Trout Habitat, Abundance, and Fishing Opportunities in Fenced vs Unfenced Riparian Habitat along Sheep Creek, Colorado[1]

Robert J. Stuber [2]

Abstract.--Fencing was used to protect 40 hectares of riparian stream habitat along 2.5 km of Sheep Creek, Colorado, from adverse impacts due to heavy streamside recreation use and cattle grazing. Fish habitat within the fenced area was narrower, deeper, had less streambank alteration, and better streamside vegetation than comparable unfenced sections. Estimated trout standing crop was twice as great, and proportional stock density (PSD) was higher than in unfenced sections. There was a higher proportion of nongame fish present in unfenced sections. Projected fishing opportunities within the fenced sections were double those estimated for a comparable length of unfenced habitat along the same stream.

INTRODUCTION

The integrity of riparian/stream ecosystems is extremely important from the perspective of fisheries, since the quality of existing fish habitat is often directly related to the overall condition of the riparian habitat. This is especially true for many medium and small size coldwater streams, as the smaller the stream, the more important the riparian zone and the influence it has (Raleigh 1979). Well developed riparian vegetation provides a number of benefits for salmonids, including cover (Raleigh 1982), streambank stabilization (McCluskey et al. 1983), shading for stream temperature regulation (Reiser and Bjornn 1979; Raleigh 1982), and a source of allochthonous food input (Meehan et al. 1977; Raleigh 1982). Maintaining this integrity is very important, especially in light of increasing angling use on many of these streams.

Multiple land use practices often result in fish habitat degradation within the riparian/stream ecosystem. Man has dramatically reduced the quantity and quality of natural riparian ecosystems by intensively developing them for other uses. This development has resulted in losses of natural vegetation to the detriment of fish and wildlife and associated recreation (Swift 1984). Fencing riparian habitat is one technique which has been employed to protect or improve fish habitat where conflicting land uses have resulted in degradation. Fencing was used to protect riparian stream habitat along Sheep Creek, Colorado, from adverse impacts due to heavy streamside recreational use (e.g., recreational vehicles, camping, etc.) and cattle grazing. Trout habitat characteristics and abundance are compared in an ongoing evaluation between fenced and unfenced sections of stream.

The purpose of this paper is to discuss differences in these parameters, along with projected potential fishing opportunities in the fenced portion of Sheep Creek versus a comparable length of unfenced habitat along the same stream.

METHODS

Study Area

Sheep Creek is a small (4-5 m width) stream on the Arapaho and Roosevelt National Forests within the South Platte River basin in northeastern Colorado. Elevation of the section under consideration is approximately 2,500 m. Low flow is about 0.2 - 0.3 m^3/sec. It is a C-1 stream type according to a Forest Service stream classification procedure (Rosgen 1985). Gradient is 1.0 - 1.5% and sinuosity is 1.5 - 2.0. Dominant channel material is cobble with a mixture of small boulders and coarse gravel. The channel is moderately confined. Soils within the valley bottom are predominantely coarse textured, with stable high alluvial terraces.

A total of 2.5 km of stream on National Forest land was originally fenced in 1956 to protect 40 hectares of riparian/stream habitat from cattle grazing impacts. The fences were maintained periodically; however, in recent years

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[2]Fisheries Biologist, USDA Forest Service, Arapaho and Roosevelt National Forests, Fort Collins, Colorado.

the fences had fallen into a state of disrepair and were rebuilt in 1982-83. Both the original construction and repair were a cooperative effort by the Colorado Division of Wildlife and Forest Service. The fenced area is divided into two enclosures (1.9 and 0.6 km of stream, respectively), with 1.3 km between, and 4.0 km of unfenced habitat above them (Fig. 1). Present impacts on the unfenced riparian habitat are heavy streamside recreational use and cattle grazing. It should be noted the land adjacent to Sheep Creek outside the fenced areas is in private ownership.

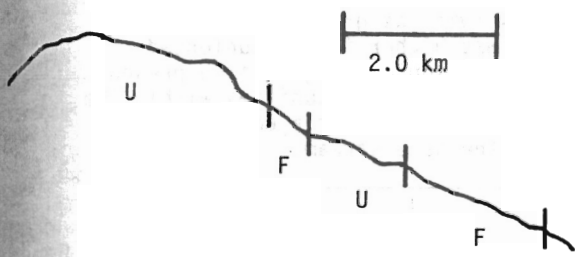

Figure 1.--Location of fenced (F) and unfenced (U) sections of Sheep Creek, Colorado

Habitat Sampling

Habitat measurements were taken at two 125 m representative stations in 1984, one inside and one outside the fenced area. The unfenced sampling station was between the two enclosures. Five stream/riparian habitat parameters were measured: stream width, depth, streambank alteration (% eroding banks), streambank vegetative stability (% vegetation), and streamside cover (dominant vegetation type). The width/depth ratio was also calculated. It was felt that these six characteristics would yield a comparative assessment of the overall fish habitat condition between the two areas. Vegetative stability and streamside cover were rated from 1 (worst) to 4 (best). Measurements and applicable ratings were made according to procedures outlined by Platts et al. (1983).

Fish Population Sampling

Three stations were sampled in late October, 1983 (one inside vs. two outside); the onset of winter weather conditions precluded additional sampling. Five stations were sampled in late September, 1984 (three inside vs. two outside). All stations were 125 m in lenth, and sampling was done with a generator powered electrofishing unit. The habitat stations sampled in 1984 were two of the fish population stations sampled in both 1983 and 1984.

Three fish population characteristics were compared between fenced and unfenced areas: (1) relative species occurrence (both trout and nongame fish); (2) trout standing crop (kg/ha); and, (3) trout species proportional stock density (PSD), an index of potential fishing quality based on lengths of fish (Anderson 1980). Only fish $\geq$ 150 mm in length were utilized in these estimates. Data from the individual stations were pooled (fenced vs. unfenced) for the comparative estimates. Population estimates for trout were made using the Seber and Le Cren (1967) two capture method. Lengths and weights of all captured fish were taken and trout standing crop estimates were made. Stock and quality lengths for the trout species PSD calculations were taken from Anderson (1980).

Fishing Opportunities

Projected potential fishing opportunities within fenced areas were compared with those from unfenced sections of the stream. Projections were based upon a fact (known angling use per km of stream in Colorado) combined with an assumption (stream fishery value can be equated to opportunities for angling use). The rationale behind this approach is presented below.

The Colorado Division of Wildlife (1983) reported that the 13,600 km of coldwater stream supported 3.8 million fishing-days in 1980 (280 fishing-days per km). According to the USDA Forest Service (1980), three fishing-days equal one recreational visitor day (RVD). Therefore, 1.0 km of stream supported 93 RVD's for coldwater fishing in 1980. The Division of Wildlife also assigns one of six fishery values to a stream (None, Poor, Below Average, Average, Above Average, Excellent). It was assumed that a stream with an "Average" fishery value would support 93 RVD's (per km per year) of coldwater fishing, and that the remaining fishery values would support a proportionate amount of projected use (Table 1).

Projected fishing opportunities within fenced vs. unfenced areas were obtained by arbitrarily assigning a fishery value to each respective area based on trout standing crop and PSD estimates. Total opportunities within the fenced section of stream and a comparable length of unfenced stream were standardized by multiplying the respective projected opportunities per km of stream by 2.5 km (length of fenced section of stream).

Table 1.--Projected RVD's (per km of stream per year) associated with fishery value of stream in Colorado.

Fishery Value	RVD's
None	0
Poor	31
Below Average	62
Average	93
Above Average	124
Excellent	155

Table 2.--Comparative fish habitat characteristics between fenced and unfenced sections of Sheep Creek, Colorado, 1984.

	Fenced	Unfenced
Average width (m)	3.7	5.5
Average depth (m)	0.2	0.1
Width:Depth	18.5	55.0
Streambank alteration (% eroding banks)	Moderate (26-50)	Major (51-75)
Streambank stability (% vegetation)	Good (50-79)	Fair (25-49)
Streamside cover (rating) (dominant vegetation type)	4 (Excellent) (Shrubs)	2 (Fair) (Grass/Forbs)

RESULTS

Fish Habitat

The stream was generally wider and shallower in unfenced areas as there was a significant difference in the average width ($P = 0.0002$) and depth ($P = 0.0006$) between the two areas. This resulted in a much lower width/depth ratio within the fenced area (Table 2). Also, there was more streambank alteration, less streambank vegetative stability, and lower quality streamside cover in the unfenced area.

Fish Population

On a relative basis there were significantly more game fish (trout) present in the fenced sections, and the number of nongame fish (longnose suckers; Catostomus catostomus) was higher in unfenced areas (X^2 analysis; $P = 0.0001$). Brown trout (Salmo trutta) were the predominant species captured in both fenced and unfenced areas. Brook trout (Salvelinus fontinalis) and rainbow trout (Salmo gairdneri) were also captured within both areas (Table 3). All captured fish were from wild populations, as no stocking takes place.

There was a significant difference ($P = 0.04$) in estimated trout standing crop in 1983 between fenced vs. unfenced areas as estimated standing crop was 96% higher (91.0 kg/ha greater) within fenced areas (Fig. 2). Estimated trout standing crop was 127% higher (74 kg/ha) within fenced areas in 1984, although this was not significantly different ($P = 0.08$) from unfenced areas.

Proportional stock density (PSD) values for brown trout within the fenced areas were 8.3 and 5.1 in 1983 and 1984, respectively, compared with a value of zero within the unfenced areas in both years. In other words, 8.3 and 5.1%

Table 3.--Relative abundance (%) of trout and nongame species captured in fenced vs. unfenced sections of Sheep Creek, Colorado, 1983-84 (average value from both years).

	Fenced	Unfenced
Trout	96.5	85.0
Brown	91.5	72.5
Brook	4.0	9.5
Rainbow	1.0	3.0
Nongame (Longnose Sucker)	3.5	15.0

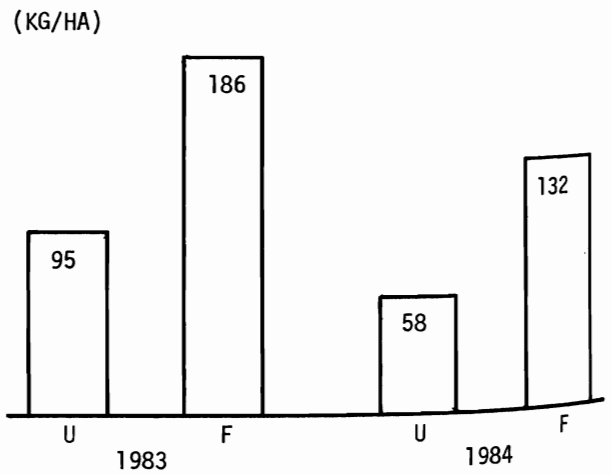

Figure 2.--Comparative average trout standing crop estimates between unfenced (U) and fenced (F) sections of Sheep Creek, Colorado

of the stock size (≥ 200 mm) brown trout were of quality size (325 mm or larger) within the fenced areas in 1983 and 1984, respectively, and there were no quality size brown trout in the unfenced areas in either year. The largest fish captured in both 1983 and 1984 were brown trout from the fenced areas (500 and 375 mm, respectively). There were no quality size rainbow or brook trout captured within either fenced or unfenced areas in both years.

Fishing Opportunities

Fishing opportunities within the fenced area and a comparable length of unfenced stream were projected to be 310 vs. 155 RVD's per year, respectively (e.g., 310 RVD's = 124 RVD's/km/year x 2.5 km, etc.). These projections were based on the assumptions that the fishery value within the fenced area was "Above Average" (124 RVD's/km/year; Table 1) whereas it was "Below Average" (62 RVD's/km/year) in the unfenced area. These assumptions were in turn based on the facts that estimated trout standing crop was twice as great in fenced areas and that there were quality fishing opportunities for brown trout (based on PSD values) within the fenced area, whereas none were present in the unfenced area.

DISCUSSION

Protection of the riparian stream ecosystem by fencing resulted in superior fish habitat conditions. Fenced areas had a narrower stream width, greater depth, and a lower width/depth ratio. Depth is important in providing a combination of pools, cover and instream movement areas for trout (Raleigh 1982). Lower width/depth ratios are associated with better fish habitat (Behnke and Zarn 1976; Platts 1981). The more stable streambanks (lower % eroding banks) and good streambank vegetative stability within fenced areas provide protection from erosion and subsequent siltation within the stream. The predominance of well-developed shrubs (willows) within the fenced area contribute more streamside cover than the grass/forbs which predominate in unfenced areas. Platts (1974) found that streams bordered by shrubs had higher fish standing crops than similar sized streams with other vegetation type borders. It appears that heavy streamside recreation use and cattle grazing have resulted in adverse impacts to the stream/riparian habitat in the unfenced sections of stream, which was evidenced by the results of the comparative habitat sampling (i.e., wider, shallower stream, more streambank alteration, etc.). It has been demonstrated in numerous other studies that protected sections of stream have superior fish habitat conditions. See Platts (1982) and Platts and Wagstaff (1984) for a synopsis of the results of these studies.

Increased estimated trout standing crop within the fenced area was the result of superior habitat conditions. Binns and Eiserman (1979) felt that the best fluvial trout habitat is associated with a high standing crop. Trout standing crop estimates were 96.5% higher (1983-84 average) within the fenced areas of Sheep Creek. Greater trout abundance within protected riparian stream habitat has been reported in other similar studies. Gunderson (1968) reported that brown trout standing crop was 31% greater in an ungrazed vs. an adjacent grazed section of Rock Creek, Montana. In a subsequent study, Marcuson (1977) reported that standing crop inside the ungrazed area had increased to 3.4 times that found in the grazed section of this same stream. Van Velson (1979) found that the fish population of Otter Creek, Nebraska, changed from 88% nongame fish to 97% trout after 4.8 km were fenced to exclude livestock.

Platts (1982) felt that these studies were somewhat biased, as there was no pre-treatment data, and it could not conclusively be proven that differences in reported trout abundance were not just a natural occurrence. The present study at Sheep Creek lacks pre-fencing fish population and habitat data; however, the fenced and unfenced sections have similar channel type, substrate, gradient, flow regime, and geomorphology. These similarities reduce the possibility that the differences were just a natural occurrence and it can safely be assumed that protection has resulted in superior habitat conditions and higher trout standing crop.

In addition to providing better habitat conditions, it should be noted that the well developed willow stands along the fenced sections of Sheep Creek probably offer some protection for trout from anglers. Fishability is more difficult than in adjacent unfenced sections and this fact may also contribute to the higher estimated standing crop.

In conclusion, fencing for the protection of the riparian/stream ecosystem at Sheep Creek has resulted in superior fish habitat conditions, 96.5% higher estimated trout standing crop, higher PSD values, and twice the projected potential fishing opportunities than in adjacent unfenced areas.

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LITERATURE CITED

Anderson, R. O. 1980. Proportional stock density (PSD) and relative weight (W_r): Interpretive indices for fish populations and communities. pp. 27-33 in Practical Fisheries Management: more with less in the 1980's, Workshop Proceedings. Gloss, S. and B. Shupp, eds. New York Chapter, American Fisheries Society.

Behnke, R. J. and M. Zarn. 1976. Biology and management of threatened and endangered western trout. USDA Forest Service, Gen. Tech. Rep. RM-28.

Binns, N. A. and F. M. Eiserman. 1979. Quantification of fluvial trout habitat in Wyoming. Trans. Am. Fish. Soc. 108:215-218.

Colorado Division of Wildlife. 1983. Today's strategy...tomorrow's wildlife. A Comprehensive Management Plan for Colorado's Wildlife. Third ed., Colo. Div. Wildl., DOW-M-D-I-83, Denver. 96 p.

Gunderson, D. R. 1968. Floodplain use as related to stream morphology and fish populations. J. Wildl. Manage. 32(3): 507-514.

Marcuson, P. E. 1977. The effect of cattle grazing on brown trout in Rock Creek, Montana. Spec. Proj. Rep. F-20-R-21-11-a. Montana Dept. Fish and Game, Helena. 26 p.

McCluskey, D. C., J. Brown, D. Bornholdt, D. A. Duff, and A. H. Winhard. 1983. Willow Planting for Riparian Habitat Improvement. Tech. Note 363, USDI Bureau Land Mgmt., Denver, Colo. 21 p.

Meehan, W. R., F. J. Swanson, and J. R. Sedell. 1977. Influences of riparian vegetation on aquatic ecosystems with particular reference to salmonid fishes and their food supply. pp. 137-145 in Proc. Symposium on Importance, Preservation, and Management of Riparian Habitat. USDA Forest Service Gen. Tech. Rep. RM-43.

Platts, W. S. 1974. Geomorphic and aquatic conditions influencing salmonids and stream classification - with application to ecosystem management. USDA SEAM Program Billings, Montana 199 p.

Platts, W. S. 1981. Effects of sheep grazing on riparian - stream environment. USDA Forest Service Res. Note INT-307.

Platts, W. S. 1982. Livestock and riparian-fishery interactions: What are the facts? pp. 507-515 in Trans. 47th N. American Wildlife and Natural Resource Conference, Wildlife Management Institute, Washington, D.C.

Platts, W. S., W. F. Megahan, and G. W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. USDA Forest Service Gen. Tech. Rep. INT-138.

Platts, W. S. and F. J. Wagstaff. 1984. Fencing to control livestock grazing on riparian habitats along streams: is it a viable alternative? N. Am. J. Fish. Manage. 4:266-272.

Raleigh, R. F. 1979. Closing remarks. pp. 89-90 in Proc. of Forum - grazing and riparian/stream ecosystems, O. B. Cope, ed., Trout Unlimited, Vienna, Virginia.

Raleigh, R. F. 1982. Habitat suitability index models: Brook trout. USDI Fish and Wildlife Service. FWS/OBS-82/10.24. 42 p.

Reiser, D. W. and T. C. Bjornn. 1979. Habitat requirements of anadromous salmonids in Influence of forest and rangeland management on anadromous fish habitat in western North America. USDA Forest Service Gen. Tech. Rep. PNW-96.

Rosgen, D. 1985. A stream classification system in Proc. of Riparian ecosystems and their management, Tucson, Arizona, April 16-18, 1985. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station General Technical Report series (in preparation).

Seber, G. A. and E. D. LeCren. 1967. Estimating population parameters from catches large relative to the population. J. Animal Ecology 36(3):631-643.

Swift, B. L. 1984. Status of riparian ecosystems in the United States. Water Resources Bulletin 20(2):223-228.

USDA Forest Service. 1980. Resource planning act assessment, 1980. USDA Forest Service, Washington, D.C.

Van Velson, R. 1979. Effects of livestock grazing upon rainbow trout in Otter Creek. pp. 53-55 in Proc. of Forum - grazing and riparian/stream ecosystems., O. B. Cope, ed. Trout Unlimited, Vienna, Virginia.