorable for pheasant and partridge populations. Both species of game birds have increased population numbers as a result of the increased amount of wheatgrass which provides a desirable cover. It is economically impossible to evaluate the negative and positive returns to wildlife due to range improvements since quantitative data are not available.

Range improvements for livestock were found to be beneficial to big game on Saddle Creek Allotment. Although data are not available to quantitatively evaluate the returns wildlife received from range improvement, interviews with Fish and Game Department personnel and USFS wildlife specialists indicate that deaths of big game have been reduced as a result of let-down fences. The same people stated that brush control projects provided more forage for cattle. With this desirable forage present, livestock did not consume as much forbs and browse as they previously had eaten. Big game prefer browse and forbs

for their diet; therefore, more feed is available for big game than was present prior to range improvements. Range improvement projects have been at least supplementary for livestock and big game animals on Saddle Creek Allotment.

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