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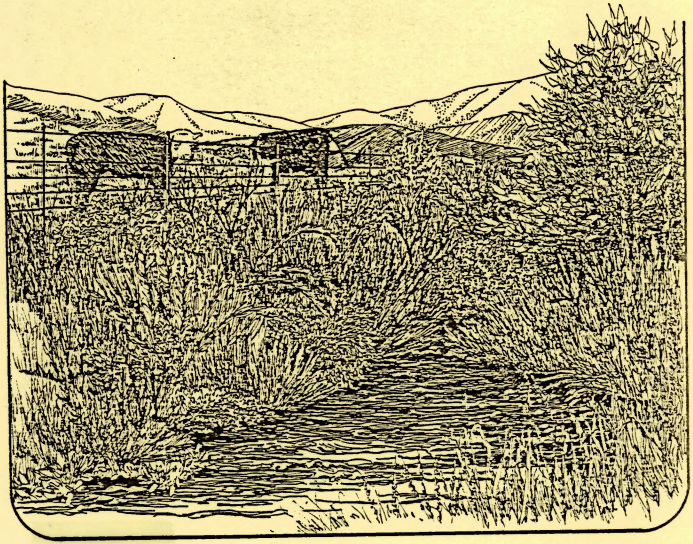

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LIVESTOCK-FISHERY INTERACTION STUDIES

OTTER CREEK, UTAH

Progress Report 2 to the USDI Bureau of Land Management,
Salt Lake City, Utah

April, 1980 to June, 1981

William S. Platts

Rodger Loren Nelson

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Forestry Sciences Laboratory, Boise, Idaho

ABSTRACT

Otter Creek was bound to be a difficult system to characterize due to inherent differences in vegetation between study sites, to fisheries management, and to ground water and surface water exchange phenomena. The treatment area (site 1) was observed to be vegetationally and geomorphically quite different than the two upstream sites, but these differences are probably due to inherent differences in channel structure. Fish population analysis results are confounded by the stocking of hatchery reared fish and the apparently minimal amount of natural reproduction. Little can yet be attributed directly to experimental manipulation, except that willow is already beginning to reestablish itself within the treatment area. Suggestions regarding future work are presented for BLM consideration.

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ACKNOWLEDGEMENTS

This report comprises information gleaned from a variety of sources, all of which are listed at the end. Most of the specific information regarding the history and condition of the South Narrows Allotment was distilled from materials supplied by David Young, Fisheries Biologist, USDI, Bureau of Land Management, Sevier River Resource Area, Richfield, Utah. In an effort to keep abundant, unwieldy referencing to a minimum, information from these sources is cited only when deemed necessary by the authors. Additional appreciation is extended to Gerry Ferringer, State Fishery Biologist, USDI, BLM, Salt Lake City, Utah for his efforts in coordinating this study; to Arthur H. Holmgren, Cooperative Extension Service and Utah State University Herbarium, Utah State University, Logan, Utah, for the identification of vegetation collected along Otter Creek; and to Dale Hepworth, Regional Fishery Biologist, Utah Division of Wildlife Resources, Southern Regional Office, Cedar City, Utah, for assistance with fish collection on Otter Creek.

PREFACE

This is the second in a series of progress reports that present the findings of the Otter Creek, Utah, Livestock-Fishery Interaction Studies, and is intended to supplement Progress Report 1 (Platts, Nelson, and Martin 1980). We have included sufficient background information in this report to produce a self-supporting document, and to provide a comparison of results from the two years of study so far completed; the reader may, however, wish to refer to Progress Report 1 for an independent presentation of the 1979 results.

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INTRODUCTION

There are 1.9 billion acres of land in the 48 conterminous United States, of which some 1.2 billion (63 percent) are rangelands, 69 percent of which, as of 1970, was grazed by domestic livestock. In the western United States, most of these rangelands are public lands administered by federal agencies. In Utah, for example, 66 percent of the state is federally owned and of this some 24 million acres (43 percent) administered by the USDI Bureau of Land Management (BLM)[1/].

Many streams of various sizes traverse this vast area, but despite their prevalence (Utah, for example, has some 2500 miles of streams on BLM land) they represent relatively little acreage. These streams, together with their adjacent riparian zones, contribute significantly to the productivity of the range, especially in arid and semi-arid regions, and present unique problems in multiple-use management. Unfortunately, this fact has only recently become widely appreciated and streams and riparian zones have frequently been ignored in rangeland planning and management in the past, a situation due largely due to their small relative size.

The various classes of livestock utilize the range in different ways, necessitating different management practices to increase the compatibility of grazing with riparian and aquatic habitat. Cattle, for example, usually congregate on lesser slopes and bottomlands, while sheep, which are less dependent on water (Stoddert and Smith 1955), usually favor steeper slopes and upland areas. Since sheep are also usually herded and cattle generally are not, management techniques to keep watersheds from being seriously altered differ between these two classes of livestock. The more commonly used cattle management strategies are suspected to be less congenial than those used with sheep and are therefore the focus of this study.

Since the riparian zone, which forms the interface between the aquatic and the dryer terrestrial range ecosystems, is disproportionately important to both systems, application of effective management techniques is critical. Because of soil moisture, soil fertility, and related factors, the riparian ecosystem is more productive than the drier upland range, and its vegetation is generally more desirable. Coupled with this are other riparian features, such as gentler terrain, shade, and drinking water, which add to the attractiveness of this habitat to cattle and lead to preferential use.

The riparian zone also provides crucial fishery habitat components which are largely determined by streamside vegetation. Overhanging vegetation and undercut streambanks are an important source of protective

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[1/] Duff, D. 1980. Personal correspondence. USDI, Bureau of Land Management, Utah State Office, Salt Lake City, Utah.

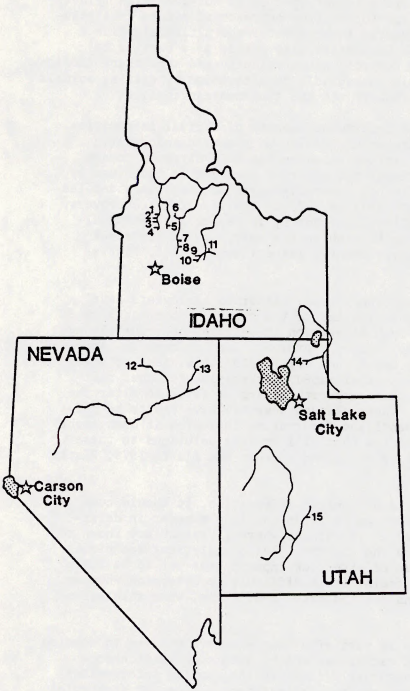
cover, food, and shade. Shading prevents water temperatures from rising or fluctuating drastically, which can lead to shifts in species composition from salmonids to more tolerant species of non-game fish (Platts 1980). In addition, detritus formed from terrestrial plants is a principal source of food for aquatic invertebrates and ultimately fish (Minshall 1967). Streamside vegetation also serves as a barrier to terrestrial pollutants and controls water velocity and streambank erosion. Since these features are all susceptible to alteration by grazing animals the needs of the resident fishery and the stockman can conflict.

Presently, there is an unfortunate dearth of factual information regarding the impacts of livestock grazing on riparian and aquatic ecosystems. As yet, only limited research has been directed toward lessening these impacts, though the constant increase in range use by cattle since the late 1800's has generally degraded rangelands and led to altered riparian habitats (Platts 1978). The resulting controversy surrounding the use of public rangelands by livestock and potential conflicts with fishery needs has led to the emergence of livestock management as a national environmental issue (Leopold 1975, Platts 1978).

Working in this information vacuum, fisheries biologists have intuitively hypothesized that grazing of the riparian zone can significantly alter a fishery. Such alteration is believed to occur through physical modification of key stream features. Such changes as increased channel breadth, decreased depth and pool-riffle ratio, loss of vegetative and structural cover, accelerated bank erosion, channel sedimentation, and increased water temperature, are expected to alter the character of the fishery. These changes however, have yet to be sufficiently evaluated and identified for routine inclusion in management strategies. Additional studies that will provide solutions to these potential problems need to be conducted (Meehan and Platts 1978, Platts 1978).

Against this background of limited information, it should come as no surprise that little help can be given the land manager in determining alternate strategies in situations where livestock are known to be exerting undue stress on the fishery. Valid analytical techniques for assessing the magnitude of livestock impacts have yet to be fully developed. Without these tools, it is difficult to determine whether changes in grazing patterns are indicated and, if so, what strategies should be implemented.

The Otter Creek study is part of a comprehensive program to develop and test an array of field techniques which, when coupled with computerized analysis, will accurately identify the complex interactions that occur between different grazing intensities, management strategies, classes of livestock, and fisheries. Studies are currently being conducted on eleven sites in Idaho, two sites in Nevada, and two sites in Utah (Figure 1). The Idaho studies monitor impacts to streams in moist, forested, high mountain meadows, while the Utah and Nevada



IDAHO BATHOLITH

1 Lower Stolle
2 Cougar Stolle
3 Guard Stolle
4 Upper Stolle
5 Johnson Creek
6 Elk Creek
7 Lower Bear Valley
8 Upper Bear Valley
9 Lower Frenchman Creek
10 Upper Frenchman Creek
11 Horton Creek

HUMBOLDT RIVER BASIN

12 Gance Creek
13 Tabor Creek

BONNEVILLE BASIN

14 Big Creek
15 Otter Creek

Figure 1. Distribution of livestock-fishery study areas.

studies monitor impacts to streams in the more arid, sagebrush-type meadows. These studies are structured to allow time-trend analysis of livestock impacts on streams on public multiple-use lands in order to help the land manager select grazing systems that are as compatible as possible with fishery needs.

This progress report deals exclusively with the Otter Creek, Utah, study which has the following objectives:

1. Determine the rehabilitation potential of Otter Creek based on past, present, and future use strategies.

2. Evaluate the efficacy of excluding livestock from the Otter Creek riparian zone by studying protected habitat within fenced exclosures.

3. Evaluate the continuous grazing system currently in use on the South Narrows Allotment.

4. Evaluate the effects on the riparian/aquatic and fisheries habitat of the alternate-year grazing system to be used in the upper Otter Creek exclosure.

5. Make recommendations as to the optimum grazing strategies relative to use and protection of the riparian zone.

STUDY AREA DESCRIPTION

Physiography

A meandering, low gradient stream, Otter Creek heads in the Fishlake Mountains of central Utah and flows southward through Grass Valley to empty into Otter Creek Reservoir at Angle, Utah. Otter Creek Reservoir, in turn, empties into the East Fork of the Sevier River, which joins the Sevier River flowing northward through Richfield, Utah before ultimately turning southwestward into the Sevier Desert and the Sevier Lake playa, remnants of ancient Lake Bonneville.

Grass Valley is a picturesque valley in Sevier and Piute Counties, flanked by two high plateaus: the Sevier Plateau on the west and the Parker Range, part of the Awapa Plateau, on the east. This is Utah's high plateau country, a structurally and ecologically complex region. The valley itself is a gentle southsloping depression caused by the uplifting of the Sevier and Awapa Plateaus; this accounts for the variable relief of the area, especially notable in the dramatic escarpment of the Parker Front.

Physiographically, the high plateaus represent the westernmost edge of the Colorado Plateau Province, which takes its name from the tablelands surrounding the middle Colorado River. This is a transition zone

between the Colorado Plateau and the vast Basin and Range Province to the west. As in the Basin and Range Province, the mountain ranges are generally linear and aligned in a north-south direction; a result of the uplifting of fault-blocks. Like the Colorado Plateau, however, the mountains are folded and in the form of plateaus.

Vegetation

Ecologically, the high plateaus also show the intergradation of different regions. This is particularly evident in Grass Valley, which, employing the classification system of Bailey (1978), represents a transitional area between three separate ecoregions. Specifically, Grass Valley, at an elevation of approximately 6500 feet, is a low lying area in the southwesternmost extension of the Rocky Mountain Forest Province, but is separated from the main body of the Colorado Plateau Province only by a depression in the Awapa Plateau between the Parker Range and the Fishlake Mountains, and is continuous with the Great Basin and the expansive Intermountain Sagebrush Province by way of the Sevier River. As a result, ecological influences of these three ecoregions are apparent.

Characteristic of the Rocky Mountain Forest Province, vegetation on the plateaus exhibits marked altitudinal zonation. Highland areas, where precipitation is abundant, are dominated by forest, grading into pinyon-juniper woodland on mid-elevation slopes. On the South Narrows Allotment, this pinyon-juniper vegetation type accounts for 46 percent of the vegetation, while the big sagebrush type, which dominates the gently inclined benches surrounding Otter Creek, accounts for 45 percent of the vegetation; grassland accounts for only two percent of the vegetation on the allotment (USDI 1968).

The fact that grassland comprises only two percent of the total vegetation does not mean that grasses are scarce, however, as blue-grama *(Bouteloua gracilis)* is a major understory component in both the pinyon-juniper and big sagebrush types, and accounts for 43 percent of the grass population;[2/] this hardy perennial grass is a sod-forming, warm-season species that is well adapated to grazing. Together with big sagebrush *(Artemesia tridentata)*, these two species are known as the sagebrush-blue grama association, a characteristic association of the cold desert biome which includes both the Great Basin and the Colorado Plateau. The abundance of these plants relative to more desirable forage species may be a result of historic grazing patterns, a point which will be developed later.

[2/] Young, D. 1980. Brief history of the South Narrows Allotment. Unpublished report. USDI, Bur. Land Manage., Sevier River Res. Area, Richfield, Utah.

Nearer the stream and including the riparian zone, soil moisture increases, as do accumulated salts, and shrubs and grasses representative of the Great Basin begin to appear. Such salt and alkali tolerant shrubs as greasewood *(Sarcobatus vermiculatus)*, an indicator of saline or alkaline conditions, rabbitbrush *(Chrysothamnus nauseosus)*, and fourwing saltbrush *(Atriplex canescens)*, a desirable browse species, gain prominence. Understory grasses in this area include such salt and alkali tolerant species as saltgrass *(Distichlis stricta)*, alkali sacaton *(Sporobolus auroides)* and Indian ricegrass *(Oryzopsis hymenoides)*. Interspersed among these on the less saline or alkaline sites are redtop *(Agrostis alba)* and needle-and-thread *(Stipa comata)*, accompanied by an assortment of sedges *(Carex spp)* and rushes *(Juncus spp)*.

Climate

Climatic conditions along Otter Creek are highly variable. Maximum summer temperatures can be as high as 105°F (41°C) with winter minimum temperatures sometimes reaching -20°F (-30°C). Annual precipitation averages about 9 inches, and ranges from a high of nearly twelve inches to a low of less than five inches. Relatively mild, low snowfall winters make the region suitable for use as winter and spring range.

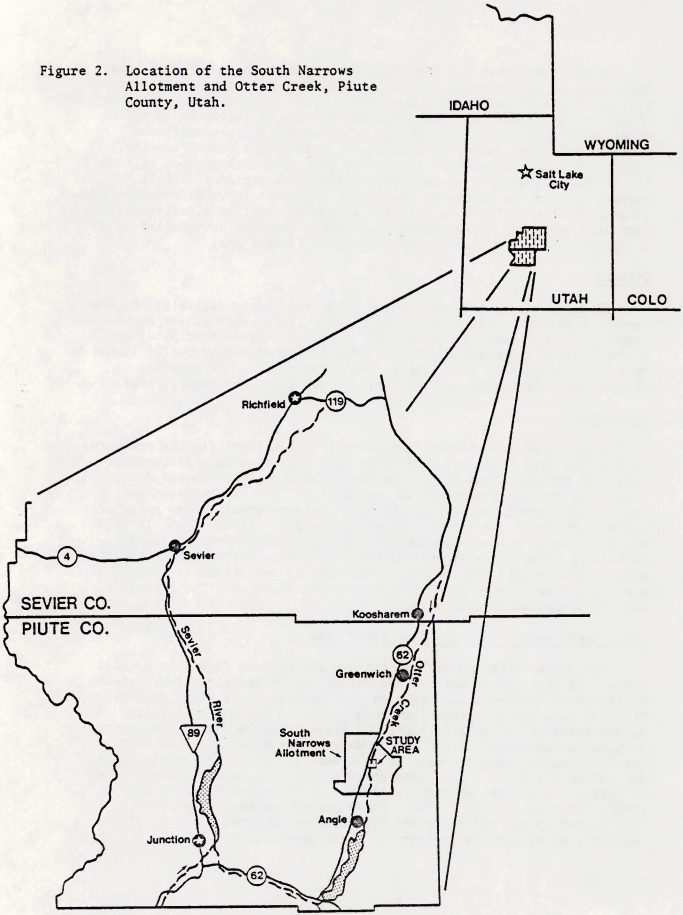
Fisheries

Otter Creek experiences considerable recreational fishing pressure. In 1969 the Utah Division of Wildlife Resources treated the stream to eliminate non-game fish so that salmonids subsequently stocked would experience reduced interspecific competition. The stream was then stocked with brown trout *(Salmo trutta)*, rainbow trout *(Salmo gairdneri)*, and eastern brook charr *(Salvalinus fontinalis)*. In addition, in 1976 the USDI Bureau of Land Management (BLM) constructed four subsurface gabions to improve the fishery by creating pools. Otter Creek supports only limited natural reproduction, however, so the stream is managed as a put-and-take fishery to provide recreation above what the stream is capable of producing naturally.

Otter Creek Aquatic Habitat Management Area

The Otter Creek Aquatic Habitat Management Area (AHMA) is a small section of Otter Creek below Grass Valley, approximately midway between the towns of Greenwich and Angle on Utah Highway 62 in Piute County. The AHMA lies wholly within the South Narrows Allotment (Figure 2), 12,588 acres of public land and 2,000 acres of state and private inholdings administered by the BLM as part of the Piute Planning Unit. Four permittees presently use the allotment as winter and spring range for cattle and sheep. The sheep chiefly graze the higher ground below the Parker Mountains, whereas cattle are largely restricted to the stream bottomlands (USDI 1979). Three fenced exclosures have been constructed by the BLM along selected reaches of Otter Creek to allow manipulation of grazing pressure on the riparian zone.

Figure 2. Location of the South Narrows Allotment and Otter Creek, Piute County, Utah.



THE SITUATION

Range Habitat

The land surrounding Otter Creek is semi-arid shrubsteppe typical of the cold desert biome. The terrain ranges from high mountains and plateaus through sloping benchlands to stream bottomlands. As is generally the case in ecosystems controlled by abiotic conditions, the plant and animal communities of the region are relatively simple and dominated by a few abundant and well-adapted species. In this case, the moderately sloping uplands support an almost uniform stand of big sagebrush, a woody shrub of relatively little value to livestock. Among these densely packed shrubs is an understory of grasses, particularly blue grama which bespeaks influence of the short grass prairies to the east. These two species comprise approximately 93 percent of the vegetation of the South Narrows Allotment[3/] and together are known as the sagebrush-blue grama association.

The local vegetation is basically that of Kuchler's (1964) Great Basin Sagebrush type which is characterized by an abundance of woody shrubs, particularly sagebrush. Sagebrush may not be the natural dominant, however, as considerable evidence points to grazing-induced vegetation shifts being the cause of its present dominance over much of the western range (Bailey 1978; Christensen 1963; Christensen and Johnson 1964; Stoddart 1941; Stoddart and Smith 1955; USDA 1936). The climax vegetation may, in fact, naturally be dominated by palatable grasses such as bluebunch wheatgrass, which the BLM considers a key forage species in the Grass Valley area (USDI 1968). Stoddart (1941) describes Palouse-type grasslands dominated by bluebunch wheatgrass as far south as Cache Valley, Utah, while Christensen (1963) in observations of relict stands of native grass in Central Utah, found wheatgrass dominated communities as far south as Sevier County. In his report, Christensen states that in situations where the bunchgrasses have been protected from grazing, sagebrush is rarely the dominant species. Presently, bluebunch wheatgrass is found only in trace quantities on the South Narrows Allotment (USDI 1968).

Sagebrush is, of course, undoubtedly an important component of the climax range vegetation, and may even be the natural dominant on certain sites; but it is likely that much of this area would be grassland without historic overgrazing. The climax vegetation of an area can be expected to be better adapted to ambient conditions than other associations, but with disturbance another species composition may be favored. Thus, with selective grazing on the palatable bunchgrasses, the successional sequence may be disrupted so that sagebrush and less palatable grasses, such as

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[3/] Young, D. 1980. Brief history of the South Narrows Allotment. Unpublished report. USDI, Bur. Land Manage., Sevier River Res. Area, Richfield, Utah.

blue grama, become dominant. In areas with a history of inappropriate grazing practices, such as overuse and use during critical periods in plant development, such shifts towards dominance by undesireable species can be expected. The quality of the range thus deterioriates in response to grazing pressure and the big sagebrush vegetation type is maintained as a grazing disclimax.

In order to control such retrogressive succession, various management techniques have been devised. These include herbicide applications and burning to reduce brush, as well as various pasturing techniques to selectively reduce grazing pressure.

Riparian Habitat

Nearer the stream greasewood is common, suggesting a soil alkalinity similar to the Great Basin to the west. Sagebrush remains plentiful on the stream banks, occasionally overhanging the stream and providing some cover for fish. Grasses are also abundant, many of them tolerant of alkaline to saline conditions, such as alkali sacaton, which can form a relatively good sod on the streambanks. Willow *(Salix sp.)*, which should exist under pristine conditions, is conspicuously absent, though it is beginning to reappear in the ungrazed study site (see also the "Results" section of this report).

Along Otter Creek, as is common along rangeland streams in the intermountain region, the riparian zone is generally narrow, with sagebrush growing down to and even overhanging the streambanks. Where the riparian zone does occur, it is extremely attractive to and heavily used by range cattle, which congregate in this relatively lush ecosystem (USDI 1979); the streambanks consequently present a highly altered, sloped appearance. In view of the preceeding discussion of grazing-induced retrogressive succession, it is reasonable to expect parallel shifts in riparian vegetation, a thesis which is supported by the replacement of palatable saltgrass by the less desirable sedges and rushes; the presence of thistle, an invader; and the conspicuous absence of willow, which would be expected in the absence of disturbance. These shifts are important because not all plants provide equal cover and food for fish, nor do they all stabilize streambanks equally.

Management Considerations

The preceding discussion brings up the question of management. There are basically five principal systems of management used to control the forage use and livestock distribution on the range. These systems are continuous (or seasonal) grazing, rotation grazing, deferred grazing, deferred rotation grazing, and rest-rotation grazing (Meehan and Platts 1978). These commonly used systems are designed to increase plant vigor and thereby help rangelands recover from historical abuse. Their effectiveness in promoting the rehabilitation of riparian habitat, however, needs clarification.

Continuous grazing has historically been the system used on the South Narrows Allotment and consists of stocking in the winter and removing the animals in early summer. It is almost a no-management system, except that the timing of stocking and removal can be manipulated so as to avoid critical developmental stages of the forage plants. Nevertheless, it is often an inadequate system, as noted by Hormay (1970) who states that, under continuous grazing at any stocking level, the more palatable and accessible plants will be killed or eliminated.

Another common grazing system is rest-rotation grazing which will be used in a modified form in the middle and upper exclosures. This system divides the range into pastures which are then systematically grazed and rested with the amount of rest being determined by the phenology of the plants involved (Hormay 1970). If correctly applied, this system can help restore the vigor of range plants, but whether it can benefit riparian vegetation is still open to question; there are, in fact, indications that it cannot help rehabilitate abused riparian habitat. Meehan and Platts (1978) suggest that this system may be harmful to riparian ecosystems because of an increased potential for livestock movement through and use of the riparian zone. A study by Starostka [4/] on Seven-Mile Creek, Utah, suggests that not only may riparian habitats not be improved under rest-rotation grazing, but that increased production of riparian vegetation following a year of rest may even increase the attractiveness of this zone to cattle. This could accelerate deterioration since structural damage does not recover as rapidly as vegetation, nor do all plant species recover at the same rate. Duff (1978) found that woody vegetation along Big Creek in northeastern Utah recovered more slowly than grasses, and that only six weeks of grazing were required to return riparian habitat which had been rested for four years within a grazing-protected area to pre-rest conditions. Thus, it would appear that rest-rotation grazing may be beneficial to range forage but not for riparian vegetation, and if rehabilitation of the riparian zone is the desired object of management, systems involving long periods of rest may be required. These questions can only be answered with research.

The three other systems either defer grazing for parts of the season or are combinations of seasonal deferment and rest. To date, none have clearly been shown to be effective in helping riparian vegetation recover, though some may be more helpful than others. Only one strategy clearly stands out as being useful in riparian recovery: complete

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[4/] Starostka, Victor J. (n.d.) Some effects of rest rotation grazing on the aquatic habitat of Seven Mile Creek, Utah. (Unpublished report on file with USDA, Forest Service, Richfield, Utah.)

rest. This can be accomplished by fencing and is being used by the BLM on some stream reaches of the South Narrows Allotment. This cannot be the final solution, but must be a consideration if high quality riparian habitat is to be conserved. The answer to this vexing problem should become clearer as this study progresses, as it will monitor three different grazing systems: fenced non-grazed as in the lower exclosure, a modified rest-rotation system (alternate year grazing) on the middle site, and continous grazing on the upstream control site.

GRAZING PATTERNS

History

Utah, along with Nevada, became part of the United States in 1848, acquired from Mexico by way of the peace treaty that ended the Mexican-American War. It was not until 1873, however, that settlers began to arrive in the Grass Valley area, and by 1911, when the town of Koosharem was incorporated, the pioneer population of the valley had grown to only 550 persons.

The very name "Grass Valley" suggests that an abundance of grass greeted the first settlers, but the type of grass in question is uncertain. Possibly, Great Basin wildrye *(Elymus cinereus)* was common here as it was on many dry bottomlands of the Intermountain west (Cronquist and others 1977), or perhaps it was bluebunch wheatgrass *(Agropyron spicatum)*. The work of Christensen (1963) documents wheatgrass dominated grassland associations as far south as Sevier County. Neither of these grasses is common any longer, though trace amounts of wildrye have been reported along Otter Creek[5/] and the Otter Creek AHMP indicates that wheatgrass is still a component of the range vegetation, though present in only trace quantities. Whatever the grass that inspired the naming of Grass Valley, its abundance undoubtedly provided good forage for livestock moving in with the early settlers.

During this early period of expansion into and settlement of the West, grazing was not officially regulated and use levels were left to the stockman's discretion. As a result, overgrazing of western rangelands became a serious problem. In order to ameliorate the problem of deteriorating range conditions, Congress, in 1934, passed the Taylor Grazing Act which created the Grazing Service of the Department of the Interior to regulate grazing on public lands; in 1946 the Grazing Service was combined with the General Land Office, and the BLM was born.

The South Narrows Allotment, with which this report is chiefly concerned, was originally part of one of two divisions of the Parker Mountain Unit as established by the Grazing Service. E. Merril Bagley

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5/ Young, D. 1980. Brief history of the South Narrows Allotment. Unpublished report. USDI, Bur. Land Manage., Sevier River Res. Area, Richfield, Utah.

became a livestock operator in Grass Valley at this time, and remains a principal operator on the South Narrows Allotment to this day. The original division boundaries were readjudicated in 1958, and established a new division called the Koosharem Division, which comprised eight grazing allotments; one of which was the South Narrows Allotment.

Initially, grazing use in the Parker Mountain unit was set at 5832 animal unit months (AUM's). On the basis of a 1956 range survey, use for this area was reduced by 33 percent in 1960 to 3840 AUM's; the South Narrows Allotment was allocated 805 of these, for use either by cattle or sheep. Adjudicated use was further reduced in 1968 to 706 AUM's when one of the permittees converted some sheep AUM's to cattle[6/].

Historically, the South Narrows Allotment has been managed under a continuous grazing system, which allows for season-long use of preferred areas and preferred vegetation. As a result, range conditions declined to the point where, in 1968, the BLM considered initiating a two-pasture deferred system to alternately rest each pasture early in the season, and to limit utilization to 35 percent on spring range and 75 percent on winter range (USDI 1968). This system was not implemented, but, as of 1977, the overall range trend has apparently remained stable.[7/] The vegetation trend in the riparian zone is less clear, but concern over this area and a desire to improve fish and wildlife habitat have led the BLM to propose the strategies contained in the Otter Creek AHMP.

Present and Future Trends

In order to improve conditions for wildlife and fish, experimental manipulation of grazing in the riparian zone has been proposed for the Otter Creek AHMA. Three fenced livestock exclosures were constructed prior to the 1979 season along selected reaches of Otter Creek, and have been designated as the lower, middle, and upper exclosures (Figure 3). The lower exclosure will receive complete rest, allowing study of riparian rehabilitation under this system, and, beginning with the upper exclosure in 1979, the two upstream pastures will be grazed during alternate years under a modified rest-rotation system. The remainder of the South Narrows Allotment will continue under the current management system at 706 dual AUM's, which is well below the estimated (USDI 1968) 847 AUM's of available forage.

Table 1 summarizes management from 1975 on the South Narrows Allotment and the AHMA and predicts some parameters for 1980 based on the Otter Creek AHMP.

6/ Because the allotment is more suitable for sheep than cattle, conversion is done on the basis of 8.75 to one in the case of conversion to cattle, and one to 5 in the case of conversion to sheep (USDI 1968).

7/ Likens, John. 1978. 1977 range trend evaluation. (Unpublished memo, USDI, BLM Memo 4115, U-503, Richfield, Utah.)

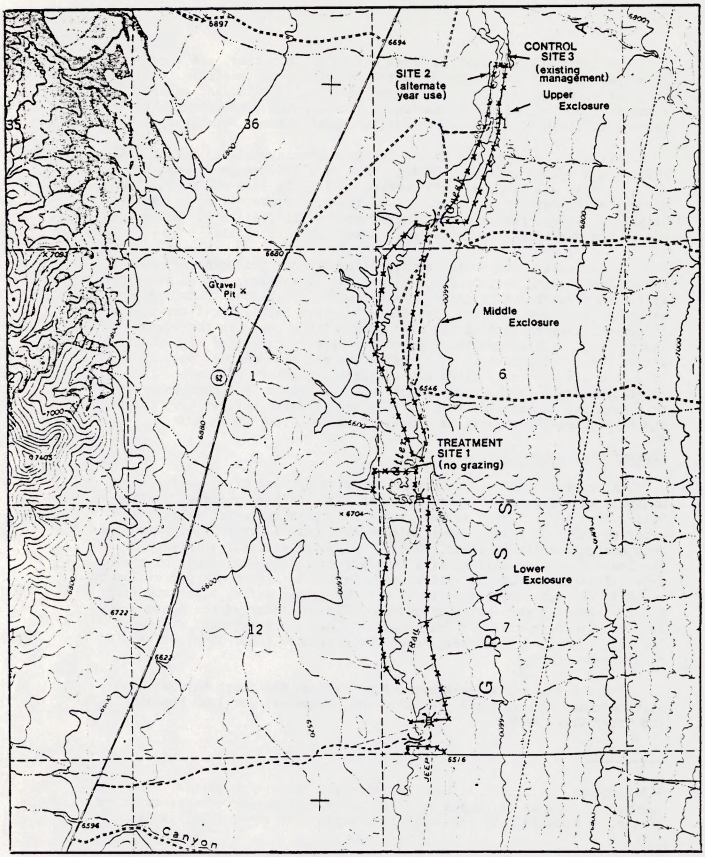

Figure 3. Otter Creek AHMA exclosures and locations of livestock-fishery study sites.

Table 1.--South Narrows Allotment and Otter Creek Aquatic Habitat Management Area grazing management: 1975-1985.

GRAZING PARAMETER		YEAR[1]										
		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Allotment Acreage		12,588	12,588	12,588	12,588	12,588	12,588	12,588	12,588	12,588	12,588	12,588
Overall Grazing Management System		AMC[2]	AMC	AMC	AMC	AMC	AMC	AMC	AMC	AMC	AMC	AMC
Grazing Season	Cattle	12/1-3/10 5/16-6/30	12/1-3/10 5/16-6/30	12/1-3/10 5/16-6/30	12/1-3/10 5/16-6/30	12/1-3/10 5/16-6/30	12/1-3/10 5/16-6/30	12/1-3/10 5/16-6/30	12/1-3/10 5/16-6/30	12/1-3/10 5/16-6/30	12/1-3/10 5/16-6/30	12/1-3/10 5/16-6/30
	Sheep	1/16-3/31	1/16-3/31	1/16-3/31	1/16-3/31	1/16-3/31	1/16-3/31	1/16-3/31	1/16-3/31	1/16-3/31	1/16-3/31	1/16-3/31
Permitted Use Intensity (AUM's)	Cattle	281	281	281	281	281	281	281	281	281	281	281
	Sheep	425	425	425	425	425	425	425	425	425	425	425
Range[3] Vegetation Use	Overall	ND	ND	ND	ND	ND	ND					
	Upper Exclosure	N/A	N/A	N/A	N/A	52.5[4]	Rested		Scheduled Rest			
Riparian Vegetation Use	Lower Exclosure	N/A	N/A	N/A	N/A	0	0					
	Upper Exclosure	N/A	N/A	N/A	N/A	0	0					
	Outside Exclosure	N/A	N/A	N/A	N/A	0	0[5]					

1/ 1980-1985 proposed.

2/ Allotment-wide continuous.

3/ No utilization data except 1979. 1968 Plan called for 75% on winter range.

4/ Cattle removed 2/8/79. Davis, Vernon C. 1979. South Narrows Allotment, utilization north exclosure. (Unpublished, USDI BLM Memo, 4115, U-503, Richfield, Utah).

5/ This figure is probably due to the time lapse between the grazing season and time of observation, riparian analysis does not effectively detect use. BLM sources (Likens, 1980, USDI BLM Memo 4190, .I-503) indicate that use, based on the middle exclosure, is about 61%.

METHODS

General

Ongoing studies are presently being conducted on a total of 15 study sites, 11 in Idaho and two each in Nevada and Utah. These sites are generally in meadow environments on National Forest lands or lower elevation sagebrush type meadows on Bureau of Land Management lands. The purpose of these studies is to refine techniques for monitoring and assessing the impacts of domestic livestock grazing on riparian and aquatic ecosystems and to allow recommendations for improved management.

The basic design of each study area is to stratify 1800 feet of stream by dividing it into 181 transects placed at 10-foot intervals along the stream. The study area is then subdivided into three 600-foot sections, with the middle section fenced to provide an area for manipulation and the up- and downstream sections serving as controls. Livestock are then either introduced to or excluded from the treatment area depending on the study site. Annual monitoring of each section then provides information on each relative to the others over the course of several seasons of use.

On Otter Creek this design has been modified for consistency with the Otter Creek AHMP. The BLM has constructed three livestock exclosures along Otter Creek to allow for manipulation of grazing in the riparian zone. The exclosure farthest downstream (the lower exclosure) has been designated as the non-grazed or treatment area and includes transects 1 through 61 at its upper end. The middle exclosure, which is not part of this study, and the exclosure immediately upstream, which is included, will be grazed during alternate years. Since continuous grazing is the current grazing system on the South Narrows Allotment and since this pasture will henceforth be rested every other year under the alternate year strategy, it is not a completely unmanipulated section; it will, however, serve as a control and contains transects 61 through 122 at its upstream end. Immediately above the upper exclosure are transects 123 through 184 in the unfenced and unmanipulated section. Figure 3 shows the locations of the exclosures along Otter Creek and Figure 4 gives a schematic illustration of the locations of the transects.

The data collected fall into four basic categories: 1) geomorphic/aquatic, 2) riparian or streamside, 3) hydrologic, and 4) biological, and include the following:

Geomorphic/Aquatic

1. Substrate materials
2. Substrate embeddedness
3. Stream width and depth
4. Bank-stream contact water depth
5. Pool width, quality, and feature
6. Riffle width
7. Streambank angle
8. Streambank undercut
9. Fisheries environment quality rating

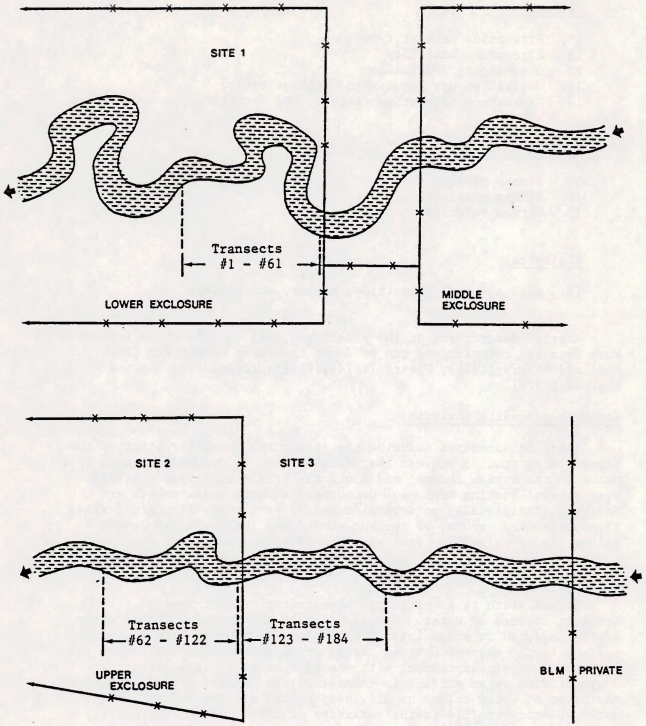

Figure 4. Schematic diagram of the Otter Creek livestock exclosures and the design of the Livestock-Fishery Interaction Study.

Riparian

10. Streamside habitat type
11. Streambank stability
12. Overhanging vegetation
13. Vegetation use (ocular and herbage meter)
14. Streambank alteration (natural and artificial)

Hydrologic

15. Stream profile
16. Stream gradient
17. Stream velocity

Biological

18. Fish species composition, number, and biomass

A brief description of the procedures used in this study follows. More detailed descriptions can be found in Morris and others (1976), Neal and others (1976), Platts (1974), Platts (1976), and Ray and Megahan (1978).

Geomorphic/Aquatic Analysis

These measurements describe the structural characteristics of the stream being studied and can therefore be used to document changes that occur in the stream channel and along the stream bank when monitored over several grazing seasons. Geomorphic/aquatic measurements are analyzed statistically to determine means, variances, standard deviations, standard errors, 95 percent confidence intervals, student's t values, and F-values for each variable in each study site.

Water Column

Stream width is a horizontal measurement of that area of the transect covered by water. Stream depth is the average of four water depths measured at equal intervals across the transect from the water surface to the channel bottom. Water depth at the intersection of the streambank or stream channel with the edge of water is a direct measurement from water surface to channel bottom. Pools are classified as that area of water column usually deeper than riffles and slower in water velocity; riffle is the remainder of the column. Pool quality rating is based on the pool's ability to provide certain rearing requirements needed by fish, particularly size, depth, and cover, and is ranked from 1 (poor quality) to 5 (high quality).

Streambanks

The streambank angle is measured with a clinometer (figures 5 and 6) which determines the downward slope of the streambank to the water. Streambank undercut is a direct horizontal measurement, parallel to the stream channel, of the erosion of the bank at the water influence area. Fisheries environment quality ratings depict the general ability of the bank-stream contact zone to provide the conditions believed necessary for high fish standing crops. This rating is a function of both stream characteristics at the bank (pool or riffle) and available cover, and is ranked from 1 (poor) to 5 (excellent).

Stream Channel

Substrate materials are classified into five classes by visually projecting each one-foot division of a measuring tape to the streambed surface and assigning the major observed sediment class to each division. Sediments are classified as boulder, rubble, gravel, and fine sediment. Instream vegetative cover is a direct measurement of the vegetative cover on the channel intercepted by the transect. Stream channel substrate embeddedness measures the gasket effect of fine sediment around the larger size substrate particles and is ranked from 1 (highly embedded) to 5 (slightly embedded).

Riparian Analysis

These measurements attempt to describe the riparian interface between the aquatic and terrestrial ecosystems. Annual monitoring of these data after the grazing season illustrates changes in many critical fishery habitat parameters. These measurements are subjected to the same statisitcal analyses as the geomorphic/aquatic measurements.

Streambank alteration assessment quantifies the natural and artificial changes occurring to the streambank and is rated as percent alteration. Streamside cover categorizes the dominant vegetation as tree, brush, grass, or exposed (numerically ranked 1 to 4). Streamside cover stability rates the ability of the streambanks to resist erosion, with 1 being poor and 5 indicating high stability. Vegetative overhang (figures 7 and 8) directly measures the length of the vegetation overhanging the water column within 12 inches of the water surface. Habitat rating is based on the belief that sand banks are of least importance to fish, while brush-sod banks are of the greatest value. Intermediate types are ranked accordingly by dominant and subdominant characters. Measurement of vegetation use is done both by ocular assessment and with a herbage meter.

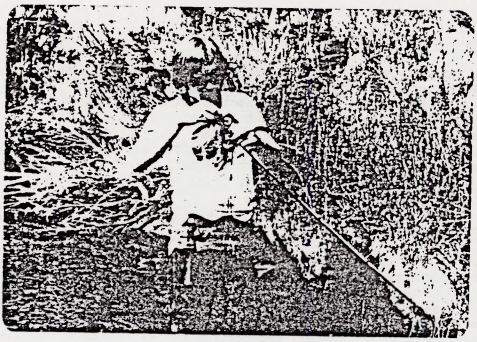

Figure 5. Measuring bank angle with a clinometer and a graduated measuring rod.

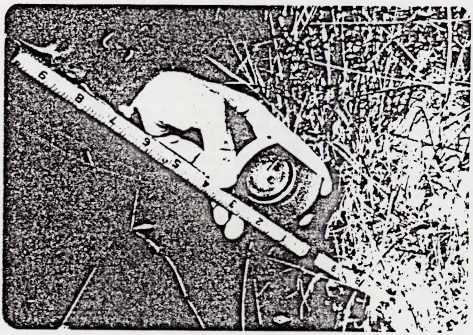

Figure 6. Close-up view of the clinometer showing a bank angle measurement of approximately 45°.

Figure 7. Measuring overhanging vegetative cover with a graduated measuring rod.

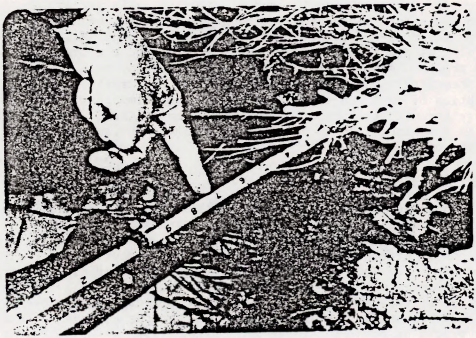

Figure 8. Close-up view of the graduated measuring rod showing a vegetative overhang measurement of approximately 1.7 feet.

Vegetation Analysis

A cursory survey of the riparian vegetation was conducted in the Otter Creek study sites because of visual differences between site 1 and sites 2 and 3. This was not intended to be an exhaustive or statistically reliable survey; rather it was intended to give a good general picture of gross differences between the sites.

Vegetation was assigned dominance visually and plant species were collected for later identification at Utah State University.

Streamside Herbage Analysis

In order to provide a quantitative complement to an ocular vegetation use assessment, a Neal Electronics Model 18-2000 herbage meter is used to measure standing vegetation. These readings are taken at approximately every fourth transect, and linear regression analysis against clipped plots provides a quantitative measure of forage biomass and use.

Fish Population Analysis

Fish populations are sampled with battery powered, portable, backpack mounted electrofishers or with gasoline powered, motor energized units (Figures 9 and 10) and electrofishing is performed using a four-step technique. Salmonids are counted, measured, and weighed, while non-salmonids are counted and weighed as a group. All are handled as carefully as practicable and promptly returned to the stream alive. The data are then statistically analyzed to determine mean lengths, weights, standing crops, and total biomass for each fish species, with the exception of mean length in the case of non-salmonids. The biomass data, together with the number of fish obtained in the four-step technique is used in a maximum-likelihood model to estimate the resident fish populations of each study site.

Water Quality Analysis

This topic was not addressed in Progress Report 1 because it is not a regular component of our battery of measurements. It is being included in this report to assist in characterizing the aquatic and riparian environments of Otter Creek and to help with the analysis of our data. Data presented here were provided by David Young, Fisheries Biologist, USDI BLM, Sevier River Resource Area Office, Richfield, Utah and are on file in that office. The responsibility for application of these data to this study lies solely with the authors. Methods employed in the 1977 survey can be found in Winget and Baumann (1977)[8/].

[8/] Winget, Robert N. and Richard W. Baumann. 1977. Macroinvertebrate and water quality-quantity survey of Otter Creek, Piute County, Utah. Unpublished report on file with USDI, BLM, Sevier River Res. Area, Richfield, Utah.

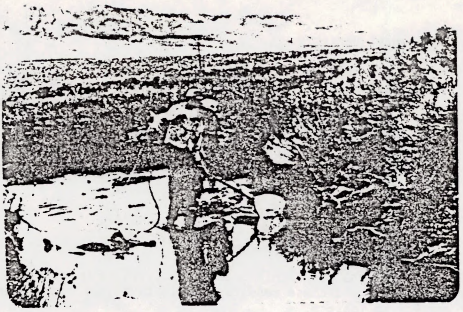

Figure 9. Electrofishing Otter Creek with a motor-energized Coffelt VVP electrofishing system.

Figure 10. Stunned fish are captured in nets attached to the ends of the electrodes.

Hydraulic and Channel Geometry

Ten transects in the central section of each 600-foot stream reach are used for hydraulic geometry measurement. The data obtained here allow us to generate a channel cross-section map. Periodic measurements over the course of the study show quantitative changes due to erosion and deposition of channel materials. The stakes are surveyed to detect changes in their relative positions, and the water surface is surveyed to allow monitoring of changes in channel gradient.

RESULTS

Geomorphic/Aquatic Analysis

Results of the 1980 geomorphic/aquatic analysis of Otter Creek are presented in Table 2, and these results are displayed for comparison with 1979 results in Table 3.

Water Column

Continued observation of Otter Creek indicates that this stream is somewhat difficult to characterize. The stream in the treatment area is narrower than the two grazed areas upstream, but somewhere between sites 1 and 2 ground water recharge apparently occurs[9]; therefore, while narrower, the treatment site is also considerably shallower. In 1980, widths and depths were consistently greater than in 1979, a difference which resulted from discharge of water from Koosharem Reservoir.[10] The increase in width was greatest in the treatment site, probably due to the fact that this area visually appears to have a wider, shallower channel than the upstream sites. The pool/riffle ratio in all sites increased slightly while pool quality ratings remained relatively stable; this is to be expected with the large, high quality pools that occur on Otter Creek.

Streambanks

Bank-water contact zone characteristics were all lower in the treatment site than in the grazed sites, probably an additional result of the reduced channelization. As a result, the fisheries rating was also observed to be considerably less in site 1, though it was higher in all three sites in 1980 than in 1979.

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[9] Winget, Robert N. and Richard W. Baumann. 1977. Macroinvertebrate and water quality-quantity survey of Otter Creek, Piute County, Utah. Unpublished report on file with USDI, BLM, Sevier River Res. Area, Richfield, Utah.

[10] We waited several days after the flow began to recede to minimize this bias; nevertheless, the effects on several geomorphic/aquatic variables are clear.

Table 2.--1980 Geomorphic/aquatic and riparian means with their 95 percent confidence intervals, Otter Creek, Utah. An asterisk (*) denotes a significant difference ($P<0.05$) between treatment and combined control means.

Variable	Site 1 Mean	Site 1 Interval	Site 2 Mean	Site 2 Interval	Site 3 Mean	Site 3 Interval	Overall Mean	Overall Interval
Geomorphic/Aquatic								
Stream Width (feet)*	15.8	14.9 - 16.7	16.8	15.9 - 17.7	15.7	14.8 - 16.6	16.1	15.6 - 16.6
Stream Depth (feet)*	0.87	0.75 - 0.98	1.41	1.30 - 1.52	1.50	1.39 - 1.52	1.26	1.20 - 1.32
Riffle Width (percent)*	34.4	26.6 - 42.2	29.8	22.0 - 37.6	2.3	0 - 10.0	22.0	17.6 - 26.5
Pool Width (percent)*	65.6	57.8 - 73.4	70.2	62.4 - 78.0	97.7	90.0 -100.0	78.0	73.5 - 82.5
Pool Rating	3.8	3.5 - 4.1	4.6	4.3 - 4.9	5.0	4.7 - 5.3	4.5	4.3 - 4.6
Bank Angle (degrees)	114	106 -122	98	90 -106	79	71 - 87	97	92 -102
Bank Undercut (feet)	0.24	0.16 - 0.32	0.39	0.31 - 0.47	0.40	0.32 - 0.48	0.34	0.30 - 0.39
Bank Water Depth (feet)*	0.31	0.16 - 0.46	0.75	0.60 - 0.89	0.75	0.61 - 0.90	0.60	0.52 - 0.69
Substrate Embeddedness*	3.1	2.8 - 3.4	3.1	2.8 - 3.4	1.5	1.2 - 1.8	2.5	2.4 - 2.7
Boulder (percent)*	0.0	0.0 - 1.5	3.4	1.9 - 4.9	1.3	0.0 - 2.8	1.6	0.7 - 2.4
Rubble (percent)*	0.3	0.0 - 6.4	26.8	20.7 - 32.8	11.8	5.7 - 17.8	12.9	9.4 - 16.4
Gravel (percent)*	78.6	72.2 - 84.9	23.9	17.6 - 30.3	13.3	7.0 - 19.7	38.5	34.8 - 42.1
Fines > 0.8 mm (percent)*	0.1	0.0 - 1.3	2.3	1.1 - 3.5	0.5	0.0 - 1.7	1.0	0.3 - 1.7
Fines < 0.8 mm (percent)	21.1	13.2 - 29.0	43.6	35.8 - 51.5	73.1	65.3 - 80.9	46.1	41.6 - 50.6
Instream Vegetative Cover (feet)	3.1	2.0 - 4.3	8.4	7.2 - 9.5	11.3	10.1 - 12.4	7.6	6.9 - 8.3
Fisheries Rating*	3.2	3.0 - 3.4	4.4	4.2 - 4.6	4.8	4.6 - 4.9	4.1	4.0 - 4.2
Riparian								
Bank Cover Stability*	2.9	2.8 - 3.1	3.4	3.3 - 3.6	3.5	3.4 - 3.7	3.3	3.2 - 3.4
Stream Cover	2.0	2.0 - 2.1	2.0	2.0 - 2.1	2.0	1/	2.0	1/
Habitat Type*	14.6	14.1 - 15.1	15.1	14.6 - 15.6	16.7	16.2 - 17.2	15.5	15.2 - 15.8
Vegetation Utilization (percent)	0	0	0	0	0	0	0	0
Bank Alteration-Natural (percent)*	15	14 - 17	8	7 - 9	8	6 - 9	10	10 - 11
Bank Alteration-Artificial (percent)	12	10 - 14	20	17 - 22	25	23 - 27	19	18 - 20
Vegetative Overhang (feet)*	0.41	0.31 - 0.51	1.17	1.07 - 1.27	0.90	0.80 - 1.00	0.83	0.77 - 0.89

1/ Rounding to the tenths digit reduces interval to zero.

Table 3.--Comparison of geomorphic/aquatic and riparian means for 1979 and 1980, Otter Creek, Utah.

Variable	Site 1			Site 2			Site 3			Overall		
	1979	1980	Δ	1979	1980	Δ	1979	1980	Δ	1979	1980	Δ
Geomorphic/Aquatic												
Stream Width (feet)	11.9	15.8	+ 3.9	14.0	16.8	+ 2.8	14.5	15.7	+ 1.2	13.5	16.1	+ 2.6
Stream Depth (feet)	0.72	0.87	+ 0.15	0.78	1.41	+ 0.63	0.92	1.50	+ 0.58	0.80	1.26	+ 0.46
Riffle Width (percent)	46.6	34.4	-12.2	38.3	29.8	- 8.5	10.2	2.3	- 7.9	31.5	22.0	- 9.5
Pool Width (percent)	53.4	65.6	+12.2	61.7	70.2	+ 8.5	89.8	97.7	+ 7.9	68.5	78.0	+ 1.5
Poot Rating	3.7	3.8	+ 0.1	4.2	4.6	+ 0.4	4.9	5.0	+ 0.1	4.3	4.5	+ 0.2
Bank Angle (degrees)	118	114	- 4	103	98	- 5	90	79	-11	103	97	- 6
Bank Undercut (feet)	0.20	0.24	+ 0.04	0.21	0.39	+ 0.18	0.24	0.40	+ 1.16	0.22	0.34	+ 0.12
Bank Water Depth (feet)	0.19	0.31	+ 0.12	0.45	0.75	+ 3.0	0.96	0.75	- 0.21	0.54	0.60	+ 0.6
Substrate Embeddedness	2.9	3.1	+ 0.2	2.9	3.1	+ 0.2	1.8	1.5	- 0.3	2.5	2.5	0.0
Boulder (percent)	0.0	0.0	0.0	0.6	3.4	+ 2.8	0.0	1.3	+ 1.3	0.2	1.6	+ 1.4
Rubble (percent)	1.8	0.3	- 1.5	23.7	26.8	+ 3.1	9.6	11.8	+ 2.2	11.7	12.9	+ 1.2
Gravel (percent)	79.4	78.6	- 0.8	39.1	23.9	-15.2	22.3	13.3	- 9.0	46.8	38.5	- 8.3
Fines > 0.8 mm (percent)	2.6	0.1	- 2.5	2.8	2.3	- 0.5	3.4	0.5	- 2.9	2.9	1.0	- 1.9
Fines < 0.8 mm (percent)	16.2	21.1	+ 4.9	29.6	43.6	+14.0	63.7	73.1	+ 9.4	36.5	46.1	- 9.6
Instream Vegetative Cover (feet)	7.9	3.1	- 4.8	8.9	8.4	- 0.5	12.1	11.3	- 0.8	9.7	7.6	- 2.1
Fisheries Rating	2.4	3.2	+ 0.8	3.4	4.4	+ 1.0	3.9	4.8	+ 0.9	3.3	4.1	+ 0.8
Riparian												
Bank Cover Stability	2.9	2.9	0.0	3.4	3.4	0	3.3	3.5	+ 0.2	3.2	3.3	+ 0.1
Stream Cover	1.6	2.0	+ 0.4	1.9	2.0	+ 0.1	1.9	2.0	+ 0.1	1.8	2.0	+ 0.2
Habitat Type	11.2	14.6	- 3.4	13.7	15.1	- 1.4	14.2	16.7	+ 2.5	13.0	15.5	+ 2.5
Vegetation Utilization (percent)	0	0	0	0	0	0	0	0	0	0	0	0
Bank Alteration - Natural (percent)	43	15	-28	23	8	-15	24	8	-16	30	10	-20
Bank Alteration - Artificial (percent)	0	12	+12	0	20	+20	0	25	+25	0	19	+19
Vegetative Overhang (feet)	0.31	0.41	+ 0.10	0.57	1.17	+ 0.60	0.27	0.90	+ 0.63	0.38	0.83	+ 0.45

Stream Channel

Substrate materials appeared to exist in the most favorable ratios within the treatment site. Gravel constituted the bulk of the surface sediments in this site and fine sediments were less abundant than in either of the two upstream sites. Rubble was most abundant in site 2 where velocity is also greatest (Platts, Nelson, and Martin 1980) boulder was not abundant any where within the study area. None of the substrate materials have exhibited any extraordinary fluctuations, and those that have been observed may be due to the higher water level that existed when Otter Creek was observed in 1980. Substrate embeddedness has remained relatively stable, but instream vegetation, though abundant in Otter Creek, declined dramatically in site 1 while remaining essentially constant in the control sites.

Riparian Analysis

Results of the 1980 riparian analysis are displayed in Table 2 and 1980 mean values are compared with those observed in 1979 in Table 3.

The results indicate that the vegetal characteristics of treatment site 1 are considerably different from those of the other two sites. These differences are most clearly illustrated by the bank cover stability and habitat type rankings in both study years, by the 1979 stream cover rankings and by the vegetation survey results presented in the next section. The higher habitat, ratings in site 2 and 3 result from the greater prevalence of shrubs (see also Table 3) whereas the better bank cover stability indicates well vegetated banks; the increased channelization in these two sites may have allowed better bank development. The increase in stream cover rating at site 1 in 1980 makes it appear similar to the other two sites, but this may be due to some flooding of the vegetation as a result of the increased water level. The more favorable vegetal overhang observed in the grazed sites also resulted from the greater abundance of brush in the two upstream sites.

The treatment site appeared to exhibit approximately the same amount of bank alteration as the grazed sites, though slightly less of this alteration could be clearly attributed to artificial processes. Vegetation use could not be detected visually at the time of our sampling.

Vegetation Analysis

Results of the vegetation sampling performed in 1980 are presented in Table 4. They indicate that grass-like plants are well represented in all three sites, whereas actual grasses are conspicuously absent from site 1, but well represented in the two upstream sites. Forbs, on the other hand, are better represented in site 1 than in sites 2 and 3. In addition, site 1 has a wider, shallower channel structure with a wider,

Table 4.--Dominant riparian vegetation, by site, of Otter Creek, Utah, 1980. Plants are grouped into 3 categories: grasses, grass-like plants, and other vascular plants (forbs and shrubs).

Site 1	Site 2	Site 3
No grasses	Muhlenbergia asperifolia Poa junifolia Agropyron smithii Agrostis tenuis Hardeum jubatum	Muhlenbergia asperifolia Poa junifolia Agrostis tenuis Hardeum jubatum
Juncus balticus Scirpus pungens Carex sp.	Juncus balticus Scirpus pungens Carex nebrascensis Carex sp.	Juncus balticus Scirpus pungens Carex sp.
Barsia hyssopifilia Mentha arvensis Thermopsis montana Sonchus asper (Bull Thistle) Sysymbrium altissiumum Senecio integerrimus	Glaux maritime Fragaria vesca Mentha arvensis Senecio integerrimus Thermopsis montana	Glaux maritime Fragaria vesca Mentha arvensis Senecio integerrimus Thermopsis montana
Number of species = 10	Number of species = 14	Number of species = 12

moister riparian zone than sites 2 or 3 (Figures 11 and 12), which, in all characterisitcs, are much more similar to one another than to site 1. This difference is borne out by the 1970 and 1980 riparian analyses (Table 5), which shows that for all riparian parameters, except vegetative overhang in 1979 and stream cover in 1980, sites 2 and 3 are more similar to one another than they are to site 1. Willow is beginning to reestablish itself in the treatment area.

Table 5.--Streamside herbage analysis linear calibration results: equation fits the form y=a+bs.

Year	Y-intercept (a)	Regression Coefficient (b)	Correlation Coefficient (r)	Coefficient of Determination (r^2)
1979	- 5.60	2.16	0.96	0.91
1980	-19.85	3.18	0.91	0.83

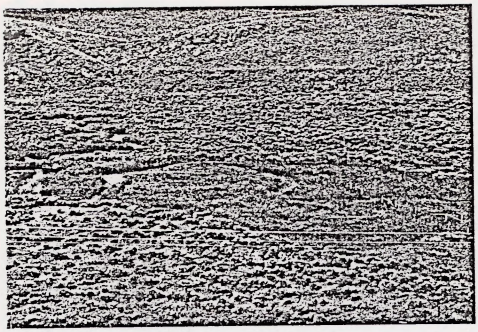

Figure 11. The meandering structure and wide riparian zone of Otter Creek in site 1. The fenceline is at transect 61 and streamflow is to the left.

Figure 12. The narrow, deep channel structure and narrow riparian zone of Otter Creek in the upstream sites. The fenceline is at transect 122 separating site 2 (left) from site 3 (right).

Streamside Herbage Analysis

Streamside herbage analysis was inadvertently not performed on the treatment area (site 1) in 1979, so no accurate potential biomass estimate was obtained in that year; therefore, for 1979 only actual biomass estimates are presented. The scatter diagram of data from the secondary sample and resulting calibration line are displayed in Figure 13. The fit of this line to the data points is excellent (r^2=0.91), indicating that determination of riparian vegetation biomass from the primary sample based on this smaller sample (pooled from all three sites) can be expected to be sufficiently accurate for production and use estimation. The regression analysis data for the secondary sample are presented with the corresponding 1979 results in Table 5.

It is apparent from the different regression coefficients that the vegetation sampled in 1980 was considerably different than that sampled in 1979. This is probably due to the fact that site 1 was not sampled in 1979 and, as has already been discussed, the riparian vegetation in that site is apparently different from the riparian vegetation in sites 2 and 3, the only sites sampled in 1979. The decrease in the coefficient of determination may also be a result of these vegetal differences.

Vegetation use is calculated from the difference between potential biomass determined from the treatment site and the remaining biomass in the grazed sites. This information plus the estimate by visual means is displayed in Table 6.

Table 6. Estimated streamside herbage biomass and vegetation use from primary sampling by year, Otter Creek, Utah.

	Potential Biomass (lb/acre)	Remaining Biomass (lb/acre)		Vegetation Use (percent)		Visual Use Estimate (percent)	
Year	(Site 1)	Site 2	Site 3	Site 2	Site 3	Site 2	Site 3
1979[1]	N.D.[2]	4,783	4,400	N.A.[3]	N.A.	0	0
1980	11,445	10,785	9,544	6	17	0	0

[1] Those familiar with Progress Report 1 will note differences in these data; these data are corrected values.

[2] N.D. - No data

[3] N.A. - Not available

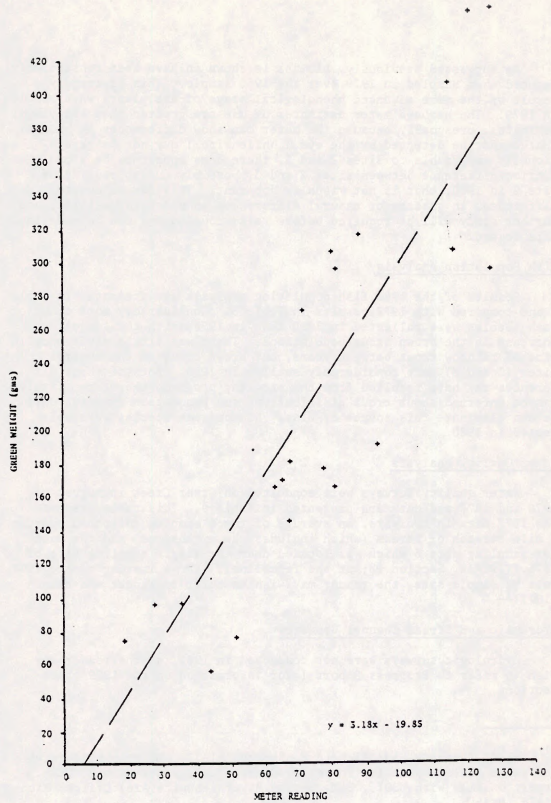

Figure 13. Scatter diagram and linear calibration line derived from the herbage analysis secondary sampling in 1980, Otter Creek, Utah.

As suggested previously, biomass is shown to have been considerably reduced when sampled in 1979 over the 1980 sample. This is largely a result of the more advanced phenological stage of the plants when sampled in 1979. The herbage meter estimates of use are greater than the visual estimates, presumably because the meter can show differences in biomass that cannot be detected by the eye. While site 1 may not be vegetationally comparable to sites 2 and 3, there does appear to be a production difference between sites 2 and 3, possibly due to resting of site 2 in 1980, that is not visually apparent. This may be due to differences in grazing or natural differences in plant composition, and further study will be required before valid conclusions can be made in this regard.

Fish Population Analysis

Results of the 1980 fish population analysis are presented in Table 7 and compared with 1979 results in Table 8. Considerably more trout of each species were collected in 1980 than in 1979, with the largest increase in the brown trout populations. There was little difference in size of rainbow trout between years, but brown trout in the control sites (2 and 3) were considerably smaller in 1980. Both of these differences may have resulted from the stocking program; therefore, little can be inferred about trout distributions and population dynamics until we can eliminate this source of bias. No non-game species were collected in 1980.

Water Quality Analysis

Water quality surveys were conducted on Otter Creek in August of 1976 and 1977 and data are presented in Table 9. This table presents the 1977 data in two ways, an average of the 6 samples collected over an 8 mile stretch of stream (which includes the exclosures) and the data for sampling site 6 which was located near the single sampling site of 1976 (T29SR1W, Section 18; at the fenceline). For a listing of the 1977 data by sample site, the reader may wish to refer to Winget and Bauman (1977)[11].

Hydraulic and Stream Channel Geometry

Hydrologic surveys were not conducted in 1980, so the reader may wish to refer to Progress Report I for information on the 1979 cross-sections.

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[11] Winget, Robert N. and Richard W. Bauman. 1977. Macroinvertebrates and water quality-quantity survey of Otter Creek, Piute County, Utah. Report on file with USDI,, BLM, Sevier River Resource Area Office, Richfield, Utah.

Table 7.--1980 fish population analysis for Otter Creek, Utah. Data collected and provided by USDI-BLM, Sevier River Resource Area, Richfield, Utah (9/15/80).

Species/ Study Site	Total No. Collected	Population Estimate	95% C.I.	Mean Length (in)	Mean Length (mm)	Mean Weight (oz)	Mean Weight (gm)	Standing Crop (#/ft^2)	Standing Crop (#/m^2)
Rainbow Trout									
Site 1	17	17	17-19	5.1	128.5	1.0	28.7	0.0018	0.019
Site 2	18	18	18-20	7.7	195.7	3.1	88.6	0.0018	0.019
Site 3	8	8	8-9	8.1	206.8	3.7	106.0	0.0008	0.009
Overall	44	44	44-47	6.7	171.2	2.4	68.2	0.0009	0.0015
Brown Trout									
Site 1	14	14	14-14	10.1	255.4	6.9	196.6	0.0015	0.016
Site 2	83	98	87-109	6.7	171.4	2.7	75.4	0.0082	0.088
Site 3	59	59	59-67	7.2	183.7	3.3	92.4	0.0065	0.067
Overall	148	171	157-185	7.2	183.6	3.3	92.7	0.0051	0.055

Table 8.--1979 and 1980 fish collections results compared by year and study site, Otter Creek, Utah.

Species/Variable	Site 1 1979	Site 1 1980	Site 2 1979	Site 2 1980	Site 3 1979	Site 3 1980	Overall 1979	Overall 1980
Rainbow Trout								
Total Catch	10	17	6	18	5	8	21	44
Population Estimate	10	17	6	18	5	8	21	44
Mean Length (in)	6.4	5.1	7.8	7.7	9.4	8.1	7.5	6.7
Mean Length (mm)	162.7	128.5	199.0	195.7	237.8	206.8	190.9	171.2
Mean Weight (oz)	4.2	1.0	4.3	3.1	6.8	3.7	4.8	2.4
Mean Weight (gm)	118.9	28.7	122.4	88.6	195.1	106.0	138.1	68.2
Standing Crop (#/ft^2)	0.0014	0.0018	0.0007	0.0018	0.0006	0.0008	0.0009	0.0015
Standing Crop (#/m^2)	0.015	0.019	0.008	0.019	0.009	0.009	0.009	0.016
Brown Trout								
Total Catch	6	14	12	83	5	59	26	148
Population Estimate	6	14	12	98	5	59	26	171
Mean Length (in)	10.2	10.1	11.4	6.7	11.4	7.2	11.1	7.2
Mean Length (mm)	260.3	255.4	290.8	171.4	289.4	183.7	283.2	183.6
Mean Weight (oz)	7.4	6.9	10.1	2.7	10.7	3.3	9.7	3.3
Mean Weight (gm)	210.9	196.6	299.0	75.4	306.6	92.4	276.4	92.7
Standing Crop (#/ft^2)	0.0008	0.0015	0.0014	0.0082	0.0009	0.0063	0.0011	0.0051
Standing Crop (#/m^2)	0.009	0.016	0.015	0.088	0.010	0.067	0.012	0.055

Table 9.--Water quality characteristics of Otter Creek, Utah, from 1976 and 1977 surveys. The 1976 data was obtained from a single sample while the 1977 average was obtained from 6 samples; the 1977 site 6 data was obtained from approximately the same location as the 1976 sample (T29S R1W, Section 18).

Character	1976[1/]	1977[2/]	
		Site 6	Average
Temperature (^{o}C)	19.0	----	----
T.D.S. (mg/l @ 180^{o}C)	----	192	194
pH	----	8.73	8.64
Conductance (μmhos/cm @ 25^{o}C)	344	319	316
Total Alkalinity (mg/l $CaCO_3$)	153	141	137
Total Hardness (mg/l $CaCO_3$)	130	116	113
Carbonate (mg/l CO_3)	----	10	7
Bicarbonate (mg/l HCO_3)	186	153	151
Ammonia (mg/l N)	----	0.01	0.01
Boron (mg/l B)	100	----	----
Calcium (mg/l Ca)	35	30	29
Chloride (mg/l Cl)	13	11	11
Fluoride (mg/l Fl)	0.5	----	----
Hydroxide (ml/l OH)	----	0.1	0.1
Magnesium (mg/l Mg)	11	10	10
Nitrate (mg/l NO_3)	----	0.05	0.05
Phosphate (mg/l Ortho P)	0.01	0.003	0.003
Potassium (mg/l K)	5.1	4	4
Silica (mg/l Si)	42	----	----
Sodium (mg/l Na)	24	18	18
Sulfate (mg/l SO_4)	10	8	7

1/ Analysis by USDI Geological Survey, Central Laboratory, Denver, Colorado and on file with USDI BLM, Sevier River Resource Area Office, Richfield, Utah.

2/ Analysis by Brigham Young University Environmental Analysis Laboratories, Provo, Utah and on file with USDI BLM, Sevier River Resource Area Office, Richfield, Utah; and reported in Winget, Robert N. and Richard W. Bauman. 1977. Macroinvertebrates and water quality-quantity survey of Otter Creek, Piute County, Utah. Report on file with USDI, BLM, Sevier River Resource Area Office, Richfield, Utah.

Little can be inferred directly from these water quality data, except that Otter Creek contains warm, nutrient-poor, moderately hard water. The 1977 values are somewhat lower than the corresponding 1976 values in every case, but whether this is due to real decreases in the variables, sampling error, or natural fluctuations is unclear since the changes are all relatively small. None of the characters can be said to be stressing to the Otter Creek game fish populations at the levels observed; although the indicated temperature of 19°C is above the 13°C optimum for rainbow trout reported by McKee and Wolf (1971), it is within healthy limits.

CONCLUSIONS

After only two seasons of data collection and grazing treatment, it is difficult to interpret the effects on Otter Creek and its riparian zone of the established grazing system used on the South Narrows Allotment (winter and spring allotment-wide continuous) relative to the grazing systems in the exclosure. Additional complications result because of the dramatic vegetational and physical differences that exist between site 1 (where grazing is totally excluded) and site 3 (upstream control sites where grazing continues) and also because of the highly artificial character of Otter Creek that results from mans' manipulation of waterflow and fishery management practices. At this point, our data indicate that Otter Creek responds slowly to management changes because of water flow control and streambank soil conditions. This increases the time period of rehabilitation under improved management practices but may also slow the deterioration that could occur under improper management. The established grazing system, with vegetation use occurring principally during the winter, appears to have few deleterious effects on riparian vegetation production; this coupled with the slow responses of the system has apparently slowed degradation of Otter Creek.

We cannot yet determine if the complete rest and alternate year grazing strategies that are being studied are producing the desired results; only additional long-term observations will allow such conclusions to be made. The funds spent by the BLM in this long-term study may be more effectively spent on another study area where there are fewer confounding influences. We suggest that the BLM carefully evaluate the two progress reports we have prepared in the light of these considerations to determine whether the Otter Creek study is likely to provide the answers needed by management. Our recommendation is to terminate this phase of the study and approach the same questions in an area that has better potential for producing viable results.

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