EFFECTS OF STREAM ALTERATIONS ON RAINBOW TROUT IN THE BIG WOOD RIVER, IDAHO

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ABSTRACT

Historically, the Big Wood River was one of Idaho's premier wild rainbow trout Salmo gairdneri streams. Since the 1940's, man-induced activities have extensively altered riparian and in-stream habitat. Most activities have been associated with development of floodplain areas and attempts to control flooding.

The biological impact of habitat alterations is examined in the paper. In 1986 and 1987, habitat types and cover components were mapped and correlated with the density and age structure of the trout population. Fish populations were assessed via mark-recapture electrofishing and snorkeling. Densities of wild rainbow trout increased as the areas of lateral scour pools, rapids, steep riffles, and plunge pools increased. Woody debris components were positively correlated with densities of trout. Snorkel surveys revealed significantly larger densities of trout in association with cover components as compared to sites without cover. Trout densities increased as the cover area increased. Locations with riprap and locations without cover supported similar trout densities.

INTRODUCTION

Historically, the Wood River drainage supported a high-quality rainbow trout Salmo gairdneri fishery end was recognized as one of the premier wild trout streams in Idaho. The drainage contains the largest area and most productive trout waters in south central Idaho (Thurow 1987).

Since the 1940s, man-induced activities have extensively altered trout habitat in the drainage. The most significant channel alterations have included: channel relocation, diking, channel clearance, and riprapping. Concurrent with channel alterations has been loss of riparian habitat. Most activities have been associated with attempts to control flooding, development of floodplain areas, and road construction. Studies conducted in 1967 and 1968 indicated 21 km of stream (22% of the area surveyed) had been altered on the main stem Big Wood River (Irizarry 1969). Simultaneously, as development proceeded, recreational opportunities in the Wood River Valley resulted in increased angling pressure. Between 1960 and 1980, Idaho's population increased by 41%. During the same period, the population of the upper Wood River Valley (Bellevue, Hailey, Ketchum, and Sun Valley) has increased by 123%.

Information on the fishery resource was incomplete, so in 1986, the Idaho Department of Fish and Game initiated an intensive fishery investigation of the Wood River Basin. The project was designed to evaluate the current status of game fish and define factors that may be limiting the population. This paper reports data from one job of a multi-faceted project.

DESCRIPTION OF STUDY AREA

The Big Wood River drainage is located in south central Idaho, encompassing portions of Blaine, Camas, Gooding and Lincoln counties. From its origin near Galena Summit, the river flows south-southwest approximately 99 km to Magic Reservoir. Below Magic Reservoir, the Big Wood River flows 89 km to its confluence with the Little Wood River near Gooding. The Malad River forms at this juncture and flows 19 km to its confluence with the Snake River near Hagerman. The watershed encompasses more than 77,400 hectares and drops in elevation from 3,000 m at its headwaters to 930 m at its confluence with the Snake River. Maximum stream discharge occurs from April through July and typically peaks in early June as the result of snowmelt from higher elevations.

Castelin and Chapman (1972) provide detailed descriptions of the study areas: climate, geography, hydrology, and water quality.

As a result of its geology, the Wood River Basin's fish fauna reflects drainage isolation. Hubbs and Miller (1942) describe the Wood River drainage as exhibiting partial isolation and disruption, with faunal peculiarities. Nonanadromous redband trout are the indigenous trout. Behnke (1979) describes specimens collected by Evermann in the 1890s with unique morphological characteristics. and suggested that the trout native to the Wood River represents an older, relic form of redband trout. Another species, the Wood River sculpin *Cottus leiopomus*, is endemic to the Wood River Basin.

METHODS

We applied a stream classification system proposed by Rosgen (1985) to stratify the Big Wood River above Magic Reservoir. Seven reaches were randomly selected within the various geomorphic stream types. Three methods were applied to evaluate the importance of various habitat types and cover components to trout populations. First, we correlated densities of trout with the area of various habitat types and cover components within reaches. Mark-recapture population estimates were completed via electrofishing within each reach. We surveyed each reach on foot and mapped habitat types and cover components. Using a rangefinder and tape, we established transects at 100 m intervals proceeding upstream. At each transect, we collected the following data: channel width, maximum depth, streambank stability rating, substrate, and streambank vegetative stability (Platts et al. 1983). Simultaneously, we identified different habitat types (riffles, pools, glides, etc.) using the definitions proposed by Bisson et al. (1982) . The length and average width of each habitat were measured to enable surface area estimation. The lengths and areas of each habitat type were summed for each reach. We also recorded cover components (woody debris, undercuts, vegetative overhang, partially exposed boulders, etc.). The length and average width of each cover component were measured to estimate area. The areas of each cover component were also summed for each reach.

Second, we conducted snorkel surveys of trout and compared fish densities associated with various cover components. Snorkel locations were systematically selected proceeding upstream at each location. A test site containing cover components (woody debris, undercuts, vegetative overhang, etc.) and a control site (identical habitat type without cover components) were paired. Sites containing riprap were also surveyed. All salmonids were counted by 100 mm size groups at each site. Following each count, we classified habitat and cover components and measured the surface area of stream counted.

Third, we conducted snorkel surveys of trout within an entire habitat type and correlated fish densities with the area of cover components. Habitats were systematically selected while proceeding upstream. All salmonids were counted by 100 mm size groups within each site. Following each count, we measured the surface area of the habitat and the total area of various cover components. The areas of each cover component were summed for each site and expressed as a percentage of the total.

RESULTS

Within mapped reaches of the Big Wood River, low-gradient riffles were the dominant habitat type, accounting for 57% of the total surface area. Lateral scour pools were the next most common habitat type, accounting for 24% of the surface area. Backwater pools, convergent channel pools, dammed pools, plunge pools, and secondary channel pools were infrequent. Despite having large individual dimensions, glides were not common and comprised 12% of the surface area. Steep riffles and rapids were also uncommon.

Large woody debris was the most abundant cover component, followed by roots and undercut banks. Although we did not attempt to quantify depth as a cover component, it is probably an important component in pools. As Bisson et al. (1982) observed, cover quantity and diversity was generally largest in pools.

Densities of age 1 and older wild rainbow trout tended to increase as the areas of lateral scour pools, rapids, riffles, steep riffles, and plunge pools increased (Table 1). Our surveys suggest that few trout reside in rapids and steep riffles. These habitat types contribute to the overall trout density within the stream reach, because pools are commonly found both above and below steep riffles and rapids, which function as hydraulic controls.

Woody debris, including root clusters, root wads, tree stumps, and large woody debris, were preferred cover components for wild rainbow trout (Table 1). Densities of trout increased as the area of these components increased. Conversely, densities of wild rainbow trout were negatively correlated with the areas of unanchored, small woody debris and grass.

Correlations were also completed after excluding Reach 6 (catch-and-release) from the remaining reaches managed under general angling regulations. Although the relationships did not change appreciably, correlations of fish density with root clusters, debris jams, large woody debris, and stumps were strengthened (Table 1).

Snorkel surveys reveled that densities of wild rainbow trout were larger in habitats with cover components than in areas with no cover or riprap (Table 2). Trout densities (fish/100 m) were eight to ten times larger where cover components were present. We observed an average of 17.4 trout/100 m^2 at sites with cover, 1.2 trout/100 m^2 with no cover, and 2.1 trout /100 m^2 with riprap An analysis of variance (P>.05) found no significant difference between the density of trout at locations with no cover and locations with riprap.

Snorkel counts of fish within an entire habitat verified that wild rainbow trout were most abundant in pool habitats; including secondary channel, plunge, lateral scour, and backwater type pools (Table 3). Although riffles and glides account for a majority of the total surface area within most stream reaches, these habitats support small densities of trout.

The presence of cover components had a pronounced effect on trout abundance. Of 2,224 trout observed in 37 sites, 71% were associated with cover components (Table 4). A larger proportion of the trout observed were associated with mid-channel areas than with no-cover or riprapped bank aareas. Densities of trout increased as the area of cover components increased. A linear relationship between percent cover and fish density was evident for all habitat types (Figure 1) and within lateral scour pools (Figure 2).

Table 1. Average Pearson correlations between density of wild rainbow trout and various habitat types and cover components, Big Wood River, 1986. Densities derived by electrofishing.

	Habitat type								
	Back water pools	Convergent channel pools	Glides	Lateral scour pools	Plunge pools	Riffles	Rapids	Secondary channel pools	Steep riffles
Density of wild rainbow trout Reaches 1 through 7	-0.178	-0.286	-0.051	+0.754	+0.515	+0.648	+0.736	+0.364	+0.580

	Cover components										
	Root clusters	Brush	Debris jams	Grass	Large woody debris	Riprap	Root wads	Unachored small debris	Stumps	Trees	Undercut banks
Density of wild rainbow trout Reaches 1 through 7	+0.845	-0.056	+0.148	-0.440	+0.434	-0.293	+0.862	-0.895,	+0.524	+0.078	-0.213
Density of wild rainbow trout excluding Reach 6	+0.865	-0.171	+0.352	-0.571	+0.901	-0.033	+0.846	-0.901	+0.571	-0.039	-0.149

Table 2. Density of wild rainbow trout observed in snorkeling transects in association with cover, no cover, and riprap, Big wood River, 1986.

Category	Reach (trout/100 m) 1	2	3	4	6	Mean trout/ 100 m	Mean trout/$_2$ 100 m	Variance	Standard deviation	Sample size
Cover component	12.0	51.8	126.4	43.8	43.9	57.4	17.4	0.81	0.284	90.0
No cover component	0.9	9.1	9.7	4.1	4.0	5.7	1.2	0.001	0.025	85.0
Riprap	--	8.8	--	9.1	6.4	8.2	2.1	0.001	0.028	9.0

Table 3. Density of wild rainbow trout observed in different habitat types by snorkeling, Big Wood River, 1987.

Habitat type	Density (trout per 100 m^2) by reach: 2 Density (N)	3 Density (N)	4 Density (N)	Mean trout/100 m^2	Mean trout/100 m	Sample size
Lateral scour pools	18.1 (7)	23.4 (5)	26.3 (5)	22.2	278.7	17
Riffles	4.6 (4)	2.8 (1)	10.5 (2)	5.7	83.8	7
Secondary channel pools	70.1 (1)	**- (O)**	61.7 (2)	63.0	376.0	3
Glides	21.1 (2)	7.3 (3)	6.3 (2)	9.3	179.1	7
Plunge pools	30.8 (1)	- (O)	**- (O)**	30.8	197.3	1
Backwater pool	**- (O)**	10.9 (1)	27.7 (1)	21.5	153.3	2
Totals	15.8 (15)	11.0 (10)	20.0 (12)			37

Table 4. Number and percent of wild rainbow trout observed in snorkeling transects in association with cover, no cover, mid-channel, and riprap areas, 1987.

	Trout by reach							
	2		3		4		Total	trout
Category	No.	(%)	NO.	(%)	No.	(%)	No.	(%)
Cover component	599	(79)	367	(69)	613	(65)	1,579	(71)
No cover component	102	(14)	38	(8)	83	(9)	223	(10)
Mid-channel	50	(7)	124	(23)	169	(18)	343	(15)
Riprap	3	(1)	-	-	76	(8	79	(4)
Totals	754		529		941		2,224	

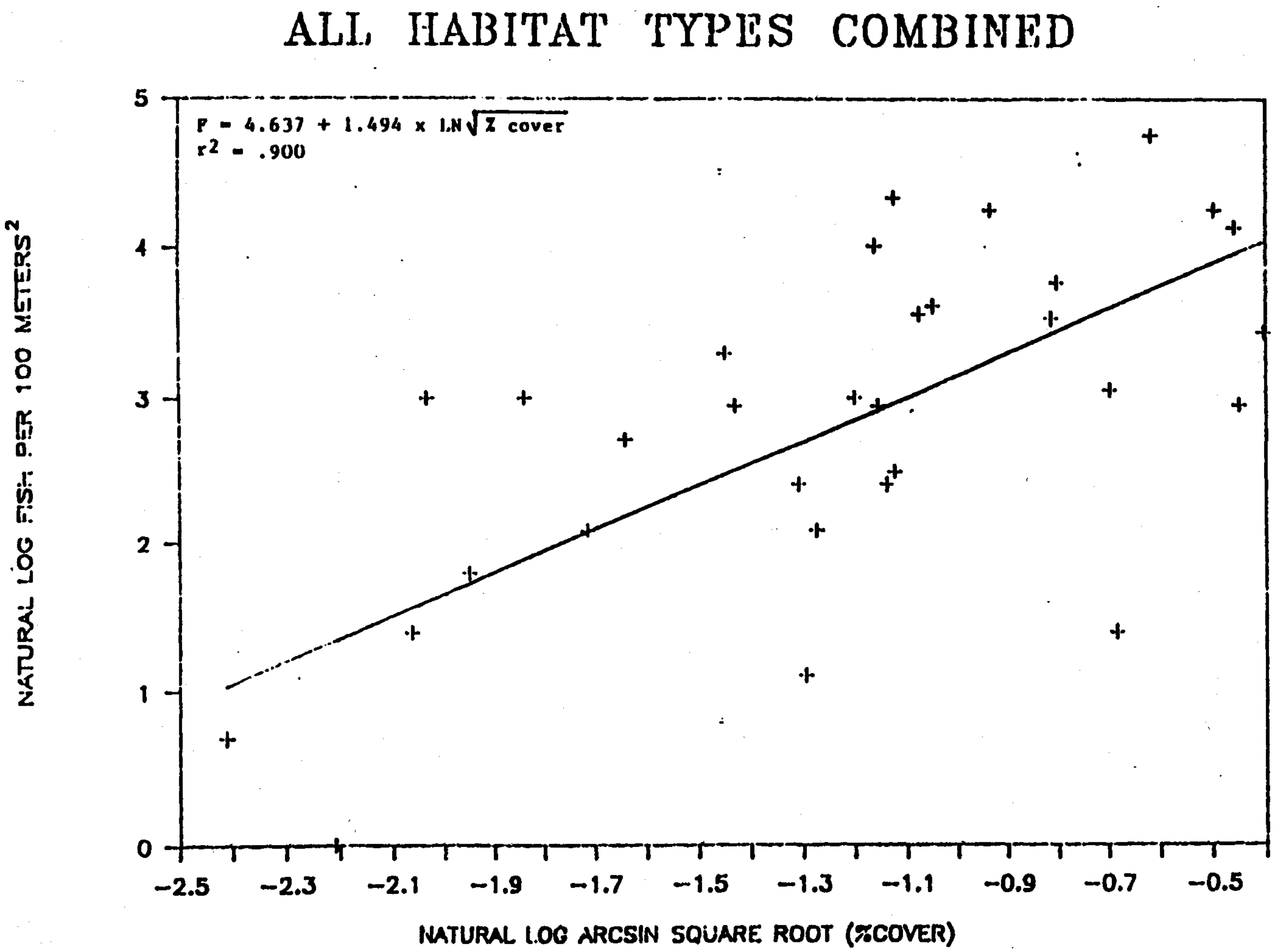

Figure 1. Linear regression of rainbow trout density versus percent cover in snorkel sites, all habitat types combined.

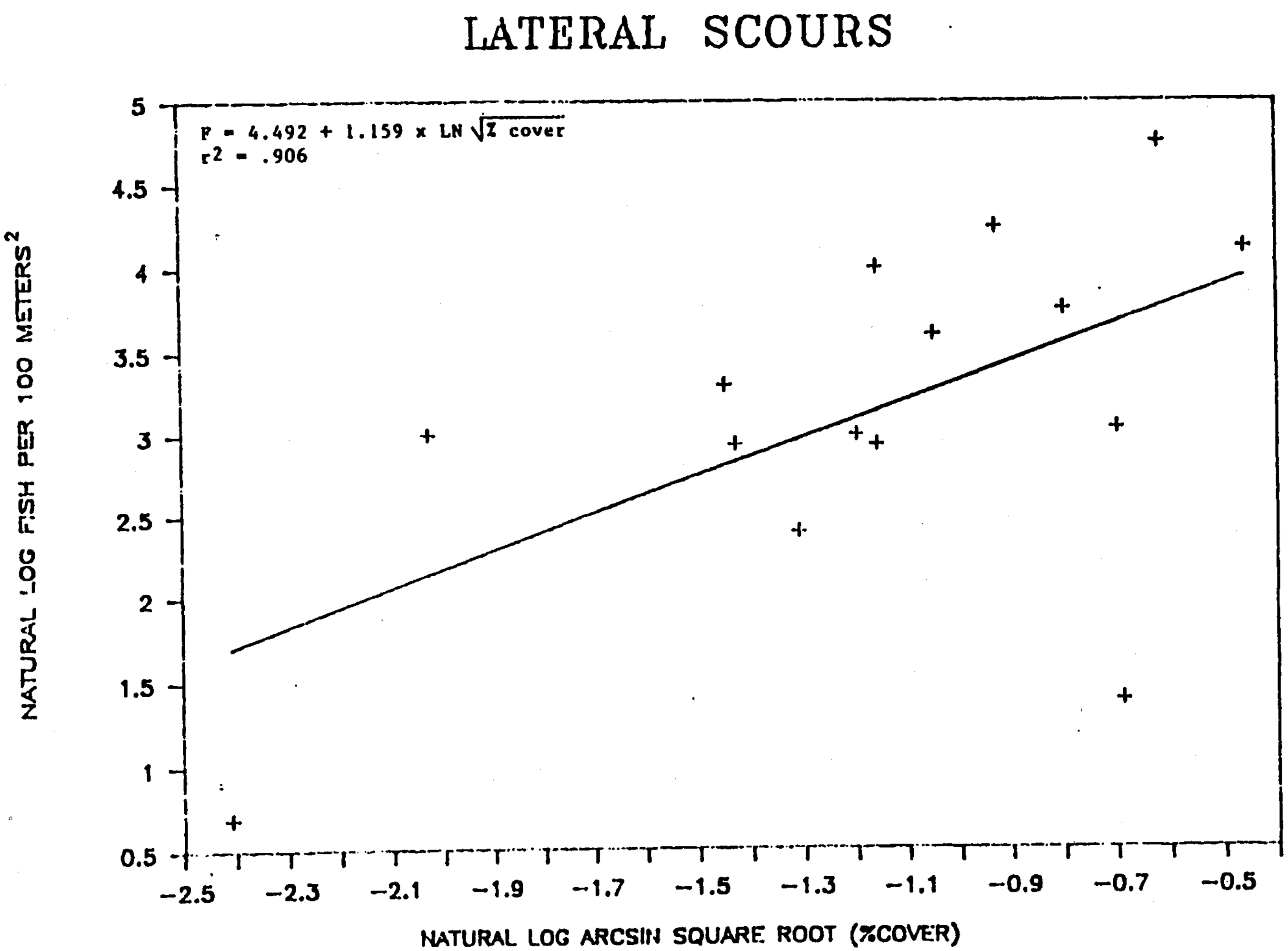

Figure 2. Linear regression of rainbow trout density versus percent cover in snorkel sites, lateral scour pools.

DISCUSSION

While it may be a shadow of its former fishery, the Big Wood River still maintains a viable wild rainbow trout population. Trout densities exceed 700 trout per km in some reaches and growth rates are comparable to other, highly productive, Idaho waters as the Henry's Fork Snake River and Silver Creek. Angler effort averages 150 angler days per km and catch rates exceed one fish per hour (Thurow 1987).

Although several factors, including angler harvest and irrigation withdrawal affect its fish populations, the most critical factor limiting the trout population in the Big Wood River appears to be the amount and quality of fish habitat. Annual mortality rates of age three and older rainbow trout are large. Within areas managed with general angling regulations, mortality rates equaled 76% and 78%, respectively, for trout sampled by electrofishing and angling (Thurow 1987). Within a catch-and-release area, annual mortality rates equaled 70% for trout sampled by electrofishing. It appears that compensatory mortality as Ricker (1975) described may be occurring. As angling mortality increased, natural mortality comprised a smaller proportion of the total mortality within general regulation reaches. Within the catch-and-release area, the reverse is true. As the percent of large woody debris increased, annual mortality rates decreased suggesting that cover quantity and quality affects annual mortality rates.

The reduction in trout populations following stream alterations is well documented. Alterations of the stream channel and riparian habitat adversely affect stream hydraulics (Marston 1982; Bottom et al. 1985), nutrient pathways (Schlosser 1982), invertebrate production (Benke et al. 1985), and fish production. Within Idaho, portions of 45 streams, totaling 1,830 km, were surveyed in 1967 and 1968 (Irizarry 1969). Undisturbed stream reaches outproduced altered areas with 1.5 to 112 times the biomass of game fish. Unaltered reaches supported seven times more catchable-sized trout and eight times the biomass of trout. Alterations reduced fish production by 80 to 90%. In Montana, undisturbed reaches of 13 streams supported 3.5 times the number and 9 times the biomass of trout in altered reaches (Peters and Alvord 1964). Whitney and Bailey (1959) documented a 94% decrease in number and biomass of trout following stream alteration.

Within the Big Wood River, fish populations in altered stream reaches have declined. Irizarry (1969) found game fish populations in altered reaches of the Big Wood River were one-tenth of those 1n unaltered, or "natural" reaches. In 1986 and 1987 trout densities were eight to ten times larger in unaltered reaches where cover components were present than in reaches with no cover or rock revetments. Densities of wild rainbow trout increased as the area of woody debris cover increased.

Our data illustrates that fish populations will benefit if stream alterations are restricted. The impacts of floodplain development may be lessened by stipulating: (1) maintenance of a riparian vegetation buffer zone between the river channel and developments, (2) maintenance of all natural floodway overflow channels, and (3) allowance of natural sheet flooding. Where stabilization of the channel is necessary, alternatives other than rock revetment should be applied. Within the Big Wood River, rock revetment is detrimental to fish populations and it creates adverse hydrologic impacts. As Williams and Krupin (1984) observed, a downstream progression of bank cutting, erosion, and bank failure can occur following installation of rock revetment. Excess flow energy is also redirected to the streambed, resulting in lateral scour and undercutting of the area below the revetment. This results in failure of the revetment and additional bedload movement. In addition to the negative hydrological impacts, a reduction in habitat diversity often occurs during riprapping of stream banks (Knudsen and Dilley 1987).

Fish populations will also benefit if measures are applied to restore channel stability and riparian vegetation in altered reaches. Habitat restoration may increase the carrying capacity of the stream and reduce natural mortality rates. The optimal habitat restoration techniques appear to be those which pin down bedload movement, allow riparian revegetation restore instream woody debris, and maintain natural sheet flooding. One approach will test the effectiveness of drop structures and vegetative management in restoring channel stability and fish habitat. A joint agreement between the U. S. Forest Service, U.S. Bureau of Land Management, Idaho Department of Transportation, Idaho Department of Fish and Game, Blaine County, and the city of Ketchum will implement this demonstration project in the Big Wood River. Other approaches to restore woody debris are also currently under evaluation.

The future of fish populations in the Big Wood River will be dependent on our ability to, 1) halt the continued, insidious loss of habitat and, 2) restore degraded areas. These tasks can be accomplished with acquisition of empirical data, public education, and enactment of legislation.

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