A Compendium of Trout Stream Habitat Improvement Projects Done by the Wyoming Game and Fish Department, 1953-1998.

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ABSTRACT

Stream habitat improvement projects done in Wyoming by the Wyoming Game and Fish Department, either alone or in partnership with other groups or agencies, were reviewed to determine if such work was, or was not, beneficial to trout. Of 71 projects that the Wyoming Game and Fish Department has been involved with since 1953, fish response was monitored at 46 projects. Posttreatment, mean wild trout abundance increased 116% and biomass doubled. Numbers of catchable wild trout, 6 inches or longer, were 88% higher and their biomass was up 95%. In mixed trout populations, where both wild and stocked fish were present, abundance increased 112% and biomass 117%. Catchables more than doubled in both numbers and biomass.

From 1953 to 1998, a variety of instream structures were employed to improve habitat for trout. These devices have proved durable and effective over time. Best trout response was at plunges (363% gain), but revetments (129% gain), tree jams (69% gain), and rock weirs (66% gain) also increased trout numbers. Both log and timber plunges exceeded minimum residual pool depth (RPD) criteria, but log plunges (RPD, 1.85 ft) were better than either timber plunges (RPD, 1.6 ft) or rock plunges (RPD, 1.35 ft). Posttreatment cover developed best at log plunges, followed by timber and rock plunges. Deflectors directed stream currents better than they dug pools.

For first and second order streams, pool diggers, such as timber plunges or small diagonal rock weirs are recommended. Third and fourth order streams are more powerful and require a sturdy structure, such as a rock vortex weir or a diagonal rock weir. All of these structures will dig pools and also act as grade controls to raise the water table locally, thus subirrigating adjacent riparian vegetation. Rock weirs, tree jams, and "jetties and piles" are recommended for large rivers. Tree and rock revetments are preferred over rock riprap or tree revetments for bank stabilization at all streams.

On the average, habitat improvement projects on first order streams ($21,200/mile,1995 dollars) cost about 21% less than second order waters ($27,000/mile), 39% less than at third order streams ($34,600/mile) and 40% less than fourth order streams ($35,400/mile). Project cost for waters of order 5, or greater ($69,300/mile), was more than triple the cost for first order streams. Project costs ranged from $4,759/mile (Tosi Creek) to $303,570/mile (Salt River) and averaged $39,016/mile.

LIST OF ACRONYMS

ACRONYM	MEANING
ADF	Average Daily Flow
ASFV	Annual Stream Flow Variation (HQI parameter)
BCI	Biotic Condition Index
BKT	brook trout
BLM	United States Bureau of Land Management
BNT	brown trout
BurRec	U. S. Bureau of Reclamation
CPST	Critical Period Stream Flow (late summer stream flow)
CTQ	Community Tolerance Quotient
CUP	Central Utah Project
CUT	cutthroat trout
HQI	Habitat Quality Index
HU	trout Habitat Unit
I/R Unit	Kirk Inberg/Kevin Roy Wildlife Habitat Management Unit
MDT	mean daily temperature
NTU	nephelometric turbidity units
pH	hydrogen ion concentration
RBT	rainbow trout
RPD	residual pool depth
RZ	Reference zone
S/M Unit	Spence/Moriarity Wildlife Management Area
SRC	Snake River cutthroat trout
TDS	total dissolved solids
TSS	total suspended solids
TZ	Treated zone
USFS	United States Forest Service
USGS	United States Geological Survey
WDEQ	Wyoming Department of Environmental Quality
WGF	Wyoming Game and Fish Department
WHD	Wyoming Highway Department (now Wyoming Department of Transportation
WHMA	Wildlife Habitat Management Area
WRRI	Wyoming Water Resources Research Institute (University of Wyoming)
YOY	Young of year
YSC	Yellowstone cutthroat trout

INTRODUCTION

That production of trout in streams is strongly affected by habitat conditions has been well documented in the fishery literature. But this fact has not always been appreciated by man. During the early 1900s, the prescription for fishery shortcomings was to stock more trout, even though results often did not appear to justify the effort (Duff 1982). Then, in the 1930s, better documentation of fish habitat through stream surveys led to efforts to correct habitat deficiencies. In the Rocky Mountains, including Wyoming, such stream habitat improvement efforts were done primarily by the Civilian Conservation Corp (CCC) from 1933-1937 (Duff 1982, Wydoski and Duff 1982). Given man's penchant for altering streams, earlier stream improvement work was likely done in Wyoming streams by other fishery workers, but the CCC projects were the first organized and documented effort.

CCC crews installed many structures in Wyoming streams. For example, structure completion cards filled out by Allen C. Randall, a biologist with the U. S. Bureau of Fisheries, documented installation of 42 devices in less than two miles of Tosi Creek near Pinedale. Other devices have been found in Sand Creek and the Big Sandy River. Although specifications for the various structure types used by the CCC have survived in several handbooks (USDC 1935, USDA 1936), records of their projects were scattered, and as structures deteriorated, much information was lost about structure locations and performance. Since evaluation of fish and habitat response to the CCC work was virtually nonexistent (an evaluation by Tarzewell [1938] in Arizona is a notable exception), little was learned about how the target fisheries may have benefited from the habitat improvements. With a poor paper trail, and little evaluation, much hard-earned knowledge about habitat management for trout in Wyoming streams did not survive to guide future workers.

After a hiatus during the war years of the 1940s, interest in habitat improvement for trout in Wyoming streams began again in the 1950s (Eiserman 1955) and 1960s (Mueller and Rockett 1966, Mueller 1979). In 1973, the Wyoming Game and Fish Department (WGF) initiated a formal habitat management program with formation of a two man Aquatic Habitat Crew stationed in Lander.

Thus began an era of more intensive habitat management in Wyoming. Working cooperatively with the U. S Forest Service (USFS) and U. S. Bureau of Land Management (BLM), the Aquatic Habitat Crew, and the WGF Statewide Habitat Construction Crew, began work on a variety of projects. With the shortcomings of the CCC program in mind, efforts were made to document and evaluate WGF projects from the start.

Beaver Creek, a second order headwater stream in the Wyoming Black Hills, was designated an experimental stream where various structures could be tested for applicability to Wyoming stream conditions. Since the early "how-to-do-it" manuals (USDC 1935, USDA 1936, USDA 1952) were not available to us in 1973, emphasis was on testing the devices detailed for Wisconsin streams in the landmark publication by White and Brynildson (1967).

At Beaver Creek, fishery and fish habitat response, as well as habitat structure performance, was monitored for 18 years (Binns 1993, 1994). Other studies were conducted on Salt Creek (Binns 1986), Hog Park Creek (Binns 1990), and Huff Creek (Binns and Remmick 1994). A comprehensive review of habitat improvement structure performance was done at several Wyoming streams by the Wyoming Cooperative Fisheries Research Unit (Hogle 1993).

Despite all this monitoring and record keeping, project data were still scattered through several databases, file cabinets, and reports. There was need to bring all habitat management information together under one cover, both for convenience, and as a learning tool for future workers. Appearance of an excellent compendium of stream habitat improvement projects in Wisconsin (Hunt 1988) gave impetus to a similar publication for Wyoming and I undertook that assignment. This Wyoming compendium documents 71 projects constructed during 1953-1998. Only projects done by WGF alone, or in partnership with other groups or agencies, are included in this compendium, which is not intended to be a listing of every stream habitat improvement project ever done in Wyoming.

Primary goals of this compendium include: 1) locate and assemble pertinent data on stream habitat improvement projects done by WGF, either alone, or in partnership with other groups, 2) compile and analyze records of fishery and fish habitat response to the individual habitat improvement projects, and 3) compile a compendium database so results of the habitat improvement program could be examined on a statewide basis. Since logic suggests habitat management on small streams should be less expensive with better response, a secondary objective was to use compendium data to assess the validity of this postulation, *"Small streams respond best to habitat improvement: their habitat recovers better, they show greater fishery benefits, and are far less costly to work on"*. Such information would be valuable in directing scarce habitat management funds to their best use.

METHODS

General

A case history was assembled for each habitat improvement project, using the sources of information listed below. As each project was unique, the case histories were designed to "stand-alone" without reference to the rest of the compendium. An MS Access database was also developed for compendium data so the information in the case histories could be orderly analyzed to determine statewide project success.

Statistical analysis of compendium fish and habitat response data was generally limited to that reported for specific projects. Unless otherwise specified, statistical differences were recognized at the 0.05 level.

Sources of Information

Information on the WGF habitat management program is scattered through various reports, files, and databases. A primary source of information for this compendium was the annual progress reports written by each regional fish management crew and issued by the WGF Fish Division in Cheyenne as a bound volume. These reports contain a wealth of data on fish sampling activities, as well as general fishery related activities on the various streams, that were often spread over several years.

Another important source of data for the compendium case histories was the Habitat Quality Index and Stream Habitat Improvement Project databases, as well as the basic project files for each habitat improvement project. The WGF Aquatic Habitat Section in Lander maintains these sources.

A third source of information was the various completion and administrative reports written by fish management and habitat personnel for specific projects. These reports are listed in the case history for the appropriate project, but references to progress reports and databases were omitted to save space.

Lastly, a “corporate knowledge” exists among the various Fish Division personnel who were associated with the different projects. This knowledge was tapped whenever possible.

Habitat Management

Several techniques were used to install habitat improvement devices at the different projects and are detailed in the case histories. Although manual installation of structures was done at a few projects, such as Hell Canyon Creek, most structures were installed with the aid of machinery. For the majority of projects, construction was handled by the statewide WGF Aquatic Habitat Construction Crew, using their personnel and equipment (Figures 1). A few projects, like the upper Green River, were built almost entirely by heavy machinery rented from a private contractor (Figure 2). WGF personnel provided project oversight on these projects.

Figure 1. The WGF Aquatic Habitat Construction Crew did the installation of stream habitat improvement structures for most projects. Here they are building a timber plunge in Big Willow Creek (top photo) and the completed plunge, with its plunge pool and a cover tree along one side, is shown in the bottom photo.

Figure 2. Installation of tree jams on the upper Green River was done with the aid of heavy equipment rented from private contractors. A work crew installed cables after the trees and rocks were placed by the tracked hoe.

Fishery

Information on fish response to the habitat improvement projects came from electrofishing samples collected by the regional fish management crews (Figure 3). Given the time span and number of personnel involved, it is not surprising that sampling gear and techniques varied widely over time. For example, some population estimates were obtained with single pass samples, while others used more sophisticated multiple pass or mark and recapture estimates. However, accuracy of these estimates is believed sufficient for purposes of this compendium. Questionable estimates were omitted. Generally, population information reported by the management crews was for trout as only within the last few years have more than qualitative data for other species been included in fish sample reports.

Several population variables were selected for use in determining fish response to the habitat improvement projects. These standard variables, or indices, are: total trout/mile, number of trout/mile that were 6 inches or greater in total length, total pounds/acre, and pounds/acre of trout 6 inches or greater. Percent change is as a benchmark to measure gain, or loss, in these indices at the different projects.

Criteria used to arbitrarily measure success of fish response to habitat improvement followed those used by Hunt (1988). Level 1 success required a posttreatment percent change increase in one of the trout population indices listed above of 25%, or more. Level 2 success required a change of 50%, or more. Hunt (1988, p.4) defended his choice of these levels: “I chose the 25% and 50% levels of postdevelopment increase as arbitrary indices that simply seemed reasonable to me as acceptable long-term annual benefits from management investments of the kind that have been made to remedy perceived deficiencies in trout carrying capacity and/or the sport fishery.” I used Hunt’s 25% and 50% levels of success for two reasons: First, so the Wyoming results could be compared with his, and second, because I agreed with his reasoning for selecting those two levels. If WGF funds had been invested in the stock market instead of habitat improvement, I feel 25% and 50% would have been a satisfactory return on the WGF investment.

Figure 3. Fish population response to stream habitat improvement was regularly monitored with electrofishing gear at many WGF projects. This scene is at a diagonal rock weir on South Cottonwood Creek.

Habitat

Changes in fish habitat features were measured using the Habitat Quality Index (HQI) protocol in Binns (1982). Residual pool depth (RPD) eliminates variation due to stream discharge fluctuations and is the maximum pool depth minus the depth at the lip, or control, of that pool. Gradient was determined either by hand level, transit, or from USGS 1:24,000 topographic maps. Elevation was also taken from these maps. Watershed area, if not listed in USGS stream flow books, e.g., Druse et al. (1990), was measured on USFS 1:126,720 maps of the various national forests. Stream order followed the Strahler method, with a first order stream defined as the first solid blue line on a USGS 1:24,000 topographic map. Stream class was taken from the WGF classification map (Anonymous 1987).

Cost of Projects

Project costs included in each case history were actual cost figures for labor, materials, and equipment, as reported by the construction crew at the time of the project. Peripheral items, such as equipment storage, office, project planning, or monitoring expenses, were not included. Cost/mile was adopted as the standard unit for all projects. For statewide analysis of fish and habitat response, project cost records were adjusted for inflation to a standard 1995 level using a GDP inflator table that can be found on the National Aeronautics and Space Administration (NASA) website (http://www.jsc.nasa.gov/bu2/inflate.html).

SUCCESS OF HABITAT IMPROVEMENT PROJECTS

Records were located for 71 stream habitat improvement projects that WGF has been involved with since 1953 (Table 1). Of these projects, response of the trout population had been evaluated at 46 projects. Unfortunately, all four population indices were not always measured at each project. Some project evaluations included only one or two indices, leading to a smaller data set for some projects.

Evaluations at these 46 projects included comparison of either pretreatment versus posttreatment samples or untreated control station versus treated station. However, four projects had both control station and pretreatment sample data to compare with posttreatment fish response. These projects were at Beartrap, Flat, Hell Canyon, and Spotted Tail creeks. For convenience in analyzing treatment effects, both pretreatment samples and control stations were labeled as reference zones (RZ) for comparison with samples taken in the treatment zones (TZ). Success of the individual projects is reported in the case history for each project. A summary of statewide success rates follows below.

Arbitrary Success Rates

For the 89 trout population indices analyzed at the 30 projects containing only wild trout, statewide trout population response after habitat improvement was positive. Stated another way, WGF funds invested in habitat development gave a satisfactory return to WGF because trout populations increased posttreatment at the majority of projects. These increases occurred in streams having wild trout only and also in streams containing mixes of wild and stocked trout. When summarized over all population categories, 81% of the 89 wild trout abundance and biomass indices had a percent change increase of 25%, or greater (level 1). And rate of success was 50%, or greater (level 2) for 74% of the indices. Rate of success for 139 population indices at projects containing both wild and stocked trout was 83% at level 1, and 76% at level 2.

Table 1. Characteristics of streams where WGF trout habitat improvement projects were located, 1953-1998. Constr. Year is the year primary construction occurred; area is drainage area upstream from the project; class is WGF stream class; width is mean wetted width.

Name	County	Constr. Year	Elevation	Area	Order	Gradient	Rosgen	Width	Class
Bear Creek	Fremont	1992	7300	65	3	1.4	C-4	26	3
Bear River State Park	Uinta	1990	6790	430	5	0.5	C-3	45	3
Beartrap Creek	Sheridan	1989	7590	10	2	1.9	E-3	5	3
Beaver Creek	Crook	1973	5000	13	2	1.1	C-3	7	3
Big Creek	Carbon	1984	7240	175	3			46	2
Big Sandy River	Sweetwater	1993	6440	1700	4	0.12	C-5	38	3
Big Willow Creek	Sheridan	1988	7985	9	1	1	C-3	13	3
Blacks Fork River	Uinta	1974	8420	156	4	0.7	B-3	58	3
Blacktail Creek	Crook	1977	4610	8	2	1.8	C-4	7	4
Bull Creek, lower	Sheridan	1986	8070	10	1	0.6	C-4	12	3
Bull Creek, upper	Sheridan	1965	8260	7	1	0.7	C-4	15	3
Clarks Fork River	Park	1981	4310	1000	5	0.5	C-3	130	3
Coal Creek	Lincoln	1980	7010	6	2	1.1	C-4	8	4
Currant Creek	Sweetwater	1990	7020	20	2	0.9	C-4	8	4
Dead Indian Creek	Park	1980	6034	53	3	3	B-3	29	3
Deer Creek	Converse	1986	7010	60	4	1.2	B-3	16	2
Flat Creek	Teton	1986	6250	100	2	0.2	C-4	30	3
Fool Creek	Sheridan	1979	8100	8	1	2.6	B-2	13	3
Granite Creek	Teton	1953	6510	90	4	0.8	C-3	45	3
Green River - 40 Rod	Sublette	1988	7360	550	5	0.2	C-3	76	2
Green River - Forest	Sublette	1990	7690	310	5	0.6	C-3	118	2
Green River blw. Fontenelle	Sweetwater	1981	6300	4300	6	0.3	C-4	300	1
Gros Ventre River	Teton	1975	6600	622	5	0.6	D-3	100	3
Hall (Fry) Creek	Converse	1985	7100	1.5	1	5.7	A-3	4	5
Hams Fork River	Lincoln	1991	7015	270	4	0.2	C-4	40	2
Hell Canyon Creek	Carbon	1982	7780	1.4	1	7.4	A-3	4	4
Hog Park Creek	Carbon	1984	8315	14	3	0.6	C-4	21	3
Horse Creek (Dubois)	Fremont	1993	7700	50	3	0.5	C-4	38	3
Huff Creek	Lincoln	1982	6600	11	1	0.7	C-4	8	4
LaBonte Creek	Converse	1981	6900	55	3	1.7	B-3	12	3
Laramie River (Monolith)	Albany	1988	7160	500	5	0.04	C-5	40	3
Laramie River - Jelm	Albany	1993	7530	400	5	0.15	B-3	66	2
Laramie River at Laramie	Albany	1974	7100	500	5	0.1		50	4
Lick Creek	Sheridan	1984	8620	6	1	3.1	B-3	11	3
Little Bighorn River	Sheridan	1996	8300	12	2	1.3	C-2	15	2
Little Popo Agie River	Fremont	1976	5500	125	4	0.5	C-3	32	2
Little Popo Agie River93	Fremont	1993	5500	125	4	0.5	C-3	32	2
Medicine Lodge Creek	Big Horn	1981	4720	70	2	1.4	C-4	45	2
Middle Fork Popo Agie R.	Fremont	1987	5405	135	4	0.9	C-3	33	3
Muddy Creek - Grizzly Unit	Carbon	1995	7320	20	1	0.6	C3, C5	6	4
N. Platte River - Douglas	Converse	1982	4790	15000	5	0.07	C-4	225	4
N. Platte River - Jacks	Converse, Goshen	1960	5000	15000	5				4
N.Platte R. Pick Bridge	Carbon	1991	6685	3000	5	0.1	C-3	135	1
N.Platte R. - Miracle Mile	Carbon	1996	5915	4300	5	0.6	F-2	150	1
Nameless Creek	Lincoln	1991	8120	2.5	1	3	B-4	5	4
North Fork Popo Agie River	Fremont	1980	5420	150	4	0.44	C-4	30	2
North Fork Powder River	Johnson	1968	8800	7	1	1.3	C-2	9	3
North Tongue River	Sheridan	1982	8450	14	3	1.6	B-3	17	3
Pass Creek	Fremont	1979	7430	6	1	2.2	B-4	8	3
Pinegrove Creek	Sublette	1985	7846	6	1	2.5	C-5	4	4
Rock Creek (Arlington)	Carbon	1970	7780	63	3	1.4	B-3	50	3

Table 1 continued.

Name	County	Constr. Year	Elevation	Area	Order	Gradient	Rosgen	Width	Class
Rock Creek (up. Green R)	Sublette	1987	7670	20	3	1.9	B-3	12	3
Salt Creek - Allred Flat	Lincoln	1981	6685	21	3	0.9	C-4	15	3
Salt Creek - state land	Lincoln	1985	6410	38	3	0.45	C-4	13	3
Salt River	Lincoln	1978	5800	830	6	0.2	C-4	70	2
So Tongue R Pine Island	Sheridan	1987	7645	80	4	0.2	C-3	43	2
South Cottonwood Ck 2	Sublette	1994	8245	21	3	0.8	C-4	23	3
South Cottonwood Creek	Sublette	1986	8240	21	3	0.8	C-4	23	3
South Tongue R. - Shutts	Sheridan	1997	7750	80	4	0.5	C-4, B-3	60	2
South Tongue R. Prune	Sheridan	1995	7655	80	4	0.2	C-4	46	2
Spotted Tail Creek	Crook	1985	5475	2	2	3.2	B-3	5	4
Squaw Creek	Fremont	1990	5600	135	3	1.1	B & C	12	3
Sunlight Creek	Park	1983	6730	1000	4	0.4	C-4	42	3
Sunlight Creek 1997	Park	1997	6730	1000	4	0.4	C-4	42	3
Sweetwater River	Fremont	1971	7450	177	4	0.2	C-4	49	3
Tepee Creek	Sublette	1982	8740	11	2	0.5	C-4	14	3
Tepee Creek - exclosure	Sublette	1980	8740	11	2	1.8	B-3	14	3
Tosi Creek	Sublette	1981	7990	30	4	1.6	B-3	28	3
Trout Creek	Sweetwater	1953	7300	8	2	1		6	3
Wind River	Fremont	1991	6800	650	5	0.6	C-3	70	2
Wolf Creek - Casper Reg.	Natrona	1995	5120	5	2			2	5

When examined by individual population variable, statewide success rates were high for both abundance and biomass (Figures 4 and 5). Projects containing only wild trout had success rates no less than 83% at level 1, and no less than 72% for level 2.

Arbitrary Success Rates by Habitat Characteristic

Success rates for wild trout/mile were generally less at streams of higher order (Figure 6, Appendix 1). When the projects were sorted for elevation, gradient, WGF stream class, and Rosgen stream type, the four abundance and biomass indices exceeded level 1 and 2 arbitrary success rates at least 50% of the time, and were often much higher (Table 2, Appendices 2-5). However, percent change gains in the indices were not consistent over the categories. At some streams, confounding factors such as angler harvest may have influenced posttreatment response of the trout population as much as stream habitat features. However, since creel census data on angler use and harvest are almost totally lacking for the projects, the actual effect of angler harvest remains unknown. Lack of information on angler harvest does not affect the conclusion that habitat improvement benefited trout at the majority of projects.

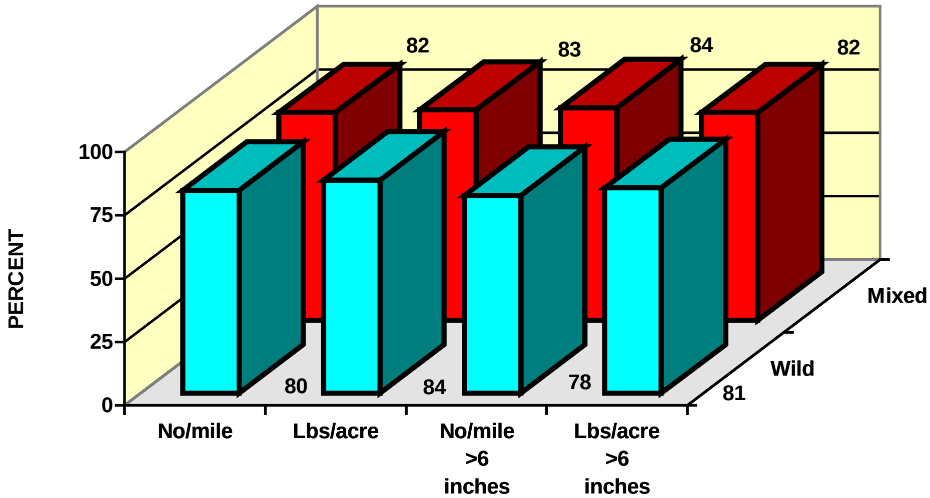

Figure 4. Success rates at Level 1 (percent change ≥ 25%) for four trout population indices, summarized over all projects. The mixed trout category summarizes all projects combined and includes both those containing only wild trout and those where fish of hatchery origin were present. Interpretation example: the percent change gain of wild trout/mile between RZ and TZ was at least 25% at 80% of the projects.

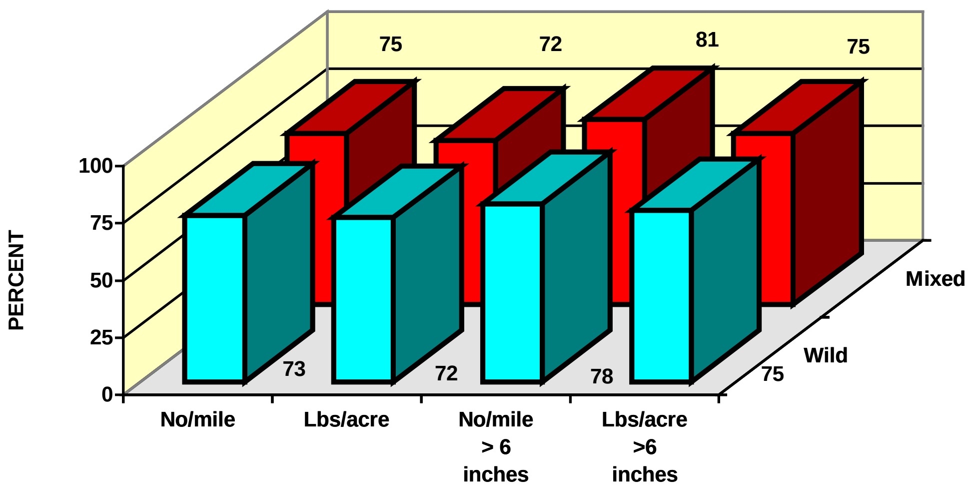

Figure 5. Success rates at Level 2 (percent change ≥ 50%) for four trout population indices, summarized over all projects. The mixed trout category summarizes all projects combined and includes both those containing only wild trout and those where fish of hatchery origin were present. Interpretation example: the percent change gain of wild trout/mile between RZ and TZ was at least 50% at 73% of the projects.

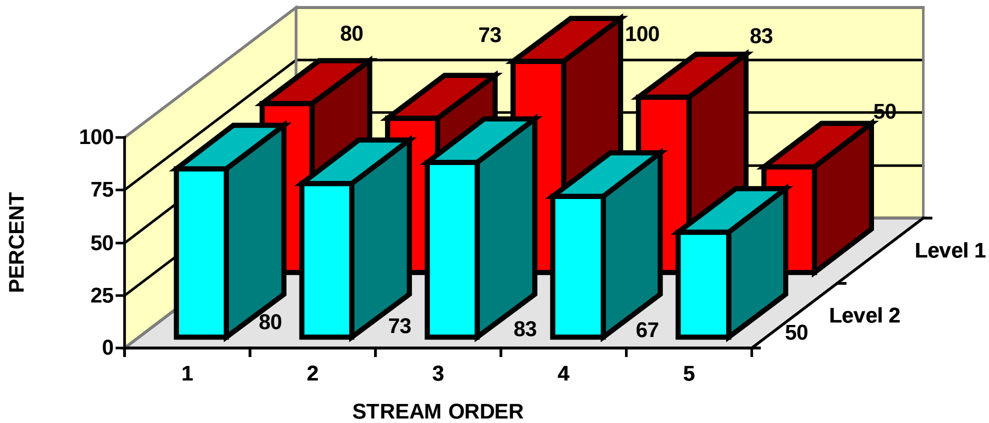

Figure 6. Success rates by stream order for wild trout subjected to habitat improvement. Level 1 requires a percent change gain in trout/mile of at least 25%, and level 2 requires a gain of at least 50%. Interpretation example: 73% of the projects done at second order streams achieved a percent gain of at least 50%.

Table 2. Lowest percent success rates for wild trout by habitat characteristic. Success level 1 is percent change of 25%, or greater, in the population indices (total trout/mile, lbs/acre, trout/mile 6 inches, or greater, or lbs/acre 6 inches, or greater). Level 2 is a change of 50%, or greater.

Success level	Habitat characteristic				
	Order	Elevation	Gradient	Stream class	Rosgen class
1	50	50	57	60	75
2	50	50	50	60	71

Empirical Changes in Trout Population Variables

When empirical data showing trout response to habitat improvement are summarized for all projects statewide, the mean posttreatment response was positive in all cases (Figures 7 and 8, Table 3). Averaged over all projects, posttreatment abundance of wild trout of all sizes increased 310% and biomass 271%. Catchable (6 inches, or greater) wild trout numbers increased 192% and their biomass was up 146%.

Empirical Success Rates by Habitat Characteristic

Response of trout to habitat improvement was also examined by sorting the statewide compendium database for habitat characteristics. Magnitude of mean percent change in the trout population variables between RZ and TZ for a specific habitat condition, such as stream order, gave an index that could be used to gage "best performance". But keep in mind that fish response at the vast majority of projects was very good and "best performance" as used here is a relative term. Comparison of performance in this section was done to give information on how and where habitat improvement could best be done even though fish and habitat response was more than adequate at most projects.

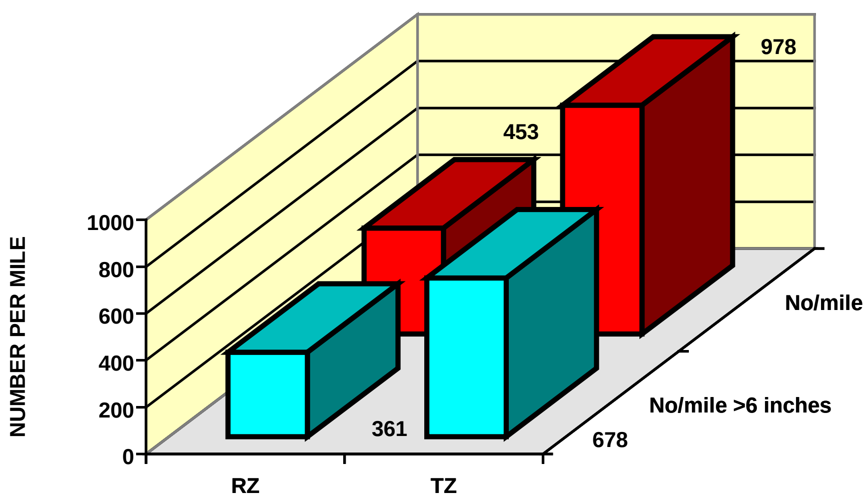

Figure 7. Mean empirical abundance of wild trout in treatment zones (TZ) and reference zones (RZ) at WGF habitat improvement projects done statewide from 1953 to 1997.

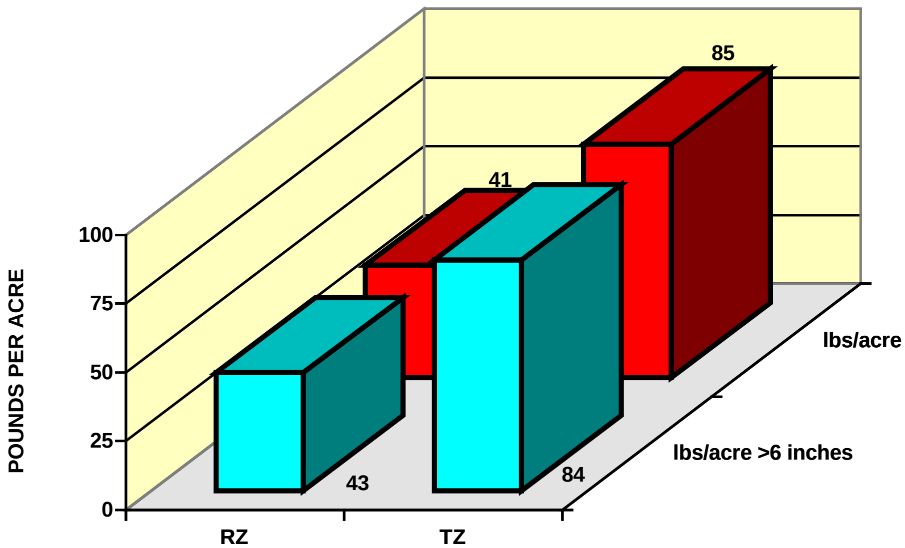

Figure 8. Mean empirical biomass of wild trout in treatment zones (TZ) and reference zones (RZ) at WGF habitat improvement projects done statewide from 1953 to 1997.

Table 3. Mean empirical values for four trout population variables averaged over all habitat improvement projects done statewide from 1953-1997. No. Meas. is number of projects with measurements; % chg. is mean percent change averaged over all projects; RZ is reference zone; TZ is treated zone. The mixed trout category summarizes all projects combined and includes both those containing only wild trout and those where fish of hatchery origin were present.

	Trout/mile				Lbs/acre				Trout/mile > 6 inches				Lbs/acre > 6 inches			
Trout Present	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.
Wild	30	453	978	310	25	41	85	271	18	361	678	192	16	43	84	146
Mixed	44	487	1,031	321	36	41	89	260	31	291	637	268	28	32	75	202

1. ***Stream Order***

Gain in wild trout abundance was greatest at second order streams, and least at third order streams (Figure 9, Appendix 6). Change in biomass was highest at second and third order streams (Figure 10).

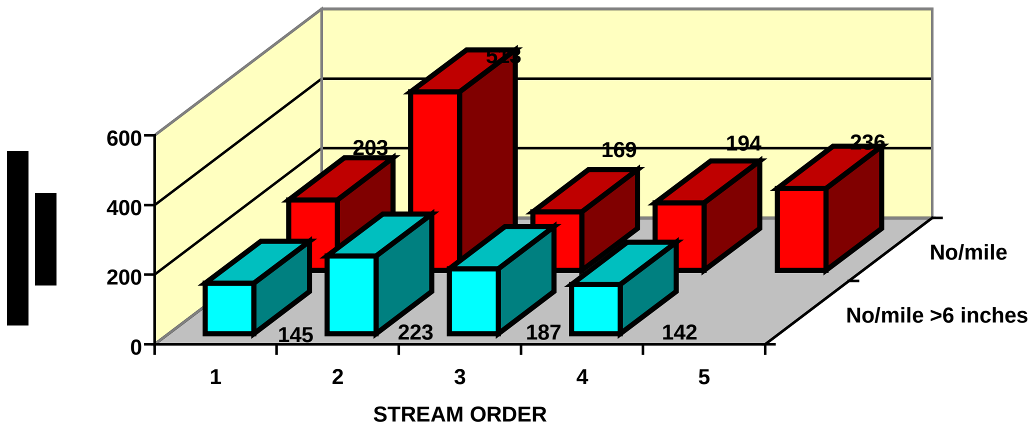

Figure 9. Mean percent change in posttreatment abundance of wild trout at streams sorted by stream order.

Flat Creek (control, 62 trout/mile; treated, 388 trout/mile) typifies average change in wild trout abundance for second order streams. Outlier projects that do not fit the norm are Spotted Tail Creek (pretreatment, 33 trout/mile; posttreatment, 866 trout/mile) and Beartrap Creek (control, 815 trout/mile; treated, 400 trout/mile). Differences in ease of angler access, and consequently harvest, are believed responsible for a -51% posttreatment difference between control and treated sections at Beartrap Creek.

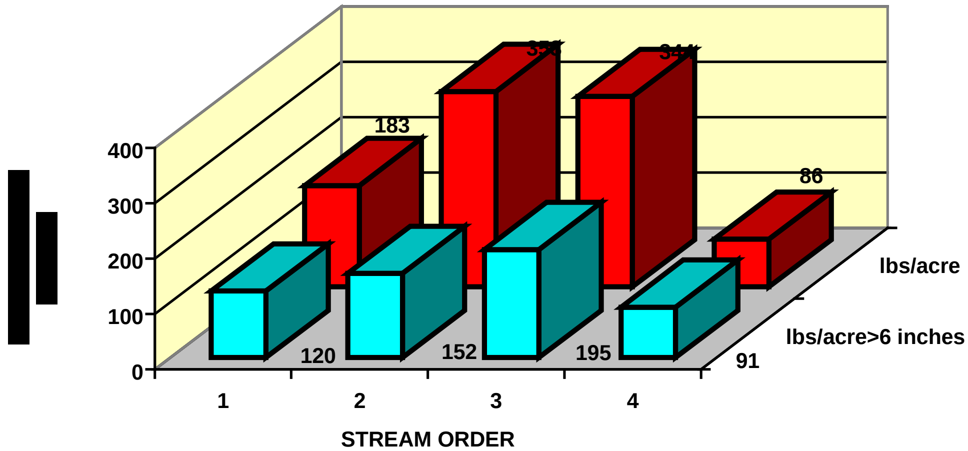

Figure 10. Mean percent change in posttreatment biomass of wild trout at streams sorted by stream order.

Posttreatment trout response at Bear River was also an extreme. With the advent of a state park next to I-80, this section of river suddenly became a high profile, high use recreational area, with attendant fishing pressure. Catchable RBT plants supported the fishery before habitat improvement in this fifth order stream, but afterwards, a fishery objective was to emphasize the native BRC fishery and no hatchery-reared trout were stocked posttreatment. Fishing pressure was such that wild trout abundance had decreased 71% three years after treatment started.

Stream Elevation

Elevations of WGF trout habitat improvement projects ranged from 4,310 ft to 8,800 ft. Abundance of wild trout increased most at projects under 6,000 ft, followed by projects between 8,000-9,000 ft (Figure 11, Appendix 7). Projects in the middle elevations had the least improvement. Although increases in overall trout biomass were greatest in streams over 8,000 ft, catchable trout biomass increased most at projects below 6,000 ft (Figure 12).

Beaver Creek typifies average abundance (pretreatment, 117 trout/mile; posttreatment, 875 trout/mile) at streams below 6,000 ft, while Squaw Creek (pretreatment, 138 trout/mile;

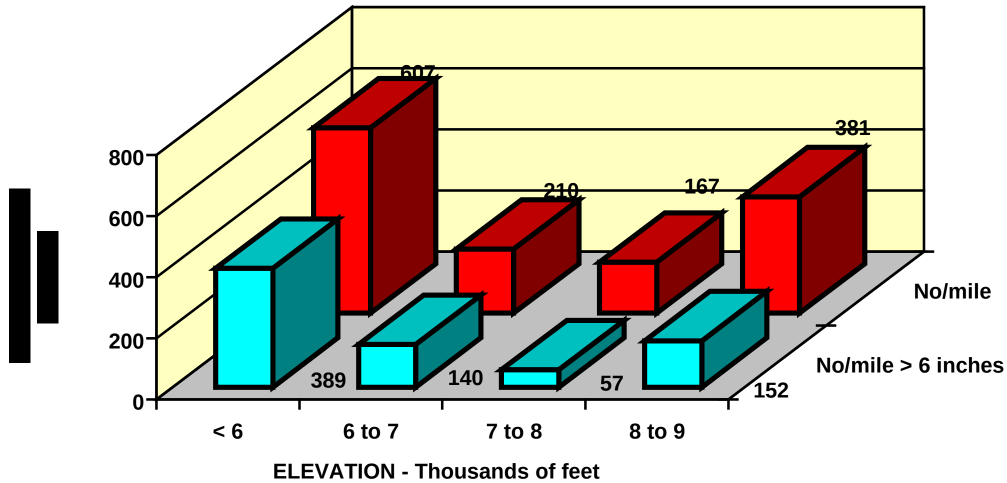

Figure 11. Mean abundance of wild trout at different elevations after habitat improvement.

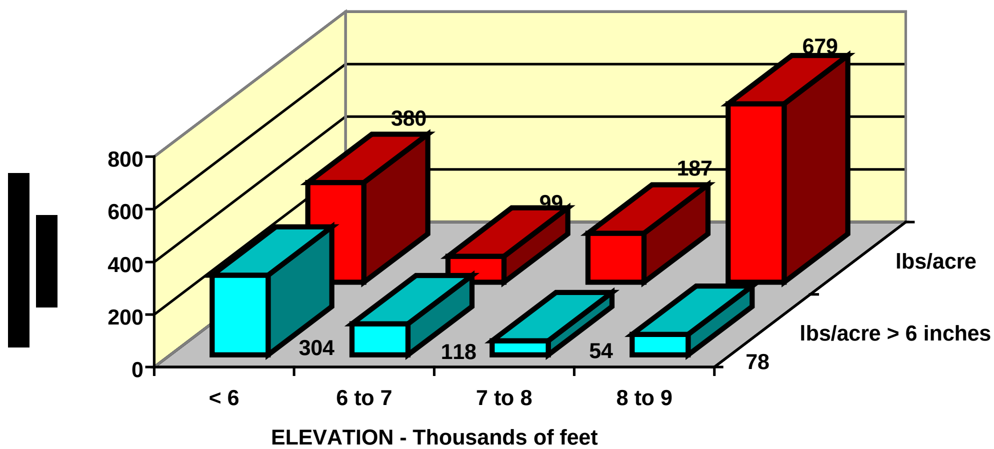

Figure 12. Mean biomass of wild trout at different elevations after habitat improvement.

Stream Gradient

A majority (79%) of WGF habitat improvement projects containing only wild trout were done on streams with gradients under 2%, but the largest gains in both trout abundance and biomass occurred at projects with a gradient greater than 3%, all of which were small, headwater creeks (Figures 13 and 14, Appendix 8). An example is Hell Canyon Creek (control, 233 trout/mile; treated, 792 trout/mile) with a 7.4% gradient. At the extremes were Nameless Creek (pretreatment, 58 trout/mile; posttreatment, 52 trout/mile; gradient, 3%) and tiny Hall (Fry) Creek (control, 194 trout/mile; treated, 1,377 trout/mile) with a 5.7% gradient.

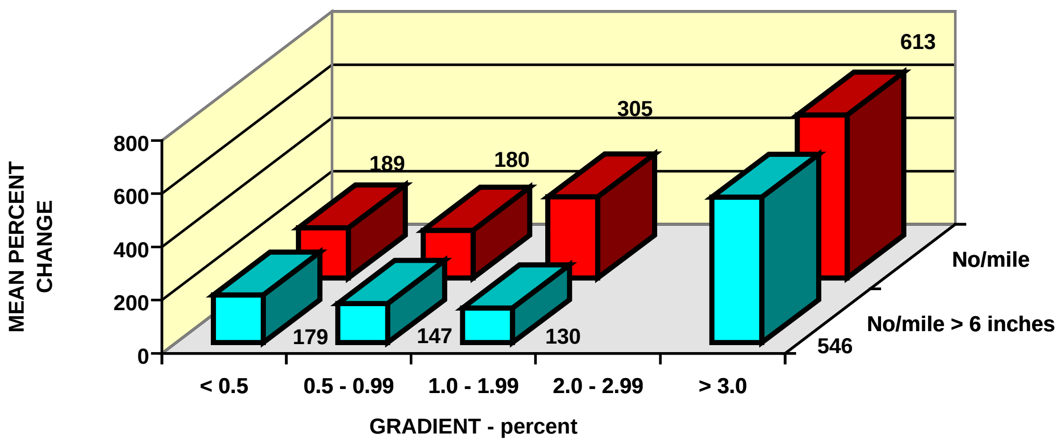

Figure 13. Mean abundance of wild trout at streams of different gradient after habitat improvement.

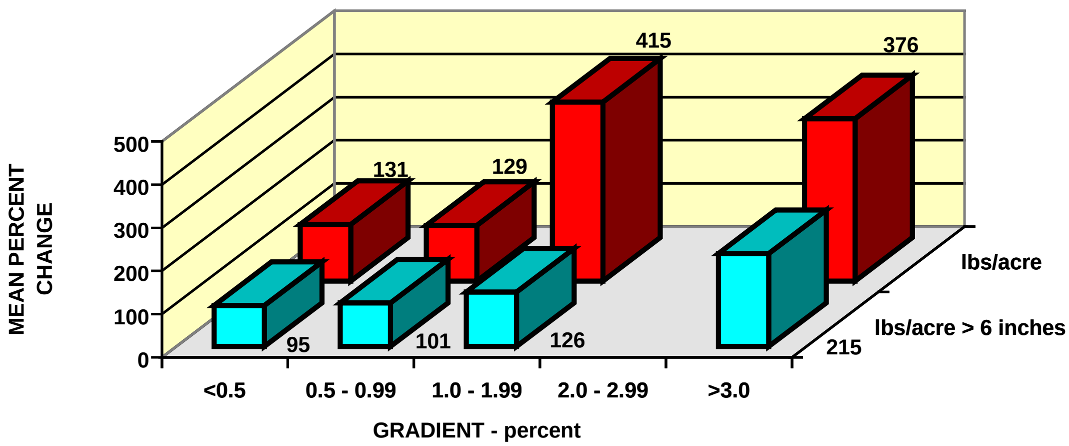

Figure 14. Mean biomass of wild trout at streams of different gradient after habitat improvement. No data is available for streams with gradients 2-3%.

WGF Stream Class

No habitat improvement projects were done on “Blue Ribbon” (WGF stream class 1) streams containing only wild trout. Most TZ (83%) were located on class 3 and 4 waters and the best response came at class 4 streams where trout abundance tripled posttreatment (Figure 15, Appendix 9). Trout biomass increased best at Class 3 streams (Figure 16). A typical Class 3 project was Rock Creek (control, 410 trout/mile; treated, 1,710 trout/mile) at the I-80 crossing near Arlington.

Class 3 streams contain fisheries of regional importance and are considered important trout waters, as opposed to Class 4 waters, which are considered low production fisheries of local importance. Trout production at Class 4 streams is likely kept to a low level by poor habitat features. When some of these limitations were removed by habitat improvement, as at Spotted Tail Creek (pretreatment, 33 trout/mile; posttreatment, 866 trout/mile), the trout population expanded positively and dramatically.

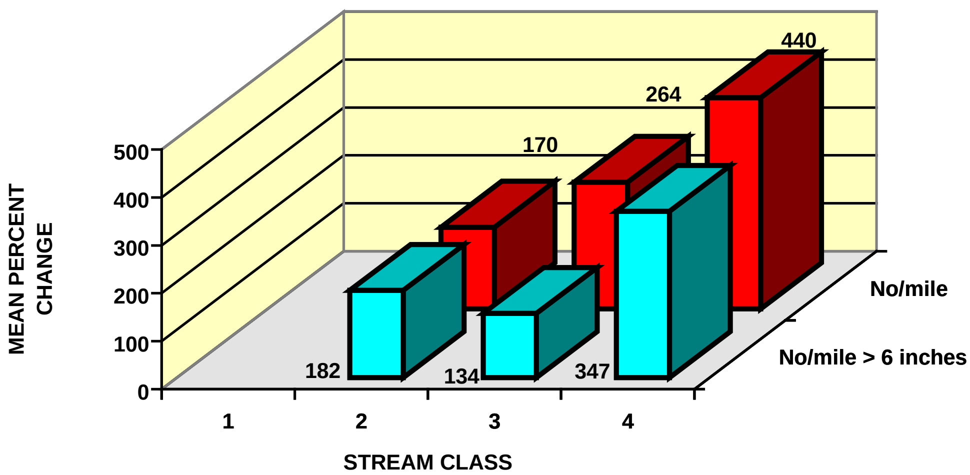

Figure 15. Mean posttreatment abundance of wild trout at streams of different WGF stream class. No projects were done on Class 1 streams.

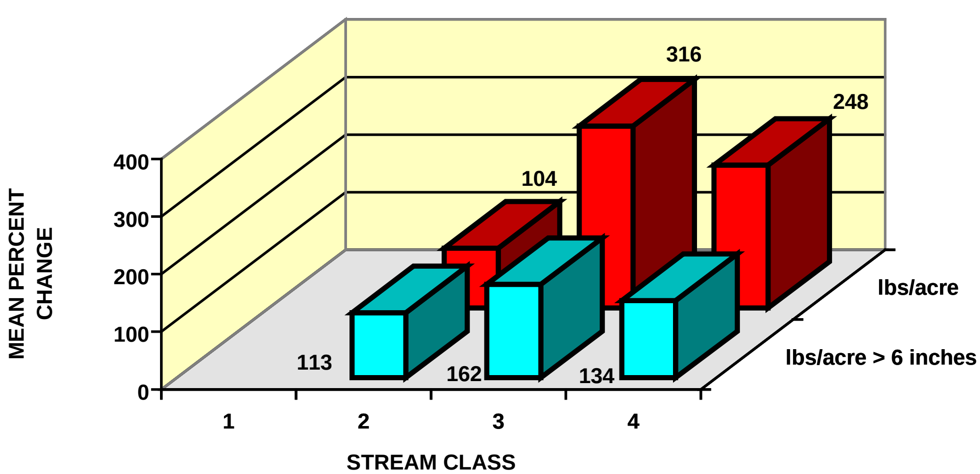

Figure 16. Mean posttreatment biomass of wild trout at streams of different WGF stream class. No projects were done on Class 1 streams.

Rosgen Stream Type

When the TZ were sorted by Rosgen stream type, best response of wild trout occurred at the A and B stream types (Figures 17 and 18, Appendix 10). Response at the C streams was not as good. A and B types have steeper gradients and rougher substrates, so treatment was pool development at 88% of the projects on these stream types, whereas at the C type streams, stabilization of eroding banks was the prescription at 66% of the TZ. The inference is that best trout response occurred at stream types where better pools were provided.

Fish response at Rock Creek on the upper Green River (pretreatment, 124 trout/mile; posttreatment, 596 trout/mile) is typical of a B type stream. Examples of B type outliers are Tosi Creek (pretreatment, 450 trout/mile; posttreatment, 461 trout/mile) and Tepee Creek within the exclosure (pretreatment, 111 trout/mile; posttreatment, 1,580 trout/mile). Rock Creek at Arlington (control, 10 lbs/acre; treated, 120 lbs/acre) is an example of unusual increase in biomass.

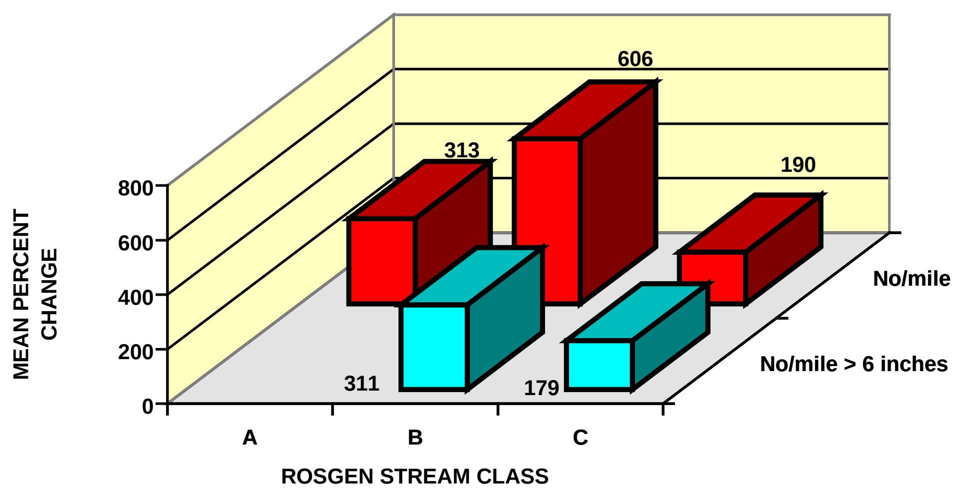

Figure 17. Mean posttreatment abundance of wild trout at streams with different Rosgen Classification. No data were available for catchable sized trout in stream type A.

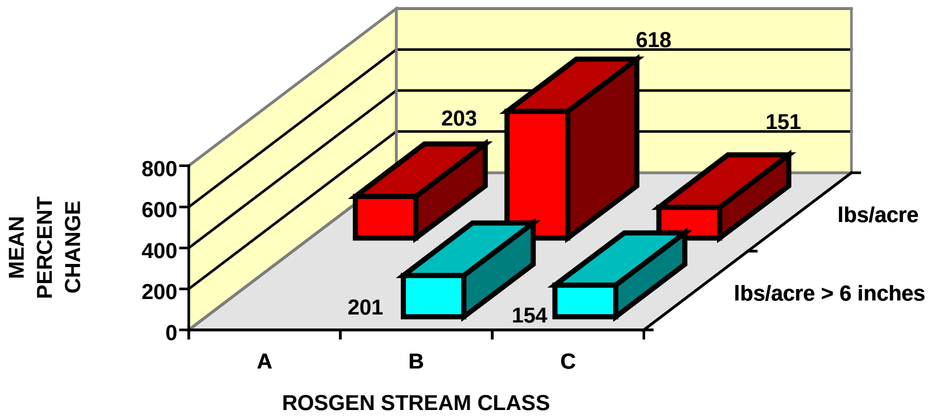

Figure 18. Mean posttreatment biomass of wild trout at streams with different Rosgen Classifications. No data were available for catchable size trout in stream type A.

Success Rates by Structure Type

A wide variety of structure types were used in the habitat improvement projects. Often several structure types were used in a single project, so delineation of fish response to a specific structure was difficult. However, the primary project goals at many TZ were either pool development or bank stabilization, meaning structure types can be grouped as either pool digger (plunge) or revetment structures.

As noted previously, best fish response appeared to be at Rosgen stream types where pool diggers were used. When empirical response of wild trout to plunges and revetments is compared, plunges had by far the best response (Figure 19). For trout populations that included trout of hatchery origin, response was again best at projects featuring plunges (Figure 20).

Fish response at Blacktail Creek (pretreatment, 277 trout/mile; posttreatment, 930 trout/mile) was typical of projects with plunges. A better than average performance was turned in at Beaver Creek (pretreatment, 117 trout/mile; posttreatment, 875 trout/mile), but at Beartrap Creek (pretreatment, 517 trout/mile; posttreatment, 400 trout/mile) fish abundance dropped 23%.

At projects emphasizing bank stabilization, Hog Park Creek (pretreatment, 804 trout/mile; posttreatment, 1,797 trout/mile) is typical. Departures from the norm include Bear River (pretre-

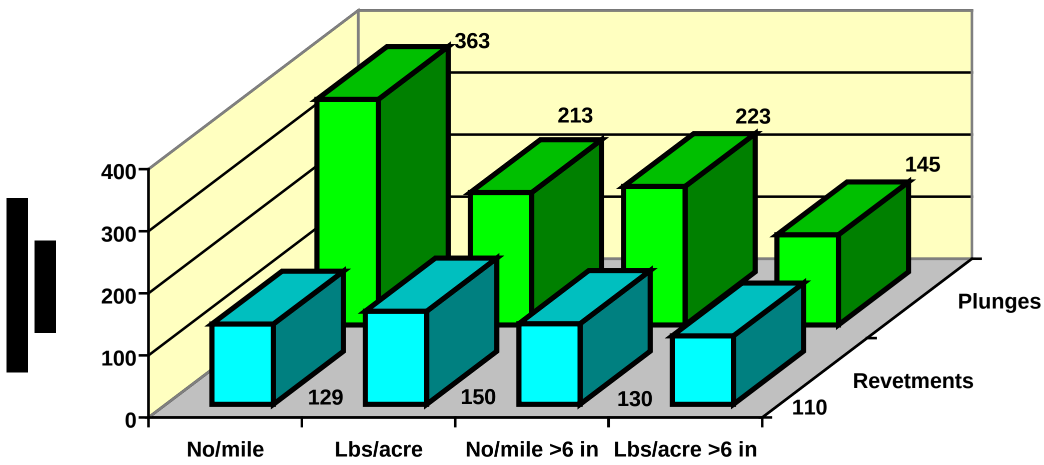

Figure 19. Posttreatment response of wild trout to plunge and bank revetment structures. Plunges include log, timber, and rock plunges, while bank stabilization devices include rock riprap, tree/rock revetments, and tree revetments. Population indices summarize all projects where these two structure types were the primary structure type affecting fish response.

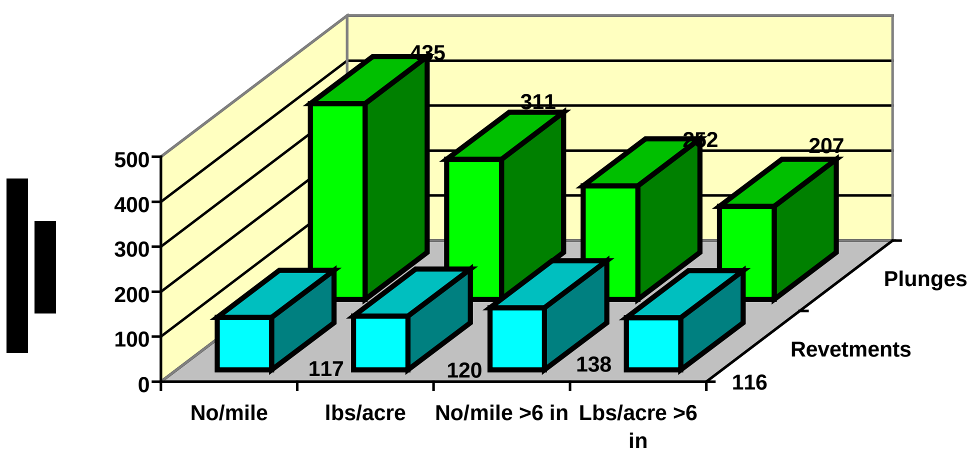

Figure 20. Posttreatment response to plunge and bank revetment structures in trout populations where both wild trout and trout of hatchery origin may be present. Plunges include log, timber, and rock plunges, while bank stabilization devices include rock riprap, tree/rock revetments, and tree revetments. Population indices summarize all projects where these two structure types were the primary structure type affecting fish response.

atment, 42 trout/mile; posttreatment, 12 trout/mile) and Flat Creek (pretreatment, 62 trout/mile; posttreatment, 388 trout/mile).

Other instream structures where fish response could be separated include tree jam and rock funnel combinations (upper Green River) and rock weirs (Big Sandy River, South Cottonwood Creek, and Sweetwater River). Deflectors were used at several projects, but since they were used in combination with other devices, fish response could not be tied to deflectors alone. Although rock weirs were built in several designs, this device benefited trout populations, as did tree jams (Figure 21).

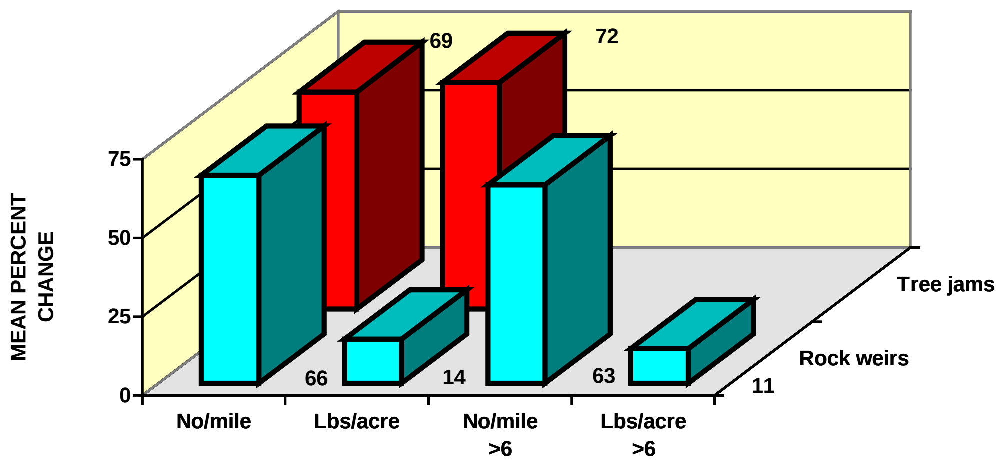

Figure 21. Posttreatment response to tree jams and rock weirs in trout populations where both wild trout and trout of hatchery origin may be present. Population indices summarize all projects where these two structure types were the primary structure type affecting fish response.

Changes in Habitat

Several projects were monitored posttreatment for changes in cover and HQI score. At 20 projects where HQI measurements were obtained, HQI score was better posttreatment at all projects and mean HU increased 59% (Figure 22). Cover increased three fold (Figure 23). A typical change in HQI Score occurred at Huff Creek (pretreatment, 30 HU; posttreatment, 48 HU), while little change was noted at Coal Creek (pretreatment, 10 HU; posttreatment, 11 HU). Large changes occurred at Hog Park Creek (pretreatment, 24 HU; posttreatment, 96 HU). Increase in cover at Big Willow Creek (pretreatment, 10%; posttreatment, 48%) was a typical response to habitat improvement. Cover changed little at Horse Creek (pretreatment, 9%; posttreatment, 12%) near Dubois, while a large response happened at Lick Creek (pretreatment, 1%; posttreatment, 16%).

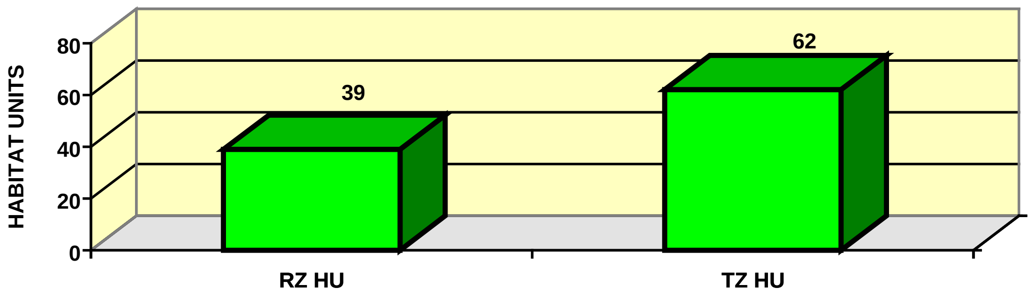

Figure 22. Mean HU for trout at 20 HQI stations located in reference (RZ) and treated zones (TZ) at habitat improvement projects.

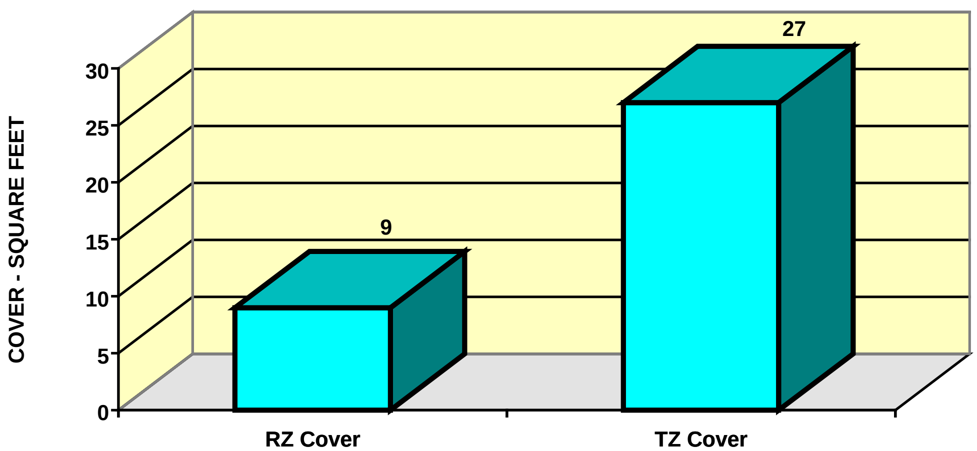

Figure 23. Mean cover for trout at 23 HQI stations located in reference (RZ) and treated zones (TZ) at habitat improvement projects.

Performance of Plunges

Analysis of RPD at rock, timber, and log plunges indicated that both timber and log plunges successfully produced good pools. Their mean RPD were greater than the focal points for both BKT (1.4 ft) and other trout (1.5 ft) (Figure 24). But rock plunges did not meet these criteria. Rock plunges often failed as pool diggers when scour during floods shifted the rocks, causing loss of structure integrity as rocks slipped down into plunge pools. At some sites, such as Salt Creek (Allred Flat), rock plunges ceased to exist after rocks slid into the plunge pool and were buried by sediment.

Plunge pools produced by log plunges had the most cover, followed by timber and rock plunges (Figure 25). Rubble and cobble moving downstream during flood events was sometimes trapped in plunge pools, which reduced pool depth and cover unless the rocks were removed during maintenance checks. This problem was especially acute in steep gradient streams like Rock Creek on the upper Green River. A second problem that sometimes reduced depth and cover was when anchor boulders slid down into the pool.

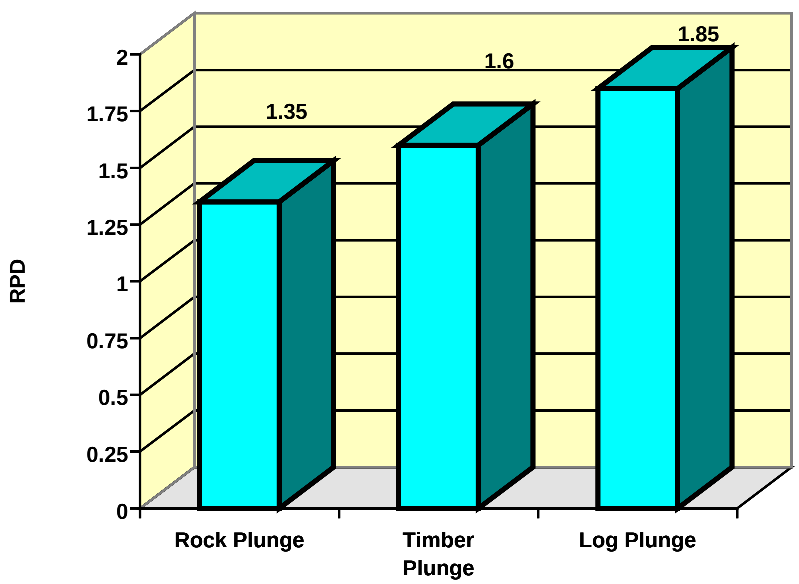

Figure 24. Mean posttreatment residual pool depth (RPD) in plunge pools at 79 rock plunges, 264 timber plunges, and 47 log plunges at habitat improvement projects in Wyoming.

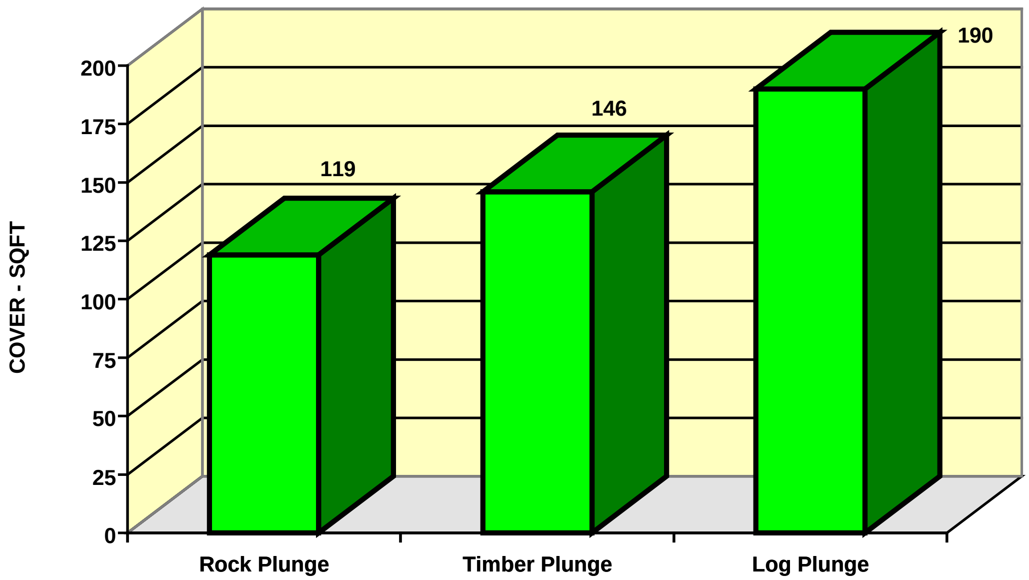

Figure 25. Mean amount of cover present posttreatment in plunge pools at 79 rock plunges, 264 timber plunges, and 47 log plunges at habitat improvement projects in Wyoming.

Performance of Deflectors

Deflectors were widely used statewide, but performance was not analyzed at most projects. An exception was at Beaver Creek in the Bear Lodge Mountains where deflectors installed in the mid 1970s were evaluated in 1991 (Binns 1994). Deflectors in Beaver Creek directed stream currents better than they dug pools. The stream channel was narrower at 65% of the deflector sites by 1991, but RPD was 1.4 ft, or greater, at only 11% of the sites and was not significantly deeper than in natural pools. By 1991, 96% of the deflectors were intact and 91% were functional. Grass sod placed over the rock fill after construction was often washed away by floods, as were fill rocks smaller than 18 inches.

Small Streams versus Large Streams

One goal of this compendium was to validate the following general statement. "*Small streams respond best to habitat improvement: their habitat recovers better, they show greater fishery benefits, and are far less costly to work on*". Material in the compendium database can be used to judge this statement.

Habitat Response

For streams where HQI evaluations were done, posttreatment cover in first order streams was more than twice that reported for streams of order 2, or greater (Figure 26). Habitat units changed most in third order streams, but no HU data were available for larger waters (Figure 27).

Fish Response

Posttreatment abundance of wild trout was best at second order streams, and least at third order waters (Figure 9). Change in catchable wild trout abundance was lowest at first and fourth order waters. Trout biomass changed most at third and fourth order streams (Figure 10).

Project Cost

On the average, habitat improvement projects on first order streams cost about 21% less than second order waters, and 39% less than at third order streams (Figure 28). Third and fourth order streams cost about the same, but projects on waters of order 5, or greater, cost over three times more than first order streams. Project costs ranged from $4,759/mile (Tosi Creek) to $303,570/mile (Salt River) and averaged $39,016/mile (1995 dollars, Table 4).

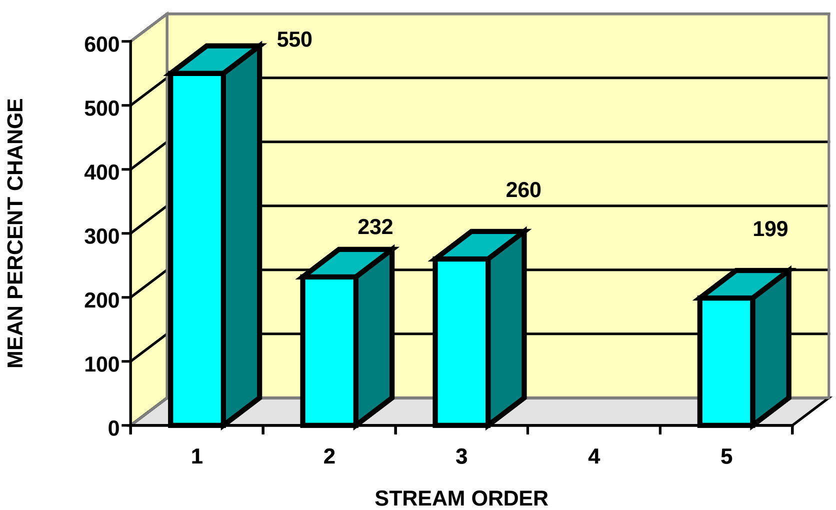

Figure 26. Posttreatment cover for trout in streams of different orders. Cover was measured at HQI stations located in RZ and TZ at habitat improvement projects and values shown are mean percent change between RZ and TZ over all observations.

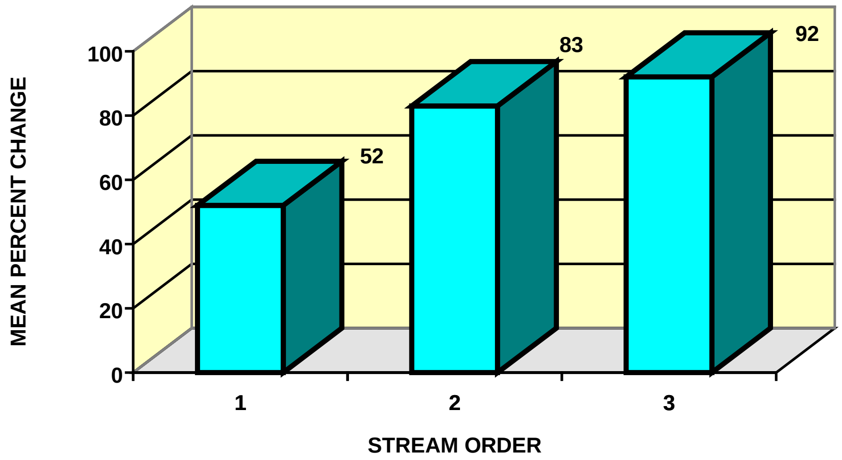

Figure 27. Change in HU at streams of different order following habitat improvement. HU was measured at HQI stations located in RZ and TZ at habitat improvement projects and values shown are mean percent change between RZ and TZ over all observations.

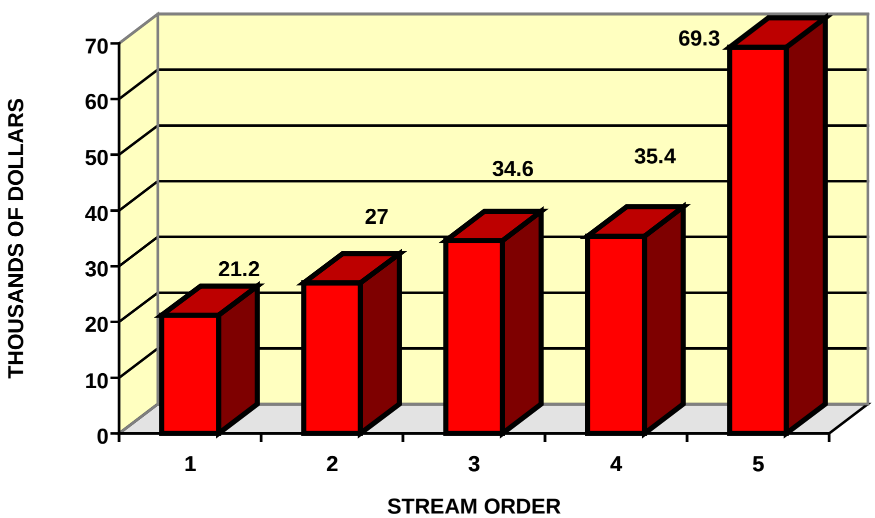

Figure 28. Cost of trout habitat improvement for 52 projects at Wyoming streams of different orders. Project cost was adjusted for inflation to 1995 US dollars.

Table 4. Cost per mile of WGF fish habitat improvement projects, 1953-1997, adjusted to 1995 US dollars.

Name	Cost	Name	Cost
Bear Creek	17,452	Little Bighorn River	38,665
Bear River State Park	101,225	Little Popo Agie River	45,054
Beartrap Creek	27,891	Little Popo Agie River93	36,053
Beaver Creek	40,218	Middle Fork Popo Agie River	15,530
Big Sandy River	7,250	Muddy Creek - Grizzly Unit	11,180
Big Willow Creek	23,398	N. Platte River - Douglas	23,570
Blacktail Creek	31,416	N. Platte River - Miracle Mile	83,065
Bull Creek, lower	34,845	N.Platte River - Pick Bridge	70,960
Clarks Fork River	15,930	Nameless Creek	8,245
Coal Creek	14,021	North Fork Popo Agie River	11,070
Currant Creek	19,886	North Tongue River	11,321
Dead Indian Creek	5,520	Pass Creek	18,050
Deer Creek	33,462	Pinegrove Creek	7,710
Flat Creek	40,655	Rock Creek (upper Green River)	45,959
Green River - 40 Rod	21,531	Salt Creek - Allred Flat	66,057
Green River - Forest	42,532	Salt Creek - state land	42,675
Gros Ventre River	38,668	Salt River	303,570
Hall (Fry) Creek	35,577	South Cottonwood Creek	60,794
Hams Fork River	75,824	South Cottonwood Creek 2	62,708
Hell Canyon Creek	13,675	South Tongue River - Pine Island	47,651
Hog Park Creek	26,154	South Tongue River - Prune	56,830
Horse Creek	26,622	South Tongue River - Shutts Flat	53,417
Huff Creek	29,893	Spotted Tail Creek	19,630
LaBonte Creek	15,475	Tepee Creek	10,350
Laramie River - Monolith	86,668	Tosi Creek	4,759
Laramie River - Jelm	34,371	Wind River	23,200
Lick Creek	29,613		

Revised Postulation

With the above evidence in hand, the general statement that small streams respond best to habitat improvement is revised. To wit, *"Based on average, statewide results, habitat improvement projects on small, first order streams are least expensive, but wild trout response is best at middle order (2 and 3) streams. Statewide, abundance increased most at second order streams, while biomass gain was best at second and third order waters. Best posttreatment gain in cover for trout can be expected at first order streams, while best improvement in HQI score should be at third order waters."*

DISCUSSION

Evaluation of habitat improvement projects done in Wyoming during 1953-98 indicated such work does help trout. Statewide empirical data indicate trout populations responded to habitat improvement by doubling in abundance and biomass. Arbitrary success at level 1 occurred at 81% of the 85 wild trout abundance and biomass indices. The rate of success was 50%, or more, (level 2) for 74% of the indices. For arbitrary success rates in Wisconsin, Hunt (1988) noted a 53% posttreatment gain for total trout, 59% for trout 6 inches, or greater, and 59% for total biomass. Empirical success rates in Wisconsin were 21% for total trout, 35% for trout 6 inches, or greater, and 49% for trout biomass (Hunt 1988).

Mean empirical abundance and biomass of trout at Wyoming projects compared favorably with results in other states (Table 5). Hogle (1993) concluded the stream habitat and trout populations had been successfully enhanced by WGF habitat improvement projects. In Colorado, Riley (1992) reported statistically significant increases in posttreatment abundance of age 1, or older, trout.

Table 5. Mean percent change in abundance and biomass of trout following habitat improvement at streams in several states. N is the number of projects.

State	N	Percent Change		Source
		Abundance	Biomass	
Wyoming	30	117	102	
Utah	1	570		Duff (1978)
Minnesota	2	539	187	Thorn (1988)
Montana	3	83	71	Lere (1982)
Wisconsin	41	21	49	Hunt (1988)
Wisconsin	3	27	80	Hunt (1992)

Posttreatment cover for trout increased three fold at 20 Wyoming streams. In Colorado, Stuber (1986) reported a 153% increase in cover after habitat improvement, while Riley (1992) documented a 129% increase. In 20 Wyoming streams, mean trout HU increased 59% posttreatment, while Stuber (1986) reported 97% more HU at five Colorado streams.

Various fishery workers have speculated that smaller streams should be less costly to work on and should yield better results. Logic suggests that construction, material, and other problems would be greater on large rivers, as opposed to small creeks. Statewide results from this compendium indicate that small streams, as represented by first order waters, are less expensive on the average, and costs rise sharply once stream order becomes greater than fourth. Although there was good response at first order streams, best wild trout response for both catchable and total trout categories occurred on second and third order streams. Posttreatment, shelter for trout improved best on first order waters, but third order streams developed more HU.

As an illustration of the problems faced on big rivers, placement of two tree jams in the North Platte River (135 ft wetted width in late summer) at the Pick Bridge PFA cost about $70,000/mile (1995 dollars) and took 366 man hours to complete after boulders were hauled to the site. Yet these structures represented a minute addition to overall fish cover, even though both jams were large. Trout were found living in the jams, but contribution to the overall river trout population was also minute. Contrast this result with the $19,630/mile cost at tiny (5 ft wide) Spotted Tail Creek, where 45 plunges were installed with 312 man-hours of labor, and the fish population increased many fold posttreatment.

HABITAT MANAGEMENT IMPLICATIONS

Statewide, both revetments and plunges produced substantial increases in trout numbers, but plunges produced 129% more trout/mile than revetments. Disparity between the other trout population indices also favored plunges. Data in this compendium, and in Hogle (1993), document the development and persistence of deep pools at WGF plunges. Hogle (1993) concluded that trout biomass was greater in man-made plunge pools than in stream sections lacking such habitat, but he did not examine streams with revetments. Although revetments produce a multitude of niches where trout can live, evidently the deep pool habitat produced by plunges is more valuable to trout, possibly because of an increased sense of security. Deep pools are often an important component of winter habitat for trout (Brown and Mackay 1995).

Both log and timber plunges developed persistent pools with RPD 1.5 ft, or greater, but log plunges proved slightly more efficient at creating deeper pools. However, timber plunges were easier to install because timbers are evenly shaped and a structure could be pre-fabricated before being placed in the stream. More effort was required to align often irregularly shaped logs into log plunge. Rock plunges consistently failed to generate deep plunge pools. Indeed, these structures often proved unstable due to currents undercutting rocks, which then slid out of position. Hogle (1993) reported timber plunges contained greater trout biomass than rock plunges.

Structure durability and performance varied widely between projects and are detailed in the case histories. Generally, structures fared best when initially installed solidly by machines and an experienced construction crew. Structures installed by hand fared less well. Hamilton (1989) reported only 14% of hand built cobble and boulder deflectors remained functionally intact one year after installation. Orsborn and Anderson (1986) listed hand labor and inexperienced workers as two factors that can doom a project.

Skimping on materials also caused problems in long-term performance and durability. This was especially true with boulder weirs, e.g., the Big Sandy River. However, the many devices installed statewide have held up surprising well over years of floods, some of which were in the 100-year category. A detailed examination of the Beaver Creek project found over 90% of the structures fully functional 18 years posttreatment (Binns 1994). In 1995, 54% of the devices remained functional despite a low frequency flood that caused many changes in the stream channel.

In California, Ehlers (1956) examined 41 CCC log dams and deflectors 18 years after installation. Only 15 pools remained of the 67 expected to develop at these structures. All rock plunges were gone. Of the nine log dams, only one remained fully functional, several were washed out or had been bypassed by the stream, and one had undercut to become a digger log. Hunt (1992) reported 63% of 72 test structures provided good or excellent trout habitat 4 years after installation. Durability and functional performance of structures were better in two smaller creeks than in a larger one.

Trees and rocks used together gave the best fish and habitat response, whether for bank stabilization, or for instream structures. Rock riprap alone often provided perfectly good bank stability, but addition of trees added an element of structure stability and additional shelter for trout that was lacking in the riprap alone. Trees used alone often suffered from continued bank scour behind the trees due to eddies or high flows being deflected into the bank.

Boulders added to streams as “fish rocks” gave variable performance. In streams with a finer substrate, scour around the rock sometimes allowed the rock to be buried after it toppled into the hole. Moreover, sediment plumes developed downstream from rocks in creeks with considerable sediment transport. Such plumes effectively canceled the pocket pool below the rock. However, boulders added to coarse substrates often provided niches of shelter around the rocks that were beneficial to trout. Single boulders added to midstream in small creeks gave variable results, e.g. Little Bighorn River. Some rocks deflected stream flow and caused bank erosion, while others created pockets of shelter around their bases usable by trout.

Boulder groupings were used at several projects, but performance was not well evaluated. Bradshaw (1992) reported a PHABSIM analysis showed boulder structures at the upper Green River and Hog Park Creek created additional habitat for juvenile trout around the rocks. A detailed analysis of boulder groupings in the Keogh River, British Columbia found three times the total salmonid standing crop after habitat improvement with boulders (Ward and Slaney 1981), and the increase in steelhead parr was proportional to the number of boulders used. They learned also that a triangular configuration with 5-7 boulders worked best.

A boulder cluster added to the Clarks Fork River, Wyoming, decreased water velocity four fold in the pocket pools below the boulders, but depth increased only 20%. Poor pool development was also noted below some rock funnels and was blamed on the presence of a well-armored stream bottom. Mechanical excavation of pools by a tracked backhoe proved to be the best solution for that problem.

HABITAT MANAGEMENT RECOMMENDATIONS

Most of the projects described in the case histories relied on instream structures to accomplish their goals. For the most part, these structures proved durable, raised trout stocks, and increased fishing opportunity. However, in recent years, trout stream habitat management has moved to a higher level with more emphasis on watershed-wide prescriptions (Williams, et al. 1997), while realizing at the same time that instream structures can provide quick help for fish habitat while watershed restoration is underway (House 1996). When a prescription calls for instream structures, devices and techniques that blend in and appear natural are preferred.

With those thoughts in mind, 45 years of habitat management in Wyoming have taught habitat managers some lessons. Recommendations for successful trout stream habitat management include the following. First, habitat managers must realize each stream is different and the prescription for treatment of fish habitat flaws will vary according to local conditions. There is no magic bullet; there is no standard structure type that will work in all situations.

Second, planning for a successful project must consider site specific and watershed factors that affect fish habitat in a stream, and the fishery therein. These factors range from human activity to basic geology and climatic features. All must be considered before deciding on a habitat improvement or restoration plan. Although most Wyoming projects described in the case histories were site specific, and some only covered a short section of stream, pre-project planning included an assessment of watershed factors and features that might affect project success.

And third, a habitat manager must be willing to say no! Projects listed in this compendium are those that were done - no record was kept for those that were rejected. When should a habitat manager say no? A partial listing of factors that should generate a negative reaction would include: 1) when the project doesn't address watershed abuse problems, e.g., continued heavy grazing by livestock will likely mean installation of instream structures will be little more than a gesture; 2) when there are land ownership problems - access by the fishing public is a requisite for habitat work by a public agency like WGF; 3) when there is no machinery access to the project; 4) when needed materials are lacking or in short shortage supply; 5) when materials are overly expensive; 6) when a stream's sediment load is high; and 6) when the project is too small to significantly affect the fishery, and consequently fishing opportunity, in the water under consideration. That is, on a small headwater creek, a few thousand feet of habitat improvement may greatly enhance the fishery, but on a larger stream, the treatment may require several miles to achieve the same purpose

Beaver activity should also be examined during project planning. Extensive beaver activity should raise a red flag; first, because instream structures may not be needed, and second, plunges and other devices make great foundations for beaver dams. And when these dams wash out, quite often a new channel is formed, which may not agree with project objectives.

Other lessons from the Wyoming program include building low profile structures that do not unduly oppose high stream flows and scheduling periodic maintenance of devices, especially during the first few years after installation. Simple acts like adding a sandbag to plug a small leak, cleaning rocks out of a plunge pool, and replacing a damaged cable can add years to the life of a structure

So, when instream structures are the prescription, what devices are best? Size of stream is key to the answer. For first and second order streams, pool diggers, such as timber plunges or small diagonal rock weirs are recommended. Third and fourth order streams are more powerful and require a sturdy structure, such as a rock vortex weir or a diagonal rock weir. All of these structures will dig pools and act as grade controls to raise the water table locally, thus subirrigating adjacent riparian vegetation. Rock weirs, tree jams, and "jetties and piles" (see the lower Green River case history) are recommended for large rivers. For bank stabilization, tree and rock revetments are preferred over rock riprap or tree revetments for all streams.

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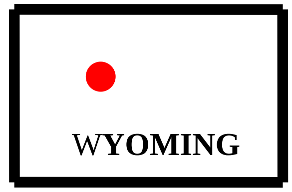
1. BEAR CREEK



FREMONT COUNTY

PROJECT BUILT: 1991 - 1992

Drainage:	East Fork Wind River	**East Fork Basin (6EF)**	
Elevation:	7,300 ft	**R.** 105 **W., T.** 43 **N., S.** 5, 6, 8, 31	
Stream Order:	Third	**Stream Class:** 3 (regionally important)	
Watershed Area:	65 sqmi	**Mean Wetted Width:** 26 ft	
Gradient:	1.4 %	**Land Status:** WGF Inberg/Roy WHMA	
Rosgen Channel Type:	C-4	**Project Length:** 2.25 miles	
Treatment Used:	Tree/rock revetments, boulder "S" dams, log plunge, rock vortex weir, boulder weir, random boulder placements		
Trout Species:	Cutthroat and brown trout		

DESCRIPTION OF STREAM: The Bear Creek watershed drains part of the Absaroka Range, a unique mountain range formed when volcanic derived material was layered thickly over existing sedimentary formations. Subsequent geologic activity formed the Absaroka volcanic rocks. Consequently, many easily eroded volcanic, glacial, and sedimentary formations are present in the drainage and strongly influence stream productivity. Bear Creek moves considerable sediment annually during spates caused by the snowmelt runoff and during summer thunderstorms. Sediment size ranges from silt to cobble. Transportation and deposition of this sediment affects fish habitat and the fishery in the project area, which is located in the broad valley below Bear Creek Canyon. Changes in channel features may occur with each spate.

Precipitation ranges from about 50 inches/year in the highlands to 10 inches/year in the lower watershed, and much of this comes as snow. However, after the snow melts, flows may become critically low and adversely affect aquatic organisms in Bear Creek. Stream bottoms in the project area have a well developed riparian community containing a variety of shrubs, trees, forbs, and grasses. With some exceptions, the riparian vegetation aids the stability of the Bear Creek channel.

PROJECT DESCRIPTION: Located about 12 miles northeast of Dubois, this project is located on WGF land that provides winter range for big game animals. The project addressed two goals: 1) provide more deep water and woody debris shelter for trout, and 2) control severe stream bank erosion where Bear Creek runs into bluffs on the west side of the valley. An objective of the erosion control was to reduce sediment entering the stream on WGF land. Stream channel stability would benefit both from the bank stabilization and from the boulder weirs, which would act both as grade controls and pool diggers. Another objective was to improve subirrigation of riparian vegetation by using these low profile weirs to elevate the water table.

THE FISHERY: Bear Creek supports a species depauperate fishery where cutthroat trout are the principal species. A few whitefish, longnose dace, mountain suckers, and brown trout may occur in the project area. No hatchery reared trout have been planted in Bear Creek since 1970 and the fishery contains wild fish, most likely derived from past plants of Yellowstone or Snake River cutthroat trout, but now adapted to conditions in the drainage. Trout abundance varies widely year-to-year in response to the highly variable habitat conditions, but best stock levels occur during years with minimal floods. Bear Creek has been identified as an important CUT nursery stream in the East Fork drainage.

With purchase of the Spence-Moriarity Habitat Management Unit in 1992, special regulations were instigated to protect cutthroat trout. In the project area, daily limit for CUT was two fish per day, CUT between 10 and 15 inches were to be released, only one trout could exceed 15 inches, and fishing was with artificial flies and lures only.

HABITAT MANAGEMENT: A 1983 HQI evaluation identified shelter for trout as a habitat shortfall. In 1990, a walk-through of the proposed project located several sites where severe erosion of steep bluffs was contributing large amounts of sediment to the stream. Stream channel stability in 1990 was noticeably poorer than in 1983, mainly due to the creek cutting through oxbows. During 1991-1992, a WGF construction crew installed 920 ft of tree and rock revetment, and several low profile pool digging structures, which included: four boulder "S" dams (Figure 1-1), a log plunge (Figure 1-2), a rock vortex weir, a rock weir, and several fish rocks. These structures were dispersed in the stream between the upper and lower campgrounds. Rocks used for riprap were hauled by WGF from a talus slope near Windy Gap, while the granite boulders and conifer trees came from the WGF Inberg/Roy unit. Project cost was $40,700 ($16,280/mile), much of which was labor and equipment costs associated with the arduous rock haul.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - No formal evaluation of fishery response was done, but anglers have reported catching trout at the structures.

Trout Habitat Response - Habitat changes were not evaluated, but steep, formerly eroding bluffs were visibly more stable when examined in 1998 (Figure 1-3). In contrast, an unprotected bluff downstream from the project continued washing away. The treated bluffs have begun to slope themselves and a good growth of willows, shrubs, and grasses has developed. Stabilization has also eliminated the large sediment plumes (bars) that formerly occurred just downstream from each bluff. The channel appeared to be more stable than pretreatment and its pool and riffle sequence was well developed. Although scour and pocket pools had developed near the rocks, development of large pools at the "S" dams was generally poor. Only one "S" dam pool had an RPD over 1.5 ft. Vortex weir RPD was 1.85 ft.

Habitat Structures - No formal evaluation was made, but structure performance and durability was visually assessed. When first built, the boulder dams and weirs protruded prominently from the channel bottom and remained that way during several low intensity spring floods. However, higher flows during 1996-1998 caused considerable scour and deposition around the boulders, and by October, 1998, many of the boulders had become embedded in the stream bottom. At that time, three of the "S" dams still retained their shape and function despite the settling action, but the fourth dam was functioning as a double deflector since its center rocks had been buried. The vortex weir was still functional, but some boulders had settled and moved out of line.

Aggradation of the creek channel upstream from the rock structures was very noticeable. Continued deposition of sediment upstream, and settling of the rocks, may eventually overwhelm and bury the structures, which is what happened at the rock weir. At the vortex weir, a massive point bar has developed just upstream and is deflecting flow to the opposite bank, where bank erosion may eventually allow the stream to bypass the structure.

An important lesson from the Bear Creek project is that a single line of rocks is insufficient to maintain "S" dam or rock weir integrity over the long term. Especially in streams with a high sediment load, as at Bear Creek. Rock vortex weirs with 3-4 lines of boulders may offer better performance and durability as pool diggers. In short, use lots of rocks!

Conclusions - Although not formally evaluated, bank stability, channel configuration, and fish abundance appear to have benefited from the habitat improvement project.

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Figure 1-1. A boulder S-dam installed in Bear Creek slows swift spring flows and provides shelter for trout.

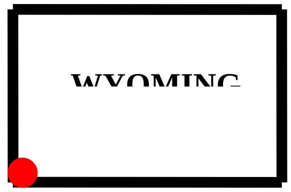
Figure 1-2. A log plunge located near the mouth of Bear Creek Canyon provides deep pool shelter for trout and helps dissipate energy during high flow events.

Figure 1-3. Six years after tree and rock revetment installation, severe bank erosion is controlled and the bank is stable. There is good growth and development of plants.

BEAR RIVER

UINTA COUNTY

PROJECT BUILT: 1990-1992



Drainage:	Bear River	**Bear River Basin (3BE)**	
Elevation:	6,790 ft	**R.** 120 **W., T.** 15 **N., S.** 22	
Stream Order:	Fifth, or greater	**Stream Class:** 3 (regionally important)	
Watershed Area:	430 sqmi	**Mean Wetted Width:** 45 ft	
Gradient:	0.5%	**Land Status:** Bear River State Park	
Rosgen Channel Type:	C-3	**Project Length:** 7,000 ft	
Treatment Used:	Tree/rock revetments, rock barbs, rock deflectors, and fish rocks		
Trout Species:	Rainbow, Bear River cutthroat, and brown trout		

DESCRIPTION OF STREAM: Heading in the Uinta Mountains of Utah, the Bear River collects water from many mountain lakes and streams before exiting the mountains and flowing northerly to Evanston. An abundant snowpack and springs feed the river, but summer flows at the project area are affected by diversions for irrigation and domestic use, and late summer flows can become very low. Various sections of the stream have been affected by channelization and the channel at the state park is influenced by the I-80 bridge, located at the lower end of the park. Cottonwood trees and willow shrubs are prominent features of the riparian vegetation at the project site.

PROJECT DESCRIPTION: This project was a cooperative venture between the Wyoming Recreation Commission (WRC) and WGF. Object was to improve bank stability and develop trout habitat in the state park as part of the larger Evanston Green Belt project. WRC provided funding to haul rocks and trees, while WGF built the instream structures.

THE FISHERY: With the advent of the state park next to I-80, this section of river became a high profile, high use recreational area, with attendant fishing pressure. Catchable RBT plants supported the fishery prior to the project, but afterwards, a fishery objective was to emphasize the native BRC fishery and no hatchery reared trout were stocked post-treatment.

HABITAT MANAGEMENT: Historically, considerable channel alteration has occurred in the river upstream from the state park and this activity has degraded river channel stability at the park. Also, an outcrop of bedrock at the I-80 bridge, and the bridge itself, act as a grade control, causing sediment deposition and channel braiding upstream through the park. Pretreatment, many stream banks were eroding and much of the river was wide and shallow, offering little shelter for trout (Figure 2-1). Experimental bank stabilization was done in the 1980s on one long eroding bank by a University of Wyoming crew using hay bales. But this effort was a dismal failure as the river soon tore apart the hay bales and bank erosion continued. During the current project, a WGF construction crew installed tree/rock revetments on 3,835 ft of eroding bank

(Figure 2-2), built 7 rock barbs and 2 rock deflectors to protect another 1,500 ft of bank, and installed 75 fish rocks. Total project cost was $121,590 ($91,714/mile); rock hauling accounted for 57% of the project cost.

Figure 2-1. An eroding stream bank along the Bear River at the Bear River State Park before bank stabilization.

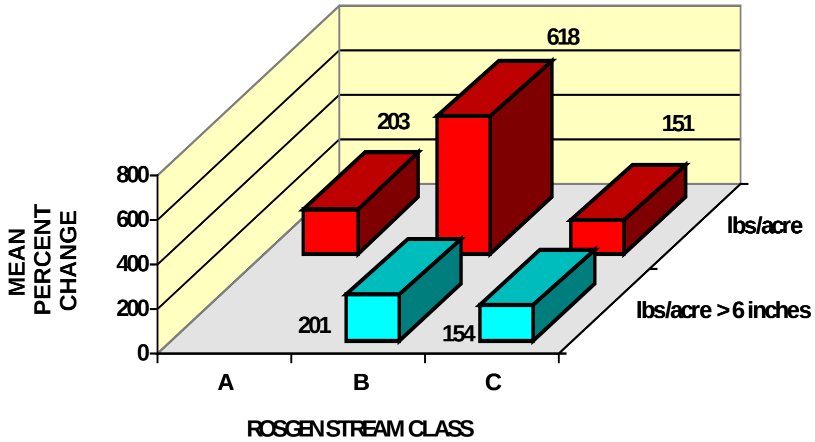


Figure 2-2. An upstream view of the eroding bank shown in Figure 2-1 after it protection with a tree and rock revetment.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Excluding stocked RBT that were present in 1990, trout abundance had decreased 71% by 1993 (Figure 2-3). RBT, BNT, and BRC were present in the 1990 sample, but only BRC were collected in 1993. Decreased trout numbers are presumably due to increased angling pressure and cessation of stocking.

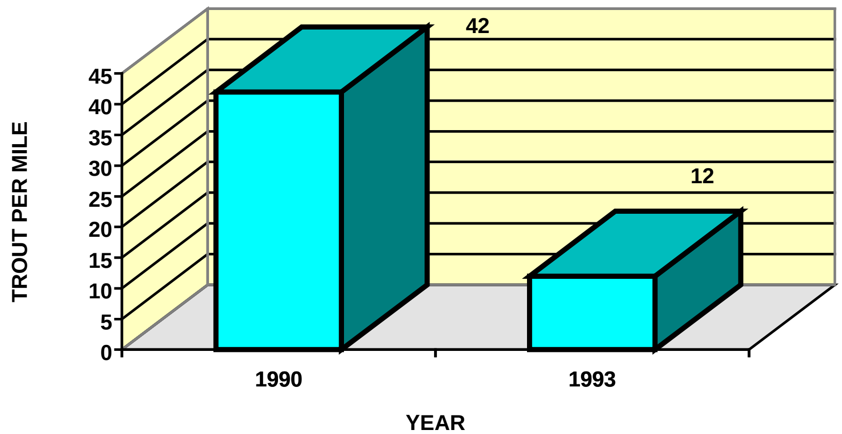


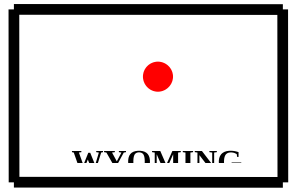
Figure 2-3. Abundance of wild trout before (1990) and after (1993) instream habitat improvement devices were added to the Bear River at the state park.

Trout Habitat Response - No formal evaluation of fish habitat was done, but visual observation indicates that good, deep pools with LWD have developed. A narrower, deeper, more stable channel has resulted from addition of the instream structures. Formerly bare point bars have re-vegetated with willows, grass, and cottonwood trees. Trout habitat gains aside, the project produced a more visually pleasing section of river for visitors.

Habitat Structures - No formal evaluation of structures was done, but a visual inspection in October 1997 found only a few minor problems. There were a few pockets of scour erosion and loose deadmen tie-downs, but most structures have proved to be durable and are still functioning. State Park personnel have maintained the bank stabilization work by adding rock riprap, especially at a key bank located at the upper end of the park.

Conclusions - Despite a decrease in wild BRC abundance, the habitat improvement project was beneficial to trout as it increased bank stability and provided more shelter for trout.

BEARTRAP CREEK



Johnson County

PROJECT BUILT: Phase I - 1966
Phase II - 1989

Drainage:	Red Fork Powder River	**Middle Fork Powder River Basin (8MP)**	
Elevation:	7,590 ft	**R.** 85 **W., T.** 46 **N., S.**35**,** SE 1/4	
Stream Order:	Second	**Stream Class:** 3 (regionally important fishery)	
Watershed Area:	10 sqmi	**Mean Wetted Width:** 5 ft	
Gradient:	1.9%	**Land Status:** BLM stock driveway	
Rosgen Channel Type:	E-3	**Project Length:** 3,000 ft	
Treatment Used:	Timber plunge, rock plunge, cover trees, rock riprap		
Trout Species:	Brook and rainbow trout		

DESCRIPTION OF STREAM: Several springs provide a steady source of water for Beartrap Creek, which extends about four miles upstream from the project site at Beartrap Meadows. The watershed features a treeless, high mountain meadow in the valley bottoms, sagebrush covered uplands, and conifer patches on the hills. Basic geologic formations in the basin are limestone, siltstone, and shale. A stock driveway passes through the BLM land at Beartrap Meadows and Beartrap Creek immediately upstream from there is on private land. Much of the basin is privately owned, but public access to Beartrap Creek is possible at the meadow and at one mile of state land immediately downstream from the BLM land. The stock driveway has had a strong influence on Beartrap Meadows, which historically has been heavily grazed, especially by sheep. Stream flow rises during the spring snowmelt runoff, but discharge is relatively stable through the summer and fall due to flow from the springs. Beartrap Creek is highly mineralized due to spring flow from the limestone formations and the stream bottom is calcified. An abundant aquatic macroinvertebrate community and a comparatively high (0.51 mg/l) nitrate nitrogen concentration indicate the creek has high productivity.

PROJECT DESCRIPTION: *Phase I:* In 1965, the state land below Beartrap Meadows was opened to public fishing access. So WGF inventoried the fishery and fish habitat at the meadows and on state land. This survey identified a shortfall of cover for trout and recommended a fish habitat improvement project. In 1966, WGF personnel added rock check dams to increase trout cover on the BLM land.

Phase II: This project was a cooperative venture between WGF and BLM in 1989. WGF furnished machinery, manpower, and expertise to plan and install the habitat improvement structures, while BLM furnished rocks, trees, and other materials. These devices were built from the upper boundary of the BLM land downstream to the washed-out culvert at the abandoned cut-off road to Sawmill Creek. After the coop project, BLM personnel installed a few additional devices downstream from the culvert. Efforts were also made by BLM to encourage livestock herders to move their animals through and not linger at the meadows.

THE FISHERY: Off-forest stream fisheries open to the public are scarce in the southern Bighorn Mountains due to extensive private land holdings. Thus, Beartrap Meadows has always been important to anglers desiring stream fishing. Easy access to the stream is provided by the Hazelton and Mayoworth roads. Angler access to the stream on state land requires more walking than does the meadow, where the road parallels the stream and the terrain is less canyon-like. In 1965, a fishery survey found a trout population containing both RBT and BKT, but also reported natural reproduction was limited. Annual stocking of sub-catchable RBT was recommended and some 2,000 to 3,000 fish were stocked annually for several years. Then plants were cut to 1,000 spring RBT per year when monitoring indicated poor growth rates. In 1985, evidence indicated natural reproduction was better than originally believed and all stocking was stopped to see if natural recruitment could support the fishery. By 1989, Beartrap Creek at the meadow was essentially a wild RBT and BKT fishery. Standard statewide fishing regulations were in effect at Beartrap Creek during this project.

HABITAT MANAGEMENT: Lack of deep pool shelter for trout was noted in the 1965 survey, which reported undercut banks were the primary cover type. Riffles dominated the stream and deep, naturally formed pools were uncommon in the meadow section (Figure 3-1). A first attempt to improve fish habitat in Beartrap Creek was made in 1966 by the WGF fish management crew stationed at Buffalo. Some 37 rock check dams were built by placing rocks as large as could be handled manually to form pools 12 to 18 inches deep. The dams were close enough together to give the stream a stair-step appearance, but were spaced so there was a riffle at the head of each pool.

Figure 3-1. Beartrap Creek before habitat improvement was shallow and lacked deep pools.

In 1989, increased angling pressure and deterioration of the hand-built rock dams prompted a second habitat improvement project. Goal of the project was to increase trout shelter on public land by creating more deep pools (Figure 3-2). A WGF construction crew used machinery to install 43 timber plunges, 15 rock plunges, 47 cover trees, and rock riprap to 100 ft of eroding bank. Project cost was $13,423 ($23,264/mile).

Figure 3-2. To provide deep pool cover for trout, as well as to help subirrigate the riparian vegetation, 58 pool digger structures were installed at Beartrap Meadows.

EVALUATION OF TROUT HABITAT MANAGEMENT

<u>Fishery Response</u> - *Phase I:* A small trout population was present in Beartrap Creek before habitat improvement, but the addition of new pool habitat, coupled with stocked RBT, produced a steady increase in both trout abundance and biomass, which peaked in 1969 (Figures 3-3 and 3-4). Trout survival and return-to-the-creel was clearly aided by the habitat project, but the 1970's saw a steady decline in the trout population as the dams were degraded by water flow and fishing pressure increased. By 1977 though, trout were still 565% more abundant than in 1965.

Phase II: Fishery response to the habitat improvement done in 1989 was not confounded by stocked trout, but the trout population at Beartrap Meadows declined steadily from 1989 to 1994 (Figures 3-3 and 3-4, Table 3-1). Comparison with the control station on state land indicated angler harvest was removing the larger trout from the population. The proportion of trout ≥6 inches in the population remained constant from 1989 to 1994 on the state land, while those at Beartrap Meadows decreased from 85% to 71% in the same period (Figure 3-5). Mean length of trout ≥6 inches increased 7% on state land, but decreased 3% at the meadows.

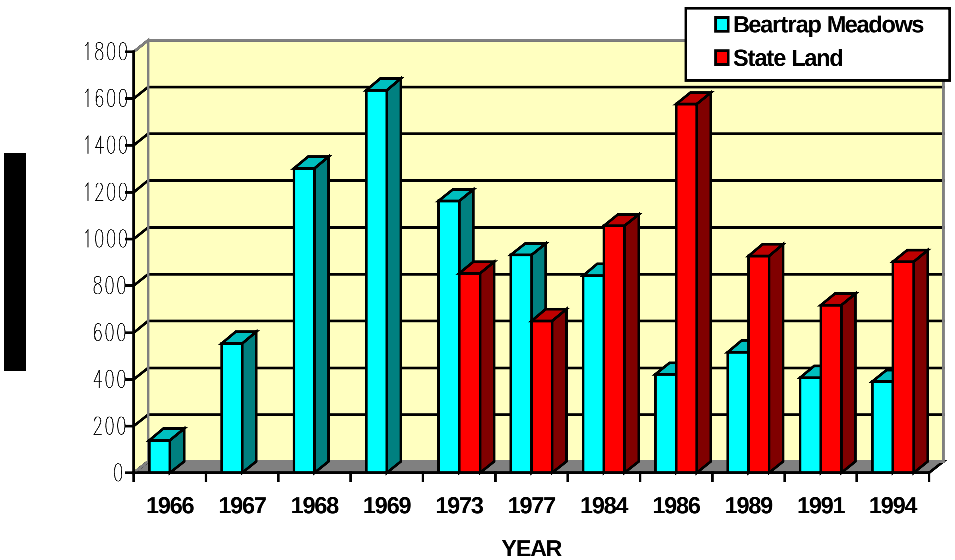


Figure 3-3. Abundance of trout in Beartrap Creek from 1966 to 1994 at Beartrap Meadows (treated) and state land (untreated). No trout were stocked after 1984.

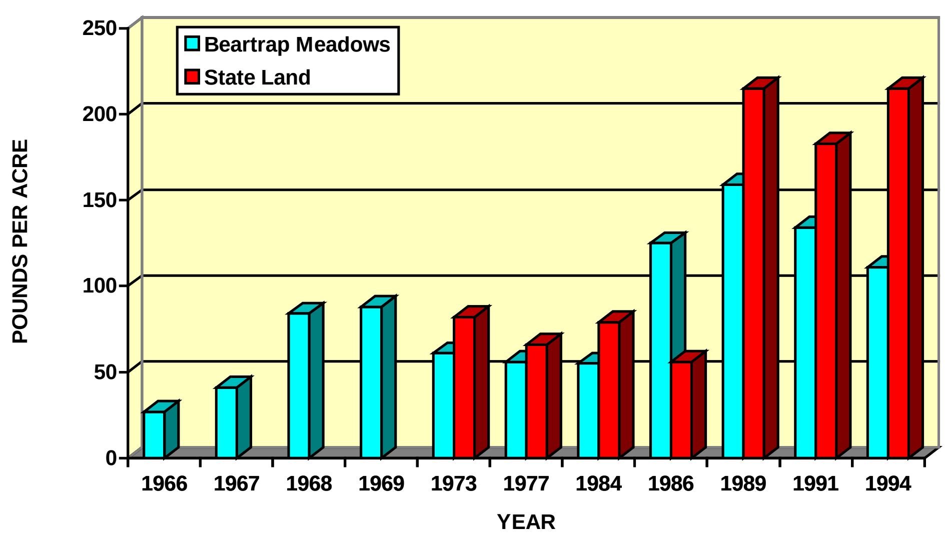


Figure 3-4. Biomass of trout in Beartrap Creek from 1966 to 1994 at Beartrap Meadows (treated) and state land (untreated). No trout were stocked after 1984.

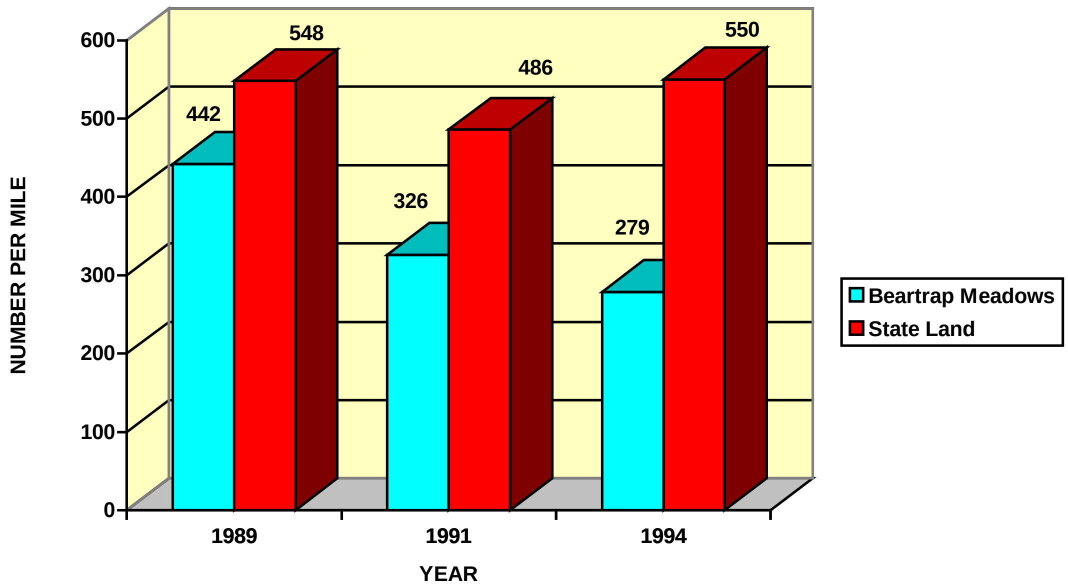


Figure 3-5. Abundance of wild trout ≥6 inches in Beartrap Creek at Beartrap Meadows and state land from 1989 to 1994.

Trout Habitat Response - HQI evaluations documented a 19% increase in HU between 1985 and 1995, while trout cover increased 148% in the same period (Figure 3-6). As expected, cover types changed following installation of the habitat improvement devices (Figure 3-7). Undercut banks and trench pools were most common before treatment, but plunge, pocket, and trench pools were the dominant cover types post-treatment. Average cover at the timber plunge pools was 38 ftsq, while each rock plunge pool added 34 ftsq. Additionally, dam pools upstream from the plunges offered deep water and undercut banks. Grass and sedge growth along stream margins has narrowed the stream in many places. Although the edge-of-water width remains at 5 ft, there is often only 3-4 ft of open water and the overhanging vegetation offers shelter for trout.

Habitat Structures - Durability and performance of the rock check dams built in 1966 was good for several years, but eventually the stream degraded dam integrity by moving the small, hand-placed rocks out of position. By the mid-1980’s most of the dams were not functioning as intended.

Six years after Phase II timber and rock plunges were installed, 86% of the timber plunges were rated in excellent condition. Both timber and rock plunges were calcified. However, RPD was ≥ 1.4 ft at only 25% of the timber plunges and 7% at the rock plunges, suggesting the deep pools originally created at the plunges did not persist. Examination showed several plunge pools filled with rocks that evidently rolled in during flood events. But even with rocks in the pools, almost all timber plunge pools had good depth during late summer. Since Beartrap Creek maintains a good flow through the summer and fall, the low RPD rating is not felt to be a serious problem. In mid-August, 1995, stream flow was adequate to produce pool depths of 18-30 inches at most plunges.

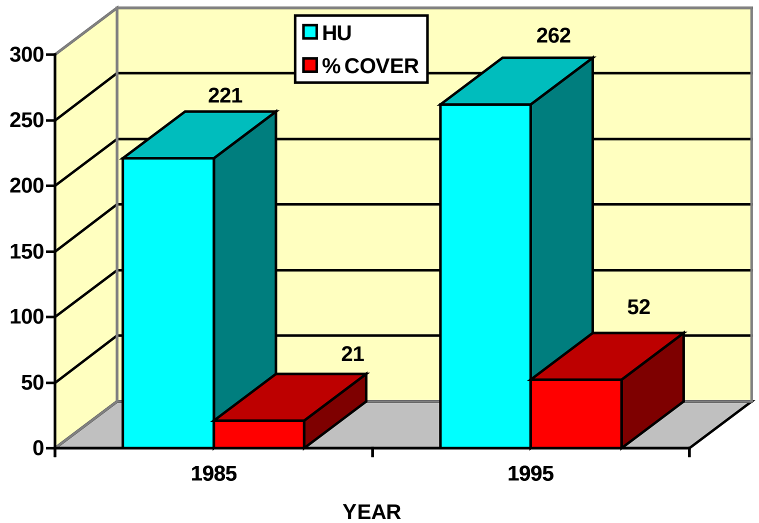


Figure 3-6. Status of Habitat Units and trout cover before (1985) and 10 years after (1995) habitat improvement at Beartrap Creek.

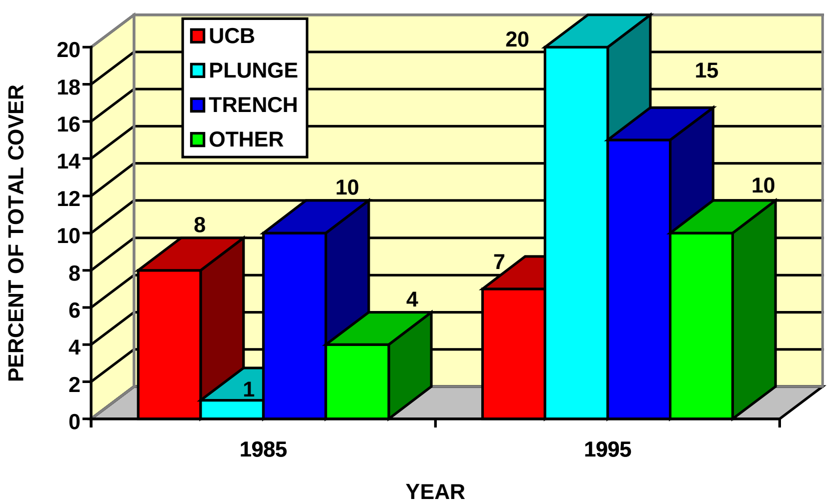


Figure 3-7. Cover types present in Beartrap Creek before and after habitat improvement. UCB is undercut banks, "plunge" is plunge pools, "trench" is trench pools, and "other" is pocket pools, runs, and vegetation.

Conclusions - Creation of the rock check dams in 1966 provided additional habitat and were instrumental in the survival and maintenance of stocked hatchery trout at Beartrap Creek. Trout abundance and biomass in the stream containing the dams increased steadily from 1966 through 1969. Afterwards, deterioration of the dams and increased fishing pressure led to a lower population level in the 1970's. But by 1977, trout numbers were still almost seven-fold greater than pretreatment.

Plunge structures installed in 1989 were in excellent condition six years later and have added considerable cover to the stream. Although harvest of larger fish by anglers pushed the wild trout population down, trout abundance was still 179% higher, and biomass was 311% greater, than in 1966 before any habitat improvement was done.

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Love, J. D. and A. C. Christiansen. 1985. Geologic map of Wyoming. U. S. Geological Survey, Denver.

Mueller, J. W. 1969. Stream improvement evaluations as related to fish populations in Beartrap Creek, Johnson County. Administrative Report, Project 0369-08-6602, Wyoming Game and Fish Department, Fish Division, Cheyenne.

Table 3-1. Summary of trout abundance and biomass changes in Beartrap Creek during 1989-1994 relative to habitat improvement.

	Untreated station				Treated Station			
			≥ 6 inches				≥ 6 inches	
Year	No/mile	lbs/acre	No/mile	lbs/acre	No/mile	lbs/acre	No/mile	lbs/acre
Pretreatment								
1989	928	215	548	172	517	159	442	149
Posttreatment								
1991	717	183	486	154	408	134	326	125
1994	913	215	550	188	391	111	279	105
Pretreatment Mean	928	215	548	172	517	159	442	149
Posttreatment Mean	815	199	518	171	400	122	302	115
Percent change	-12	-7	-5	-1	-23	-23	-32	-23
Untreated Stn Mean.	815	199	518	171				
Treated Stn Mean.	400	122	302	115				
Percent change	-51	-39	-42	-33				

BEAVER CREEK

CROOK COUNTY

PROJECT BUILT: 1973-1977

Drainage:	Belle Fourche River	**Belle Fourche River Basin (8BF)**	
Elevation:	4,900-5,040 ft	**R.** 63 **W., T.** 53 **N., S.** 27	
Stream Order:	Second	**Stream Class:** 3 (Regionally important fishery)	
Watershed Area:	13 sqmi	**Mean Wetted Width:** 6.6 ft	
Gradient:	1.0-1.2%	**Land Status:** Black Hills National Forest	
Rosgen Channel Type:	C-3	**Project Length:** 2.2 miles	
Treatment Used:	Triangular wooden deflectors, wooden plunges, wooden double deflectors, wooden bank overhangs, channel blocks, overpour ramps, rock deflectors, and pine trees (for LWD).		
Trout Species:	Brook trout		

DESCRIPTION OF STREAM: Beaver Creek drains a north aspect of the Bear Lodge Mountains in northeast Wyoming. High flows (≥ 50 cfs) are caused by the annual snowmelt runoff and, less frequently, by intense rainfall. Small springs and seeps supply base flow (≤ 1 cfs). Streamflow was relatively normal during the 1970s, but became extremely low during the 1980s due to drought. Stream substrate is mainly flat cobble and gravel with a few boulders and shale outcrops. The riparian zone is generally < 100 yd wide and features various grasses and forbs, scattered thickets of hawthorn, and occasional boxelder trees. Ponderosa pine, bur oak, and aspen dominate the valley sides and uplands.

PROJECT DESCRIPTION: The project is situated downstream from the confluence of Togus Creek with Beaver Creek, about 10 miles north of Sundance. WGF funded, constructed, and evaluated the habitat improvement structures. Project purpose was to stabilize eroding stream banks, narrow the stream, create pools and other shelter areas for trout, then study the long-term response of the trout population to the habitat management. Another project goal was to study feasibility and durability of various habitat improvement structures in this stream type. Accordingly, instream habitat improvement devices were installed at suitable sites in the HMA, working downstream from a starting point located several hundred yards below Togus Creek.

THE FISHERY: Beaver Creek was chemically treated in 1970 to control nongame fish and was restocked 1970-1974 with BKT fingerlings. No trout were stocked after 1974, and the population was maintained by natural recruitment. In 1973, Beaver Creek, in the HMA, contained BKT and mountain suckers, but RBT occasionally migrated upstream into the HMA. By 1980, white suckers, creek chubs, and longnose dace had moved upstream into the HMA. Opportunity for stream fishing is scarce in this area and Beaver Creek fills that need. Anglers mainly used the HMA in early summer before flows become too low. Fishery and habitat response to habitat management was monitored at a 450 ft site within the treated area. This site was electrofished from 1973-1990, but habitat parameters were only measured 1973-1977.

HABITAT MANAGEMENT: In the early 1970s, Beaver Creek had few deep pools or overhanging banks (Figure 4-1). Much of the stream was riffle. Bank erosion was more widespread than would be expected from natural causes. Much of the bank instability was related to use of the stream bottoms by cattle. The HMA was fenced by USFS in 1973 and grazed only lightly thereafter. To correct these habitat shortcomings, a WGF construction crew installed 111 stream habitat improvement devices in the HMA: 47 triangular wooden deflectors, 16 wooden plunges (Figures 4-2 and 4-3), 8 wooden double deflectors, 7 wooden bank overhangs, 6 channel blocks, 3 wooden overpour ramps, 2 rock deflectors, 1 rock double deflector, 21 large pine trees, and rock riprap on 2,150 ft of eroding bank (Figure 4-4). Project cost was $27,400 ($12,455/mile).

Figure 4-1. Before habitat improvement, Beaver Creek was wide, shallow, and lacked deep pools. Bank erosion was wide spread.

Figure 4-2. This timber plunge at Beaver Creek had a log grade control to maintain pool depth.

Figure 4-3. Many trout filled pools were provided by timber plunges at Beaver Creek.

Figure 4-4. Eroding stream banks at Beaver Creek stabilized with rock riprap, which also sheltered trout by furnishing many hiding places among the rocks along the water's edge. Juvenile trout were especially fond of such habitat. Good vegetation growth and bank stability displayed at this site only two years after treatment.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - After 7 years, BKT ≥ 6 inches had increased 1,814%, BKT < 6 inches had increased 1,462%, and the total population had reached 2,074/mile (Figure 4-5, Tables 4-1 and 4-2). Biomass increased steadily from 11 to 268 lbs/acre, peaking 7 years after habitat development. By 1990, after extended drought during the 1980s, the brook trout population had dropped to 222/mil (41 lb/acre), its lowest level in 17 years. Trout density (up 90%) and biomass (up 273%) were still better than before treatment.

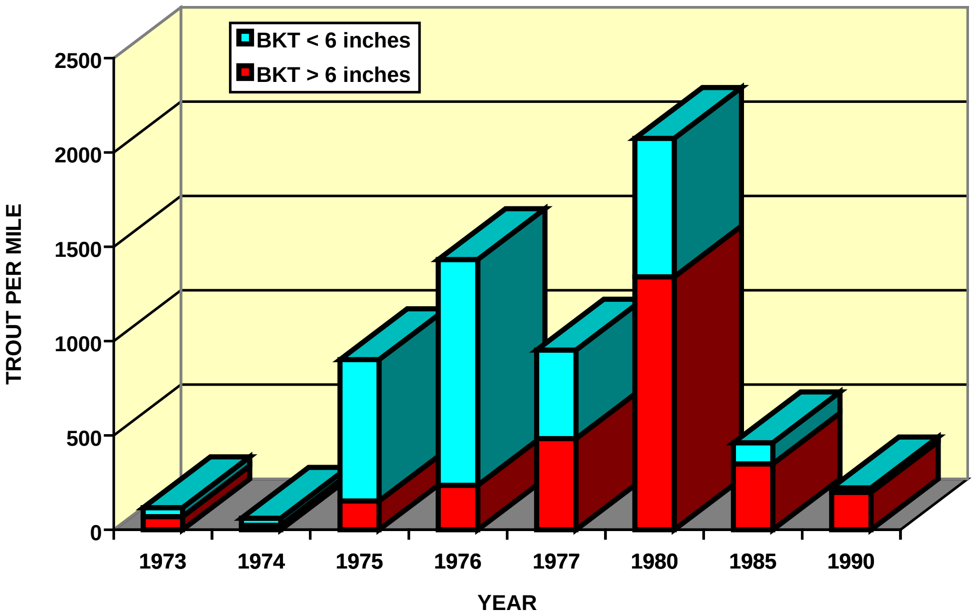

Figure 4-5. Changes in brook trout abundance at Beaver Creek following habitat improvement in 1973. Data were collected only during those years for which bars are shown.

Trout Habitat Response - Pretreatment cover for trout was poor and consisted of fallen grass sod, a few short undercut banks, small woody debris, and corner pools having little overhead cover. After treatment, deep plunge pools, pocket pools associated with rock riprap, and scour pools at deflectors and bank overhangs caused a 338% increase in cover area (Figures 4-6 and 4-7). By 1991, 58% of the functional plunges had an RPD of 1.4 ft or more and mean plunge pool cover was 190 sqft/plunge. Many trout used the pools created by plunge structures, especially during dry years. However, RPD at pools associated with deflectors was 1.4 ft or greater at only 11% of the sites, and cover averaged 38 sqft/deflector pool. RPD at double deflector pools was 1.4 or greater at only 33% of the devices. In 1973, Beaver Creek contained 22 HU, but 3 years after treatment, habitat quality had improved to 49 HU, a 123% increase. In contrast, an untreated reference site logged a 9% decrease in HU between 1975 and 1976.

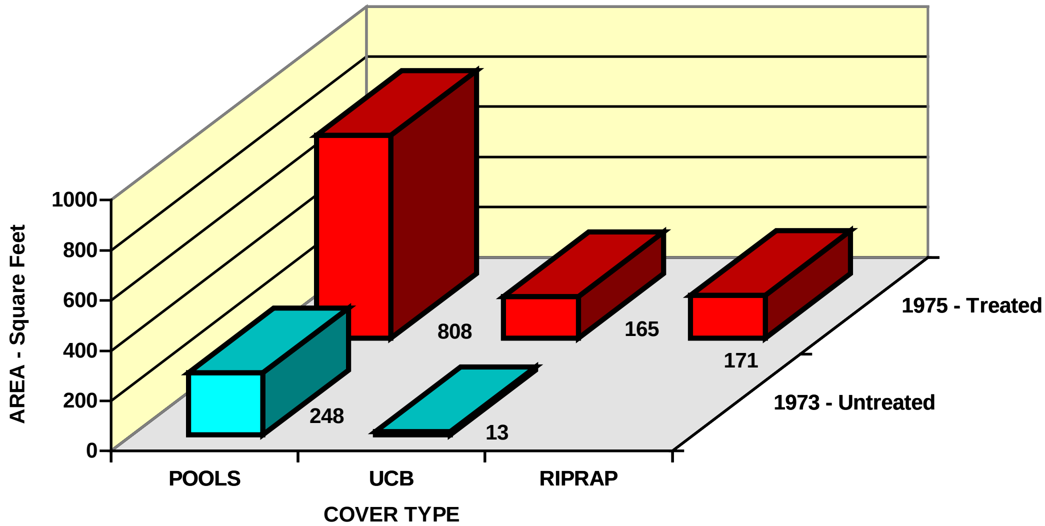

Figure 4-6. Change in cover type and area before and 2 years after treatment.

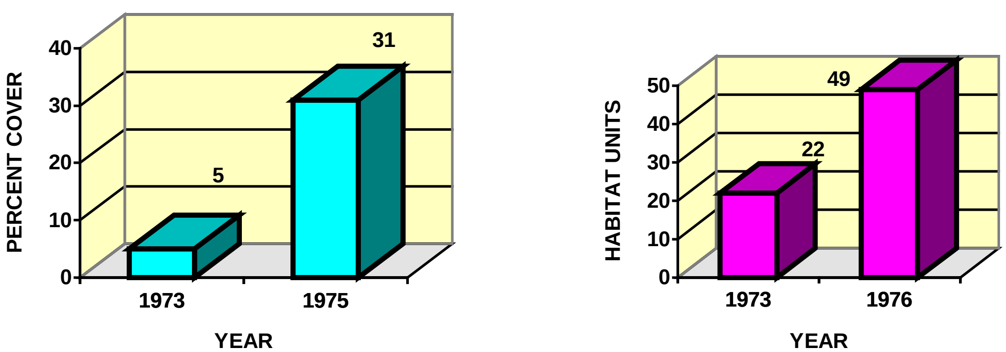

Figure 4-7. Change in cover (left) and HU (right) at Beaver Creek before (1973) and after habitat improvement devices were added to the creek.

<u>Habitat Structures</u> - Over 90% of the habitat improvement devices remained fully functional 18 years after installation, even though some of them were esthetically displeasing due to exposure of logs and planks. Wooden plunges were comparatively easy to install and dug good pools. Deflectors worked better directing currents than digging pools. Wood bank overhangs and overpour (Hewitt) ramps provided variable results, were expensive and hard to install, were apt to be damaged by floods, and are not recommended for Wyoming streams.

In 1995, a low frequency flood buried several structures with stream-borne sediment, mostly at the upper end of the project. Other structures washed out or were damaged; an inventory found 54% of the devices installed in 1973-1977 were still functional.

Conclusions - Installation of habitat improvement devices in Beaver Creek increased cover for trout 338%. In response, BKT numbers increased almost 18 fold and the fishery became self-sustaining. These devices provided key shelter for trout during extended drought. Ultimately though, the fish population was reduced to a low level by extensive drought, despite the habitat improvements. However, trout abundance was still 90% higher than pretreatment.

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Binns, N. A. 1994. Long-term responses of trout and macrohabitat to habitat management in a Wyoming headwater stream. North American Journal of Fisheries Management 14: 87-98.

Table 4-1. Summary of trout population abundance and biomass in Beaver Creek before (1973) and after (1974-1990) habitat improvement.

Year	Number/mile	Pounds/acre	Number/mile > 6 inches	Pounds/acre > 6 inches
Pretreatment				
1973	117	10.5	70	10
Posttreatment				
1974	61	6	23	5
1975	902	38	153	33
1976	1453	59	236	57
1977	952	113	483	103
1980	2074	268	1340	225
1985	461	86	349	79
1990	222	8	198	6
Pretreatment Mean	117	10.5	70	10
Posttreatment Mean	875	83	397	73
Percent Change	648	690	467	630

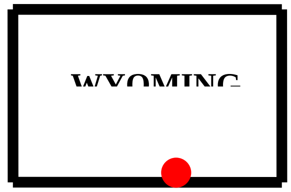
Table 4-2. Brook trout size, condition, and density at the Beaver Creek study stations 1973-1990.

Year	Fish 6 in and longer (total length)				Biomass (lbs/acre)		Density (Number/mile)		
	Mean length (in)	Maxi-mum length (in)	Mean weight (lb)	Mean condi-tion	≥ 6 in	< 6 in	≥ 6 in	< 6 in	< 3 in (age 0)
				Upper Treated Station					
1973	7.7	8.3	0.22	47.1	10	<1	70	47	35
1974	7.9	8.4	0.21	42.5	5	1	23	38	26
1975	7.6	11.1	0.24	52.2	33	5	153	749	714
1976	7.5	11.5	0.23	52.5	57	2	236	1,197	1,162
1977	7.2	8.8	0.17	46.3	103	10	483	469	422
1980	6.8	9.2	0.12	37.5	225	43	1,340	734	330
1985	7.4	10.8	0.16	36.6	79	7	349	112	83
1990	6.9	7.7	0.13	40.0	6	2	198	24	0
				Upper Control Station					
1990	6.7	7.2	0.13	42.5	6	2	40	54	54
				Lower Treated Station					
1973					0	2	0	350	256
1975	7.2	10.3	0.20	50.2	42	5	188	390	378
1976	7.8	9.6	0.22	45.6	26	25	96	1,699	1,676
1977	7.0	8.1	0.16	44.7	50	3	223	248	236
1980	6.6	7.7	0.13	42.2	13	7	82	270	235
				Lower Control Station					
1975	7.9	9.4	0.22	43.9	25	1	142	178	178
1976	7.3	8.3	0.2	50.9	21	5	112	489	482

BIG CREEK

CARBON COUNTY

PROJECT BUILT: 1983-1986



Drainage:	North Platte River	**Big Creek Basin (5BC)**
Elevation:	7,240 ft	**R.** 81 **W., T.** 14 **N., S.** 20
Stream Order:	Third	**Stream Class:** 2 (statewide importance)
Watershed Area:	~ 175 sqmi	**Mean Wetted Width:** 46 ft
Gradient:		**Land Status:** Private land (A-A Ranch)
Rosgen Channel Type:		**Project Length:** 5,280 ft
Treatment Used:	Rock deflectors, rock weirs, fish rocks, rock riprap	
Trout Species:	Brown and rainbow trout	

DESCRIPTION OF STREAM: Big Creek heads in the Medicine Bow National Forest near the Colorado-Wyoming line. It drains a southeast aspect of the Sierra Madre Mountains. In the project area, the stream flows in a narrow, rocky canyon.

PROJECT DESCRIPTION: Although located on private land, the WGF fish habitat crew made suggestions for fish habitat improvement as an extension service to the landowner. After sites for eight structures were located, actual construction was done by a private contractor and was funded by the landowner.

THE FISHERY: Both wild brown and rainbow trout occur in Big Creek, but catchable hatchery rainbow trout were stocked for several years before and after the project. Creel data collected by the A-A Ranch indicated only 19% of the hatchery trout were being caught.

HABITAT MANAGEMENT: An evaluation of fish habitat on Big Creek through the canyon found that habitat was generally good, but some sections of “flat” water lacked suitable pool shelter for trout. Structures (four rock weirs and four rock deflectors) were constructed by Stream Team, Ltd., Longmont, Colorado (Figures 5-1 and 5-2).

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response – Pre-treatment and post-treatment electrofishing by WGF indicated wild BNT and RBT increased 304% (Figure 5-3). BNT increased the most. Hatchery trout nearly doubled in abundance relative to pretreatment levels, suggesting the structures provided suitable shelter to hold these fish in the project area.

Figure 5-1. Addition of boulder weirs to Big Creek increased deep pool habitat for trout.

Figure 5-2. Close-up view of a boulder weir at Big Creek, which created pocket pools, a dam pool, and a plunge pool. These weirs also acted as grade controls and helped increase subirrigation of the riparian zone.

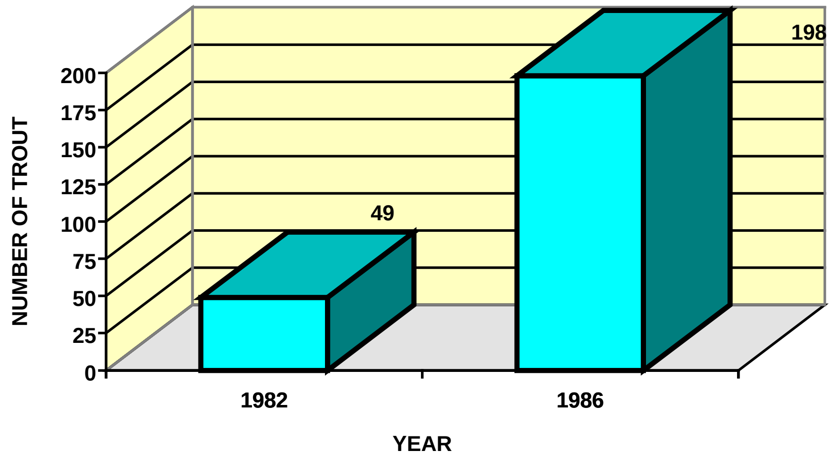


Figure 5-3. Trout abundance in Big Creek before (1982) and after (1986) boulder structures were added to the stream. These population estimates were done by WGF each spring before high water.

Trout Habitat Response - No evaluation.

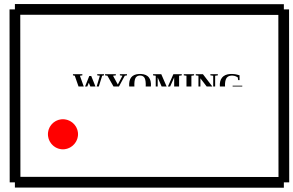
Habitat Structures - No evaluation.

Conclusions - Addition of boulder structures to Big Creek increased the wild trout population four fold.

BIG SANDY RIVER

SWEETWATER COUNTY

PROJECT BUILT: 1992-1997



Drainage:	Green River	**Lower Big Sandy River Basin (3BS)**	
Elevation:	6,400-6,460 ft	**R.** 108 **W., T.** 23 **N., S.** 2, 11, 12, 13, 24, 25, 26, 27, 28	
Stream Order:	Fourth	**Stream Class:** 3 (regionally important)	
Watershed Area:	1,700 sqmi	**Mean Wetted Width:** 38 ft	
Gradient:	0.12%	**Land Status:** BLM	
Rosgen Channel Type:	C-5	**Project Length:** 20 miles	
Treatment Used:	"S" dams, vortex weirs, diagonal weirs, lateral weirs, rock deflectors, rock jetties, egg hatching boxes, fencing.		
Trout Species:	Brown, rainbow, and cutthroat trout		

DESCRIPTION OF STREAM: The Big Sandy River drains a southwest aspect of the Wind River Mountains, but at lower elevations much of this large watershed drains a semi-arid, cold desert. Headwaters in the Shoshone National Forest receive considerable snow during winter and the annual snowmelt runoff often provides the annual peak flow. However, water flow at the project area is controlled by releases from Big Sandy Reservoir and irrigation return flows from. Irrigation of hayfields near Eden and Farson apparently contributes to the many springs located along the river bottoms downstream from Farson. River flow is generally adequate for trout, but the water is high in dissolved minerals. ADF is about 72 cfs, the ASFV ratio is about 12, and CPSF is about 50% ADF. Irrigation return flows artificially elevate summer flows and late summer flows are not a problem. Lowest discharge is during winter. An unstable sand and fine gravel substrate is characteristic of the lower Big Sandy River.

PROJECT DESCRIPTION: Located about 8 miles southwest of Farson, habitat improvement was done on the Big Sandy River between Bone Draw and Gasson Bridge. This project was a cooperative venture between Trout Unlimited (Flaming Gorge/Lower Green River Chapter), WGF, BLM, U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service, and the Central Utah Project. Installation of structures was spread over several years as funds became available, and work was continuing in 1997. Project objectives were to increase shelter for trout, increase habitat diversity, and improve riparian vegetation through grazing changes and better subirrigation gained by raising the streamside water table.

THE FISHERY: A few trout have inhabited the lower Big Sandy River over the years, but generally inhospitable and poor habitat strongly limited trout abundance. Trout were few and far between, utilizing isolated patches of suitable cover. Although there was some evidence that trout might migrate upstream from the Green River during spawning seasons, angler use of the lower Big Sandy River was virtually non-existent. Pretreatment stream classification was "4", a locally important fishery. Posttreatment, the fishery was upgraded to class "3", a regionally important fishery. Statewide fishing regulations applied.

HABITAT MANAGEMENT: Riparian vegetation along the Big Sandy River has historically been heavily grazed by both sheep and cattle. Bank stability was poor. Thus, there was little shelter for trout from undercut banks or overhanging vegetation. A shifting sand substrate further reduced living space for trout. Irrigation return flows, both overland and from springs, contributed to a high load of dissolved minerals. Above Farson, TDS is less than 50 ppm, but downstream from the irrigated area, TDS may exceed 2,000 ppm.

First efforts at habitat improvement on the lower Big Sandy were at Bone Draw, a small tributary fed by springs. Hatching boxes for trout eggs and pool diggers were installed in Bone Draw by TU in the 1980s under WGF guidance. When evidence accumulated that trout were present in the river near Bone Draw, interest was generated toward improving habitat in the river proper. Beginning in 1992, habitat improvement devices were systematically built in the river from Bone Draw to below Big Bend. By 1997, 51 boulder structures had been built and 45 of these were rock weirs (Figures 6-1 and 6-2) . Installation and rock hauling was done by private contractors. Most of the rocks were hauled from the old iron ore mine on South Pass. Project cost was about $145,000 ($7,250/mile).

Figure 6-1. Addition of rock weirs to the Big Sandy River increased habitat diversity by creating dam pools, plunge pools, and turbulence. Spaces between the rocks are important shelter for juvenile trout. These weirs also acted as grade controls and raised the local water table, which better subirrigated riparian vegetation near the weirs. The stream narrowed as sediment deposited in new lateral and point bars and riparian vegetation colonized these bars.

Figure 6-2. A boulder weir on the Big Sandy River turns the flow into a rocky bluff to create better shelter for trout. A livestock exclosure is at top right.

EVALUATION OF TROUT HABITAT MANAGEMENT

<u>Fishery Response</u> - By 1994, abundance of trout 6 inches, or greater, had increased 190% over pretreatment values (Figure 6-3). Biomass was 88% higher (Figure 6-4). Posttreatment abundance of all trout was 134% better than pretreatment.

<u>Trout Habitat Response</u> - Addition of the boulder structures to the formerly monotonous stream bed greatly diversified the instream habitat. Turbulence near the weirs created pools and runs, which attracted trout. Each weir also served as a local grade control, raising the water table and increasing subirrigation of stream side vegetation. When coupled with grazing changes, there was a positive response by riparian vegetation. Sedges and willows became more abundant and bank stability improved. Eroding banks decreased 22 % posttreatment, while HQI analysis documented an 8% increase in habitat units. Sediment deposition caused the stream to narrow and deepen as these new bars became covered with vegetation.

<u>Habitat Structures</u> - Durability and performance of the structures was good through 1997. An ongoing evaluation will monitor structure durability over the long term. A key question to be answered is: will the river eventually overwhelm and bury the weirs with sand? Although the weirs appeared stable through 1997, by late 1998 some appeared to have settled considerably. These devices were usually those built with only a minimum number of rocks. A lesson emerging from this project is that when building rock weirs, use plenty of rocks!

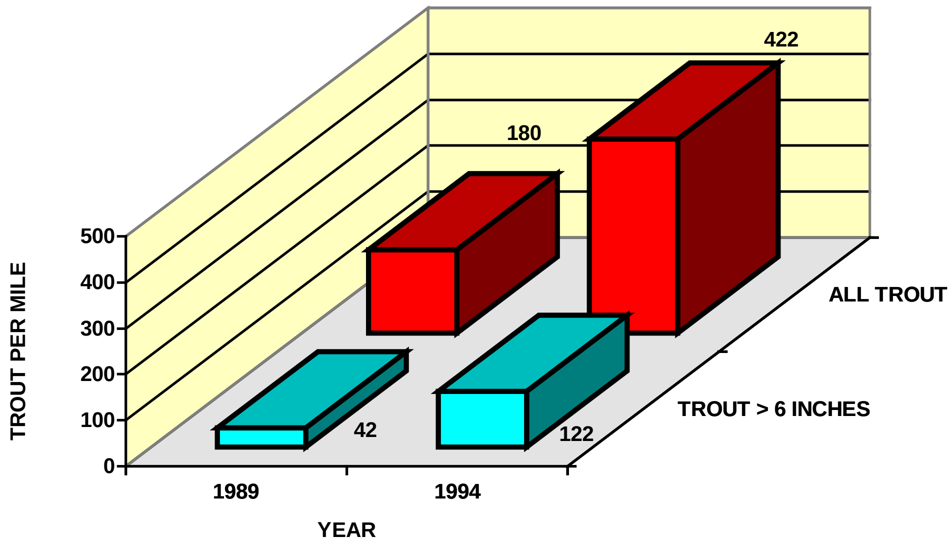


Figure 6-3. Mean abundance of trout before (1989) and after (1994) boulder habitat improvement structures were installed in Big Sandy River. Numbers shown are means for the combined electrofishing data at Bone Draw and Big Bend.

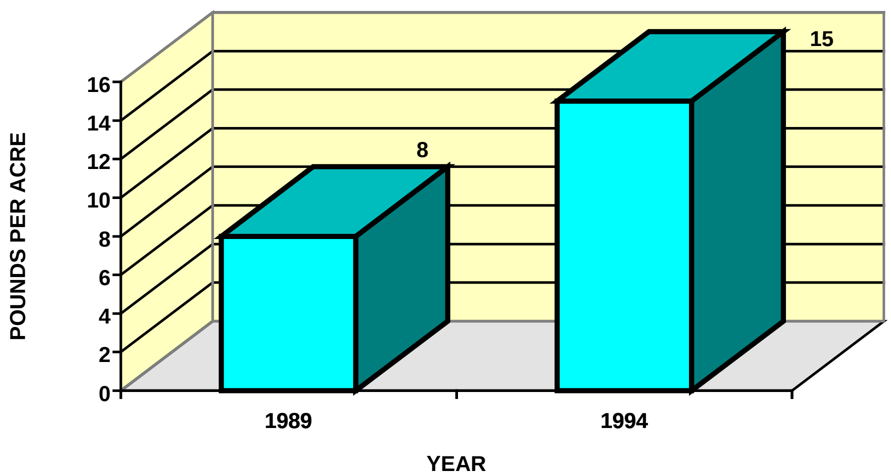


Figure 6-4. Mean biomass of trout 6 inches, or greater, before (1989) and after (1994) boulder habitat improvement structures were installed in Big Sandy River. Numbers shown are means for the combined electrofishing data at Bone Draw and Big Bend.

Conclusions - Construction of various boulder habitat improvement devices in the Big Sandy River has proved beneficial to both trout and their habitat. Additional cover for trout has been created and trout abundance has increased 134% posttreatment. Catchable size trout increased 190%. Revegetation of sediment bars trapped by the weirs has narrowed the river, while riparian vegetation grown denser due to better subirrigation.

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Dey, P and T. Annear. 1995. Big Sandy River Habitat Quality Index measurements: 1989 and 1994. Administrative Report, Fish Division, Wyoming Game and Fish Department, Cheyenne.

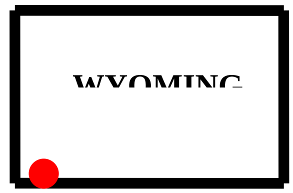
Table 6-1. Abundance and biomass of trout before and after habitat improvement in the lower Big Sandy River.

			Trout ≥6 inches	
Year	Number/mile	Pounds/acre	Number/mile	Pounds/acre
Bone Draw Station				
Pretreatment: 1989	320		50	9.6
Posttreatment: 1994	756	26.6	182	18.7
Percent Change	136		264	95
Big Bend Station				
Pretreatment: 1989	39		33	6.3
Posttreatment: 1994	89	11.8	63	11.4
Percent Change	128		91	81
Both stations combined				
Pretreatment mean	180		42	8
Posttreatment mean	422		122	15
Percent Change	134		190	88

BLACKS FORK RIVER

UINTA COUNTY

PROJECT BUILT: 1974



Drainage:	Green River (Flaming Gorge Reservoir)	**Blacks Fork River Basin (3BF)**	
Elevation:	8,420 ft	**R.** 117 **W., T.** 12 **N., S.** 2	
Stream Order:	Fourth	**Stream Class:**	3 (regionally important)
Watershed Area:	156 sqmi	**Mean Wetted Width:**	58 ft
Gradient:	0.7%	**Land Status:**	BLM
Rosgen Channel Type:	B-3	**Project Length:**	200 ft
Treatment Used:	Gabion “fish rocks”		
Trout Species:	Rainbow and Colorado River cutthroat trout.		

DESCRIPTION OF STREAM: Heading in the Wasatch National Forest, the Blacks Fork River drains a north aspect of Utah’s Unita Mountains. Considerable snow falls in the drainage during most winters. Stream flow is from springs, rainfall, and snowmelt, but flow at the project area is controlled by Meeks Cabin Reservoir. Consequently, summer flows remain high to supply irrigation water for downstream ranches, while winter flows may become low. Stream substrate is boulder, cobble, and gravel. Considerable movement of substrate particles occurs during floods. Aquatic macroinvertebrate production is low (46 organisms/sqft). River alkalinity is 59 mg/l, pH is about 7, and hardness is 54 mg/l.

PROJECT DESCRIPTION: A cooperative project between WGF and the WRRI, a primary goal of this experimental project was to determine if hand built, low profile gabion baskets would economically create pocket pools to shelter trout. Field work was done by WRRI, while WGF provided funding.

THE FISHERY: Historically, the Blacks Fork River fishery has been marginal due to various habitat limitations, such as unstable stream substrate, relatively unproductive water chemistry, and seasonal flow fluctuations. Trout populations were low pretreatment, but a few CRC were reported present. With the construction of Meeks Cabin Dam, angler use of the tailwater increased many fold, and the stream was managed as a basic yield fishery.

HABITAT MANAGEMENT: Few deep pools were present in the tailwater and lack of shelter for trout was listed as a primary habitat shortcoming. To correct this problem, WRRI hand built seven experimental gabion structures, which were scattered through the test section to simulate large boulders. Placement varied as to depth, velocity, and orientation to the thalweg. Metal overhangs were installed on three of the structures to provide overhead cover on the downstream edge of the structure. Cost per structure was $62.50 for materials and each required about 6 man hours of labor to install.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Evaluation of the fishery response was attempted, but was unsuccessful due to high river flows at the time samples were taken. In April, 1975, no trout were found in treated or untreated sections.

Trout Habitat Response - Areas of quiet water were created downstream from the structures. These pocket pools varied from 4 to 16 ft in length.

Habitat Structures - Durability of the artificial “fish rocks” proved to be very poor as floods soon buried or destroyed the structures. As intended, the gabions created downstream scour pools, but the baskets soon settled into the pools and were covered with cobble and gravel. During the first winter, some structures were pushed out of position by pressure generated by ice build-up on the gabions.

Conclusions - Artificial “fish rocks” created by gabion baskets were unsuccessful as they did not survive flood flows or winter ice conditions. They are not recommended for Wyoming streams having unstable bottoms.

INFORMATION SOURCES

Wesche, T. A. 1974. Design and construction of habitat improvement structures on the Blacks Fork River, fall, 1974. Water Resources Research Institute, University of Wyoming, Laramie.

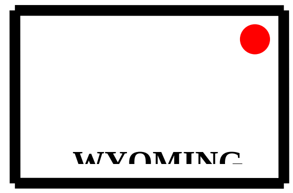
Wesche, T. A. 1975. Spring, 1975 evaluation of Black’s Fork improvement structures. Typewritten memo, Fish Division, Aquatic Habitat Section, Wyoming Game and Fish Department, Lander.

Wiley, R. W. Suggested program of fishery management for the Blacks Fork River downstream from Meeks Cabin Reservoir, Typewritten report, Fish Division, Aquatic Habitat Section, Wyoming Game and Fish Department, Lander.

BLACKTAIL CREEK

CROOK COUNTY

PROJECT BUILT: 1977



Drainage:	Belle Fourche River	**Belle Fourche River Basin (8BF)**	
Elevation:	4,610 ft	**R.** 64 **W., T.** 53 **N., S.** 24 NE 1/4	
Stream Order:	Second	**Stream Class:** 4 (locally important)	
Watershed Area:	8 sqmi	**Mean Wetted Width:** 7 ft	
Gradient:	1.8%	**Land Status:** Black Hills National Forest	
Rosgen Channel Type:	C-4	**Project Length:** 530 ft	
Treatment Used:	Timber plunges, rock plunges, and rock riprap		
Trout Species:	Wild brook trout		

DESCRIPTION OF STREAM: Located about 15 miles north of Sundance, Blacktail Creek drains a northwest aspect of the Bear Lodge Mountains in the Black Hills National Forest. High flows are caused by the annual snowmelt runoff and, less frequently, by intense rainfall. Small springs and seeps supply base flow. During the 1970's, streamflow and water temperatures were adequate for trout, but drought during the 1980's and 1990's dropped flows to critically low levels and raised water temperatures. Stream substrate is mainly cobble and gravel, but high concentrations of calcium carbonate and sulfate cause a light marl formation on the streambed. Water quality is conductive to good macroinvertebrate and fishery production, but the water is "hard". TDS is 1,460 ppm, pH is 8.0, and alkalinity is 155 ppm. Various grasses and forbs, scattered thickets of hawthorn, and occasional boxelder trees occupy the riparian zone, which is about 100 yd wide at the project site. Ponderosa pine, bur oak, and aspen dominate the valley sides and uplands.

PROJECT DESCRIPTION: Instream fish habitat was improved in Blacktail Creek as an experiment to see if providing more deep pools would increase abundance of catchable-size BKT. Work was done and funded by WGF, with concurrence of USFS.

THE FISHERY: In 1975, Blacktail Creek contained a self-sustaining population of wild brook trout. But an inventory of the fish population through a section of poor habitat found no BKT larger than 7.2 inches. Mean size was 4.8 inches. A graveled forest road parallels the stream so angler access is good. Angler use of the fishery was not determined, but was probably limited to local "after-work" and weekend anglers. Standard, statewide fishing regulations applied.

HABITAT MANAGEMENT: Pretreatment, Blacktail Creek contained few pools having any depth (Figure 9-1). Habitat type was mostly shallow riffle and run. To provide deep pools, a WGF construction crew installed five timber plunges, three rock plunges, one log plunge, and 60 ft of rock riprap (Figure 9-2). Total cost was about $1,400 ($13,400/mile).

Figure 8-1. Pretreatment, Blacktail Creek was shallow and lacked deep pool habitat for trout.

Figure 8-2. Timber plunges installed in Blacktail Creek created deep pool shelter for brook trout and often contained numerous fish for several years posttreatment.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - BKT abundance and biomass increased in Blacktail Creek posttreatment (Figures 9-3 and 9-4). Mean abundance of trout age-1, or older, increased 236% over the mean pretreatment level (Table 9-1). Biomass improved 78%. Seven years after habitat structures were installed, BKT age-1, or older, were 62% more abundant than in 1975-77. However, trout longer than 6 inches decreased steadily from 1977 (340/mile) to 1979 (130/mile), possibly due to angler mortality. Anglers have been observed at other projects and they tend to "key-in" on the plunge pools and select for larger fish. Even with light angler use, a few anglers can easily crop off the larger trout in a small stream and thus alter the length-frequency distribution.

Much of the population increase noted in 1978 was in the 5 inch size class (age-1), while the 1979 increase was mostly fish in the 4 inch size group. But by 1984, mean posttreatment length of all trout had dropped 6% over pretreatment mean length, while mean condition of age-1, or older, fish had decreased 4%. Which suggests that either the population had stunted due to the better habitat or angler harvest had removed larger fish and skewed the length-frequency distribution. A more likely scenario is that both factors affected the population. At any rate, the project did not meet its goal of producing more catchable-size fish.

Trout Habitat Response - Addition of pool digging structures increased pool depth through the study station. RPD was about double one year after plunges were built, despite the plunge pools not being dug out when the plunges were built. When examined in 1984, two plunges had dug deep pools, but the other two surviving plunges had only small, mediocre plunge pools.

Habitat Structures - A flash flood in 1978 washed out the log plunge and a timber plunge. They were not replaced. Both were located on "S" bends of the stream, a poor location as flood flow continued natural lateral erosion at the bends, thus washing around one end and burying the devices in the newly formed point bar. The other plunges survived the flood and continued to function. But by 1990, all plunge pools were plugged with *Chara* and no trout were seen.

Conclusions - Instream habitat improvement at Blacktail Creek provided more deep pool shelter for trout. BKT abundance increased three fold posttreatment, while biomass was up 78%. But the project did not achieve its goal of providing more catchable-size fish as juvenile fish increased most in both abundance and biomass. Reduced stream flow and warmer water observed at other Black Hills streams in the 1980s also affected Blacktail Creek and apparently eliminated its trout population by 1990.

INFORMATION SOURCES

Mueller, J. W. 1984. The influence of habitat improvement structures on the fish population and physical characteristics of Blacktail Creek, Crook County. Administrative Report, Project No. 3084-08-7601, Fish Division, Wyoming Game and Fish Department, Cheyenne.

Rockett, L. C. 1979. The influence of habitat improvement structures on the fish population and physical characteristics of Blacktail Creek, Crook County, Wyoming. Administrative Report, Project No. 3079-08-7601, Fish Division, Wyoming Game and Fish Department, Cheyenne.

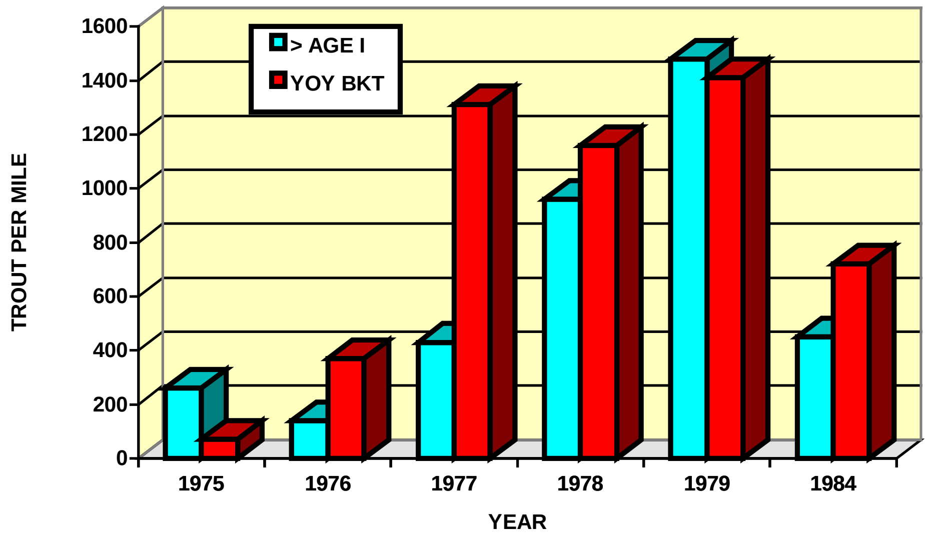


Figure 8-3. Abundance of BKT at Blacktail Creek before (1975-1977) and after habitat improvement. Age I includes all BKT age I, or greater, while YOY BKT includes only young of the year.

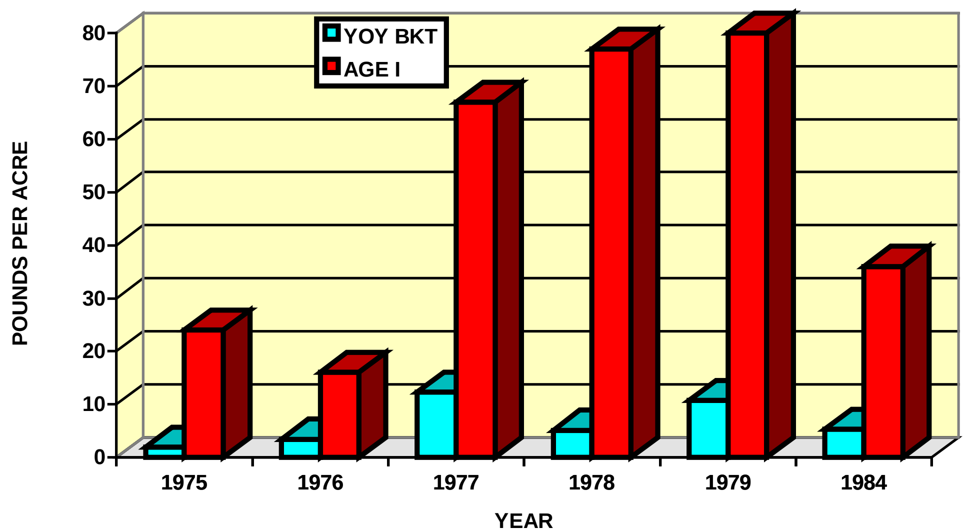
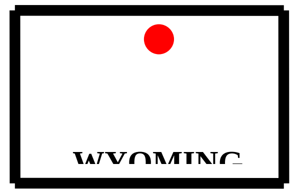


Figure 8-4. Biomass of BKT at Blacktail Creek before (1975-1977) and after habitat improvement. Age I includes all BKT age I, or greater, while YOY BKT includes only young of the year.

Table 8-1. Abundance and biomass of BKT at Blacktail Creek 1975-1984 before and after instream habitat improvement.

	Young of year		Trout $\geq$ Age 1	
Year	Trout/mile	Pounds/acre	Trout/mile	Pounds/acre
Pretreatment				
1975	71	1.9	260	24
1976	370	3.4	140	16
1977	1,310	12.3	430	67
Posttreatment				
1978	1,160	5.1	860	77
1979	1,410	10.7	1,480	80
1984	720	5.3	450	36
Pretreatment mean	584	6.4	277	36
Posttreatment mean	674	7	930	64
Percent change	15	9	236	78

BULL CREEK, LOWER



SHERIDAN COUNTY

Project Built: 1986, 1989

Drainage:	North Tongue River	**Tongue River Basin (8TR)**	
Elevation:	8,070 ft	**R.** 89 **W., T.** 55 **N., S.**9; NW 1/4	
Stream Order:	First	**Stream Class:** 3 (Regionally important fishery)	
Watershed Area:	10 sqmi	**Mean Wetted Width:** 12 ft	
Gradient:	0.6%	**Land Status:** Bighorn National Forest	
Rosgen Channel Type:	C-4	**Project Length:** 1,100 ft	
Treatment Used:	Timber plunges, rock deflectors, tree and rock revetments, rock riprap, cover trees.		
Trout Species:	Snake River cutthroat, rainbow, and brook trout		

DESCRIPTION OF STREAM: Bull Creek flows northerly from the crest of the Bighorn Mountains to join the North Tongue River about 3.5 miles west of Burgess Junction. This 8 mile long headwater stream drains both dense conifer forest and mountain meadows. In the alpine upper drainage, snowfields feed the stream well into the summer. Springs and seeps supply base flow. Discharge peaks in June with the early snowmelt runoff, but remains adequate for trout through the summer and late summer flow is not a problem. Upstream from the broad meadow at the project site, valley type is generally "V" shaped with steep sidehills, and a stream gradient over 2%, except in the occasional meadow where gradient is usually 1%, or less.

PROJECT DESCRIPTION: This project was a cooperative effort between WGF and Bighorn National Forest to improve fish habitat in Bull Creek, a popular and heavily used fishery. USFS contributed funds, rocks, and trees to the project, while WGF furnished funding, labor, finished materials, and equipment. Fish habitat improvement was done at a meadow just upstream from highway 14-A at the bottom of the drainage. Pretreatment, the stream in the project area featured extensive riffles and lacked deep pool shelter for trout. Sediment deposition was a serious problem, which was exacerbated by unstable stream banks in the drainage. A primary project goal was to increase the stream's carrying capacity for trout by providing additional deep pools and better shelter. Improved habitat would also increase overwinter survival and return-to-the-creel of stocked trout. Another goal was to stabilize eroding stream banks in the project area.

THE FISHERY: At its higher elevations, Bull Creek does not support a wild trout population. Only in the lowermost creek has very limited natural reproduction been found. The fishery is essentially supported by stocking juvenile SRC, but catchable RBT have been stocked in the past. A few wild BKT occur in the lower creek. SRC stocked at 4.5 inches grew to 8.5 inches in one year, which is very good for a small stream at this elevation. However, Highway 14-A, a heavily traveled tourist route, makes lower Bull Creek easily accessible to anglers and harvest has traditionally been high. In the project area, few trout survived long enough to grow large. When the project was built, liberal statewide fishing regulations were in effect. But to counter the heavy fishing mortality, and permit SRC to live long enough to possibly reproduce, angling restrictions were imposed in 1990 (catch and release for SRC, artificial lures or flies only). BKT remained under statewide catch regulations.

HABITAT MANAGEMENT: Instream cover for trout was fair (21%) pretreatment and included undercut banks and a few corner pools. Bank erosion (42%) was a habitat flaw, which may have been related to livestock grazing in the creek bottoms. In 1986, a WGF construction crew installed 8 timber plunges, 3 rock deflectors, 120 ft of tree/rock revetments and 60 ft of rock riprap. Cover trees were added to the plunges in 1989. Project cost was $5,430 ($26,064/mile) for labor, materials, and equipment.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Although trout abundance and biomass increased posttreatment, intense angling pressure soon removed most catchable trout each year (Figure 10-1, Table 10-1). Few large trout survived past their second summer in the stream. The habitat structures helped the trout population, but also attracted and focused angler use, to the detriment of the larger fish. However, after special regulations were imposed in 1990, the trout population expanded steadily and by 1996, abundance had increased many fold over pretreatment levels. After several years of sampling, the fisheries management crew concluded that SRC natural reproduction was virtually nonexistent in the project area and stocking juvenile SRC was necessary to maintain the fishery.

Trout Habitat Response - Five years after treatment, Bull Creek contained 12% more HU and stream banks had stabilized within the project area (Figure 10-2). Cover had increased 52% by 1991. Not only were deep plunge pools formed, but the low gradient caused long, deep pools to form upstream from each plunge (Figure 10-3). And these upstream pools also trapped much silt - some lateral and middle bars were over 2 ft deep - during years with a low snowmelt runoff. Larger spring floods usually scoured away the sediment. Dammed and plunge pools associated with the plunges accounted for 66% of the total cover in 1991 and undercut banks added another 24%. Pretreatment cover was 64% scour pools and 31% undercut banks. By 1993, 88% of the plunge pools had RPD 1.5 ft, or deeper, and cover averaged 78 sqft /plunge pool. Riparian vegetation grew vigorously posttreatment, indicating the plunges improved bank water storage and increased subirrigation of streamside plants (Figure 10-4).

Habitat Structures - Maintenance needs of the plunges were few as they required only occasional resealing. All plunges were rated as being in good condition in 1993.

Conclusions - Instream habitat improvement devices provided 52% more shelter for stocked juvenile trout and the trout population increased 1,418%. But intense fishing pressure removed most SRC soon after they reached catchable size, so special regulations were imposed in 1990 to control the harvest. After six years of this protection, plus having benefited from habitat improvement, trout longer than 6 inches were 4,118 % more abundant than pretreatment.

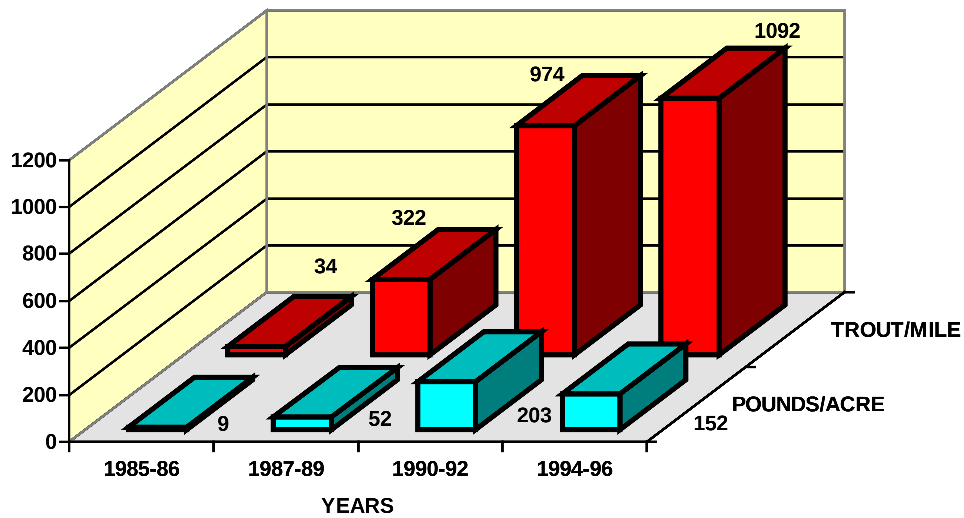


Figure 9-1. Abundance and biomass of trout longer than 6 inches in lower Bull Creek 1985-1992. Values are means for the years shown. Habitat improvement devices were installed in 1986 and restrictive angling regulations were imposed in 1990.

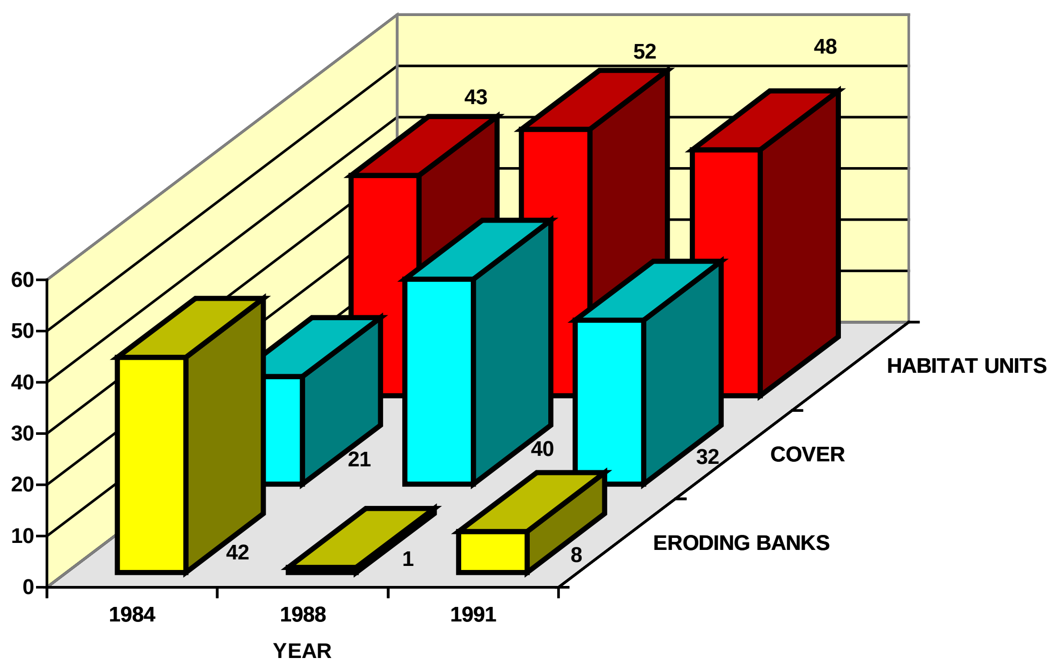


Figure 9-2. Eroding banks (%), cover (%), and habitat units at Bull Creek before and after habitat improvement in 1986.

Figure 10-3. Timber plunges installed in Bull Creek provided both plunge pools and dam pools to shelter trout.

Figure 10-4. In addition to improving shelter for trout with more pool habitat, the plunges aided streamside vegetation by increasing bank storage of water to better subirrigate plants.

INFORMATION SOURCES

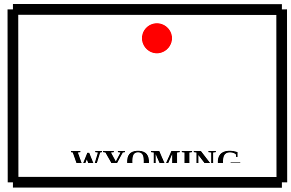
Hogle, J. S. 1993. Salmonid habitat and population characteristics related to structural improvement in Wyoming streams. Masters thesis. University of Wyoming, Laramie.

Stewart, B. 1995. Response of fish populations to a restricted harvest regulation on the upper North Tongue River and Bull Creek. Administrative Report, Project 30-833-030-17, Fish Division, Wyoming Game and Fish Department, Cheyenne.

Table 10-1. Summary of trout abundance and biomass at lower Bull Creek before and after habitat improvement.

			≥ 6 inches	
Year	Number/mile	Pounds/acre	Number/mile	Pounds/acre
Pretreatment				
1985	46	14	46	14
1986	21	6	21	6
Posttreatment				
1987	421	59	329	55
1988	458	62	431	61
1990	669	111	617	108
1991	1,018	134	783	126
1992	2,183	439	1,591	381
1996	2,475	195	1,434	162
Pretreatment Mean	34	10	34	10
Posttreatment Mean	1204	167	864	149
Percent change	3,441	1,570	2,441	1,390

BULL CREEK, UPPER



SHERIDAN COUNTY

Project Built: 1965

Drainage:	North Tongue River	**Tongue River Basin (8TR)**	
Elevation:	8,260 ft	**R.** 89 **W., T.** 55 **N., S.**16; SW 1/4	
Stream Order:	First	**Stream Class:** 3 (Regionally important fishery)	
Watershed Area:	7 sqmi	**Mean Wetted Width:** 15 ft	
Gradient:	0.7%	**Land Status:** Bighorn National Forest	
Rosgen Channel Type:	C-4	**Project Length:** 1,000 ft	
Treatment Used:	Digger-log devices, artificial spawning crib, wire fence exclosure.		
Trout Species:	Snake River cutthroat trout.		

DESCRIPTION OF STREAM: Bull Creek drains a conifer, meadow, and alpine watershed, flowing northerly to join the North Tongue River about 3.5 miles west of Burgess Junction. Snowmelt and springs are the primary water sources. Discharge peaks in June with the early snowmelt runoff, but remains adequate for trout through the summer and late summer flow is not a problem. Upstream from the upper meadow, valley type is generally “V” shaped with steep side hills and stream gradient is over 2%,

PROJECT DESCRIPTION: A poor two-track dirt road leading from Highway 14A provided access to the project area until 1998, when USFS closed the road at the campground near the highway. Structures were built in 1965 where the stream meanders through a large meadow located about 1.5 miles upstream from the highway. Access to the drainage above this “upper meadow” was by foot or horse only. WGF and USFS personnel worked together on the project. Primary project goal was to increase over winter survival and return-to-the-creel of stocked trout by providing additional deep pools and better shelter. A secondary goal was to see if better habitat would improve natural reproduction of trout.

THE FISHERY: Bull Creek has been stocked with various trout species since 1935, but none became established due to poor reproductive success. A survey in 1960 reported a few BKT and CUT in lowermost Bull Creek, but no trout were found in the upper reaches. Over the years, the fishery has historically been supported by stocking juvenile or catchable hatchery reared trout. Emphasis in 1965 was on SRC. Angling regulations were liberal then and angler use was light, but fishing pressure likely increased with construction of Highway 14A in 1968.

HABITAT MANAGEMENT: Pretreatment, the stream at the upper meadow project area featured extensive riffles and lacked deep pools or other shelter for trout. This meadow has historically been grazed heavily by livestock with attendant serious damage to stream banks. Sediment deposition was a serious problem, exacerbated by unstable stream banks in the drainage.

In 1964, to evaluate egg hatching success, eyed SRC eggs were placed in both egg boxes and artificial redds dug into riffles. Eggs planted in boxes hatched very successfully, but eggs planted in native gravel were less successful. Sediment buildup in the boxes increased steadily as summer progressed. A clay hardpan under the thin layer of gravel and cobble was believed to be suppressing natural reproduction. Even if trout could excavate redds in this material, water percolation through it would be poor. A recommendation was made to install an experimental spawning device using imported gravel.

In 1965, using materials obtained locally, WGF personnel manually installed 9 timber digger-log structures and built an artificial spawning crib at the upper meadow, which was filled with 2 cuyd of washed 1-inch gravel brought from Sheridan. Several digger-logs and the spawning crib were enclosed by a fence built by USFS personnel. Project cost was not recorded.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Posttreatment, the fishery continued to be supported by periodic plants of SRC juveniles and trout could usually be observed in the pools dug by the stream improvement structures. Evaluation of fishery response to the habitat improvement was confounded by irregular stocking of trout and lack of pretreatment samples. Posttreatment, trout abundance ranged from 45 to 510 trout/mile through 1978. The strong dependence of this fishery on the hatchery product was demonstrated when no trout were stocked in 1981 or 1982 and the population dropped from 510 trout/mile (1978) to 44 trout/mile (1983).

No evidence of spawning activity was noted at the spawning crib. And although spawning pairs of SRC were observed on riffles above the exclosure in 1966, no naturally reproduced trout were found posttreatment. In 1990, in response to increased fishing pressure, catch and release restrictions were imposed on Bull Creek. Fishing was allowed with only artificial lures or flies and all trout, except BKT, had to be released.

Habitat Response - As pool diggers, the digger-logs were successful and they provided holding and rearing water for stocked SRC for many years (Figure 11-1). Trout were often seen in the deeper digger-log pools. By 1993, these pools still harbored trout, but their RPD ranged from 0.6 ft to 1.7 ft. Only one plunge pool (11%) had RPD 1.5 ft, or greater, the minimum focal point depth for SRC. In those years when the exclosure was intact and did exclude livestock, streamside vegetation grew lushly inside the exclosure and grass hung down into the stream to shelter trout.

Habitat Structures - An inventory in 1993 located seven of nine digger-log structures. All seven were functional, but in various stages of disrepair. Many of the digger-logs were also functioning as grade controls. Only the downstream cross-timber of the spawning crib remained by 1993 and it had created a small pool.

Unfortunately, effectiveness of the exclosure has been erratic. When key USFS personnel were transferred, the fence was no longer maintained. Deep snow soon smashed the wires down, rendering the exclosure useless, and it was not functional for about 15 years in the 1970’s and 1980’s. USFS rebuilt the exclosure in 1986, but during several summers thereafter, the fence was down in several places and cattle grazed inside the exclosure. Unless the fence was repaired each year prior to livestock use of the area, the exclosure provided poor protection for the stream banks and habitat improvement structures.

Conclusions - Digger-logs installed in 1965 provided extra cover and deep holding water for stocked SRC and were still 78% functional 28 years after installation. Their condition ranged from fair to good, but by 1993 only one pool met RPD criteria for SRC. There was no evidence that the spawning device was successful. Effectiveness of the fenced exclosure was erratic due to lack of timely maintenance.

INFORMATION SOURCES

Mueller, J. W. And L. C. Rockett. 1966. The installation of an artificial spawning device in Bull Creek, Sheridan County. Project 664-3-1 (865-3-4), Administrative Report, Fish Division, Wyoming Game and Fish Department, Cheyenne.

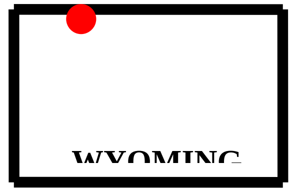
Rockett, L. C. 1965. Evaluation of conditions for natural reproduction in Bull Creek, Sheridan County, Wyoming. Project No. 664-3-1, Administrative Report, Fish Division, Wyoming Game and Fish Department, Cheyenne.

Figure 11-1. Built in 1965, a digger-log was still furnishing pool shelter for trout at the upper meadow on Bull Creek 25 years later.

CLARKS FORK RIVER

PARK COUNTY

PROJECT BUILT: 1981-1985, 1998



Drainage:	Clarks Fork River	**Clarks Fork River Basin (2CF)**	
Elevation:	4,310 ft	**R.** 103 **W., T.** 56 **N., S.** 22	
Stream Order:	Fifth, or greater	**Stream Class:** 3 (regionally important)	
Watershed Area:	~1,000 sqmi	**Mean Wetted Width:** 130 ft	
Gradient:	0.5%	**Land Status:** BLM	
Rosgen Channel Type:	C-3	**Project Length:** 3.4 miles	
Treatment Used:	Rock funnels, fish rocks, tree jams		
Trout Species:	Rainbow, brown, cutthroat, and brook trout		

DESCRIPTION OF STREAM: The Clarks Fork River drains the rugged North Absaroka Mountains located east of Yellowstone Park. Some of its headwaters are located in Montana, but many tributaries join the river in Wyoming as the river flows easterly to exit the mountains just upstream from the project area. USGS and WGF instream flow crew records indicate ADF is about 920 cfs, CPSF is 550 cfs, and the ASFV ratio is 27. Peak flow of record is the 100 year flood in June, 1981, which peaked at about 14,800 cfs. Stream flow is fed by an abundant snowpack and summer flows are more than adequate for trout. Maximum summer water temperature is 70-75F. In the project area, the river flows through arid rangeland and its stable channel is incised in a sand and rock terrain. A sandy stream substrate is well armored by boulders and rubble. Riparian vegetation is cottonwood trees, willows, and low-growing juniper bushes. Away from the river, vegetation is sparse and typical of a cold desert.

PROJECT DESCRIPTION: A cooperative venture between WGF, BLM, and the Park County Parks and Recreation Board, boulder structures were added to the river to increase cover for trout in the WGF Public Fishing Area. Major funding was provided by the Board, while construction oversight and project planning was done by WGF.

THE FISHERY: This section of the Clarks Fork River is not very productive and the fishery is supported by both wild and hatchery trout. A sand and boulder substrate limits natural reproduction. Whitefish are abundant through the project area.

HABITAT MANAGEMENT: Pretreatment, the river was typified by long reaches lacking deep pools. Shallow glides and runs were common. Rock funnels were built to concentrate flood flows, increase water velocity, and scour pools (Figure 12-1). Pocket pools were also expected to develop around the boulders. Boulders were gathered from terraces and benches near the stream by a private contractor, NEPECO of Byron. Working each spring at the PFA located just below the canyon, a large frontend loader used over 2,000 boulders to construct 15 boulder habitat improvement structures under WGF direction from 1981-1985. Numerous large fish rocks were also placed in the river.

In 1981-1982, three rock funnels were built in the Public Fishing Area upstream and downstream from the Highway 120 bridge. About 270 large fish rocks were also added to the river in this PFA. Costs of the 1981-1985 work was $11,570/mile. In 1998, seven tree jams were added to the PFA below the canyon, using 176 boulders and 88 trees, and another 50 boulders were used to reinforce several funnels.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Although several attempts were made to obtain meaningful population estimates, the size of the river precluded effective electrofishing. However, the sampling effort did establish that trout density increased posttreatment, and that 87% of the trout captured were found in association with the rock structures.

Trout Habitat Response - Much additional pool habitat developed near the boulder structures. Posttreatement, Hogle (1993) reported a 100% increase in HU and 120% increase in cover for trout. During high flows, the devices tended to slow and “pond” the river flow to some extent, which encouraged deposition of sediment along the shoreline. Considerable new willow and cottonwood tree growth developed on these new bars (Figure 12-2).

Habitat Structures - The boulder structures have proved durable, having endured a 100 year flood and smaller annual events. Some boulders have settled, but all structures remained functional in 1998.

Conclusions - Installation of the boulder structures more than doubled shelter for trout and the fishery has proved to be very popular with anglers. Although electrofishing proved ineffective in providing fish population estimates, 87% more trout were captured in association with the structures than elsewhere. Anglers often fished near the boulder structures because they caught more trout there.

INFORMATION SOURCES

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Hogle, J. S. 1993. Salmonid habitat and population characteristics related to structural improvement in Wyoming streams. Masters thesis. University of Wyoming, Laramie.

Saville, D. 1998. Clarks Fork fisheries habitat improvement and wetland development - environmental assessment. Cody Resource Area, Bureau of Land Management, Cody, Wyoming.

Stahl, L. 1998. Clarks Fork Stream Improvement. Typewritten report, Fish Division, Wyoming Game and Fish Department, Cody.

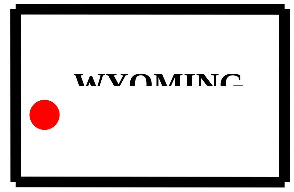
Figure 12-1. Two lines of boulders created a rock funnel to provide pool shelter and habitat diversity for fish in the Clarks Fork River. Instream fish rocks downstream from the slot of the funnel provide additional shelter.

Figure 12-2. Deposition of sediment along the shoreline near the rock funnels, plus better subirrigation of stream banks caused by ponding behind the devices, allowed establishment and lush growth of riparian vegetation, such as the willows shown here.

COAL CREEK

LINCOLN COUNTY

PROJECT BUILT: 1979-1981



Drainage:	Thomas Fork Bear River	**Bear River Basin (3BE)**	
Elevation:	7,010 ft	**R.** 119 **W., T.** 29 **N., S.** 13	
Stream Order:	Second	**Stream Class:** 4 (locally important)	
Watershed Area:	6 sqmi	**Mean Wetted Width:** 8 ft	
Gradient:	1.1%	**Land Status:** BLM	
Rosgen Channel Type:	C-4	**Project Length:** 5280 ft	
Treatment Used:	Timber plunges, upstream "V" plunge, rock dam, double deflectors, single deflectors, tree revetments, fenced enclosure		
Trout Species:	Bear River cutthroat trout		

DESCRIPTION OF STREAM: Coal Creek, a headwater tributary of the Thomas Fork Bear River, drains part of the Gannett Hills and is located about 20 miles south of Afton. Valley sides and the stream bottoms are desert-like. The riparian zone contains sagebrush, rabbit brush, sedges, and various grasses and forbs. Willows occur higher in the drainage, but are rare in the project area and the riparian area has no trees or large shrubs. But aspen and various conifers occur in the upper elevations and on north-facing slopes in some side draws. Rolling hills characterize the landscape, which is grazed by both cattle and sheep. Flow from scattered springs and infrequent summer rainfall feeds base flow, while the snowmelt runoff produces an annual spring flood. Flows may become crucially low and warm for trout in late summer. Stream substrate is gravel and silt.

PROJECT DESCRIPTION: After BLM implemented a Habitat Management Plan for the Coal Creek drainage, funds were allocated for an enclosure in the upper Coal Creek drainage and instream structures were built within it. This project was a cooperative venture between WGF and BLM. WGF furnished planning expertise, a construction crew, and equipment to build the instream structures and the enclosure. BLM furnished funds and some materials. Project goals were to stabilize eroding stream banks, provide additional summer and overwintering cover for BRC, and increase riparian vegetation growth. Instream structures were designed to help stabilize the stream channel by providing grade controls at intervals, as well as raise the water table and better subirrigate the riparian area to assist vegetation growth.

THE FISHERY: BRC are native to the Thomas Fork drainage and are considered a "sensitive" species. As in other small headwater streams, trout numbers in Coal Creek may fluctuate widely from year-to-year and are very sensitive to flow conditions. Access to the project area is by poor jeep road, which greatly reduces angler use of the fishery. Special fishing regulations were instigated in 1982 to protect the BRC population: all BRC under 10 inches were to be released and angling was by flies or lures only.

HABITAT MANAGEMENT: Extensive grazing by livestock over many years had greatly affected the upper Coal Creek drainage. Streamside vegetation was dominated by more tolerant species, and the vigor of willow and aspen stands had been reduced by cattle trampling and feeding on young shoots. Beaver activity was consequently much reduced by a shortage of food and materials for building dams. Stream bank erosion was wide spread and vegetative vigor was much reduced along the stream (Figure 13-1). In 1979, a WGF construction crew enclosed about 1 sqmi of creek bottoms and valley sides with a wire and pole fence. No costs were recorded. Then to improve habitat conditions for BRC, instream structures were built within the enclosure. In 1980, a WGF construction crew installed 6 timber plunges (Figure 13-2), 3 single deflectors, 3 double deflectors, and one each of log plunge, upstream "V" plunge, rock plunge, and wire trash catcher. The rough terrain and poor access to the project meant no rocks or trees could be imported. Only rocks found on site were available to armor structures. Aspen tree revetments were built at eight eroding banks and 35 pools were improved in the canyon by rearranging rocks. Project cost was $4,050 ($4,050/mile).

In 1981, a WGF crew built a 1.5 acre wire and pole fence enclosure around a cold spring located on state land a few hundred yards upstream from the BLM enclosure. Objective was to allow vegetation to grow and shade the spring flow so the cold water could reach Coal Creek. Cost of the enclosure was $3,570.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Trout abundance had increased 132% seven years after the instream structures were installed (Figure 13-3). Biomass was up 11% (Figure 13-4). Abundance of trout 6 inches, or greater, was 55% greater, but their biomass was 16% less than pretreatment. Mean length of BRC decreased from 6.9 inches to 5.6 inches. An electrofishing sample five weeks after structures were built reported an mean length of 9.6 inches, suggested that the new habitat immediately attracted any larger trout in the vicinity. Total trout population at that time was about double the pretreatment level.

Unfortunately, the better habitat was not sufficient to overcome other habitat limitations, such as warm temperatures and low stream flows during drought. In 1987 following several good water years, BRC abundance was 442/mile, but no fish were found in 1989 during drought. When the population was again checked in 1995, abundance was 290 trout/mile.

Trout Habitat Response - HQI analysis of habitat response to the habitat improvement reported a 10% gain in habitat units seven years after treatment (Figure 13-5). Cover for trout had doubled and bank stability had improved 48%.

Although maintenance of the enclosure fence by BLM was irregular and some cattle grazed inside at intervals, overall vegetation response was good over the long term (Figure 13-6). Growth of streamside sedges and grasses was noticeably better posttreatment (Figure 13-7). Deep pools were provided by the structures and undercut banks developed as the streamside vegetative cover improved. Use of aspen in the tree revetments was a mistake because beaver immediately took advantage of that new food supply and built a complex of dams, which created new pool habitat for trout and aided riparian vegetation, while drowning out several structures. The overall effect of the beaver ponds were likely positive, but benefits were transient because floods periodically washed out the dams. Building material and food were once again restrictive for the beaver once the imported aspens were depleted. From the standpoint of water temperatures, shoal areas in the pond became warm during summer, but the deep, original channel was cool and water exiting the dam was several degrees colder than water entering the pond.

Vegetation grew well inside the spring enclosure, especially after the local range rider was persuaded not to pasture his spare horses inside the enclosure. This vegetation shaded water flowing from the enclosed spring so it was cooler than the stream.

Figure 13-1. Pretreatment, stream bottoms at upper Coal Creek had been extensively grazed by livestock for so many years that streamside plant vigor was much reduced and only more tolerant species grew. Watershed health was poor.

Figure 13-2. A freshly installed timber plunge in Coal Creek already provides pool habitat to shelter trout.

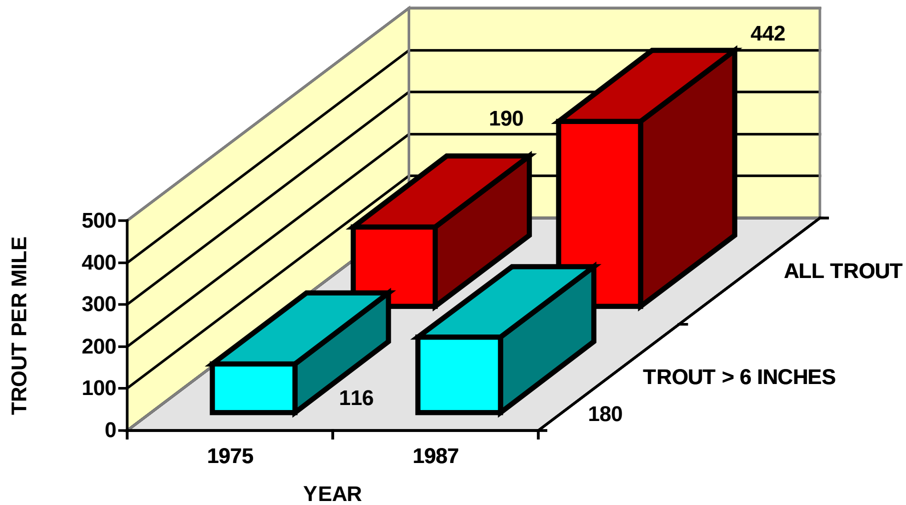


Figure 13-3. Abundance of BRC in Coal Creek before (1975) and seven years after habitat improvement structures were installed.

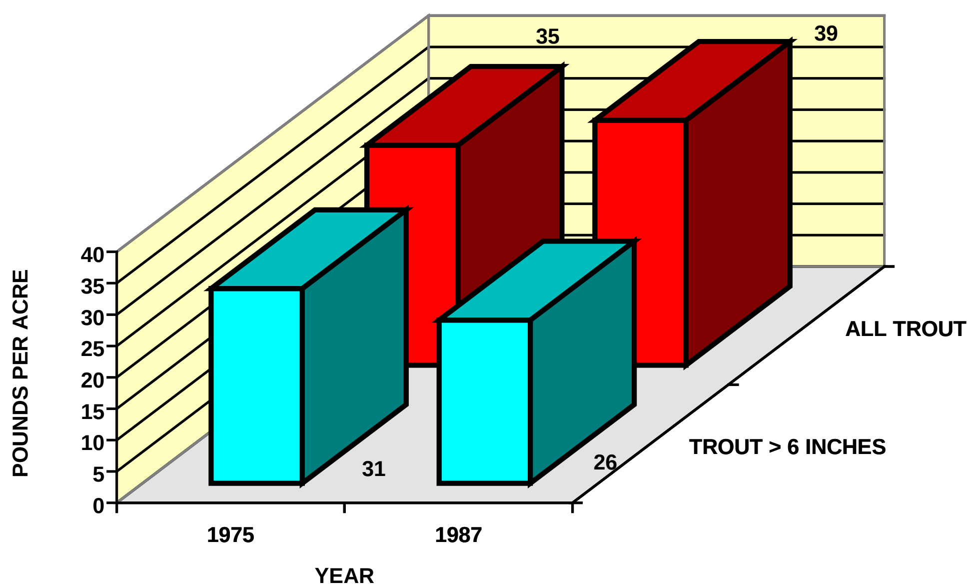


Figure 13-4. Biomass of BRC in Coal Creek before (1975) and seven years after habitat improvement structures were installed.

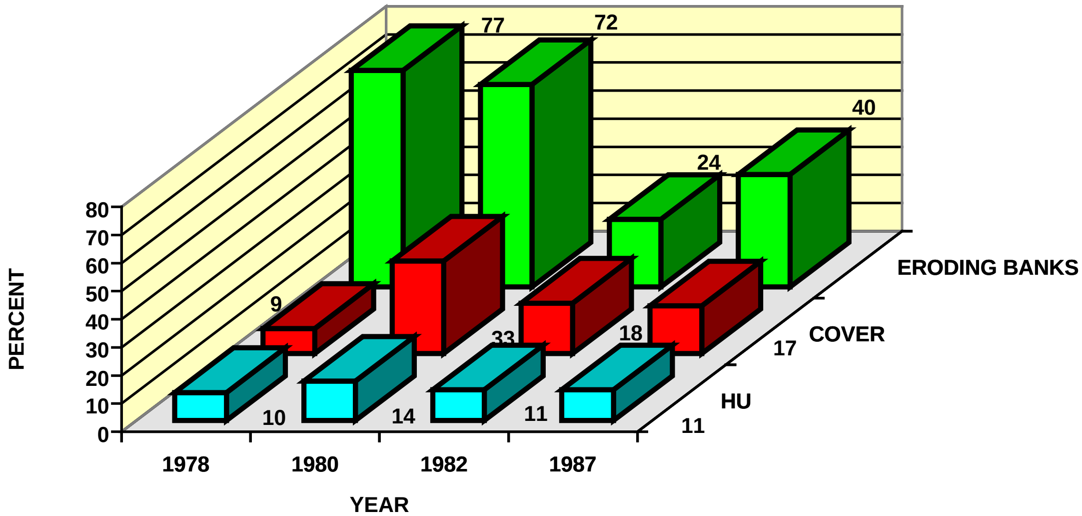


Figure 13-5. Changes in eroding banks, cover for trout, and HU at Coal Creek before (1978) and after habitat improvement.

Habitat Structures - By 1995, most of the structures were intact despite being exposed to several major floods, including a 75-100 year flood in 1984. But at least one timber plunge, a deflector, and the log plunge were destroyed within a year or two after installation. Fine-grained soils proved susceptible to erosion and allowed the stream to wash around these structures. Lack of a good rock source definitely limited how well structures could be armored against floods.

Conclusions - Construction of an enclosure and instream habitat improvement structures aided the trout population over the long term. Seven years posttreatment, trout abundance had increased 132% and biomass was up 11%. Catchable trout abundance had improved 55%, but their biomass dropped 16%. Mean length of BRC decreased 19%. Unfortunately, stream flow in this headwater stream continued to control the fish population, which crashed during dry spells. However, the improved habitat provided allowed trout to regain their former abundance once stream flows became better.

INFORMATION SOURCES

Dey, P. 1996. Instream flow crew observations and recommendations - Coal Creek. Memorandum dated 12 June 1996, Aquatic Habitat Crew files, Fish Division, Wyoming Game and Fish Department, Lander.

Binns, N. A. 1981. Bonneville cutthroat trout, *Salmo clarki utah*, in Wyoming. Fisheries Technical Bulletin No. 5, Fish Division, Wyoming Game and Fish Department, Cheyenne.

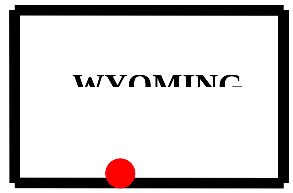
Figure 13-6. Upper Coal Creek within the enclosure after ten years. Due to lack of regular maintenance, the exclosure did not provide complete protection from livestock grazing and vegetation within the fence was grazed sporadically. Even so, the riparian vegetation growth, as seen here, was better in 1989 than it was pretreatment.

Figure 13-7. When the exclosure fence was intact and provided protection from livestock grazing, grasses and sedges grew abundantly in the stream bottoms.

CURRANT CREEK

SWEETWATER COUNTY

PROJECT BUILT: 1990-1992



Drainage:	Flaming Gorge Reservoir	**Eastside Flaming Gorge Tribs Basin (3ES)**	
Elevation:	7,020 ft	**R.** 106 **W., T.** 14 **N., S.** 11	
Stream Order:	Second	**Stream Class:** 4 (locally important)	
Watershed Area:	20 sqmi	**Mean Wetted Width:** 8 ft	
Gradient:	0.9%	**Land Status:** BLM, state	
Rosgen Channel Type:	C-4	**Project Length:** 3.5 miles	
Treatment Used:	Timber plunges, exclosures, grazing management change		
Trout Species:	Colorado River cutthroat trout and brook trout		

DESCRIPTION OF STREAM: Currant Creek drains a north aspect of Little Mountain, then flows westerly to Flaming Gorge Reservoir. In the project area, the creek is situated in a deep canyon. Away from the stream, the arid landscape is mostly sagebrush, rabbitbrush, and greasewood. Sedges, grasses, and some willows grow in the narrow riparian zone. In many sections, the creek is deeply incised in the valley floor and cut banks are common. Aspen and conifers grow in the upper watershed. Stream flow is fed by snowmelt, occasional rainfall, and springs. Discharge and water temperatures in the project area are generally adequate for trout, but both may reach crucial levels during occasional drought years. Downstream from the project area, water quality deteriorates from an increased silt load.

PROJECT DESCRIPTION: Located about 25 miles south of Rock Springs, the Currant Creek project was a cooperative venture between WGF, BLM, the Flaming Gorge/Lower Green River Chapter of Trout Unlimited (TU), and local ranchers. BLM negotiated grazing agreements to allow for a period of rest at the project area and supplied a backhoe and operator, fence materials, food for volunteers, equipment and assistance for hauling material to the site, and manpower during construction. Local ranchers granted access across private land so equipment, materials, and manpower could more easily access the project. They also cooperated with changes in grazing management. TU provided trees for planting at each structure, funds to buy some of the materials, and many hours of volunteer labor during construction. WGF supplied equipment, manpower, planning expertise, and materials. Partial funding was supplied through a $15,000 WGF habitat enhancement grant. Objectives of the habitat improvement effort were: 1) increase deep pool and overwintering habitat for CRC, 2) install a series of grade control devices to reduce swift stream velocities, lateral erosion, and channel downcutting, and 3) stimulate growth of riparian vegetation by raising the water table and increasing sub-irrigation on the floodplain.

THE FISHERY: Pretreatment, Currant Creek contained one of the few remaining wild CRC populations in the Little Mountain area and had been graded "B" for purity. As CRC are considered a sensitive species, status of the Currant Creek population was cause for concern. A wild BKT population is also well established in the drainage. Since anglers had to access the stream either through private land (by permission only), or by a poor two track dirt road down the side of the canyon, fishing pressure has historically been light. Statewide fishing regulations applied in the 1980's, but when annual surveys indicated a declining CRC population, the stream was closed to all fishing in 1990. From 1990-1994, pure strain hatchery reared CRC fingerlings were stocked annually to upgrade the population.

HABITAT MANAGEMENT: Over the years, irrigation and grazing practices, design of road crossings, and eradication of beaver had all contributed to deterioration of watershed condition and degradation of the stream channel. Nickpoints and channel downcutting had created a channel that was deeply incised in the valley floor at some places. At Janes Meadow, livestock had extensively grazed the floodplain and riparian vegetation was cropped short. Eroding banks were common through the project area and the stream bottom was silty pretreatment. Although a few lateral scour pools and undercut banks were present at the meadow, cover for trout was rated poor, being only 7% in 1979. Since CRC overwinter in deep pools, the lack of deep pools was a serious habitat shortcoming.

To correct these problems, a work crew from the cooperating entities installed 15 timber plunges in 1990, 12 in 1991, and 15 in 1992. Structures were placed in suitable sites at Janes Meadow and downstream to near Dry Hollow. To overcome the lack of a suitable rock source, bags of "Rich Rap" concrete were used to armor banks at each plunge. Bags were set in place and the concrete cured after moisture seeped in through permeable bag liners, thus forming a concrete "rock" when the paper rotted away. Aspen, mountain alder, and western red birch were planted within small enclosures made from welded mesh fence. These mini-enclosures were erected on both banks at each plunge to protect both plantings and plunges from cattle. A cost accounting summary was prepared only for work done in 1991. Project cost for 1991 was $20,170. Assuming similar costs for the other two years, total project cost was about $60,500 ($17,300/mile)

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Pretreatment, poor habitat conditions amplified and exaggerated fluctuations in the population . For example, drought in 1990 caused a sharp drop in abundance. Posttreatment, habitat was better, but evaluation of trout response to the habitat improvement was confounded by the stocking of juvenile CRC. However, wild BKT abundance (13%) and biomass (97%) increased after habitat improvement, which suggests the overall trout population would also have benefited from the habitat improvement. Catchable-size BKT mean abundance improved over six fold, and their mean biomass, more than doubled posttreatment. Abundance and biomass of all trout 6 inches, or greater, more than doubled following installation of the plunges (Figures 13-1 and 13-2, Table 13-1).

Trout Habitat Response - No formal evaluation was made of trout habitat changes, but the new plunges produced good plunge pools, controlled grade, stopped headcuts, and caused silt to deposit upstream from the plunge. Reduced grazing at Janes Meadow, and better sub-irrigation of the floodplain, prompted good growth of vegetation thereon and that, in turn, led to better instream fish cover. Re-establishment of sedges and other streamside vegetation on sediment deposits soon narrowed the stream. More cover for trout was formed as bank stability improved, undercut banks formed, and bankside vegetation drooped into the water.

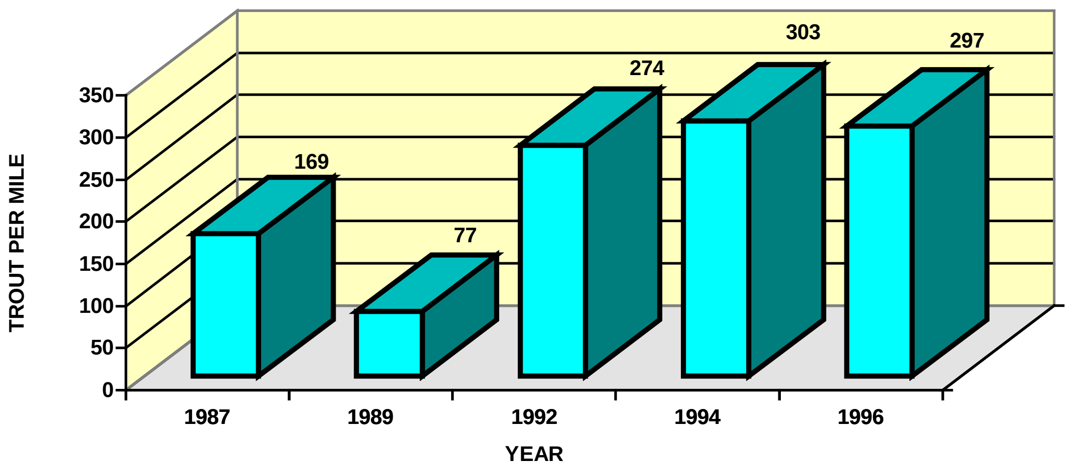


Figure 14-1. Abundance of trout 6 inches, or greater, at Currant Creek before (1987-1989) and after habitat improvement.

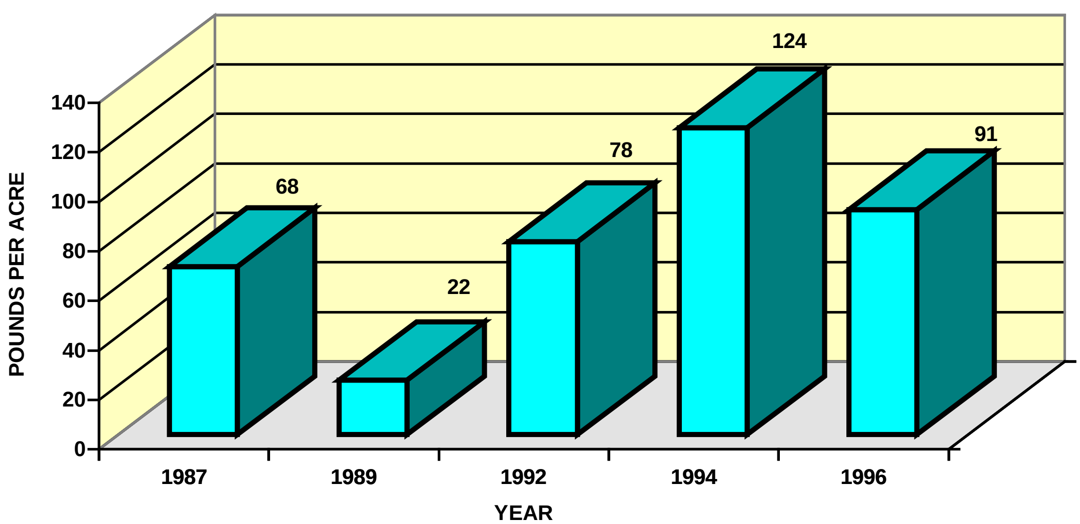


Figure 14-2. Biomass of trout 6 inches, or greater, at Currant Creek before (1987-1989) and after habitat improvement.

Habitat Structures - Minor maintenance was required at several plunges each year following installation. Durability and performance of the plunges was good. However, the 1993 spring runoff flushed much sediment into upper Janes Meadow, burying the old channel and forming a bypass channel, which threatened to capture all stream flow and thus isolate several plunges. Sediment also plugged several plunge pools and buried one plunge. To counteract this problem, a sandbag dike was built to force all flow back into the old channel. This effort was successful and the buried plunge pools soon began to clean themselves of sediment.

Conclusions - Installation of plunges created deep pool habitat at Currant Creek. This effort, plus watershed-wide changes in grazing practices that improved streamside conditions, increased shelter for trout. Posttreatment, catchable-size wild BKT abundance increased six fold, while biomass doubled. Abundance and biomass of all catchable-size trout more than doubled.

Table 14-1. Abundance and biomass of trout at Currant Creek before and after habitat improvement.

			Trout ≥ 6 inches	
Year	Number/mile	Pounds/acre	Number/mile	Pounds/acre
Pretreatment				
1987	296	72	169	68
1989	88	26	77	22
Posttreatment				
1992	285	78	274	78
1994	358	126	303	124
1996	332	92	297	91
Pretreatment mean	192	49	123	45
Posttreatment mean	325	99	291	98
Percent change	69	102	137	118

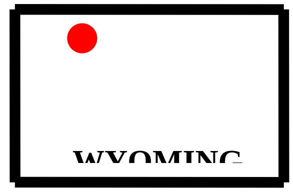
Figure 14-3. Pretreatment, Currant Creek at Janes Meadow was heavily grazed by livestock for many years. Deep pools were lacking and bank erosion was common.

Figure 14-4. Reduced livestock grazing and better subirrigation aided recovery of riparian vegetation at Janes Meadow. Deep plunge pools furnished good shelter for trout.

DEAD INDIAN CREEK

PARK COUNTY

PROJECT BUILT: 1980



Drainage:	Clarks Fork River	**Clarks Fork Basin (2CF)**
Elevation:	6,034 ft	**R.** 104 **W., T.** 55 **N., S.** 8, SW1/4
Stream Order:	Third	**Stream Class:** 3 (regionally important)
Watershed Area:	53 sqmi	**Mean Wetted Width:** 29 ft
Gradient:	3.8%	**Land Status:** Shoshone National Forest
Rosgen Channel Type:	B-3	**Project Length:** 1,320 ft
Treatment Used:	Wood deflectors, tree/rock revetment, fish rocks	
Trout Species:	Yellowstone cutthroat, rainbow, and brook trout	

DESCRIPTION OF STREAM: Dead Indian Creek is a steep gradient, mountain stream that heads in the North Absaroka Wilderness. Its watershed is bounded by steep, rugged mountain peaks, such as Dead Indian Peak, elevation 12,216 ft, and Trout Peak, elevation 12,244 ft. Alpine vegetation, conifer patches, and mountain meadows occur in the watershed. Riparian vegetation in the project area is primarily willow, cottonwood, conifer, grass, and forbs. Stream flow is fed by both snowmelt and springs. An annual snowmelt flood flushes the channel during May and June but late summer stream flow remains adequate for trout. Stream substrate at the project area is 53% boulders (> 6 inches), 16% cobble, 30% gravel, and 20% fines. Late summer fish food production is good with about 300 macroinvertebrates per sqft. Macroinvertebrate biodiversity is excellent (DAT diversity, 22) and the BCI is 100.

PROJECT DESCRIPTION: Habitat improvement at Dead Indian Creek was a cooperative venture between WGF and the Shoshone National Forest. USFS contributed $1,500 and a source for rocks and trees, while WGF furnished construction expertise and equipment. Only about one-fourth mile of stream near the USFS campground was included in the habitat improvement effort. Project goal was to increase shelter for trout so catchable trout would stay in the heavy use area near the campground until caught. But limited funds and a long, expensive rock haul reduced habitat management options for this small project and only a few structures were built.

THE FISHERY: Except for about one mile near the campground, angler access to Dead Indian Creek is restricted by rugged terrain to foot or horse travel. Although wild trout occur in Dead Indian Creek, natural reproduction is limited, and the wild fish population was unable to support a fishery near the campground due to extensive angler use. Considerable tourist traffic passes through this area as the Dead Indian Pass road provides access to the Northeast Entrance at Yellowstone National Park. Thus, the fishery has historically been supported with annual plants of catchable trout, especially through the campground where use is heaviest. Adequate harvest of these fish depends on the fish staying in the heavy use area for at least one summer, but electrofishing surveys indicated few fish stayed put after being stocked.

HABITAT MANAGEMENT: Pretreatment, the stream had few pools suitable to hold trout through the summer. Streamside vegetation and bank stability was affected by heavy grazing and trampling by cattle. To provide additional pocket pool habitat for trout and stabilize eroding stream banks, a WGF construction crew installed 41 fish rocks, 2 deflectors, and 180 ft of tree/rock revetment (Figure 15-1). Rocks used in the project were hauled in by private contractor from Lily Lake. Location and type of structure was limited both by the small supply of rocks and poor access to the stream through the campground due to camping units and vegetation. Project cost was $2,970 ($11,880/mile). In 1982, USFS excluded livestock from the campground with a fence.

Figure 15-1. Boulder fish rocks (foreground) and a tree/rock revetment (far edge of stream) provided additional shelter for trout in Dead Indian Creek.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Mean trout abundance increased 13% posttreatment and trout appeared to be better distributed throughout the study station (Figure 15-2). Instream boulders were providing holding cover and trout were found in these pocket pools.

Trout Habitat Response - No habitat measurements were taken.

Habitat Structures - In June, 1981, intensive and extended rainfall on the snowpack generated a 100 year flood, which washed away at least one camping unit and part of the campground road at the lower end of the campground. Considerable stress was placed on the habitat improvement structures. Clusters of fish rocks were shifted from their original position by the flood, but continued to provide pocket pools usable by trout. Other fish habitat features through the campground were also altered by the flood. Near the damaged camping unit and road, instream trout habitat was further damaged when USFS repaired flood damage by channelizing the stream, armoring banks with large boulders, and removing the deflectors.

Conclusions - Some additional cover was provided by the fish rocks, but fish response was minimal due to the small scale of the project and the severe flood damage in 1981.

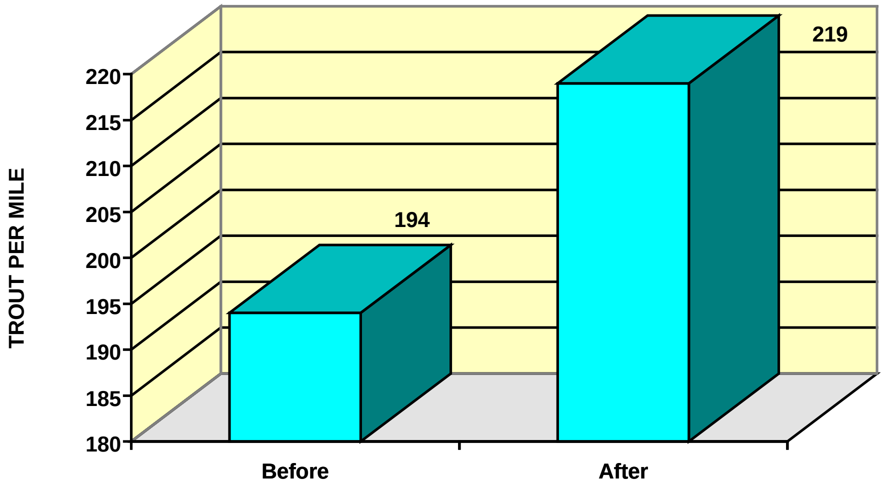


Figure 15-2. Mean trout abundance in Dead Indian Creek before (1975-1976) and after (1983-1985) habitat improvement.

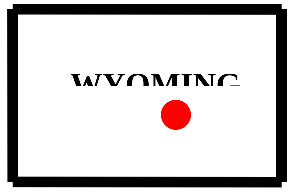
INFORMATION SOURCES

Kent, R. 1984. Observations of habitat and the fishery of Dead Indian Creek, Park County, Wyoming. Administrative Report, Project No. 2284-08-7302, Fish Division, Wyoming Game and Fish Department, Cheyenne.

DEER CREEK

CONVERSE COUNTY

PROJECT BUILT: 1986



Drainage:	North Platte River	**North Slope Laramie Range Basin (1LR)**	
Elevation:	7,010 ft	**R.** 77 **W., T.** 30 **N., S.** 14, NW 1/4	
Stream Order:	Fourth	**Stream Class:** 2 (statewide importance)	
Watershed Area:	60 sqmi	**Mean Wetted Width:** 16 ft	
Gradient:	1.2%	**Land Status:** Medicine Bow National Forest	
Rosgen Channel Type:	B-3	**Project Length:** 1,000 ft	
Treatment Used:	Boulder deflectors, tree and rock revetments, fish rocks		
Trout Species:	Brown and rainbow trout		

DESCRIPTION OF STREAM: Extreme streamflow fluctuation characterizes streams in the Laramie Range, where rugged, granitic formations dominate the watershed, soil layers are thin, and water flows readily from the landscape. During snowmelt and storm runoff events, stream discharge is high and forms wide channels. But during the rest of the year, base flows often become critically low. Deer Creek is subject to these same conditions, but at the project site, it is large enough to have relatively good base flows and aquatic productivity. The project is located in upper Deer Creek Canyon, a rocky, rugged "V" shaped canyon that the stream has cut through granite. Upstream from the canyon, the watershed contains both granite and easily eroded sandstone and conglomerate formations. Severe bank erosion is common there and contributes to a high sediment load in Deer Creek during floods. Despite the rocky nature of the canyon, stream bank erosion is a problem. Excessive livestock grazing in the watershed has been linked to bank instability, as well as decreased aspen and cottonwood regeneration. Decreased beaver activity in tributaries has also affected bank stability, sediment transport, and runoff pattern in the watershed.

PROJECT DESCRIPTION: This project was a coop effort between WGF and the Medicine Bow National Forest. An original project proposal was to defer livestock grazing by fencing them from the project area for at least five years. Then install fish habitat improvement structures to control bank erosion and provide better shelter for trout. Riparian improvement measures would also be undertaken. An USFS environmental assessment approved this course of action. But first, a pilot project was undertaken to determine structure types that would best endure the periodic severe floods. Accordingly, a joint WGF and USFS crew worked with a private contractor to install a few habitat improvement devices in a short section of Deer Creek. An experimental drift fence was also built by USFS to keep cattle from the project area. Unfortunately, due to lack of funds, loss of key USFS personnel, and an inadequate source of rocks, the larger project was never undertaken.

THE FISHERY: Access is by a very rough two track road. As much of the watershed is private land, and the 0.75 mile parcel of forest land is isolated, public access depends on the willingness of landowners to allow public passage across their land. Despite these access limitations, this fishery is popular with the public. An electrofishing sample in 1985 found 2,376 trout/mile and 295 lbs/acre. Both brown trout and rainbow trout were abundant. Standard statewide fishery regulations apply.

HABITAT MANAGEMENT: Severe bank erosion existed in the project area. Some steep cutbanks had little chance of healing without help, so the pilot project focused on one cutbank and a low eroding bank. A joint WGF and USFS crew worked with a private contractor and his front-end loader to install three boulder deflectors, several cover trees, 400 ft of tree and rock revetment, and 25 fish rocks in Deer Creek (Figure 15-1). Trees and large boulders were gathered locally, but finding enough boulders of adequate size proved difficult. Cost of these structures was $4,740 ($25,030/mile). An experimental drift fence was built by USFS along the forest boundary just north of the pilot project to keep cattle from the project area. USFS also planted willow shoots along stream margins.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - No evaluation was done.

Trout Habitat Response - No formal evaluation was done, but photos were taken and a visual inspection ten years after construction found the deflectors had formed sediment bars where willow growth was better than pretreatment, the stream had narrowed there to scour a deep pool, and the cover trees appeared to still be effective to some extent (Figure 15-2). At the low bank, bank stability was improved, but stability at the cutbank appeared to be only about 75% better than pretreatment.

Habitat Structures - Visual evaluation confirmed durability and integrity of the rock structures, but the cover trees and trees used in revetments proved to be less durable.

Conclusions - This project was too small to affect other than site specific fishery values, but the boulder structures have demonstrated good durability, with little shifting of rocks. Effectiveness of the drift fence was debatable, as cattle frequently trespassed into the project area through damaged fence sections.

INFORMATION SOURCES

Anonymous. 1984. Deer Creek riparian and fish habitat improvement project, environmental assessment and decision notice. USDA Forest Service, Laramie Peak Ranger District, Medicine Bow National Forest, Laramie.

McMillan, J. 1989. A fishery and habitat survey of the Deer Creek drainage, Converse and Natrona County, Wyoming. Administrative Report, Fish Division, Wyoming Game and Fish Department, Cheyenne.

Figure 15-1. A boulder deflector and a tree/rock revetment (far bank) as they appeared soon after construction in 1986.

Figure 15-2. Ten years after construction, the boulder deflector is intact and functional, but the tree/rock revetment on the far bank has deteriorated. Good growth of willow and other vegetation has developed on the bar formed upstream and downstream from the deflector.

FLAT CREEK

TETON COUNTY

PROJECT BUILT: 1984-1987

Drainage:	Snake River	**Snake River Basin (4BJ)**	
Elevation:	6,250 ft	**Location:** R.116 W., T. 41 N., S. 2, 11	
Stream Order:	Second	**Stream Class:** 3 (regionally important fishery)	
Watershed Area:	100 sqmi	**Mean Wetted Width:** 30 ft (mid-August)	
Gradient:	0.2%	**Land Status:** National Elk Refuge - USFWS	
Rosgen Channel Type:	C-4	**Project Length:** 2.5 miles	
Treatment Used:	Wood deflectors, rock deflectors, skyhook bank cover devices, tree revetments, rock riprap, rock funnel, and pool excavation.		
Trout Species:	Brook and Snake River cutthroat trout.		

DESCRIPTION OF STREAM: In the project area, Flat Creek meanders through a broad treeless meadow containing few willows. Condition of the watershed is fair to good, but is affected by about 10,000 elk wintering on the refuge. Stream flow typically peaks (175-200 cfs) in May or June from snowmelt, but springs also contribute all year long. And summer discharge, 50-100 cfs, is augmented by transbasin diversion from the Gros Ventre River. Flat Creek transports the diverted water to South Park for irrigation of hayfields. Flow drops sharply to 30 cfs, or less, after the diversion is shut off in October. Riffle substrate at the HQI stations is 5% cobble, 45% gravel, and 50% fines. Sinuosity is 2.8 and maximum summer water temperature is about 68^{o}F.

PROJECT DESCRIPTION: A large-scale project plan was developed by WGF in 1983 for the 2.5 mile section of Flat Creek upstream from Nowlin Creek, which is located on the National Elk Refuge about three miles north of Jackson. During 1984-1987, a cooperative habitat improvement effort by TU (Jackson Hole Chapter), WGF, and USFWS improved instream habitat in a mile of stream near the Federal Fish Hatchery. This mile long project is the focus of the evaluation reported in this report. TU raised money to rent extra equipment and help pay project expenses; they also furnished 30 man days of volunteer labor. Additional labor was provided during the 1980's by YCC personnel and students from Jackson High School ("Take Pride in America" program). USFWS provided an Environmental Assessment, equipment, and manpower, while WGF provided project design, a 404 permit, equipment, manpower, project evaluation, and construction oversight. Trees and rocks were trucked to Flat Creek, while the other structures were built from lumber purchased locally. Total project cost was $79,070: $37,910 from WGF, $32,160 from TU, and $9,000 from USFWS ($30,410/mile). Project leader was Ralph Hudelson (WGF).

THE FISHERY: Flat Creek is very popular with anglers and supported an estimated 1,900 angler days for wild SRC and BKT in 1988. The fishery is noted for trophy SRC longer than 20 inches total length and harvest is controlled by special regulations, with a trend over the last decade toward more stringent regulations. Currently, the fishing season is 1 August to 31 October, angling is by artificial flies only, and the limit is one SRC over 20 inches per day.

HABITAT MANAGEMENT: During 1932-1966, water diverted into Flat Creek via the North Gap diversion canal washed sediment from canal to creek. This massive sediment influx plugged riffles and filled pools, thus reducing trout spawning, nursery, rearing, and shelter areas in Flat Creek. In 1966, an aqueduct was installed, but much sediment remained instream. By 1984, much of the stream remained wide and shallow, with silty substrate, little cover, and poor trout productivity.

From 1978 to 1983, YCC crews installed several tree revetments between Nowlin Creek and the hatchery outfall. In 1983, they built a one acre buck and pole exclosure to reduce elk grazing on willow shoots along the stream. Also in 1983, several riffles were cleaned of sediment using a small “riffle scrubber”, which proved ineffective at Flat Creek.

During 1983, a habitat improvement plan was designed to stabilize stream banks, provide better cover for trout, and narrow and deepen the stream by promoting sediment deposition in point and lateral bars. A narrower channel, with its deeper, swifter flow, would encourage natural cleaning of fine sediment from riffles. To speed the process, a backhoe scraped riffles to loosen substrate, and selected pools were excavated. Wooden bank overhangs mimicked overhanging bank cover, while deflectors directed stream currents. Eroding banks were stabilized with trees and rocks.

In 1984, a WGF construction crew installed fish habitat improvement devices in 1,400 ft of Flat Creek near the Jackson National Fish Hatchery. They built 13 rock-filled wooden deflectors, one rock deflector, and stabilized 570 ft of stream bank with five tree revetments (Figure 17-1), using 56 conifers backed with rock riprap. At seven sites, 800 cuyd of sediment was excavated to create a pool with 8,000 sqft of surface area - this material was spread along the stream banks, where it revegetated naturally.

In 1985, habitat was improved in 3,200 ft of stream from the hatchery outfall upstream to the 1984 work. After TU members built 167 8-ft skyhook bank cover panels (Figure 17-2), see Hunt 1993 for design), a work party installed 1,336 ft of skyhook bank overhangs, 800 ft of tree revetment, 100 ft of rock riprap (Figure 17-3), 17 rock deflectors, and 13 log deflectors. Downstream from these structures, but just upstream from the hatchery outfall, a large pool was excavated as a sediment trap. Several other pools were excavated and the material spread along the banks.

No structures were installed in 1986 due to unusually high flow and this delay allowed observation of stream response to the structures. In 1987, skyhook bank overhangs and a rock funnel were added to 650 ft of stream below the hatchery outfall. In 1994, three drop structures were installed in Flat Creek just below the aqueduct to dissipate velocity and reduce bank cutting. This was a NRCS erosion control project and is not included in project cost figures presented above.

EVALUATION OF TROUT HABITAT MANAGEMENT

<u>Fishery Response</u> The trout population was monitored at two sites containing habitat improvement structures and at two untreated sites downstream from the habitat project. Evaluation was complicated by trout moving downstream after diversion water was shut off each year in early October. This problem can avoided by comparing only fish samples taken in September.

From 1984-1992, SRC abundance increased steadily (Figure 17-4, Tables 17-1 and 17-2). Eight years after treatment began, total SRC abundance was 561% greater than pretreatment, and biomass had increased 453%. In 1990-1992, total trout abundance in the treated area was 10% greater than in the untreated area. Biomass was up 45% (Figure 17-5). SRC longer than 15 inches were 43% more abundant post-treatment (Figure 17-6). Although common in upper Flat Creek, few BKT occurred pre-treatment (30/mile), mainly in the upper project area. BKT abundance increased markedly post-treatment, but peaked in 1987 (193/mile) and declined thereafter, apparently due to displacement by the expanding SRC population (Figure 17-4). Annual counts of SRC redds indicate little change in spawning activity attributable to the habitat improvement project.

Trout Habitat Response In response to the instream structures, the low flow channel narrowed from 31 ft to 23 ft at one transect, and from 37 ft to 23 ft at another. Considerable sediment deposited in tree revetments, point and lateral bars, the silt trap, and downstream from deflectors. Pools developed near most deflector points and the thalweg became more sinuous. Trout were obs-

Figure 17-1. A bank protected with a tree revetment as it appeared six years posttreatment. A deep slot was excavated in the channel along the tree edge when the trees were installed.

Figure 17-2. Four years posttreatment, a bank protected by skyhook bank panels offers overhead bank cover for trout.

Figure 17-3. Rock riprap was used to stabilize only a few banks at Flat Creek. Five years posttreatment, the rocks retain their original configuration and the wing deflector has caused the low flow channel to narrow as sediment has deposited in a bar downstream from the deflector.

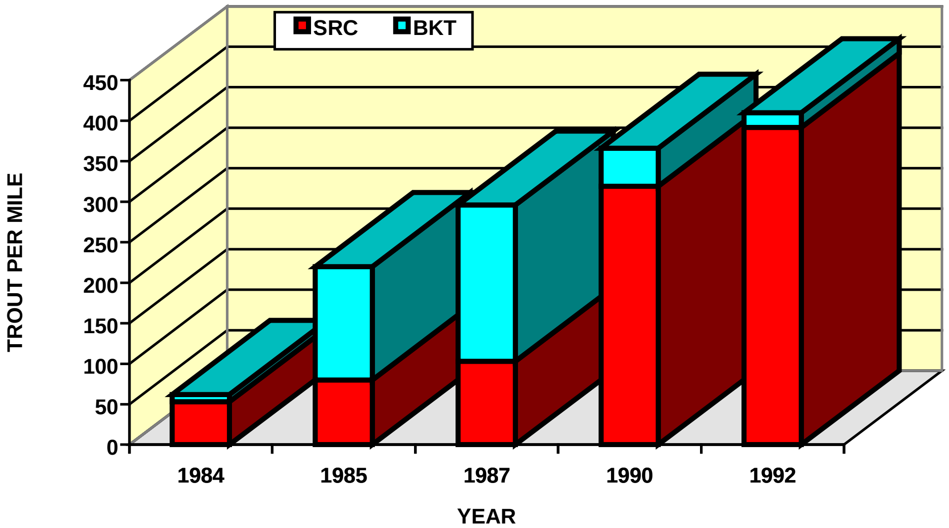


Figure 17-4. Trout abundance in September at Flat Creek from 1984 (pretreatment) through 1992.

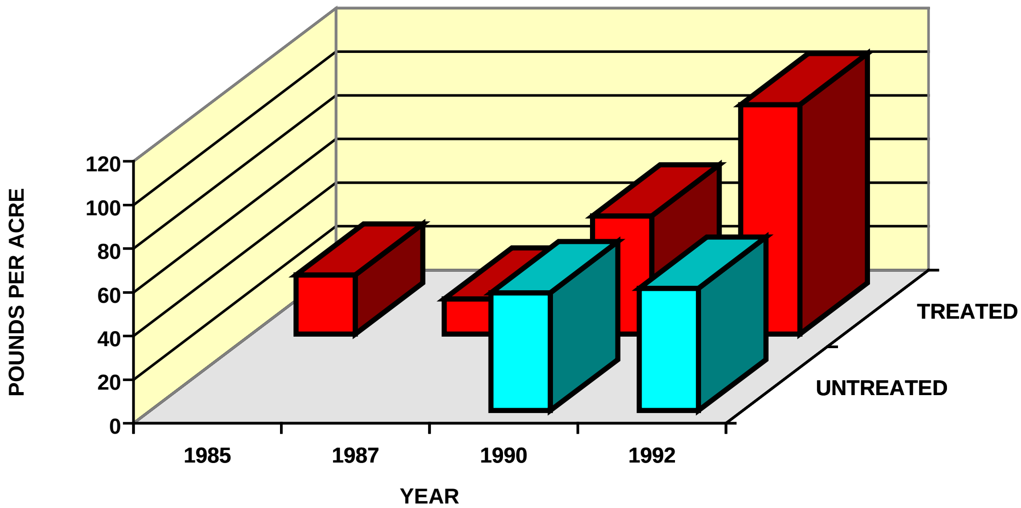


Figure 17-5. Total trout biomass in September at the treated and untreated sections of Flat Creek, 1985-1992.

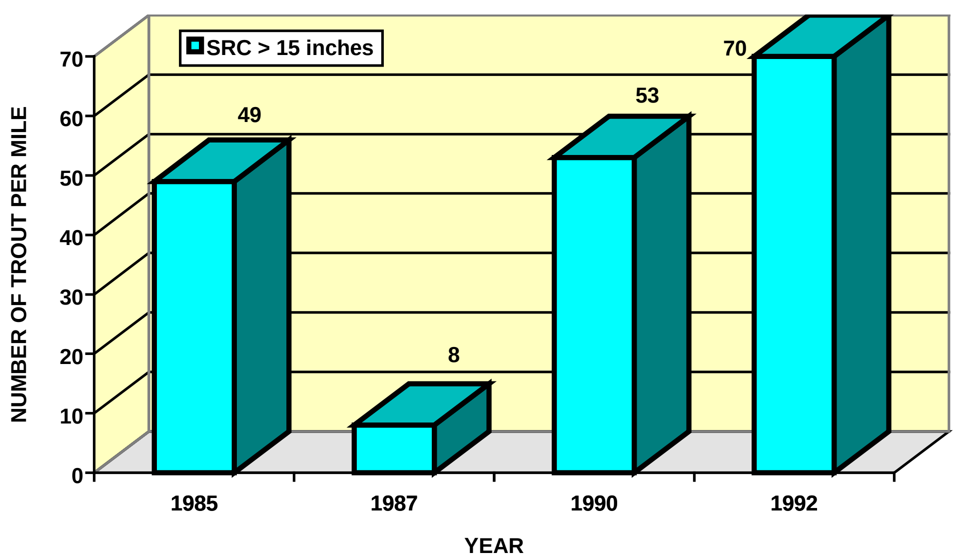


Figure 17-6. Abundance of cutthroat trout longer than 15 inches in Flat Creek, 1985-1992.

erved by snorkeling in the treated reach. Smaller trout preferred cover associated with tree revetments, while larger trout usually held position in pools near bank cover, where they fled if disturbed. Although sediment tolerant taxa continued to dominate the macroinvertebrate fauna, the BCI increased from 72 (1984) to 86 (1988), suggesting improved habitat conditions post-treatment. After 1994, the NRCS drop structures apparently reduced sediment input from bank erosion below the aqueduct outfall as the stream appeared cleaner in 1995 and 1996.

Habitat Structures Unusually high flow during the 1986 snowmelt runoff tested the structures. Some skyhook bank overhangs shifted due to backfill settling, some were inundated by gravel and fine sediment, and fill dirt covering the overhang ledges washed away at others. During summer, flow under the overhang ledges was too swift for effective trout resting cover, and trout were not using the overhangs as anticipated. So all skyhook devices were modified by shoving large boulders under the overhang at intervals to slow flow and help support the overhang. Some log deflectors suffered loss of center fill and cover ledges. Repairs were made as necessary and the sediment trap was again excavated in 1990.

Conclusions - Installation of 20 deflectors, 1,370 ft of tree revetments, 1,336 ft of skyhook bank overhangs, 100 ft of rock riprap, a rock funnel, and excavation of several pools narrowed Flat Creek, stabilized banks, increased cover for trout, and tied up excess sediment in bars and stream banks. Stream width was 32% less posttreatment. SRC clearly benefited from the improved habitat as both abundance (six fold increase) and biomass (five fold increase) was greater post-treatment. Trophy-size SRC abundance increased 43% post-treatment.

INFORMATION SOURCES

Hudelson, R. 1982. The cutthroat trout population response to fly fishing only regulations on a portion of Flat Creek within the National Elk Refuge. Administrative Report, Project 1079-13-16-7301, Fish Division, Wyoming Game and Fish Department, Cheyenne.

Hudelson, R. 1989. Flat Creek restoration project National Elk Refuge. Administrative Report, Fish Division, Wyoming Game and Fish Department, Cheyenne.

Hunt, R. 1993. Trout stream therapy. University of Wisconsin Press, Madison.

Table 17-1. Total trout population data for September samples at Flat Creek 1984-1992.

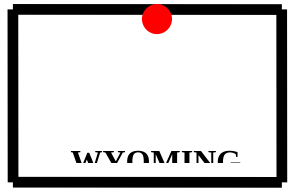
Year	Trout/mile	Pounds/acre
Pretreatment		
1984	62	19
Untreated		
1990	498	55
1992	211	56
Treated		
1990	366	57
1992	410	105
Pretreatment mean	62	19
Untreated mean	354	56
Treated mean	388	81
Pretreatment/Treated percent change	526	326
Untreated/Treated percent change	10	45

Table 17-2. Trout electrofishing sample data from Flat Creek 1984-1994. Pretreatment population is represented by the 1984 data, which combined 10/4/84 and 9/19/85 data collected from stream sections with no structures.

	DATE										
	1984	Sept. 19 1985	Oct. 8 1986	Sept. 17 1987	Oct. 20 1988	Oct. 29 1989	Sept. 25 1990	Oct. 3 1991	Sept. 20 1992	Oct. 14 1993	Oct. 17 1994
						Cutthroat Trout **Treated Area**					
Number/mile	53	80	99	103	84	102	319	203	392	388	491
Pounds/mile	69	70	46	26	50	96	163	164	306	396	354
Pounds/acre	19	22	11	6	18	33	54	56	104	134	117
Mean Length (inches)		10.7	8.4	7.1	10.4	11.2	8.7	11.7	10.9	7.9	7.6
Mean Weight (pounds)	1.94	0.88	0.46	0.25	0.59	0.94	0.51	0.81	0.78	1.02	0.72
						Untreated Area					
Number/mile					81	128	487	186	211	436	199
Pounds/mile					84	88	195	141	200	275	133
Pounds/acre					24	25	54	40	56	78	34
Mean Length (inches)					11.6	8.7	7.9	11.4	8.3	7.2	9.2
Mean Weight (pounds)					1.04	0.69	0.4	0.76	0.95	0.63	0.67
						Brook Trout **Treated Area**					
Number/mile	9	140	191	193	68	25	47	83	18	14	6
Pounds/mile	<1	22	40	6	8	10	20	2	1	5	1.4
Pounds/acre	<1	5.3	9.4	9.5	2.1	2.7	3.3	6.8	0.7	1.3	0.5
Mean Length (inches)		6.3	7.5	7.8	5.5	9.1	7.8	8.4	5.9	8.7	6.4
Mean Weight (pounds)	0.02	0.16	0.21	0.21	0.09	0.32	0.21	0.24	0.12	0.27	0.24
						Untreated Area					
Number/mile					12	12	11	0	0	11	0
Pounds/mile					4	2	2	0	0	1	0
Pounds/acre					1	0.5	0.6	0	0	0.3	0
Mean Length (inches)					7.9	7.3	7.8	0	0	6	0
Mean Weight (pounds)					0.3	0.17	0.19	0	0	0.11	0

FOOL CREEK

SHERIDAN COUNTY



PROJECT BUILT: ***Phase I*** **(USFS) 1978-1979**
Phase II **(TU) 1992-1995**

Drainage:	North Tongue River	**Tongue River Basin (8TR)**	
Elevation:	7,780 - 8,160 ft	**R.** 89 **W., T.** 56 **N., S.** 27, 28, 29	
Stream Order:	Second	**Stream Class:** 3 (regional importance)	
Watershed Area:	8 sqmi	**Mean Wetted Width:** 13 ft	
Gradient:	2.6%	**Land Status:** Bighorn National Forest	
Rosgen Channel Type:	B-2	**Project Length:** 2.5 miles	
Treatment Used:	Log and timber plunges, log, gabion, and rock deflectors, half-log structures, bank cover logs, digger logs, .		
Trout Species:	Rainbow and cutthroat trout		

DESCRIPTION OF STREAM: Dense conifer stands, old clear-cut patches, mountain meadows, limestone and dolomite outcrops, and alpine slopes characterize the Fool Creek watershed. An abundant snow pack and springs feed the stream, which drains a basin situated between Lake Creek and North Tongue River in the northern Bighorn Mountains. In the project area, the creek flows in a steep-sided valley with conifers and wet meadows on north facing slopes. On the drier south facing hillsides, a sagebrush-grass-forb-scattered conifer community covers the uplands. Riparian vegetation is sedges, rushes, grasses, forbs, and a few willows.

PROJECT DESCRIPTION: *Phase I:* At the request of Bighorn National Forest personnel, the WGF aquatic habitat crew designed structure types and locations in about 1.5 miles of stream downstream from the cow camp cabin. USFS personnel then hand built about 30 structures in 1978 and 70 structures in 1979. Log plunges (Figures 18-1 and 18-2), log wing deflectors (Figure 18-3), double deflectors (Figure 18-4), cover logs, and half-logs were used. USFS also built two livestock exclosures in the stream bottoms and planted willow cuttings. Except for WGF planning time, *Phase I* funding, construction, and structure maintenance was entirely by USFS.

Phase II: Under the direction of USFS personnel, members of the Little Bighorn Chapter of Trout Unlimited hand built about 30 rock and log plunges near the Forest Road 15 crossing. Work began in 1992 and was continued at annual TU work parties until structures had been installed in about one mile of creek.

THE FISHERY: Easy angler access to Fool Creek is provided from gravel-surfaced Forest Road 15, which parallels the creek through the project area. For many years, SRC, YSC, and several varieties of RBT have been stocked to maintain this popular fishery. Progress reports from the regional fish management crew document evaluations of this stocking program. Recent efforts have been directed towards establishing a reproducing population of YSC, which are native to the Tongue River drainage. However, fish surveys made in 1980, and again in 1998, concluded that natural reproduction by trout is basically nonexistent in Fool Creek and the fishery must be supported by periodic stocking of hatchery reared trout.

Figure 18-1. Rocks and logs were added to this wing deflector to create a plunge, which is controlling grade and providing plunge pool shelter for trout.

Figure 18-2. This log plunge in a meadow section of Fool Creek is intact and providing pool shelter for trout 19 years after being built.

Figure 18-3. A log wing deflector was used to direct flow into a boulder to create scour pool shelter along the edge of the boulder, but no deep pool cover developed.

Figure 18-4. Offset double deflectors increased habitat diversity in Fool Creek and provided some overhead cover near deflector tips, but no deep pool shelter formed.

HABITAT MANAGEMENT: For many years, cattle have grazed the Fool Creek watershed and sheep have used the headwaters. In the project area, cattle degraded riparian vegetation and stability of stream banks. A habitat evaluation documented that much of the stream was wide and shallow, with long stretches of riffle. Pools lacked depth and cover was rated very low (6%). Some 14% of the stream banks were eroding and this percentage would have been higher if banks were not so rocky. Although water temperatures are cold in this high mountain stream, fish food and water quality rated excellent. Consequently, habitat management focused on providing deep pool habitat to increase survival and return to the creel of the stocked trout.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Although Fool Creek in the project area has been regularly electrofished by the regional fish management crew, extensive stocking of hatchery reared trout, the lack of naturally produced trout, and an unknown angler harvest rate, made difficult any long term evaluation of fishery response to the habitat improvement program. However, an evaluation of the *Phase I* work one year after treatment indicated trout were attracted to the structures as abundance was up 124% over pretreatment levels (Figure 18-5). Overwinter survival of stocked RBT was 32% better (Figure 18-6).

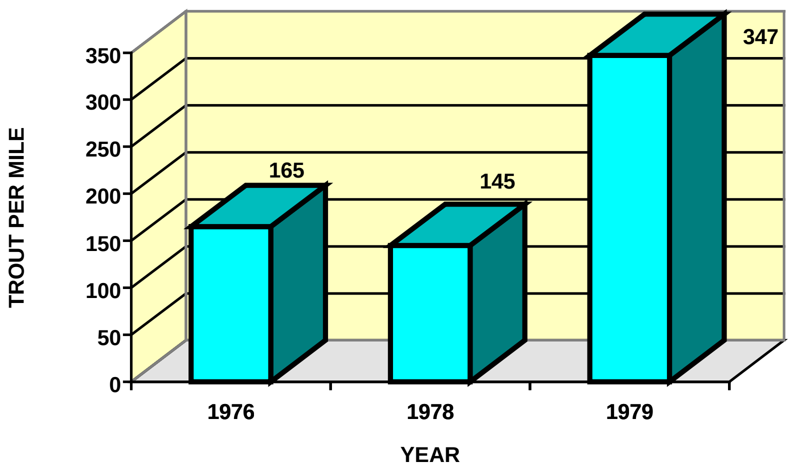


Figure 18-5. Abundance of trout at Fool Creek before (1976-1978) and after (1979) instream habitat improvement structures were installed.

Trout Habitat Response - No posttreatment evaluation was done.

Habitat Structures - An evaluation of *Phase I* habitat structures in 1985 found 37% of the wooden plunges were washed out, 83% of the half-logs were non-functional, and none of the bank cover logs and log revetments were working. Many of the pool digging structures no longer had good pools. But 89% of the deflectors were functional. That fall, USFS personnel spent two weeks removing rocks that had rolled into the plunge pools during floods in this high gradient creek. These rocks were used to plug leaks and armor the plunges at bank ends. In 1986, 53% of the structures were reported in good condition, 31% in fair condition, and 16% in poor, non-functional condition.

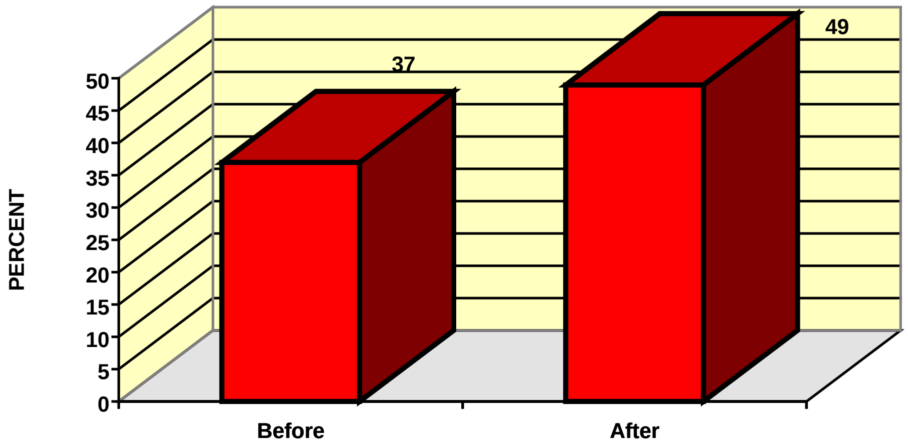


Figure 18-6. Mean overwinter survival rates for RBT stocked in Fool Creek before (1977-1978) and after (1979-1980) instream habitat improvement.

In 1998, an inspection located 40 wooden plunges built during *Phase I*. One plunge was washed out, one was functioning as a digger log, but the rest were at least partially functional. Mean RPD of the plunge pools was 1.56 ft, but only 53% of the pools had an RPD of 1.5, or greater. Poor pool depth was commonly caused by rocks that had rolled into and plugged the plunge pools, which emphasizes the need for regular maintenance of plunge pools in steep gradient streams.

Pool diggers built during *Phase II* included 23 rock plunges and 6 log plunges. Mean RPD for rock plunges was 1.75 ft, and 1.58 ft for log plunges. At both types, RPD was 1.5 ft, or greater, at 83% of the plunge pools. Recent removal of rocks from pools was evident at these structures, but not at the *Phase I* devices.

Deflectors were in various states of disrepair, but were functional and working to narrow the stream. However, few had produced pools with a RPD greater than 1.5 ft. Three half log devices were located and were furnishing cover for juvenile trout. Adult trout were seen using some of the bank cover logs.

Conclusions - One year after treatment, trout abundance had increased 124% and overwinter survival of stocked trout was 32% better. A visual assessment of the various habitat devices during 1998 found most offer shelter for trout and the project goal of providing more deep pool cover for trout has been met.

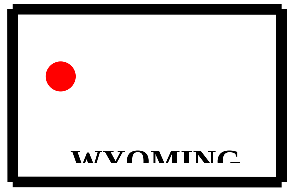
INFORMATION SOURCES

Rockett, L. C. 1980. The effect of livestock exclosure and stream improvement structures on the introduced rainbow trout population of Fool Creek. Administrative Report No. 3080-08-7904, Fish Division, Wyoming Game and Fish Department, Cheyenne.

GRANITE CREEK

TETON COUNTY

PROJECT BUILT: July, 1953



Drainage:	Hoback River	**Hoback River Basin (4HR)**	
Elevation:	6,510 ft	**R.** 114 **W., T.** 39 N**., S.** 35	
Stream Order:	Fourth	**Stream Class:** 3rd (regionally important fishery)	
Watershed Area:	90 sqmi	**Mean Wetted Width:** 40-50 ft	
Gradient:	0.8%	**Land Status:** Bridger-Teton National Forest	
Rosgen Channel Type:	C-3	**Project Length:** 1,584 ft	
Treatment Used:	Rock-filled wire cribs, trash catchers, rock-filled log deflector, log digger raft, boulder clusters, cover trees.		
Trout Species:	Brook and Snake River cutthroat trout.		

DESCRIPTION OF STREAM: Granite Creek drains a rugged, granitic watershed in the Gros Ventre Range. Its drainage features steep slopes, narrow valleys, and considerable alpine area. Stream flow comes mainly from snowmelt and springs, peaking in June and remaining adequate for trout during summer and fall. Discharge during installation of the structures was estimated as about 170 cfs. In the project area, the riparian area is mainly coniferous forest and willow, with occasional sagebrush/grass parks and aspen patches. Channel substrate is predominately cobble, rubble, and small boulder. There are no upstream diversions or impoundments.

PROJECT DESCRIPTION: The project is about 3 miles upstream from the confluence of Granite Creek and the Hoback River, and is situated about 17 miles southeast of Jackson. WGF funded and constructed the habitat improvement structures. Project purpose was to create pools and other shelter areas for trout, but the overall project goal was to study feasibility and durability of habitat improvement structures in this stream type.

THE FISHERY: Pretreatment, Granite Creek contained a small population of wild SRC and BKT. Whitefish and sculpin were also present, but whitefish numbers fluctuated widely during the study. Trout were found mainly in pools and eddies, few trout occurred in non-pool areas. To monitor project effectiveness, fish were collected with electrofishing gear, but sampling was hampered by water volume, swiftness, and clarity. Population estimates were done one year before treatment, immediately following structure installation, and one year later.

HABITAT MANAGEMENT: Prior to treatment, long, shallow (1 ft, or less) riffles and runs were prominent. Flow was swift and few pools were present in either treated or untreated areas. WGF Fisheries Management personnel installed all structures by hand - no heavy equipment was used. The 21 structures included: 4 rock-filled wire cribs with a tree attached to each, 4 wire cribs without trees, 5 trash catchers built from metal post and wire fence, 3 dead trees cut down and cabled to the stream bank, 2 groups of boulder clusters, a rock-filled log deflector, and a log digger raft attached to that deflector. These hand-built devices were labor intensive, requiring 372 hours to build. Total project cost was estimated at $9,039 ($29,830/mile, 1995 dollars).

Devices were grouped according to type. Starting at the downstream project boundary, the “log section” (cabled trees, log deflector, and one rock crib with attached tree) was first. Next was the “boulder section”, containing boulders pried loose and rolled into place from a steep hillside. Then came the “trash catcher section”, followed by the plain rock cribs, and the rock cribs with trees attached.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response A few trout were found pretreatment (Figure 19-1). Much of the study station was fast riffle with little woody debris, pools, or other shelter for trout. One year after structures were installed, trout abundance had increased 479%. Fish were located in the woody debris and pools associated with the habitat structures. Untreated segments situated just upstream and downstream from the study area were also electrofished, but no trout were captured.

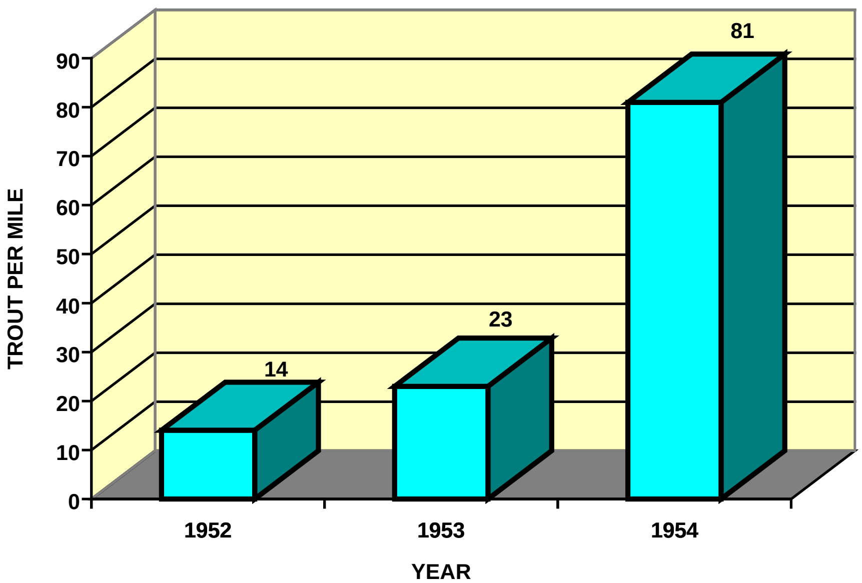


Figure 19-1.Trout abundance in Granite Creek before (1952) and after habitat improvement structures were installed in July, 1953. Data are from fall samples only, and includes all trout recorded for the treated area. Data adapted from Eiserman (1955).

Trout Habitat Response Additional slack water and pool area, up to 5 ft deep, was created by the habitat improvement structures and the channel was narrowed in some sections. Woody debris quantity was greater. Net result was more holding water for trout. Minor bank erosion was reported around some structures.

Habitat Structures Although some structures created good shelter for trout, others were considered failures (Table 19-1). The most costly structures produced the least improvement in trout habitat. Log-raft, log-crib, and crib-tree devices required 124 man-hours with no habitat development. Good pools were formed by the trash-catcher, rock-crib, and crib-tree structures. But driving the steel posts into the cobble streambed proved difficult. Boulders created pocket pools and pools developed around the dead trees cabled along the bank.

After one year, trash-catchers had captured much debris and scoured deep pools downstream from the structures. However, weight of debris and force of current caused some downstream tilting of the woven wire and steel posts. Swift flows stripped branches from some of the anchored trees and durability of the wire crib-tree structures was questionable.

When the project was visited in 1980, all trash-catchers and associated pools were gone. Their steel posts had been sheared off or bent over by the force of the current. Some of the crib structures were recognizable and were still creating some pool area (Figure 19-2). Pocket water was still present around the boulders, but no deep pools.

Figure 19-2. A stream-lined wire crib deflector on the south bank of Granite Creek was still largely intact and functional in 1980. A pool/run is present downstream from the point of the device. A similar device on the opposite bank had largely disintegrated by 1980, but the two structures have narrowed the stream at this point. Flow is from top to bottom.

<u>Conclusions</u>: Although comparatively easy to install, the trash-catchers had little permanency and were soon overwhelmed by swift currents and debris loading. Boulder placements proved durable and furnished as much habitat as the more elaborate structures. Rotting of wood was a problem in structures using untreated wood - results from Granite Creek suggest an effective life for untreated wood of 20 years, or less. Woven wire rock-crib deflectors placed along sides banks were durable, but similar structures placed in mid-channel did not persist. As with gabion structures, rotting of wire over time was a problem with these cribs. Trout abundance in the treated area increased five fold after one year, but benefits from the habitat devices did not persist due to failure of most structures within a few years.

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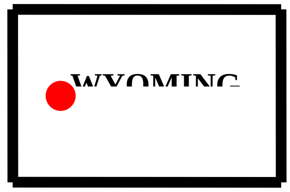
Hagen, G. O. 1952. Study of fish populations and stream conditions prior to the installation of stream improvement devices. Project F-1-R-1, Job No. 1, Work Plan No. 1, Wyoming Game and Fish Department, Cheyenne.

Hagen, G. O. 1953. Installation and study of stream improvement devices. Project F-1-R-2, Job No. 2, Work Plan No. 1, Wyoming Game and Fish Department, Cheyenne.

Table 19-1. Type of structure, cost in 1953 dollars (cost adjusted for inflation to 1995 in parenthesis), man-hours, and effectiveness of fish habitat improvement structures installed in Granite Creek in July, 1953. Data adapted from Eiserman (1955).

Structure Type	**Number**	**Man-hours**	**Cost of Materials**	**Effectiveness of Structure (Date of Evaluation)**
Wire-crib-tree	4	32	$21.64 ($115.33)	(1955) Satisfactory, deep holes and slack water developed. (1980) All structures gone.
Streamlined wire-crib	4	120	$56.30 ($300.06)	(1955) Satisfactory, deep holes developed, smooth divergence in stream cover. (1980) Mid-channel cribs gone; some wire and rock left of crib on north bank; south bank crib intact and functional with pool/run - these two cribs have narrowed the stream.
Wire Trash-Fence	5	35	$21.00 ($111.92)	(1955) Satisfactory, deep holes and cover developed. (1980) All structures gone, bent over and sheared off fence posts are only remnant.
Loose boulders and rocks	2 groups	53	None	(1955) Satisfactory, slack water and cover developed. (1980) Provides pocket pools at higher flow; LWD caught on lower boulder placement provides shelter for trout.
Dead trees felled and cabled to bank	3	8	$9.03 ($48.13)	(1955) Satisfactory, even though trees washed over against bank, they provided cover for trout. (1980) trees mostly gone, but two butt ends still cabled along bank and offer cover at higher flows.
Wire-crib-tree in log section	1	8	$4.23 ($22.54)	(1955) Failure, structure silted in, no cover or pool area produced. (1980) No sign of structure.
Log-crib "V" deflector	1	76	$4.77 ($25.42)	(1955) Failure, no cover or pool, silt deposition. (1980) logs have rotted away, but pile of rocks still acts as deflector at some flows. Some bank scour behind crib.
Log digger raft	1	40	$8.57 ($45.67)	(1955) Failure, washed toward bank, resting on bottom, no cover. (1980) no trace of structure.
Totals		372 hours	$125.54 ($669.34)	

GREEN RIVER - FORTY ROD FLAT



SUBLETTE COUNTY

PROJECT BUILT: 1988-1990

Drainage:	Colorado River	**Green River Basin (7GR)**	
Elevation:	7,360 ft	**R.** 111**W., T.** 34,35 **N., S.** 5,32	
Stream Order:	Fifth	**Stream Class:** 2 (statewide importance)	
Watershed Area:	~550 sqmi	**Mean Wetted Width:** 76 ft	
Gradient:	0.2%	**Land Status:** Private (WGF Public Fishing Easement)	
Rosgen Channel Type:	C-3	**Project Length:** 2 miles	
Treatment Used:	Boulder sills, rock and tree revetment		
Trout Species:	Brown, rainbow, brook, and cutthroat trout.		

DESCRIPTION OF STREAM: The Green River heads in the Wind River, Gros Ventre, and Wyoming ranges. Granitic formations characterize the Wind River Range, while the Gros Ventre and Wyoming ranges feature sedimentary rock types. Much of the mountainous area is above timberline with prolonged snow cover, glaciers, and seasonal extremes in climate. Glacial flour colors the river a light green and discharge is strongly affected by snow and glacier melt. Although flow peaks during May and June, summer discharge often remains relatively high due to snowmelt through the summer. Flow usually drops sharply in early October when snowmelt lessens as winter approaches in the mountains. Coefficient of variation for the annual flow is 0.19, meaning the river has little year to year variation and ground water contributions are important. Annual mean discharge is ~500 cfs and mean annual runoff is 362,000 acre feet per year at the Warren Bridge USGS gage at upper Forty Rod Flat. Other than several irrigation diversions, there are no dams upstream from the project area; the flow pattern is essentially natural.

PROJECT DESCRIPTION: Boulder sills were installed by WGF to prevent the river from shifting all flow into one channel, with resultant loss of fishery values. A tree and rock revetment was installed to prevent further bank erosion at the public fishing area parking lot. WGF funded the work.

THE FISHERY: Although the PFA allows some public access to the Green River fishery in this area, much of the river is fishable only by floaters. In the 1960's, this section was rated as "Blue Ribbon" (Class 1, nationally important fishery) and was noted for brown trout up to 12 pounds. Many anglers were attracted by the chance to catch large brown trout, thus leading to a steady increase in fishing pressure. But since then, fish habitat deteriorated and the fishery was downgraded to Class 2. Standard, statewide fishing regulations apply. Both stocked and wild fish are present.

HABITAT MANAGEMENT: Over the years, channelization by the various landowners has caused an instable river channel through Forty Rod Flat. Heavy livestock grazing and herbicide use in the river bottoms caused loss of much willow and other riparian vegetation. Consequently, there is considerable lateral erosion and annual channel changes. At a PFA parking area, lateral cutting by the river took out about 20 ft of stream bank and destroyed a key boat ramp used by float fishermen. Further upstream, channelization around an irrigation diversion prompted the river to head-cut a side channel, which, if unchecked, would cause the river to shift its flow away from the main channel. That, in turn, would have precipitated further bulldozer work to close the side channel so flow could continue to the diversion. About a mile of fish habitat and its fishery would then be lost. Accordingly, WGF installed tree and rock revetment on 735 ft of cut bank at the parking lot, plus rock sills on both the main and side channels above the irrigation diversion. Cost was $34,381 ($17,190/mile). Project goals were: 1) to maintain flow in each channel and provide a grade control that would, hopefully, allow the river to begin stabilizing its channel through the PFA, and 2) to stabilize banks at the main parking lot, which is a major floater access point, so eventually a better boat ramp could be built.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - No evaluation was done.

Trout Habitat Response - No evaluation was done.

Habitat Structures - No formal evaluation was done, but the work has withstood low frequency floods, including the 1997 snowmelt flood. Inspection of the river channel through the PFA after the huge flood in 1997 showed considerable channel adjustments, but the river appeared to be moving toward equilibrium. Both channels continue to flow below the sills. At the parking lot, the cut bank has become stable and is revegetating with willows, grass, and forbs.

Conclusions - Further bank erosion at the parking lot was stopped by the tree and rock revetment, while the sills have kept flows in both channels to maintain the fishery.

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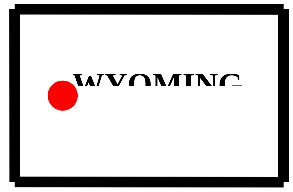
GREEN RIVER - ON FOREST

SUBLETTE COUNTY

PROJECT BUILT: 1987 - 1993



Drainage:	Colorado River	**Green River Basin (7GR)**	
Elevation:	7,690 ft	**R.** 110 **W., T.** 38 **N., S.** 14, 23, 26	
Stream Order:	Fifth	**Stream Class:** 2 (statewide importance)	
Watershed Area:	~310 sqmi	**Mean Wetted Width:** 118 ft	
Gradient:	0.6%	**Land Status:** Bridger-Teton National Forest	
Rosgen Channel Type:	C-3	**Project Length:** 4.5 miles	
Treatment Used:	Tree jams, boulder funnels, tree and rock revetments, cover trees, fish rocks		
Trout Species:	Rainbow, brown, brook, and cutthroat trout		

DESCRIPTION OF STREAM: The upper Green River heads in the Wind River and Gros Ventre ranges. Granitic formations characterize the Wind River Range, while the Gros Ventre range features sedimentary rock types. Much of the mountainous area is above timberline with prolonged snow cover, glaciers, and seasonal extremes in climate. Glacial flour colors the river a light green. Although flow peaks during May and June, discharge is strongly affected by snow and glacier melting, and discharge often remains relatively high through the summer. Flow usually drops sharply in early October when melting slows as winter approaches in the mountains. Annual mean discharge is ~500 cfs and mean annual runoff is 362,000 acre feet per year at the Warren Bridge USGS gage. Coefficient of variation for the annual flow is 0.19, meaning the river has little year to year variation and ground water contributions are important. Other than small irrigation diversions in the Tosi Creek drainage, there are no dams or irrigation diversions upstream from the project area; the flow pattern is essentially natural. The river flows through a broad U-shaped valley shaped by glaciers. Valley bottoms are open and covered with sage, grass, and forbs, with only a few scattered patches of trees. Sidehills have a dense conifer and aspen growth. Willows are common along the stream, but the few streamside trees contribute little LWD to the river.

PROJECT DESCRIPTION: Located about 30 miles northwest of Pinedale, the habitat improvement project is situated between the forest boundary and Kendall Bridge. This project was a cooperative venture between WGF, the Bridger-Teton National Forest, and Trout Unlimited (Pinedale and Jackson chapters). WGF furnished planning and construction expertise, funds, labor, materials, and equipment, USFS contributed funds, rocks, and trees to the project, and TU provided funds to rent additional heavy equipment. Project objective was to increase trout carrying capacity of the river by increasing shelter quantity and quality for trout. Structures near the forest boundary were also designed to control lateral erosion and head-cutting by the river caused by past channelization on private land downstream from the forest.

THE FISHERY: Easily accessible from the Green River Lake graveled road, the Green River on forest has long been popular with anglers and fishing pressure has steadily increased over the years. Wild trout have always been present, but poor habitat limited fishery productivity. River water flowing down from the granitic Wind River Mountains contained few nutrients. Consequently, trout were stocked for many years to satisfy angler demands on the fishery. Most stocked trout were RBT, but some were BNT and BKT. Pretreatment, large fish were not common, but RBT up to 13 pounds had been taken. In 1982, special regulations (2 fish limit, trout between 10 and 20 inches must be released, flies and artificial lures only) were implemented to reduce harvest and increase numbers of larger fish. Stocking of catchable trout was also phased out.

HABITAT MANAGEMENT: Tie drives, which began in 1867 and continued until about 1940, had a great influence on a river channel originally shaped by glacier activity. To facilitate passage of ties down river, and reduced chances for tie jams, boulders and other channel roughness were often removed, with dynamite if necessary. Thus, many pretreatment river reaches in the project area were dominated by long, wide, shallow riffles and glides that offered little shelter for trout. Deep holes and LWD were scarce. Both summer and overwintering habitat was poor. Late summer cover graded very poor, with less than 1% of the river offering shelter to trout. Cobble and boulders cemented with sand and gravel armored the river bottom. Population evaluation with electrofishing gear captured few trout, which were found mainly in the few deep pools. In 1986, USFS cabled several experimental trees along the east bank near the Guard Station. This LWD attracted many trout and caused discussion about upgrading trout shelter on a wider scale.

After a habitat assessment identified 71 sites where structures could help, a multi-year habitat improvement project was launched. A WGF work crew installed 27 tree jams, 6 rock funnels, several individual cover trees, and numerous fish rocks between the forest boundary and Kendall Bridge. A steep, eroding bluff near the forest boundary was stabilized with a 330 ft tree/rock revetment (Figures 21-1 and 21-2). Contractors hauled boulders and trees to the project. Then structures were built using loaders and a tracked hoe to move the rocks and trees. Rock funnels are boulder fields (loose sills) with a rock-free slot in the middle. Purpose of the slot (funnel) is to concentrate flow and increase velocity so pool development is encouraged at the bottom of the slot. This slot also allows floater passage through the rock field. Tree jams are limbed trees grouped to resemble natural log jams and were built along one stream bank or the other (Figures 21-3 and 21-4). These trees are held in place by cables secured, with epoxy glue, into holes drilled in boulders. Project cost was $166,500 ($27,750/year, $37,000/mile), of which WGF paid for 56%, USFS 27%, and TU 16%.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - A 1.2 mile station through the upper project area from Kendall Bridge to the Whiskey Grove Campground was sampled with an electrofishing boat in 1989 before any structures were added to the river. No catchable RBT were being stocked then, but stocking of fingerlings continued. By 1993, total trout abundance had increased 69% over the 1989 levels, and biomass was up 72% (Figures 21-5 and 21-6).

A second station from the Guard Station to forest boundary (2.6 miles) was sampled with a single pass in 1989. Only 6% of the area sampled was occupied by habitat improvement devices, but 85% of the trout were caught at the few structures then in place,. Most trout were in the 3-9 inch size, indicating the new habitat offered a viable niche for younger fish. However, trout up to 12 lb were also caught at the tree jams. Although no population estimate was made in 1989, the samples documented existence of a small pretreatment population in the lower project area.

Posttreatment, trout abundance increased steadily at the lower station, and by 1996, the population was 375% greater than in 1990 (Figure 21-7). Biomass more than doubled over the

Figure 21-1. Its equilibrium disturbed by channelization downstream on private land, the Green River was actively cutting laterally into this steep bluff located just upstream from the forest boundary. This tree and rock revetment had just been installed when the picture was taken in October, 1988.

Figure 21-2. The same steep bluff shown in Figure 21-1 as it appeared ten years after treatment. Willows, sagebrush, and various grasses and forbs have actively colonized and helped stabilize the bluff. A deep pool/run has formed along the edge of the revetment. Many of its trees and rocks are submerged and offer cover for trout.

Figure 21-3. A tree jam continues to function and shelter trout despite low flows. At upper right, a rock funnel is visible; its slot concentrates low flow into a narrower channel and the deep pool dug out near the tree jam. Adult trout favor the deeper water along the face of the jam, while juvenile trout often find haven within the jumble of trees.

Figure 21-4. The same tree jam as shown in Figure 21-3 during a spring snowmelt runoff. Trout can find shelter within the jam and are able to gain respite from the swift flood flows, from which there was previously no shelter. Juvenile trout have especially benefited from the cover provided by the trees and rocks.

same period (Figure 21-8). BNT were reported as uncommon in 1969 despite plants of juveniles made 1960-1969 in an effort to establish the species in the upper river. By 1980, that effort was termed largely unsuccessful due to poor habitat and limited spawning success. Only a few BNT were found pretreatment. But after treatment, their abundance increased steadily and the population appeared to be still expanding in 1996. A 1996 electrofishing survey reported wild RBT outnumbered trout of hatchery origin. Although BKT had been stocked in the past, BKT taken in 1996 were wild fish.

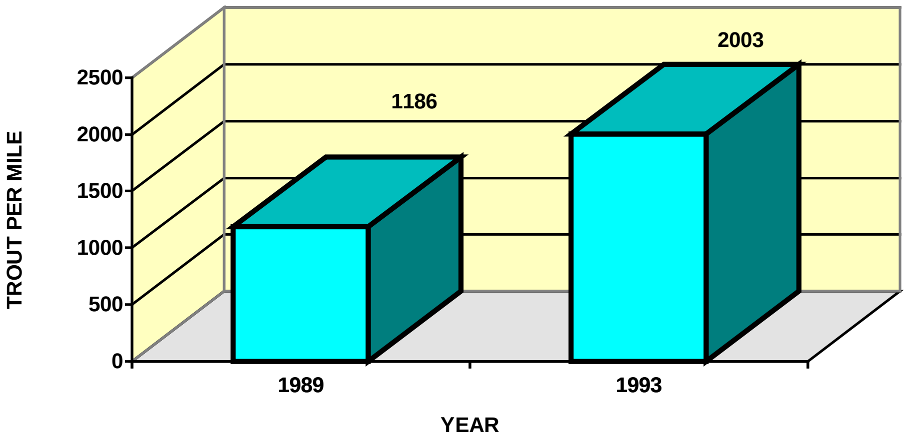


Figure 21-5. Trout abundance in the Green River in the upper project area (Kendall Bridge to Whiskey Grove Campground) before (1989) and after habitat improvement (1993).

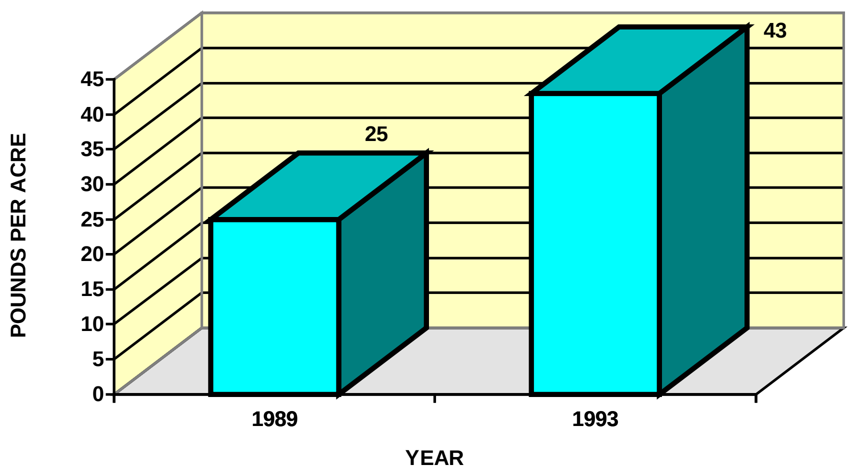


Figure 21-6. Trout biomass in the Green River in the upper project area (Kendall Bridge to Whiskey Grove Campground) before (1989) and after habitat improvement (1993).

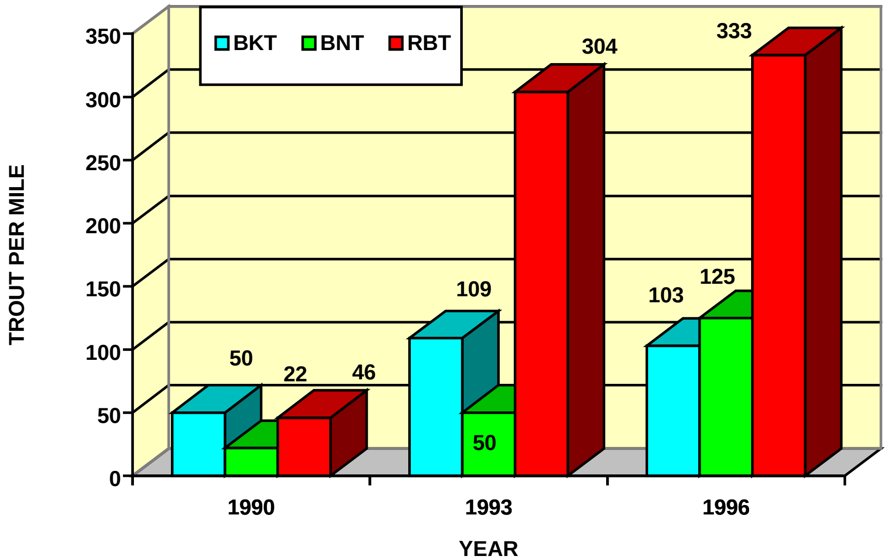


Figure 21-7. Trout abundance in the Green River between the forest boundary and the Guard Station from 1990 to 1996, by species. Most structures had been installed by 1992.

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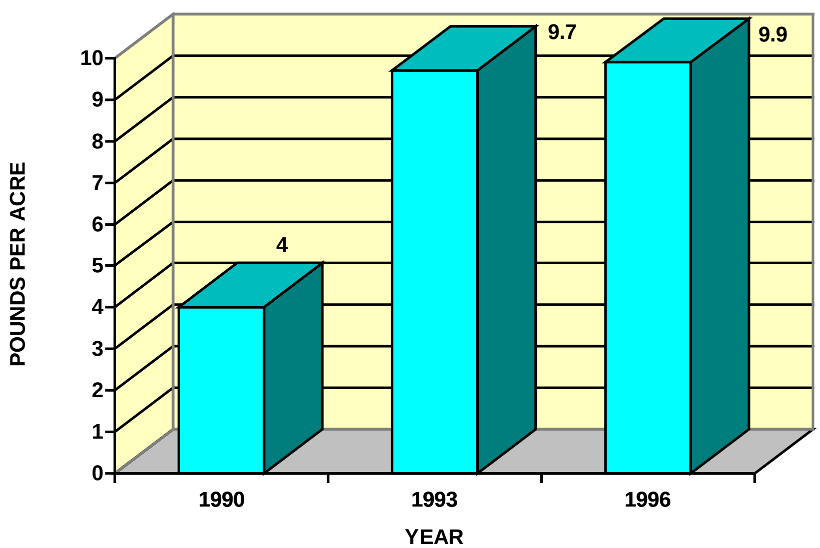

Figure 21-8. Trout biomass in the Green River between the forest boundary and the Guard Station from 1990 to 1996. Most structures had been installed by 1992.

Trout Habitat Response - The structures were designed to provide overhead shelter for trout, deflect river currents, and trap sediment. A goal was to narrow and deepen the base flow channel, while leaving intact the flood channel. These devices were designed to function at all flows and posttreatment inspection established that much valuable shelter was provided at both flood and base flows. Considerable sediment was trapped in the tree jams, where aquatic vegetation flourished and provided good shelter for juvenile trout. Larger trout utilized the deeper water along the edges of the structures. Numerous pocket pools developed around the boulders, but the LWD habitat consistently contained the most trout.

Total cover at an HQI station increased 80% from 1978 to 1994 (Figure 21-9). Within the lower electrofishing station (boundary to Guard Stn) are 11 tree jams, 3 rock funnels, and one 330 ft tree and rock revetment. Total new cover added to the electrofishing station by these devices totaled 101,520 sqft: 35,300 sqft from tree jams (3,209 sqft per structure), 57,875 sqft from the funnels (19,300 each), and 8,350 sqft from the revetment.

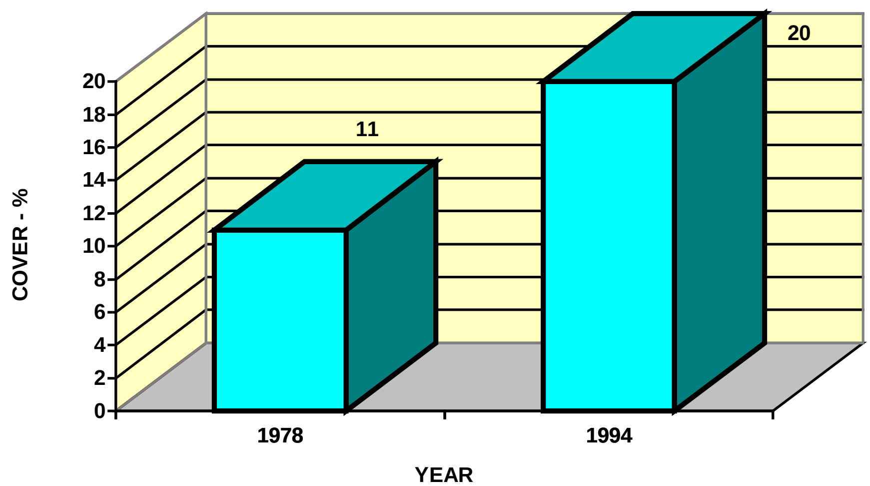

Figure 21-9. Pretreatment (1978) and posttreatment (1994) cover for trout in the Green River downstream from the Guard Station.

Habitat Structures - Performance of the various rock and tree structures has been good, despite several big floods. However, deterioration of cables has allowed several trees to wash away. Trees anchored midstream proved to be vulnerable to damage as they caught the full force of the current, and were more prone to move up and down, causing extra stress on cables. Trees anchored along one bank or another have endured better, especially those where silt deposits have further anchored the trees. The lesson is clear: a tree jam requires annual inspection and prompt maintenance of any faulty cables if the structure is to endure. Lone cover trees did not endure as well as groupings of trees, nor did they attract fish as well.

Durability and performance of the rock funnels was good. They acted as grade controls and created pocket pools. As intended, much of the base flow flowed through the slot, where water velocity was often very swift (>3 fps), especially during flood flows. But flow through the slots was not swift enough to break the bottom armor and scour pools below the structures. Consequently, these pools were excavated with a tracked hoe, after which flow through the slot maintained pool depth and configuration, and the pools attracted many trout.

Conclusions - Pretreatment, the popular upper Green River fishery was strongly supported by stocked trout. Survival of natural recruitment was hindered by lack of LWD and deep pool shelter, especially during winter. By 1996, new shelter offered by the habitat improvement structures had prompted a four fold increase in trout numbers and a doubling of biomass. Many of these fish were wild, naturally reproduced stock. And large trout were more numerous posttreatment. A combination of special regulations and better cover for trout has produced a fishery having a good balance of different sized trout. This fishery attracts many anglers each year.

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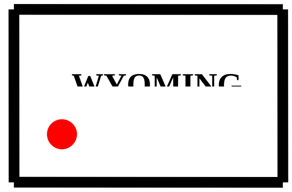
Table 21-1. Fish population data for the Green River in the habitat improvement area during 1989-1996.

Year	Number/mile	Pounds/acre
Kendall Bridge to Campground		
Pretreatment		
1989	1186	25
Posttreatment		
1993	2003	43
Percent change	69	72
Guard Station to Forest Boundary		
Posttreatment		
1990	118	4.0
1993	463	9.7
1996	561	9.9

GREEN RIVER - Fontenelle Dam Tailwater



SWEETWATER COUNTY

PROJECT BUILT: 1976-1996

Drainage:	Flaming Gorge Reservoir	**Middle Green River Basin (3GR)**
Elevation:	6,250-6,350 ft	**R.** 109-111 **W., T.** 22-24 **N., S.** various
Stream Order:	Sixth, or greater	**Stream Class:** 1 (national importance)
Watershed Area:	4,300 sqmi	**Mean Wetted Width:** 325 ft
Gradient:	0.1%	**Land Status:** BLM, USFWS, private
Rosgen Channel Type:	C-4	**Project Length:** 30 miles
Treatment Used:	Fish rocks, rock groins, rock weirs, rock piles	
Trout Species:	Rainbow, brown, and cutthroat trout	

DESCRIPTION OF STREAM: Downstream from Fontenelle Reservoir, the Green River is a large stream meandering through a cold desert rangeland. River bottom vegetation features cottonwood trees, willows, and various other shrubs, while drier benches away from the river have sagebrush, rabbitbrush, and greasewood. Stream flows are strongly controlled by water releases from Fontenelle Dam and a large portion of the project is located within the Seedskadee National Waterfowl Refuge.

PROJECT DESCRIPTION: Habitat improvement on the lower Green River has been a combination of cooperative projects between WGF, BurRec, USFWS, and Trout Unlimited. Rocks were made available from BurRec, Texas Gulf Incorporated, a BLM quarry on South Pass, and other sources. Funding was obtained from several sources. A primary project goal was to increase cover for trout in the tailwater.

THE FISHERY: A popular and well-used trout fishery developed in the Green River below Fontenelle Dam after the dam was constructed in the 1960s. Supported mostly by stocked trout, the fishery has developed a reputation for large trout. At project inception in 1976, statewide fishing regulations were in effect, but by 1996 fishing was controlled by special regulations: a one trout/day limit, trout less than 20 inches must be released, fishing by artificial flies or lures only.

HABITAT MANAGEMENT: Although the river at its surface appears to be a slow moving stream, water velocities along the river bottom are often too swift for trout to maintain position without shelter. And much of the river is long, high velocity riffles and rubbly glides. Installation of large boulders in various configurations was designed to overcome this habitat shortcoming. Habitat improvement began in 1976 when a private contractor using a large crane placed large sandstone boulders in the river. However, freezing and thawing soon broke these rocks. In 1981-1982, 31,000 tons of granite boulders were scattered as fish rocks at several sites (Figure 22-1). Several eroding banks were also armored with 2,650 ft of rock riprap. Total cost of the 1981-1982 work was $632,376 ($21,436/mile).

But in 1985, serious seepage problems forced release of water from the reservoir and altered fish habitat throughout the tailwater. After this severe flood, mitigation money made

available during 1991 allowed repositioning of scattered fish rocks. Observations had previously noted that large boulders placed in midstream were not effective on rubbly glides because a large rock is so massive, trout have trouble feeding around it. Jetties along the bank, with piles of smaller rocks positioned between each jetty, created a more complex habitat for trout and had attracted trout better than the midstream boulders (Figures 22-2 and 22-3). Thus, previously installed boulders were rearranged into groupings so shelter for trout would be maximized.

Several rock weirs were constructed on the waterfowl refuge to improve fish and wildlife habitat by returning flow to side channels, aiding riparian vegetation subirrigation by elevating the water table, and by increasing habitat diversity in the main channel. Additionally, still water at the mouth of these side channels has been shown to be important winter habitat for trout. No cost figures are available for this later work.

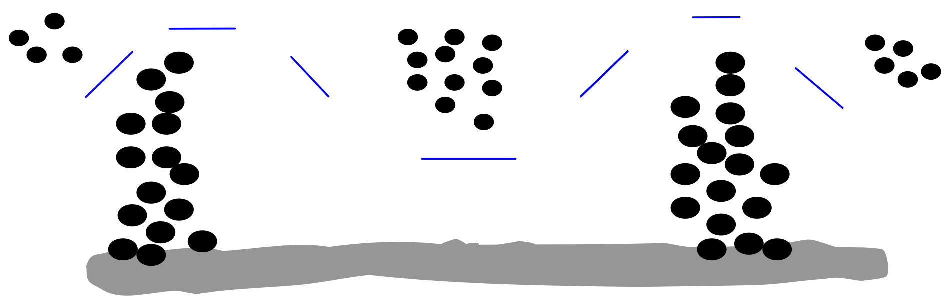


Figure 22-1. Schematic drawing of a "jetties and piles" structure for increasing trout cover in the lower Green River. Arrows indicate direction of river flow.

Figure 22-2. Boulder “jetties and piles” added along edges of the lower Green River increased habitat complexity and were well used by trout.

Figure 22-3. Granite boulders were added to the Green River downstream from Fontenelle Reservoir to increase shelter for trout.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Although regular attempts were made to evaluate trout response to the rock project, a combination of poor electrofishing efficiency, erratic river flows, and a variable stocking program made difficult a valid assessment of treatment effects. However, anglers reported catching trout around the rocks and observations with snorkel gear found trout near rock groupings, or in the pools behind rock structures. Many trout also associated with rock riprap or piles of rocks placed near the bank. Two years after boulders were installed at the Hay Farm section, trout abundance had increased 153%. The observed difference between pretreatment and posttreatment trout abundance was not statistically significant due to high standard errors in the sample data. Although the population increase was real, pretreatment data were so poor due to sampling problems that statistical proof was precluded. Another problem is that minimal overwinter survival of stocked trout limits the number of fish available to utilize the fish rocks.

Installation of the rock weirs benefited the fishery by providing a plunge with turbulent water, plus many niches for trout near the rocks. Spaces between weir rocks provided good winter shelter for young trout. Upstream from the weirs, the dam pool provided an area with little or no velocity, in contrast to high velocities elsewhere on the river, and attracted many trout. Anglers began fishing near the weirs almost before construction was complete and have continued to do so. Interestingly, these sites had previously received little angler use before the weirs were built.

Trout Habitat Response - Evaluation of habitat response was limited in scope, but velocities were less at the boulder structures.

Habitat Structures - Movement of boulders by river flows or ice was insignificant. Some movement and settling of small rocks (3 ft, or less, in diameter) was observed where substrate was composed of fine material. Sediment plumes developed behind some boulders.

Conclusions - Addition of boulders in various configurations to the Fontenelle tailwater increased habitat diversity, trout shelter and bank stability. Evaluation of fish response was confounded by poor sampling efficiency, a variable fish stocking program, and erratic river flows, but trout did use the boulder structures posttreatment and the project accomplished its primary goal.

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GROS VENTRE RIVER

TETON COUNTY

PROJECT BUILT: 1975

Drainage:	Snake River	**Gros Ventre River Basin (4GV)**
Elevation:	6,600 ft	**R.** 115 **W., T.** 42 **N., S.**8, 9, 17, 18
Stream Order:	Fifth	**Stream Class:** 3 (regionally important)
Watershed Area:	622 sqmi	**Mean Wetted Width:** 100 ft
Gradient:	0.6%	**Land Status:** Grand Teton National Park and National Elk Refuge
Rosgen Channel Type:	D-3	**Project Length:** 10,500 ft
Treatment Used:	Rock groins, rock dike, rock riprap	
Trout Species:	Snake River cutthroat and rainbow trout.	

DESCRIPTION OF STREAM: A major tributary of the Snake River, the Gros Ventre River drains a mountainous, forested watershed in the Bridger-Teton National Forest. Included in the drainage are the Gros Ventre Wilderness and part of the Gros Ventre Range. In the project area, the river has exited the mountains and flows on the Jackson Hole valley floor downstream from Kelly. Mean annual discharge is 475 cfs, with peak flow occurring during the annual snowmelt runoff in May and June. Summer flow at Kelly is adequate for trout, but downstream irrigation diversions often greatly reduce flows. Stream substrate is predominately cobble and rubble up to 12 inches in diameter. Stream banks are unconsolidated, easily eroded alluvial materials, and the stream channel was wide, shallow, and braided. Channel stability was poor.

PROJECT DESCRIPTION: Located about five miles north of Jackson, the habitat improvement work was situated near a National Park Service campground. Since the river forms the boundary between Teton Park and the National elk refuge, permission to trespass and install the structures was gained from both federal agencies. Objective of the project was to improve channel stability and reduce braiding downstream from the structures. WGF funded the project.

THE FISHERY: Downstream from Kelly, the Gros Ventre River generally offers poor habitat for trout and the pretreatment population was about 14 trout/mile. Wild SRC were the primary species, but a few RBT, and SRC x RBT hybrids, were also present pretreatment. Anglers from the campground frequently fished the river with much enthusiasm, but with little success. Standard statewide fishing regulations were in effect.

HABITAT MANAGEMENT: In 1974, Dr. Morris Skinner and associates from Colorado State University inspected and measured the river through the project area. They concluded that the Gros Ventre River is a very complex river still adjusting to a massive flood in 1927 when the river breached the landslide at Lower Slide Lake. Constant shifting of streambed material, widespread bank erosion, and downstream movement of coarse bedload from the landslide was causing a wide, shallow, and relatively straight river pattern. Since Upper and Lower Slide lakes filtered out the normal influx of fine grained sediment to the lower river, this loss of fines reduced bank cohesion, which affected river form, pattern, and stability. Self-rejuvenation of a stable form and pattern by the river under existing conditions was not felt to be possible, so Dr. Skinner and his team developed recommendations to stabilize the system.

A stream section with a pending oxbow cutoff was identified as a crucial point. Further channel instability would result if the cutoff took place. Their plan was to prevent the cutoff by stabilizing a weak bank, which was located just upstream from a natural geological control point (a rocky bluff). These two hard points would encourage the river to form a narrower, deeper channel containing better fish habitat. This plan was an experiment to see if stabilization of a key site would prompt the river towards a more stable pattern downstream. If successful, such action would be much less expensive than trying to train the river with an extensive series of structures. During May 1975, an 800 ft stabilization structure was completed. It included 200 ft of rock riprap, seven rock groins, and a 95 ft cobble dike. Cost was $2,147 ($14,170/mile).

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Trout in the river responded favorably to the improved habitat. A snorkeling evaluation in 1979 noted many 6-12 inch trout near, and downstream from, the bank stabilization. Trout were abundant near the groins and their associated boulders. In 1989, the fish population in a 2.5 mile section, including the bank stabilization site, was evaluated with an electrofishing raft. Total trout abundance was 543% higher than in 1972, and SRC had increased 221% (Figure 23-1).

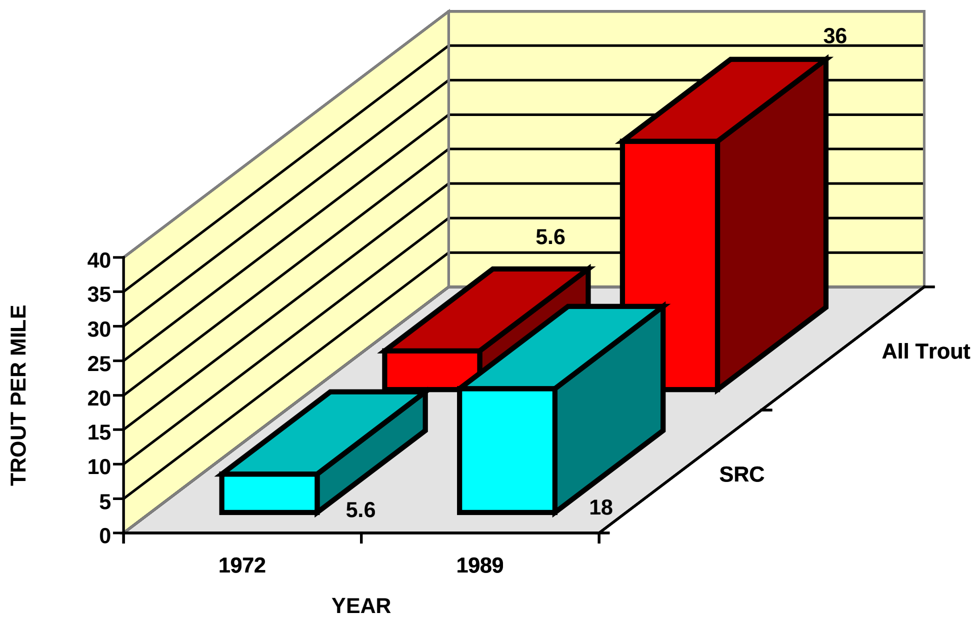

Figure 23-1. Trout abundance in the Gros Ventre River habitat improvement section 1972-1989.

Trout Habitat Response - A more definite meander pattern soon developed downstream from the bank stabilization site. Five years after treatment, the improved pattern extended two miles below the treatment site. A snorkeling evaluation in 1979 noted that fish habitat in a 2.75 mile downstream segment was superior to that in the 1.25 mile segment upstream from the habitat work. SRC were found mainly in pools and deep runs.

Habitat Structures - Additional rock riprap was added to the structure at intervals from 1977 to 1985 to counter material washed away by the river. Generally, the structure fulfilled its purpose through this period as deep pools and runs developed in a single thread channel. However, in 1986, a heavy snow pack produced an extraordinary flood that severely damaged the stabilization structure. Only two groins survived, and the bank riprap was substantially eroded at its lower end with about 20 ft of bank lost. Further damage occurred in 1987, so in 1988, the original groins were reinforced by adding rocks. Cost of this Band-Aid repair was $1,654 and an estimated $12,000 would have been needed to completely repair the structure. Monitoring by the Jackson fish management crew documented continued erosion of the structure through 1993.

Conclusions - Addition of rock riprap and groins at a key site on the Gros Ventre River produced a single thread channel in a formerly braided river section. More and deeper pools resulted from this process. Better fish habitat caused by the stabilization structure increased the trout population six fold. However, the river continually attacked the structure during each snowmelt flood until a large flood severely damaged the stabilization work 11 years after installation. Although the device was repaired, attempts by the river to adjust its channel will eventually destroy the structure. Controlling a braided river by increasing bank stability at a key point appears to be a valid concept, but any future projects should use gabions or very large boulders, and plan for regular maintenance.

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Mulhern, P. F. 1975. Form and pattern on the Gros Ventre River. Master’s thesis. Colorado State University, Fort Collins.

Skinner, M. 1975. Analysis of the stability of an alluvial system. Typewritten report presented to Fish Division, Wyoming Game and Fish Department, Cheyenne.

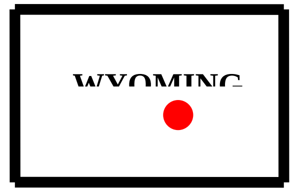
Table 23-1. Trout abundance in the Gros Ventre River before and after habitat improvement.

	Number per mile			
Year	SRC	RBT	Hybrid	All Trout
Pretreatment				
1972	5.6			5.6
Posttreatment				
1989	18.0	14.0	3.0	36.0
Percent Change	221			543

HALL (FRY) CREEK

CONVERSE COUNTY

PROJECT BUILT: 1985



Drainage:	Deer Creek	**North Slope Laramie Range Basin (1LR)**
Elevation:	7,100 ft	**R.** 77 **W., T.** 30 **N., S.** 14
Stream Order:	First	**Stream Class:** 5 (low productivity waters)
Watershed Area:	1.5 sqmi	**Mean Wetted Width:** 4 ft
Gradient:	5.7%	**Land Status:** Medicine Bow National Forest
Rosgen Channel Type:	A-3	**Project Length:** 1,900 ft
Treatment Used:	Timber plunges, rock riprap, tree revetment, offset dike, channel block	
Trout Species:	Rainbow and brown trout	

DESCRIPTION OF STREAM: Extreme stream flow fluctuation characterizes streams in the Laramie Mountains, where rugged, granitic formations dominate the watershed, soil layers are thin, and water flows readily from the landscape. Hall Creek is a steep gradient stream draining a granite watershed in the Deer Creek Range. Discharge is high during snowmelt and storm runoff events, but base flow often becomes critically low during summer. Some stream sections become dry, but stream flow recovers if enough rain falls in late summer and early fall. A coniferous forest cloaks the upper basin and north facing slopes in the lower basin. Aspen patches are scattered about the drainage, while south facing slopes have a sagebrush, grass, and forb community. In the project area, grass, forbs, and scattered willow clumps characterize the narrow riparian zone.

PROJECT DESCRIPTION: A cooperative effort by WGF and Medicine Bow National Forest, the project is located in the lower Hall Creek drainage about 23 miles southeast of Casper. WGF and USFS biologists developed habitat improvement plans jointly as part of the proposed Deer Creek riparian and aquatic habitat improvement project. Habitat improvement structures were installed in Hall Creek following approval of the Environmental Assessment for the Deer Creek project.

THE FISHERY: Years ago, Hall Creek contained an active beaver pond complex, which supported a good fishery for local residents. Loss of the beaver ponds virtually destroyed this fishery as the stream then contained many shallow riffles and few deep pools (Figure 24-1). The stream was essentially unsuited to trout larger than juvenile size during low flows. Despite these shortcomings, RBT migrate up the stream to spawn when flows are high during the spring snowmelt. Drainage inventory documented that Hall Creek is one of two tributary streams providing major spawning potential and trout recruitment to the Deer Creek RBT fishery. YOY RBT were common in lower Hall Creek prior to treatment, but lack of deep pools likely meant poor overwinter survival, unless fall rains added enough stream flow to enable the fish to migrate down to Deer Creek.

Figure 24-1. Pretreatment, Hall Creek was wide, shallow, and lacked deep pool shelter for trout.

HABITAT MANAGEMENT: Despite the rocky nature of the Hall Creek watershed, stream bank erosion was a problem. Excessive livestock grazing in the watershed had been linked to bank instability, as well as to decreased aspen and cottonwood regeneration. A series of beaver ponds once occurred along the stream, but deterioration of aspen stands through natural succession, intensive livestock use, and normal beaver use led to decreased beaver activity. When floods washed out the ponds, bank stability, sediment transport, and runoff pattern in the watershed were affected.

Using a WGF backhoe, a joint agency work crew installed eight timber plunges, a rock offset dike, a rock and tree channel block, and 92 ft of rock riprap (Figures 24-2 and 24-3). Rock and trees were obtained locally. Cost was $9,300 ($25,844/mile). A drift fence was built in 1984 by USFS along the forest boundary to reduce livestock use of the Hall Creek riparian area so it could heal naturally.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - RBT populations in Hall Creek fluctuate widely in concert with stream discharge, making difficult any evaluation of treatment effects. But Hogle (1993) reported trout abundance differed in treated (1,377/mile) and untreated (194/mile) sections during late August. Following the habitat improvement, YOY RBT were common in Hall Creek plunge pools and nearby riffles during late summer. Unfortunately, a few larger trout also took up residence in the deep pools and were potential predators on the concentrated fry.

Trout Habitat Response - Plunge pools were dug out to a depth of at least two feet during construction. An evaluation 11 years later indicated the pools had retained their depth, and in some cases, had become deeper. HQI measurements documented a 650% increase in cover and a 86% decrease in eroding banks through the HQI station (Figure 24-4).

Figure 24-2. A joint WGF and USFS work crew building a timber plunge in 1985 to provide deep pool shelter for trout in the rocky substrate at Hall Creek.

Figure 24-3. A timber plunge at Hall Creek continues to furnish deep pool shelter for juvenile trout 11 years after installation.

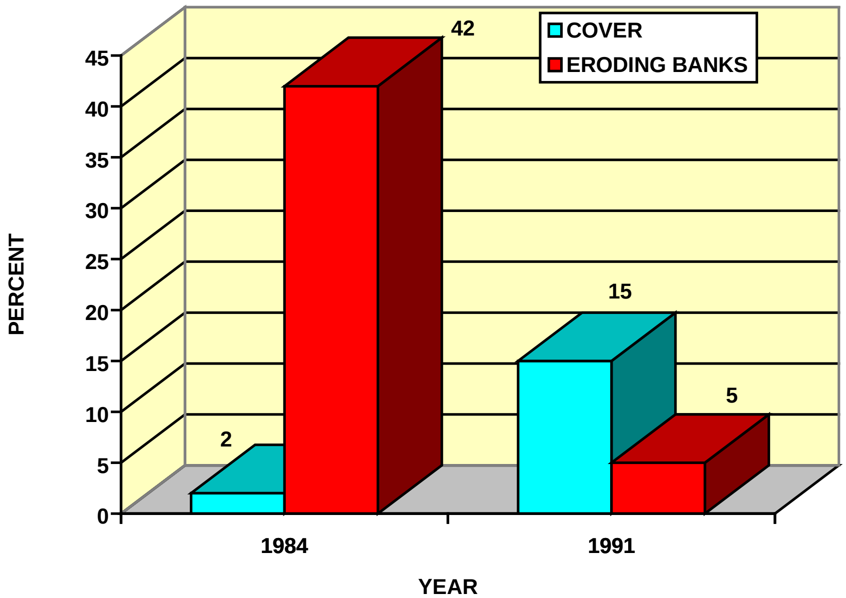


Figure 24-4. Changes in cover and eroding banks at Hall Creek before (1984) and after (1991) installation of habitat improvement devices.

Habitat Structures - In 1986, a joint agency work crew did a half-day of maintenance work on the plunges. All plunges were visited in 1996 and checked for problems. Six of the plunges were rated in good condition, but one was leaking badly underneath the timbers, and another was washed out around one end. RPD was 1.5 ft, or greater, (range: 1.5 to 3.0 ft) at all plunges and even the damaged ones supported good plunge pools. Effectiveness of the drift fence installed by USFS was debatable, as cattle frequently trespassed into the project area through damaged fence sections.

Conclusions - Adding timber plunges to Hall Creek increased deep-water cover available to YOY RBT seven fold. Eroding banks had decreased 86% 11 years posttreatment. Trout abundance was 610% greater in the TZ than in a RZ.

INFORMATION SOURCES

Anonymous. 1984. Deer Creek riparian and fish habitat improvement project, environmental assessment and decision notice. USDA Forest Service, Laramie Peak Ranger District, Medicine Bow National Forest, Laramie.

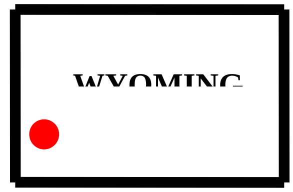
Hogle, J. S. 1993. Salmonid habitat and population characteristics related to structural improvement in Wyoming streams. Masters thesis. University of Wyoming, Laramie.

McMillan, J. 1989. A fishery and habitat survey of the Deer Creek drainage, Converse and Natrona County, Wyoming. Administrative Report, Fish Division, Wyoming Game and Fish Department, Cheyenne.

HAMS FORK RIVER

LINCOLN COUNTY

PROJECT BUILT: 1988, 1990-1992



Drainage:	Green River	**Upper Hams Fork Basin (3UH)**	
Elevation:	7,015 ft	**R.** 116 **W., T.** 22 **N., S.** 17,18,19,20	
Stream Order:	Fourth	**Stream Class:** 2 (statewide importance)	
Watershed Area:	270 sqmi	**Mean Wetted Width:** 40 ft	
Gradient:	0.2%	**Land Status:** Private - WGF public fishing easement (Peternal PFA)	
Rosgen Channel Type:	C-4	**Project Length:** 4.7 miles	
Treatment Used:	Tree/rock revetments, fish rocks, rock dike at earth slide		
Trout Species:	Brown and rainbow trout		

DESCRIPTION OF STREAM: Flowing southward from the Bridger-Teton National Forest, the Hams Fork River drains an area between Commissary Ridge and the Tump Range in the Overthrust Belt. A mixture of private, USFS, BLM, and state lands are located in the watershed. Vegetation types range from conifer-aspen forest to sagebrush-grass. Many willows grow in streamside riparian areas, even in the lower drainage. In the project area, the river meanders through hayfields, ranch land, and willow patches in a broad valley about four miles downstream from Kemmerer City Reservoir, which is located about two miles downstream from the much larger Lake Viva Naughton. This impoundment captures stream flow from for use at the Utah Power and Light Company plant west of Kemmerer. Although stream flow through the Peternal PFA is controlled by reservoir releases, the diversion point for the power plant is downstream so stream flows generally remain adequate for trout through the PFA. Mean CPSF is 64 cfs, the ASFV ratio is 48, and ADF is 144 cfs. Stream substrate is primarily cobble and gravel.

PROJECT DESCRIPTION: Purchase of a public fishing easement through the Peternal Ranch in 1987 carried with it an obligation to stabilize eroding stream banks. Accordingly, a project was planned and implemented by WGF to stabilize banks and improve trout habitat as far as possible at the Peternal PFA.

THE FISHERY: Prior to the habitat improvement project, the river supported a fishery for wild BNT and RBT. Abundance was only about 60 trout/mile despite many deep corner pools. Fishing was by permission only, which probably reduced angler pressure somewhat, but since the reservoir and tailwater fisheries were very popular with anglers, fishing mortality probably contributed to the small population. Some of the RBT were likely drift from the reservoirs. Beginning in 1987, the PFA was stocked annually with RBT and BNT. BRC were stocked on occasion. Statewide fishing regulations applied.

HABITAT MANAGEMENT: Although the river downstream from Kemmerer City Reservoir contained good trout habitat, habitat conditions deteriorated with progression downstream. Summer water temperatures and silt deposition increased, and trout production decreased. Much of the silt came from extensive lateral stream bank erosion, which was caused, in part, by the sediment hungry water released from the two reservoirs. Some sediment also entered the stream from several slow moving earth slides along the south side of the valley.

In 1988, a potential oxbow cutoff was stopped with rock riprap hauled by a private contractor. Over three years, starting in 1990, a WGF construction crew installed 9,390 ft of tree and rock revetment, 455 ft of rock riprap, 420 ft of rock dike at two slide areas, and about 50 fish rocks. Cost was $322,990 ($68,700/mile). Private contractor from a quarry near Kemmerer City Reservoir hauled rocks, while the conifer trees came from the Bridger-Teton National Forest.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Pretreatment fishery measurements were collected, but posttreatment measurements are not scheduled until 1998. Increased trout abundance was reported in 1989, but may have resulted mainly from intensive stocking of hatchery trout.

Trout Habitat Response - As with the fishery, pretreatment HQI measurements were collected and are to be repeated in 1998. Informal observations in 1997 indicate a huge increase in trout habitat quality, especially in providing cover for trout. Virtually all stream banks stabilized with revetments remain stable and are providing good shelter for trout.

Habitat Structures - About 60% of the structures were inspected in 1997. Other than several pockets of localized scour within revetments, the majority of the revetments were in good condition. At the two slide areas, the rock dikes had improved the stability of banks and channel, but some fracturing of boulders was noted. Good vegetation growth has developed on formerly bare banks now protected by the dikes.

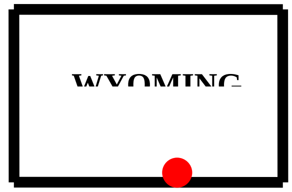
Conclusions - Bank stability and shelter for trout has been vastly improved with the revetments.

Figure 25-1. Many unstable stream banks on the Peternel PFA were stabilized with tree and rock revetments, which also provide shelter for trout along stream edges.

HELL CANYON CREEK

CARBON COUNTY

PROJECT BUILT: 1982-1983, 1989



Drainage:	Savery Creek	**Savery Creek Basin (3SC)**	
Elevation:	7,780 ft	**R.** 88 **W., T.** 14 **N., S.** 17	
Stream Order:	First	**Stream Class:** 4 (locally important)	
Watershed Area:	875 acres	**Mean Wetted Width:** 4 ft	
Gradient:	7.4%	**Land Status:** Medicine Bow National Forest	
Rosgen Channel Type:	A-3	**Project Length:** 2,640 ft	
Treatment Used:	Log plunges, log deflectors		
Trout Species:	Wild Colorado River cutthroat trout		

DESCRIPTION OF STREAM: Located on the west slope of the Sierra Madre Mountains, Hell Canyon Creek flows in a deep canyon to drain a northwest aspect of Green Ridge. Dense conifer-aspen forest covers north-facing slopes, while south-facing slopes have a shrub, forb, and grass community. Riparian vegetation on the narrow valley floor is a variable mixture of aspen, conifers, shrubs, grass, and forbs. Winter snowfall is usually substantial and springs, snowmelt, and rainfall contribute to stream flow, which is continuous in the project area. Upper stream reaches become dry in late summer, but a few old beaver ponds in mid-drainage help maintain flows. Beaver activity is sporadic in the drainage. Stream substrate is mostly boulder and cobble.

PROJECT DESCRIPTION: Habitat improvement in 1982-1983 was a cooperative venture between the Medicine Bow National Forest and WGF. Both agencies contributed manpower and funding. Objective was to increase deep-water habitat for CRC to aid late summer and overwinter survival. In 1989, BLM and WGF worked together to build additional habitat improvement structures on BLM land located downstream from the forest boundary.

THE FISHERY: CRC, a sensitive trout species, is the only fish in this small headwater stream and genetic purity has been rated good. At project inception, standard statewide fishing regulations were in force, but special regulations (catch and release, flies and artificial lures only) were later enacted to protect the fishery.

HABITAT MANAGEMENT: Due to the coarse stream substrate, few deep pools were present pretreatment and lack of such shelter for trout was identified as a limiting factor. A joint USFS and WGF work crew installed 7 log plunges and 2 log deflectors at selected sites upstream from the forest boundary (Figures 26-1 and 26-2). The crew worked one week each year. Due to the canyon, there was no access for motorized equipment and workers had to hike into the project each day. All devices were hand-built, with rocks and trees gathered on site. That fact, plus the rocky stream bottom, limited the number of structures that could be built in the time available. Project cost was $4,400 ($8,800/mile). In 1989, BLM and WGF personnel installed several more structures downstream from the forest boundary. No structure count or cost was reported.

Figure 26-1. A log plunge in Hell Canyon Creek near the forest boundary 14 years after construction is still intact and acting as a grade control. Its plunge pool furnishes shelter to trout and a jumping point for trout seeking to move upstream past the structure.

Figure 26-2. This log plunge offers deep, shady pool habitat for CRC.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Prior to habitat improvement, the CRC population was at a low level. Most fish were found in pools, or in an occasional beaver pond. Posttreatment, mean trout abundance increased 240%, and biomass increased 196% over pretreatment levels (Figure 26-3, Table 26-1). In 1985, both a station with habitat improvement devices and an untreated reference station were electrofished. At the treated section, CRC were 88% more abundant, and biomass was 209% higher than at the reference station (Figure 26-4).

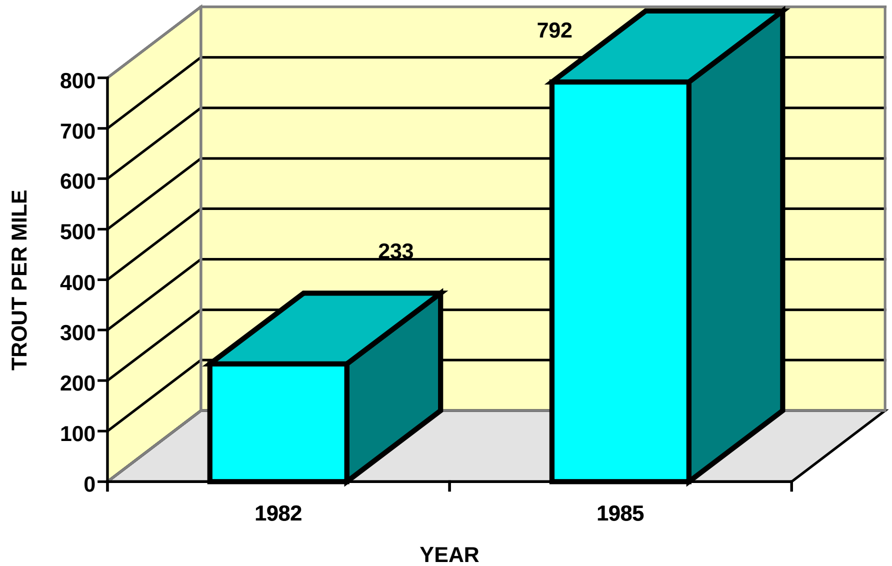


Figure 26-3. Trout abundance at Hell Canyon Creek before and after habitat improvement.

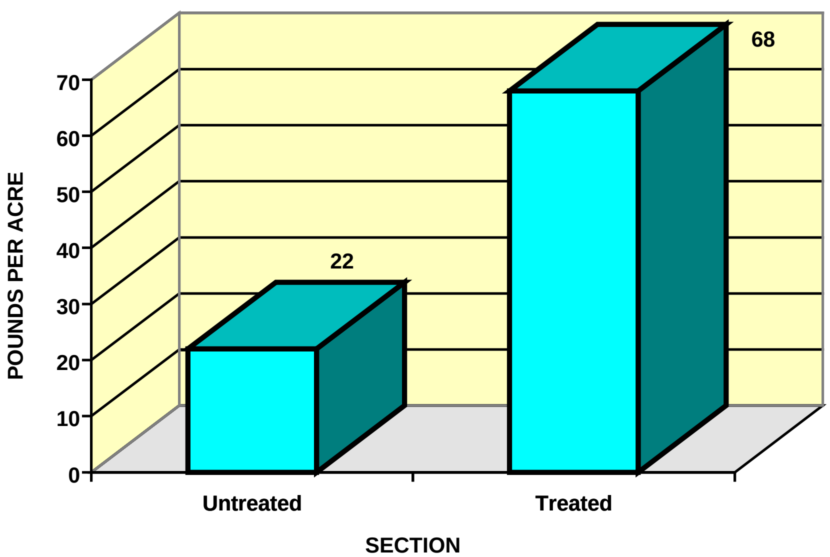


Figure 26-4. Trout biomass at Hell Canyon Creek in 1985. The untreated section was located upstream from the area containing habitat improvement structures.

Trout Habitat Response - When the project was inspected in 1995, all seven plunges were located. They had added 195 sqft of plunge pool cover to the stream (range, 3-48 ft, mean, 28 sqft/plunge) and trout were seen in most of the plunge pools. Some structures also had cover for trout in dam pools upstream from the plunges. Both log deflectors were located. They had successfully fulfilled their purpose of preventing a channel change that would have isolated several plunges. On the BLM land, six plunge structures were located and had added 152 sqft of pool cover to the creek (range, 14-54 sqft, mean, 25 sqft/plunge).

Habitat Structures - In 1995, six of the seven log plunges on forest were functional. One did not have a plunge pool as the stream bottom had filled in level with the plunge log. It was serving as a grade control. RPD was 1.5 ft, or deeper, at 43% of the seven devices. All seven plunges on forest were intact and their condition graded good (> 80%), despite the lack of a plunge pool at one device. Log deflector condition was good. Sediment deposition and grass growth had incorporated them into the stream banks where they blended in well with the terrain. On the BLM land, condition at 80% of the plunges graded good, but none of the plunges had RPD 1.5 ft, or deeper, (range, 0.5 ft to 1.4 ft, mean, 0.77/plunge). Sediment deposition appeared to be greater at the BLM section.

Conclusions - Addition of log plunges created new deep pool habitat and doubled both CRC abundance and biomass. Durability of the structures was good after a decade in the stream even though they were built by hand. However, construction of the devices by hand labor was very arduous and time consuming, and is not recommended for sites where machinery can be used.

INFORMATION SOURCES

Bruscino, M. T. and D. D. Miller. 1987. Stage II and III environmental surveillance and inventories. Administrative Report for Projects 5086-07-8301 and 5086-13-6602, Fish Division, Wyoming Game and Fish Department, Cheyenne.

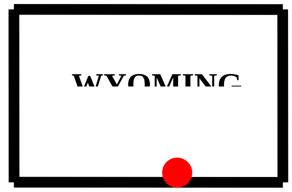
Table 26-1. Abundance and biomass for CRC at Hell Canyon Creek before and after habitat improvement, as well as at the untreated reference station in 1985.

Year	Number/mile	Pounds/acre
Pretreatment		
1982	233	23
Posttreatment		
1985	792	68
Percent change	240	196
Untreated (1985)	420	22
Treated (1985)	792	68
Percent change	88	209

HOG PARK CREEK

CARBON COUNTY

PROJECT BUILT: 1984-1986



Drainage:	Encampment River	**Encampment River Basin (5ER)**	
Elevation:	8,315 ft	**R.** 84 **W., T.** 12 **N., S.** 5, 8, 9	
Stream Order:	Third	**Stream Class:** 3 (regionally important)	
Watershed Area:	14 sqmi	**Mean Wetted Width:** 21 ft	
Gradient:	0.6%	**Land Status:** Medicine Bow National Forest	
Rosgen Channel Type:	C-4	**Project Length:** 3.6 miles	
Treatment Used:	Tree/rock revetments, rock deflectors, cover trees, fish rocks, rock funnel, boulder clusters, minimum stream flow.		
Trout Species:	Brown, brook, and rainbow trout		

DESCRIPTION OF STREAM: Hog Park Creek drains an eastern aspect of the Sierra Madre Mountains, flowing about three miles from the Continental Divide to Hog Park Reservoir. A conifer and aspen forest is the main vegetative component in the watershed, but grass, forb, and sagebrush covered parks are common. In the project area, the riparian zone is a treeless mountain meadow containing mixed grasses, forbs, sedges, and short willows.

Water is transported into the drainage, via pipeline and transbasin tunnel, from the North Fork Little Snake River. This water is stored in Hog Park Reservoir as part of the City of Cheyenne water supply project and is used to replace water piped to Cheyenne from Douglas Creek, a tributary of the North Platte River in the Snowy Range. Stream flows in Hog Park Creek are controlled by the reservoir, and prior to 1986, flow in the creek often fluctuated widely. Water releases from the reservoir during winter and late summer were historically minimal. From 1979 to 1984, CPSF averaged 16% of ADF, and the ASFV ratio was 251 - suggesting a very unstable flow regime.

PROJECT DESCRIPTION: A coop project between the Medicine Bow National Forest and WGF, the habitat improvement affected the 3.6 miles between the dam and the confluence with the Encampment River. However, restoration work was done only at specific sites (about 7,900 ft total). Project costs were paid from a mitigation fund established by the City of Cheyenne to restore fish habitat damaged by the Stage II component of the City's water development plan. WGF and USFS biologists jointly developed a restoration plan. Its primary goals were to trap excess sediment in bars and banks, force the creek to scour out deep-water areas, and provide more shelter for trout.

THE FISHERY: Although some stocked RBT pass through the dam outlet works into the tailwater, wild BNT and BKT make up the bulk of the tailwater fishery. Easily accessed by graveled roads from both Wyoming and Colorado, the reservoir and tailwater complex is popular and well used. Standard statewide fishing regulations apply to Hog Park Creek.

HABITAT MANAGEMENT: Originally built in 1965-1966 (Stage I), Hog Park Reservoir was enlarged during the 1980s (Stage II). But in October 1982, large quantities of sediment washed downstream into the tailwater when a holding pond failed. This sediment spill aggraded the channel, plugged pools, eliminated shelter for trout, and reduced both fish food and fish populations. Since the sediment influx into the creek was a direct violation of both state and USFS permits, which forbade pollution of the stream, the City of Cheyenne and their contractors were forced to pay a $62,000 fine. This money was used to establish a mitigation fund. They also agreed to contribute a supply of large boulders for habitat restoration work.

To add insult to injury, a massive 75-100 year flood occurred in May 1985 when a large volume of water was released in a short time from the reservoir to compensate from an unusually high snowmelt runoff. This flood degraded fish habitat even more. Consequently, USFS forced the city to abide by the terms of their special use permit and reduce flow fluctuations in the tailwater. A minimum flow of 15 cfs was mandated and enforced. After 1986, the minimum stream flow became an important component of the habitat restoration.

Habitat restoration was directed by USFS and WGF biologists, using a tracked backhoe and rubber tired front-end loader to move and place trees and rocks. The machinery was rented, with operators, from private contractors. A USFS work crew cut trees and attached cables to posts buried in the banks. Work began in 1984 at the upper valley, above the graveled road crossing, when 950 ft of tree and rock revetments, four boulder deflectors, and 370 ft of rock riprap were installed (Figure 27-1). In 1985, 444 ft of rock riprap (4 sites), 684 ft of tree revetments (7 sites), and 7 rock deflectors were built downstream from the graveled road (Figure 27-2). During 1986, habitat improvements were added to the creek in the lower valley, near the confluence with South Fork Hog Park Creek. A work crew built 1,200 ft of tree revetment, 600 ft of tree/rock revetment, 11 rock deflectors, 4 tree deflectors, and a rock funnel. Boulder clusters and fish rocks were installed at 5 sites. Total project cost was $66,000 ($18,300/mile).

Figure 27-1. Stream banks scoured bare by flood waters were stabilized with tree and rock revetments, which narrowed Hog Park Creek and provided shelter for trout. This picture, taken three years posttreatment, shows riparian vegetation starting to establish on the point bar. By 1997, more vegetation had developed on the bar.

Figure 27-2. Larger conifers and less rock were used in this revetment, seen here three years posttreatment.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - The massive sediment influx, followed a few years later by an exceptional flood, greatly reduced trout populations in Hog Park Creek prior to habitat improvement. Trout abundance in the lower valley dropped 60% between 1973 and 1983, while biomass decreased 75%.

In both the upper and lower valleys, improved water flows and instream habitat improvement structures combined to increase trout abundance after 1985 (Figures 27-3 and 27-4). Catchable trout (6 inches, or greater) numbers increased 345% from 1983 to 1987 at the upper valley and 163% in the lower valley. By 1987, biomass had increased 687% at the lower valley and 563% at the upper valley over pretreatment levels (Figure 27-5). At the upper valley, catchable trout were 160% more abundant by 1995 than in 1983 (Table 27-1).

For the stream as a whole, total trout abundance increased 134% posttreatment and biomass improved 359% (Table 27-1). Catchable trout were 273% more abundant after habitat restoration. A rank-sum test indicated abundance and biomass were significantly different during the pretreatment and posttreatment periods.

Trout Habitat Response - In the lower valley, HQI analysis reported a 56% drop in HU from 1975 to 1985 (Figure 27-6). Lower valley cover for trout decreased 79% and bank erosion increased 73%. Severely eroded banks and little cover for trout also typified the upper valley prior to restoration work.

After habitat restoration, HU increased 260% in the lower valley and 376% in the upper valley. By 1987, cover for trout in the lower valley had almost returned to the 1975 level. For the stream as a whole, cover had increased almost four fold two years after restoration. Eroding banks decreased 77% in the lower valley and 93% in the upper valley. By 1991, five years after treatment, lower valley HU were 133%, cover 229%, and eroding banks 54% better than pretreatment levels.

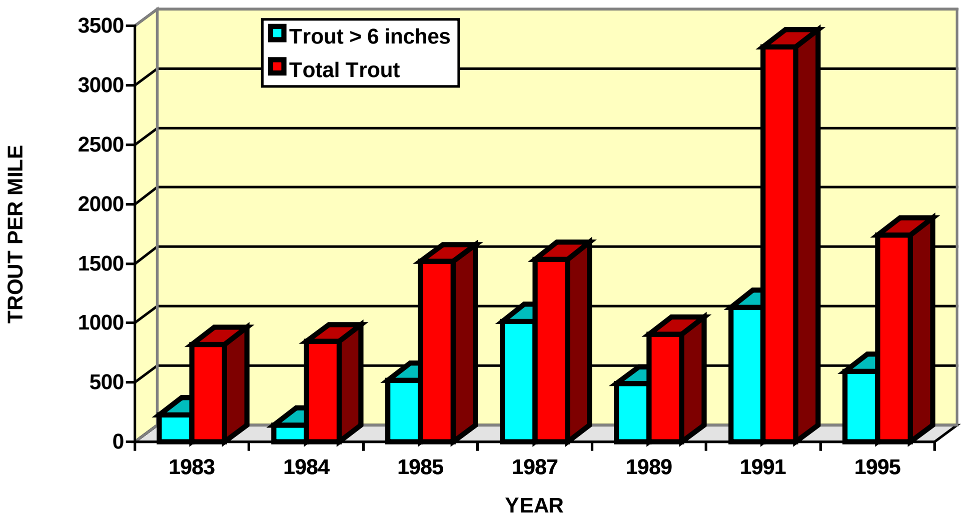


Figure 27-3. Abundance of trout at Hog Park Creek in the upper valley during 1983-1984 (pretreatment) and 1985-1995 (posttreatment).

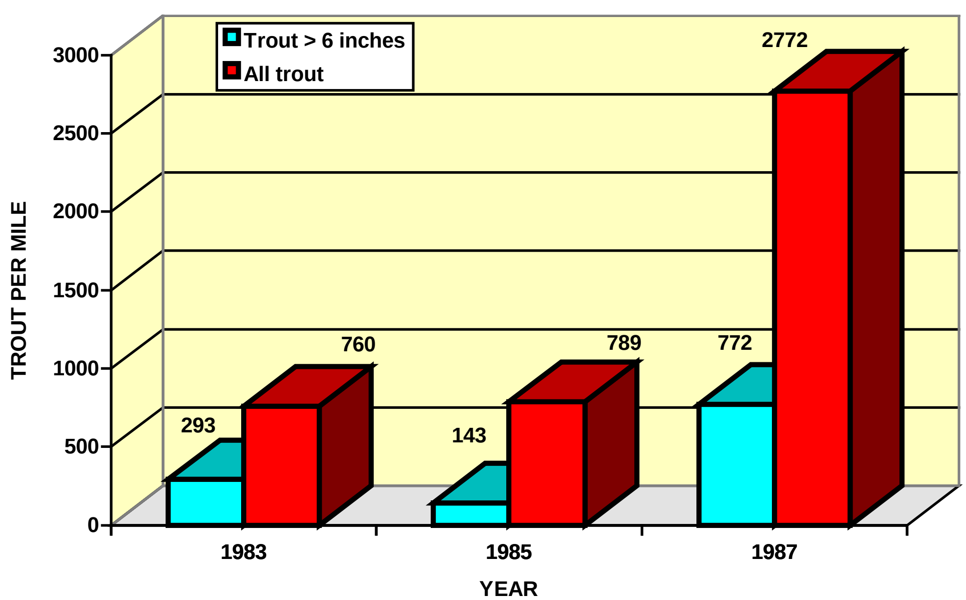


Figure 27-4. Abundance of trout at Hog Park Creek in the lower valley during 1983-1985 (pretreatment) and 1987 (posttreatment).

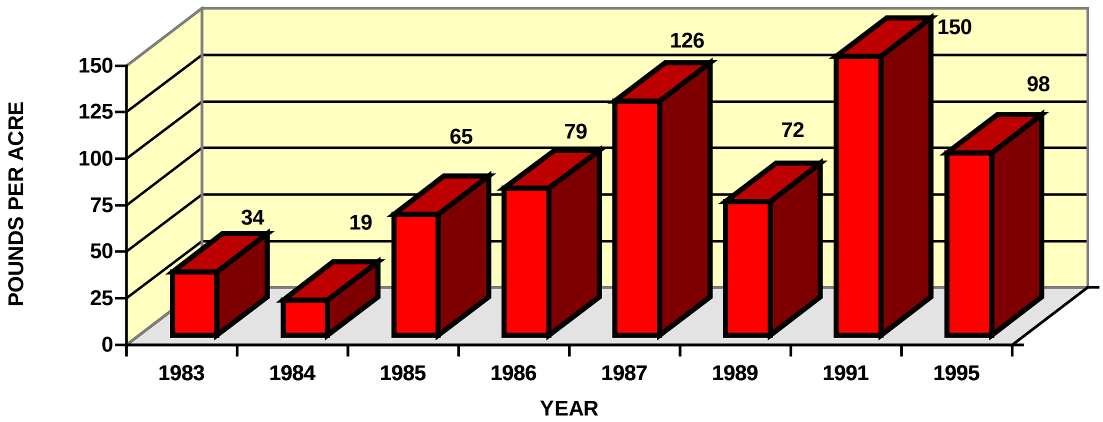


Figure 27-5. Biomass of trout at the upper valley fish monitoring site before (1983-1984) and after (1985-1995) habitat improvement.

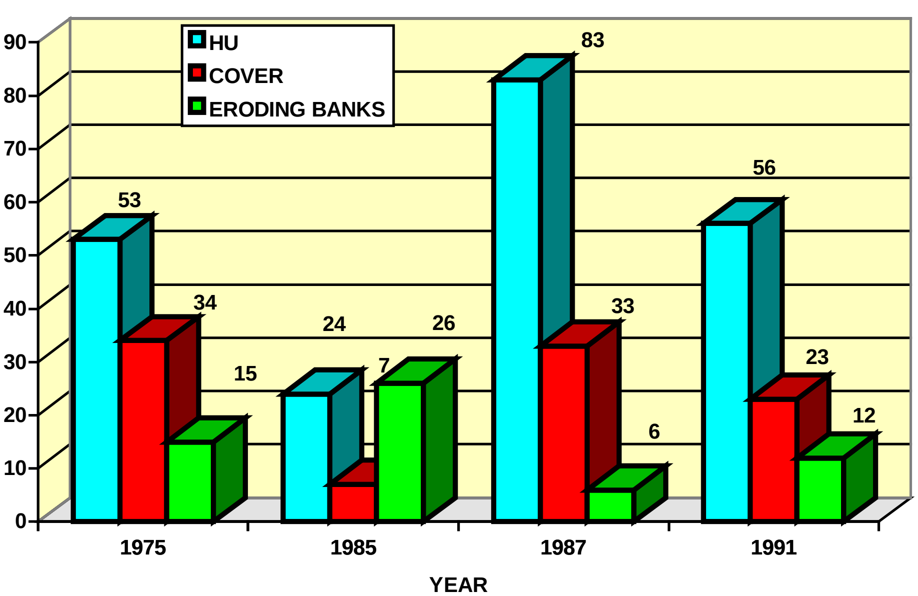


Figure 27-6. Fish habitat parameters at Hog Park Creek in the lower valley from 1975 to 1991. Habitat was restored there in 1986.

<u>Habitat Structures</u> - An examination of the habitat improvement structures in September, 1997 found the structures largely intact and functional. Narrowing and deepening of the stream was very noticeable, as was development of point bars. Many of the point bars had revegetated with grasses, and formerly eroding banks were stable with good grass and willow growth. Some small patches of bank erosion persisted though.

<u>Conclusions</u> - Installation of habitat restoration devices and establishment of a 15 cfs minimum flow benefited the trout population in Hog Park Creek. For the stream as a whole, total trout abundance increased 134% posttreatment and biomass improved 359%. Catchable trout were 273% more abundant after habitat restoration. A rank-sum test indicated trout abundance and biomass were significantly different during the pretreatment and posttreatment periods. Five years after treatment, lower valley HU were 133%, cover 229%, and eroding banks 54% better than pretreatment levels.

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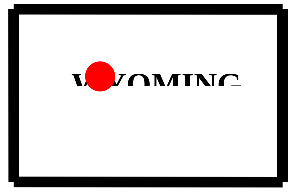
Table 27-1. Trout abundance and biomass in Hog Park Creek before and after habitat restoration structures were installed. UV is upper valley and LV is lower valley.

		All trout		Catchable trout
Year	Site	Number/mile	Pounds/acre	Number/mile
Pretreatment				
1983	UV	821	34	228
1983	LV	760	21	293
1984	UV	846	19	142
1985	LV	789	15	143
Posttreatment				
1985	UV	1,519	65	518
1986	UV	1,360	79	
1987	UV	1,537	126	1,015
1987	LV	2,772	118	772
1989	UV	906	72	488
1991	UV	3,325	1,133	150
1995	UV	1,742	98	594
Pretreatment mean		804	22	202
Posttreatment mean		1,880	101	753
Percent change		134	359	273

HORSE CREEK (Dubois)



FREMONT COUNTY

PROJECT BUILT: 1993

Drainage:	Wind River	**Horse Creek Basin (3HS)**	
Elevation:	7,700 ft	**R.** 106 **W., T.** 43 **N., S.** 19, SW 1/4	
Stream Order:	Third	**Stream Class:** 3 (regionally important)	
Watershed Area:	50 sqmi	**Mean Wetted Width:** 38 ft	
Gradient:	0.5%	**Land Status:** Shoshone National Forest	
Rosgen Channel Type:	C-4	**Project Length:** 6,500 ft	
Treatment Used:	Tree and rock revetments, boulder “S” dam, barb digger logs		
Trout Species:	Brook, rainbow, and brown trout		

DESCRIPTION OF STREAM: Horse Creek heads in the Five Pockets Basin located between Cathedral and Ramshorn peaks in the Absaroka Mountains. Geologic type is the Absaroka volcanic rocks, which contain various easily eroded formations. Much of the watershed is mountainous, with steep cliffs and rocky plateaus. Higher elevations feature alpine vegetation, while conifers are prevalent below timberline. But grassy parks and aspen patches also occur in the forested sections. Willows, forbs, and grasses make up the riparian plant community. In the upper project area, Horse Creek meanders through an open, treeless meadow. At the lower end of the meadow, a rock outcrop forms a grade control, where gradient steepens, and the stream flows through a short canyon to meet Burroughs Creek at the USFS campground.

Stream flow is fed by an ample snow pack, which produces a snowmelt flood each spring that may adversely affect fish habitat. A low frequency flood in June, 1981 washed out the bridge below the campground and damaged stream banks in the meadow. But base flows are adequate for trout during all seasons. Water quality is good, but low in nutrients. Although the stream is generally cold from snowmelt, river temperatures during summer are suitable for trout at the project area.

PROJECT DESCRIPTION: Located about 10 miles north of Dubois, habitat improvement at Horse Creek was a cooperative project between WGF and the Shoshone National Forest. USFS furnished funding, NEPA documentation, and trees, while WGF furnished funding, a 404 permit, planning and construction expertise, manpower, and equipment. Project goals were: 1) to stabilize eroding stream banks to reduce sediment entering the stream from this source, and 2) to provide additional shelter and holding water for trout.

THE FISHERY: Easily accessible from a graveled road that parallels the stream in the project area, Horse Creek has long been a favorite with anglers. There is continual fishing pressure during summer and fall, especially near the USFS campground located in the lower project area. Like other streams in the area, Horse Creek has low productivity. Severe winter conditions and the annual snowmelt flood also limit fishery potential. Although a small population of wild brook trout is present, hatchery trout mainly support the fishery. Both RBT and CUT have been stocked in the past, but did not establish adequate self, sustaining populations. Present stocking policy is catchable RBT to satisfy angler demand for larger trout and better fishing than the wild BKT population can support. Statewide fishing regulations apply at Horse Creek.

HABITAT MANAGEMENT: Several large patches of timber within the watershed were clear-cut about 1960 and several access roads were built. Considerable cattle grazing also has occurred in the drainage, but was sporadic in the project area. A private ranch located just upstream from the project was grazed primarily by horses. All of these activities, and the bank erosion at the meadow, were potential sources of sediment that degraded water quality and hampered the fishery in the project area.

Of these sources, bank instability at the meadow was most easily addressed. HQI measurements at the meadow documented 89% stream bank erosion. Shannon-Weaver diversity dropped sharply in aquatic macroinvertebrate samples taken just downstream from the eroded banks and the lower index values were believed due to the influx of sediment. To correct this problem, a WGF construction crew built 2,500 ft of tree and rock revetments, 20 upstream digger log barbs, and a boulder "S" dam. Project cost was $31,300 ($25,425/mile).

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Four years after instream structures were added to Horse Creek, trout abundance had increased 33% (Figure 28-1) and biomass was up 127% (Figure 28-2). Catchable trout (6 inches, or greater in total length) were 246% more abundant posttreatment, while biomass was 296% higher (Table 28-1). Catchable RBT biomass increased five fold posttreatment, while mean length of RBT increased from 5.7 inches to 8.2 inches. All of which suggests the structures were providing more habitat to retain stocked trout in the project area.

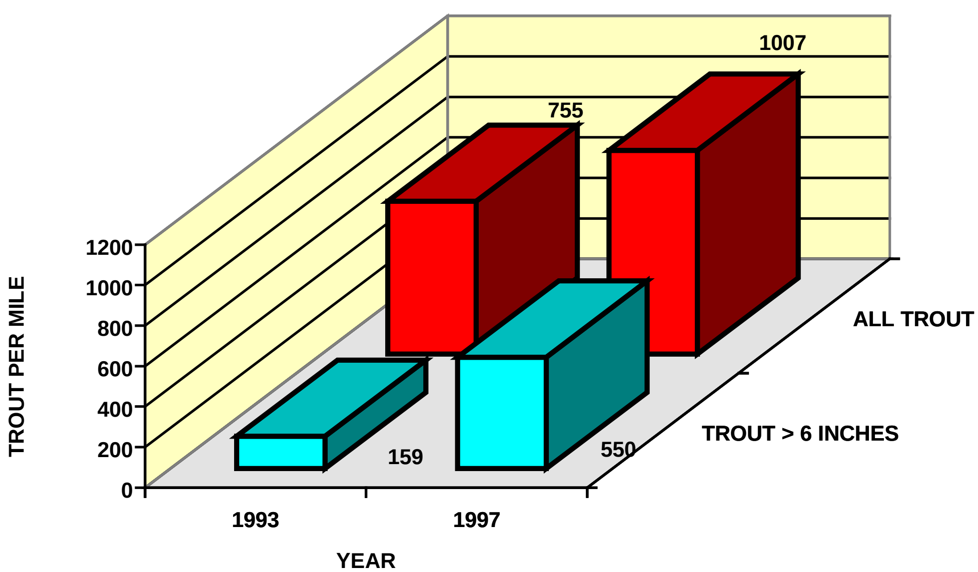


Figure 28-1. Abundance of trout at Horse Creek before (1993) and after (1997) habitat improvement.

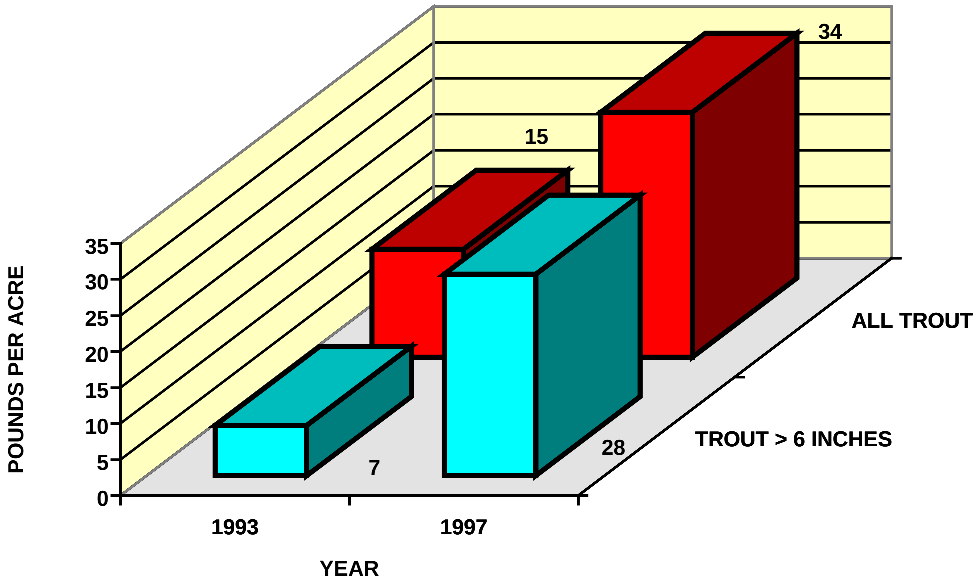


Figure 28-2. Biomass of trout at Horse Creek before (1993) and after (1997) habitat improvement.

Trout Habitat Response - Posttreatment, better pool habitat for trout was present after the stream channel adjusted to the new structures. Many pools previously lacking overhead cover were now edged by large woody debris formed by the tree and rock revetments (Figure 28-3). An HQI analysis documented a 33% increase in shelter for trout and an 80% drop in bank erosion. Habitat quality more than doubled, going from 23 HU to 53 HU two years after habitat improvement.

Figure 28-3. Four years posttreatment, instream digger log barbs and tree/rock revetments have reduced erosion of banks and stabilized the channel in the meadow at Horse Creek.

Habitat improvement also benefited aquatic fish food organisms. Three years after treatment, mean abundance was 45% higher at two sample sites within the treated area, but at two control sites, abundance was down 27% (Figure 28-4). At the meadow station, fish food abundance was up 34% over the pretreatment level, 19 taxa were present, and the Shannon-Weaver diversity index value (2.37) was comparable to the mean (2.39) at the other sites. In 1990, the meadow station had an index value 42% lower than the mean for the control sites and only 12 taxa. In 1996, the composition of the macroinvertebrate community indicated some sedimentation was still present at the three stations below the horse ranch, where bank stability continued to be poor. At the control station near the top of the meadow, above the ranch, strong resident populations of cleanwater taxa continued to be present, which indicated good water quality and a clean instream substrate.

Habitat Structures - By 1997, durability and performance of the habitat improvement structures was good. At one revetment, inadequate rock riprap behind the trees allowed high water to open up a 50 ft segment of eroding bank. But all other revetments were in good condition. The digger log barbs created good pools.

Conclusions - Addition of habitat improvement structures to Horse Creek increased shelter for trout (33%), decreased bank erosion (80%), and improved the aquatic fish food population (34%). Both trout abundance (up 33%) and biomass (up 127%) were greater posttreatment.

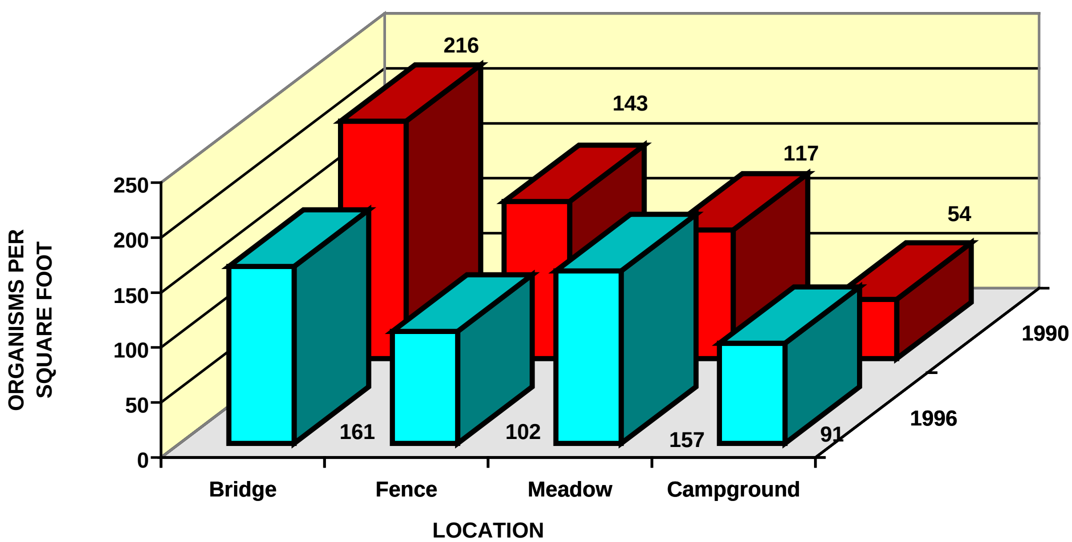


Figure 28-4. Abundance of aquatic macroinvertebrates at Horse Creek during September 1990 and 1996. The meadow and campground sites were within the habitat improvement area, while the bridge and fence sites were upstream from the treated section.

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Connell, K. 1978. A study to determine habitat deterioration in streams in the upper Wind River drainage as a result of logging. Administrative Report, Project 2077-07-6801, Fish Division, Wyoming Game and Fish Department, Cheyenne.

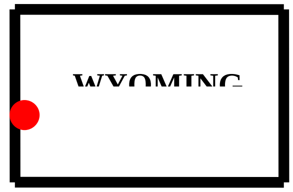
Table 28-1. Abundance and biomass of trout at Horse Creek before and after habitat improvement.

	All trout		Catchable trout	
Year	Number/mile	Pounds/acre	Number/mile	Pounds/acre
Pretreatment				
1993	755	15	159	7
Posttreatment				
1997	1,007	34	550	28
Percent change	33	121	246	296

HUFF CREEK

LINCOLN COUNTY

PROJECT BUILT: 1978-1983



Drainage:	Thomas Fork Bear River	**Bear River Basin (3BE)**	
Elevation:	6,435 - 6,655 ft	**R.** 119 **W., T.** 27,28 **N., S.** 3, 34	
Stream Order:	First (upper project) Second (lower project)	**Stream Class:** 4 (locally important fishery)	
Watershed Area:	11 sqmi	**Wetted Width:** 8 ft (August)	
Gradient:	0.4 - 2.1%	**Land Status:** BLM	
Rosgen Channel Type:	B-3 and C-4	**Project Length:** 4 miles	
Treatment Used:	Timber plunges, rock plunges, wire trash catchers, wooden deflectors, rock deflectors, and rock riprap.		
Trout Species:	Wild Bear River cutthroat trout		

DESCRIPTION OF STREAM: In the project area, Huff Creek flows through a steep-sided, U-shaped canyon to join with Coal Creek. Above the canyon, the drainage opens up into a grass and sagebrush basin, bounded by alluvial fans and steep slopes. Access to the drainage is by a rough two track dirt road. Fed by springs, Huff Creek is perennial in the canyon, but becomes intermittent about a mile upstream from the canyon. Huff Lake, a shallow pond of several acres, lies at the head of the drainage.

Stream discharge varies seasonally and is unaffected by diversions or impoundments. Peak flows occur in May and June when the snowpack melts. A bank-full flood (2-year occurrence) would be 65 cfs, a low frequency flood (100-year occurrence) 326 cfs, and the average annual flow 6 cfs. Summers are hot and dry, the winters are cold and snowy. The riparian zone is desert-like, containing sagebrush, rabbit brush, sedges, and various grasses and forbs. Willow shoots are sporadic, and there are no trees or large shrubs. But aspen and various conifers occur in the upper elevations, and on north-facing slopes in some side draws.

PROJECT DESCRIPTION: Located about 30 miles south of Afton, Huff Creek was a cooperative project between WGF and BLM to increase BRC abundance through drainage-wide habitat management, which included the construction of instream habitat improvement structures and better control of livestock grazing. After BLM implemented a Habitat Management Plan for the Coal Creek drainage, livestock grazing patterns changed. In the Huff Creek watershed, a range rider employed by grazing permittees controlled livestock, and BLM built two exclosures with barbed wire fence. Instream structures were installed by WGF to provide additional pool shelter for BRC and stabilize eroding stream banks. A second goal of the plunges was to stimulate riparian vegetation growth by raising the water table near the structures.

THE FISHERY: In the 1950s, Huff Creek and Huff Lake were noted for good fishing. But the BRC fishery steadily deteriorated due to habitat degradation. Natural eutrophication extirpated trout from Huff Lake. By 1978, the trout population in Huff Creek was severely depressed and the species had been classed as a “sensitive species” in Wyoming. In 1982, the fishery was protected by special regulations: artificial lures only and BRC 10 inches or less must be released.

HABITAT MANAGEMENT: Aerial photos taken in 1940 show Huff Creek as a stable stream where beaver ponds and willow patches were common. But livestock overgrazing and elimination of streamside willows by herbicides caused fish habitat to deteriorate. By 1978, common habitat flaws included closely grazed riparian vegetation, severe bank erosion, down cutting by the stream, excessive siltation, and unnaturally high summer water temperatures. Pools were exposed and offered little shelter to BRC. Little vegetative cover for trout existed along most stream banks.

A 2-acre exclosure was built in the lower drainage in 1976 by BLM. In 1978, a 38-acre, 1.3 mile long exclosure was built in the upper canyon.

During 1981-1983, a WGF construction crew installed 36 low-profile timber plunges, 9 rock plunges, 7 wire and cable trash catchers, a wooden double deflector, a rock deflector, 14 small rock grade controls, and 3,760 ft of rock bank revetments. All structures were built in the lower two-thirds of the large exclosure and labor, materials, and equipment cost $16,730 ($19,230/mile). A backhoe and dump truck aided in the construction, but some rock revetments were placed by hand when banks were inaccessible to heavy equipment. Rocks were obtained from a small alluvial fan just upstream from the large exclosure. BLM also installed several wire and fence post trash catchers just above the small exclosure.

Figure 29-1. A timber plunge remains function 10 years posttreatment. Streamside vegetation has become well established with protection from cattle use and better subirrigation of the riparian zone through elevation of the water table near the plunge. Peaks of the Sublette Range appear in the background.

Figure 29-2. A timber plunge still provides a deep pool sheltering trout a decade after it was built. Such pools are crucial to BRC survival as they are pool-oriented fish. Turbulence from the plunge helps aerate the pool when water temperatures become overly warm during summer.

EVALUATION OF TROUT HABITAT MANAGEMENT

The grazing system (rest early, graze late) implemented in 1978 improved riparian vegetation in the canyon. Restricting cattle to the upper basin reduced grazing along lower Huff Creek and allowed better growth of streamside plants. Grazing inside the exclosures was greatly reduced by the fencing and herding, but there was some grazing by trespass cattle. Once grazing was reduced, streamside vegetation grew denser, and the stream narrowed as vegetation encroached on the channel. This vegetation trapped silt and helped build up banks.

Fishery Response - After 1978, Huff Creek BRC responded to better habitat conditions by expanding steadily in both numbers and biomass (Figures 29-3 and 29-4, Table 29-1)). By 1986, both BRC abundance (mean, 385 trout/mi; SD, 136) and biomass (mean, 50 lb/acre; SD, 4) were significantly better than in 1978 (mean, 35 trout/mi; SD, 18; mean, 8 lb/acre; SD, 6). Catchable-size fish ($\geq$ 6 in) were significantly more abundant (mean, 106 trout/mi; SD, 65) than in 1978 (mean, 29 trout/mi; SD, 27). Biomass of catchable-size fish was significantly better in 1986 (mean, 41 lb/acre; SD, 4) than in 1978 (mean, 8 lb/acre, SD, 7).

By 1989, mean BRC numbers (170 trout/mi) were still significantly higher than in 1978 (35 trout/mi), despite severe drought in 1987-89 and a 75-100 year flood in 1984. Drainage-wide BRC abundance and biomass peaked in 1984 at 456 trout/mi and 56 lb/acre. The largest population (1984; 685 trout/mi, 82 lb/acre) occurred at the site containing instream structures within an exclosure. Continued drought caused BRC abundance to decrease to 89 trout/mile by 1993.

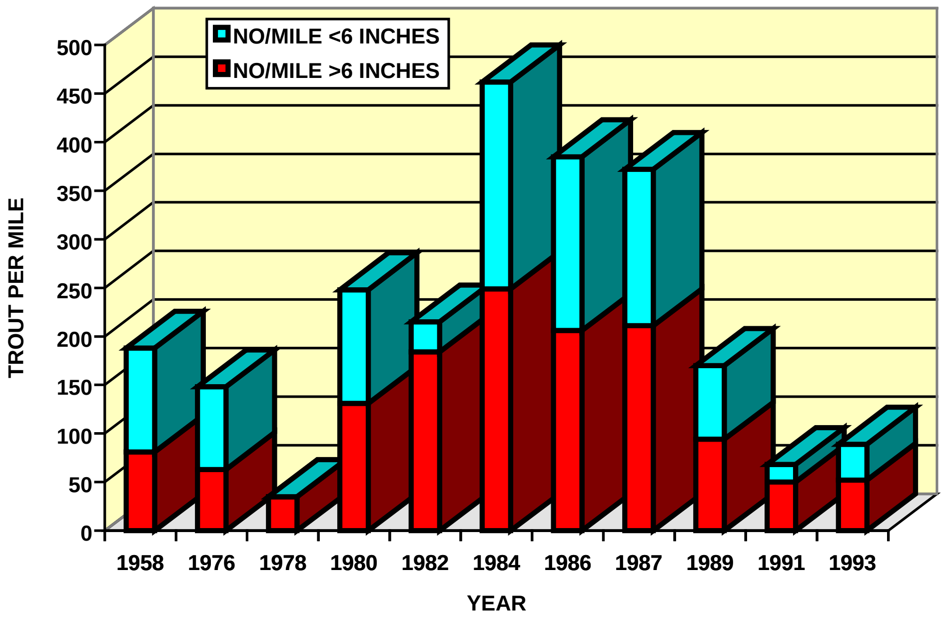


Figure 29-3. BRC abundance in Huff Creek from 1958 to 1993. Severe drought affected the population after 1987.

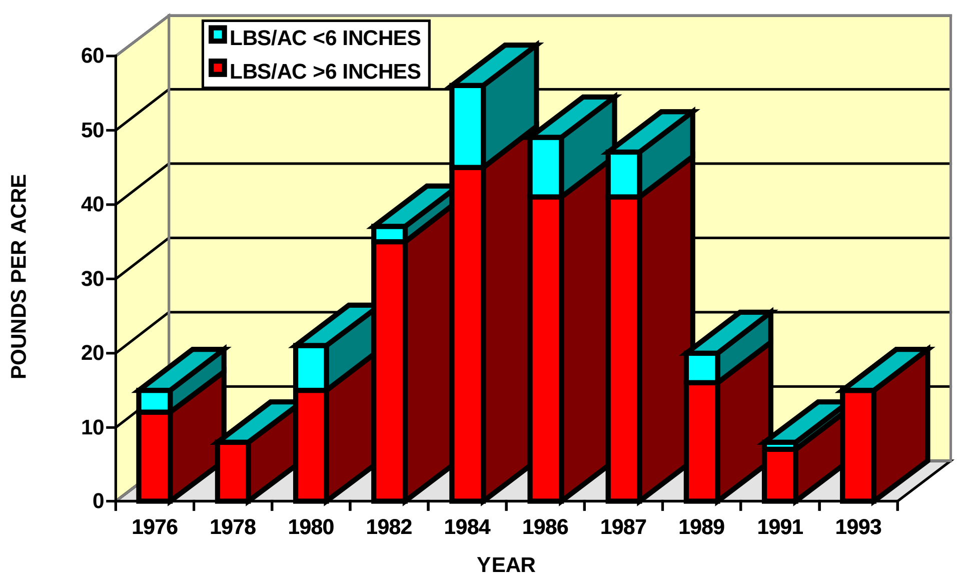


Figure 29-4. Biomass of BRC at Huff Creek from 1976 to 1993. Severe drought affected the population after 1987.

<u>Trout Habitat Response</u> - BRC habitat improved with the change in habitat management (Figure 29-5). Habitat quality was significantly better by 1986 (mean HU, 48; SD, 6) than pretreatment (mean HU, 30; SD, 2). Even after 3 years of severe drought, habitat quality in 1989 (mean HU, 38; SD, 2) was still significantly better than pretreatment levels. Before treatment, the HQI predicted a BRC stock of 60 lb/acre, if habitat limitations were corrected. The actual biomass attained was 56 lb/acre in 1984.

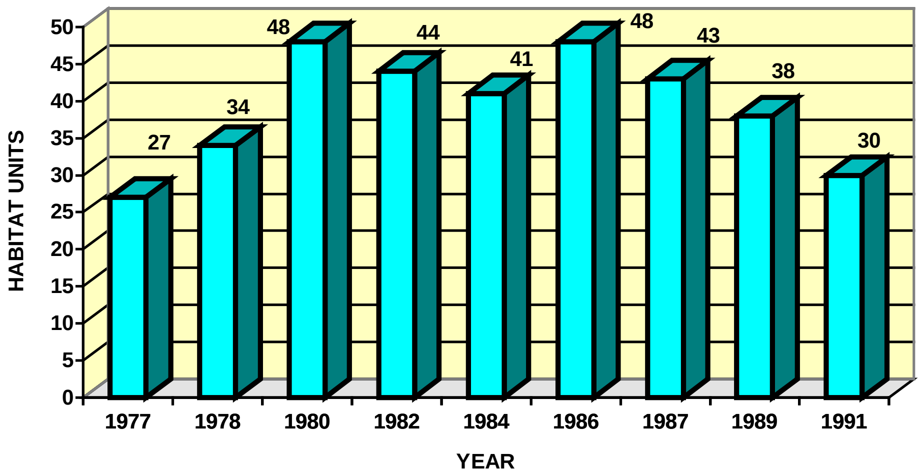


Figure 29-5. Instream habitat conditions in Huff Creek, as documented by HQI analysis from 1977 to 1991.

Cover for BRC increased after treatment, but later decreased during drought (1987-1991, Figure 29-6). Yet cover was significantly more abundant in 1989 (mean, 18%; SD, 5) than before treatment (mean, 7%; SD, 3). Plunge pools created by instream structures were deeper than natural pools, and greatly aided fishery rejuvenation. BRC abundance was correlated to the previous year's stream discharge, the quantity of cover, and pool area.

Although drainage-wide bank stability had improved by 1989 (mean, 41%; SD, 21), it was not significantly different than before treatment (mean, 50%; SD, 15). Many eroding banks persisted along the stream course, both inside and outside of the exclosures.

Habitat Structures - Additional deep-water habitat was effectively provided by the plunge structures. When evaluated in 1991, each timber plunge contained 60 sqft of cover, with RPD 1.5, or deeper, at 58% of the plunge pools. Condition of the devices was rated good. Rock plunge pools had 51 sqft of cover and 80% had RPD 1.5, or deeper. Plunge structures needed little maintenance for several years, but were resealed in 1989 with sandbags to reduce leakage.

Banks treated with rock riprap generally became stable. Rocks placed by machine effectively stabilized eroding banks, but floods, which reduced bank stability, often displaced smaller, hand-placed rocks. Trash catchers logged variable results. Normal wire and fence-post trash catchers dug deep plunge pools, but had problems with end-cutting and structure collapse. Most trash catchers reinforced with a top cable dug deep pools and resisted end-cutting. Instream structures

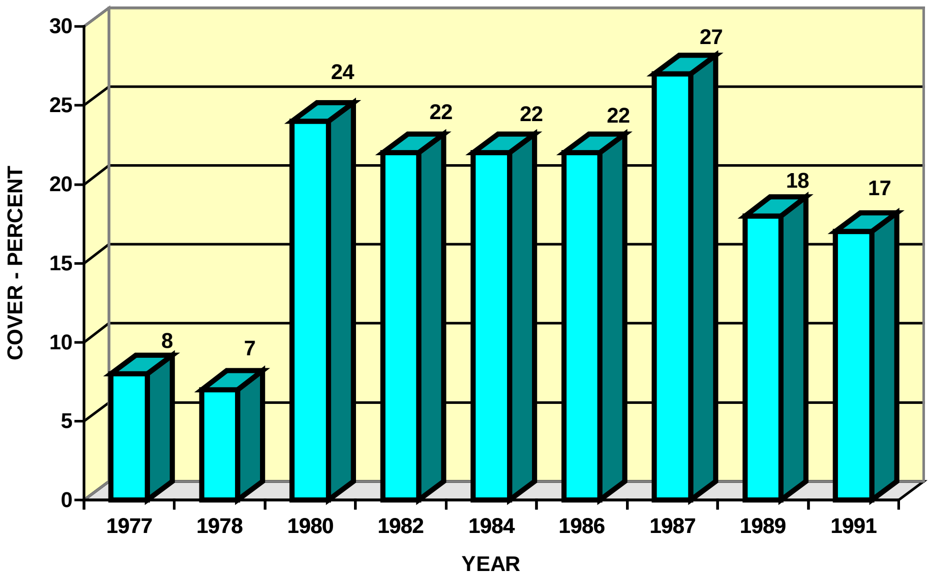


Figure 29-6. Cover available for trout in Huff Creek from 1977 to 1991.

were still effective in 1996. Since this is deep snow country, the fences needed annual maintenance, much of which BLM contracted to the range rider. When fence maintenance was not done, cattle soon found their way into the exclosures and began damaging stream banks and streamside plants.

Conclusions - Instream habitat improvement devices, exclosures, a "rest early, graze late" scheme, and aggressive herding of cattle effectively increased BRC numbers in Huff Creek. Posttreatment, mean BRC abundance was 85% higher, and biomass 145%, than pretreatment. Although the adverse effects of prolonged drought were moderated by the habitat improvements, ultimately, drought reduced the fish population to a low level, despite the better habitat conditions. However, this level was still 154% higher than pretreatment.

BRC habitat improved with the change in habitat management. Mean posttreatment HU were 24% better than pretreatment, while cover was 190% better. Bank stability was not significantly better posttreatment.

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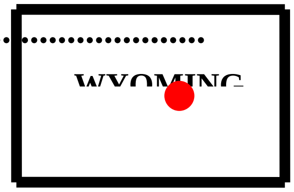
Table 29-1. Population data for Bear River cutthroat trout living in Huff Creek 1958-1993. Figures are means for all stations available each year.

Year	Mean length	Mean weight	Number per mile	Number per mile >6 inches	Pounds per acre	Pounds per acre > 6 inches
Pretreatment						
1958	5.6	0.07	222	81		
1976	6.5	0.11	148	63	15	12
1978	8.4	0.24	35	35	8	8
Posttreatment						
1980	6.4	0.10	248	131	21	15
1982	7.6	0.16	215	184	37	35
1984	8.2	0.19	456	249	56	45
1986	8.6	0.22	385	206	49	41
1987	6.8	0.14	372	211	47	41
1989	7.0	0.13	170	94	20	16
1991	6.9	0.13	68	50	8	7
1993	5.8		89	52	15	15
Pretreatment Mean	6.8	0.14	135	60	12	10
Posttreatment Mean	7.2	0.15	250	147	41	22
Percent change	5	7	85	242	145	120

LABONTE CREEK ....



ALBANY COUNTY

PROJECT BUILT: 1980 - 1984

Drainage:	North Platte River	**North Slope Laramie Range Basin (1LR)**	
Elevation:	6,900 ft	**R.** 74 **W., T.** 28 **N., S.** 13**,** 14, 17, 18	
Stream Order:	Third	**Stream Class:** 3 (regionally important fishery)	
Watershed Area:	55 sqmi	**Mean Wetted Width:** 12 ft	
Gradient:	1.4 - 2%	**Land Status:** Medicine Bow National Forest	
Rosgen Channel Type:	B-3	**Project Length:** 3 miles	
Treatment Used:	Boulder plunges, boulder double deflectors, rock riprap, tree revetments, log plunges, cover trees, fish rocks		
Trout Species:	Rainbow and brook trout		

DESCRIPTION OF STREAM: Situated in the Laramie Range, where rugged, granitic formations dominate the watershed, soil layers are thin, and water flows readily from the landscape, extreme streamflow fluctuation characterizes LaBonte Creek. During the snowmelt runoff, stream discharge is often high, and during summer, storm driven flash floods are possible. But during the rest of the year, base flows often become critically low, and stream temperatures may become marginal for trout. At the project location, LaBonte Creek flows through LaBonte Creek Canyon and the valley bottoms are relatively narrow. Riparian vegetation is cottonwood trees, conifers, willows, sagebrush, grasses, and forbs, while conifer and aspen patches grow on valley sideslopes. Stream substrate is very rocky and dominated by boulders.

PROJECT DESCRIPTION: A cooperative venture between WGF and the Medicine Bow National Forest, primary project objective was to provide deep pools for trout shelter during low flow periods. Another objective was to preserve channel integrity and esthetics by using materials procured on-site to produce natural appearing habitat improvement structures. The project was funded by USFS, while WGF provided expertise, manpower, and non-contractual equipment. Construction done in 1980-1981 was evaluated in 1982 when no construction money was available. After funding was restored, more devices were built in 1983-1984.

THE FISHERY: Stream fishing on public land in this area is at a premium as many streams have very low discharge during summer, and much land is privately owned. Even with low summer flows, LaBonte Creek in the canyon is a popular outdoor recreation area. Forest and rugged mountain vistas provide excellent scenery. Almost four miles of LaBonte Creek is readily accessible from a graveled road down the canyon. Downstream from the USFS campground at Curtis Gulch, access is by a very rugged two track dirt road into the lower canyon, which is designated as a big game range. Visitor use of the canyon increased from 1,660 visitor days in 1976 to 4,060 in 1984. This fishery is especially popular with early summer anglers utilizing higher seasonal stream flows to fish for wild RBT and BKT. Due to poor return to the creel, LaBonte Creek had not been stocked with trout since the mid-1950's. But with steadily increasing usage of the area, public demand for a better fishery also increased. So beginning in 1983, the stream was annually stocked with sub-catchable RBT. Angler utilization and harvest of the stocked fish were reported to be excellent. Standard statewide fishery regulations applied.

HABITAT MANAGEMENT: Pretreatment, much of the stream was riffle, which became very shallow during summer. A few natural, deep pools were present and were well used by trout. Primary emphasis of the habitat project was to create additional deep pools by building structures from granite boulders obtained on-site. Accordingly, USFS hired a front-end loader and a tracked backhoe to move the rocks into place and dig out the new plunge pools. A joint WGF-USFS work crew provided manpower. Structures installed in 1980 - 1981 were experimental to see which designs best withstood flood flows. Emphasis was on low profile rock designs to reduce resistance during floods. Ten boulder plunges, two double deflectors, and several boulder grade controls were added to the stream. In 1983, five rock double deflectors having a higher profile design were installed near Prospect Gulch, and in 1984, two log plunges and a rock deflector were installed near the confluence of Big Bear Creek (Figure 30-1). Total project cost for 20 structures was $27,800 ($9,267/mile).

Figure 30-1. A log plunge still provides deep pool shelter for trout in LaBonte Creek 11 years after it was built. RPD was over 4 ft in this pool.

EVALUATION OF TROUT HABITAT MANAGEMENT

<u>Fishery Response</u> - Six years after treatment, LaBonte Creek was sampled with electrofishing gear at two stations within the upper project. One site had boulder structures and cover trees; the other was an untreated control upstream from the first station. Both were equally available to stocked trout. Trout abundance at the treated site was 135% greater than at the untreated station (Figure 30-2). Biomass was 32% greater (Figure 30-3). Comparison with average trout abundance in 1979 shows a four-fold increase by 1988 at the treated station. Although fish stocking and fishing pressure confound this comparison, the untreated site had double the trout abundance in 1988 as was present in 1979. This suggests that stocking added about half of the increase noted at the treated station, meaning that the habitat improvement work approximately doubled trout abundance over pretreatment levels. No creel census data are available, but observation indicates good acceptance of the habitat improvement work by the fishing public. Weekend and holiday use has been heavy. USFS personnel reported as many as six anglers at a time fishing at one plunge pool.

<u>Trout Habitat Response</u> - Plunge pools formed by the various structures added 7,500 sqft of cover to the stream, and additional, unmeasured cover was available to trout in the dam pools upstream from the plunges. Cover for trout was nine-fold greater in the stream section containing plunges and cover trees than in the untreated section (Figure 30-4). In the untreated section, pocket pools, undercut rocks, and overhanging willows furnished cover while in the treated section, plunge pools were the primary cover type.

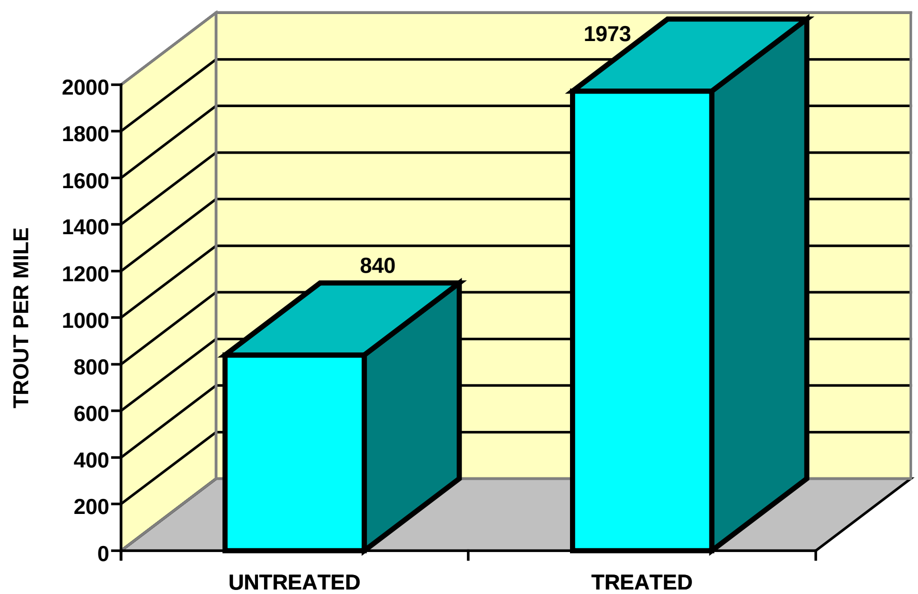


Figure 30-2. Trout abundance at LaBonte Creek seven years after habitat improvement. Boulder plunges and cover trees were added to the treated stream section in 1981; the untreated section was located immediately upstream and represented pretreatment habitat conditions in the creek.

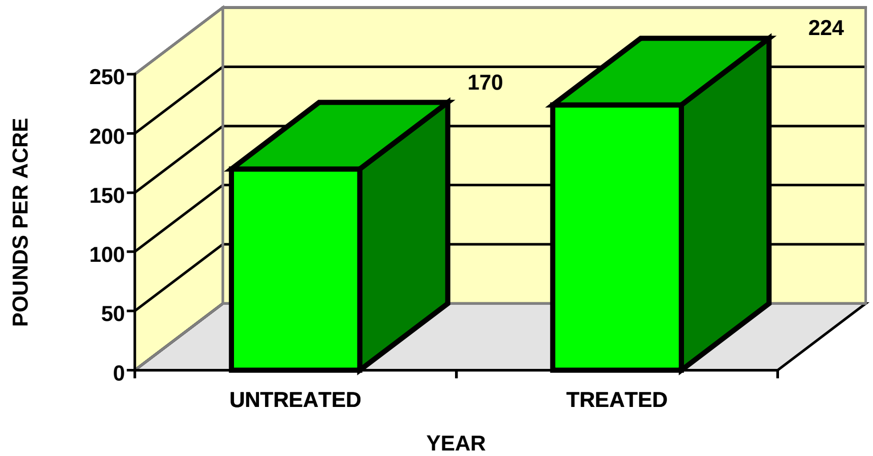


Figure 30-3. Trout biomass at LaBonte Creek seven years after habitat improvement. Boulder plunges and cover trees were added to the treated stream section in 1981; the untreated section was located immediately upstream and represented pretreatment habitat conditions in the creek.

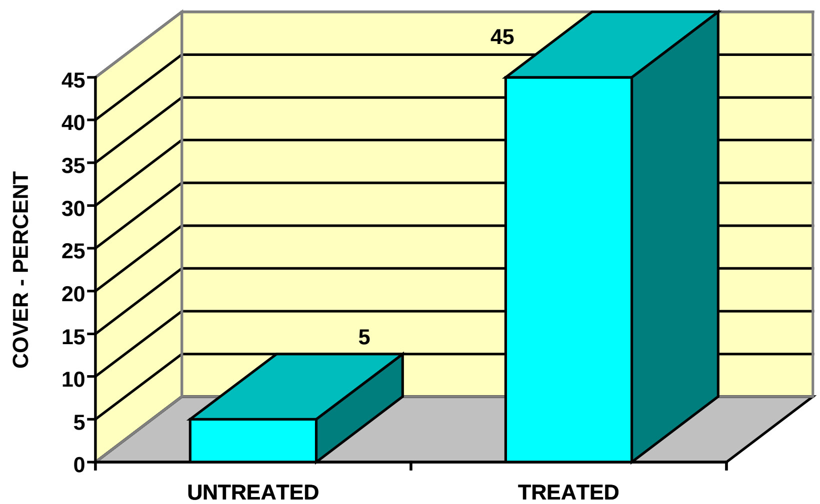


Figure 30-4. Cover for trout in LaBonte Creek. The treated section contained boulder plunges and cover trees.

Habitat Structures - In 1995, all 20 of the pool forming structures were located and evaluated. Of the 11 boulder plunges, five had RPD 2 ft, or deeper, and two had RPD over 3 ft (Figures 30-5 and 30-6). Boulder plunge pools with poor depth either had pools filled with rocks or damage to the plunge itself from rocks shifted by river currents. One boulder plunge had disintegrated, but had since formed a deep trench pool with RPD over 2 ft. The remaining boulder plunges were rated in good condition. All six double deflectors were rated in good condition with RPD 2 ft, or deeper, and one was over 4 ft deep. The higher profile structures suffered more rock slippage than did the lower profile devices. Both log plunges had RPD 3 ft, or deeper. One log plunge was in good condition, but the other had been undercut by the stream and was acting as a digger-log. A non-parametric rank sum test indicated significantly more cover was associated with plunge pools at boulder double deflectors (mean, 467 sqft) than at boulder plunge pools (mean, 395 sqft).

Conclusions - Boulder habitat improvement structures installed in LaBonte Creek proved to be durable and provided considerable extra deep water cover for trout. Cover for trout was nine-fold greater in the stream section containing plunges and cover trees than in the untreated section. Trout abundance was 135% greater in a treated stream section than in an adjacent untreated section. Although the habitat improvement project likely contributed to the observed increase in angler use, the scarcity of running water fisheries in this area was also a factor, and public demand for an acceptable trout fishery in LaBonte Creek would have increased even without the project. The structures have provided more holding water for trout, have provided a better return to the creel of stocked trout, and have made possible a better fishery in a stream with marginal habitat conditions.

INFORMATION SOURCES

McKnight, R. 1985. LaBonte Creek Habitat Improvement. Administrative Report, Fish Division, Fish Management Section, Wyoming Game and Fish Department, Casper.

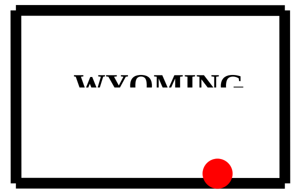
Figure 30-5. A pair of boulder plunges (foreground) and a boulder double deflector (top of photo) as they appeared soon after construction.

Figure 30-6. The same view seen in Figure 30-5 11 years after the structures were built. Riparian vegetation has responded positively to reduced cattle grazing, sediment deposition, and improved subirrigation of the riparian zone near the plunges.

LARAMIE RIVER - Jelm

ALBANY COUNTY

PROJECT BUILT: 1993



Drainage:	Laramie River	**Upper Big Laramie River Basin (5UL)**	
Elevation:	7,530 ft	**R.** 77 **W., T.** 13 **N., S.** 23, 22	
Stream Order:	Fifth, or greater	**Stream Class:** 2 (statewide importance)	
Watershed Area:	~ 400 sqmi	**Mean Wetted Width:** 66 ft	
Gradient:	0.15%	**Land Status:** WGF Public Fishing Area	
Rosgen Channel Type:	B-3	**Project Length:** 3,200 ft	
Treatment Used:	Rock riprap, rock barbs, rock funnel, rock weir, fish rocks		
Trout Species:	Brown and rainbow trout		

DESCRIPTION OF STREAM: Headwaters of the Laramie River are in the Colorado Rockies as the project site is only a few miles into Wyoming from the state line. Stream flow is generally adequate for trout at the PFA. Primary riparian vegetation is cottonwood trees and willows.

PROJECT DESCRIPTION: Primary goal for the habitat improvement project was to increase the trout population by providing additional shelter. An additional goal was to stabilize any eroding banks through the PFA. This project was funded and constructed by WGF.

THE FISHERY: There is much private land in this river section, thus the PFA affords public fishing access to a popular fishery and it is heavily used. Angling is controlled by special regulations (10-16 inch slot limit for BNT and all RBT must be released). Electrofishing samples in 1990 showed 35 lbs/acre in the project area, as opposed to 73 lbs/acre in a nearby section having better habitat.

HABITAT MANAGEMENT: An original habitat improvement proposal was to install devices through the PFA, but this plan was amended and much abbreviated after one landowner complained about the proposed project. Consequently, no work was done upstream from the parking lot; only a short section near and immediately downstream from the parking lot was worked. A WGF construction crew installed 1,150 ft of rock riprap, three upstream rock barbs, one rock funnel, one rock sill, and 32 fish rocks. Project cost was $21,712 ($35,825/mile).

EVALUATION OF TROUT HABITAT MANAGEMENT

<u>**Fishery Response**</u> - No evaluation was done for the abbreviated project.

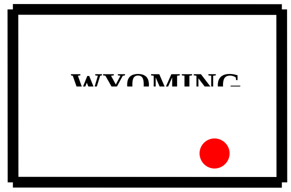
<u>**Trout Habitat Response**</u> - No evaluation was done for the abbreviated project.

<u>Conclusions</u> - Although no formal evaluation was done, visual observation indicates additional shelter for trout was created by the structures and banks were stabilized.

LARAMIE RIVER at Laramie

ALBANY COUNTY

PROJECT BUILT: 1974



Drainage:	North Platte River	**Upper Big Laramie River Basin (5UL)**
Elevation:	7,100 ft	**R.** 73 **W., T.** 16 **N., S.** 32
Stream Order:	Fifth, or greater	**Stream Class:** 4 (local importance)
Watershed Area:	~ 500 sqmi	**Mean Wetted Width:** 50 ft
Gradient:	< 0.1%	**Land Status:** highway right of way
Rosgen Channel Type:		**Project Length:** 1,000 ft
Treatment Used:	Metal bank overhangs	
Trout Species:	Brown and rainbow trout	

DESCRIPTION OF STREAM: In the project area, the Laramie River flows along the west side of Laramie, just east of I-80. Headwaters of the river are mainly in Colorado, but part of the watershed drains the south end of the Snowy Range. Due to irrigation and domestic water withdrawals upstream from town, summer stream flow may be very low (10-20 cfs). ADF is 105 cfs, with peak flows to 3,250 cfs during the snowmelt runoff. Stream substrate is sand and fine gravel.

PROJECT DESCRIPTION: Installation of metal bank overhangs was undertaken by the Wyoming Water Resources Research Institute (WRRI) at the University of Wyoming on an experimental basis to determine if this type of structure would work. Funding was by WGF.

THE FISHERY: A low population of BNT and RBT occurred through the project area and fishing pressure was low. Chemical and silt pollution were factors influencing both fish population level and public use of the fishery.

HABITAT MANAGEMENT: For many years creosote pollution from a major tie production plant located just upstream adversely affected water quality, but pollution abatement measures reduced this problem. However, when the U.S. Highway 130-230 bridge across the river was relocated, about 1,300 ft of river channel was channelized. WRRI was commissioned by WGF to evaluate the channel and recommend corrective measures. Their recommendations included increasing shelter for trout with metal bank overhangs. To test this concept, WRRI installed several overhangs occupying about 30 linear feet of bank.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - No evaluation.

Trout Habitat Response - The channelized section was located just upstream from the new bridge, which acted to encourage deposition by the river. Consequently, the river channel was very unstable for several years after the bridge was built. By 1998 though, the channel had stabilized, with prominent willow and other riparian vegetation throughout the project area.

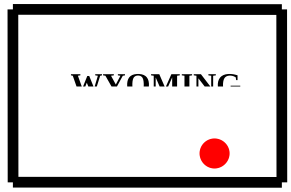
Habitat Structures - All of the experimental overhangs were either destroyed or buried by the river within a few years.

Conclusions - Experimental metal bank overhangs failed to endure in the unstable channel upstream from the new bridge. Such structures are not recommended for use in Wyoming streams.

INFORMATION SOURCES

Wesche, T. A. 1974. Habitat evaluation and subsequent rehabilitation recommendations for the Laramie River channel change area in Laramie, Wyoming. Water Resources Research Institute, University of Wyoming, Laramie.

LARAMIE RIVER (Monolith PFA)



ALBANY COUNTY

PROJECT BUILT 1987 -1989

Drainage:	North Platte River	**Upper Big Laramie River Basin (5UL)**
Elevation:	7,160 ft	**R.** 74 **W., T.** 15 **N., S.** 14, 22, 23, 27, 28
Stream Order:	≥ Fifth	**Stream Class:** 3 (regionally important)
Watershed Area:	~ 500 sqmi	**Mean Wetted Width:** 40 ft (August)
Gradient:	0.02 -0.06%	**Land Status:** City of Laramie, WGF public fishing easement
Rosgen Channel Type:	C-5	**Project Length:** 3.7 miles
Treatment Used:	Tree/rock revetments, rock deflectors, rock sills	
Trout Species:	Rainbow and brown trout	

DESCRIPTION OF STREAM: In the project area, the Laramie River flows through ranch land on the Laramie Plains. Its headwaters are mainly in Colorado, but part of the watershed drains the south end of the Snowy Range. Due to irrigation and domestic water withdrawals upstream from the PFA, summer stream flow is often very low. Consequently, there is considerable annual fluctuation in stream flow. Stream substrate is sand and fine gravel.

PROJECT DESCRIPTION: After the City of Laramie purchased the old Monolith Ranch in 1982 for its water rights, an agreement between the city and WGF guaranteed public access to about 3.7 river miles. Subsequently, an access road to the river, a parking lot, and a restroom were built for angler use. Then the Travelle Chapter of the Izaak Walton League built a fence around the parking lot and the adjacent river bend, and the city riprapped an eroding bank there with concrete chunks. During the mid-1980s, WGF developed a habitat improvement plan for the entire PFA. This plan was implemented in 1987, with help from the Izaak Walton League. Project objectives were bank stabilization, restoration of riparian vegetation, provision of more shelter areas for trout, and a larger trout population. In 1990, the Monolith PFA was established when a legal public fishing easement agreement was signed by the city and WGF.

THE FISHERY: Pretreatment, the trout fishery at the Monolith was very poor due to lack of shelter and other habitat shortcomings. Fishing pressure was very light. Surveys with an electrofishing boat found only a few BNT. These were always taken in an occasional deep pool or patch of LWD. Standard statewide fishing regulations were in effect.

HABITAT MANAGEMENT: Historically, the Laramie River through the Monolith Ranch had been very heavily grazed by cattle. Fish habitat was described as “very grim” and “it can’t get any worse”. Bank erosion was 100%, deep pools were lacking, and the stream was wide and shallow (Figure 33-1).

Riparian vegetation - willows and cottonwood trees - was much reduced, as was instream LWD. Upstream irrigation withdrawals often reduced summer stream flow through the Monolith to a minimal level.

Figure 33-1. Pretreatment, the Laramie River through the Monolith PFA was wide, shallow, and lacked deep pools. Bank erosion was 100% and was exacerbated by heavy cattle grazing.

Located only four miles from West Laramie, the new public fishing area had a high potential for heavy public use. This prediction proved true even before habitat improvement was done and added impetus to the work. After a private contractor hauled in a 10,300 cuyd of limestone riprap and 1,000 boulders from the Mountain Cement Company quarry, a WGF construction crew installed habitat improvement structures (Figure 33-2). Some of the earlier work was experimental to determine which devices would work best in the sand bottom stream. Over a three-year period, the crew installed 18,350 ft of tree/rock revetments, 18 boulder deflectors, 9 rock sills, 2 rock funnels, and at least 65 fish rocks. Cost was $237,450 ($64,174/mile). Funding for the project was mostly from federal Wallop-Breaux money on a 75% federal to 25% state match.

Figure 33-2. A WGF construction crew builds a tree/rock revetment. After the trees are placed, and anchored with cables to deadmen, the rocks are placed behind the trees to further anchor cable, trees, and bank. Note the point bars lack willows and other vegetation.

Under the direction of Mr. Al Morton, retired USFS range and wildlife manager, the Izaak Walton League fenced, over several years, much of the riparian zone along the river. The Izaaks furnished Labor after WGF supplied the materials. Fencing cattle away from the river was an important component of the habitat improvement as the city leased the grazing rights and many cattle continued to use the ranch. Several water gaps, with fence panels designed to swing with river currents, were built after consultation with the grazing lessee.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - In response to the intensive angling pressure, many juvenile and catchable RBT and BNT were stocked annually. This extensive stocking program completely confounded any meaningful electrofishing evaluation of fish response to the habitat improvement. However, the habitat improvement structures have been well used by trout and have attracted many anglers annually, who have reported good fishing on the PFA. Both BNT and RBT weighing several pounds have been reported. During each October, BNT have built spawning redds on the sills. Although egg-hatching success is unknown, a few wild juvenile trout are caught each time the PFA is electrofished.

Trout Habitat Response - Many deep pools and runs have developed near the tree/rock revetments, which have added a LWD component to the habitat (Figure 33-3). Habitat diversity has also been increased by the rock sills, which were intended to function both as grade controls and as attachment sites for macroinvertebrate organisms. Pretreatment, cover for trout was very sparse, but after a decade, cover had increased four fold (Figure 33-4). Removing livestock from the riparian zone proved beneficial to stream bank vegetation. By 1997, extensive willow growth had developed along the stream edges, especially on the point bars. Some willows were from cuttings planted by Laramie school children, but much growth occurred from natural root systems that had been repressed by cattle use.

Despite the gains made from the structures, summer water flow were a major problem through 1997. Low flows in late summer have greatly slowed water velocity, reduced habitat niches available to trout, raised water temperatures to crucial levels, and encouraged excess algae growth. Late summer flows continue to be a limiting factor for trout at the Monolith PFA.

Habitat Structures - Durability and performance of the habitat structures has been good through 1997 and maintenance needs have been minimal. Rocks and trees continue to age and blend better into the environment with each passing year. Some fence maintenance has been required. And constant vigilance by Laramie regional fishery personnel has been necessary to note and promptly remove trespass livestock. The experimental rock funnels did not provide much cover for trout and are not recommended for this type of stream.

Conclusions - Addition of habitat improvement structures to the sand bed river benefited trout by providing more LWD shelter and deep pools for holding trout. Acceptance of the project by the angling public has been favorable and the area is heavily fished. Eroding banks have stabilized and growth of riparian vegetation has been very good within the area enclosed by the fences. Minimal stream flow in late summer continues to be a major limiting factor for which no solution has yet been devised.

Figure 33-3. Eight years after this tree/rock revetment was built, stream banks are stable and there is cover for trout along the deep interface of trees and water. Willows and other riparian vegetation have established on the point bars and along the banks.

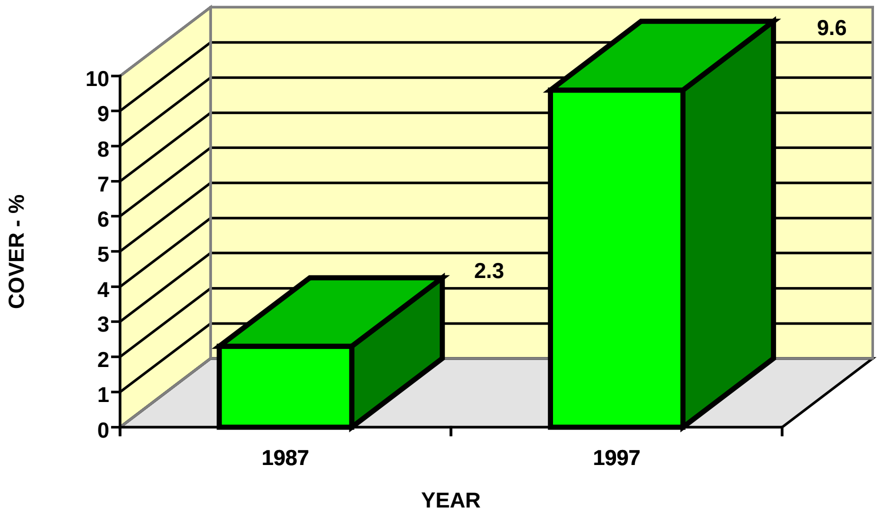


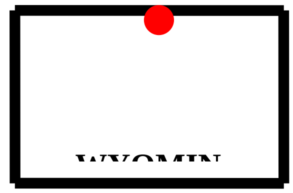
Figure 33-4. Cover available for trout at the Monolith PFA on the Laramie River before and after habitat improvement.

INFORMATION SOURCES

Hogle, J. S. 1993. Salmonid habitat and population characteristics related to structural improvement in Wyoming streams. Masters thesis. University of Wyoming, Laramie.

Roten, R. 1987. A happy home for fish being made in Laramie River on Monolith Ranch. The Laramie Daily Boomerang**,** Sunday, October 25, 1987.

LICK CREEK



SHERIDAN COUNTY

PROJECT BUILT 1984-1986, 1989, 1990-1991

Drainage:	Dry Fork Little Bighorn River	**Little Bighorn River Basin (8LH)**	
Elevation:	8,620 ft	**R.** 90 **W., T.** 56 **N., S.** 20 NW 1/4	
Stream Order:	First	**Stream Class:** 3 (regionally important)	
Watershed Area:	6 sqmi	**Mean Wetted Width:** 11 ft	
Gradient:	3.1%	**Land Status:** Bighorn National Forest	
Rosgen Channel Type:	B-3	**Project Length:** 4,300 ft	
Treatment Used:	Timber plunges, rock double deflectors, and upstream “V” plunge		
Trout Species:	Snake River cutthroat and rainbow trout		

DESCRIPTION OF STREAM: Lick Creek drains a northeast aspect of the northern Bighorn Mountains, where much snow falls during winter. Snow melt, rainfall, and springs furnish a natural stream flow regime and late summer flow is adequate for trout. Grass and forb parks interspersed with patches of conifer cover the watershed. A few logged areas are present. Lick Creek flows from a patch of conifers into Lick Creek Meadows as a first order stream with a steep 4.8% gradient and relatively straight channel. In mid-meadow, it becomes a second order stream having a 3% gradient. Through the lower meadow, the creek meanders more and gradient is 1.8%. Stream substrate is primarily gravel and cobble. Nitrate concentrations are variable, but are usually higher than most Wyoming headwater streams. A likely source is spring flow, but livestock use of the watershed may also be a factor. Algae grows abundantly during summer where the stream bed is undisturbed by livestock.

PROJECT DESCRIPTION: Located about 10 miles northwest of Burgess Junction, the project is easily accessible by a two track dirt road leading from Forest Road No.15, which is graveled. Recreational usage is high in the northern Bighorn Mountains and Lick Creek is a popular destination. Recreational use of the Lick Creek watershed intensified when Forest Road No. 15 was built in 1983. Prior to that, a poor two track dirt road furnished the only access. However, despite the increased demand for fishing at Lick Creek, fish habitat quality remained poor and hindered fishery quality. At the meadows, the stream was wide, shallow, and contained very few deep pools. Consequently, a habitat improvement project was designed in 1983 and implemented in 1984 as a coop venture between WGF and the Bighorn National Forest. Construction was done by WGF, while USFS contributed Sikes Act funds. Objective of the project was to furnish deep pool habitat to shelter stocked juvenile trout and hold them in the area while they grew to catchable size. A second goal was to see if better habitat would stimulate natural reproduction so the fishery could become self supporting.

THE FISHERY: Although stocked in the 1950s, Lick Creek at the meadows was devoid of fish when checked in 1980. RBT were subsequently stocked in 1980 and their survival was monitored. No evidence of natural reproduction had been found by 1983 when only four of the trout stocked in 1980 were found in 855 ft of stream. Only one trout was located in the 300 ft HQI station.

Starting in 1985, about 2,000 juvenile SRC were stocked every 2-3 years to satisfy public demand for a fishery at this stream. As several anglers used the fishery each day during summer, and angler harvest of larger trout was believed to be significant, trout abundance fluctuated widely from year to year depending on when fish were last stocked. Standard statewide fishing regulations applied. By 1996, absolutely no evidence of natural reproduction had been found despite regular electrofishing over a 16 year period and the Sheridan fish management crew concluded that any fishery in Lick Creek would have to be maintained with regular infusions of hatchery fish.

HABITAT MANAGEMENT: An HQI evaluation in 1983 at the proposed habitat improvement project identified lack of cover for trout as a primary habitat shortcoming. Total cover for the station was only 0.8% and shallow pocket pools furnished the only shelter. Overhanging bank cover was virtually nonexistent due to trampling of banks by cattle. Bank stability was poor with 72% eroding stream banks (Figure 34-1).

Over a three year period, a WGF construction crew installed 36 timber plunges, 7 rock double deflectors, and one modified upstream “V” plunge (Figure 34-2). Structures were installed at irregular intervals starting where the stream enters the meadow downstream to where the creek changes from meadow to canyon. Cover trees were added to the plunges in 1989 and in 1990-1991, USFS, with Trout Unlimited help, built three pole-fence enclosures to exclude livestock from the stream and its immediate riparian zone through the meadow. In 1998, the water gaps between the exclosures were removed to create one large exclosure. Total WGF project cost through 1989 was $16,875 ($20,720/mile).

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Evaluation of fishery response to the habitat improvement work is confounded by both fishing pressure and periodic plants of young hatchery fish. However, grouping the data averages fluctuations and highlights trends. Mean posttreatment abundance of SRC 6 inches, or greater, was 365% greater than in the pretreatment period (Figure 34-3, Table 34-1). Biomass was 273% higher. Keeping in mind that no trout were present before 1980, and stocking alone was unable to maintain a fishery between 1980 and 1984, adding habitat improvement devices to the stream increased trout abundance many fold over the 1980 level. The combination of structures and stocking established a fishery where none would otherwise be possible.

Trout Habitat Response - Installation of the plunges provided 3,550 sqft of new plunge pool shelter for trout project-wide. But continued grazing of streamside areas by cattle kept stream banks in disturbed state and hindered recovery of instream fish habitat features. Exclusion of cattle with the exclosures produced a favorable response by riparian vegetation. When examined in 1996, many shoots of Wolf’s willow, a low growing species found at high elevations, had naturally become re-established within the exclosures. Specimens of Drummond’s willow had been introduced by USFS and were growing well within cages. Beak’s sedge, with its strong, bank strengthening root system, was well established within the exclosures, but was uncommon outside of them. Thick algae growth was common on the stream bottom within the exclosure, but much reduced, or absent, outside.

Figure 34-1. Lick Creek looking downstream across Lick Creek Meadow in 1983, prior to installation of habitat structures. Pretreatment Lick Creek was wide, shallow, and lacked deep pools. The meadow had been heavily grazed for many years.

Figure 34-2. An upstream view of Lick Creek in the same area as Figure 34-1 seven years after timber plunges were added to the stream. The pole fence at the top of the picture is part of the livestock exclosure.

By 1997, there was 16 times more cover for trout within the upper exclosure than in 1983, eroding banks had decreased 85%, and HU score was up 117% (Figure 34-4). But at an untreated reference site, cover rated less than 1%, all stream banks were eroding, the stream was 42% wider, and HU were 33% less than at the treated station. Only a few shallow pocket pools offered potential shelter for trout. Aquatic macroinvertebrates were 338% more abundant within an exclosure containing plunges than at an untreated stream section. Note that these were adjusted HQI evaluations, where the flow, temperature, and NO_3 attributes were held constant at 1983 levels.

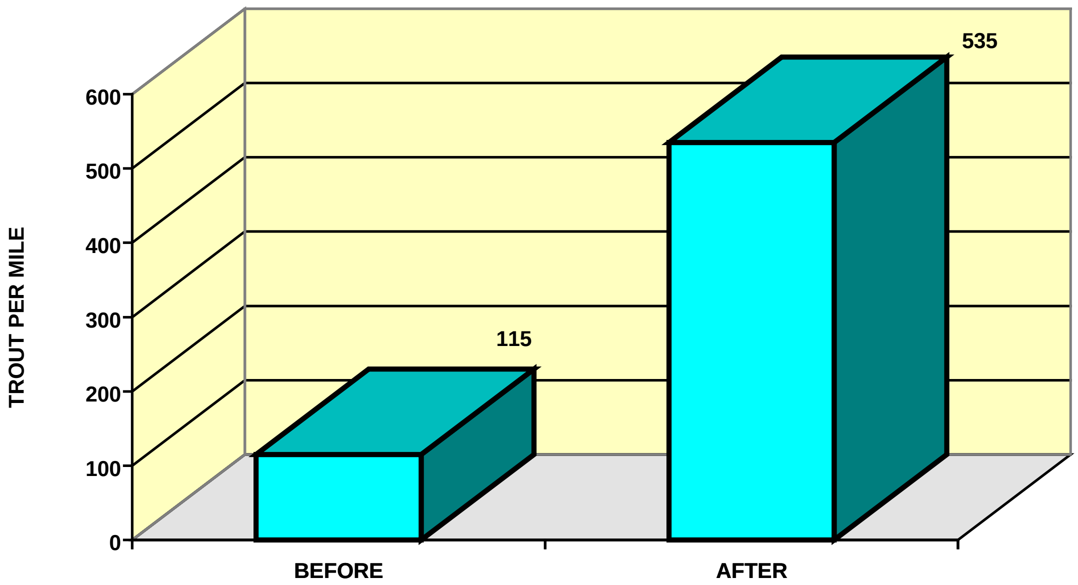


Figure 34-3. Abundance of trout 6 inches, or greater, in Lick Creek before (1980-1983) and after (1987-1996) habitat improvement structures were added to the stream.

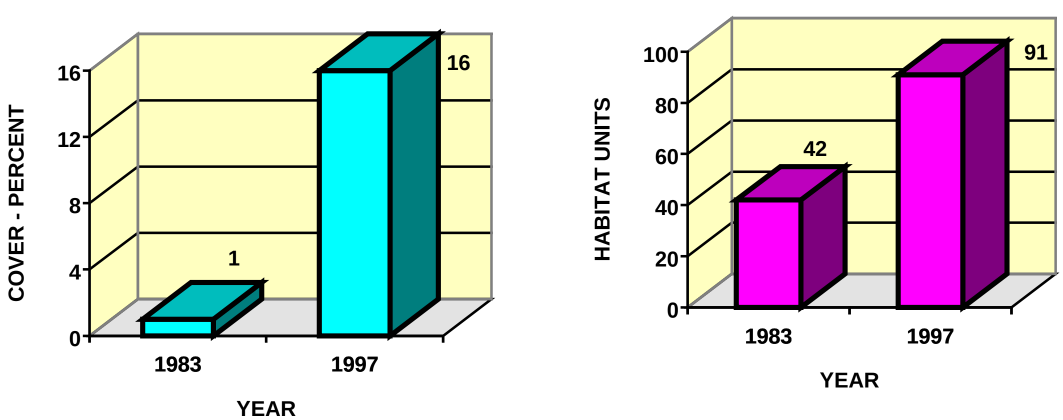


Figure 34-4. Cover available for trout (left) and habitat units (right) present at Lick Creek before (1983) and after (1997) habitat improvement.

Habitat Structures - An informal visual assessment of the plunge structures rated their condition as good in 1997 when mean cover was 96 sqft/plunge pool. Main problems included rocks rolling, or sliding, into the plunge pools, and loss of anchor rocks at plunge ends. Five years after the last plunge was built, all 37 were examined and RPD was 1.5 ft, or greater, at 53% of the plunge pools. Mean plunge pool RPD was

1.56 ft. At that time, only 20% of the boulder double deflectors had a pool RPD of 1.5 ft, or greater. RPD was l ft, or less, at all naturally formed pools. Hogle (1993) reported a significant difference between maximum depths at plunge pools as opposed to natural pools.

In 1998 when the 37 devices had been in the stream 12-14 years, their performance appeared to have stabilized. Their plunge pools had a mean RPD of 1.58 ft and 62% had RPD 1.5 ft, or greater. Only 2 of 7 boulder double deflectors (29%) had RPD 1.5 ft, or greater.

Conclusions - After angler access to Lick Creek was improved due to road construction, trout were stocked in an effort to provide a fishery, but the effort failed due to habitat shortcomings and a total lack of natural reproduction. After habitat was improved, abundance of trout 6 inches, or greater, increased four fold even though stocking rates remained constant. Stocking juvenile trout in combination with habitat improvement produced a good trout fishery where none was present before treatment. Addition of 37 plunge structures to Lick Creek provided over 3,500 sqft of deep plunge pool shelter, plus additional space from dam pools. Fencing livestock away from the creek and riparian zone increased riparian vegetation growth, resulting in better bank stability and more undercut bank shelter.

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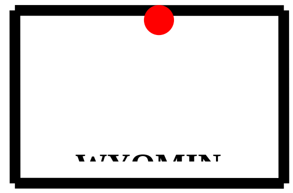
Binns, N. A. 1994. Long-term responses of trout and macrohabitat to habitat management in a Wyoming headwater stream. North American Journal of Fisheries Management 14: 87-98.

Hogle, J. S. 1993. Salmonid habitat and population characteristics related to structural improvement in Wyoming streams. Masters thesis. University of Wyoming, Laramie.

Table 34-1. Abundance and biomass of trout 6 inches, or greater, in Lick Creek before (1981-1983) and after (1987-1996) habitat improvement.

Year	Number/mile ≥6 inches	Pounds/acre ≥ 6 inches
Pretreatment		
1981	253	40
1982	68	16
1983	25	11
Posttreatment		
1987	282	86
1988	614	78
1990	90	27
1991	1,018	96
1994	987	160
1996	220	48
Pretreatment Mean	115	22
Posttreatment Mean	535	82
Percent change	365	273

LITTLE BIGHORN RIVER



SHERIDAN COUNTY

PROJECT BUILT: ***Phase I:*** **1980**
Phase II: **1995-1996**

Drainage:	Little Bighorn River	**Little Bighorn River Basin (8LH)**	
Elevation:	8,300 ft	**R.** 91 **W., T.** 56 **N., S.** 14	
Stream Order:	Second	**Stream Class:** 2 (statewide importance)	
Watershed Area:	12 sqmi	**Mean Wetted Width:** 15 ft	
Gradient:	1.3%	**Land Status:** Bighorn National Forest	
Rosgen Channel Type:	C-2	**Project Length:** 9,500 ft	
Treatment Used:	Log plunges, timber plunges, boulder plunges, rock double deflectors, tree jams, fish rocks, tree and rock revetments, rock riprap		
Trout Species:	Brook, rainbow, and Yellowstone cutthroat trout		

DESCRIPTION OF STREAM: Draining a northeast aspect of the Bighorn Mountains, the Little Bighorn River heads near Bald Mountain and flows northerly into Montana. Its watershed features coniferous forest, grassy parks, and alpine meadows. In the project area, the stream flows through Dayton Meadows, a broad treeless meadow. A fringe of short willows, mainly Wolf's Willow, grows on banks in the narrow riparian zone. On the valley sideslopes, a distinct tree line separates the meadow from a conifer forest. An abundant snowpack causes an annual snowmelt flood in May and June and maintains a clear, cold discharge through the summer. Summer flow is not a problem. Stream substrate is primarily boulder, rubble, and cobble.

PROJECT DESCRIPTION: Habitat improvement at the Little Bighorn River was done in 1980 (*Phase I*) and 1995-1996 (*Phase II*). *Phase I* was funded and constructed by the Bighorn National Forest, while *Phase II* was a cooperative venture between WGF and USFS. In *Phase II,* USFS furnished funding, trees, and rocks, EIS, and permits. WGF furnished planning and construction expertise, manpower, materials, and equipment. Project goals were to provide more deep pools for overwintering habitat, increase other types of instream shelter for trout, and stabilize eroding banks to reduce sediment entering the creek from that source.

THE FISHERY: Easy angler access to Dayton Meadows is provided from Highway 14A by Forest Road No. 125, which parallels the stream through the meadow. Highway 14A is an major access route for traffic to and from Yellowstone Park and the Little Bighorn River is very popular with the fishing public (about 300 angler days/year). Historically, catchable RBT (6 inches, or longer) have been planted to satisfy angler demands for larger fish and better fishing than could be provided by the wild BKT population. Natural reproduction was poor by trout other than BKT and there was very little carryover of RBT. Through the 1980s, statewide fishing regulations applied, but in 1994, special regulations required that all CUT be released. These regulations were designed to protect YSC, which, starting in 1990, were stocked as juveniles in an attempt to establish a self-sustaining population of this native species. If successful, the RBT plants would be phased out.

HABITAT MANAGEMENT: From about 1890 to 1920, gold mining activity near Bald Mountain also affected the Little Bighorn River, and its tributary Half Ounce Creek. At upper Dayton Meadows, stream channels were dredged and placer mined for gold, while stream flow was diverted as needed to support the mining. Historically, the meadows were heavily grazed by sheep until the allotment was changed to cattle in the mid-1980s. In 1988, a modified rotation grazing scheme was started. Under this plan, Little Bighorn River was grazed mid-August to early September one year and during September the next year. Camping was banned at the meadows in the early 1990s to reduce human damage to the meadow.

Even with recovery from past mining, grazing, and recreational use, the rocky substrate would prevent the stream from developing many deep pools (Figure 35-1). Since such pools are crucial for overwintering trout at this elevation, plans were developed to address this shortcoming and improve fish habitat so the fishery would be better able to satisfy angler demand.

In *Phase I* (1980), a private contractor hired by USFS installed several log plunges, deflectors, and floating logs. Some large fish rocks were added a few years later. Cost was not recorded. In *Phase II*, a WGF construction crew installed 11 boulder plunges, 14 timber plunges, 5 log plunges, 10 tree jams, 10 double boulder deflectors, 125 ft of rock riprap, and several clusters of fish rocks (Figure 35-2). They also repaired three of the log plunges built in 1980. Phase II cost was $69,570 ($38,670/mile).

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - *Phase I.* During 1981-1994, mean abundance of wild BKT was 67% higher in the treated section than at an untreated site (Figure 35-3, Table 35-1). Biomass was 188% better(Figure 35-4). A rank sum test indicated both abundance and biomass of BKT were significantly better posttreatment. Catchable BKT (6 inches, or greater) numbers in the treated area increased three fold, while biomass increased 261%. In the stream section containing habitat improvement structures, BKT abundance was 135% greater by 1994 than in 1981, and biomass had improved 42%.

Phase II. One year after all structures were built, BKT abundance had doubled and biomass had tripled (Table 35-1). Catchable trout were 214% more abundant at the treated station and their biomass had improved four fold.

Evaluation of RBT and YSC response to the habitat improvement was hopelessly confounded by stocked hatchery trout and angler harvest. But both species were seen using the new habitat created by both *Phase I and Phase II* structures.

Trout Habitat Response - No formal evaluation of habitat changes was done, but trout could be seen using the many new deep pools (Figure 35-5). LWD shelter was more common and bank stability was better than pretreatment. Angler acceptance of the habitat improvement devices was very good. Pools formed by the structures were heavily fished.

Habitat Structures - All timber and log plunges were rated in good condition when examined in 1997. Mean RPD was 1.78 ft for timber plunges, 1.82 ft for log plunges, and 1.62 ft for rock plunges. Timber plunges had 80% with RPD 1.4 ft, or deeper, (BKT focal point) and 70% had RPD 1.5 ft, or deeper, (CUT focal point). Log plunges had 60% for both depths, but rock plunges had 80% deeper than 1.4 ft, and only 50% over 1.5 ft. Although mean pool depth was about equal between timber and log plunges, timber plunges more consistently had a RPD acceptable to both BKT and CUT.

Figure 35-1. Pretreatment, pockets of bank erosion were common and the rocky substrate kept the river from scouring many natural deep pools.

Figure 35-2. This is the same site shown in Figure 35-1 after a timber plunge and a tree/rock revetment were added. Provision of a deep plunge pool adds a key element for overwinter survival of trout.

Conclusions - Installation of instream habitat improvement structures in the Little Bighorn River created many new deep pools suitable for overwintering trout. Diversity of shelter usable by trout was much better posttreatment. Wild BKT abundance increased 67%, and biomass 188%, after habitat improvement. Catchable wild BKT increased three fold, while biomass was up 261%. Posttreatment abundance and biomass were statistically different from pretreatment levels.

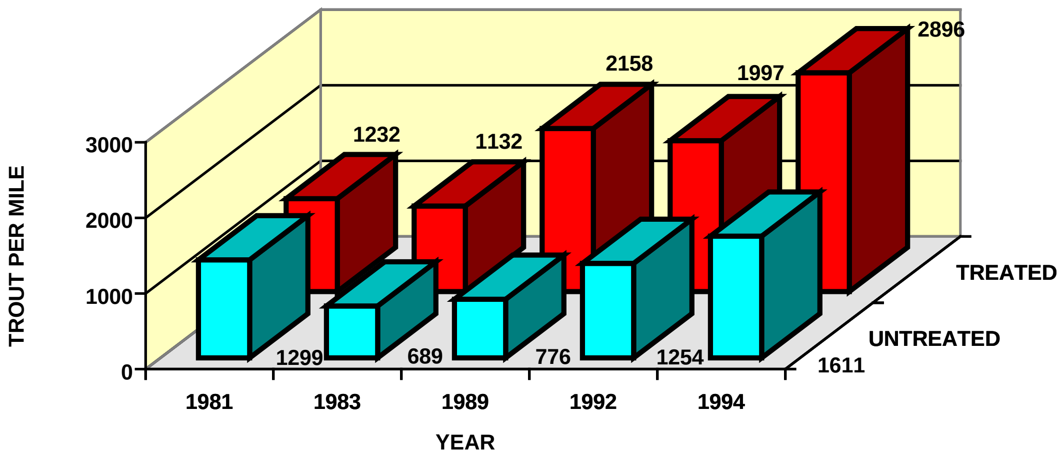


Figure 35-3. Mean abundance of wild BKT during 1981-1994 in an untreated section of the Little Bighorn River and at a section where habitat improvement devices were installed.

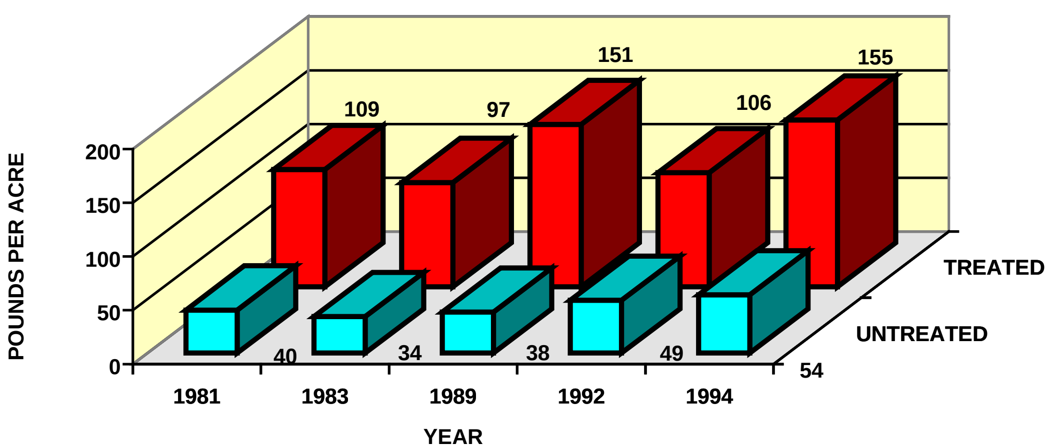


Figure 35- 4. Mean BKT biomass during 1981-1994 in an untreated section of the Little Bighorn River and at a section where habitat improvement devices were installed.

Figure 35-5. A deep pool is provided by a rock plunge, which could also be called a rock vortex weir. Swift stream flows are slowed and ponded by the structure to shelter trout.

INFORMATION SOURCES

Anonymous. 1995. Environmental Assessment for Little Bighorn Meadows habitat improvement project. U. S. Forest Service, Paintrock Ranger District, Greybull, Wyoming.

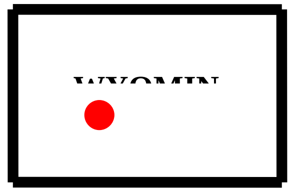
Anonymous. 1995. Decision notice and finding of no significant impact for Little Bighorn Meadows habitat improvement project. U. S. Forest Service, Paintrock Ranger District, Greybull, Wyoming.

Table 35-1. Abundance and biomass of wild BKT at the Little Bighorn River in sections with and without habitat improvement devices.

			≥ 6 inches	
Year	Number/mile	Pounds/acre	Number/mile	Pounds/acre
Untreated				
1981	1,299	40	225	24
1983	689	34		
1989	776	38	297	29
1992	1,254	49	289	21
1994	1,611	54	393	28
Treated				
1981	1,232	109	462	85
1983	1,132	97		
1989	2,158	151	1,277	129
1992	1,997	106	641	57
1994	2,896	155	1,192	106
1997	2,513	133	1,025	109
1981-1994 Untreated mean	1,125	43	301	26
1981-1994 Treated mean	1,883	124	893	94
Percent change	67	188	197	261
Percent change 1997 treated vs. 1981-1994 untreated mean	123	209	214	319

LITTLE POPO AGIE RIVER

FREMONT COUNTY



PROJECT BUILT: ***Phase I:*** **1976-1979**
Phase II: **1991-1995**

Drainage:	Popo Agie River	**Little Popo Agie River Basin (6PL)**	
Elevation:	5,500 ft	**R.** 99 **W., T.** 32 **N., S.**34	
Stream Order:	Fourth	**Stream Class:** 2 (statewide importance)	
Watershed Area:	125 sqmi	**Mean Wetted Width:** 32 ft	
Gradient:	0.5	**Land Status:** Private, but WGF has an easement for a Public Fishing Area.	
Rosgen Channel Type:	C-3	**Project Length:** 1.6 miles	
Treatment Used:	Tree/rock revetments, fish rocks, offset dikes		
Trout Species:	Wild brown and rainbow trout		

DESCRIPTION OF STREAM: Heading on the Shoshone National Forest, the Little Popo Agie River drains eastward from the south end of the Wind River Mountains, a heavy snowpack area,. Much of the watershed is mountainous forest, but at the project site, the stream has exited the mountains and flows through ranchland. Stream flow is fed by melting snow, springs, and rainfall, and is adequate for trout in the project area. Although some irrigation diversions affect flow, late summer flow is generally not a problem. Mean ADF is about 80 cfs, CPSF is 60% of ADF, and the ASFV ratio is 49. Substrate is cobble, rubble, and gravel.

PROJECT DESCRIPTION: Initial bank stabilization was done in 1976-1977 at the lower PFA. In 1979, boulder placements were added to the upper PFA, and in 1991, several more tree/rock revetments were completed downstream from the 1979 work. Work was mostly funded by WGF, but the Lander Chapter of Trout Unlimited contributed funds toward tree hauling in 1991. Trees came from the Shoshone National Forest, while rocks were hauled by WGF from both forest and BLM quarries. Project goals were to stabilize eroding stream banks and provide additional shelter for trout within the PFA.

THE FISHERY: Prior to 1974, catchable RBT were stocked annually in the PFA, despite the presence of a wild BNT population. A wild RBT population in the upper drainage contributed a few fish to the PFA fishery through downstream drift. No trout were stocked after 1974 to see if BNT could maintain a wild population under existing fishing pressure. To assist them, the stream habitat improvement project was initiated to maximize habitat. Being within 10 miles of Lander, the Little Popo Agie River PFA was popular with anglers, offering both good fishing and access in an area having limited public access. Standard statewide regulations were in effect.

HABITAT MANAGEMENT: Livestock grazing and channel manipulation around irrigation diversions has affected the river in the past, but some sections of good habitat persisted within the PFA. Many banks were unstable pretreatment. At one stream bank in the lower PFA, six feet of bank washed away during a spring runoff prior to project inception.

Phase I - In 1976, a WGF construction crew installed tree and rock revetments, plus several clusters of fish rocks and an offset dike, at the lower PFA (Figure 36-1). They also fenced both banks through the improvements - fencing was completed in 1977. Cost for the two year project was about $7,000 ($8,200/mile). Permission to fence was generously granted by the landowner, Ted Wilkes, and represented a milestone in landowner cooperation to protect streamside areas so both landowner and fish would benefit. In 1979, 66 boulders were installed as fish rocks at the upper PFA and an additional 111 ft of stream bank was stabilized with rock riprap. Cost for the 1979 work was $3,630 ($9,580/mile).

Phase II - An offset dike was built by NCRS to prevent an oxbow cutoff near the upper boundary of the PFA. This work was done in 1987 as a cost sharing project between NCRS, WGF, and the landowner, Dr. Charles McMahon. Total cost was $5,148. During 1991-1995, 1,610 ft of tree/rock revetments, 8 upstream digger logs, and 3 tree jams were built by a WGF construction crew downstream from the 1979 work (Figure 36-2). Also added to the river were 130 fish rocks. Cost was $30,450 ($33,500/mile).

Figure 36-1. Addition of a tree/rock revetment to this steep bank during *Phase I* provided good overhead cover for trout along its base, stabilized the bank, and eliminated it as a source of sediment. Pretreatment, the river was actively eroding all along the base of the bluff, which contributed much sediment to the stream during high water.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Once the catchable RBT plants were eliminated, the trout population soon reverted to a wild fishery and BNT became more numerous posttreatment. Periodic electrofishing evaluations also found a few wild RBT in the trout population. Mean trout abundance was 128% higher posttreatment than pretreatment, and biomass was 116% better (Figure 36-3, Table 36-1). Trout 6 inches, or greater, were 125% more abundance posttreatment, and their biomass was 102% higher (Figure 36-4).

Figure 36-2. This tree/rock revetment was built during *Phase II* to stabilize an eroding stream bank, slow swift currents on an extended riffle, and provide cover for BNT.

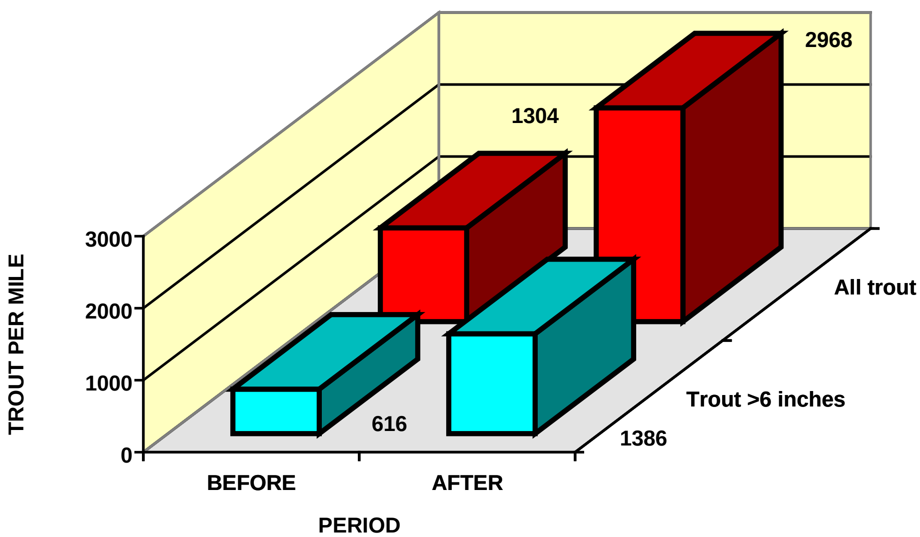


Figure 36-3. Mean trout abundance at the Little Popo Agie River Public Fishing Area before (1975-1976) and after (1988-1997) habitat improvement.

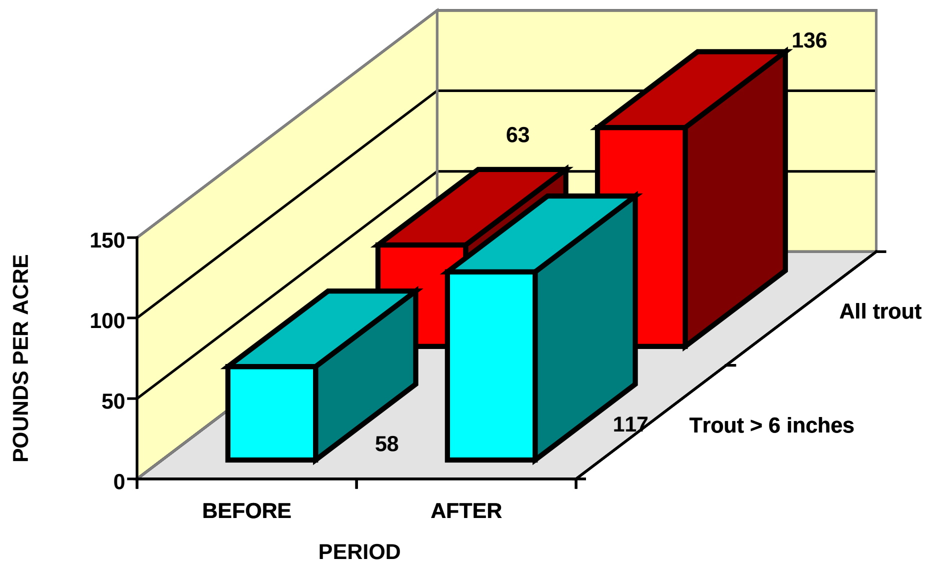


Figure 36-4. Mean trout biomass at the Little Popo Agie River Public Fishing Area before (1975-1976) and after (1988-1997) habitat improvement.

Trout Habitat Response - No formal evaluation of habitat was done, but pocket pools developed around the boulder “fish” rocks, while shelter for trout was present around the tree and rock revetments.

Habitat Structures - No formal evaluation was done, but revetments were in good condition in 1997. The fence required periodic maintenance, as did the offset dike in the lower PFA. Some of the structures in the upper PFA were damaged by the river after the landowner reworked the channel around his irrigation diversion and changed river equilibrium.

Conclusions - Habitat improvement generated a prompt and positive response from the wild trout population. BNT abundance and biomass doubled posttreatment. The structures have proved durable through 20 years of spring runoff floods, and wild BNT have maintained their population despite increased angler use of the PFA.

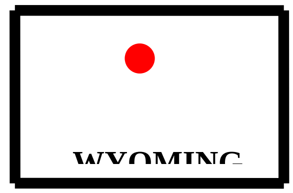
Table 36-1. Trout abundance and biomass at the Little Popo Agie River Public Fishing Area before (1975-1976) and after (1988-1997) habitat improvement. Catchable trout are 6 inches, or greater, total length.

	All trout		Catchable trout	
Year	**Number/mile**	**Pounds/acre**	**Number/mile**	**Pounds/acre**
Pretreatment				
1975	1,203	69	561	63
1976	1,404	57	672	52
Posttreatment				
1988	5,015	192	2,071	173
1992	3,027	129	1,250	92
1997	863	88	836	87
Pretreatment mean	1,304	63	616	58
Posttreatment mean	2,968	136	1386	117
Percent change	128	116	125	102

MEDICINE LODGE CREEK

BIG HORN COUNTY

PROJECT BUILT: 1981



Drainage:	Paintrock Creek	**Paintrock Creek Basin (2PR)**	
Elevation:	4,720 ft	**R.** 89 **W., T.** 50 **N., S.** 15, 22	
Stream Order:	Second	**Stream Class:** 2 (statewide importance)	
Watershed Area:	70 sqmi	**Mean Wetted Width:** 45 ft	
Gradient:	1.4%	**Land Status:** WGF Medicine Lodge Wildlife Habitat Management Unit	
Rosgen Channel Type:	C-4	**Project Length:** 2,640 ft	
Treatment Used:	Tree/rock revetments, rock riprap, rock dike to put stream back in old channel		
Trout Species:	Brown and rainbow trout		

DESCRIPTION OF STREAM: Medicine Lodge Creek heads in the Cloud Peak Wilderness in the Bighorn Mountains and flows westerly to join with Paintrock Creek near Hyattville. Stream flow is fed by melting snow and springs. ADF is 35 cfs, peak flow of record is 344 cfs, and the ASFV ratio is 54, suggesting a relatively stable flow pattern. CPSF is 21.8 cfs, 62%ADF, a four rating for HQI.

PROJECT DESCRIPTION: Pretreatment, the stream had many cutbanks and had been channelized near the lower unit boundary when the land was a private ranch. Project goal was to fix some of the bank erosion and move the stream back into its original channel. WGF financed and did the work.

THE FISHERY: Although stocked with RBT, wild BNT density was about 2,060 trout/mile at time of treatment.. The fishery is popular and well used by anglers.

HABITAT MANAGEMENT: A WGF construction crew installed 180 ft of bank stabilization at several locations between the bridge and lower unit boundary, using tree/rock revetments or rock riprap. To effect the channel change, a 65 ft dike was built to divert all stream flow back into the old channel (Figure 37-1). No costs were reported.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - No evaluation of the habitat improvement work was done.

Trout Habitat Response - No evaluation of the habitat improvement work was done.

Habitat Structures - When inspected in 1993, the dike was functional and stable. All flow was down the new channel, which had narrowed and developed several good pools, LWD, and other shelter features usable by trout. Vegetation growth was good in the old channel (Figures 37-2 and 37-3). Some of the tree revetments had been damaged by fire and several new cutbanks were noted. But those banks stabilized in 1981 were generally stable and furnishing shelter to trout.

Conclusions - Diverting the stream back into its old channel restored original habitat features and provided cover for trout. Banks treated in 1981 were generally stable 12 years later and were sheltering trout, but some bank instability was still present at other sites within the project area.

Figure 37-1. A 65 ft dike was constructed to divert all flow away from the channelized section and back into the old stream channel.

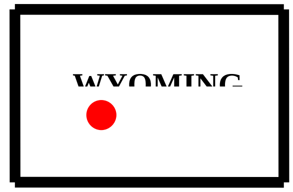
Figure 37-2. A pretreatment view of Medicine Lodge Creek through the channelized section, which contained very little shelter for trout.

Figure 37-3. The channelized section of Medicine Lodge Creek 12 years after flow was diverted back into the old channel.

MIDDLE FORK POPO AGIE RIVER

FREMONT COUNTY

PROJECT BUILT: 1987



Drainage:	Popo Agie River	**Middle Fork Popo Agie River Basin (6PM)**	
Elevation:	5,405 ft	**R.** 100 **W., T.** 33 **N., S.** 19, NW 1/4	
Stream Order:	Fourth	**Stream Class:** 3 (regionally important)	
Watershed Area:	135 sqmi	**Mean Wetted Width:** 33 ft	
Gradient:	0.9%	**Land Status:** City of Lander	
Rosgen Channel Type:	C-3	**Project Length:** 1,400 ft	
Treatment Used:	Rock sill, rock riprap, rock deflector, rock funnels, fish rocks		
Trout Species:	Rainbow and brown trout		

DESCRIPTION OF STREAM: The Middle Popo Agie River drains an easterly aspect of the Wind River Mountains. Heading near 13,192 ft Wind River Peak in the Popo Agie Wilderness, the river collects water from numerous mountain lakes and streams before exiting the mountains near Lander. It then flows through ranch land and subdivisions before reaching the project site at City Park. An abundant snowpack and springs feed stream flow. However, withdrawals made for irrigation and domestic use often greatly reduce summer flows through town to the point where trout survival is affected.

PROJECT DESCRIPTION: Instream habitat improvement in the Middle Fork Popo Agie River at City Park was a joint venture between WGF and the City of Lander. Rocks donated by Kelly Connell were hauled by city trucks to City Park where a WGF construction crew built instream fish habitat structures with the rocks. Goal of the project was to provide additional shelter and holding areas for trout, especially when river flow is low.

THE FISHERY: Low summer flows often make the river a marginal habitat for trout through town, but catchable RBT are stocked at City Park to satisfy public demand for a fishery there. Many youngsters and elderly anglers utilize the fishery, which is also supported by wild BNT. Fish stock was 260 trout/mile (10 lbs/acre) in October 1986.

HABITAT MANAGEMENT: Past City of Lander efforts at flood control had channelized the river through City Park and degraded fish habitat. Much of the river was wide and shallow, with only an occasional pool offering shelter to trout. Most of the stream banks had been armored with river cobble bulldozed up on the bank and held in place with common stock fence. Corrosion of the fence at the river's edge allowed the stream to wash away the cobble and threatened bank stability during high flows, so large boulders were placed along the base of the city riprap to solidify the situation. A deflector and the two funnels consolidated low flows into a narrower, deeper channel with the thalweg next to the boulder-faced riprap. Several other banks were also armored with boulders and bank stabilization totaled 820 ft. Pocket pools were provided by 39 fish rocks scattered through the area. A rock sill was placed as a grade control, energy break, and pool digger where the channel narrowed near the lower end of the project. Cost to

WGF was $3,170 ($11,960/mile), which included rental of a second loader to place the rocks. No cost records were kept by the city for the rock haul.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - No posttreatment evaluation of the fishery was made.

Trout Habitat Response - No posttreatment evaluation of habitat was done, but visual observation indicated the fish rocks and boulder structures have provided additional shelter for trout and have improved bank stability.

Habitat Structures - Boulder structures have endured several exceptional flood events and still remained functional by 1998 (Figures 38-1 and 38-2). But the 1991 spring runoff eroded the bank next to the rock sill, so the city destroyed the structure and again bulldozed the channel in that area. Structures above the footbridge were not affected by this activity and retained their integrity.

Conclusions - Addition of rock structures to a channelized section of the Middle Popo Agie River provided additional shelter and holding areas for trout.

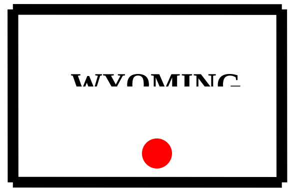
Figure 38-1. Stream banks through City Park had been treated years before by pushing river cobble up along the bank and covering the rocks with common stock fence. Subsequent corrosion of wire at river's edge allowed rocks to be sucked out from under the fencing by pressure differentials (Venturi effect) during high flows. Large boulders placed at the bottom of the riprap have successfully stabilized the banks.

Figure 38-2. Pretreatment, low flows in the Middle Fork were spread shallowly across the riverbed due to previous channelization. Posttreatment, the river has formed a deeper thalweg near the right bank, thus concentrating low flows to aid trout.

MUDDY CREEK - Grizzly WHMA

CARBON COUNTY

PROJECT BUILT: 1995-1996



Drainage:	Little Snake River	**Muddy Creek Basin (3MC)**	
Elevation:	7,320 - 7,560 ft	**R.** 89 **W., T.** 16, 17 **N., S.** 3, 32	
Stream Order:	First	**Stream Class:** 4 (low production waters)	
Watershed Area:	20 sqmi	**Mean Wetted Width:** 4-7 ft	
Gradient:	0.6%	**Land Status:** WGF Wildlife Habitat Management Area (WHMA)	
Rosgen Channel Type:	C-3 to C-5	**Project Length:** 24,000 ft (4.5 miles)	
Treatment Used:	Timber plunges, rock plunges, sheet piling plunges		
Trout Species:	BKT		

DESCRIPTION OF STREAM: Located about 25 miles southwest of Rawlins, where the forested Sierra Madre Mountains grade out to an arid, cold shrub desert, Muddy Creek heads on the west side of the Continental Divide. A northwest aspect of the steep ridges and hills along the divide is drained by Muddy Creek. Wide, treeless valleys and rolling hills are the dominant topographical features away from the headwaters. Sagebrush, rabbitbrush, and grass combinations characterize the watershed, which also has scattered patches of aspen and mountain shrubs at higher elevations. Geological formations present in the drainage are highly erosive and generate much fine-grain sediment.

Stream flow is supported by snowmelt and springs, which are common in the headwaters. Groundwater flowages generally keep stream temperatures below 75F, but temperatures may reach levels marginal for trout in the lower project area. Silt is the dominant stream substrate type and few gravel substrates suitable for trout spawning are present. Although Muddy Creek in the upper Grizzly Unit has stable banks and good sinuosity, shelter for trout is limited to aquatic vegetation and a few over-hanging banks. But in the lower unit, stream character is quite different. Most banks are eroding, the stream is actively downcutting, many stream sections are gullied, and typical riparian vegetation is no longer present. Pools, undercut banks, over-hanging vegetation, and other features that could furnish cover for trout are lacking.

PROJECT DESCRIPTION: Since CRC are classed as a “sensitive species”, one step away from listing as a federal “threatened species”, restoration of CRC to streams in its historic range, such as Muddy Creek, is a priority for WGF. Habitat improvement work on Muddy Creek was a cooperative venture by WGF, BLM, and the federal Central Utah Project (CUP), but a WGF construction crew did structure installation. Partial funding was provided from CUP mitigation monies. Downstream from the WHMA, additional habitat improvement structures were installed by BLM and the local conservation district.

THE FISHERY: Pretreatment fishery surveys found only BKT, speckled dace, and mountain suckers in upper Muddy Creek. In 1986, BKT stock was reported as 29 trout/mile at the project site, and in 1991, BKT were reported as still present in the stream. Fishing pressure was reported as light due to the small trout population and degraded habitat. A proposal was advanced to remove the BKT by chemical treatment and restock with CRC. This would be done after fish habitat was improved.

HABITAT MANAGEMENT: About 38,000 acres of rangeland are in the Grizzly Unit, of which 72% are BLM, 24% are state, and 3% are WGF. Extensive livestock grazing for many years had seriously degraded watershed condition and trout habitat was poor in Muddy Creek. Since the headwaters of the creek were within the unit, the opportunity was present to initiate a watershed project to improve habitat conditions for both fish and wildlife, while still providing carefully managed livestock grazing. In the project reported here, a WGF construction crew installed 11 plunges made from interlocking C-LOC brand PVC plastic panels, 10 timber plunges, and 4 rock plunges over a two year period (Figures 39-1 and 39-2). Total project cost was $50,800 ($11,180/mile), of which 63% was CUP money and 37% was in-kind costs by WGF.

To prevent upstream migration of BKT, or non-game fish that would compete with CRC, once the species was re-introduced, a gabion fish barrier was installed on Sanger Ranch property at elevation 6,825 ft, which is located downstream from the Grizzly Unit. Barrier cost was $18,450 for which BLM, WGF, and the National Fish and Wildlife Foundation provided funds.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - A recently constructed project for which no evaluation has been yet been completed.

Trout Habitat Response - Evaluation is on-going and no results have yet been reported.

Habitat Structures - A recently constructed project for which no evaluation has been yet been completed, but visual observations indicate structures are holding up well, are providing deep water shelter for trout, and are furnishing the desired grade control effect.

Conclusions - No fish or habitat measurements are yet available, so any conclusions are premature. However, visual observations indicate the structures have improved trout habitat.

INFORMATION SOURCES

Oberholtzer, M. 1987. A fisheries survey of the Little Snake River drainage, Carbon County, Wyoming. Administrative Report, Project 5086-01-8501, Fish Division, Wyoming Game and Fish Department, Cheyenne.

Wilbert, C., K. Steiner, and R. Straw. 1992. Proposed wildlife habitat management plan for the Grizzly Wildlife Habitat Management Area. Typewritten report, Habitat and Technical Services Division, Wyoming Game and Fish Department, Cheyenne.

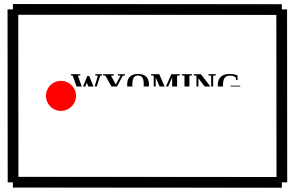
Figure 39-1. A series of three plunges made from C-LOC brand PVC plastic panels provides deep pools for fish, grade controls, and elevated water level to better subirrigate the stream banks on lower Muddy Creek.

Figure 39-2. A freshly constructed plunge made from C-LOC brand PVC plastic panels on upper Muddy Creek.

NAMELESS CREEK

LINCOLN COUNTY

PROJECT BUILT: 1991



Drainage:	LaBarge Creek	**LaBarge Creek Basin (7LA)**	
Elevation:	8,120 ft	**R.** 116 **W., T.** 29 **N., S.** 36	
Stream Order:	First	**Stream Class:** 4 (locally important)	
Watershed Area:	2.5 sqmi	**Mean Wetted Width:** 5 ft	
Gradient:	3%	**Land Status:** Bridger-Teton National Forest	
Rosgen Channel Type:	B-4	**Project Length:** 7,200 ft	
Treatment Used:	Timber plunges		
Trout Species:	Colorado River cutthroat and brook trout		

DESCRIPTION OF STREAM: Nameless Creek drains a small portion of Absaroka Ridge in the upper LaBarge Creek watershed. Although considerable snow falls during winter, the Nameless Creek watershed is small and stream flow becomes low during late summer. Base flow is maintained by springs and seeps, but the creek is intermittent a short distance upstream from the project. A conifer and aspen forest covers the watershed and the narrow riparian zone features extensive willow growth. Stream substrate is gravel and cobble.

PROJECT DESCRIPTION: Although Nameless Creek is a small headwater stream, it is of interest because it contains CRC, which are listed as a “sensitive species”, a step away from designation as a federal “threatened species”. A cooperative habitat improvement project between WGF and the Bridger-Teton National Forest was implemented to ensure the CRC population in the stream was not lost. Objective of the project was to create additional deep pools that CRC could use for rearing and overwintering habitat, especially during low flow periods.

THE FISHERY: Both CRC and BKT have historically occurred in Nameless Creek, but CRC are the primary species. CRC in Nameless Creek are considered “B” grade purity. Angler use is light, partially because willows along the banks make the stream hard to fish. Statewide fishing regulations were in effect at project inception, but a one cutthroat trout creek limit was later instigated for the whole LaBarge Creek drainage to protect CRC. Pure strain (“A” grade), fin-clipped CRC juveniles were stocked at Nameless Creek in 1990-1992 to upgrade the population. BKT were permanently removed from the stream above the fish barrier whenever encountered during electrofishing samples.

HABITAT MANAGEMENT: After a gabion fish barrier was built in 1989 on the lower stream to block other trout species from migrating up Nameless Creek, efforts turned to improving existing habitat for CRC. An analysis of fish habitat in the creek indicated deep pools were lacking and only an occasional small beaver pond provided deep water for overwintering CRC. So a project was planned to improve habitat by providing more deep pools. A WGF construction crew built 18 timber plunges upstream from the fish barrier. Cost of the plunges was $10,185 ($7,470/mile). USFS provided materials and built a seasonal “lay-down” fence to control cattle usage of the stream bottoms.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Stocked hatchery trout confounded evaluation of fishery response to the habitat improvement structures. Evaluation was further complicated by natural fluctuation in CRC abundance. During “wet-years”, CRC year class strength was generally better than during “dry-years”. BKT presence in fish samples was also erratic, especially since BKT were removed to reduce competition with CRC. However by 1995, time had eliminated most stocked CRC and wild CRC abundance was about equal to the 1980 level, but was 10% less than the pretreatment mean (Figure 40-1).

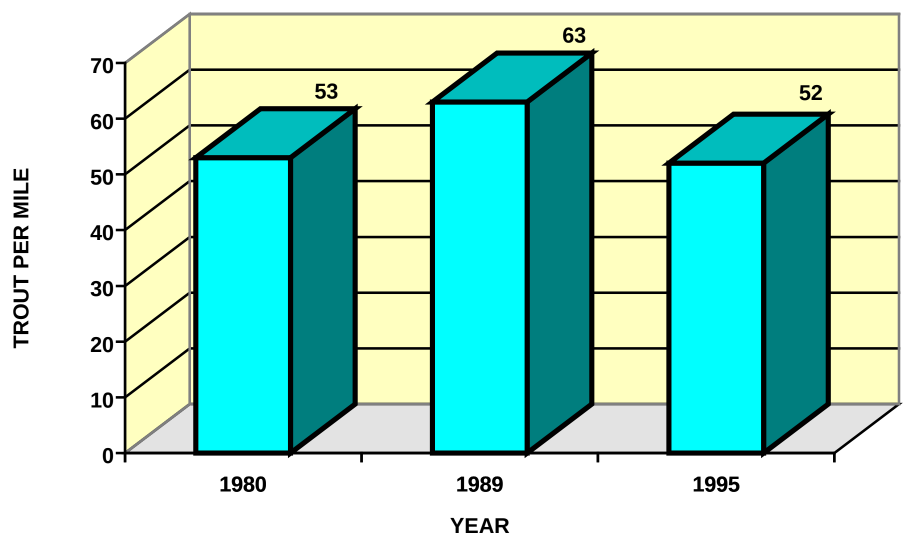


Figure 40-1. Abundance trend of CRC at Nameless Creek before (1980-89) and four years after habitat improvement.

Trout Habitat Response - Installation of the plunges added 220 sqft of plunge pool cover to the creek. By 1995, mean cover per plunge pool was 16 sqft. Dam pools created some additional cover upstream from the plunges. However, only 6% of the plunge pools had RPD 1.5 ft, or deeper, which is the critical focal point depth for CUT. Mean RPD was only 1 ft (range, 0.5-1.56 ft).

Habitat Structures - By 1995, 94% of the plunges were rated as being in good condition (Figures 40-2 and 40-3). But many of the plunge pools were filled with rocks that had rolled into the pools during high water events. Periodic cleaning these rocks out of the pools would easily restore pool depth to levels more useful to CRC.

Conclusions - Installation of plunges in Nameless Creek created 220 sqft of additional cover for trout, but lack of maintenance kept pool depths below best levels. Lack of maintenance for the fence allowed cattle to graze and damage the stream bottoms. Consequently, posttreatment CRC abundance was about the same as pretreatment.

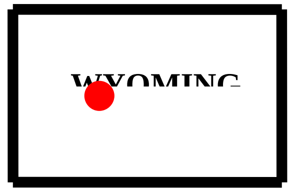
Figure 40-2. Timber plunges built in tiny Nameless Creek acted as grade controls and provided additional shelter for CRC trout.

Figure 40-3. A close-up view of a timber plunge in Nameless Creek.

NORTH FORK POPO AGIE RIVER

FREMONT COUNTY

PROJECT BUILT: 1980, 1997



Drainage:	Popo Agie River	**North Fork Popo Agie River Basin (6PM)**	
Elevation:	5,420 ft	**R.** 1 **E., T.** 2 **S., S.** 23, NW 1/4	
Stream Order:	Fourth	**Stream Class:** 2 (statewide importance)	
Watershed Area:	150 sqmi	**Mean Wetted Width:** 30 ft	
Gradient:	0.44%	**Land Status:** WGF Public Fishing Area	
Rosgen Channel Type:	C-4	**Project Length:** 1,000 ft	
Treatment Used:	Rock riprap, tree/rock revetments, and removed old car bodies		
Trout Species:	Brown and rainbow trout		

DESCRIPTION OF STREAM: An easterly aspect of the Wind River Mountains is drained by the North Fork Popo Agie River. Heading near 12,842 ft Lizard Head Peak in the Popo Agie Wilderness, the river collects water from numerous mountain lakes and streams before exiting the mountains near Lander. It then flows through ranch land and subdivisions in a broad valley before reaching the project site. Stream flow is fed by an abundant snowpack and springs. However, withdrawals made for irrigation use may reduce summer flows through the PFA. Riparian vegetation is hayfields, willows, and cottonwood trees.

PROJECT DESCRIPTION: A primary goal of the fish habitat improvement project at the Second Street PFA on the North Fork Popo Agie River was to increase numbers of wild trout by stabilizing eroding banks and increasing shelter available for trout. This project was done by WGF in collaboration with Pete Deal, who was landowner at that time. Funding was by WGF as part of the upkeep on the PFA.

THE FISHERY: Being close to Lander, the North Fork PFA receives considerable angler use. Prior to 1979, the fishery was supplemented with annual stocking of catchable rainbow trout, despite the presence of wild BNT and RBT. After 1979, stocking was stopped to see if wild fish could support the fishery. Standard, statewide fishing regulations applied.

HABITAT MANAGEMENT: Lack of shelter for trout, plus severe bank erosion caused by intensive cattle use and poor farming practices in the riparian zone, characterized the pretreatment stream. To help correct the habitat shortcomings, a WGF construction crew installed 975 ft of rock riprap or tree/rock revetment through the PFA. Ten car bodies were also removed from the stream channel. Cost of the project was $1,140 ($6,020/mile). In spring, 1997, rock riprap was added to several eroding banks to repair flood damage. No costs were reported.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Although the habitat improvement work was not intensive, the trout population responded positively to the better habitat. Posttreatment, trout abundance increased five fold over pretreatment values and catchable trout (7 inches, or greater) increased 418%(Figure 41-1).

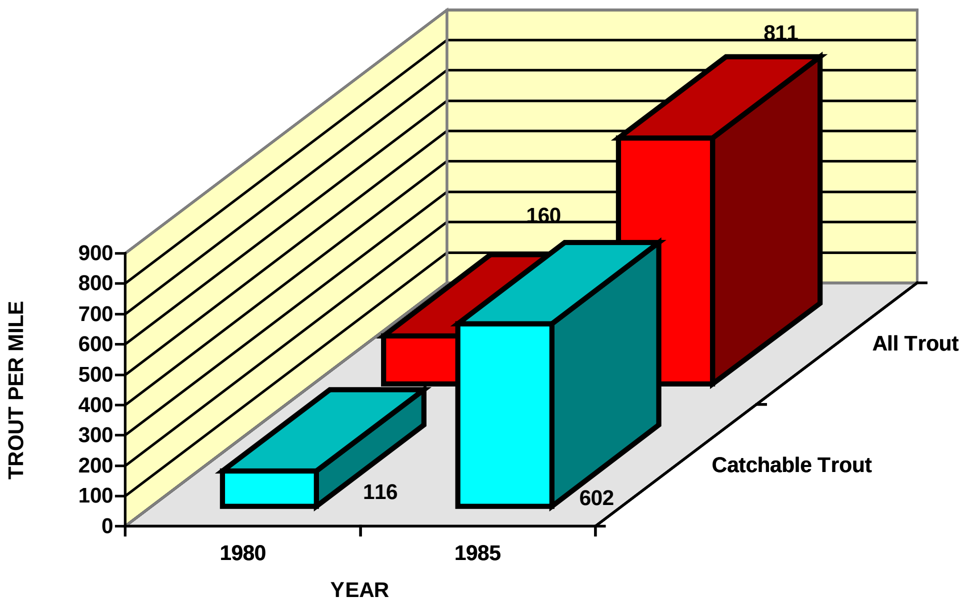


Figure 41-1. Abundance of catchable sized trout (7 inches, or greater) and total trout in the North Fork Popo Agie River at the Second Street public fishing area before (1980) and after (1985) habitat improvement.

Trout Habitat Response - No evaluation of fish habitat was done.

Habitat Structures - Structures endured minor flood damage annually, but continued to function until an exceptional flood in 1991 essentially wiped out all habitat improvement devices. Although flood magnitude was likely great enough to demolish the devices by itself, extensive cattle grazing in and along stream banks, farming to the edge of the stream, and allowing irrigation return flows to run unchecked over the banks to further erode them caused structure integrity to deteriorate and thus contributed to their demise. In spring, 1997, rock riprap was added to several eroding banks to repair flood damage.

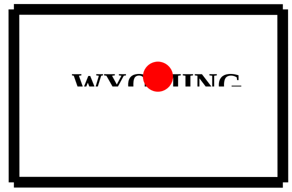
Conclusions - Five years after installation of rock riprap and tree/rock revetments, catchable and total trout abundance had increased five-fold, but the structures did not survive an exceptional flood in 1991.

Figure 41-2. A construction crew adds rock riprap behind tree revetments at the PFA on the North Fork Popo Agie River.

NORTH FORK POWDER RIVER

JOHNSON COUNTY

PROJECT BUILT: 1968



Drainage:	Powder River	**Powder River Basin (8PR)**	
Elevation:	8,800 ft	**R.** 85 **W., T.** 48 **N., S.** 29, NE 1/4	
Stream Order:	First	**Stream Class:** 3 (regionally important)	
Watershed Area:	7 sqmi	**Mean Wetted Width:** 9 ft	
Gradient:	1.3%	**Land Status:** Bighorn National Forest	
Rosgen Channel Type:	C-2	**Project Length:** 4,000 ft	
Treatment Used:	Riparian area enclosed within a fence		
Trout Species:	Brown, rainbow, and brook trout		

DESCRIPTION OF STREAM: A small headwater stream, the North Fork Powder River drains a south aspect of the Bighorn Mountains before flowing into Dullknife Reservoir several miles downstream from the project. Its watershed includes conifer patches, rocky peaks, and large grassy parks. Riparian vegetation is grass, forbs, and clumps of short willows. An ample snow pack produces an annual snowmelt flood in May and June. Both snowmelt and springs feed stream flow the rest of the year, so summer discharge and temperatures remain adequate for good trout production in the project area, but winter flows may become critically low. ADF is 43 cfs, CPSF is 43% of ADF, and the ASFV ratio is 175. Boulders, rubble, and cobble are prominent in the stream substrate, except where bank erosion has deposited fine sediment.

PROJECT DESCRIPTION: Historically, livestock grazing has been an important summer use of the watershed as the numerous grassy parks produce much feed; cattle had grazed the stream valley so intensively before the fence was built that there was considerable damage to banks and streamside vegetation. Construction of the exclosure was an attempt to improve fish habitat by protecting a section of stream bottom vegetation.

THE FISHERY: Accessed by a good gravel road leading south from Highway 16, the North Fork Powder River is a popular fishery and catchable RBT have been stocked for many years to satisfy angler demand. Wild BNT, BKT, and RBT are also present. Statewide fishing regulations apply.

HABITAT MANAGEMENT: In 1968, personnel from the Bighorn National Forest built a wire fence to enclose a 0.75-mile long section of the stream bottoms downstream from the road crossing. Objective was to keep livestock from grazing the riparian area. No cost or construction details are available.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - In 1989, several hundred feet of stream were electrofished to evaluate effectiveness of the exclosure. One sample station was situated with the exclosure at its lower end and a control station was immediately upstream from the fenced area. Abundance of wild trout was twice as high, and biomass was three times greater, inside the exclosure than outside it (Figures 42-1, 42-2, 42-3, and Table 42-1). Catchable wild trout (6 inches, or greater, total length) abundance and biomass inside the exclosure were four times greater than outside of it.

Trout Habitat Response - Trout habitat inside and outside the exclosure was evaluated with the HQI in 1989 and 1992. Inside the exclosure, instream cover for trout was almost triple that present outside and HQI score was 17% higher. There was 80% less bank erosion inside the exclosure. These gains were made despite periodic grazing by trespass cattle (Figure 42-4). When the 1989 evaluations were done, the fence had been cut and there appeared to be more cattle inside the exclosure than on the nearby rangeland. However, the fenced area had evidently excluded enough cattle usage over the long term for trout habitat to become better than at nearby stream sections subjected to normal grazing (Figures 42-5 and 42-6).

Habitat Structures - Trespass cattle continued to use the enclosed area because either the fence was not maintained, or the wires were deliberately cut. Without regular maintenance or prompt removal of trespass livestock, such exclosures cannot function at optimal levels.

Conclusions - Despite being grazed by some trespass cattle each year and irregular maintenance, the exclosure still reduced grazing intensity and improved fish habitat over the long term. Inside the exclosure, there was three times more cover and 80% less bank erosion. Catchable wild trout were four fold more abundant inside the exclosure than at a site immediately upstream. And the exclosure contained twice as many trout of all sizes.

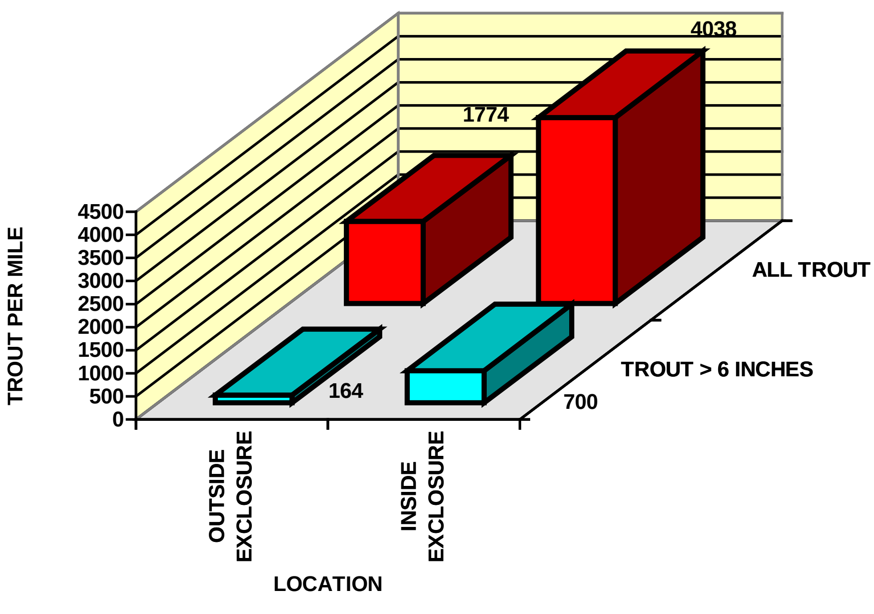


Figure 42-1. Abundance of wild trout at North Fork Powder River 21 years after the riparian area was fenced to exclude livestock grazing.

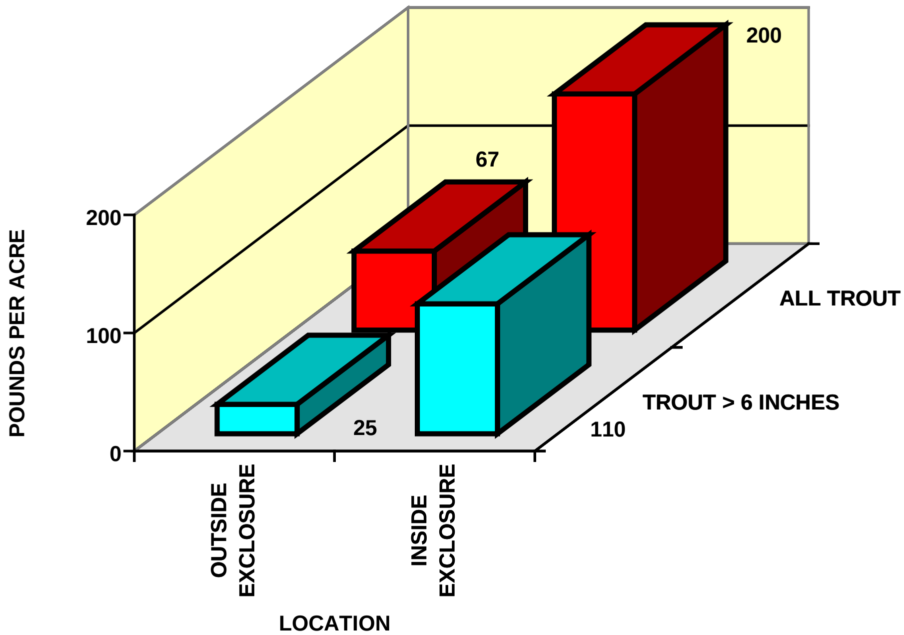


Figure 42-2. Biomass of wild trout at North Fork Powder River 21 years after the riparian area was fenced to exclude livestock grazing.

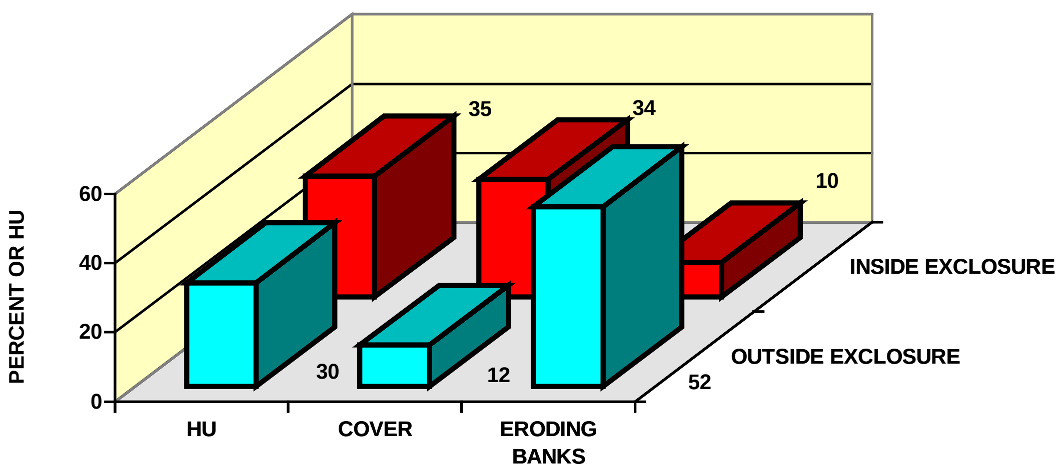


Figure 42-3. Cover, eroding stream banks, and habitat units inside and outside the livestock exclosure at North Fork Powder River in 1989 and 1992.

INFORMATION SOURCES

Mueller, J. W. 1979. The effect of the livestock exclosure fence on the fish population in the North Fork of Powder River, Johnson County, 1979. Administrative Report, Project No. 3079-07-7001, Fish Division, Wyoming Game and Fish Department, Cheyenne.

Table 42-1. Abundance and biomass of trout at North Fork Powder River 21 years after the riparian area was fenced to exclude livestock grazing. Catchable trout are 6 inches, or longer, total length.

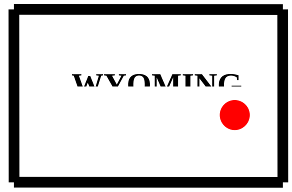
	All trout		Catchable trout	
Year	Trout/mile	Pounds/acre	Trout/mile	Pounds/acre
Outside of exclosure				
1989	1,774	67	164	25
Within exclosure				
1989	4,038	200	700	110
Percent change	128	198	327	340

Figure 42-4. Trespass cattle inside the exclosure at North Fork Powder River.

Figure 42-5. Eroding stream banks and cattle trails along the stream were common outside the livestock exclosure at North Fork Powder River when the exclosure was evaluated in 1989.

Figure 42-6. Healing is well underway at a formerly eroding bank inside the livestock exclosure at North Fork Powder River 21 years after the area was fenced.

NORTH PLATTE RIVER
(Douglas Greenbelt Rock Project)



CONVERSE COUNTY

PROJECT BUILT: 1982-1985

Drainage:	North Platte River	**North Platte River Basin (1MG) - Mills to Glendo Reservoir**
Elevation:	4,790 ft	**R.** 71 **W., T.** 32 **N., S.** 8
Stream Order:	Fifth, or greater	**Stream Class:** 4 (locally important)
Watershed Area:	15,000 sqmi	**Mean Wetted Width:** 255 ft
Gradient:	0.07%	**Land Status:** City of Douglas Greenbelt
Rosgen Channel Type:	C-4	**Project Length:** 17,054 ft (3.23 miles)
Treatment Used:	Fish rocks	
Trout Species:	Rainbow and brown trout	

DESCRIPTION OF STREAM: As a large, low gradient, lowland river in eastern Wyoming, the North Platte River meanders through short grass prairie rangeland, ranch lands, and various towns. In the project area, the river flows through the City of Douglas where it has 82% flat water, 16% riffles, and 2% pools. River flow is strongly controlled by releases from Alcova Reservoir, but the river also gains water from several small drainages along the Laramie Range. River substrate is mostly silt, sand, and gravel.

PROJECT DESCRIPTION: Fish habitat improvement was done in two phases. In Phase I, a Resource Conservation and Development (RC & D) project was sponsored by the City of Douglas, SCS, USFWS, and WGF. Walkways, bike paths, picnic sites, and other greenbelt activities were included with the boulder placements. Phase I was done entirely within the city limits upstream from the West Yellowstone Highway Bridge. Phase II was a similar project done downstream from that bridge to the I-25 crossing. It was funded from a 50% matching grant from the Wyoming Recreation Commission and an additional 1% sales tax in the city.

THE FISHERY: Pretreatment, continued population growth in the City of Douglas and development of the greenbelt had placed additional demands on the trout fishery through the town. Periodic stocking of catchable rainbow trout supported a "put and take" fishery, but no matter how many trout were stocked, the fishery was constrained by habitat shortfalls. Even stocked trout need a place to live until caught.

HABITAT MANAGEMENT: A survey of fish habitat identified lack of shelter for trout as a major habitat flaw. To correct this problem, in 1982, a private contractor added 235 large boulders to the 1.23 miles of river above the bridge. These rocks averaged 4.3 tons apiece. In 1985, a contractor added about 400 more boulders to the two miles below the bridge. WGF assisted with project design and contractor oversight. Cost was $20,000 in Phase I and $29,000 in Phase II. Total project cost was $15,170/mile.

EVALUATION OF TROUT HABITAT MANAGEMENT

<u>**Fishery Response**</u> - Annual plants of hatchery-reared trout were increased posttreatment. Over 6,000 catchable RBT and 770 brood cull RBT were stocked in 1983 alone, when an estimated 4,600 anglers harvested 3,500 trout within the improvement area. By comparison, estimated angler take in 1976 was 16 trout/mile. Public response to the rock project was very favorable and gave impetus to additional placement of rocks during Phase II. Electrofishing evaluation documented increased trout abundance in the Phase I project area (Figure 43-1).

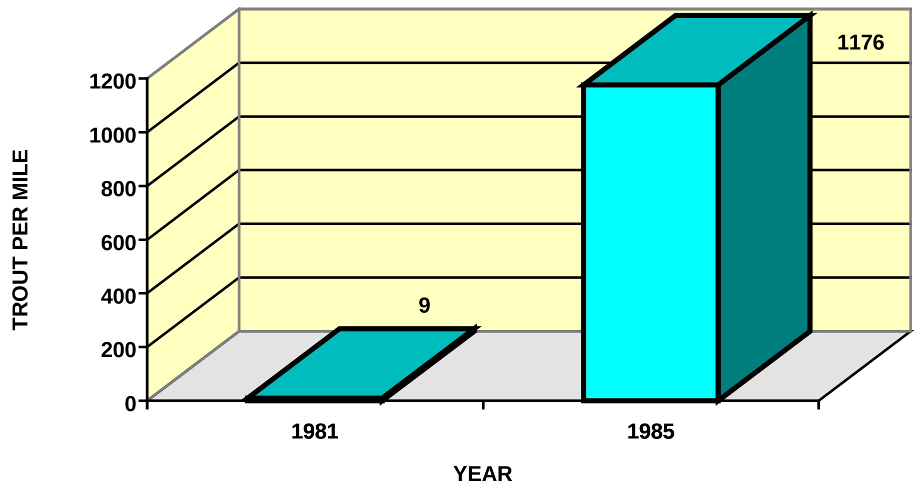


Figure 43-1. Abundance of trout before (1981) and after (1985) habitat improvement in the North Platte River at Douglas.

Annual stocking of trout was continued to satisfy public demand. However, in 1990, river flows became very low during midsummer and river temperatures reached levels lethal to trout. An electrofishing survey that fall found only recently planted trout. As this temperature incident demonstrates, this fishery will have to be maintained as a "put and take" fishery by stocking catchables since little year-to-year carryover can be expected, despite the habitat offered by the rock project.

<u>**Trout Habitat Response**</u> - No formal evaluation was done posttreatment, but visual observation indicated development of many pocket pools near the rocks.

<u>**Habitat Structures**</u> - No movement of rocks was detected despite several severe floods and the boulders continued to furnish shelter to trout through the 1980's. But an inspection of the project in 1990 indicated considerable silt and sand deposition upstream and downstream from individual rocks, with attendant loss of shelter for trout. Clusters of 3-4 rocks that had sufficient current to keep sand scoured away continued to contain trout. A lack of high, scouring flows may have contributed to the problem and the inspection team believed the rocks might be functional at higher flows. Their recommendation was that boulders should be placed in groups along the edge of fast water, such as runs. Random boulder placement in slow water apparently did not create useful trout habitat on a long-term basis.

Conclusions - Addition of boulders to the North Platte River at Douglas created additional holding shelter for hatchery trout in a popular fishing area. Angler harvest and utilization levels posttreatment increased sufficiently to justify the habitat improvement work. Due to potentially high summer water temperatures, best utilization of the habitat improvements would be to support a "put and take" trout fishery during spring and fall when the river water is cool.

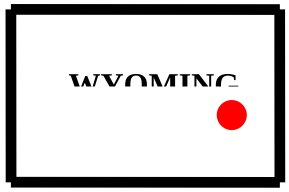
INFORMATION SOURCES

Anonymous. 1986. Summary of Douglas RC & D project, 1985. Pages 387-401 *in*: Annual Progress report for 1985, Casper Regional Fish Management Crew, Fish Division, Wyoming Game and Fish Department, Cheyenne.

McKnight, R. 1981. Aquatic habitat improvement - North Platte River. Typewritten report, Casper Regional Fish Management Crew, Wyoming Game and Fish Department.

McKnight, R. And R. Rintamaki. (No date). Creation of an urban fishery. Typewritten report, Casper Regional Fish Management Crew, Wyoming Game and Fish Department.

NORTH PLATTE RIVER
(Experimental Stream Improvement Jacks)



CONVERSE AND GOSHEN COUNTIES

PROJECT BUILT: 1960-1962

Drainage:	North Platte River	**North Platte River Basin**
Elevation:	Variable	**R.** various**, T.** various**,**
Stream Order:	Fifth, or greater	**Stream Class:** 4 (locally important)
Watershed Area:	15,000 sqmi, or greater	**Mean Wetted Width:** 200 ft, or greater
Gradient:	Variable	**Land Status:** variable
Rosgen Channel Type:	Variable	**Project Length:**
Treatment Used:	Metal jacks, car bodies, cement tiles	
Trout Species:	Rainbow and brown trout	

DESCRIPTION OF STREAM: As a large, low gradient, lowland river in eastern Wyoming, the North Platte River meanders through short grass prairie rangeland, ranch lands, and various towns. River flow is strongly controlled by releases from Alcova and Glendo reservoirs, but the river also gains water from several small drainages along the Laramie Range. River substrate is mostly silt, sand, and gravel. River water is often turbid, especially near Torrington.

PROJECT DESCRIPTION: Fish habitat improvement was done by the Casper Fish Management Crew as a federal aid (Dingle-Johnson) project. Objectives of the work were: 1) determine if the jacks would withstand high flows, and conversely, ice conditions, 2) determine if the devices would improve fish cover and food, 3) determine which structure type worked best, and 4) determine fish use of the structures. Structures were installed in the river near Glenrock, Douglas, and Torrington.

THE FISHERY: Periodic stocking of catchable rainbow trout supported a "put and take" fishery, but no matter how many trout were stocked, the fishery was constrained by habitat shortfalls. Channel catfish were also stocked periodically.

HABITAT MANAGEMENT: A survey of fish habitat identified lack of shelter for trout as a major habitat flaw. To correct this problem, in the spring of 1960, experimental jacks and tripod structures built from pipe and car frame scraps were installed in the river near Torrington. Two types of device were used: tripod shapes that were welded using old car frames or pipe, and car bodies. In 1962, 100 jack structures were placed in the river near Douglas and another 100 on the Brubaker lease at Glenrock. Cement tiles were installed near Torrington to see if catfish would use them as spawning sites.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Electrofishing evaluations of the various structures through 1969 indicated mainly forage and rough fish used the structures. However, some use by trout was documented at the Douglas and Glenrock jacks. In the river near Torrington, catfish were only found near the structures. No evidence was found that catfish used the cement tiles.

Trout Habitat Response - No formal evaluation was done posttreatment, but visual observation indicated the devices provided resting areas and food producing areas for fish in the otherwise barren sandy river bottom. During constant flow periods, the structures trapped sand and were largely ineffective, but high flows cleaned out the structures so fish could use them for shelter.

Habitat Structures - By 1966, structures near Glenrock and Douglas were reported to have been broken up by ice, or buried by sediment. Car bodies tended to trap sediment more than the jacks and were judged aesthetically displeasing. Jacks near Torrington were still functional and providing shelter for fish nine years after installation. Primarily non-game fish occupied this habitat, but some channel catfish and trout were taken near the devices.

Conclusions - Addition of metal habitat improvement structures to the North Platte River below Casper provided some shelter for trout over the short term, but non-game fish were the primary beneficiaries of the devices. Use by fish depended a great deal on river flow since higher flows cleaned sediment from the structures so fish could use them. Jacks installed near Glenrock and Douglas were broken up by ice, or buried by sediment after a few years. Devices near Torrington were still functional nine years posttreatment.

INFORMATION SOURCES

Peterson, L. 1962. A study of stream improvement devices - North Platte River. Typewritten Federal Aid Progress Report, Small Fisheries Development, Platte River Improvement, Fish Division, Aquatic Habitat Section, Wyoming Game and Fish Department, Lander.

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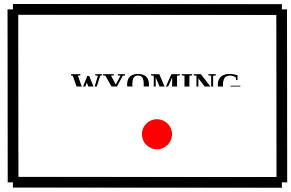
NORTH PLATTE RIVER - Miracle Mile

NATRONA COUNTY

PROJECT BUILT: 1996-1998



Drainage:	North Platte River	**NPR Miracle Mile Basin (1MM)**
Elevation:	5,915 ft	**R.** 84 **W., T.** 26 **N., S.** 27, SE 1/4
Stream Order:	Fifth, or greater	**Stream Class:** 1 (nationally important)
Watershed Area:	~ 4,300 sqmi	**Mean Wetted Width:** ~ 150 ft
Gradient:	0.6%	**Land Status:** U. S. Bureau of Reclamation
Rosgen Channel Type:	F-2	**Project Length:** 2,640 ft
Treatment Used:	Large fish rocks, boulder double deflector, and boulder sills	
Trout Species:	Brown and rainbow trout	

DESCRIPTION OF STREAM: Just upstream from the project, the North Platte River exits the Seminoe Mountains through Kortes Canyon. Kortes Dam is located about one mile upstream and totally controls stream flow. Discharge ranges from 500 cfs (winter) to several thousand cfs. Through the project area, the river is deep and swift. Banks are totally stable, having been previously riprapped with large boulders by BurRec. Stream substrate is rubble and boulders, with little finer material due to the erosive power of the silt-free water coming from the dam.

PROJECT DESCRIPTION: This project was a cooperative venture between WGF and BurRec to enhance trout habitat in a section of the North Platte River. WGF developed plans and recommendations for habitat improvement, while BurRec provided $42,492 ($84,986/mile) to install the boulders. Primary project objective was to increase trout abundance by providing more shelter.

THE FISHERY: Many anglers use the Miracle Mile, which is located between Kortes and Pathfinder reservoirs. This section of river was often dewatered for many years after Kortes Dam was built, but after a study in 1963 by BurRec, WGF, and USFWS recommended a minimum 500 cfs discharge, Congress authorized an operational change at Kortes Dam to include the minimum flow. Consequently, a phenomenal trout fishery developed and became nationally famous for its large fish. The Miracle Mile is classed as a Blue Ribbon trout stream by WGF and supports about 29,000 annual angler days.

Trout populations and angler use at the Miracle Mile have been monitored for many years by WGF and the pretreatment population was about 4,512 trout/mile 6 inches, or greater, total length. BNT comprise 82% of the population and RBT 18%. Average weight was 1.86 pounds per trout and average length was 14.7 inches. However, pretreatment fishing pressure was such that the trout population trend was downward, despite special fishing regulations (2 fish limit) and periodic stocking of hatchery trout.

HABITAT MANAGEMENT: An evaluation of habitat conditions identified the project area as having potential for habitat improvement. Stream flow through the east channel near a small island at the mouth of the canyon was deep and swift. Shelter areas for trout were limited to pocket pools near the few existing boulders. Since rocks are periodically removed from the canyon walls above the road leading to the dam for safety reasons, ample boulders were available close to the project. Adding these boulders would slow the swift water velocities and provide additional cover for trout. In 1996, a contractor hired by BurRec used a front-end loader and a tracked hoe with a hydraulic thumb to place about 125 boulders (about 200 cuyd) in the east channel. Most boulders were scattered as fish rocks, but some were used to build a rock sill, which slowed and deepened water near the fish rocks. In 1997, about 100 boulders were scattered as fish rocks in the west channel or used to create a double deflector and a rock sill there. The deflector and sill were intended to deepen an existing pool. In 1998, 50 additional fish rocks were placed in the west channel near the head of the island, 20 were added to the deflector, and 10 were used to armor the island between the sills.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Project monitoring is underway. Informal observation by the Casper fish management crew indicates an increase in angler use within the project area, where few anglers were seen pretreatment. Anglers have commented that the project area looks like it should hold fish and that is why they fish it.

Trout Habitat Response - No formal project evaluation, but numerous pocket pools have been created by the fish rocks.

Habitat Structures - No formal evaluation.

Conclusions - Any conclusions would be premature as project monitoring is incomplete.

INFORMATION SOURCES

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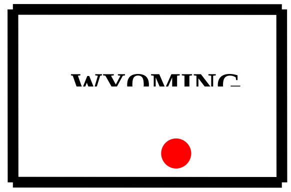
Boyd, D. 1995. Improving the Miracle Mile. Casper Star Tribune, Casper, Wyoming.

Figure 45-1. Large boulders were added to a swift section of the river to supplement fish cover provided by several existing boulders.

Figure 45-2. A loose rock sill was constructed to act as a grade control, raise water levels in the upstream river, and provide additional shelter for fish.

NORTH PLATTE RIVER - Pick Bridge



CARBON COUNTY

PROJECT BUILT: 1991

Drainage:	North Platte River	**North Platte River, North, Basin (5NP)**	
Elevation:	6,685 ft	**R.** 85 **W., T.** 18 **N., S.** 1, NW 1/4	
Stream Order:	Fifth, or greater	**Stream Class:**	1 (national importance)
Watershed Area:	~3,000 sqmi	**Mean Wetted Width:**	135 ft
Gradient:	0.1%	**Land Status:**	WGF Public Fishing Area
Rosgen Channel Type:	C-3	**Project Length:**	1,500 ft
Treatment Used:	Tree jams		
Trout Species:	Brown and rainbow trout		

DESCRIPTION OF STREAM: Heading in the Colorado Rocky Mountains, the North Platte River enters Wyoming as a large river. Picking up water from both the Snowy Range and the Sierra Madre Mountains, it flows through ranch lands in a broad valley near Saratoga. At Saratoga, river ADF is 1,140 cfs, mean CPSF is 460 cfs, and the ASFV ratio is 39, suggesting a relatively stable flow regime. Eroding banks are common. Located about 10 miles downstream from Saratoga, the project area features cottonwood trees, willows, and hayfields in the riparian zone. Away from the river, vegetation grades into a more arid rangeland type featuring sagebrush, rabbitbrush, and greasewood.

PROJECT DESCRIPTION: A cooperative project between the Saratoga Chapter of Trout Unlimited and WGF, this experimental project was undertaken on a limited basis with the goal of improving habitat for trophy size trout. TU contributed funds, while WGF planned and constructed the structures.

THE FISHERY: One of Wyoming's few "blue-ribbon" trout streams, the North Platte River near Saratoga is popular with anglers. The fishery is predominately wild RBT and BNT. Due to the large amount of private land, boat fishing is a popular way to access the river. But at the WGF public fishing areas, both bank and boat fishing can be done. Special regulations govern anglers (6 fish limit, only 1 trout over 20 inches, all trout 10 to 15 inches must be released, fishing with flies or artificial lures only).

HABITAT MANAGEMENT: Lack of shelter for trout, especially trophy size trout, was identified as a habitat shortcoming during lower flows when the stream edge pulls away from the banks. To correct the problem, a WGF construction crew built two experimental tree jams. Previous attempts at bank stabilization at this PFA had been unsuccessful due to the power of the river when in flood, so no attempt was made to install stabilization devices. Cost of the project was $18,264 ($64,290/mile), of which 44% was used hauling pine trees and boulders to the project site.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - An electrofishing evaluation of trout response to the tree jams was attempted by the Fish Population Crew, but determining fish response attributable to the tree jams proved impossible due to the small size of the structures compared to the overall river size. However, observation during fish sampling verified that the structures did attract and provide cover for trout.

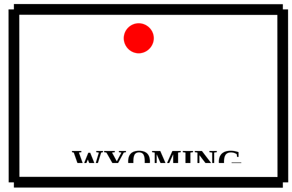
Trout Habitat Response - No habitat measurements were taken.

Habitat Structures - At higher flows, the tree jams functioned to provide shelter for trout, but at lower flows, they acted as deflectors to push the thalweg away from the trees.

Conclusions - No conclusions can be drawn - project was too small.

Figure 46-1. Tree jams were constructed in the North Platte River at Pick Bridge as an experiment to determine if this type of structure was feasible for this river.

NORTH TONGUE RIVER



SHERIDAN COUNTY

Project Built: 1982-1983

Drainage:	Tongue River	**Tongue River Basin (8TR)**	
Elevation:	8,400 - 8,500 ft	**R.** 90 **W., T.** 55 **N., S.** 15, 22	
Stream Order:	Third	**Stream Class:** 3 (Important trout water)	
Watershed Area:	14 sqmi	**Mean Wetted Width:** 17 ft	
Gradient:	1.3 - 2.0%	**Land Status:** Bighorn National Forest	
Rosgen Channel Type:	B-3	**Project Length:** 1 mile	
Treatment Used:	Timber plunges, log plunges, upstream “V” log plunges, rock plunges, wooden and rock deflectors, rock riprap, and channel blocks		
Trout Species:	Snake River cutthroat and rainbow trout		

DESCRIPTION OF STREAM: North Tongue River drains eastward from Little Bald Mountain (elevation, 9,906 ft) in the northern Big Horn Mountains. Discharge peaks in late May or early June from early snowmelt runoff, but both late snowmelt and flow from springs contribute to discharge later in the summer. In the project area, late summer stream flow is not a problem and peak summer water temperatures are in the mid-60s. A low sinuosity and steep gradient characterize this headwater stream. Downstream from Trail Creek, North Tongue River features a narrow (50-75 ft wide) valley floor, which is confined by steep hillsides with conifers on one side and sagebrush/grass rangeland on the other. Riparian vegetation is essentially grass and sagebrush with a few willows. But the upper project area between Trail and Fishhook creeks has a gentler gradient, a broader floodplain, and more willows.

PROJECT DESCRIPTION:, This cooperative fish habitat improvement project between WGF and Bighorn National Forest is located about seven miles west of Burgess Junction. Upper North Tongue River is a popular and heavily used fishery, which has historically been supported largely by stocked trout. A primary project objective was to provide more deep pools and thus increase rearing habitat for stocked juvenile SRC. Improved habitat would also increase overwinter survival and return-to-the-creel of stocked trout. USFS contributed funds, rocks, and trees to the project, while WGF furnished funding, labor, finished materials, and equipment.

THE FISHERY: At its higher elevations, the river does not support a wild trout population. Natural reproduction is absent in the project area, but young SRC stocked at 49 per pound (3.75 inches) have reached catchable size by the next summer. Since 1961, SRC have been stocked to provide a basic yield fishery along Highway 14-A, a heavily traveled tourist route which parallels the stream. Over the years, RBT have also been stocked at various points in the North Tongue River, but the primary emphasis in the project area has been on SRC. Angler use and harvest has traditionally been high on this river and few trout survived long enough to grow large. When the project was built, liberal statewide fishing regulations were in effect, but by 1990, the intensive fishing pressure had prompted restrictive regulations (catch and release, fishing with flies or lures only) on a portion of the river several miles downstream from the project. In 1996, the special regulation area was expanded to include all of the upper North Tongue River and its tributaries.

HABITAT MANAGEMENT: Instream cover for trout was low (5%) pretreatment and was mainly small pools. No deep pools occurred in the study section. Bank erosion (46%) was another habitat flaw, which may have been related to historically intense livestock grazing in the creek bottoms. Over a two year period, a WGF construction crew installed 9 timber plunges (Figure 47-1), 8 log plunges, 5 boulder plunges, 2 upstream "V" log plunges (Figure 47-2), 6 wooden deflectors, 2 rock deflectors, 125 ft of rock riprap and tree revetments, and 2 channel blocks made from pine trees. Most of the work was done in a 2,000 ft section downstream from Trail Creek. Only six plunges were located between Trail and Fishhook creeks. Project cost was $7,285 ($7,285/mile) for labor, materials, and equipment time.

Figure 47-1. Two timber plunges near the confluence with Trail Creek slow swift currents, dissipate energy, and provide deep water to shelter trout.

EVALUATION OF TROUT HABITAT MANAGEMENT

<u>Fishery Response</u> - The trout population was monitored by electrofishing gear at one station located in mid-project. Young SRC were stocked each year, so only age-1 and older fish were compared to determine fishery response to the habitat management. Posttreatment mean abundance was 104% greater than pretreatment, while biomass had increased 157% (Table 47-1). SRC abundance and biomass initially increased post-treatment, but later decreased (Figures 47-3 and 47-4). Removal of larger fish by anglers and possible downstream migration of larger trout out of the treated area were postulated to explain this drop in abundance. Further electrofishing elsewhere on the river, and a creel census, established that downstream movement of trout was not a likely factor, but fishing mortality was severely depressing the SRC population. Few SRC survived in the river longer than 15 months after being stocked.

<u>Trout Habitat Response</u> - By 1991, trout habitat had increased 43%. Cover for trout improved three fold due to new shelter furnished by deep pools at plunges, as well as shelter near tree revetments (Figure 47-

5). Stream bank stability improved 39%, despite continued heavy grazing and a shortage of rock riprap that limited the quantity of bank stabilization that could be done. By 1995, log plunges averaged only 93 sqft of cover, compared to 145 sqft at timber plunges. The upstream “V” log plunges averaged 240 sqft of cover, but most of this cover was at one structure.

Habitat Structures - By 1995, the instream structures were generally still functioning as intended. An evaluation of the wooden plunge structures found 75% still in good condition. Of the 12 plunge pools measured, 57% had a RPD 1.5 ft, or deeper. Timber plunges had the best overall performance with mean RPD of 1.65 ft, and 71% with RPD 1.5 ft, or deeper. However, one upstream “V” log plunge had an RPD of 3.2 ft and 360 sqft of cover. Although it required resealing one year after being built, it has functioned satisfactorily since then. Rock plunges had poor durability and performance due to shifting of rocks by stream currents.

Figure 47-2. A log vortex weir (upstream “V” plunge) acts as a grade control to slow stream flow and furnishes valuable pool shelter for trout.

Conclusions - Instream habitat improvement devices provided 200% more shelter for trout. Consequently, the trout population doubled within two years. But by 1986, numbers of age-0, and larger, trout had decreased almost to pretreatment levels, possibly due to increased fishing mortality after anglers discovered and “keyed-in” on the plunge pools.

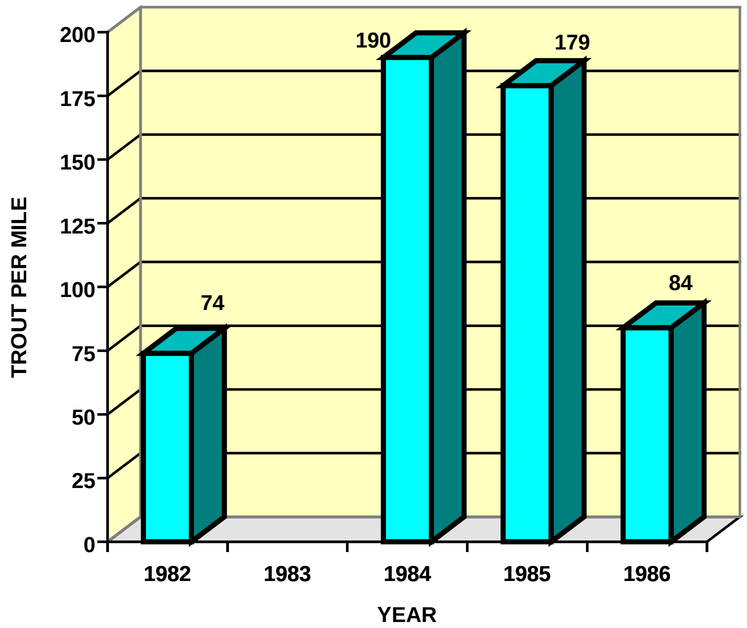


Figure 47-3. Abundance of age-1+ SRC at the habitat improvement area on North Tongue River, 1982-1986.

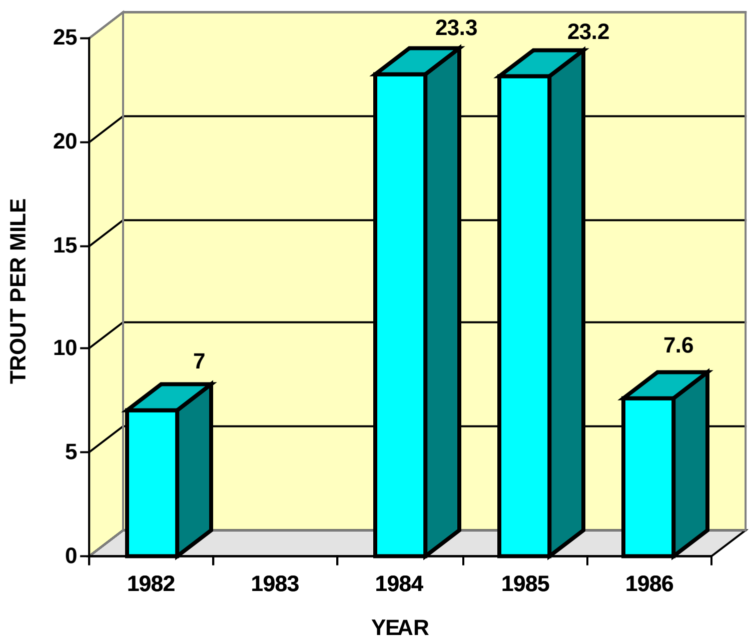


Figure 47-4. Biomass of age-1+ SRC before (1982) and after (1984-1986) habitat management on North Tongue River.

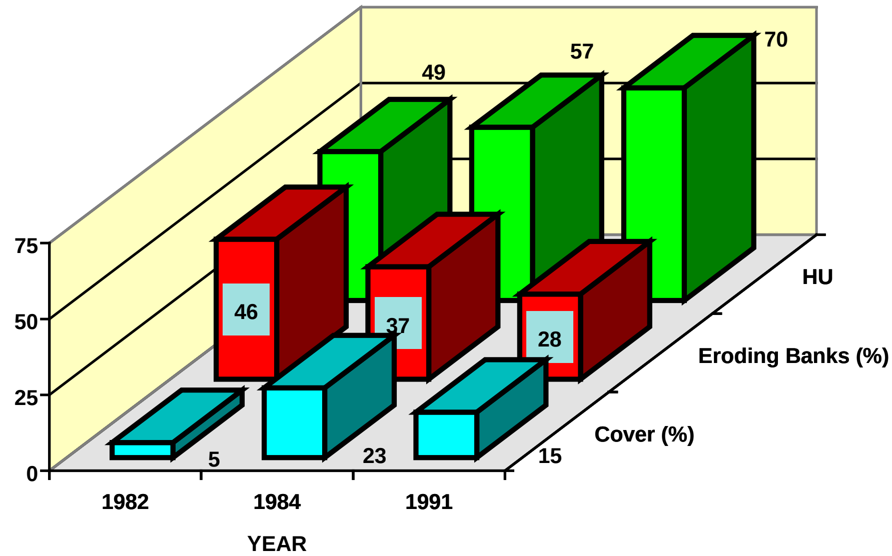


Figure 47-5. Cover, eroding banks, and Habitat Units at North Tongue River before (1982) and after (1984-1991) habitat improvement.

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Steward, B. 1995. Response of fish populations to a restricted harvest regulation on the upper North Tongue River and Bull Creek. Administrative Report, Project 30-833-030-17, Fish Division, Wyoming Game and Fish Department, Cheyenne.

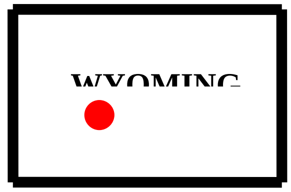
Table 47-1. Trout populations in the habitat improvement section at upper North Tongue River before and after structures were installed.

Year	Number/mile	Pounds/acre
Pretreatment		
1982	74	7
Posttreatment		
1984	190	23
1985	179	23
1986	84	8
Pretreatment mean	74	7
Posttreatment mean	151	18
Percent change	104	157

PASS CREEK

FREMONT COUNTY

PROJECT BUILT: 1979



Drainage:	Little Popo Agie River	**Little Popo Agie River Basin (6PL)**	
Elevation:	7,430 ft	**R.** 100 **W., T.** 31 **N., S.** 35, NW 1/4	
Stream Order:	First	**Stream Class:** 3 (regionally important)	
Watershed Area:	6 sqmi	**Mean Wetted Width:** 8 ft	
Gradient:	2.2%	**Land Status:** Shoshone National Forest	
Rosgen Channel Type:	B-4	**Project Length:** 2,640 ft	
Treatment Used:	Timber plunges, double deflectors, single deflectors, channel block, rock plunge, rock riprap, tree/rock revetment, and a pole deflector system to control cattle movement.		
Trout Species:	Wild rainbow and brook trout		

DESCRIPTION OF STREAM: Pass Creek is a small, bushy stream that drains a northerly aspect of Limestone Mountain near South Pass in the Wind River Mountains. Its mountainous watershed contains a mix of conifer or aspen patches interspersed with parks covered with sagebrush, grass, and forbs. Along the stream, willow, river birch, grass, sagebrush, and forbs are common. Shrub growth is sometimes dense in the riparian area and may hinder human access to the stream. Stream flow from snowmelt and springs is adequate for trout through the summer and fall. Several summer homes are present in the middle basin.

PROJECT DESCRIPTION: Habitat improvement at lower Pass Creek was a cooperative venture between WGF and the Shoshone National Forest. USFS provided partial funding, rocks, trees, and the pole deflector system, while WGF provided project planning and construction of instream habitat improvement structures. Project goals were to improve fish shelter and riparian vegetative cover in the 1.5 miles upstream from the Pass Creek confluence with the Little Popo Agie River. But the rugged terrain limited equipment access and actual instream habitat improvement was only done in the NW 1/4 of section 35, that is just downstream from a small meadow.

THE FISHERY: Angler access to Pass Creek is provided by the dirt Limestone Mountain - Freak Mountain road, but most fishing occurs near the summer homes, and in the lower one-third of the drainage where the road is close to the stream. Standard statewide regulations apply. Pretreatment, the fishery consisted of 2,310 trout/mile (91 lbs/acre). BKT ranged up to 7.6 inches in length, while RBT ranged up to 8 inches. RBT from the Little Popo Agie River are believed to run up Pass Creek to spawn, meaning Pass Creek may function as a nursery and rearing tributary for the river.

HABITAT MANAGEMENT: Pretreatment, a lack of deep pools and slow water pockets was identified as a primary limiting factor to fish production in Pass Creek. A study section contained only 7% shelter for trout and 42% eroding banks. Over many years, concentrated cattle grazing in the stream bottoms during summer had degraded both bank stability and riparian vegetation. Their continual use of trails parallel to the stream also contributed to bank instability. Consequently, USFS erected a pole deflector system, which is a series of short pole fences erected perpendicular to the stream axis at regular intervals (Figure 48-1). Purpose was to block existing trails, discourage cattle from trailing close to the stream, reduce mechanical bank damage, and reduce forage utilization in the riparian area. To provide additional shelter for trout, a WGF construction crew built 7 timber plunges, 8 double deflectors, 3 single deflectors, 1 channel block, 804 ft of rock riprap, and 214 ft of tree/rock revetment (Figures 48-2 and 48-3). An attempt was also made to stabilize a small mass wastage site where earth slumpage was adding sediment to the stream. Project cost was $4,500 ($9,000/mile)

Figure 48-1. A pole deflector system was erected along Pass Creek by USFS to discourage cattle movement parallel to the stream.

Figure 48-2. Double deflectors were installed in Pass Creek to narrow the stream flow and encourage scouring of pools for trout shelter.

Figure 48-3. Here a combination structure was used in Pass Creek. After the eroding bank was protected with rocks, a conifer was laid over the top to discourage cattle use along that bank. The wing deflector narrows and deepens flow along the face of the rocks, thus increasing cover for trout.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - No valid posttreatment evaluation was done, but many trout could be seen using the new pools provided by the plunge structures. Downstream drift of trout from the high-density population in Pass Creek may provide recruitment for the fishery in the Little Popo Agie River

Trout Habitat Response - Twelve years after treatment, cover for trout had increased 143% and eroding banks were 88% better (Figure 48-4). HQI score remained virtually constant, being 102 HU in 1979 and 99 HU in 1991. Growth of riparian vegetation was so good posttreatment that the brush along the stream banks impeded angler access to the stream.

Habitat Structures - No posttreatment evaluation was done. As with cattle control fences at other streams, lack of maintenance was a problem at Pass Creek.

Conclusions - Addition of instream habitat improvement structures doubled the amount of deep pool habitat available for trout in Pass Creek and many trout could be seen using these pools.

INFORMATION SOURCES

Hogle, J. S. 1993. Salmonid habitat and population characteristics related to structural improvement in Wyoming streams. Masters thesis. University of Wyoming, Laramie.

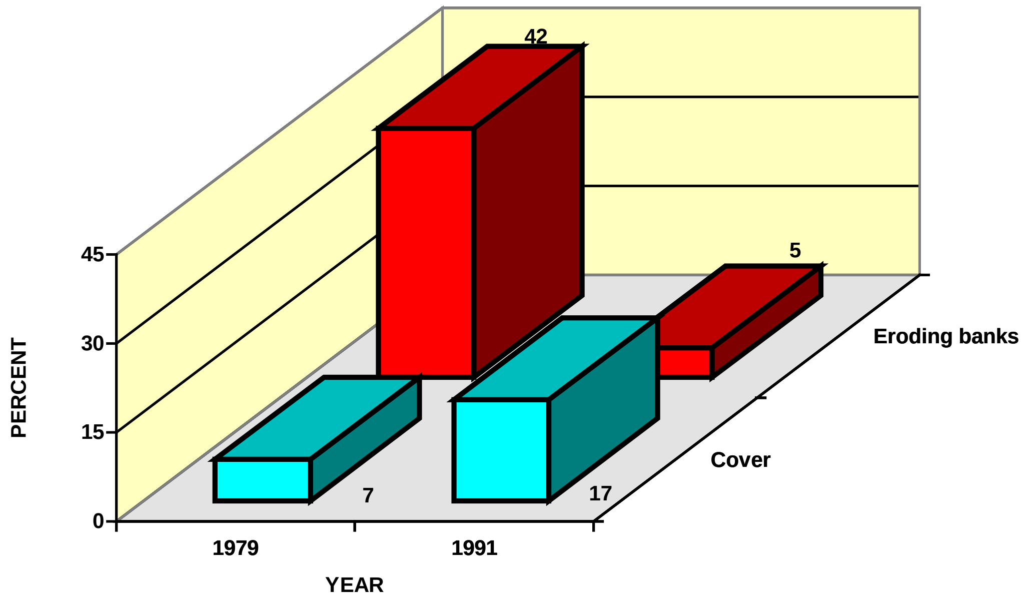
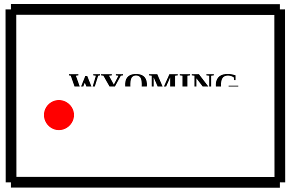


Figure 48-4. Amount of cover and eroding banks present in Pass Creek before (1979) and after (1991) habitat improvement.

PINEGROVE CREEK

SUBLETTE COUNTY

PROJECT BUILT: 1980, 1985-1986, 1990



Drainage:	Dry Piney Creek	**Dry Piney Creek Basin (7DP)**	
Elevation:	7,846 ft	**R.** 114 **W., T.** 28 **N., S.** 11, SW 1/4	
Stream Order:	First	**Stream Class:** 4 (locally important)	
Watershed Area:	6 sqmi	**Mean Wetted Width:** 4 ft	
Gradient:	2.5%	**Land Status:** BLM	
Rosgen Channel Type:	C-5	**Project Length:** 2,640 ft	
Treatment Used:	Timber plunges, barbwire livestock exclosure		
Trout Species:	Colorado River cutthroat trout		

DESCRIPTION OF STREAM: Draining easterly from Deadline Ridge, Pinegrove Creek is bounded on the south by Pinegrove Ridge and on the north by Narrow Ridge. Heading on the Bridger-Teton National Forest, the stream soon exits the forest and flows down into a more arid setting on BLM land, where the project is located. The entire watershed is within the LaBarge oil and gas field. Water flows in most of the creek during "wet-years", but during "dry-years", stream flow is not dependable and the stream may be intermittent on BLM land. Beaver dams are common on forest, but only occasional in the project area. Streamside vegetation at the lower exclosure is sagebrush, willows, grass, various forbs, a few aspen, and an occasional conifer. Stream substrate is mainly small gravel and fine sediment.

PROJECT DESCRIPTION: Surveys during the late 1970's documented CRC presence in several West Side Tributaries of the Green River - those small streams along the east slope of the Wyoming Range - and prompted activity to preserve these remnant populations. At Pinegrove Creek, a cooperative effort was made by BLM and WGF to protect and upgrade CRC habitat. Pure strain CRC were stocked to supplement the existing population, barbwire exclosures were built to control cattle, and instream pool digger structures were installed in the lower exclosure.

THE FISHERY: A small remnant population of CRC was present in the headwaters prior to 1970. To upgrade and supplement this population, pure-strain CRC were transplanted into Pinegrove Creek from North Beaver Creek in 1972 and 1974. Fertilized CRC eggs were also stocked in 1974. Survival of the 1972 plant was questionable due to an oil spill shortly after the fish were planted, but the 1974 plant evidently endured for several years. CRC presence in the lower exclosure where the habitat improvement structures were built has depended on water flow and the occurrence of oil spills.

HABITAT MANAGEMENT: For many years, Pinegrove Creek has suffered periodic pollution from oil spills and cattle have heavily grazed the drainage. Some stream sections were beginning to form gullies. In 1980**,** two livestock exclosures were built on Pinegrove Creek by BLM. During 1985-1986, a WGF construction crew installed 13 timber plunges within the lower exclosure. Due to the fine soil type and a shortage of rocks for riprap, these plunges developed leaks as water washed under or around the timbers and plunge performance was generally poor for several years. In 1990, 12 plunges were completely rebuilt by a WGF construction crew and impervious filter cloth was installed to ensure the devices sealed properly (Figure 49-1). Total WGF cost for the 1985-1986 work was $2,040 ($4,080/mile), and the 1990 work cost $4,310 ($8,620/mile). There is no cost record for the BLM exclosures.

Figure 49-1. Timber plunges installed in Pinegrove Creek have provided shelter for trout, grade control for the stream, and subirrigation for the riparian vegetation.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Although the exclosures and instream structures have been electrofished periodically over the years, there are no meaningful "before and after" fish population data. During "wet-years", CRC occur in both exclosures and use the plunge pools. During "dry-years", the stream is often dry or too warm for CRC in the lower exclosure. Oil spills are a continual threat.

Trout Habitat Response - By 1991, cover was 250% better and bank erosion had decreased 59% (Figure 49-2). HQI score had doubled from 1 HU to 2 HU. Despite periodic trespass by cattle, vegetation on the stream banks and flood plain was well developed when the lower exclosure was visited in October 1997 (Figure 49-3). Deposition of sediment in lateral and point bars, and the subsequent revegetation, had narrowed the stream. A small, new beavers dam and pond was present. Development of the riparian vegetation has been aided by the subirrigation provided by the plunges and periodic beaver dams. Gully development appeared to have slowed. Burning off the stagnant, old sagebrush growth inside the lower exclosure might be a logical next step at this project.

Habitat Structures - An inventory in October 1997 located all 12 timber plunges. Condition of the plunges was rated good at 83% of the devices, but only 8% of the plunge pool RPD were 1.5 ft, or deeper. This lack of depth was likely due to the filter cloth installed under the structures, which would prohibit the stream from digging a deep plunge pool. However, pool depth was usable for CRC at the flow observed. And, over the long term, the grade control provided by the plunges may be more valuable than the plunge pools.

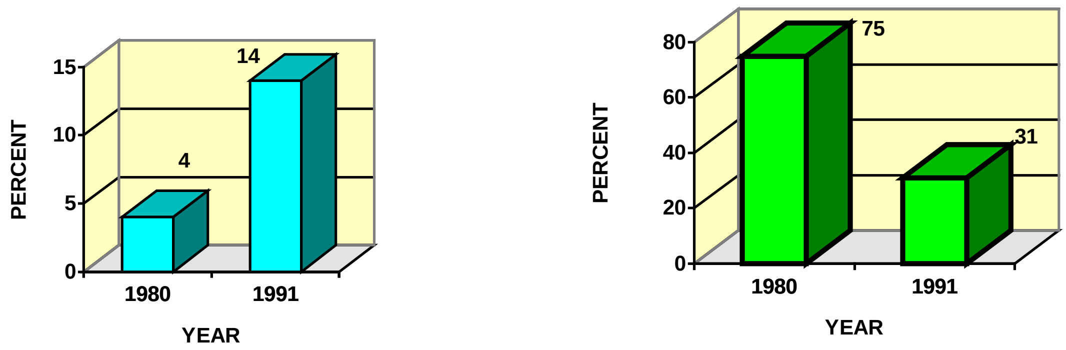


Figure 49-2. Cover (left) and eroding banks (right) in Pinegrove Creek before (1980) and after (1991) habitat improvement.

Figure 49-3. Riparian vegetation has grown denser following protection from grazing and better subirrigation. Prior to treatment, the stream in this section had begun to down cut and form a gully. Posttreatment, this trend has been reversed.

<u>Conclusions</u> - Trout habitat and the CRC population benefited from the two exclosures and the installation of timber plunges. Posttreatment, additional cover for trout was present, the stream was narrower, and the riparian vegetation was visibly better. However, the CRC population is strongly influenced by factors not addressed by the original habitat improvement, namely, drought and oil spills. Consequently, trout abundance fluctuates widely from year to year despite the habitat improvements.

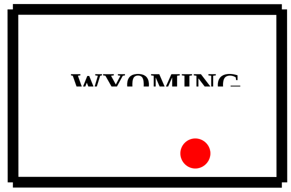
INFORMATION SOURCES

Hogle, J. S. 1993. Salmonid habitat and population characteristics related to structural improvement in Wyoming streams. Masters thesis. University of Wyoming, Laramie.

ROCK CREEK (Near Arlington)

CARBON COUNTY

PROJECT BUILT: 1970



Drainage:	Medicine Bow River	**Upper Medicine Bow River Basin (5UM)**	
Elevation:	7,780 ft	**R.** 78 **W., T.** 19 **N., S.** 30 NW 1/4	
Stream Order:	Third	**Stream Class:** 3 (regional importance)	
Watershed Area:	63 sqmi	**Mean Wetted Width:** 50 ft	
Gradient:	1.4%	**Land Status:** Private and I-80 right-of-way	
Rosgen Channel Type:	B-3	**Project Length:** 1,200 ft	
Treatment Used:	Boulder deflectors and fish rocks		
Trout Species:	Rainbow, brown, and brook trout		

DESCRIPTION OF STREAM: Rock Creek drains a northeast aspect of the Snowy Range, including Rock Creek Ridge. Timbered, mountainous land in the Medicine Bow National Forest is a major component of its watershed and winter snowfall there furnishes much water to the stream. In the project area, the stream has exited the mountains onto broad river bottoms and ranchland near the I-80 Arlington Junction. Summer stream flows through the project are reduced by diversions for the King Canyon Canal and late summer flows may become crucially low for trout during some years. ADF is about 73 cfs and the ASFV ratio is about 230, suggesting major flow fluctuations. Stream substrate is primarily rubble and cobble.

PROJECT DESCRIPTION: When I-80 was built in 1970, a 1,200 ft section of Rock Creek was channelized where the interstate highway crosses the creek on twin bridges. Wyoming Highway Department (WHD) and WGF worked together to develop a plan to mitigate the loss of fish habitat. Cost of the restoration was included as part of highway construction funds with boulders being placed by contractors working on I-80. WHD supervised the work. A primary project goal was to restore the channelized stream section to a productivity level comparable with that in the original stream.

THE FISHERY: Upstream from the canal diversion, water flow and trout abundance is better and the stream is a class 2 water (statewide importance). Flow fluctuations limit the fishery below the canal diversion, but the stream still supports good fishing for BNT, BKT, and RBT where good habitat is present.

HABITAT MANAGEMENT: Channelization removed all pools and the channel roughness components needed by trout. Subsequently, large sandstone boulders averaging 7-8 tons and 2-10 ft diameter were placed in the channel to slow and deflect swift currents. About 76 boulders were scattered within the channel using heavy equipment. A few rocks were placed under the east bridge, but most were situated upstream from the highway crossing. No rocks were placed under the west bridge, which was a control section.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - An electrofishing evaluation in 1969, prior to habitat restoration, reported 34% fewer trout in the channelized stream than in an unaltered control station located a half mile upstream. Evaluation of the rock placements in 1975 found 662% more trout than at the upstream control. Within the channelized section, a boulderless reach under the west bridge had the fewest fish, 62% less than the upstream control, and nearly eight times less than an adjacent section containing boulders. Pattern of rock placement did not affect trout abundance, but density apparently did. Trout abundance per boulder was 20% less in a section with boulder density of 0.3 rocks/linear yard of stream than in an adjacent section having 0.2 rocks/yard.

In 1984, both the upstream control and treated stations were electrofished. Trout abundance in the boulder section was 317% higher, and biomass was 1,100% higher, than in the untreated section (Figures 50-1 and 50-2).

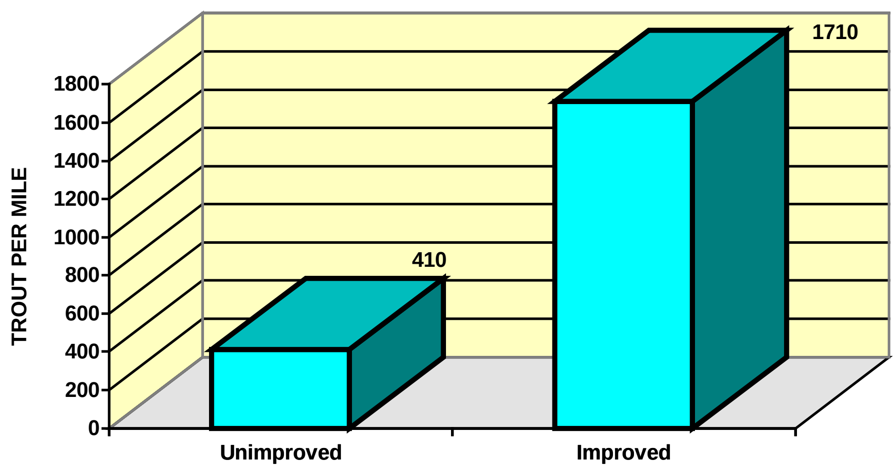


Figure 50-1. Trout abundance in 1984 at Rock Creek. The improved section contained numerous large boulders as opposed to an unaltered, natural channel in the unimproved section.

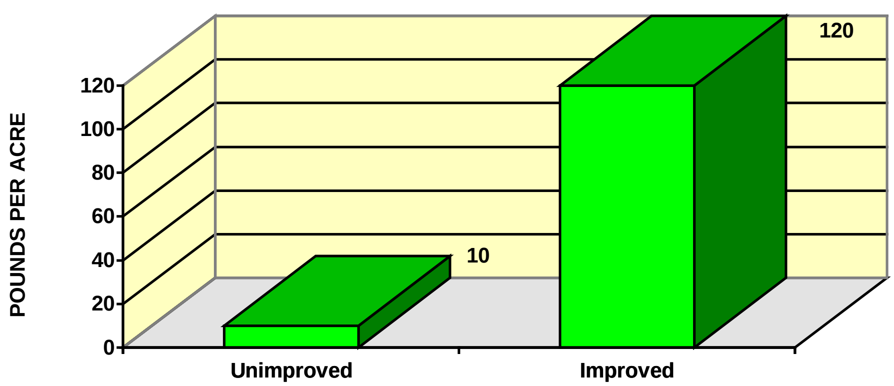


Figure 50-2. Trout biomass in 1984 at Rock Creek. The improved section contained numerous large boulders as opposed to an unaltered, natural channel in the unimproved section.

Trout Habitat Response - Excellent pool habitat developed around many of the boulders after only two spring floods. Logs and other LWD that hung up on the boulders to create debris jams provided additional fish habitat. An inspection of the project in 1997 found the steam had built large cobble and rubble bars in response to the channel roughness provided by the boulders and LWD (Figures 50-3 and 50-4). Many boulders had pools associated with them and some of these pools were providing very good trout habitat. The thalweg meandered naturally within the channel and the stream had a natural appearance. In contrast, the boulderless section under the west bridge retained a monotonous, channelized appearance.

Habitat Structures - Due to their large size, the boulders moved very little from their original position. Some became more embedded in the stream bottom as water undercut their bases and sediment was deposited. Some rocks near the edge of the stream furnished shelter for trout only at high flow.

Conclusions - Addition of large boulders to the channelized stream soon created good habitat for trout. And the trout population recovered from a low level to a density comparable to the upstream control within two years, thus achieving the project objective. Fourteen years after habitat restoration, trout abundance was four-fold greater in the boulder section than at the upstream control. Rock Creek appeared very natural 27 years after treatment and the boulders have not interfered with bridge integrity.

INFORMATION SOURCES

Kanaly, J. 1971. Stream improvement evaluation in the Rock Creek Fishway, Carbon County. Administrative Report Project No. 0571-08-6602. Fish Division, Wyoming Game and Fish Department, Cheyenne.

Kanaly, J. 1975. Stream improvement evaluation in the Rock Creek Fishway, Carbon County (Addendum). Administrative Report Project No. 0575-08-6602. Fish Division, Wyoming Game and Fish Department, Cheyenne.

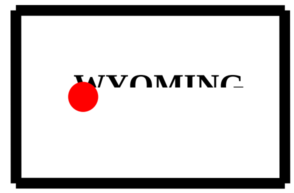
Figure 50-3. As mitigation for channelization done during construction of I-80, 76 large boulders were placed in Rock Creek under the east bridge and upstream from the west bridge crossing. Rock placement extended upstream into the tree-lined section shown in the photo.

Figure 50-4. Rock Creek as it appeared 27 years posttreatment. Photo view is looking downstream toward the west bridge and covers the same area occupied by the bulldozer and boulders in Figure 50-3.

ROCK CREEK - Upper Green

SUBLETTE COUNTY

PROJECT BUILT: 1987



Drainage:	Green River	**Green River Basin (7GR)**	
Elevation:	7,670 ft	**R.** 110 **W., T.** 38 **N., S.** 26, SE 1/4	
Stream Order:	Third	**Stream Class:** 3 (Regionally important)	
Watershed Area:	20 sqmi	**Mean Wetted Width:** 12 ft	
Gradient:	1.9%	**Land Status:** Bridger-Teton National Forest	
Rosgen Channel Type:	B-3	**Project Length:** 750 ft	
Treatment Used:	Log plunge, boulder plunge, tree/rock revetment, cover trees		
Trout Species:	Brook, brown, rainbow, and Colorado River cutthroat trout.		

DESCRIPTION OF STREAM: A major tributary of the upper Green River, Rock Creek drains an eastern aspect of the Gros Ventre Range. It exits the mountains through a steep-sided canyon, then flows across the valley of the Green River to enter the river on private land downstream from the forest boundary. Stream flow is natural from a rugged, forested watershed, which features conifers, aspen, grass-sagebrush-forb parks, and alpine vegetation. Willows are common along the stream. Discharge holds up good during summer and late summer flows are not a problem. In the project area, gradient is steep and the stream bottom rocky.

PROJECT DESCRIPTION: Rock Creek is located about 22 miles northwest of Pinedale, just upstream from the forest boundary. Habitat improvement was a cooperative project between WGF and the Bridger-Teton National Forest. WGF furnished expertise, manpower, equipment, and funds, while USFS provided funds, rocks, and trees. Primary project objective was to slow swift flows in a high velocity section, install grade controls to stabilize that section, and provide additional shelter for trout.

THE FISHERY: BKT are the primary species, but the drainage contains a small resident population of wild CRC, which are considered a sensitive species. Rock Creek is an important BKT nursery stream for the Green River. Angler use of Rock Creek is undocumented, but given the intensity of recreational use in the upper Green River area, Rock Creek likely attracts its share of anglers. Standard, statewide regulations applied.

HABITAT MANAGEMENT: Historically, the creek flowed across a delta on private ranchland to the Green River. Its channel was sometimes braided, but it furnished good trout habitat, especially for juvenile BKT. After the ranch was subdivided, the stream was severely channelized downstream from the forest boundary. Thus, a project objective was to forestall possible lateral erosion and headcutting by the stream on forest in response to the channelization. Through the project area, the stream channel was already straight and ditch-like - it appeared to have been straightened at some past time, perhaps for tie drives. Water velocities through the section were high and there was little shelter for trout of any size. Habitat type was swift rapids and pocket pools, with virtually no deep pools (Figure 51-1). A WGF construction crew installed 6 log plunges (Figure 51-2), 5 rock plunges, and 275 ft of tree and rock revetment. Project cost was $5,028 ($35,397/mile). Trees and rocks were obtained locally.

Figure 51-1. Pretreatment, Rock Creek through the project area was characterized by swift rapids and a straight channel. Only shallow pocket pools were present.

Figure 51-2. Log plunges were built in Rock Creek to provide grade control and furnish pool shelter to trout. Cover trees placed along the sides of plunge pools added both cover and structural stability.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Pretreatment, the trout population was sparse through the project area. Following installation of the pool digging devices, trout abundance and biomass increased sharply then dropped to lower levels (Figures 51-3 and 51-4). But five years after the structures were installed, trout abundance was 408%, and biomass 172%, higher than pretreatment (Table 51-1). Catchable trout (6 inches, or longer, total length) were 178% more abundant by 1992 than pretreatment. Both 1988 and 1992 were years with relatively low stream flows, which would have encouraged development of the trout population. In contrast, 1990 was a wet year and swift flows may have swept trout out of the project area despite the structures.

Trout Habitat Response - After log plunges were added to Rock Creek, shelter for trout increased 256% (Figure 51-5). Plunge pools were an important new habitat component, but the stream also formed dam pools and deep glides upstream from the structures, which contrasted to the swift rapids found pretreatment. Adding the new cover increased habitat from 16 HU to 19 HU in one year. However, plunge pool cover decreased in later years when some plunge pools filled with cobble and boulders that rolled in during floods. Eight years after treatment, cover was still 55% better than pretreatment and mean cover per plunge pool was up 183% (Figure 51-6). But only 33% of the plunge pools had RPD 1.4 ft, or deeper, and this percentage remained constant from 1988 to 1995.

Habitat Structures - All six log plunges were still in place in 1997, despite a very high snowmelt flood that spring. They continued to maintain channel grade and provide fish habitat through the project area. The headcut that was threatening channel integrity upstream from the forest boundary pretreatment was stopped by the plunges. Some slippage of rocks and movement of side-logs at the plunges occurred though. One log plunge was buried level with the stream bottom and had no plunge pool, but the other five structures all had good pool development. There was still a problem with rocks rolling into the plunge pools. Slippage of boulders had seriously damaged the rock plunges.

Conclusions - Five years after plunge structures were added to Rock Creek, trout abundance had increased five-fold and biomass was three times greater. Channel integrity was maintained by the habitat improvement structures despite severe channelization downstream from the project.

INFORMATION SOURCES

Binns, N. A. 1972. An inventory and evaluation of the game and fish resources of the upper Green River in relation to current and proposed water development programs. Completion Report, Project B-002-Wyo, Wyoming Water Resources Research Institute, University of Wyoming, Laramie.

Kurtz, J. 1980. Fishery management investigations - a study of the upper Green River fishery, Sublette County, Wyoming (1975-1979). Administrative Report, F-44-R, Fish Division, Wyoming Game and Fish Department, Cheyenne.

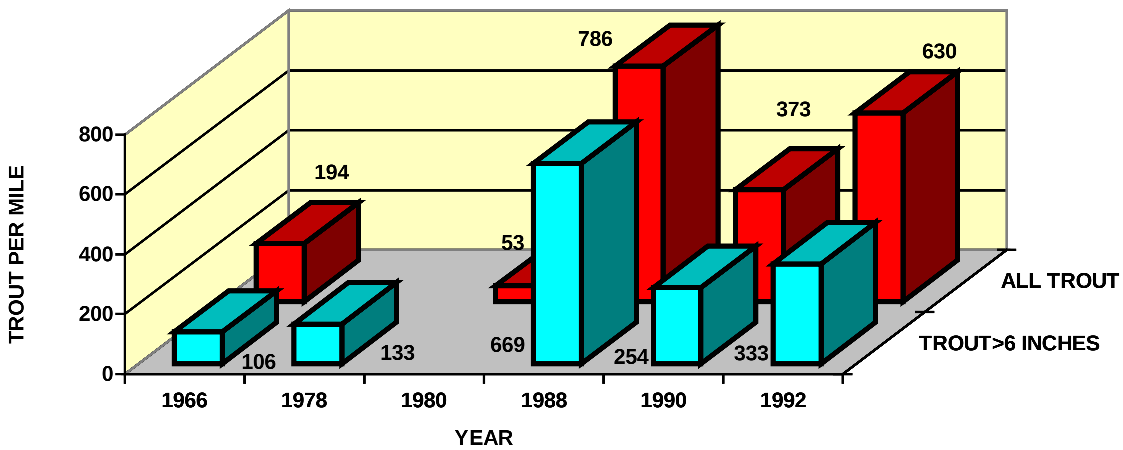


Figure 51-3. Trout abundance in Rock Creek before (1966-1980) and after (1988-1992) habitat improvement.

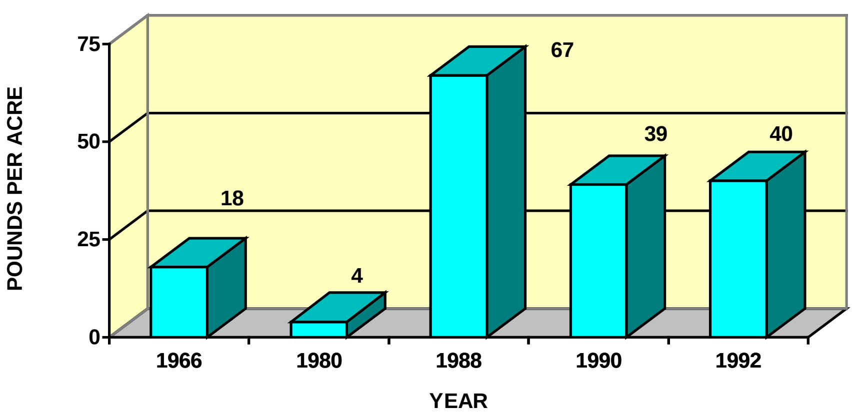


Figure 51-4. Trout biomass in Rock Creek before (1966-1980) and after (1988-1992) habitat improvement.

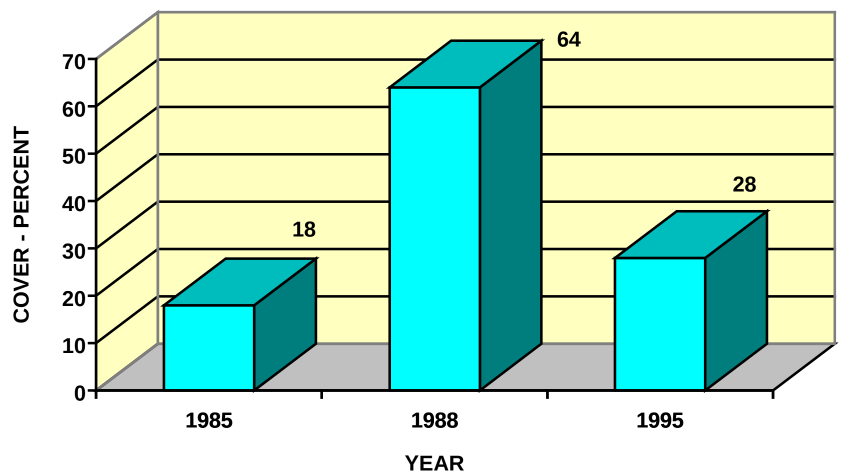


Figure 51-5. Cover for trout in Rock Creek 1985-1995.

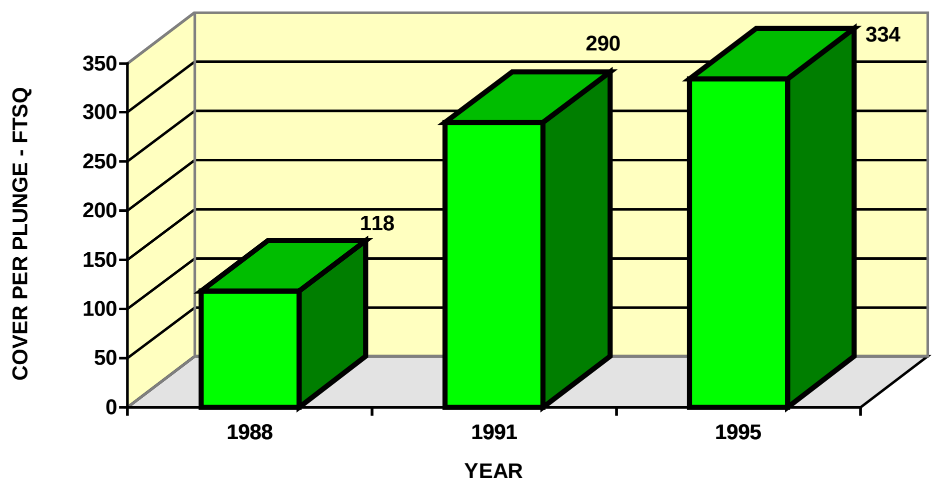


Figure 51-6. Change in cover available for trout at plunge pools as Rock Creek adjusted to the plunge structures from 1988-1995.

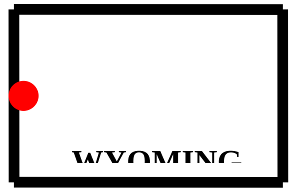
Table 51-1. Mean empirical values for four characteristics of the Rock Creek trout population before and after habitat improvement.

YEAR	TROUT/MILE	LBS/ACRE	TROUT/MILE > 6 INCHES	LBS/ACRE > 6 INCHES
Pretreatment				
1966	194	18	106	11
1978			133	19
1980	53			
Posttreatment				
1988	786	67	669	58
1990	373	39	254	35
1992	630	49	333	37
Pretreatment mean	124	18	120	15
Posttreatment mean	596	52	419	43
Percent Change	380%	189%	249%	187%

SALT CREEK - Allred Flat

Lincoln County

PROJECT BUILT: 1981-1988



Drainage:	Thomas Fork Bear River	**Bear River Basin (3BE)**	
Elevation:	6,640 - 6,685 ft	**R.** 119 **W., T.** 29 **N., S.** 23, SE 1/4	
Stream Order:	Third	**Stream Class:** 3 (regionally important fishery)	
Watershed Area:	21 sqmi	**Mean Wetted Width:** 15 ft	
Gradient:	0.9 %	**Land Status:** Bridger-Teton National Forest	
Rosgen Channel Type:	C-4	**Project Length:** 13,500 ft (2.5 mi)	
Treatment Used:	Rock/tree revetments, deflectors, log plunges, upstream "V" plunges, rock plunges, gabion plunge, channel blocks, cover trees		
Trout Species:	Wild Bear River cutthroat trout		

DESCRIPTION OF STREAM: Salt Creek extends about 6 miles upstream from the project area, draining a section of the Gannett Hills south of Afton. This area is part of the Overthrust Belt and contains easily eroded shale, siltstone, and limestone formations. Its watershed has steep, rounded hills vegetated with a sagebrush, grass, and forb community, and scattered patches of conifer or aspen. At Allred Flat, the treeless riparian area features patches of tall willows and a grass-sedge-rush-forb community. Scattered aspen and conifer stands grow on the valley side slopes. Salt Creek is a perennial stream in the project area, but after the snowmelt flood, stream flow drops quickly to a low level in late summer. ADF is 20 cfs, the ASFV ratio is 61 and CPSF is 33% ADF. Beaver activity is common in the upper drainage, but was sporadic in the project area at project inception.

PROJECT DESCRIPTION: This project was a cooperative venture between WGF and Bridger-Teton National Forest to improve and stabilize fish habitat in Salt Creek. USFS contributed funds, rocks, and trees to the project, while WGF furnished funding, labor, finished materials, and equipment. Fish habitat improvement was done from the salt spring upstream to near the confluence with Little White Creek. Although the Allred Flat segment was completed in 1988, USFS hired a private contractor in 1994 to install additional structures in Salt Creek Canyon downstream from the salt spring. Originally designed to be part of the Rocky Mountain Stream Habitat Improvement Workshop held at Jackson in 1982, the Salt Creek project was initially a 3,000 ft demonstration project at upper Allred Flat featuring several types of fish habitat improvement structures. After the workshop, habitat improvement work was continued downstream through the remainder of Allred Flat to stabilize the stream and riparian area.

THE FISHERY: BRC, listed as a sensitive species in Wyoming, are the only trout in Salt Creek, which parallels Hwy 89, a heavily traveled access route for Yellowstone and Grand Teton National Parks. A popular USFS campground and picnic area is located at upper Allred Flat. Both factors act to increase fishing pressure on Salt Creek. In 1982, the fishery was protected by special regulations (artificial lures only, BRC 10 inches or less must be released).

HABITAT MANAGEMENT: Prior to the project, the Salt Creek channel was wide and very unstable, with many cut banks, nickpoints, and downcutting. Causes included past grazing practices, past highway construction on the west side of the valley, and loss of beaver in the project area. Sheep moved through lower Allred Flat enroute to summer range at higher elevations and there was some grazing along the east side of the valley. Due to the risk of mortality from the high traffic volume, ranchers preferred to keep livestock away from the highway. In 1990, USFS enclosed 125 acres of the flat with a “lay-down” fence that was erected during summer to protect the riparian area. Structures installed by a WGF construction crew included: 7 wood deflectors, 2 upstream “V” log plunges, 2 rock plunges, 1 rock deflector, 1 log plunge, 1 timber plunge, 1 gabion plunge, and 9,460 ft of tree/rock revetments. Rocks and pine trees were hauled by WGF from sources near the salt spring. Project cost over 10 years, including maintenance in 1990, was $98,900 ($39,560/mile).

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - An electrofishing station at lower Allred Flat was used as a control site until habitat structures were built there in 1986. A second station in the workshop demonstration area served as the treated site. Abundance of all BRC increased 64% posttreatment, while biomass was 47% higher (Table 52-1). BRC 6 inches, or longer, were 62% more abundance after habitat work and their biomass increased 105%. The population displayed much variation in numbers, both by site and year-to-year (Figures 52-1 and 52-2), but a non-parametric rank sum test indicated significant difference between treated and untreated fish population abundance and biomass.

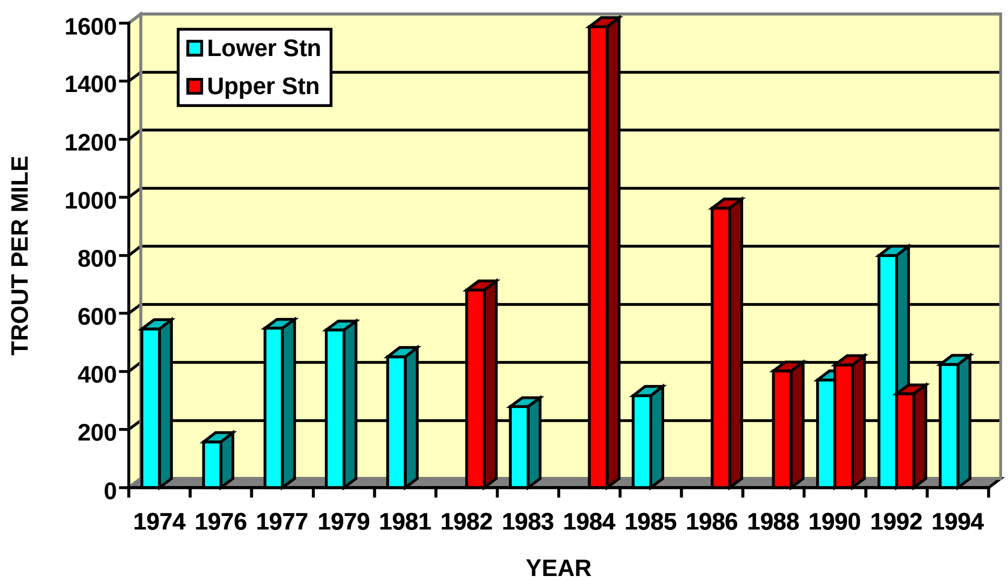


Figure 52-1. Bear River cutthroat trout abundance in Salt Creek (Allred Flat) 1974-1994. Habitat improvement devices were not installed at the lower (control) station until 1986, but the upper station was affected by structures from 1982 on. Severe drought affected the Salt Creek fishery from 1988-1994.

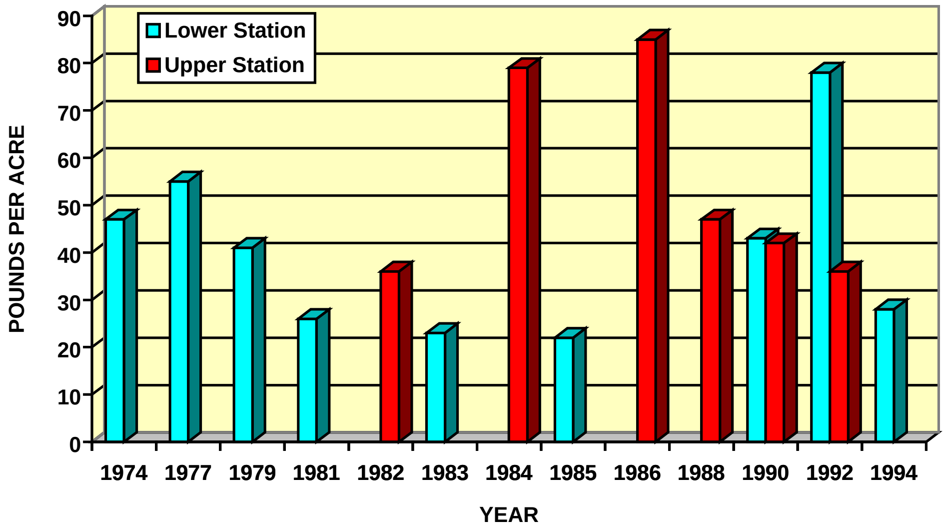


Figure 52-2. Bear River cutthroat trout biomass in Salt Creek (Allred Flat) 1974-1994. Habitat improvement devices were not installed at the lower (control) station until 1986, but the upper station was affected by structures from 1982 on. Severe drought affected the Salt Creek fishery from 1988-1994.

<u>Trout Habitat Response</u> - Installation of the tree/rock revetments stabilized stream banks and added large amounts of LWD to the stream channel (Figure 52-3). Deep pools developed in association with the revetments, while spaces under the trees provided overhead cover for trout. Deep pools also developed at many of the plunges (Figure 52-4). All of which led to a 107% increase in shelter for trout and a 148% increase in HU 14 years after treatment (Figures 52-5 and 52-6). Plunge pool cover at the log plunge was 210 sqft in 1995, compared with 84 sqft at the upstream "V" log plunge, and 300 sqft at the gabion plunge.

Figure 52-3. Tree and rock revetments stabilized corner pools and added woody debris to the stream. Many trout were attracted to deep pools containing overhead cover furnished by the woody debris.

Figure 52-4. A deep plunge pool developed at this upstream "V" log plunge, furnishing valuable deep water cover for trout.

Habitat Structures - Post-treatment, the habitat structures promoted stability in the stream channel and its habitat. Structure durability and performance was generally good. A final maintenance was performed in 1990 when 1,200 ft of tree/rock revetment was repaired, mainly by adding more rocks behind the trees. In the early 1990's, considerable beaver activity occurred throughout the project area. Beaver built dams on several of the structures and the ponds aided both the fish population and the riparian vegetation during a period of drought. The riverine system appeared very stable by 1996.

In 1997, an exceptional flood washed out all beaver dams. Very deep pools (RPD over 3 ft) had been created at the log plunge, the uppermost upstream "V" plunge, and the gabion plunge. These devices were in good condition, except for some leakage at the upstream "V" plunge. Other than occasional eroded spots behind the tree revetments, and a few logs washed crosswise to the current, the tree/rock revetments showed little flood damage. An oxbow cut-through occurred upstream from a beaver dam, but at another site, a narrow isthmus (6 ft wide in 1982) had increased to 35 ft wide in 1997 due to sediment deposition and vegetation development along the tree/rock revetment. The rocks and trees had prevented this potential oxbow cut-through.

Although a deep pool developed at the lower upstream "V" log plunge soon after construction, the stream later adjusted its channel, forming a deep corner pool about 50 ft upstream, and filling in around the man made structure. Only poor pools were present in 1997 at this plunge and at two timber plunges installed in mid-project. But these devices were still acting as grade controls to prevent headcutting. Plunges built of boulders fell apart within two years and the rocks either formed loose boulder clusters providing pocket pools, or were buried by the stream.

An attempt to change the stream back into an old channel by blocking an oxbow cut-through did not work. By 1997, all stream flow was through the channel-block into the cut-through.

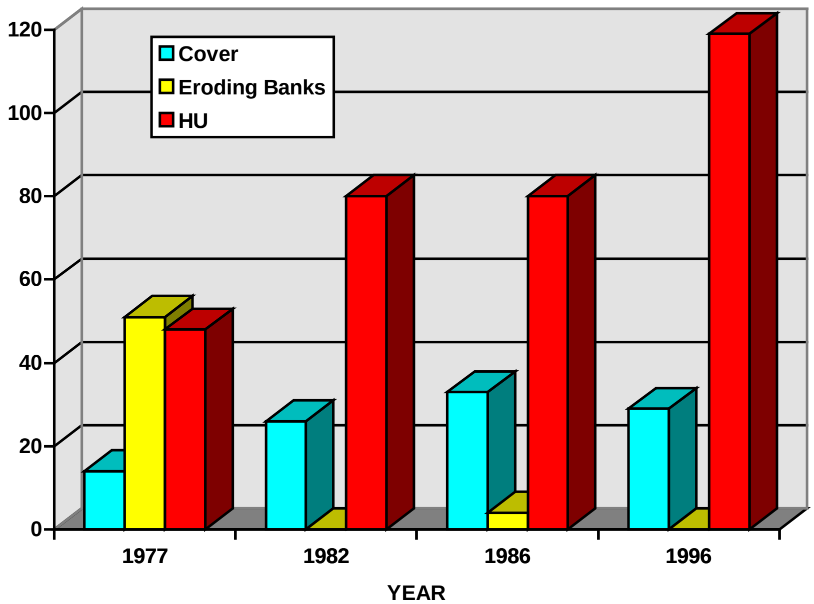


Figure 52-5. Changes in percent trout cover, percent eroding banks, and number of HU in Salt Creek before (1977) and after (1982-1996) habitat improvement.

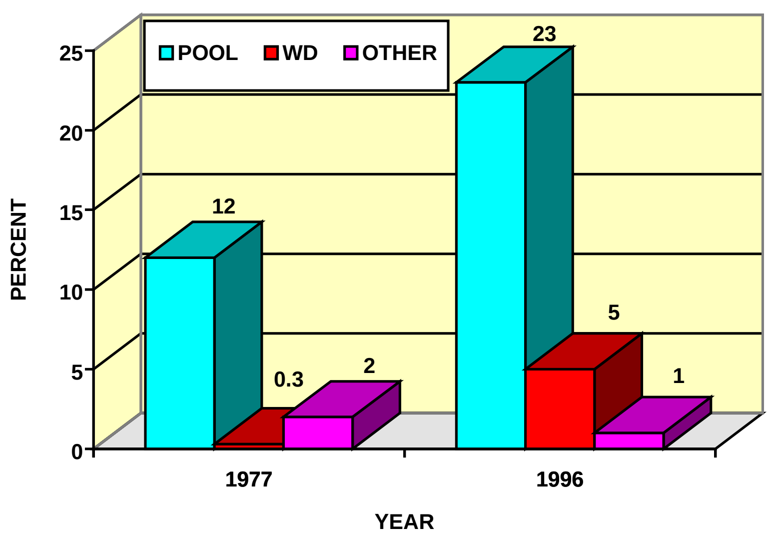


Figure 52-6. Composition of trout cover at Salt Creek (Allred Flat) pretreatment (1977) and in 1996, 14 years after habitat improvement. "Pools" includes lateral scour pools, trench

pools, and pocket pools, “WD” is woody debris, “other” includes undercut banks and vegetation.

<u>Conclusions</u> - Habitat improvement devices reversed ongoing fish habitat deterioration by stopping headcuts, stabilizing eroding banks, and providing more shelter for trout. In the habitat improvement section, BRC abundance increased 64% and was statistically better than in the untreated site. Stability of the riverine and riparian ecosystem was aided by the habitat improvement devices, which encouraged dam building by beavers post-treatment. Although the beaver dams washed away in the 1997 flood, their loss should be only temporary. Durability and performance of the habitat improvement devices had generally been good by 1997.

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Lageson, D. R. And D. R. Spearing. 1988. Roadside Geology of Wyoming. Mountain Press Publishing Company, Missoula, Montana.

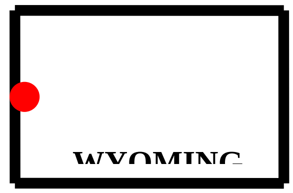
Table 52-1. Abundance and biomass of Bear River cutthroat trout at Allred Flat on Salt Creek from 1974-1994. Catchable trout are 6 inches, or longer, total length.

	All trout		Catchable trout	
Year	**Number/mile**	**Pounds/acre**	**Number/mile**	**Pounds/acre**
<u>Untreated</u>				
1974	547	47		
1976	158			
1977	549	54		
1979	543	41	195	28
1981	451	26	195	21
1983	279	23	117	11
1985	317	22	240	21
<u>Treated</u>				
1982	681	36	340	31
1984	1,588	79	416	56
1986	963	85	288	59
1988	402	47	391	46
1990	371	43	318	43
	423	42	247	34
1992	800	78	422	54
	323	36	171	27
1994	424	28	127	21
Untreated mean	**406**	**36**	**187**	**20**
Treated mean	**664**	**53**	**302**	**41**
Percent change	**64**	**47**	**62**	**105**

SALT CREEK - State Land

Lincoln County

PROJECT BUILT: 1982-1990



Drainage:	Thomas Fork Bear River	**Bear River Basin (3BE)**
Elevation:	6,410 ft	**R.** 119 **W., T.** 28 **N., S.** 16; NW 1/4
Stream Order:	Third	**Stream Class:** 3 (regionally important fishery)
Watershed Area:	38 sqmi	**Mean Wetted Width:** 13 ft
Gradient:	0.45 %	**Land Status:** State School Section
Rosgen Channel Type:	C-4	**Project Length:** 1/2 mile
Treatment Used:	Rock/tree revetments, deflectors, log plunge, upstream “V” plunge, rock grade control, cover trees	
Trout Species:	Wild Bear River cutthroat trout	

DESCRIPTION OF STREAM: Salt Creek extends about 10 miles upstream from the project area, draining a section of the Gannett Hills south of Afton. This area is part of the Overthrust Belt and contains easily eroded shale, siltstone, and limestone formations. Rounded, steep hills covered with a sagebrush, grass, and forb community, and scattered patches of conifer or aspen, characterize the watershed. At Salt Creek on the state land, the treeless riparian area features a few willow patches and a grass-sedge-rush-forb community. Salt Creek is a perennial stream in the project area, but after the snowmelt flood, stream flow drops quickly to a low level in late summer. ADF is 20 cfs, the ASFV ratio is 61 and CPSF is 33% ADF. Stream substrate is predominately gravel, sand, and silt. Beaver activity is common in the upper drainage, but not in the project area.

PROJECT DESCRIPTION: Objective of this project was to improve and stabilize fish habitat in lower Salt Creek on public land. Fish habitat improvement was done from Dipper Creek upstream to the fence marking private land. Work was done sporadically as time permitted when the construction crew was working at Allred Flat. Thus in some years, little was accomplished on the state land project, especially since trees and rocks had to be hauled from on-forest sources. But by 1985, all plunges were in place and enough tree/rock revetments were finished to affect the fish population at the electrofishing station. In 1990, all structures done in previous years were repaired and the remaining tree/rock revetments were finished.

THE FISHERY: BRC, listed as a sensitive species in Wyoming, are the only trout in Salt Creek, which parallels Hwy 89, a heavily traveled access route for Yellowstone and Grand Teton National Parks. Fishing pressure is believed to be less than on-forest as the stream on the state land section is visually less appealing to anglers and few have been seen fishing there. In 1982, the fishery was protected by special regulations (artificial lures only, BRC 10 inches or less must be released).

HABITAT MANAGEMENT: Prior to the project, the Salt Creek channel featured severe streambank erosion (81% eroding banks) and cover for trout was sparse (9%). Causes of channel instability included past grazing practices, herbicide use, and highway construction, which constricted the floodplain and realigned the stream channel. Due to the risk of mortality from the high traffic volume, ranchers preferred to keep livestock away from the highway, so there was very little grazing during the project period. However, periodic herbicide application may have occurred from county weed and pest operations. Structures installed by the WGF Construction Crew included 1,330 ft of tree/rock revetments and one of each device: wood deflector, upstream "V" log plunge, rock grade control, and log plunge (Figures 53-1 and 53-2) Project cost over 8 years was $15,500 ($31,000/mile), which includes maintenance.

Figure 53-1. A log plunge installed in Salt Creek provided both grade control and shelter for trout. But by 1997, the plunge pool had migrated downstream to form a deep corner pool along the face of the tree/rock revetment (top of picture, right).

Figure 53-2. An upstream "V" log plunge (log vortex weir) produced a deep plunge pool that provided excellent shelter for trout in Salt Creek.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Posttreatment trout abundance was 47% higher than pretreatment, while biomass increased 85%. Catchable trout (6 inches, or greater, total length) abundance and biomass doubled posttreatment (Table 53-1). There was much yearly variation in the BRC population (Figures 53-3 and 53-4), but a non-parametric rank sum test indicated significant difference between treated (after 1984) and untreated (before 1984) trout abundance and biomass.

Trout Habitat Response - Installation of the tree/rock revetments stabilized stream banks, narrowed the stream channel, and added large amounts of LWD to the stream (Figure 53-5). Deep pools (RPD, 2 ft, or greater) developed near the revetments, while spaces under the trees provided overhead shelter for trout. By 1991, HU had increased 50%, cover was up 33%, and eroding banks had become stable (Figure 53-6).

Habitat Structures - Several of the revetments required additional rock be added behind the trees during the project. Also, the upstream “V” plunge required periodic maintenance to repair leakage. Following an above average snowmelt flood in 1997, the project was inspected. Banks behind many of the revetments were stable and the revetments had trapped considerable sediment. In some cases, gravel and silt have buried portions of the trees. New willow growth was noted on point bars. And sediment deposits and vegetation growth have built out the bank to narrow the channel and bury all but the tip of the wood deflector. Although the log plunge produced a good plunge pool that endured for several years, by 1997, the pool had moved downstream 30 ft to form a corner pool and the log plunge was incorporated into a riffle/run. It was still acting as a grade control. In 1997, RPD was 3 ft, or deeper, at the upstream “V” plunge, which appear to be in good condition.

Conclusions - Habitat improvement devices reversed ongoing fish habitat deterioration by stabilizing eroding banks and providing 33% more shelter for trout. Post-treatment, BRC abundance was 47% better in the habitat improvement section, a statistically significant increase. Durability and performance of the habitat improvement devices was satisfactory once a determined effort was made to complete the project in 1990.

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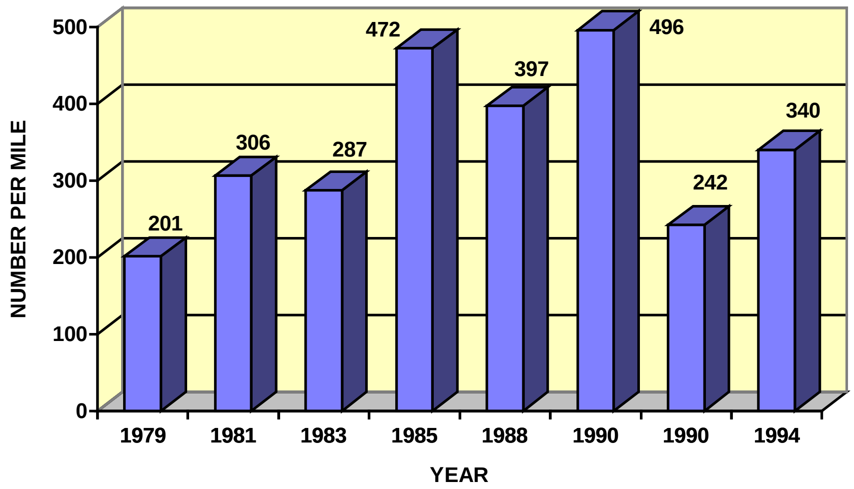


Figure 53-3. Bear River cutthroat trout abundance in Salt Creek (State Land) 1979-1994. Habitat improvement was completed in 1985 at the fish sampling station. Drought affected the Salt Creek fishery from 1988-1994.

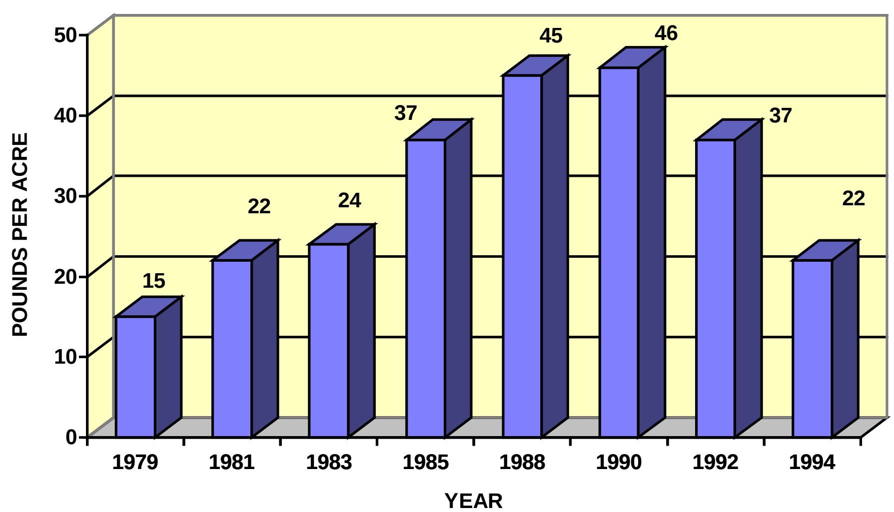


Figure 53-4. Bear River cutthroat trout biomass in Salt Creek (State Land) 1979-1994. Habitat improvement was completed in 1985 at the fish sampling station. Drought affected the Salt Creek fishery from 1988-1994.

Figure 53-5. Tree and rock revetments stabilized eroding banks, provided deep pool habitat, and many of the logs furnished overhanging bank shelter for trout.

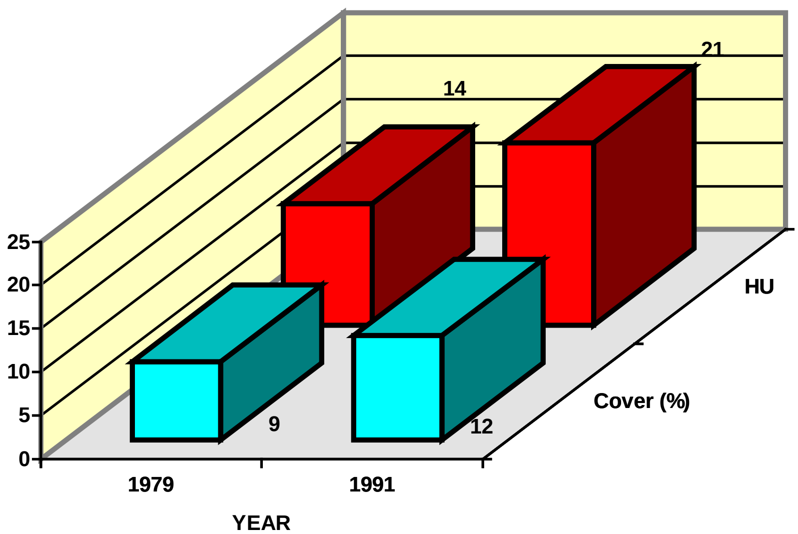


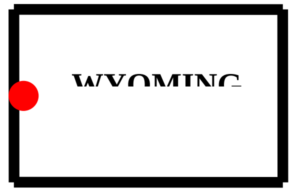
Figure 53-6. Cover and HU at Salt Creek on state land before (1979) and after (1991) habitat improvement.

Table 53-1. Abundance and biomass of BRC before and after habitat improvement at Salt Creek on state land. Catchable trout are 6 inches, or longer, total length.

Year	All trout		Catchable trout	
	Number/mile	Pounds/acre	Number/mile	Pounds/acre
Pretreatment				
1979	201	15	107	12
1981	306	22	127	14
1983	287	24	111	17
Posttreatment				
1985	472	37	278	32
1988	397	44	286	40
1990	496	46	372	42
1992	242	37	185	31
1994	340	22	113	16
Pretreatment mean	265	20	115	14
Posttreatment mean	389	37	247	32
Percent change	47	85	115	129

SALT RIVER

LINCOLN COUNTY



PROJECT BUILT ***Phase I:*** **1972-1977**

Phase II: **1978-1984**

Drainage:	Snake River (Palisades Reservoir)	**Lower Salt River Basin (4LS)**	
Elevation:	5,675 - 5,900 ft	**R.** 119**W., T.** 34-36 **N., S.** various	
Stream Order:	Sixth	**Stream Class:** 2 (statewide importance)	
Watershed Area:	830 sqmi	**Mean Wetted Width:** 70 ft	
Gradient:	0.2%	**Land Status:** Private	
Rosgen Channel Type:	C-4	**Project Length:** 28 miles of river	
Treatment Used:	Tree revetments, rock deflectors, fence off riparian area to prevent livestock use.		
Trout Species:	Brown, rainbow, and Snake River cutthroat trout		

DESCRIPTION OF STREAM: Heading in the Bridger-Teton (Wyoming) and Caribou (Idaho) national forests, the Salt River drains parts of the Salt River Range, Tygee Ridge, and the Gannett Hills before flowing northerly through Star Valley, a 50 mile long valley situated just east of the Wyoming-Idaho state line. Star Valley consists of the "upper valley" near Afton, and the "lower valley" near Thayne and Etna, the two sections being separated by the "narrows". Agriculture is the predominate land use. Predominant riparian vegetation is willows, cottonwood trees, grass, and forbs. Stream flow is fed by an abundant snow pack and many springs, especially in the upper valley. Although the snowmelt runoff produces an annual flood in May and June, stream flow is very constant throughout the year, as indicated by a low coefficient of variation (0.18) and an ASFV ratio of 9. ADF is 770 cfs, CPSF is 90% ADF, and the peak flow of record was 5,930 cfs in June, 1986. In Star Valley, the Salt River meanders extensively on a wide valley floor.

PROJECT DESCRIPTION: During 1972, WGF initiated a project to stabilize eroding stream banks, protect the riparian area with fences, and remove old car bodies from the stream channel. Primary thrust of the work was on WGF public fishing areas in the lower valley, but some landowners also participated on a cost share basis (50% match). Since this effort scarcely addressed the overall problem of habitat degradation in the lower valley, a second effort was initiated by the Soil Conservation Service (SCS) who developed a Resource Conservation and Development (RC & D) Critical Area Treatment Plan for the lower valley, with the Star Valley Conservation District and WGF acting as sponsors. Funding was 75% federal RC & D and 25% WGF. Landowners had to provide access for construction and agree to maintain the revetments.

THE FISHERY: SRC were the native trout in the drainage, but both RBT and BNT have been introduced. In 1971, the trout population was 49% stocked SRC, 18% wild SRC, and 32% wild brown trout. Estimated abundance was 595 trout/mile. In 1996, only 5% stocked trout were reported present in the fishery and abundance was 1,598 trout/mile. Since a main highway to the Teton-Yellowstone National Park complex parallels the stream, the Salt River has been popular with anglers for many years, many of whom were non-resident. But since most stream banks are privately owned, public access has been limited to WGF public fishing areas and float fishing from boats. At the time of the project, angling was under statewide fishing regulations, but in later years, special regulations (11 - 18 inch slot limit, 4 trout limit, only 1 fish over 18 inches) were imposed on a section near Thayne.

HABITAT MANAGEMENT: In 1970, an evaluation of aerial photos taken in 1939 and 1964 established that severe fish habitat degradation had occurred due to agricultural activities along the river. Willows had been removed from 19 miles of river by bulldozer, herbicides, and livestock grazing, and the river channel was 10% wider. After above average snowmelt runoffs during 1971 and 1972 flooded many farm lands in the lower valley, many stream sections suffered channel alteration under the guise of flood control. Fourteen miles of natural channel were altered and 17% of these changes were severe enough to be permanent. And thanks to the long history of abuse, the lower valley river channel was no longer stable. Much sediment was moving through the system due to accelerated lateral erosion by a river seeking to restore its meander pattern. Alternative reaches were aggrading and degrading, large gravel and cobble point bars had developed, and most concave banks had suffered serious erosion and undercutting. All of which had degraded fish habitat.

To address angler concerns about fishery deterioration due to habitat degradation, WGF instigated the Phase I project, which treated 4,500 ft of bank at various sites. Phase I cost to WGF was $6,690 ($7,850/mile of treated bank). However, this "bandaid" approach was deemed unsuitable when channel changes at adjacent, untreated river sections began to threaten the stability of treated sites. Needed was treatment of whole sections rather than random sites.

Therefore, WGF hired Dr. Morris Skinner, Colorado State University, to assess fluvial geomorphology of the river and recommend a plan of treatment based on sound river mechanics. His plan became the RC & D project. Primary emphasis was on bank stabilization with tree revetments, aided by rock deflectors in key spots, and fencing of the riparian zone, when allowed by the landowner (Figures 54-1 and 54-2). Barrier trees were placed to block cattle access to stream banks when fencing was not allowed. SCS and WGF worked together to initiate the plan, while actual construction was done by private contractors, who were selected by sealed bid. Phase II cost was $175,105 ($6,254/mile) for treatment of 33,868 ft of bank over 28 miles of river. Total cost to treat the 28 mile river section during both Phase I and II was $181,800 ($6,493/mile).

Additional "bandaid" treatment was made downstream from Grover Lane during the early 1990s using $40,000 from Environmental Protection Agency 319 funds. Mixed results were reported as to structure effectiveness, and further work was effectively killed when SCS closed their Afton office and Trout Unlimited became disenchanted with progress of the project.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Three years after a river section was treated in 1978, catchable trout (6 inches, or longer, total length) had increased 66% (Figure 54-3). No fish samples were possible during the mid-1980s due to a series of wet years and exceptionally high river flows. After a record flood in 1986 severely damaged several tree revetments and degraded shelter available to trout, the fishery declined and the decline was aggravated by a severe drought from 1987 to 1992, plus pollution from a cheese factory at Thayne. However, samples taken during a comprehensive study of the fishery, which began in 1995, indicated increased trout abundance by 1996.

Figure 54-1. Tree revetments were installed in the Salt River to protect eroding banks.

Figure 54-2. Due to the large volume of water and a degraded channel, spring snowmelt floods often flooded river bottom areas and threatened to cut through oxbows. Here a tree revetment is protecting a bank by reducing pressure on the bank from over bank flood flows.

Stock density in 1981 was compared by habitat type using analysis of variance. Good natural habitat contained 204% more trout than did poor habitat, while tree revetment habitat had 259% more trout than were found in the poor section. And the revetments held 18% more trout than the good habitat. These differences were statistically significant.

Trout Habitat Response - Size of the river and swift flows made difficult any evaluation of actual fish habitat changes in the time available, thus no formal evaluation was done.

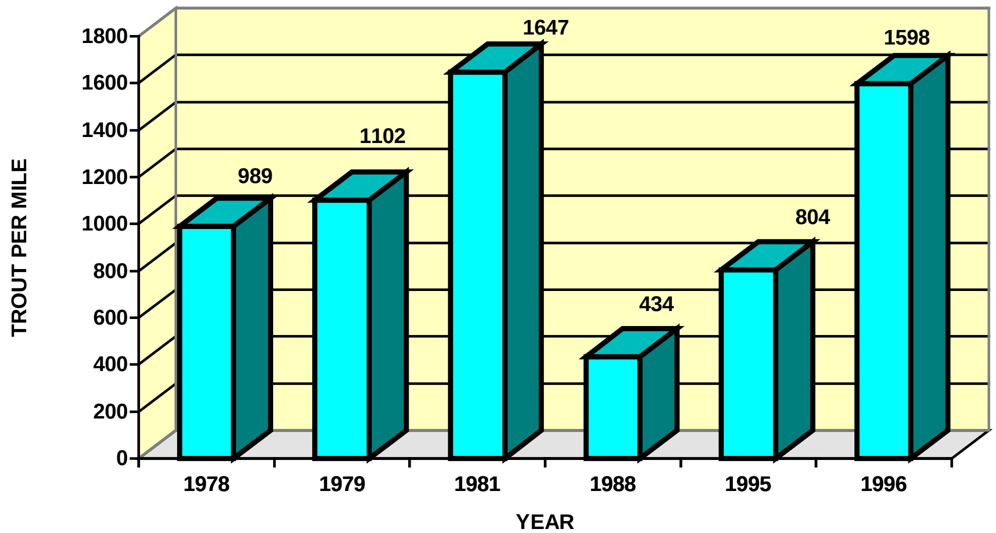


Figure 54-3. Catchable trout abundance in the Salt River downstream from Thayne Bridge before (1978) and after (1981-1996) habitat improvement.

Habitat Structures - Estimated life of the tree revetments was 10 years when the Phase II project was initiated. Prior to the exceptional flood in 1986, 40% of the tree revetments were still intact. After the flood, inspection found only 25% intact. But many of the surviving structures were reported functional in the 1990s (Figure 54-4).

Conclusions - Prior to the abnormal floods in 1983-1986, the tree revetments had effectively prevented lateral bank erosion and caused the channel to deepen next to the structures. Initially, the tree revetments provided both overhead cover and deeper water for trout, and catchable trout abundance and biomass had doubled three years after treatment. Later decreases in trout numbers can be tied to flood damage to the revetments, loss of shelter niches within the trees due to sediment deposition, and pollution from the cheese factory.

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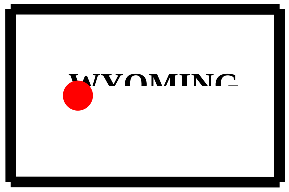
Figure 54-4. Several years after a tree revetment was installed, this formerly eroding bank is very stable. Note the dense growth of willows that has developed along the bank behind the trees.

SOUTH COTTONWOOD CREEK

SUBLETTE COUNTY

PROJECT BUILT: ***Stage I:*** **1984-1988**
Stage II: **1994**



Drainage	Cottonwood Creek	**Cottonwood Creek Basin (7CO)**	
Elevation:	8,240 ft	**Location: R**. 115 W., **T**. 32 N., **S.** 14, 15	
Stream Order:	Third	**Stream Class:** 3 (regionally important fishery)	
Watershed Area:	21 sqmi	**Mean Wetted Width:** 23 ft (August)	
Gradient:	0.8%	**Land Status:** Bridger-Teton National Forest	
Rosgen Channel Type:	C-4	**Project Length:** 1.5 mile	
Treatment Used:	Log plunges, rock deflectors and funnels, random fish rocks, rock/tree revetments, cover trees, diagonal rock weirs.		
Trout Species:	Colorado River cutthroat, Snake River cutthroat, and brook trout		

DESCRIPTION OF STREAM: Heading near Triple Peak in the Bridger-Teton National Forest, South Cottonwood Creek drains an easterly aspect of the Wyoming Range. Steep, rugged mountainous terrain marks the upper watershed, but in the project area, the stream has exited the mountains and flows in a wide valley between high ridges. An abundant snowpack maintains a cold stream-flow and late summer flow is not a problem. Peak flow of record was 466 cfs (June 1988), late summer base flow is 20-30 cfs, and minimum winter flow is about 10 cfs. ADF of record is 42 cfs, CPSF is 45% ADF, and ASFV ratio is 43, suggesting a fairly stable flow regime. There are no diversions or man-made impoundments upstream from the project, but beaver ponds are common several miles upstream. Instream substrate is 7% boulder, 36% cobble, 55% gravel, and 2% fines. Mean embeddedness on riffles is 30%. Maximum summer water temperature of record is 56^{o}F.

PROJECT DESCRIPTION: Located about 26 miles northwest of Big Piney, South Cottonwood Creek has historically supported a population of CRC, a sensitive species in Wyoming. Aquatic habitat in the stream was improved as a cooperative project between WGF and Bridger-Teton National Forest. USFS contributed funds and raw materials to the project, while WGF furnished funding, planning and construction expertise, manpower, materials, and equipment. Primary project goal was to help re-establish CRC by stabilizing the stream channel and increasing the carrying capacity of the stream.

THE FISHERY: Before treatment, a small population of wild BKT was present, and prior to 1982, about 10,000 SRC were planted annually. CRC were found in 1973 and 1976 samples, but not in 1981. Beginning in 1983, pure strain fingerling CRC were stocked when available in an effort to build the population up. As the stream has long been popular with anglers, special regulations protected CRC.

During the 1980s, creel restrictions were used, but in 1992, regulations specified release of all cutthroat trout.

HABITAT MANAGEMENT: Prior to treatment, South Cottonwood Creek in the project area was wide, shallow, and relatively straight, possibly due to tie drives years ago. Extensive point and lateral bar development, persistent bank erosion, and recent oxbow cutoffs indicated channel instability. Shelter for trout was sparse (5% of total area) and was mostly pocket pools, small undercut banks, and an occasional deep lateral scour pool.

As funds became available, instream structures designed to create deep pools and other shelter for trout were installed in two phases.

Phase I (downstream from the bridge on the Lander Creek road) - Instream structures were installed by a WGF construction crew in 4,425 ft of stream during 1984-88. They placed 7 log plunges, 1 rock plunge, 3 rock deflectors, 3 log deflectors, 2 rock funnels, 42 fish rocks, 75 ft of tree blocks (to block cattle from bank edges), and 2,389 ft of tree/rock revetment. No work was done in 1987 so the stream could adjust to these structures. Cost was $38,100 ($45,474/mile) for labor, materials, and equipment time.

Phase II (upstream from the bridge on the Lander Creek road) - During 1994, instream structures were installed by a WGF construction crew in 4,200 ft of stream. They built 5 diagonal boulder weirs, 2 log plunges, 80 ft of rock riprap, and 1,280 ft of tree/rock revetment. Cost was $48,570 ($61,060/mile).

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - In the *Phase I* project, the fish population was monitored with electrofishing gear at Stn TRT, where structures were installed in 1984-85, and at a reference site located upstream from the treated area (Stn UT). Stn UT was abandoned after habitat structures were installed there in 1994. Stn TRT-2 was activated in 1993 for evaluation of *Phase II.* Periodic stocking of cutthroat trout, unknown angler harvest, and an extended drought in 1987-1993 complicated evaluation of the habitat management. Angler comments were favorable about the habitat improvements, despite the bushy cover trees at the plunges.

Phase I Project

Trout in South Cottonwood Creek responded favorably to the habitat improvement. Mean trout abundance and biomass doubled posttreatment (Figures 55-1 and 55-2, Table 55-1). Catchable trout (6 inches, or greater, total length) abundance increased 76% and biomass 108% posttreatment. By 1993, numbers of catchable trout had tripled compared to 1984, but their biomass was 24% less. Despite drought, the treated stream reach had 156% more catchable trout then than did the untreated section.

Nine years after treatment, CRC biomass was six times greater and abundance was 148% higher (Tables 55-2 and 55-3). In 1993, the treated area had 57% more CRC than did Stn UT, and biomass was up 230%. Wild BKT clearly benefited from habitat management. Prior to treatment, they were 54% more abundant (biomass 76% greater) in Stn UT than at Stn TRT. But by 1993, Stn TRT contained 157% more BKT and three times as much biomass as Stn UT. Compared to the 1984 levels, BKT abundance and biomass were six fold greater at Stn TRT by 1993.

However, after an above average snowmelt flood in 1996, the population dropped sharply. This flood may have pushed trout downstream into a large beaver pond just below the study station and thus reduced trout numbers in the sample station. Fewer CRC and BKT were collected than in 1993. A few large SRC were collected for the first time in several years - they may have been flushed from upstream beaver ponds breached by the flood.

Phase II Project

At Stn TRT-2, trout abundance increased 55% from 1993 to 1996, but most of these fish were BKT under 6 inches (Tables 55-4 and 55-5). CRC abundance decreased 24%, but as at Stn TRT, the 1996 flood may have adversely affected population numbers within the study site. No catchable CRC were captured in 1996. Since only two years had elapsed since construction, the trout population was likely still adjusting to the new habitat and any conclusions about population response may be premature.

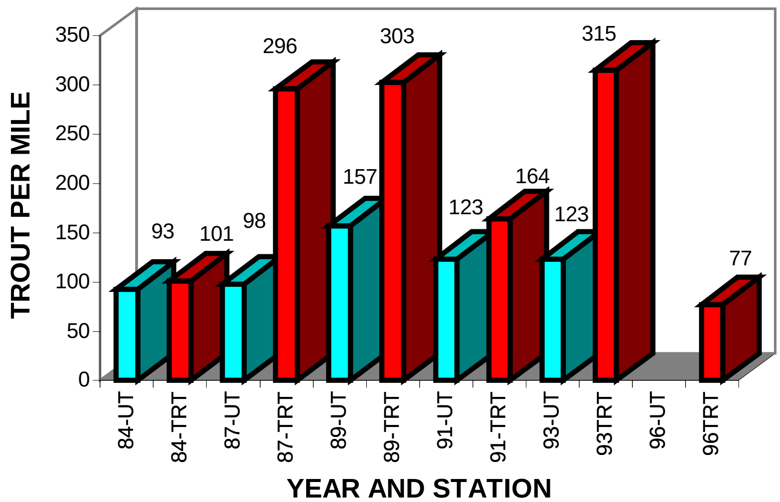


Figure 55-1. Catchable trout (6 inches, or longer, total length) abundance at South Cottonwood Creek 1984-1996 at the reference station (UT) and treated station (TRT).

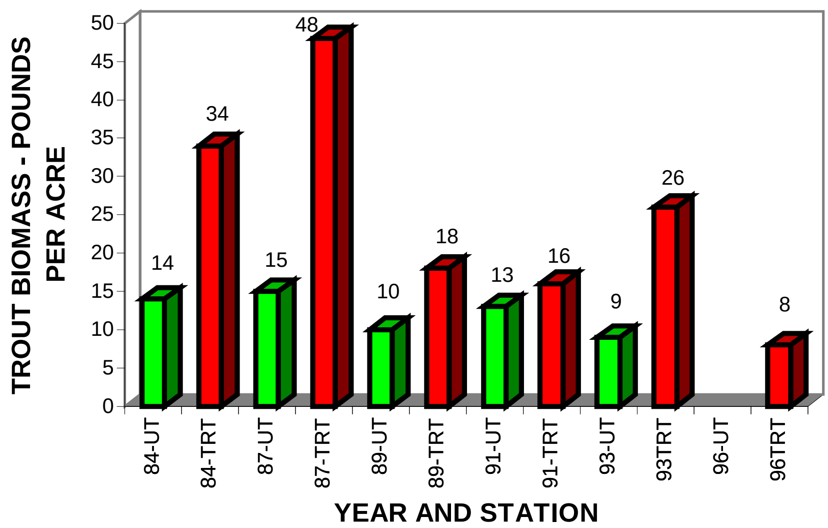
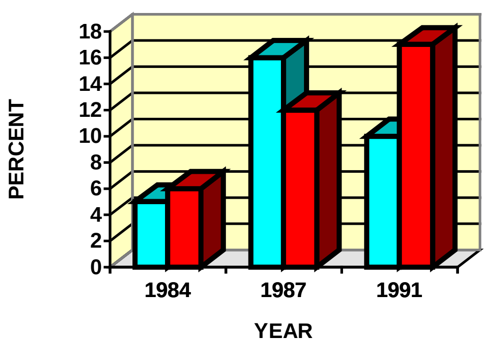


Figure 55-2. Catchable trout (6 inches, or longer, total length) biomass at South Cottonwood Creek 1984-1996 at the reference station (UT) and treated station (TREATMENT).

<u>Trout Habitat Response</u> - In the *Phase I* project, mean posttreatment cover was 160% better than pretreatment (Figure 55-3). Deep pool cover increased most. Habitat quality increased from 58 HU to 106 HU, an 83% improvement. Hogle (1993) also reported 106 HU, indicating the improved habitat was persisting. Eroding banks were not treated aggressively during *Phase I* and by 1987, bank erosion had doubled to 12% at the HQI station.

In the *Phase II* project, mean posttreatment cover was up 167% after two years. Lateral scour pools comprised 85% of the cover in 1992, but in 1996, lateral scour pools, trench pools, and large woody debris were the main cover components (Figure 55-4). After two years, HU had increased 26% and eroding banks had decreased 80%.



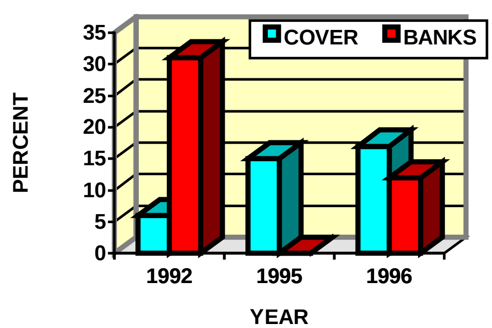


Figure 55-3. Cover and eroding stream banks before (1984 left, 1992 right) and after habitat improvement at South Cottonwood Creek (*Phase I* project, left) and (*Phase II* project, right).

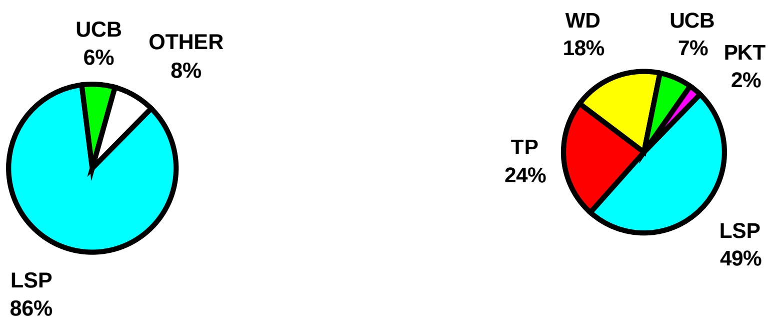


Figure 55-4. Cover types at *Phase II* project before (1992, left) and after (1996, right) habitat improvement at South Cottonwood Creek. Other cover types include runs, backwater pools, pocket pools (PKT), and woody debris (WD). UCB is undercut banks, LSP is lateral scour pool, and TP is trench pool.

Habitat Structures - For the entire *Phase II* project, mean pretreatment RPD for all pools with RPD 1 ft, or deeper, was 1.6 ft, but three years after treatment, it had increased to 1.9 ft. At one pool modified by a diagonal weir (Figure 55-5), RPD increased from 1.15 ft to 2.0 ft (up 73%), while RPD remained constant (1.74 ft) at a natural, untreated LSP. Mean RPD for all log plunges in both *Phase I and II* was 2.05 ft in 1997.

In the *Phase I* project, 71% of the log plunges were rated as being in good condition in 1997 and both log plunges in the *Phase II* project were in good condition (Figure 55-6). In the 1980s, beaver built a large dam on a log plunge within the *Phase I* project, rendering the plunge inoperable, but providing a deep beaver pond. Neither plunge nor dam was functional in 1997 after the snowmelt flood breached the dam and washed a new channel around one side.

Conclusions - Installation of habitat improvement devices at South Cottonwood Creek provided additional deep pool habitat, increased cover for trout 164%, and reduced bank erosion. After the *Phase* I project, mean trout abundance and biomass doubled posttreatment. Nine years after treatment, CRC biomass was six times greater and abundance was up 148%. Compared to the 1984 levels, BKT abundance and biomass were six-fold greater by 1993.

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Hogle, J. S. 1993. Salmonid habitat and population characteristics related to structural improvement in Wyoming streams. Master's thesis. University of Wyoming, Laramie.

Table 55-1. Summary of trout abundance and biomass in South Cottonwood Creek at the untreated and treated sections. Catchable trout are 6 inches, or longer, total length.

	All trout		Catchable trout	
Year	Number/mile	Pounds/acre	Number/mile	Pounds/acre
Phase I				
Untreated				
1984	177	14	93	14
1987	98	15	98	15
1989	185	10	157	10
1991	169	14	123	13
1993	359	12	123	9
Treated				
1984	243	36	101	34
1987	328	48	296	47
1989	348	19	303	18
1991	318	19	164	16
Untreated mean	198	13	119	12
Treated mean	420	28	209	25
Percent change	112	111	76	108
Phase II				
Pretreatment				
1993	348	12	112	9
Posttreatment				
1996	538	12	104	7
Percent change	55	0	-7	-22

Table 55-2. *Phase I* project abundance of CRC, SRC, and BKT in the treated (TRT) and reference (UT) sections at South Cottonwood Creek before (1984) and after (1987-1996) habitat improvement. Stn TRT was downstream from the Lander Creek Road bridge and Stn UT was upstream from that bridge.

		Trout/mile							
Year	**Area**	**CRC Total**	**CRC ≥ 6 in**	**SRC Total**	**SRC ≥ 6 in**	**BKT Total**	**BKT ≥ 6 in**	**All Trout Total**	**All Trout ≥ 6 in**
1984	UT	31	10	21	21	125	62	177	93
	TRT	101	20	61	61	81	20	243	101
1987	UT	28	28	0	0	70	70	98	98
	TRT	106	95	0	0	222	201	328	296
1989	UT	101	101	0	0	84	56	185	157
	TRT	282	248	0	0	66	55	348	303
1991	UT	28	14	14	14	127	95	169	123
	TRT	169	79			149	85	318	164
1993	UT	160	23	11	11	188	89	359	123
	TRT	251	79	0	0	484	236	735	315
1996	TRT	49	0	12	12	486	65	547	77

Table 55-3. *Phase I* project biomass of CRC, SRC, and BKT before (1984) and after (1987-1996) habitat improvement at South Cottonwood Creek. Stn TRT was downstream from the Lander Creek road bridge and Stn UT was upstream from that bridge.

		Pounds/acre							
Year	**Area**	**CRC Total**	**CRC ≥ 6 in**	**SRC Total**	**SRC ≥ 6 in**	**BKT Total**	**BKT ≥ 6 in**	**All Trout Total**	**All Trout ≥ 6 in**
1984	UT	0.6	0.3	8.8	8.8	5.1	4.6	14.5	13.7
	TRT	1.9	0.5	31.4	31.4	2.9	2.6	36.2	34.5
1987	UT	8.6	8.6	0	0	6.3	6.3	14.9	14.9
	TRT	18.6	18.2	0	0	28.9	28.9	47.5	46.7
1989	UT	6.7	6.7	0	0	3.7	3.2	10.4	9.9
	TRT	14.9	13.9	0	0	4.4	4.2	19.3	18.1
1991	UT	0.9	0.7	5.9	5.9	6.7	6.0	13.5	12.6
	TRT	6.7	5.5	0	0	12.3	10.9	19.0	16.4
1993	UT	4.0	2.0	0.9	0.9	7.6	6.3	12.5	9.2
	TRT	13.2	11.0	0	0	18.8	15.0	32.0	26.0
1996	TRT	0.5	0	3.7	3.7	9.4	3.9	13.6	7.6

Table 55-4. *Phase II* project abundance of CRC, SRC, and BKT before (1993) and two years after (1996) treatment at South Cottonwood Creek. Stn TRT-2 was 600 ft upstream from the bridge on the Lander Creek road.

		Trout/mile							
Year	**Area**	**CRC Total**	**CRC ≥ 6 in**	**SRC Total**	**SRC ≥ 6 in**	**BKT Total**	**BKT ≥ 6 in**	**All Trout Total**	**All Trout ≥ 6 in**
1993	TRT2	160	23	0	0	188	89	348	112
1996	TRT2	122	0	10	10	406	94	538	104

Table 55-5. *Phase II* project biomass) of CRC, SRC, and BKT before (1993) and two years after (1996) treatment at South Cottonwood Creek. Stn TRT-2 was 600 ft upstream from the bridge on the Lander Creek road.

		Pounds/acre							
Year	**Area**	**CRC Total**	**CRC ≥ 6 in**	**SRC Total**	**SRC ≥ 6 in**	**BKT Total**	**BKT ≥ 6 in**	**All Trout Total**	**All Trout ≥ 6 in**
1993	TRT2	4.0	2.0	0.9	0.9	7.6	6.3	12.5	9.2
1996	TRT2	0.7	0	1.7	1.7	9.4	5.1	11.8	6.8

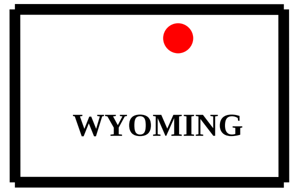
Figure 55-5. A diagonal rock weir was coupled with a tree/rock revetment to provide a deep pool having considerable woody debris shelter. Electrofishing always found many trout in this patch of cover. The weir extends from the large light colored rocks in the foreground across the stream into the point bar.

Figure 55-6. A log plunge constructed during Phase I provides both pool habitat and grade control to slow swift flows. Cover trees were installed on both sides of the plunge pool to furnish cover for trout and to make fishing the pool more challenging to anglers.

SOUTH TONGUE RIVER - Pine Island

SHERIDAN COUNTY

PROJECT BUILT: 1987



Drainage:	Tongue River	**Tongue River Basin (8TR)**	
Elevation:	7,645 ft	**R.** 55 **W., T.** 88 **N., S.** 5	
Stream Order:	Fourth	**Stream Class:** 2 (statewide importance)	
Watershed Area:	80 sqmi	**Mean Wetted Width:** 50 ft	
Gradient:	0.2%	**Land Status:** Bighorn National Forest	
Rosgen Channel Type:	C-3	**Project Length:** 2,100 ft	
Treatment Used:	Tree and rock revetments, rock riprap, rock deflectors, rock funnels, cover trees, fish rocks		
Trout Species:	Rainbow, brown, and brook trout		

DESCRIPTION OF STREAM: Heading in the Bighorn National Forest, South Tongue River drains a northeast aspect of the Bighorn Mountains. From the watershed crest, it flows northerly about 16 miles to join Tongue River in Box Canyon. Stream flow is fed by an abundant snowpack, which creates an annual snowmelt flood in May and June and maintains a clear, cold base flow. Peak summer water temperature is about 66°F. Late summer flow is not a problem, but flow becomes low during winter. Mean seven day low flow is 27 cfs (13% ADF) and occurs during middle to late winter. ADF is 204 cfs, CPSF is 57% of ADF, and the ASFV ratio is 116, suggesting a variable flow regime. Stream substrate is mainly rubble, cobble, and gravel. A coniferous forest covers much of the watershed, but grassy montane parks and alpine meadows are also prominent. In the project area, willows and various grasses are common along the stream banks, while a lodgepole pine forest covers the uplands away from the stream.

PROJECT DESCRIPTION: Habitat improvement in South Tongue River at the Pine Island picnic area was a cooperative venture between WGF and the Bighorn National Forest. USFS supplied partial funding, trees and rocks, and helped haul rocks. WGF furnished planning and construction expertise, labor, materials, and equipment. Project goals were to stabilize eroding stream banks, provide more shelter for trout, and increase stocks of wild trout.

THE FISHERY: Highway 14 parallels South Tongue River in the project area allowing easy angler access to the fishery. In addition, a popular campground, summer homes, a picnic area, and a resort (Arrowhead Lodge) are located near the river. Thus, the fishery has long been popular with the public and is heavily used during summer and fall. Catchable RBT were routinely stocked for many years to satisfy anglers, but wild RBT, BNT, and BKT were also present. Statewide fishing regulations applied. Surveys during the late 1980’s documented both a poor return to the creel of the hatchery catchables and the presence of many wild trout. So stocking was stopped in 1990 to see if wild fish could support the fishery.

HABITAT MANAGEMENT: Pretreatment, eroding stream banks and lack of cover for trout were important limiting factors for the fishery. Some of these problems may go back to past tie drives, highway construction, and heavy livestock grazing. In 1965, an effort was made to improve fish habitat as partial mitigation for degradation of the river by new highway construction. USFS placed boulders and rock structures in the river between Pine Island and the Prune Creek campground. Although most of these structures were located upstream from the present project, two boulder deflectors were still functional within the 1987 project area. In 1987, a WGF construction crew installed 760 ft of tree and rock revetments, 220 ft of rock riprap, 2 rock deflectors, 2 rock funnels, 3 cover trees, and 104 fish rocks. Rocks were also added to the two USFS boulder deflectors to make them more effective. These structures were placed in the half mile of river upstream from the highway bridge near the Pine Island picnic area. Total project cost was $14,600 ($36,700/mile).

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Posttreatment, mean trout abundance increased 106% over pretreatment levels and mean biomass was 147% higher (Figures 56-1 and 56-2). Catchable wild trout (6 inches, or greater, total length) abundance and biomass more than doubled (Table 56-1). Ten years after habitat improvement, wild trout biomass was 264%, and abundance 131%, higher than pretreatment. Catchable trout numbers and biomass had tripled by 1997.

Trout Habitat Response - No formal evaluation of trout habitat was done, but photos documented improved bank stability, narrowing of the river channel, and creation of more shelter for trout (Figure 56-3). Many fish were taken with electrofishing gear from pockets of cover located at the various structures (Figure 56-4).

Habitat Structures - Durability and performance of the various devices was good. All structures were in good condition a decade after installation.

Conclusions - Installation of habitat improvement structures provided more shelter for trout, improved bank stability, and increased the wild trout population. Ten years after habitat improvement, wild trout biomass was 264%, and abundance 131%, higher than pretreatment. Catchable trout numbers and biomass had tripled by 1997 when the fishery was totally supported by wild fish.

INFORMATION SOURCES

Rockett, L. C. 1979. Evaluation of boulder stream improvements in South Tongue River, Sheridan County. Administrative Report, Project No. 3079-08-6505, Fish Division, Wyoming Game and Fish Department, Cheyenne.

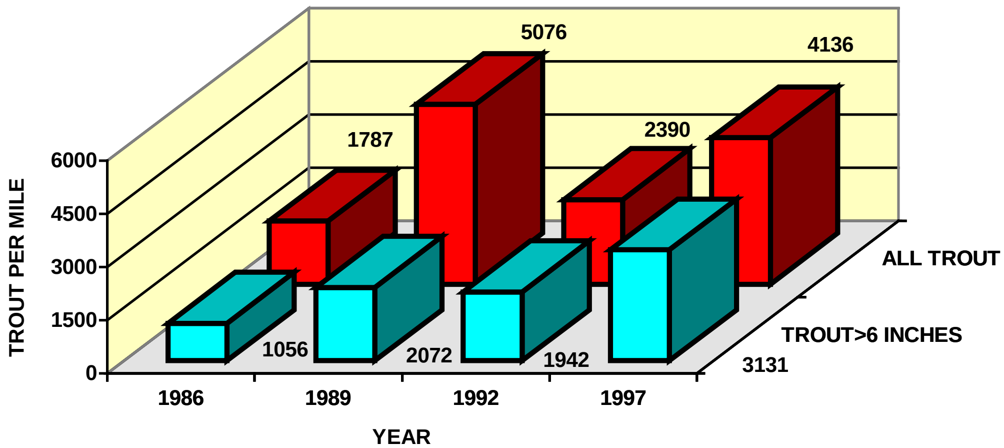


Figure 56-1. Abundance of trout at Pine Island on South Tongue River before (1986) and after habitat improvement in 1987

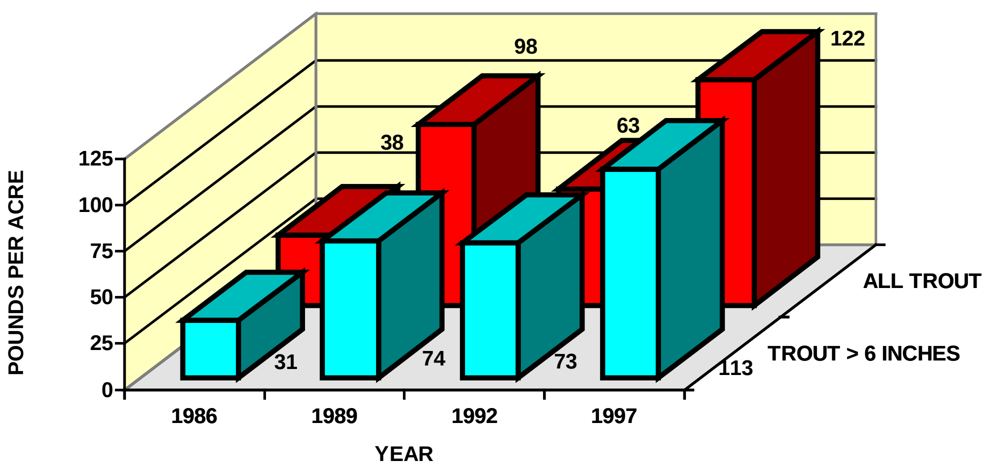


Figure 56-2. Biomass of trout at Pine Island on South Tongue River before (1986) and after habitat improvement in 1987.

Figure 56-3. A decade after an unstable bank in front of the cabin was treated with a tree/rock revetment, the river has adjusted to form a natural diagonal bar and a deep, trout-filled run along the revetment.

Figure 56-4. Pretreatment, this bank was being severely eroded by the river, but ten years after a tree/rock revetment was installed, the bank is completely healed. When this section is electrofished, many trout are found living in the deep pools and woody debris along the bank.

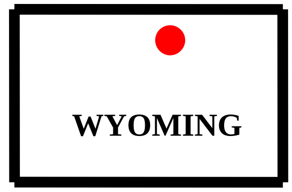
Table 56-1. Abundance and biomass of wild trout at the Pine Island project on South Tongue River before and after habitat improvement. Catchable trout are 6 inches, or greater, total length.

	All trout		Catchable trout	
Year	Number/mile	Pounds/acre	Number/mile	Pounds/acre
Pretreatment				
1986	1,787	38	1,056	31
Posttreatment				
1989	5,076	98	2,072	74
1992	2,390	63	1,942	73
1997	4,136	122	3,131	113
Posttreatment mean	3,867	94	2,382	87
Percent change	106	147	126	181

SOUTH TONGUE RIVER - Prune Creek

SHERIDAN COUNTY

PROJECT BUILT: 1994, 1995



Drainage:	Tongue River	**Tongue River Basin (8TR)**	
Elevation:	7,655 ft	**R.** 88 **W., T.** 55 **N., S.** 5	
Stream Order:	Fourth	**Stream Class:** 2 (statewide importance)	
Watershed Area:	80 sqmi	**Mean Wetted Width:** 46 ft	
Gradient:	0.2%	**Land Status:** Bighorn National Forest	
Rosgen Channel Type:	C-4	**Project Length:** 4,000 ft	
Treatment Used:	Tree and rock revetments, rock deflectors, diagonal sill, diagonal digger log, and fish rocks		
Trout Species:	Rainbow, brown, and brook trout		

DESCRIPTION OF STREAM: Heading in the Bighorn National Forest, South Tongue River drains a northeast aspect of the Bighorn Mountains. From the watershed crest, it flows northerly about 16 miles to join Tongue River in Box Canyon. Stream flow is fed by an abundant snowpack, which creates an annual snowmelt flood in May and June and maintains a clear, cold base flow. Peak summer water temperature is about 66°F. Late summer flow is not a problem, but flow becomes low during winter. Mean seven day low flow is 27 cfs (13% ADF) and occurs during middle to late winter. ADF is 204 cfs, CPSF is 57% of ADF, and the ASFV ratio is 116, suggesting a variable flow regime. Stream substrate is mainly rubble, cobble, and gravel. A coniferous forest covers much of the watershed, but grassy montane parks and alpine meadows are also prominent. In the project area, willows and various grasses are common along the stream banks, while a lodgepole pine forest covers the uplands away from the stream.

PROJECT DESCRIPTION: Habitat improvement in South Tongue River near the Prune Creek Campground area was a cooperative venture between WGF and the Bighorn National Forest. USFS supplied permits, partial funding, rocks, trees, and an EIA. WGF furnished planning and construction expertise, manpower, equipment, and funds. Project goals were to stabilize eroding stream banks, provide more shelter for trout, and increase stocks of wild trout.

THE FISHERY: Highway 14 parallels South Tongue River in the project area allowing easy angler access to the fishery. In addition, a popular campground, summer homes, a picnic area, , and a resort (Arrowhead Lodge) are located near the river. Thus, the fishery has long been popular with the public and is heavily used during summer and fall. Statewide fishing regulations apply. Catchable RBT were routinely stocked for many years to satisfy anglers, but a wild population of RBT, BNT, and BKT was also present. Surveys during the late 1980s documented both a poor return to the creel of the hatchery catchables and the presence of many wild trout. So stocking was stopped in 1990 to see if wild fish could support the fishery.

HABITAT MANAGEMENT: Pretreatment, eroding stream banks and lack of cover for trout were important limiting factors for the fishery. Some of these problems may go back to past tie drives, highway construction, and livestock grazing. In 1965, an effort was made to improve fish habitat as partial mitigation for degradation of the river by new highway construction. USFS placed fish rocks and boulder structures in the river between the Pine Island picnic area and the Prune Creek campground. Most were still functional in 1994. In 1994-1995, a WGF construction crew installed 2,200 ft of tree and rock revetments, 6 rock deflectors, a diagonal rock weir, a diagonal digger log, and 75 fish rocks. Total project cost was $43,050 ($56,830/mile). Installation of habitat improvement structures in the river near the campground continued efforts to improve fish habitat in the heavily fished stream reach near the highway.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Two years after habitat improvement, trout abundance was 29% higher than the pretreatment mean and mean biomass was up 50% (Figures 57-1 and 57-2). Catchable (6 inches, or longer, total length) wild trout were 56% more abundant and their biomass was up 54% (Table 57-1). Compared with the 1986 population, when trout were still being stocked, wild trout biomass in 1997 had tripled, and abundance had doubled.

Trout Habitat Response - No formal evaluation of trout habitat was done, but photos documented improved bank stability, narrowing of the river channel, and creation of more shelter for trout. Many fish were taken with electrofishing gear from pockets of cover located at the various structures.

Habitat Structures - Durability and performance of the various devices was generally good. Two years after installation, most structures were in good condition. But firewood scavengers at the campground damaged one revetment soon after installation and an exceptional snowmelt flood in 1997 caused minor damage to some revetments. Deep pools persisted at both the diagonal rock weir and the digger log (Figures 57-3 and 57-4). And both pools have proven popular with both trout and anglers.

Conclusions - Installation of habitat improvement structures provided more shelter for trout and improved bank stability. Two years after habitat improvement, wild trout abundance was 29% higher than the pretreatment mean and mean biomass was up 50%. Catchable trout were 56% more abundant and their biomass was 54% higher.

INFORMATION SOURCES

Rockett, L. C. 1979. Evaluation of boulder stream improvements in South Tongue River, Sheridan County. Administrative Report, Project No. 3079-08-6505, Fish Division, Wyoming Game and Fish Department, Cheyenne.

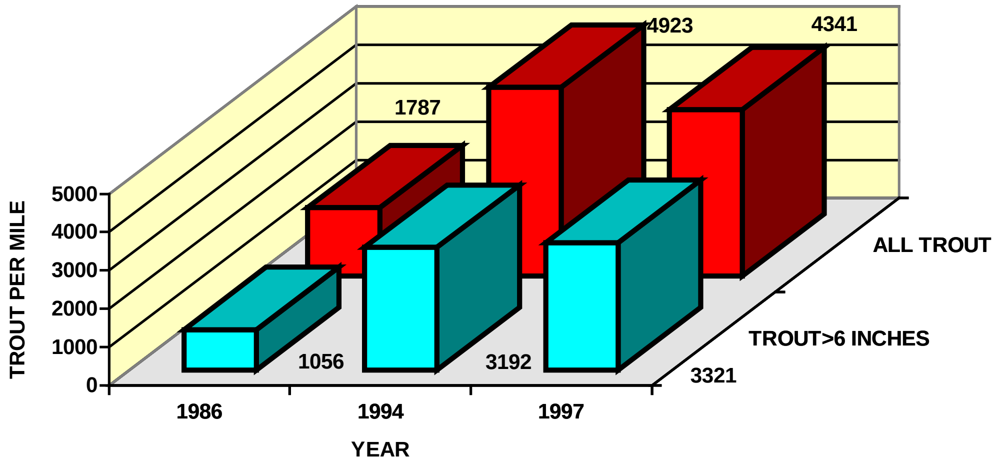


Figure 57-1. Abundance of trout at South Tongue River, Prune Creek section, before (1986-1994) and after habitat improvement devices were installed in 1994-1995.

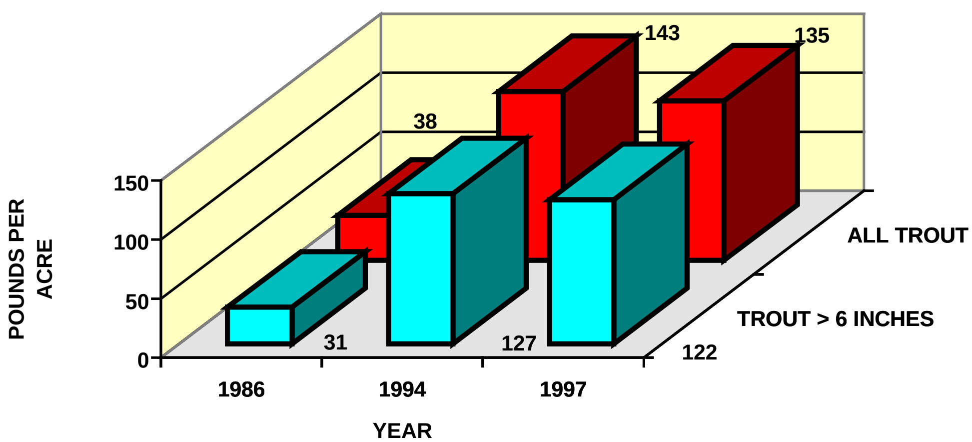


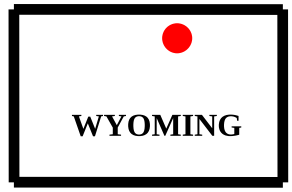
Figure 57-2. Biomass of trout at South Tongue River, Prune Creek section, before (1986-1994) and after habitat improvement devices were installed in 1994-1995.

Figure 57-3. A diagonal digger log weir was built to provide deep pool habitat in a shallow run.

SOUTH TONGUE RIVER - Shutts Flat

SHERIDAN COUNTY

PROJECT BUILT: 1997 - 1998



Drainage:	Tongue River	**Tongue River Basin (8TR)**	
Elevation:	7,735 ft - 7,770 ft	**R.** 88 **W., T.** 55 **N., S.** 9, NW 1/4	
Stream Order:	Fourth	**Stream Class:** 2 (statewide importance)	
Watershed Area:	80 sqmi	**Mean Wetted Width:** 60 ft	
Gradient:	0.2% - 0.8%	**Land Status:** Bighorn National Forest	
Rosgen Channel Type:	C-4	**Project Length:** 7,400 ft	
Treatment Used:	Tree and rock revetments, fish rocks, rock deflectors, barbs, rock sills, and vortex weirs		
Trout Species:	Wild rainbow, brown, and brook trout		

DESCRIPTION OF STREAM: Heading in the Bighorn National Forest, South Tongue River drains a northeast aspect of the Bighorn Mountains. From the watershed crest, it flows northerly about 16 miles to join Tongue River in Box Canyon. Stream flow is fed by an abundant snowpack, which creates an annual snowmelt flood in May and June and maintains a clear, cold base flow. Peak summer water temperature is about 66^{o}F. Late summer flow is not a problem, but flow becomes low during winter. Mean seven day low flow is 27 cfs (13% ADF) and occurs during middle to late winter. ADF is 204 cfs, CPSF is 57% of ADF, and the ASFV ratio is 116, suggesting a variable flow regime. Stream substrate is mainly rubble, cobble, and gravel. A coniferous forest covers much of the watershed, but grassy montane parks and alpine meadows are also prominent. In the project area, willows and various grasses are common along the stream banks, while a lodgepole pine forest covers the uplands away from the stream.

PROJECT DESCRIPTION: Habitat improvement in South Tongue River at Shutts Flat was a cooperative venture between WGF, Big Horn Mountain Fly Fishers (Little Big Horn Chapter of Trout Unlimited - Sheridan), and the Bighorn National Forest. TU furnished funds for rock hauling and installed several tree revetments by hand at lower Shutts Flat. USFS supplied permits, partial funding, rocks, trees, and an EIA. WGF furnished planning and construction expertise, manpower, equipment, and funds. Project goals were to stabilize eroding stream banks, provide more shelter for trout, and increase stocks of wild trout.

THE FISHERY: Highway 14 parallels South Tongue River about a mile downstream from the project area and a dirt side road allows public access to a trailhead located a quarter mile downstream from lower Shutts Flat. Angler access to the Shutts Flat fishery is walk-in or by 4-wheelers from the trailhead. A popular campground, summer homes, a picnic area, and a resort (Arrowhead Lodge) are located near the highway. Thus, this popular fishery is heavily used during summer and fall. Statewide fishing regulations apply. Catchable RBT were routinely stocked in the river near the highway for many years to satisfy anglers, but wild RBT, BNT, and BKT were also present. Surveys during the late 1980s documented both a poor return to the creel of the hatchery catchables and the presence of many wild trout. So stocking was stopped in 1990 to see if wild fish could support the fishery.

HABITAT MANAGEMENT: Pretreatment, eroding stream banks and a wide, shallow channel lacking cover for trout were important limiting factors for the fishery (Figure 58-1). Some of these problems may go back to past tie drives and livestock grazing. Installation of habitat improvement structures at Shutts Flat was designed to expand on previous work done at the Prune Creek campground and Pine Island segments, thus bettering fish habitat in a long reach of stream subject to heavy angling pressure. In 1997, a WGF construction crew installed 1,823 ft of tree and rock revetments, 6 rock deflectors, a diagonal rock weir, 2 rock vortex weirs (Figure 58-2), 2 loose rock sills, 5 rock barbs, 1 tree barb, 63 ft of rock revetment, and several fish rocks. Rock was also added behind 900 ft of TU tree revetments. In 1998, the crew installed 2 rock vortex weirs, a diagonal rock weir (Figure 58-3), 930 ft of tree/rock revetment, 40 ft of tree revetment, and 194 ft of cover trees (Figure 58-4). Rocks were hauled to site from a construction project on Highway 14 and trees were cut onsite. Total project cost was $81,667 ($58,271/mile).

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Fishery evaluation was underway by the Sheridan regional fish crew.

Trout Habitat Response - Several HQI stations were established and will be monitored for “before and after” comparison of habitat changes posttreatment.

Habitat Structures - No evaluation possible as project monitoring is ongoing.

Conclusions - No conclusion possible as project monitoring is ongoing.

Figure 58-1. Pretreatment, South Tongue River at Shutts Flat lacked deep pool habitat through this section. Many eroding banks were also present.

Figure 58-2. Where long shallow runs were present at Shutts Flat, as in Figure 58-1, several rock vortex weirs were constructed to provide deep pool shelter for trout. In addition to providing pools, these weirs act as grade controls and encourage sub-irrigation of downstream riparian vegetation by raising water tables in the floodplain.

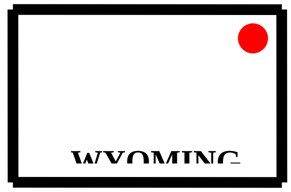
Figure 58-3. Diagonal rock weirs were also constructed to create deep pools and control stream grade.

Figure 58-4. Cover trees were anchored next to rock vortex weirs (foreground) to provide shelter for trout using the pools. In this instance, a large trout moved in under the trees before construction was complete, thus demonstrating the need for such habitat. Tree/rock revetments on eroding banks can be seen downstream.

SPOTTED TAIL CREEK

CROOK COUNTY

PROJECT BUILT: June 1985



Drainage	Sand Creek	**Belle Fourche River Basin (8BF)**	
Elevation:	5,475 ft	**Location:** R. 60 W., T. 51 N., S. 20, 29	
Stream Order:	Second	**Stream Class:** 4 (locally important fishery)	
Watershed Area:	2.1 sqmi	**Mean Wetted Width:** 5 ft (June)	
Gradient:	3.2%	**Land Status:** Black Hills National Forest	
Rosgen Channel Type:	B-3	**Project Length:** 1,840 ft	
Treatment Used:	Timber, rock, and log plunges, fish rocks		
Trout Species:	Brook trout		

DESCRIPTION OF STREAM: Snowmelt, rainfall and small springs are the main water sources for Spotted Tail Creek, which is located in the Black Hills about 12 miles east of Sundance. Peak flows occur in early May during snowmelt runoff. Summer base flow is usually 1 cfs, or less, but high intensity rainstorms cause occasional flash floods. Maximum summer water temperature of record is 78^{o}F. Channel substrate is 15% boulder, 35% cobble, 35% gravel, and 10% fines - there are occasional bedrock outcrops. Watershed condition was generally good at time of project, but it had been adversely affected by past mining and livestock grazing. Through the project area, the stream channel had been dredged for gold years ago, exposing bedrock in places and leaving rocky spoil piles along the banks. Grass, forbs, occasional willow bushes, and a few pine trees grow in the riparian area. Ponderosa pine, aspen, and oak bushes dominate valley sideslopes.

PROJECT DESCRIPTION: Habitat improvements were installed in Spotted Tail Creek starting about 0.5 mile upstream from the Sand Creek confluence, and ending at the confluence with a nameless tributary from the west at elevation 5,480 ft. In this area, few streams provide fishing for anglers, so a project objective was to provide more stream fishing for trout by increasing production of trout with better habitat. This project was a cooperative venture between WGF and Black Hills National Forest. USFS contributed trees, rocks, and partial funding, while WGF furnished funding, labor, finished materials, and equipment.

THE FISHERY: Before treatment, the BKT population was limited by poor rearing and overwintering habitat. Few trout lived in the creek, as shelter was poor. Spawning success was questionable as no naturally reproduced juveniles were found prior to treatment. Occasional upstream migration of trout from Sand Creek apparently supported the population. After 100 BKT were removed in 1978 and 1979 for a kidney disease study, the general population trend was downward. An electrofishing sample in 1983 found only five BKT in 800 ft of stream. Mean length was 8.1 inches (range, 6.5-9.5 inches).

HABITAT MANAGEMENT: Pretreatment, Spotted Tail Creek was shallow and lacked deep pools. A few small step pools, undercut rocks, pocket pools, and undercut banks provided the only cover for trout. To provide deep pool habitat, a WGF construction crew installed 36 timber plunges (Figure 59-2), eight rock plunges, and one log plunge in 1,840 ft of stream. Plunge pools were dug out by backhoe to ensure deep pool development in the rocky substrate. WGF labor, materials, and equipment time cost was $4,990 ($14,260/mile). Cost per plunge was $111.

Figure 59-1. Pretreatment, Spotted Tail Creek was shallow and lacked deep pools, as in this view of the control section.

Figure 59-2. Building timber plunges in Spotted Tail Creek created deep plunge pools, and in some cases, dam pools. An additional benefit was increased sub-irrigation of the riparian area as the plunges raised water tables in the floodplain.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Following structure installation in 1985, the stream was restocked on May 27, 1986 with BKT (3.6 inches mean length). No further stocking was done in the period 1986-1992. Posttreatment fish samples were collected from a 350-ft station in the treated area and a 470 ft reference station just upstream from the treated area.

After habitat improvement, BKT steadily increased in abundance and biomass (Figures 59-3 and 59-4). No age-0 fish were found in 1987, but naturally reproduced age-0 BKT were numerous from 1988 on. Three years after treatment, the population had increased many times over pretreatment levels (Table 59-1). In the treated section, mean length decreased to 5.4 inches in 1988 due to many naturally reproduced 3-6 inch fish. And in the control section, 93% of BKT were YOY, indicating habitat was still not suitable for very many larger fish. Catchable trout (6 inches, or longer, total length) were 679% more abundant (biomass up 107%) in the treated section than in the untreated area. Mean posttreatment abundance for catchable BKT was 733% greater than pretreatment (biomass up 300%).

Seven years after treatment, Hogle (1993) reported BKT abundance in the treated area was 4,248% greater than in 1983. Biomass was up 1,687% and age-0 fish made up 31% of the population. Most BKT were collected from plunge pools.

Trout Habitat Response - Cover for trout was poor (5%) pretreatment, but by 1991, cover had improved six-fold (Figure 59-5). Plunge pools were the most common cover type posttreatment and averaged 39 sqft of cover/plunge in 1988. In 1987, RPD was 1.40 ft, or greater, at 60% of the timber plunges and 50% of the surviving rock plunges. RPD at the lone log plunge was 1.42 ft. At the treated station, HQI score improved 46% from 1984 to 1988, and was 8% better in 1988 than at the reference site. By 1991, HQI score had dropped 16%, but was still 23% better than in 1984 (Figure 59-5).

Habitat Structures - When the entire project was examined in 1997, 35 wood plunges were located. About 90% were rated as being in good condition and had developed deep pools. All plunges were inconspicuous and hard to find due to moss growing on the structures, abundant grass growth on plunge ends, and well-weathered timbers. Stream bottoms were covered with abundant grass, forb, and willow growth, and only a few cattle were in the project area. This contrasts with pretreatment when cattle that spent most of the summer there heavily grazed the riparian area.

Conclusions - Adding 45 plunges to Spotted Tail Creek increased cover for trout six fold and sparked development of a wild brook trout fishery. Following a single stocking of BKT, the population increased many times over the very low pretreatment level and became self-sustaining. Three years after treatment, catchable BKT were 679% more abundant in the treated section than in an untreated control section. Seven years posttreatment, wild BKT abundance was 4,248% greater than pretreatment and biomass was up 1,687%. Wild age-0 fish made up 31% of the population.

INFORMATION SOURCES

Hogle, J. S. 1993. Salmonid habitat and population characteristics related to structural improvement in Wyoming streams. Master's thesis. University of Wyoming, Laramie.

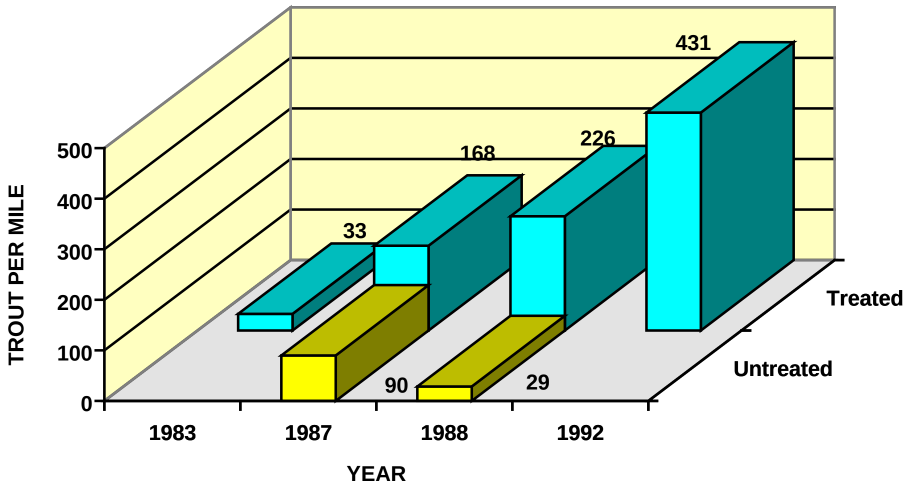


Figure 59-3. Abundance of catchable BKT (6 inches, or longer, total length) in Spotted Tail Creek from 1983 to 1992.

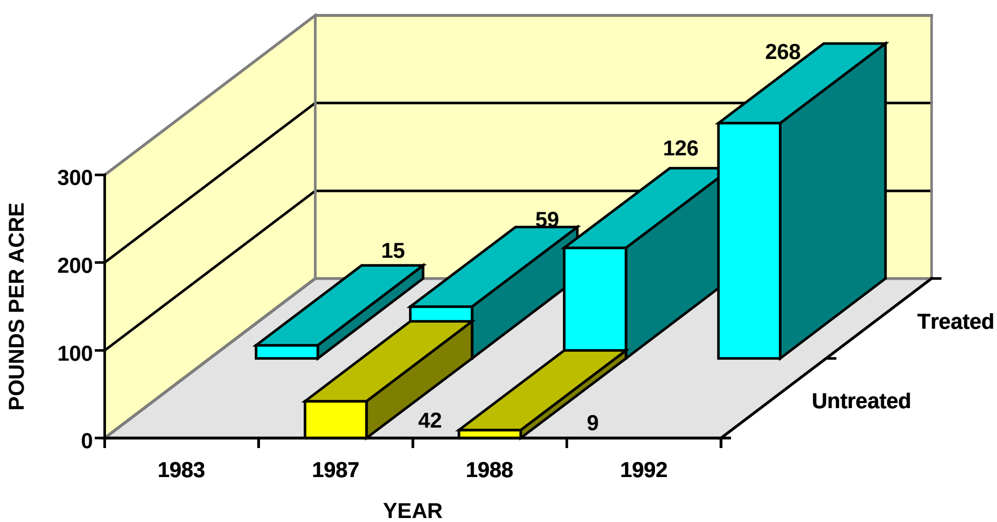


Figure 59-4. Total biomass of BKT at Spotted Tail Creek 1983-1992.

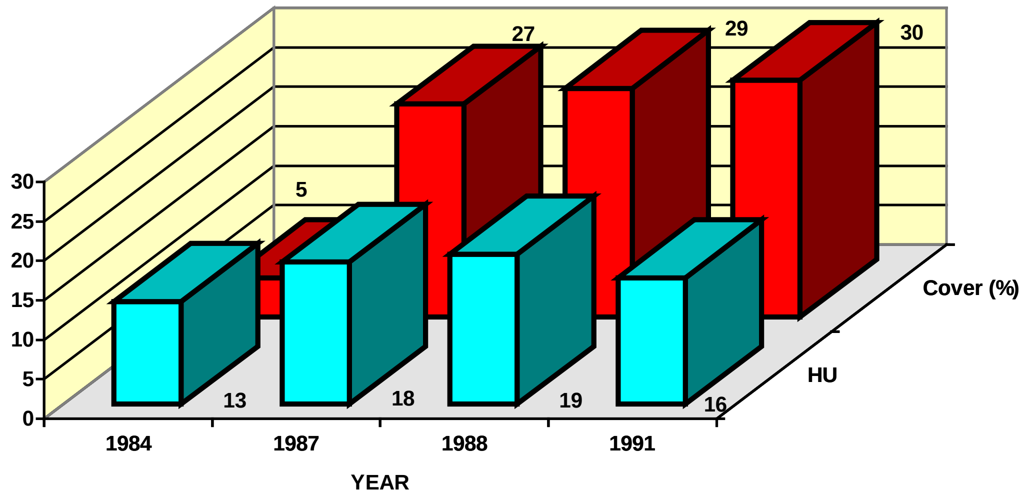


Figure 59-5. Cover for trout and HQI score (HU) in Spotted Tail Creek before (1984) and after (1987-1991) habitat improvement.

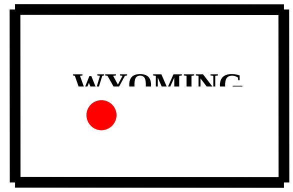
Table 59-1. Mean abundance and biomass of BKT in treated and reference sections at Spotted Tail Creek before (1983) and after (1987-1992) habitat improvement. UT is the untreated reference area and TRT is the treated area.

		Abundance		**Biomass**	
Year	**Area**	Total No/mile	No/mile ≥ 6 inches	Total lbs/acre	lbs/acre ≥ 6 inches
PRETREATMENT					
1983	TRT	33	33	15	15
POST-TREATMENT					
1987	TRT	168	168	59	59
	UT	90	90	42	42
1988	TRT	996	226	126	61
	UT	442	29	62	9
1992	TRT	1,435	431	268	
Pretreatment mean		33	33	15	15
Posttreatment mean	TRT	866	275	151	60
	UT	266	60	52	26
Percent change Pretreatment vs. Posttreatment		2,524	733	907	300
Untreated vs. Treated		226	358	190	131

SQUAW CREEK

FREMONT COUNTY

PROJECT BUILT: 1990-1998



Drainage:	Middle Fork Popo Agie River	**Middle Fork Popo Agie River Basin (6PM)**
Elevation:	5,300 - 5,760 ft	**R.** 100 **W., T.** 33 **N., S.** 7,12,21,22,23,28
Stream Order:	Second and Third	**Stream Class:** 3 (regionally important)
Watershed Area:	25 sqmi	**Mean Wetted Width:** 12 ft
Gradient:	3.6% upper; 1.1% lower	**Land Status:** Private, City of Lander
Rosgen Channel Type:	B and C	**Project Length:** about 6 miles
Treatment Used:	Rock riprap, rock weirs, fences, vegetation planting, grazing modification, improved irrigation systems.	
Trout Species:	Brown and brook trout	

DESCRIPTION OF STREAM: Heading in the Shoshone National Forest, Squaw Creek drains an easterly aspect of the Wind River Mountains, but is a “front drainage” situated along the lower edge of the mountains. An ample snow pack, rainfall, and springs feed stream flow, but once it exits the mountains, several irrigation diversions remove water. However, late summer and winter flow is generally adequate for trout due to flow from irrigation returns and springs. Once away from the mountains, Squaw Creek flows through various ranches, farms, and subdivisions before passing through Lander and joining with Baldwin Creek. Riparian areas vary from heavily farmed and grazed vegetation to dense patches of willows, hawthorn, chokecherry, and river birch. Only a few cottonwood and aspen trees grow along the stream bottoms upstream from town.

PROJECT DESCRIPTION: A primary goal of the Squaw Creek/Baldwin Creek 319 Water Quality Improvement Project was to reduce nonpoint source pollution while correcting problems that were causing erosion in the riparian area. Silt coming from widespread bank erosion was the primary pollutant targeted. Lead agency for this watershed wide project was the Popo Agie Conservation District. The POCD coordinated funding and consulting efforts with the Wyoming Game and Fish Department, Wyoming Department of Environmental Quality, U. S. Environmental Protection Agency, Fremont County Weed and Pest, U. S. Forest Service, U. S. Bureau of Land Management, and the Natural Resource Conservation Service. Improvement efforts were on a cost-share basis: 60% DEQ and EPA, 25% Conservation District (from mill levy), and 15% landowner. Although some work was also done on Baldwin Creek, this report focuses on Squaw Creek where the fishery was monitored.

THE FISHERY: Headwaters of Squaw Creek contain mainly wild brook trout, but wild brown trout are dominant through the project area. Trout abundance and water quality is generally less with increased distance from the mountains. Fishing pressure is spotty as anglers must obtain permission to trespass from landowners. Standard, statewide regulations applied.

HABITAT MANAGEMENT: After the drainage was settled in the late 1800's, the diversified, natural vegetation along Squaw Creek was steadily modified due to heavy grazing, poor farming practices, road building, herbicide use, and subdivision development. Pretreatment, bank erosion was severe and wide spread, generating large amounts of sediment, which often kept the stream muddy through the summer (Figure 60-4). Nickpoints, headcuts, and oxbow cuts were identified pre-project at several sites, indicating poor channel stability. To correct the problem, problem stream banks were riprapped with rocks, rock weirs were built to stop headcuts, irrigation control structures were installed, some areas were fenced to exclude livestock, and landowners were encouraged to develop better land use practices. An information and education program was started for high school students, featuring hands-on, outdoor classroom experience where Squaw Creek flows through the high school grounds. By 1995, the Conservation District had cost-share contracts with 30 landowners and another 25 contracts pending for completion by 1997.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - The Lander Regional fish management crew monitored fish response at four locations. Treated sites were compared with an ungrazed control site at the top of the project area and with pretreatment records. At the control site, bank erosion and grazing had been controlled 25 years previously and riparian vegetation is well developed. Cover for all sizes of trout is plentiful - overhanging brush, debris jams, rock and log step dams, and undercut banks.

By 1998, trout numbers had deteriorated at the town sites to less than pretreatment levels (Figures 60-1 and 60-2, Table 60-1). At Northside Park, trout abundance and biomass were down 92% from the 1991 level. Abundance dropped 79% at the high school from 1995-1998. Although sediment and turbid water continued to plague those two urban sites, the fishery may have also been affected by pollution other than sediment. And as both sites are on public land, angling pressure may also have played a role. Upstream from town, trout numbers increased 83% at the Bauman sample site and remained relatively steady at the control, increasing only 16% (Figure 60-3). Biomass was up three-fold at the Bauman site and doubled at the control. Considering how seriously degraded habitat once was in this stream, additional time will be needed for the fishery to stabilize through the project area.

Trout Habitat Response - Since some banks were not stabilized until 1998 and others were not treated at all, some bank erosion and muddy water continued in 1998. But visual inspection of the stream bottoms, and comparison with pretreatment photos, shows considerable improvement in both riparian vegetation and bank stability in Squaw Creek (Figures 60-4, 60-5, 60-6 and 60-7). Much sediment was present in the stream pretreatment, and more time may be needed for this sediment to move down through the system so the stream, and its fishery, can heal. Although initial riparian response was good, information gained at the control site suggests full recovery of all vegetative components will be a slow process over many years. Willow patch recovery took years at the control.

Habitat Structures - No formal monitoring was done, but informal spot inspections indicate good performance and durability of the instream structures.

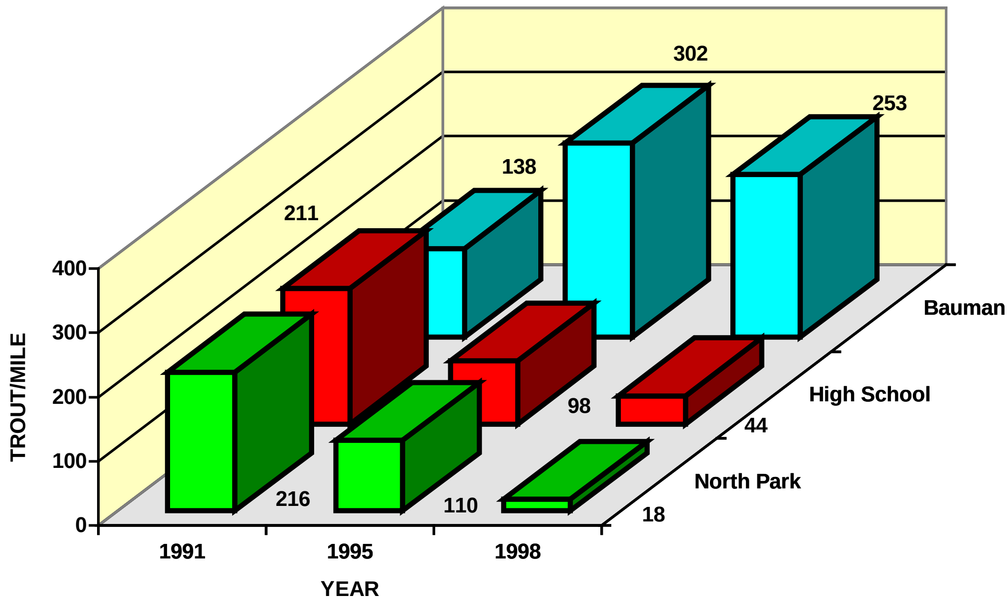


Figure 60-1. Trout abundance in Squaw Creek following erosion control measures within the watershed. Samples were taken in 1989 at the high school site, not in 1991.

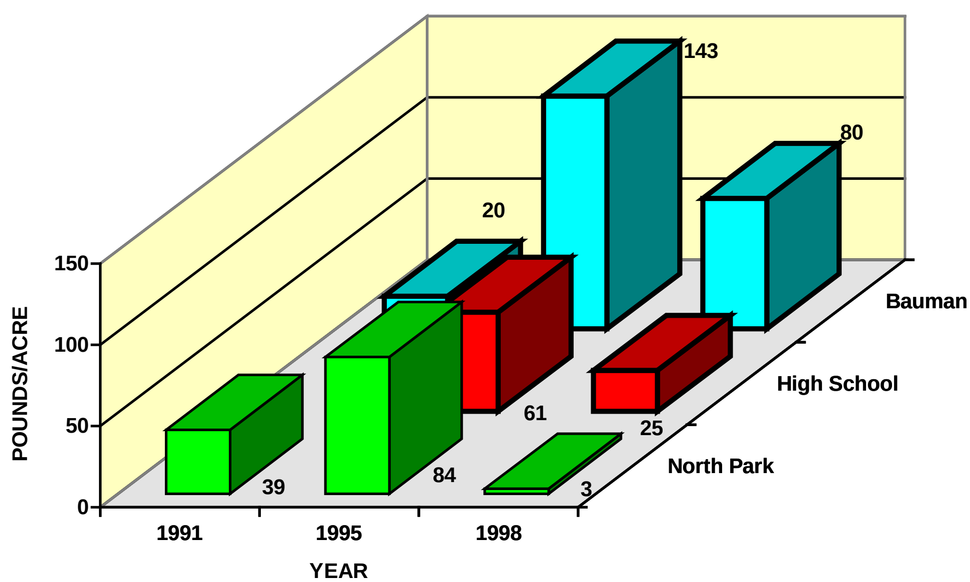
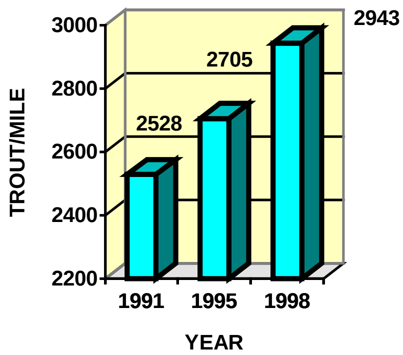


Figure 60-2. Trout biomass in Squaw Creek following erosion control measures within the watershed. No biomass was reported for the high school site prior to 1995.



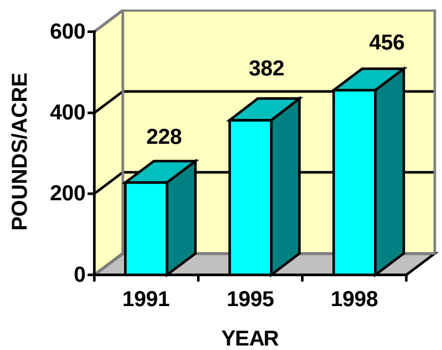


Figure 60-3. Trout abundance (left) and biomass (right) trends in Squaw Creek at the control site (Binns Place) during the period when erosion control measures were being applied to downstream areas.

Conclusions - Riparian vegetation and stream bank conditions were better by 1998. Upstream from town, trout abundance had improved 83% and biomass 300%, but town sample sites showed serious deterioration of the trout population. Poor response of the fishery through town may reflect angling pressure, or it may indicate other habitat problems, such as chemical pollution, or more likely, not enough time has elapsed for the system to heal. Trout numbers at the control station increased 16% from 1991 to 1998, suggesting a slow adjustment of the trout population as the once degraded habitat continued to heal, even though banks were stabilized 25 years ago.

Figure 60-4. Severe bank erosion was rampant in the Squaw Creek drainage before efforts were made to control silt pollution in the watershed. Spring snowmelt floods often carved off large chunks of soil and washed it downstream to bury pools and riffles with silt.

Figure 60-5. Reduced grazing and stabilization of stream banks with rock revetments allowed riparian vegetation to return and resume its stabilizing role in stream ecology. This area is the same area shown in Figure 60-4.

Figure 60-6. Annual spring floods degraded stream banks, caused oxbow cutoffs, and other channel adjustments. At low flow, little cover for trout was contributed by the small amount of riparian vegetation and pools were often choked with silt.

Figure 60-7. Posttreatment, the stream channel is much more stable. This is the same area as shown in Figure 60-6.

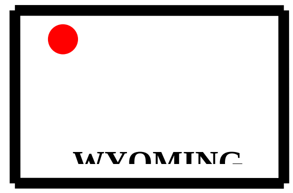
Table 60-1. Trout abundance and biomass in Squaw Creek during 1991-1998. All figures are for brown trout, except (**) indicates brook trout. Town stations are Northside Park and High School, while Bauman's Property is the country station.

Location	Date	Mean length (inches)	Trout/mile	Lbs/acre	Trout/mile ≥6 inches	Lbs/acre ≥6 inches
Northside Park	1991	7.3	216	39	54	30
(elev. 5,340 ft)	1995	11.7	110	84	94	72
	1998	8.9	18	3	18	3
High School	1991	10.8	211	-	211	-
(elev. 5,380 ft)	1995	12.2	98	61	98	61
	1998	9.6	44	25	22	24
Bauman Property	1991	7.3	138	20	69	17
(elev. 5,520 ft)	1995	11.8	302	143	302	143
	1998	11.5	253	80	228	78
Binns Place	1991	6.4	2,528	228	1,363	198
(elev. 5,750 ft)	1995	7.6	2,705	382	2,211	362
(control stn.)	1998	7.9	2,899	452	2,357	420
		**6.2	44	3	22	2
Control Stn. mean		7.9	2,725	355	1,984	327
Pretreatment mean						
Town		9.0	214	39	132	30
Country		7.3	138	20	69	17
Posttreatment mean						
Town		10.3	64	44	56	35
Country		11.6	278	112	265	110
Percent change, pretreatment vs. posttreatment						
Town		14	-70	13	-58	17
Country		59	101	460	284	547

SUNLIGHT CREEK

PARK COUNTY

PROJECT BUILT: 1983, 1997



Drainage:	Clarks Fork River	**Clarks Fork River Basin (2CF)**	
Elevation:	6,730 ft	**R.** 105 **W., T.** 55 **N., S.** 17	
Stream Order:	Fourth, or greater	**Stream Class:** 3 (regionally important)	
Watershed Area:	135 sqmi	**Mean Wetted Width:** 42 ft	
Gradient:	0.4%	**Land Status:** WGF Wildlife Habitat Management Unit	
Rosgen Channel Type:	C-4	**Project Length:** ~ 1 mile	
Treatment Used:	Tree and rock revetments		
Trout Species:	Cutthroat, rainbow, and brook trout		

DESCRIPTION OF STREAM: Situated just east of Yellowstone National Park, Sunlight Creek heads in the North Absaroka Wilderness. Its watershed features rugged mountains and various geological formations, including the Absaroka volcanic rocks, which contribute much sediment to the stream. Vegetation ranges from alpine tundra and bare rock to conifer patches and mountain meadows at lower elevations. Riparian vegetation in the project area is willow, conifers, aspen, cottonwood trees, and various forbs and grasses. An abundant snowpack furnishes a river flow that is generally adequate for trout during summer and fall, but flow may become low during winter. ADF is 124 cfs, mean CPSF is 104 cfs, and the ASFV ratio is 75. Base flow generally occupies only about a third of the channel width through much of the project area due to deposition of sediment at point and lateral bars. Stream substrate is mainly gravel 1 to 3 inches in diameter.

PROJECT DESCRIPTION: Funded and constructed by WGF, stabilization of severe bank erosion at the WHMA was the primary goal.

THE FISHERY: Although wild trout were present in 1983, the fishery was popular with the angling public and was supplemented with periodic hatchery plants.

HABITAT MANAGEMENT: Sunlight Creek is unstable through the project area, partly from past channel abuses upstream on private land, and partly from the large sediment load. In the early 1980's, the river shifted its flow to began cutting into an irrigated hayfield and road. Since the WHMA furnishes vital winter range for elk migrating from Yellowstone Park, preservation of the hayfield was a priority. In 1983, a WGF construction crew installed about 500 ft of tree and rock revetments along the eroding river bend, where cutbanks ranged from 4 to 10 ft in height. But these revetments did not withstand flood flows over time, and by the early 1990s, severe bank erosion was again present. Consequently, in 1997 about 3,050 ft of bank was stabilized prior to high water with 101 conifer trees, 365 four foot boulders, 515 three foot rocks, and 710 cuyd of 12-24 inch riprap.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - No evaluation was done.

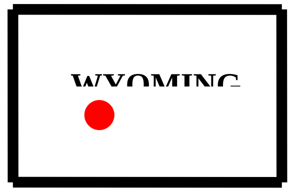
Trout Habitat Response - No evaluation was done for the 1983 project, but monitoring is underway for the 1997 work.

Habitat Structures - Anchoring the tree and rock revetments into the tall cutbanks proved difficult, and floods damaged or washed away many of the structures. Bank erosion continued behind the revetments, probably because not enough trees and rocks were used to counter the intensity of the floods and the river's tendency for lateral erosion at this site. More and larger rocks and trees were used in 1997, along with a better anchoring method. These structures withstood an extreme flood in 1997.

Conclusions - Stabilizing bank erosion on a river this size requires a large commitment of trees and rocks.

SWEETWATER RIVER

FREMONT COUNTY



PROJECT BUILT: ***Phase I*** **- 1964-1966**
Phase II **- 1968**
Phase III **- 1971-1973**

Drainage:	North Platte River	**Sweetwater River Basin (6SW)**	
Elevation:	7,450 ft	**R.** 101 **W., T.** 28 **N., S.** 20 SW 1/4	
Stream Order:	Fourth	**Stream Class:** 3 (regionally important)	
Watershed Area:	177 sqmi	**Mean Wetted Width:** 49 ft	
Gradient:	0.2%	**Land Status:** Private, BLM, state	
Rosgen Channel Type:	C-4	**Project Length:** 1,100 ft	
Treatment Used:	Log and rock deflectors, rock weirs, and fish rocks. Addition of dolomite, nitric acid, and trona for productivity enhancement.		
Trout Species:	Brown, brook, and rainbow trout		

DESCRIPTION OF STREAM: Heading in the Bridger-Teton National Forest, where its watershed features granitic rocks and coniferous forest, the Sweetwater River drains a southwest aspect of the Wind River Mountains. In the project area, the stream flows in broad valley between sagebrush covered hills and the riparian area is a mountain meadow studded with willow clumps. Stream substrate in the project area is primarily cobble and coarse gravel with an occasional granite boulder. Silt and sand deposits are common where flow is slow. An abundant snowpack and springs furnish a stream flow adequate for trout year around. ADF is 65 cfs, CPSF is 43% ADF, and the ASFV ratio is 107, indicating a possible wide variation between high and low stream flows during any given year. Maximum discharge of record is 1,150 cfs.

PROJECT DESCRIPTION: Habitat improvement on the Sweetwater River was a WGF experimental project to see if productivity in a relatively sterile high mountain stream could be chemically or physically enriched. During *Phase I*, dolomite was added to the river upstream from Highway 28, and in *Phase II*, trona was placed instream. *Phase III* involved installation of instream structures intended to provide more shelter for trout and increase bank stability. WGF funded and evaluated the projects.

THE FISHERY: Due to private land holdings, and rough terrain, fishing pressure in the Sweetwater River drainage is sporadic. Wild BNT, BKT, and RBT are present in the drainage, but at access points where angler use is greatest, the fishery has been supplemented with catchable-size, domestic RBT for many years. For example, the large meadow upstream from Highway 28 is a popular public fishing spot. Although this area is private land, the landowner allows public access for fishing. Standard statewide fishing regulations apply.

HABITAT MANAGEMENT: In its upper reaches, the Sweetwater River drains from granite formations and consequently lacks dissolved minerals and nutrients. Additionally, the river near the highway bridge had been periodically channelized to keep a smooth flow under the bridge. Cattle have grazed the meadow in the project area each summer for many years.

In *Phase* I, 90 cuyd of dolomite (calcium magnesium carbonate) from Limestone Mountain was added to the river at four locations, six miles apart, between Highway 28 and the USFS Sweetwater Guard Station. Two of the weirs were built just upstream from the highway bridge. This rock was placed as low profile rock weirs that completely spanned the stream. Ninety gallons of nitric acid was also dripped into the river at one site in an effort to increase the rate at which the dolomite entered into solution. During *Phase II*, a ton of trona (sodium sesquicarbonate) from the West Vaco mine near Green River City was placed in the river at two locations between the highway and guard station.

All *Phase* III work was located just upstream from the highway bridge and was done with permission of the landowner, Blair and Hay Land and Livestock Company. In 1971, 22 fish rocks, 3 log deflectors, and another dolomite weir were built in 1,100 ft of stream. All of the deflectors were "attracting" deflectors (angled downstream). In 1973, 175 ft of severely eroding bank was protected with several jetties built with dolomite chunks. However, eddies continued to erode the bank between the jetties and several years later, these spaces were filled with dolomite so the bank was completely armored. At the same time, 150 ft of dolomite riprap was used to stop bank erosion being caused by one of the log deflectors.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Both trout abundance and average weight of fish were slightly higher after the dolomite treatment. But project personnel felt this result was more likely due to an improved physical habitat caused by scour and ponding at the dolomite dams. Response of the trout population after addition of trona was not monitored.

Stocking of hatchery trout and an unknown angler harvest confounded evaluation of trout response to the instream structures installed in Phase III. However, four years after treatment, abundance of wild trout had increased 8%, while catchable trout numbers were up 28% (Figure 62-1, Table 62-1). Biomass for all wild trout increased 7%, but catchable trout biomass was down 34%, possibly due to anglers harvesting the larger trout (Figure 62-2). Many YOY and juvenile trout were reported in the samples.

Trout Habitat Response - *Phase I* - Dolomite chunks placed in the river proved to be relatively insoluble, but posttreatment increases were reported for TDS, alkalinity, calcium, magnesium, and chloride. Algae abundance and density were higher posttreatment, and this increase appeared to be directly related to increased macronutrients. Aquatic macroinvertebrates, especially Trichoptera and Plecoptera, also increased posttreatment, but this change may have been due to a more suitable substrate that developed at the dolomite weirs. Trout abundance and average weights were higher posttreatment, but again, changes in the physical habitat may have influenced this result. Nitric acid did not appreciably affect nutrient levels in river water. When the study was terminated, no definite trends were evident that the dolomite had significantly increased the biological and chemical productivity of the river.

Phase II - Trona dissolved quickly in the river, but affected chemistry for only a short distance. TDS, alkalinity, sodium, and macroinvertebrate abundance were higher posttreatment, but the increases were relatively small and not considered significant from a fishery standpoint. Adding larger quantities of trona might have greater effects on nutrients and fish food organisms, but would be cost prohibitive. Fishery response was not evaluated.

Phase III - Habitat changes were not monitored after the structures were installed. When checked in 1998 though, both banks treated with riprap were stable with good grass and willow growth (Figure 62-3). A deep pool was present along the upper bank, where good trout shelter was

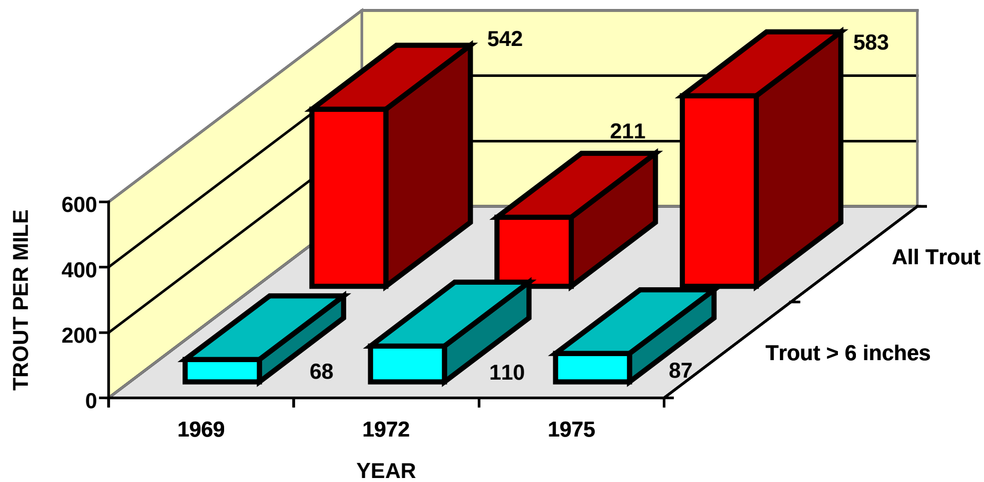


Figure 62-1. Abundance of wild trout before (1969) and after (1972-1975) addition of instream habitat improvement structures in the Sweetwater River.

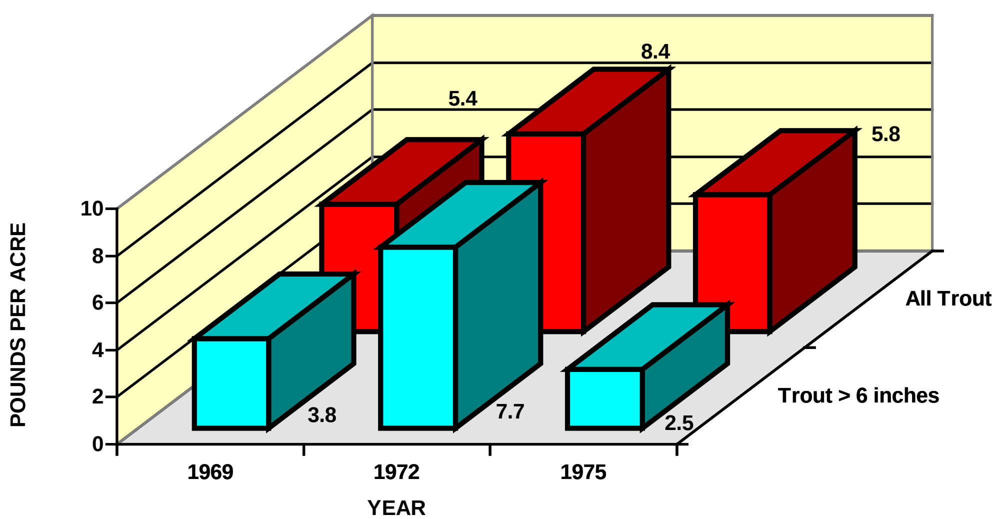


Figure 62-2. Biomass of wild trout before (1969) and after (1972-1975) addition of instream habitat improvement structures in the Sweetwater River.

in the irregular rock riprap. At the second bank, the river was riffle and no longer flowed next to the bank. Banks that were eroding in 1971 were still unstable. Some of the fish rocks provided pocket pool shelter for trout, but many had only shallow pools at low flow. Only one dolomite weir had a pool.

Habitat Structures - One log deflector was reported missing soon after installation and was believed to have been removed by man. In 1998, one log deflector was found intact, but almost buried by the point bar developing opposite the uppermost riprapped bank. A third deflector was still functional at higher flows even though the logs had separated (Figure 62-4). Bank erosion was still evident below this attracting deflector. All dolomite weirs had sunk and were level with the streambed. Only a few dolomite chunks were visible near the banks, as the river (Figure 62-5) had evidently buried most of the original rocks.

Conclusions - Although macronutrients, macroinvertebrates, and algae increased after dolomite or trona was added to the Sweetwater River, these changes were not large enough to be beneficial to the fishery. Neither technique appeared to be practical or cost effective. Four years after instream structures were added to a channelized section of river, wild trout abundance increased 8% and biomass 7%. Catchable-size wild trout abundance improved 28% over pretreatment levels, but biomass declined 34%. Angler harvest may have affected trout response to the treatment by removing larger fish.

INFORMATION SOURCES

Bosley, C. E. 1967. Sweetwater River water quality study. Job Completion Report, Research Project Segment, Trout Fisheries Investigations, Job No. 1, D. J. Project F-1-R-7. Fish Division, Wyoming Game and Fish Department, Cheyenne.
Pedlar, D. 1969. Sweetwater River water quality study. Administrative Report, Project 0268-21-6301, Fish Division, Wyoming Game and Fish Department, Cheyenne.

Table 62-1. Abundance and biomass of wild trout in the Sweetwater River before (1969) and after (1972-1975) instream structures were installed. Catchable trout were 6 inches, or longer, total length.

Year	Trout per mile		Pounds per acre	
	All trout	Catchable trout	All trout	Catchable trout
Pretreatment				
1969	542	68	5.4	3.8
Posttreatment				
1975	583	87	5.8	2.5
Percent change	8	28	7	-34

Figure 62-3. A formerly eroding bank as it appeared 25 years after it was stabilized with limestone chunks. Willows have become established along the bank behind the riprap to further stabilize it. Compared to surrounding willow clumps, the new willow growth is still short, even after 25 years, which points out the long period of time sometimes necessary for riparian vegetation to become reestablished after severe disturbance.

Figure 62-4. Two logs are all that remain of a log deflector installed 27 years previously. Attracting deflectors, like this one, were built to protect the bank on the left, but are still causing erosion (picture foreground, left). This type of structure is not

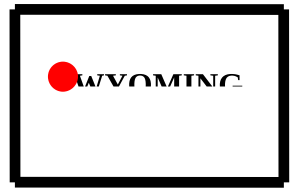
recommended in Wyoming for bank protection because it deflects flow into the bank instead of away from it.

Figure 62-5. A few limestone boulders on the bank are all that remain of a rock weir after 25 years. The stream has presumably buried the instream portion of the weir.

TEPEE CREEK

SUBLETTE COUNTY

PROJECT BUILT: 1980 - 1983



Drainage:	Tosi Creek	**Green River Basin (7GR)**
Elevation:	8,740 ft	**R.** 111 **W., T.** 39 **N., S.**1**,** SE 1/4
Stream Order:	Second	**Stream Class:** 3 (regionally important)
Watershed Area:	11 sqmi	**Mean Wetted Width:** 14 ft
Gradient:	0.5% (revetments); 1.8% (exclosure)	**Land Status:** Bridger-Teton National Forest
Rosgen Channel Type:	C-4 (revetments) B-3 (exclosure)	**Project Length:** Two miles
Treatment Used:	Tree revetments, trees on top of bank to block cattle movement, 3 acre fenced exclosure	
Trout Species:	Wild brook and cutthroat trout	

DESCRIPTION OF STREAM: A major tributary of Tosi Creek, Tepee Creek drains Bacon Ridge, Tepee Creek Ridge, and the Red Hills. Geological formations include sandstone, siltstone, and shale, all of which yield sediment to the stream. Red Creek, at the lower end of the project, is intermittent, but adds considerable sediment to Tepee Creek during the spring runoff. Discharge is adequate during summer, but may become low in late summer. Flow is fed by numerous springs and snowmelt runoff, and ranges from less than 5 cfs to more than 50 cfs during floods. Conifer patches and sagebrush-grass parks dominate the headwaters. A few scattered stands of aspen grow in the basin. In the project area, the vegetation is dry meadow type consisting mainly of sagebrush, forbs, sedges, and various grasses. A narrow belt of short willows grows along the stream. Lack of willow and aspen forage limits beaver activity to a few dams.

PROJECT DESCRIPTION: Located about 30 miles northwest of Pinedale, the Tepee Creek watershed is at the divide between the Green and Gros Ventre rivers. A cooperative project between WGF and the Bridger-Teton National Forest, the goals of the Tepee Creek project were to reduce adverse effects of livestock grazing on fish habitat in the stream, stabilize eroding stream banks, and to increase cover for trout. An overall project objective was to reduce sediment input to the stream. WGF furnished funding, expertise, equipment, and manpower, while USFS contributed expertise, partial funding, trees, and fencing. This project was located in a sagebrush park between the Red Creek confluence and the second road crossing of Tepee Creek.

THE FISHERY: Original surveys in 1957 found well-established populations of wild BKT and CUT. Although more recent surveys have found that SRC are also present, a small resident population of CRC has been identified and enhancement of habitat conditions for this sensitive species was a driving force behind the project. Yet BKT are the most common trout in the drainage. A good logging road provides easy angler access to much of Tepee Creek, but fishing pressure is believed to be light. Standard statewide fishing regulations apply.

HABITAT MANAGEMENT: Comparison of aerial photos as far back as 1955 established that beaver ponds in the watershed have steadily decreased in number over time. Rather than the formerly continuous network of ponds efficiently trapping sediment, trapping of beaver, and their over-utilization of aspens and willows has reduced beaver activity to just a few scattered dams. Cattle have grazed this area since about 1885, but from 1930-1957 it was a sheep allotment. After 1957, sheep were removed and about 1,000 head of cattle have since grazed the area each summer. By 1980, trampling by cattle congregating along the stream banks had caused serious bank erosion. In 1970, nine blocks of 25 acres each were clear-cut within the Tepee Creek watershed. Although buffer zones protected the stream somewhat from sediment inputs, the main logging road has contributed sediment to the stream.

With loss of beaver ponds and continued heavy grazing, channel downcutting, severe bank erosion, and gullying of the stream were felt to be realistic future scenarios. To reverse this trend and provide some relief to the fishery, USFS fenced a 3-acre, half-mile long exclosure in 1980. In 1982-1983, a WGF construction crew installed 4,400 ft of lodgepole pine revetments on eroding stream banks upstream from the exclosure. Since rocks were unavailable, these trees were cabled to deadmen and no rock riprap was used to anchor and strengthen the revetments. Trees were also anchored on top of banks to discourage cattle from trailing along stream banks. Cost of the bank stabilization was $5,550 ($6,660/mile).

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Electrofishing stations within the tree revetment section and the exclosure monitored response of the trout population to the habitat improvement effort. After 12 years, trout abundance within the exclosure had increased 1,166% over pretreatment levels (Figures 63-1, 63-2, and 63-3, Table 63-1). In the bank stabilization area, trout abundance increased steadily until 1990, but by 1992, abundance had fallen back to the pretreatment level. Deterioration of the tree revetments is believed to be a major cause of this decline. But trout population levels may have been also influenced by fishing pressure, grazing along the stream, and by the presence or absence of beaver ponds within the project area.

In the tree revetment section, posttreatment abundance and biomass averaged 87% and 85% more than pretreatment. More juvenile trout (6 inches, or less, total length) were found in posttreatment Tepee Creek. Pretreatment, catchable trout (6 inches, or longer) made up 65% of the population. But after treatment, catchable trout averaged 56% of total trout abundance and further declined 1985-1992, suggesting either increased harvest of the larger fish, or better juvenile survival, or both.

Trout Habitat Response - Change in trout habitat was not formally monitored in the tree revetment section, but more shelter for trout was obviously present in and around the trees. In several instances, the trees formed artificial overhanging banks that yielded many trout to electrofishing samples. Seven years after livestock were excluded from the exclosure, trout cover had increased 125%, HU were up 291%, and eroding banks had decreased 82% (Figure 63-4).

Habitat Structures - Stream banks were protected by the tree revetments for several years, and in several instances, sediment deposition within the revetments formed a grassy berm below the original cutbank (Figure 63-5). And good shelter for trout formed along the interface between tree line and stream. At other sites though, lack of rock behind the trees was the primary reason for continued bank instability. After several floods, trees began to wash loose, or were left out of the water when the thalweg changed.

Several hundred feet of tree revetments were isolated after

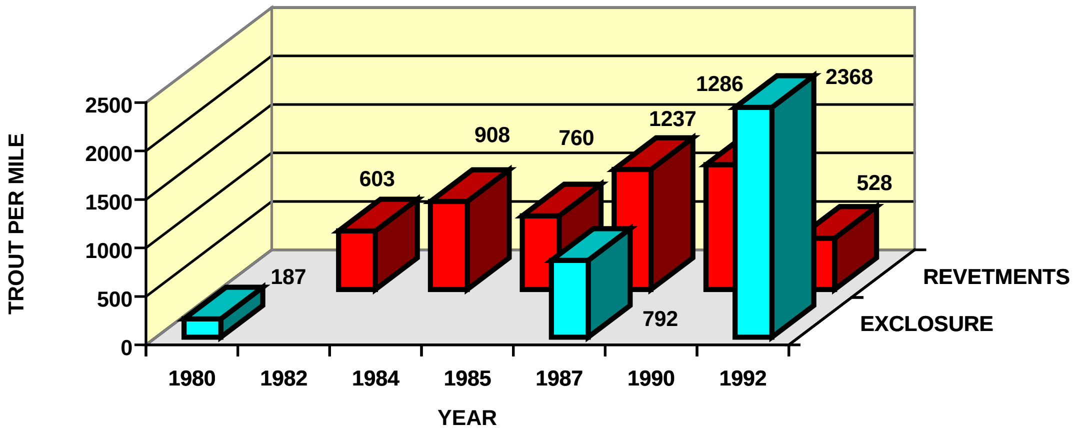


Figure 63-1. Abundance of trout within the exclosure and in the section containing tree revetments 1980-1992.

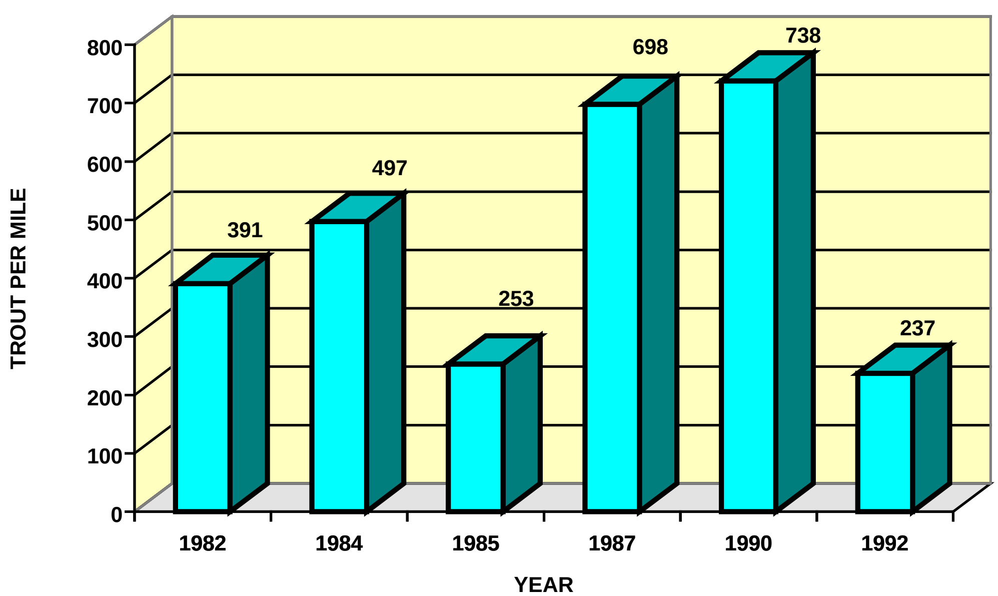


Figure 63-2. Abundance of catchable trout (6 inches, or longer, total length) in the tree revetment section at Tepee Creek 1982 (pretreatment) and 1992 (9 years posttreatment).

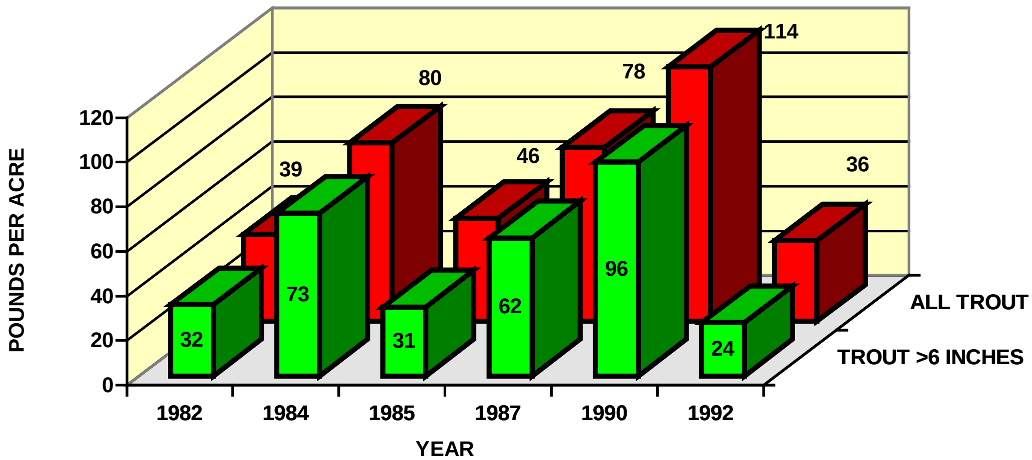


Figure 63-3. Biomass of trout within the tree revetment area at Tepee Creek 1982 (pretreatment) and 1992

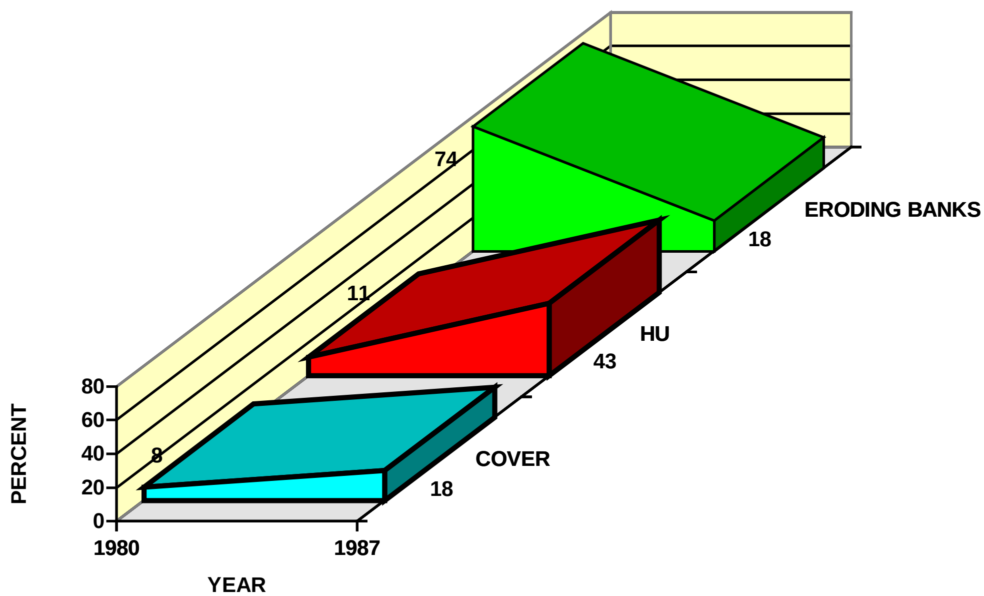


Figure 63-4. Posttreatment changes in trout cover and eroding banks within the exclosure at Tepee Creek 1980-1987.

On a beaver dam washed out and the creek formed a new channel. When the revetments were examined in 1994, several tree revetments resembled toothpicks and offered about as much cover (Figure 63-6). Others were effective LWD cover. Tree blocks along the bank tops helped control cattle trampling of stream banks, but were not entirely effective - more trees would have helped. Heavy grazing posttreatment continued to damage stream banks and the riparian vegetation.

Conclusions - Addition of tree revetments to control bank erosion at Tepee Creek was only about 50% effective after a decade. Good cover and stable banks were created at some sites, but not at others. Eroding banks continued to exist at many sites. The trees added LWD to the stream and helped trout in that respect. Although trout abundance initially increased posttreatment, deterioration of structures eventually caused a deterioration of the trout population. Flood damage over time to the revetments proved to be cumulative and could have been prevented with addition of rocks behind the revetments. Continued heavy grazing posttreatment did not help.

Removing cattle from the riparian area with the exclosure proved effective in increasing trout abundance over the long term. Performance of the revetments would have been better if livestock had been entirely fenced away from the stream.

INFORMATION SOURCES

Anonymous. 1980. Environmental assessment, Tepee Creek habitat improvement plan. Typewritten report, Pinedale Ranger District, Bridger-Teton National Forest, Pinedale.

Table 63-1. Trout abundance and biomass at Tepee Creek from 1978-1992, as determined by electrofishing samples.

LOCATION	YEAR	NO/MILE	NO/MILE >6 INCHES	LBS/ACRE	LBS/ACRE >6 INCHES
Exclosure	1978	35			
	1980	187		8	
	1987	792	532	69	58
	1992	2,368	776	218	99
Mean 1978-80 (pretreatment)		111		8	
Mean 1987-92 (posttreatment)		1,580	654	144	79
Pretreatment/Posttreatment Percent Change		1,323		1,614	
Revetments	1973	405			
	1982	603	391	39	32
	1984	908	497	80	73
	1985	760	253	46	31
	1987	1,237	698	78	62
	1990	1,286	738	114	96
	1992	528	237	36	24
Mean 1973-82 (pretreatment)		504	391	39	32
Mean 1984-92 (posttreatment)		944	485	71	57
Pretreatment/Posttreat		87	24	82	78

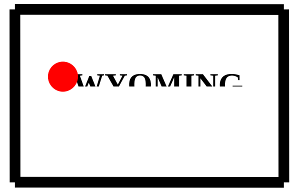
Figure 63-5. A decade after tree revetments were installed, this stream bank is stable. Although some trees near the stream curve are out of the water, the trees in the foreground (note branches protruding from the grass) have formed a grassy berm and offer overhead cover for trout.

Figure 63-6. This photo shows the contrast in effectiveness of the tree revetments. In the foreground, the bank is stable with woody debris shelter offered trout by the trees. However, at the top of picture, left, the bank there is still unstable and the trees were not effective at preventing bank erosion.

TOSI CREEK

SUBLETTE COUNTY

PROJECT BUILT: 1981



Drainage:	Green River	**Green River Basin (7GR)**	
Elevation:	7,990 ft	**R.** 110 **W., T.** 39 **N., S.** 16, SW 1/4	
Stream Order:	Fourth	**Stream Class:** 3 (regionally important)	
Watershed Area:	30 sqmi	**Mean Wetted Width:** 28 ft	
Gradient:	1.6%	**Land Status:** Bridger-Teton National Forest	
Rosgen Channel Type:	B-3	**Project Length:** 1.6 miles	
Treatment Used:	Log plunge, upstream "V" plunge, upstream "U" plunge, tree and rock revetments		
Trout Species:	Brook and cutthroat trout		

DESCRIPTION OF STREAM: A major tributary of the upper Green River, Rock Creek drains an easterly aspect of the Gros Ventre Range. Stream flow is natural from a rugged, forested watershed, which features conifers, aspen, grass-sagebrush-forb parks, and alpine vegetation. In the project area, the river bottoms are covered with a dense willow growth through which the stream flows in a relatively straight channel. A steep gradient and boulder-cobble stream bottom characterize the channel. Discharge is adequate during summer and late summer flows are not a problem.

PROJECT DESCRIPTION: Located between the falls and the Snook Moore Ranch, about 28 miles northwest of Pinedale, Tosi Creek was a cooperative project between WGF and Bridger-Teton National Forest. WGF furnished expertise, manpower, funds, and equipment, while USFS contributed funds to this comparatively small project. In 1935, the Civilian Conservation Corp (CCC) built 40 fish habitat improvement devices in this section. An evaluation in 1978 reported most of the CCC structures were washed out, seven were in "fair" condition, and only two rock-crib dams were still intact. A goal of the 1981 project was to supplement the historical CCC work with several new dams, and if time permitted, repair at least one CCC dam to extend its life.

THE FISHERY: BKT are the primary species, but the drainage contains a small resident population of wild CRC. Angler access is limited by the dense willow growth and by private land further downstream. However, jeep roads parallel both sides of the stream in the project area and the public can access the stream either through the Moore Ranch, or if the river crossing below the ranch is passable, by going around the ranch. Some anglers walk in. Fishing pressure is light, but Tosi Creek is an important BKT nursery stream for the Green River.

HABITAT MANAGEMENT: Much of the section is shallow riffle and rapids during summer, with only a few good pools. Needed were structures that would dig and maintain deep pools to slow flows and shelter trout. But the straight, steep channel below the falls produces a swift, strong river flow during the spring snowmelt runoff, which puts considerable pressure on manmade devices. As time, rocks, and funds were limited, a WGF construction crew installed only three plunges at widely separated locations, put in 175 ft of tree-rock revetments, and repaired one CCC rock crib dam by replacing rocks in the crib. Rocks and trees were obtained locally. Cost of the project was $4,555 ($2,850/mile).

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Pretreatment electrofishing records for the project area are lacking, but the population is believed to have been low. An electrofishing sample in 1982, a year after the structures were installed, found both BKT and CRC at a station that included one plunge. A control station without any habitat improvements contained no trout. When the treated station was sampled again in 1990, the trout population was virtually unchanged from 1982. Trout evidently moved into the new habitat soon after construction and the population has stabilized. Fewer catchable trout (6 inches, or longer, total length) occurred in 1990 (Figures 64-1 and 64-2, Table 64-1), but trout biomass had increased 29% over the 1982 level.

Trout Habitat Response - All three plunges initially furnished good pools. A decade after treatment, HQI score had increased 47% and cover was 22% better (Figure 64-3). By 1994, RPD was still 1.5 ft, or deeper, at the two surviving plunge pools and cover per plunge pool was 671 sqft. Including dam pools formed upstream from the plunges, 1,480 sqft of cover had been added to the stream.

Habitat Structures - Beaver built a dam on the log plunge soon after construction and when the dam washed out, the plunge was destroyed (Figure 64-4). When inspected in 1994 though, the remains of the plunge had functioned as a deflector and formed a good pool (RPD, 2 ft). By 1994, rotten timbers at the CCC plunge repaired by WGF had caused it to fail. However, it was still functioning as a double deflector and still had a good pool (RPD over 2.5 ft) having 440 sqft of cover. The upstream “V” and upstream “U” plunges built by WGF were still functional and in good condition (Figure 64-5). Of the two structures, the upstream “V” had the best pool (RPD, 2.35 ft). A CCC rock crib dam located just below the falls was still functional in 1994, but the middle timbers were showing some deterioration (Figure 64-6). After 59 years of service, this well built device was still furnishing about 500 sqft of cover in the plunge pool, where RPD was over 5 ft.

Conclusions - Addition of three plunges to Tosi Creek added 1,480 sqft of cover for trout. After 8 years, trout abundance near the devices had increased 2%, and biomass was 29% higher. But the project was too limited to significantly increase trout abundance in the 1.6-mile stretch of creek. Upstream “V” plunges appear to have the best potential to withstand the torrential spring runoff flows, provided beaver do not build dams on the devices. Washouts of beaver dams built on habitat improvement structures often occur at one side, thus forming a new channel and rendering the device inoperable. Examination of the CCC structures found channel changes on one side at several devices, suggesting beaver dam washouts may have caused those structures to fail.

INFORMATION SOURCES

Hogle, J. S. 1993. Salmonid habitat and population characteristics related to structural improvement in Wyoming streams. Masters thesis. University of Wyoming, Laramie.

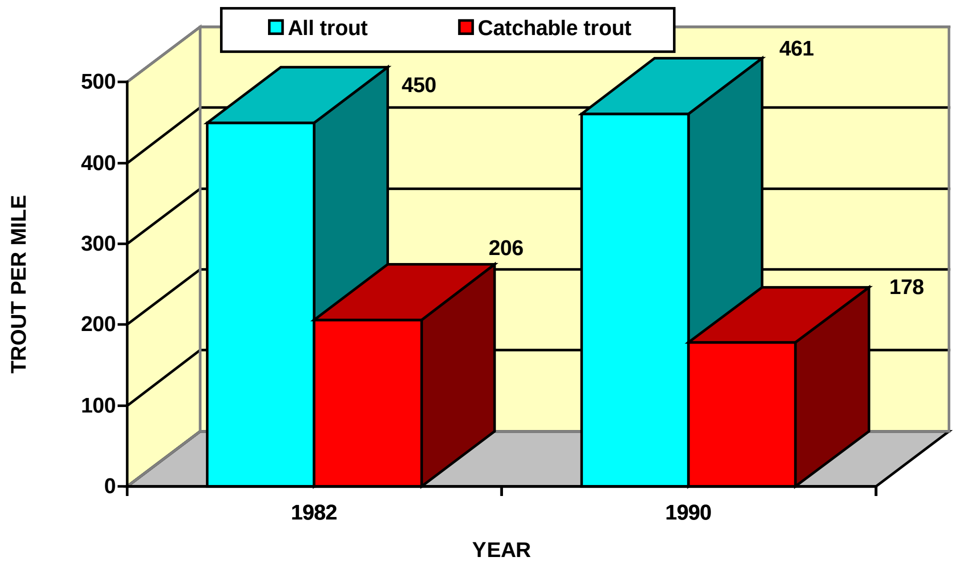


Figure 64-1. Abundance of trout in Tosi Creek one and nine years after habitat improvement. Catchable trout are 6 inches, or longer, total length.

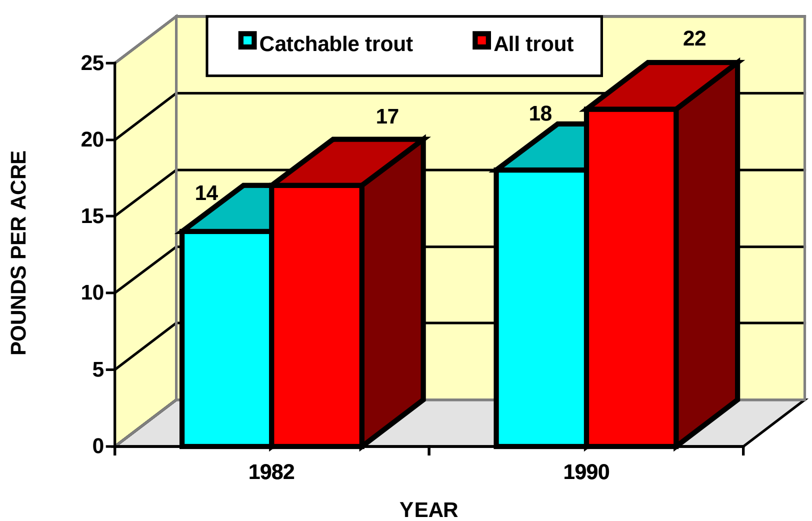


Figure 64-2. Biomass of trout before, and eight years after, installation of habitat improvement devices at Tosi Creek. Catchable trout are 6 inches, or longer, total length.

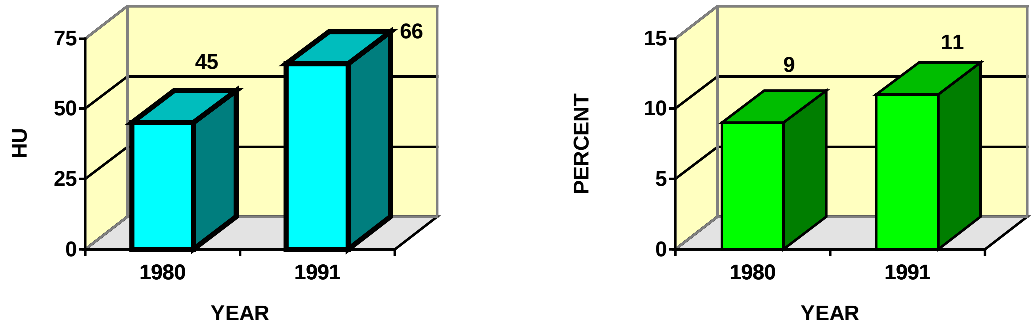


Figure 64-3. HQI score (left) and cover for trout (right) in Tosi Creek before (1980) and after (1991) habitat improvement.

Table 64-1 Mean empirical values for four characteristics of the Tosi Creek trout population after habitat improvement. Catchable trout are 6 inches, or longer, total length.

Year	Trout/mile	Lbs/acre	Catchable trout/mile	Catchable trout lbs/acre
1982	450	17	206	14
1990	461	22	178	18
PERCENT CHANGE	2	29	-14	28

Figure 64-4. A CCC rock crib dam built in 1935 on Tosi Creek was still functional in 1994 and furnishing deep pool habitat for trout.

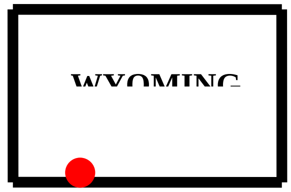
Figure 64-5. Beaver added their own dam to a log plunge constructed by WGF on Tosi Creek. Unfortunately, the next year's snowmelt flood washed out the beaver dam and took the log plunge with it.

Figure 64-6. An upstream "V" plunge built by WGF was in good condition 12 years after construction. It was furnishing both shelter to trout and a grade control to slow swift stream flows in this section.

TROUT CREEK

SWEETWATER COUNTY

PROJECT BUILT: 1953



Drainage:	Sage Creek	**East Side Flaming Gorge Tribs (3ES)**
Elevation:	7,300 ft	**R.** 105 **W., T.** 14 **N., S.** 17
Stream Order:	Second	**Stream Class:** 3rd (regionally important fishery)
Watershed Area:	8 sqmi	**Mean Wetted Width:** 4-7 ft
Gradient:	1%	**Land Status:** BLM, State
Rosgen Channel Type:	--	**Project Length:** 2,500 ft
Treatment Used:	Single log deflector, triangle log deflector, digger log, rock dam, fish rocks, rock deflector, cover trees and brush, rock filled wire crib.	
Trout Species:	Colorado River cutthroat trout	

DESCRIPTION OF STREAM: Trout Creek drains a northeast aspect of Little Mountain in an arid region east of Flaming Gorge Reservoir. Its valley is narrow and steep-sided. Springs and seeps in the upper drainage furnish a steady base flow, but snowmelt runoff and summer thunderstorms can produce floods. Normal summer discharge is about 4 cfs, maximum summer water temperature is in the mid-60s, TDS is 220 ppm, pH 8.3, and conductivity 375 mhos. Sagebrush and willow dominate the riparian area. Channel substrate is fine shale and gravel, with considerable silt and sand. Below the project, the stream is permanently diverted on private land for stock and irrigation use and becomes unsuitable for game fish.

PROJECT DESCRIPTION: Situated 45 miles southwest of Rock Springs, the project is accessed by a two-track dirt road leading from the Sage Creek county road. Project objective was to increase pools and other shelter for trout, but an overall project goal was to study feasibility and durability of habitat improvement structures in this stream type. WGF funded the project and constructed the habitat improvement structures using mostly native materials.

THE FISHERY: Trout Creek originally contained a small, self-sustaining population of CRC and mountain suckers. Initial surveys in the early 1950s found few CRC, so SRC were stocked periodically until 1974, when the decision was made to manage the stream for native CRC only. In the project reported here, fish were collected with electrofishing gear one year before treatment, immediately following structure installation and 16 months later.

HABITAT MANAGEMENT: Prior to treatment, long, shallow riffles were prominent and few pools were present (Figure 65-1). Cover for trout was limited to small holes under banks or overhanging brush. Decadent, silted-in beaver ponds were common drainage-wide, but a few active ponds provided vital living space for trout. Livestock, especially sheep, had heavily grazed much of the watershed. WGF Fisheries Management personnel installed 58 structures by hand: 16 log or trash deflectors, 7 digger logs, 6 rock dams, 4 rock deflectors, 3 triangle log deflectors, 2 rock-filled wire cribs, 1 double deflector, brush or cover trees at several sites, several log or rock bank protectors, and several clusters of fish rocks or grade controls.

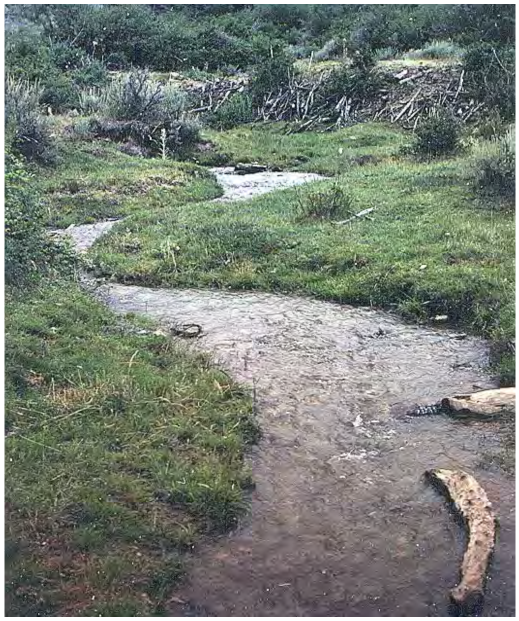


Figure 65-1. Pretreatment, Trout Creek contained mostly riffles and few pools. Its watershed was degraded from many years of extensive livestock grazing.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - Although the fishery was monitored post-treatment, results were inconclusive, as trout abundance had declined drastically by project end, apparently from illegal angling.

Trout Habitat Response - Additional pool and slack water created by the habitat improvement devices provided more living space for CRC. Good shelter for trout was created where currents were deflected under overhanging brush. In May 1954, trout were well distributed over the project area and were taking advantage of the new cover offered by the devices.

Habitat Structures - Variable results were posted by the different devices (Table 65-1). Unfortunately, gains in habitat were short lived due to silt deposition and channel changes. By 1976, all structures had disappeared.

Conclusions: An overgrazed watershed and a high sediment load in Trout Creek made fish habitat improvement impractical. Fish populations would have benefited more from a multi-use watershed plan to restore vegetative vigor so the watershed can function properly.

INFORMATION SOURCES

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Hagen, G. O. 1952. Study of fish populations and stream conditions prior to the installation of stream improvement devices. Project F-1-R-1, Job No. 1, Work Plan No. 1, Fish Division, Wyoming Game and Fish Department, Cheyenne.

Long, W. M. 1976. Trout Creek. Administrative Report, Project 4475-00-7301, Fish Division, Wyoming Game and Fish Department, Cheyenne.

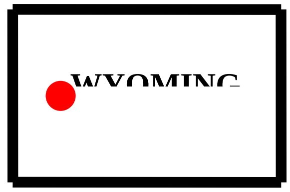
Table 65-1. Evaluation of habitat improvement devices 16 months after placement in Trout Creek.

Structure Type	Effectiveness of Structure
Digger Logs	Functioned as designed to create pools. Long-term value is doubtful due to stream cutting around or undercutting logs so digger log does not function.
Log “V” Wing Deflector	Functioned as designed. Effectively deflected currents under brush and banks to provide suitable shelter for trout.
Rock Dams and Rock-Filled Wire Cribs	Much silt deposition upstream from dams, leaving little fish habitat. But plunge pools created shelter.
Small Log Deflectors	Functioned as desired in 50% of cases, but long term value is doubtful due to debris and sediment accumulations
Rock Devices	Poor performance, many washed out or silted-in. Small pools formed near larger rocks, but long-term value is doubtful.

WARREN BRIDGE PFA - GREEN RIVER

SUBLETTE COUNTY

PROJECT BUILT: 1999



Drainage:	Colorado River	**Green River Basin (7GR)**	
Elevation:	7,550 ft	**R.** 111**W., T.** 36 **N., S.** 22,23	
Stream Order:	Fifth	**Stream Class:** 2 (statewide importance)	
Watershed Area:	~550 sqmi	**Mean Wetted Width:** 250 ft	
Gradient:	0.2%	**Land Status:** BLM and private (WGF Public Fishing Area)	
Rosgen Channel Type:	C-4	**Project Length:** ~8 miles	
Treatment Used:	Tree jams		
Trout Species:	Brown, rainbow, brook, and cutthroat trout.		

DESCRIPTION OF STREAM: The Green River heads in the Wind River, Gros Ventre, and Wyoming ranges. Granitic formations characterize the Wind River Range, while the Gros Ventre and Wyoming ranges feature sedimentary rock types. Much of the mountainous area is above timberline with prolonged snow cover, glaciers, and seasonal extremes in climate. Glacial flour colors the river a light green and discharge is strongly affected by snow and glacier melt. Although flow peaks during May and June, summer discharge often remains relatively high due to snowmelt through the summer. Flow usually drops sharply in early October when snowmelt lessens as winter approaches in the mountains. Coefficient of variation for the annual flow is 0.19, meaning the river has little year to year variation and ground water contributions are important. Annual mean discharge is ~500 cfs and mean annual runoff is 362,000 acre feet per year at the Warren Bridge USGS gage at upper Forty Rod Flat. Other than several irrigation diversions, there are no dams upstream from the project area; the flow pattern is essentially natural.

PROJECT DESCRIPTION: This fish habitat improvement project is a three year cooperative venture between BLM, WGF, and USFS as part of the Upper Green River Habitat Management Plan signed by these agencies in 1993. One goal of that plan is to increase fish production with instream structures. After an assessment of trout habitat in the Warren Bridge PFA identified 14 sites where additional LWD would benefit the fishery, a plan was developed whereby tree jams would be built in selected parts of the river upstream from Warren Bridge on Highway 191. Consequently, tree jams were built in the river in 1999 to increase shelter for trout by providing additional LWD. Additional construction is planned for following years.

THE FISHERY: The Green River in the Warren Bridge PFA supports a popular fishery for both boat and wading anglers. Many anglers use the area each year, fishing for both wild and stocked trout. Standard, statewide regulations apply.

HABITAT MANAGEMENT: Present habitat conditions through the Warren Bridge PFA limit the trout fishery. Some portions of the stream are wide and shallow, with few deep holes and virtually no large woody debris to shelter trout (Figure 66-1). Excessive areas of the river are typified by wide, shallow gravel and cobble riffles, which offer little holding water for trout (Figure 66-2). Sandbars are common in sections having slow flow. Some of the habitat shortcomings are due to past tie drives and abuse of the riparian area by agricultural interests. Lack of cover was identified as a primary factor limiting the trout population, so addition of LWD was prescribed to increase shelter for trout. In 1999, a joint WGF and BLM work crew, using a tracked excavator and a front-end loader rented from a private contractor, toiled to build five tree jams and one rock barb. In addition to funds from WGF and BLM, mitigation money from the Central Utah Project helped finance the project. As work is ongoing, no project cost information is available.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - New project, evaluation is ongoing.
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Trout Habitat Response - New project, evaluation is ongoing.
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Habitat Structures – New project, evaluation is ongoing.

Conclusions - New project, evaluation is ongoing.

INFORMATION SOURCES

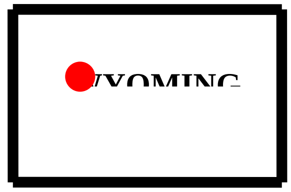
Anonymous. 1993. Upper Green River Habitat Management Plan. U. S. Department of the Interior, Bureau of Land Management, Rock Springs District, Pinedale Resource Area, Wyoming. Typewritten report.

Binns, N. A. 1972. An inventory and evaluation of the game and fish resources of the upper Green River in relation to current and proposed water development programs. Completion Report, Project B-002-Wyo, Wyoming Water Resources Research Institute, University of Wyoming, Laramie.

Figure 66-1. In the area where tree jams were built in October 1999, the Green River is a wide, meandering stream with few deep holes and virtually no woody debris.

Figure 66-2. Wide, shallow gravel and cobble riffles typify the Green River at the Warren Bridge PFA through the section where tree jams were installed in 1999. Sand deposits are common on the stream substrate where flow is slow in this section.

WIND RIVER
(Public Fishing Areas Near Dubois)



FREMONT COUNTY

PROJECT BUILT: 1978-1994

Drainage:	Wind River	**Wind River (above Reservation) Basin (6WU)**	
Elevation:	6,555-6,800 ft	**R.** 106 **W., T.** 41 **N., S.** 15, 30	
Stream Order:	Fifth, or greater	**Stream Class:**	2 (statewide importance)
Watershed Area:	~650 sqmi	**Mean Wetted Width:**	70 ft
Gradient:	0.6%	**Land Status:**	WGF Public Fishing Area
Rosgen Channel Type:	C-3	**Project Length:**	2,640 ft
Treatment Used:	Rock riprap		
Trout Species:	Brown and rainbow trout		

DESCRIPTION OF STREAM: Heading in the Wind River and Absaroka mountain ranges, the Wind River gathers water from various streams and lakes before entering the project area, which is located downstream from Dubois. Granitic formations characterize the Wind River Range, while the Absaroka Range features metamorphic rock types of volcanic origin. Much of the mountainous area is above timberline with prolonged snow cover, glaciers, and seasonal extremes in climate. Although flow peaks in May or June during the snow melt runoff, discharge usually remains adequate for trout through the summer. Formations at lower elevations in the basin are easily eroded and feed sediment into the river during spring runoff and the occasional summer rainstorm. Cottonwood trees and willows are the prominent riparian vegetation.

PROJECT DESCRIPTION: One segment of the project was at the Jakeys Fork PFA near the mouth of Jakeys Fork. Past landowner attempts to stabilize eroding stream banks and protect houses had channelized the river and destroyed river stability, so over several years, WGF hauled and installed rock riprap on several severely eroding banks. At the second segment, boulder riprap was added to stabilize an eroding stream bank upstream from the Highway 26 bridge. Funding was from normal WGF PFA maintenance moneys.

THE FISHERY: Access through private land to the river is provided by the WGF public fishing easements and the river provides a fishery for BNT and RBT that is popular with anglers. Statewide fishing regulations apply.

HABITAT MANAGEMENT: Installation of the rock riprap was an attempt to correct past abuses of the river channel, stabilize the channel, and provide more cover for trout. Work was done each spring when flow was low between ice-out and the spring runoff. Cost of the four-year project was $11,076 ($22,152/mile).

Figure 66-1. A formerly eroding stream bank has been stabilized with rock riprap. Woody debris visible in the picture washed in naturally during floods.

EVALUATION OF TROUT HABITAT MANAGEMENT

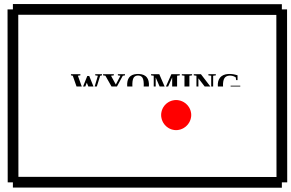
Fishery Response - No evaluation was attempted.

Trout Habitat Response - No evaluation was attempted.

Habitat Structures - Durability of the riprap has proved good, except when one bank revetment at the Jakeys Fork PFA was bulldozed by a misguided landowner and had to be reconstructed by a WGF crew. Formerly eroding banks have been stabilized by the riprap at both sites.

Conclusions - Installation of the rock revetments improved bank stability and increased shelter areas for trout.

WOLF CREEK
(WGF Casper Regional Office)



NATRONA COUNTY

PROJECT BUILT: 1995

Drainage:	North Platte River	**North Slope Laramie Range Basin (1LR)**	
Elevation:	5,120 ft	**R.** 80 **W., T.** 33 **N., S.** 24, NW 1/4	
Stream Order:	Second	**Stream Class:** 5 (low productivity)	
Watershed Area:	5 sqmi	**Mean Wetted Width:** 2 ft	
Gradient:		**Land Status:** WGF	
Rosgen Channel Type:		**Project Length:** 400 ft	
Treatment Used:	Timber plunges, rock sill, rock check dams, boulder plunge, rock riprap, tree/rock revetment		
Trout Species:	none		

DESCRIPTION OF STREAM: Heading on Casper Mountain, tiny Wolf Creek flows to the North Platte River through suburban Casper. Fed by springs, rainfall, and snowmelt, upper Wolf Creek is a steep gradient, step-plunge pool stream with a clean rocky substrate. In the lower drainage, water quality is uncertain due to the suburban setting and the stream is shallow with few pools. Stream banks in the project area are vegetated with trees, shrubs, and grass.

PROJECT DESCRIPTION: A variety of fish habitat improvement structures were installed in Wolf Creek at the WGF Casper Regional Office by a WGF construction crew. Purpose of the project was to provide a demonstration area where the public could view functioning habitat improvement devices. Funding was from a $2,000 Wyoming Wildlife - Worth the Watching grant. No records were kept of actual construction costs.

THE FISHERY: Although BKT occur in the headwaters and a few RBT have been reported from the section between the mountain and highway, Wolf Creek is considered unsuitable for trout in the project area. But when water conditions are favorable, trout may occasionally utilize the habitat provided by the devices.

HABITAT MANAGEMENT: Not a habitat management project - demonstration project only. Timber plunge, rock plunge, tree/rock revetment, and rock riprap are the demonstration devices built in Wolf Creek.

EVALUATION OF TROUT HABITAT MANAGEMENT

Fishery Response - No evaluation was attempted.

Trout Habitat Response - No evaluation was attempted.

Figure 68-1. A timber plunge (top of photo) and a rock plunge (foreground) slow flows in Wolf Creek and provide pool habitat for fish.

Habitat Structures - Structures were still functioning four years after installation.

Conclusions - No conclusions can be drawn. Demonstration project only.

A Compendium of Trout Stream Habitat Improvement Projects Done by the Wyoming Game and Fish Department, 1953-1998.

By

N. Allen Binns,
Aquatic Habitat Supervisor

Appendices

Fish Division
Wyoming Game & Fish Department

Cheyenne, Wyoming 82006
April, 1999

Appendix 1. Arbitrary success rates for four trout population variables summarized by stream order. The total trout category contains some trout populations with trout of hatchery origin. L1 success level is ≥ 25%; L2 success level is ≥ 50%. Interpretation example: At order 1, for number/mile, 80% of 5 wild trout populations subjected to habitat improvement had posttreatment percentage gains of 25%, or more, and 80% had percentage gains of 50%, or more.

		No/mile			Lbs/acre			No/mile > 6 inches			Lbs/acre > 6 inches		
			% Success			% Success			% Success			% Success	
Stream Order	Trout Present	No. Meas.	L1	L2	No. Meas.	L1	L2	No. Meas.	L1	L2	No. Meas.	L1	L2
1	Wild	5	80	80	3	100	100	1	100	100	1	100	100
	Total	9	89	89	6	100	100	5	100	100	5	100	80
2	Wild	11	73	73	7	73	64	7	57	57	7	57	57
	Total	13	77	77	13	77	69	9	67	67	9	67	67
3	Wild	6	100	83	6	100	83	5	100	100	4	100	100
	Total	11	91	82	10	90	70	9	89	89	8	88	88
4	Wild	6	83	67	4	100	75	5	80	80	4	75	75
	Total	8	75	63	5	80	60	7	86	71	6	83	67
≥5	Wild	2	50	50									
	Total	3	67	67	2	50	50	1	100	100			

Appendix 2. Arbitrary success rates for four trout population variables summarized by stream elevation. The total trout category contains some trout populations with trout of hatchery origin. L1 success level is ≥ 25%; L2 success level is ≥ 50%. Interpretation example: At elevation group 6,000-6,999 ft, for number/mile, 75% of 8 wild trout populations subjected to habitat improvement had posttreatment percentage gains of 25%, or more, and 63% had percentage gains of 50%, or more.

		No/mile			Lbs/acre			No/mile > 6 inches			Lbs/acre > 6 inches		
			% Success			% Success			% Success			% Success	
Stream Elevation (feet)	Trout Present	No. Meas.	L1	L2	No. Meas.	L1	L2	No. Meas.	L1	L2	No. Meas.	L1	L2
<6,000	Wild	7	100	100	6	100	100	6	100	100	5	100	100
	Total	6	100	100	5	100	100	6	100	100	4	100	100
6,000 - 6,999	Wild	8	75	63	6	83	50	3	100	100	3	100	100
	Total	9	67	67	6	83	33	2	100	100	2	100	100
7,000 - 7,999	Wild	11	73	64	10	70	60	7	57	57	7	57	57
	Total	16	75	63	15	73	67	11	73	64	11	64	45
8,000 - 8,999	Wild	4	75	75	3	100	100	2	50	50	1	100	100
	Total	10	90	90	8	88	88	9	78	78	8	88	88

Appendix 3. Arbitrary success rates for four trout population variables summarized by stream gradient. The total trout category contains some trout populations with trout of hatchery origin. L1 success level is ≥ 25%; L2 success level is ≥ 50%. Interpretation example: At gradient <0.5%, for number/mile, 83% of 6 wild trout populations subjected to habitat improvement had posttreatment percentage gains of 25%, or more, and 50% had percentage gains of 50%, or more.

		No/mile			Lbs/acre			No/mile > 6 inches			Lbs/acre > 6 inches		
			% Success			% Success			% Success			% Success	
Stream Gradient	Trout Present	No. Meas.	L1	L2	No. Meas.	L1	L2	No. Meas.	L1	L2	No. Meas.	L1	L2
<0.5	Wild	6	83	50	5	100	80	4	100	100	3	100	100
	Total	8	75	50	6	83	67	7	100	86	5	80	80
0.5 - 0.99	Wild	8	88	88	6	83	67	5	80	80	4	100	100
	Total	14	93	86	12	83	75	10	80	80	9	89	89
1.0 - 1.99	Wild	10	70	70	10	70	60	7	57	57	7	57	57
	Total	13	77	77	13	77	62	10	70	70	10	70	50
2.0 - 2.99	Wild	0											
	Total	1	100	100									
3.0 - 3.99	Wild	3	67	67	2	100	100	2	100	100	2	100	100
	Total	4	50	50	2	100	100	3	100	100	3	100	100
>4.0	Wild	2	100	100	2	100	100						
	Total	3	100	100	2	100	100						

Appendix 4. Arbitrary success rates for four trout population variables summarized by stream class. The total trout category contains some trout populations with trout of hatchery origin. L1 success level is ≥ 25%; L2 success level is ≥ 50%. Interpretation example: At class 3, for number/mile, 71% of 17 wild trout populations subjected to habitat improvement had posttreatment percentage gains of 25%, or more, and 65% had percentage gains of 50%, or more.

		No/mile			Lbs/acre			No/mile > 6 inches			Lbs/acre > 6 inches		
			% Success			% Success			% Success			% Success	
Stream Class	Trout Present	No. Meas.	L1	L2	No. Meas.	L1	L2	No. Meas.	L1	L2	No. Meas.	L1	L2
1	Wild	0											
	Total	0											
2	Wild	4	100	75	3	67	100	4	100	100	3	100	100
	Total	6	100	83	5	100	100	6	100	100	4	100	100
3	Wild	17	71	65	15	80	60	10	60	60	9	78	67
	Total	27	74	67	22	77	59	19	74	68	18	78	67
4	Wild	8	88	88	7	86	86	4	100	100	4	100	100
	Total	9	89	89	8	88	88	5	100	100	5	80	80
5	Wild	0											
	Total	1	100	100									

Appencix 5. Arbitrary success rates for four trout population variables summarized by Rosgen classification. The total trout category contains some trout populations with trout of hatchery origin. L1 success level is ≥ 25%; L2 success level is ≥ 50%. Interpretation example: At Rosgen class B, for number/mile, 83% of 7 wild trout populations subjected to habitat improvement had posttreatment percentage gains of 25%, or more, and 83% had percentage gains of 50%, or more.

		No/mile			Lbs/acre			No/mile > 6 inches			Lbs/acre > 6 inches		
			% Success			% Success			% Success			% Success	
Rosgen Class	Trout Present	No. Meas.	L1	L2	No. Meas.	L1	L2	No. Meas.	L1	L2	No. Meas.	L1	L2
A	Wild	3	100	100	2	100	100						
	Total	3	100	100	2	100	100						
B	Wild	7	83	83	6	100	83	4	75	75	4	100	75
	Total	10	67	67	7	100	71	6	83	83	6	100	83
C	Wild	16	88	75	14	86	71	11	100	91	9	89	89
	Total	27	89	74	24	83	75	22	91	86	18	89	83
D	Wild	1	100	100									
	Total	1	100	100									
E	Wild	2	0	0	2	0	0	2	0	0	2	0	0
	Total	1	0	0	2	0	0	2	0	0	2	0	0

Appendix 6. Mean empirical values for four trout population variables averaged over habitat improvement projects sorted for stream order. No. Meas. is number of projects with measurements; % chg. is mean percent change; RZ is reference zone; TZ is treated zone. The mixed trout category summarizes all projects combined and includes both those containing only wild trout and those where fish of hatchery origin were present.

		No/mile				Lbs/acre				No/mile > 6 inches				Lbs/acre > 6 inches			
Stream Order	Trout Present	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.
1	Wild	5	208	653	203	3	19	59	183	1	60	147	145	1	10	22	120
	Mixed	9	373	1,105	569	6	31	117	418	5	116	730	812	5	20	97	492
2	Wild	11	295	734	513	11	57	101	353	7	233	317	223	7	61	72	152
	Mixed	13	351	791	444	13	55	102	321	9	228	378	211	9	55	78	161
3	Wild	6	358	902	169	6	21	73	344	5	139	393	187	4	17	119	195
	Mixed	11	407	870	124	10	34	74	233	9	129	331	151	8	13	69	165
4	Wild	6	1,178	2,088	194	4	52	97	86	5	824	1,574	142	4	46	86	91
	Mixed	8	974	1,692	163	5	43	79	70	7	604	1,154	133	6	33	60	70
5	Wild	2	24	24	236	2	2	1	-52								
	Mixed	3	411	684	180	2	14	22	10	1	989	1,654	66				

Appendix 7. Mean empirical values for four trout population variables averaged over habitat improvement projects sorted for stream elevation. No. Meas. is number of projects with measurements; % chg. is mean percent change; RZ is reference zone; TZ is treated zone. The mixed trout category summarizes all projects combined and includes both those containing only wild trout and those where fish of hatchery origin were present.

		No/mile				Lbs/acre				No/mile > 6 inches				Lbs/acre > 6 inches			
Stream Elevation (feet)	Trout Present	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.
<6,000	Wild	7	328	1,081	607	6	33	111	380	6	161	527	389	5	25	134	304
	Mixed	7	328	1,081	607	6	33	111	380	7	279	687	343	5	25	134	304
6,000 - 7,000	Wild	8	160	276	210	6	24	49	99	3	121	232	140	3	15	32	118
	Mixed	11	227	438	179	7	45	74	90	4	101	205	152	4	13	28	111
7,000 - 8,000	Wild	11	757	1,380	167	10	61	84	187	7	655	1,012	57	7	69	75	54
	Mixed	16	720	1,321	156	15	50	75	152	11	467	780	90	11	52	64	73
8,000 - 9,000	Wild	4	369	1,093	381	3	23	104	679	2	297	627	152	1	32	57	78
	Mixed	10	511	1,185	540	8	27	112	523	9	168	616	479	8	18	77	360

Appendix 8. Mean empirical values for four trout population variables averaged over habitat improvement projects sorted for stream gradient. No. Meas. is number of projects with measurements; % chg. is mean percent change; RZ is reference zone; TZ is treated zone. The mixed trout category summarizes all projects combined and includes both those containing only wild trout and those where fish of hatchery origin were present.

		No/mile				Lbs/acre				No/mile > 6 inches				Lbs/acre > 6 inches			
Stream Gradient	Trout Present	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.
< 0.5	Wild	6	997	1,697	189	5	45	86	131	4	853	1,638	179	3	41	80	121
	Mixed	8	838	1,399	160	6	38	72	110	7	644	1,261	143	5	27	52	84
0.5 - 0.99	Wild	8	402	844	180	6	29	67	113	5	291	618	147	4	30	59	101
	Mixed	14	423	875	373	12	25	65	221	10	200	511	363	9	23	60	255
1.0 - 1.99	Wild	10	315	765	305	10	51	85	395	7	220	287	130	7	57	107	162
	Mixed	14	518	1,188	271	14	60	111	325	11	208	469	202	11	45	99	203
2.0 - 2.99	Wild																
	Mixed																
3.0 - 3.99	Wild	3	119	595	913	2	34	151	549	2	47	275	546	2	21	60	216
	Mixed	4	138	501	688	2	34	151	549	3	69	362	485	3	21	67	235
> 4.0	Wild	3	282	987	313	2	23	68	203								
	Mixed	3	282	987	313	2	23	68	203								

Appendix 9. Mean empirical values for four trout population variables averaged over habitat improvement projects sorted for WGF stream class. No. Meas. is number of projects with measurements; % chg. is mean percent change; RZ is reference zone; TZ is treated zone. The mixed trout category summarizes all projects combined and includes both those containing only wild trout and those where fish of hatchery origin were present.

		No/mile				Lbs/acre				No/mile > 6 inches				Lbs/acre > 6 inches			
Stream Class	Trout Present	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.
1	Wild																
	Mixed																
2	Wild	4	1,652	2,997	170	3	64	122	104	4	978	1,923	182	3	56	109	113
	Mixed	6	1,486	2,646	136	5	52	106	115	6	867	1,705	165	4	48	105	150
3	Wild	17	302	646	264	15	42	78	316	10	232	363	134	9	48	95	162
	Mixed	28	376	815	325	23	43	87	303	20	171	418	290	19	30	74	231
4	Wild	8	202	624	440	7	28	83	248	4	67	219	347	4	21	42	134
	Mixed	9	200	591	399	8	31	85	230	5	78	234	305	5	25	53	131
5	Wild	1	194	1,377	610												
	Mixed	1	194	1,377	610												

Appendix 10. Mean empirical values for four trout population variables averaged over habitat improvement projects sorted for Rosgen stream classification. No. Meas. is number of projects with measurements; % chg. is mean percent change; RZ is reference zone; TZ is treated zone. The mixed trout category summarizes all projects combined and includes both those containing only wild trout and those where fish of hatchery origin were present.

		No/mile				Lbs/acre				No/mile > 6 inches				Lbs/acre > 6 inches			
Rosgen Class	Trout Present	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.	No. Meas.	RZ	TZ	% Chg.
A	Wild	3	282	987	313	2	23	68	203								
	Mixed	0															
B	Wild	8	199	298	606	7	20	103	618	5	98	275	311	5	18	108	201
	Mixed	11	253	811	465	8	39	118	545	7	97	294	184	7	17	91	205
C	Wild	16	611	1,197	190	14	34	72	151	11	459	929	179	9	32	64	154
	Mixed	27	610	1,210	281	24	32	78	195	22	335	777	289	19	24	65	225
D	Wild	1	6	36	500												
	Mixed	1	6	36	500												
E*	Wild	2	666	400	-37	2	179	122	-31	2	480	302	-37	2	156	115	-28
	Mixed	2	666	400	-37	2	179	122	-31	2	480	302	-37	2	156	115	-28

* Heavy fishing pressure adversely affected the fish population in Beartrap Creek.