BIOTIC RESPONSES TO REMOVAL OF SEDIMENT FROM A TRIBUTARY OF SILVER CREEK

A Progress Report

To

The Nature Conservancy

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INTRODUCTION

Intensive agriculture and a lack of riparian buffer zones have led to increasing levels of sediment being deposited in the tributaries of Silver Creek. This situation may threaten the Silver Creek trout fishery by covering spawning areas, and limiting suitable habitat available for trout and aquatic invertebrates. Sediment has accumulated to depths of 1.0 to 1.5 m in several of these streams. Silver Creek is largely a spring-fed system, and spring season flows coupled with the low gradient are not great enough to naturally flush accumulated sediment.

Sediment loading may regulate fish populations indirectly by modifying available habitats. This may result from loss of habitat, decreases in the availability of prey, or from behavioral changes in the fish (Environmental Protection Agency 1979). Accumulated sediment may reduce the amount of living space available for trout (Hunt 1969) and the production of aquatic invertebrates (Cordone and Kelley 1961, Chapman 1962). The reduced water depth could limit the standing crop of trout in a stream by making habitat unsuitable for larger individuals or species primarily relying upon water depth as cover. According to generalized probability of curves for adult rainbow trout (Salmo gairdneri), usage drops from 100% at water depths greater than 0.65 m to 20% or less at depths less than 0.35 m (Bovee 1978, Fig. 1).

Baseline biological data previously collected by Idaho State University (Griffith, et al. 1982) in two Silver Creek tributaries suggested that overwintering habitat for trout may not be adequate due to sediment accumulations. Generally, as water temperatures drop below 4°C

Figure 1. Probability of use curve indicating the relationship between water depth and the presence of adult rainbow trout. From Bovee 1978.

trout seek cover beneath undercut banks or at the bottom of deep pools and become inactive until water temperatures rise again in spring. October 1981 and March 1982 fish abundance data exhibited a very noticeable change in numbers of both brook trout (*Salvelinus fontinalis*) and rainbow trout present in the tributaries. Brook trout declined by an average of 80% and rainbow trout by 87% in study sections of the streams in March 1982 as opposed to October 1981. In the sediment-laden portions of these streams, aquatic invertebrate numbers were low during spring sampling. Organisms most valuable as trout food, such as *Hydropsyche* caddisflies and *Baetis* mayflies, were nearly absent. Thus, it appears that trout move out of the tributaries during the winter due to some limiting factor in the stream environment.

Because of The Nature Conservancy's program to acquire land and secure riparian easements in the Silver Creek system, sediment inputs into the stream are being reduced. Several management options are available to deal with the sediment-choked sections of streams on the Silver Creek Preserve. Those include waiting for a year of unusually high water flow to flush out accumulated sediment, building instream structures, or starting a program of active sediment removal.

The first option was deemed unsuitable because of the low probability of such an event occurring in the Silver Creek system. The second option was not selected because of The Nature Conservancy's desire to maintain the system in as natural a state as possible, and also because instream structures tend to have very local effects in removing sediment. Sediment removal appeared to be most feasible at this time, and this study was designed to test the feasibility of sediment removal as a method of rehabilitating trout habitat.

Using a suction dredge, we sought to remove sediment from several short sections of a tributary of Silver Creek to evaluate the response of fish, aquatic invertebrates, and aquatic macrophytes.

I. Objective: Assess fish abundance in dredged versus non-dredged sections of stream.

Hypothesis: There will be a significant increase in numbers of trout and a decrease in numbers of non-game fish in dredged sections of stream.

A. Objective: Assess the winter holding capacity for trout of dredged versus non-dredged sections of stream.

Hypothesis: There will be a significant increase in numbers of trout utilizing the dredged sections as compared to the non-dredged sections during the winter season.

B. Objective: Assess rate of recolonization and movement patterns of trout between dredged and non-dredged sections of stream.

Hypothesis 1: There will be a significant movement of trout longer than 100 mm into dredged sections of stream.

Hypothesis 2: There will be significant movement of trout smaller than 100 mm out of dredged sections of stream.

II. Objective: Assess the recolonization rates of aquatic invertebrates in dredged sections of stream.

Hypothesis: There will be a significant decrease in numbers of miners such as Chironomidae and Tubificidae in dredged sections of stream.

Hypothesis: There will be a significant increase in numbers of those species utilizing gravel substrates.

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III. Objective: Assess the recolonization rate, species composition change, and density of aquatic macrophytes in dredged versus non-dredged sections of stream.

Hypothesis: There will be a significant decrease in the density of *Chara* in dredged sections of stream.

DESCRIPTION OF STUDY AREA

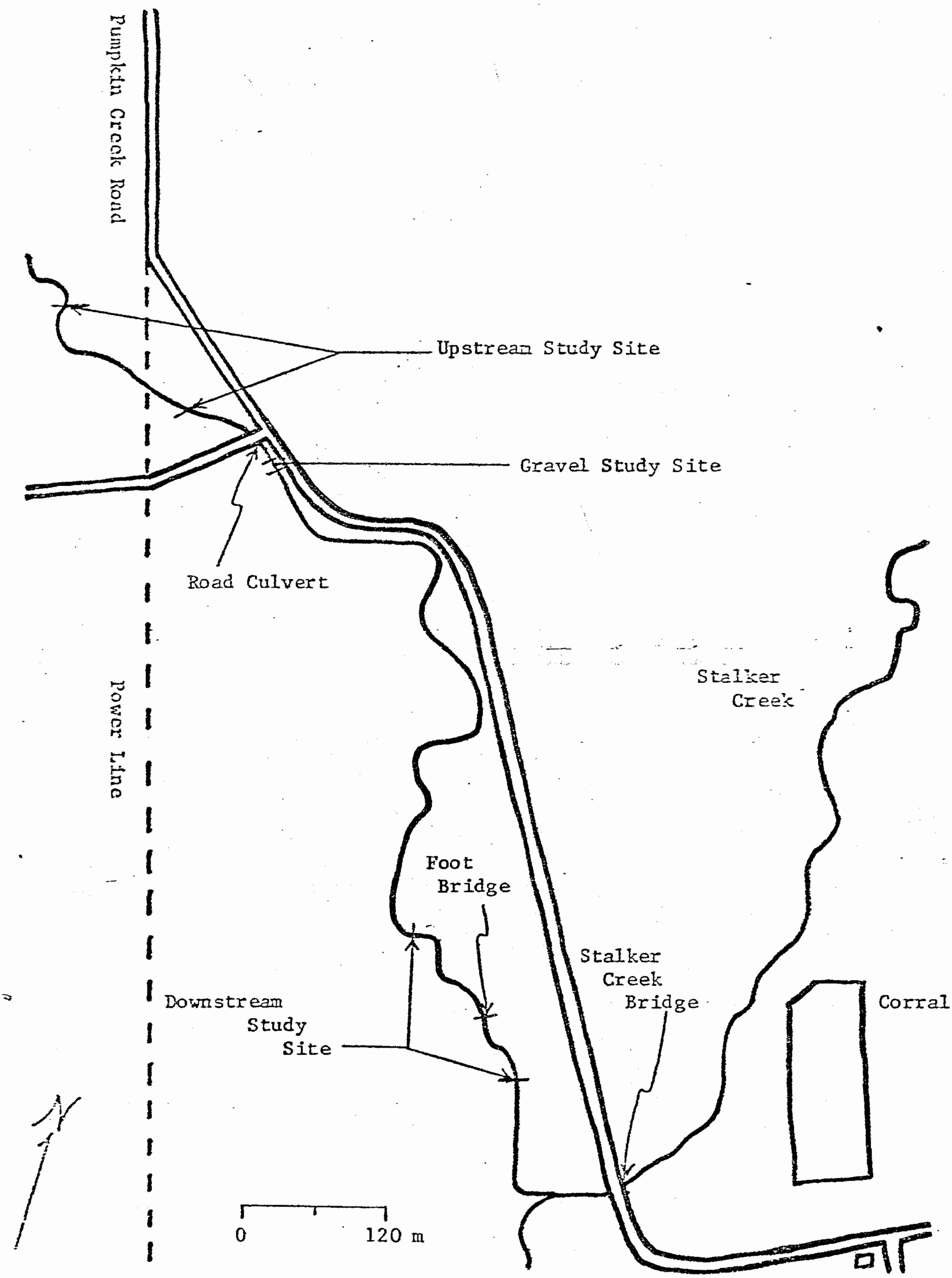
The tributary of Silver Creek selected for study was Mud Creek (elevation 1490 m), a low gradient stream flowing approximately 2.5 km from a spring source downstream to its confluence with Stalker Creek. Mud Creek has an average width of 4.5 m in the study area and summer discharge of approximately 0.3 m^3/sec.

Much of the stream bottom in the study area is covered by a layer of silt and sand which reaches a maximum depth of approximately 1.5 m. There are small areas of exposed gravel, most of which is partially imbedded with silt.

Aquatic vegetation colonizing the substrate is largely *Chara vulgaris*, *Potamogeton pectinatis* (pondweed), and *Zannichellia palustris* (pondweed), with lesser amounts of *Rorippa* sp. (watercress), and *Hippuris* sp. (mare's tail).

A complete surveillance of the creek was done before selecting test sections. Three sites were chosen to be dredged. The first section is located above a road culvert on the Stalker Creek Road (Figure 2) and is approximately 35 m in length, with sections of the same length above and below the test section to be studied as controls. This site had sediment accumulations averaging 0.7 m with dense *Chara* growth throughout.

Figure 2. Location of three study sites on Mud Creek.



Pumpkin Creek Road
Upstream Study Site
Gravel Study Site
Road Culvert
Stalker
Creek
Power Line
Foot
Bridge
Stalker
Creek
Bridge
Corral
Downstream
Study
Site
0
120 m

Lengths of the test and control sections were determined to take advantage of the presence of rock dams at approximately 35 m intervals. The second test section was located downstream from the culvert. It is a gravel area 12 m in length which was one-fourth to three-fourths imbedded with fine silt and clay. This section of stream had sediment removed from one-half the channel (test) and left unaltered on the other half (control). A third site of 35 m is located immediately below a foot bridge on Mud Creek approximately 150 m upstream from the confluence with Stalker Creek. Sections of the same length are located immediately above and below the test section as controls. This site was colonized by sparse vegetation growth and had average sediment depths of 0.3 m prior to dredging.

METHODS

Sediment was removed from the three sections of Mud Creek using a suction dredge developed by the U. S. Forest Service Missoula Equipment Development Center for cleaning salmonid spawning gravel. The pump is a lightweight unit designed for fire suppression and has a capacity of 4.4 l/sec. A 7.5 cm - diameter suction nozzle was coupled to a PVC Pardee eductor. Separators were available to remove sediment from water discharge but were not used in this instance.

Dredging was initiated at the head of a station and progressed downstream. Water discharge was pumped approximately 30 m from the stream onto the bank where sediment was filtered out by dense vegetation. Approximately 80 man-hours were needed to dredge each 170 m^2 section at the upstream and downstream sites. Three man-hours were needed to dredge the 12 m gravel area using a specially adapted gravel cleaning head.

One transect perpendicular to the stream channel was established for each test and control section at the upstream and downstream sites. Two transects were established at the gravel section. The exact placement of each transect was done randomly. Fence posts were placed at the ends of each transect. Transects were established for the purpose of obtaining invertebrate samples with a Hess net.

Sediment Depth and Aquatic Vegetation

Each test and control section at the upstream and downstream sites was marked off every 5 m with wooden stakes on either side of the stream channel. A measuring tape was stretched between stakes and a single series of measurements at every 0.5 m mark were made. At each measuring point across the stream, total depth (water surface to firm stream bottom), sediment depth, and height of submerged aquatic vegetation was recorded to the nearest centimeter using a probe. Water velocity was also taken at each point using a Marsh-McBirney Model 201 portable water current meter. These measurements were taken prior to dredging on 9-10 June 1982 and 18-20 June at the upstream and downstream sites, respectively. This was also done immediately following sediment removal at each site on 17-18 June and 1 July.

Aquatic Invertebrates

A series of samples of 1/16 m^2 of stream substrate were taken with a Hess net (mesh size 0.39 mm) at each transect prior to dredging, and at approximately two-week intervals following dredging during the period June-August 1982. A complete set of samples was also taken in October and November. Four samples per transect were taken at test and control sections. The net was used to sample the upper 8 cm of substrate.

Samples were preserved with 10% formalin in the field, and in the laboratory they were sorted to separate invertebrates from debris. Organisms were identified to the genus level where feasible.

Fish

Fish populations were monitored prior to dredging at the upstream and downstream sites in test and control sections by electroshocking with block nets. Electroshocking samples were conducted at approximately two-week intervals following dredging during the period June-August 1982. A single series of samples were taken in October and November. A single pass was made through each section with electroshocking gear.

Weight and total length of all trout collected were recorded and scales were taken. Non-game species were counted and released. Trout collected during June-August were given a fin clip or punch to assess movement patterns and then released.

RESULTS AND DISCUSSION

Sediment Depth and Aquatic Vegetation

As of 21 November, there had been no appreciable deposition of new sediment at the upstream dredged site. Measurements taken on 2 October substantiate this. Results at the downstream site have not been as satisfactory. Following dredging, this area refilled with sediment to levels approximately equal to those prior to sediment removal. Measurements to be taken in January 1983 will confirm this. The gravel section has remained relatively stable since sediment removal due to the greater velocities caused by the road culvert approximately 50 m upstream. The test section remains clear of sediment except for small areas where it is one-fourth imbedded with silt.

Sediment and water depths at the upstream test section prior to dredging averaged 73 and 29 cm, respectively. Following dredging, sediment depth decreased 66% to an average of 25 cm over a firm, clay bottom. Water depth was doubled to approximately 58 cm and water velocity dropped from 19 to 12 cm/s following sediment removal.

At the downstream site, sediment and water depths averaged 31 and 27 cm, respectively. Immediately following dredging, sediment depth averaged 20 cm over a gravel substrate. Water depth increased by approximately one-third to 36 cm and water velocity decreased from 25 to 13 cm/s following sediment removal.

Prior to dredging on 9 June, Potamogeton was the dominant vegetation, averaging 20-30 cm in height at the upstream test and control sections. No Chara growth from the present year was observed at this time. Vegetation was sparse at the downstream area prior to dredging. Following dredging at these two sections, recolonization, density, and species composition were monitored on 11 July and 7 August.

Aquatic macrophyte recolonization appeared slow in the upstream test section. Potamogeton plants which remained following dredging appeared damaged and were covered by a filamentous algae. There was no appreciable regrowth of vegetation in this section as of 11 July. During this same sampling period in the control sections, Chara, Potamogeton, and Zannichellia averaged 10, 46, and 16 cm in depth, respectively.

Vegetation transects were sampled a second time at the upstream site on 7 August. Potamogeton appeared to regain its vigor and averaged 42 cm in height in the test section as compared to 73 cm in the controls.

Density of Potamogeton was greater in the controls than the test section by a factor of 5. Chara and Zannichellia were colonizing most of the test section by this date, averaging approximately 5 and 10 cm in depth, respectively. In the control sections, Chara averaged 28 cm and Zannichellia 34 cm, with Chara being the dominant species present followed by Potamogeton and Zannichellia.

Vegetation was not sampled at the downstream site because of its patchy distribution. Chara beds were present only along streambanks through June and July with the main stream channel being relatively devoid of plant growth. Sparse Potamogeton and Zannichellia growth in the test section was observed by mid-August, averaging 5-10 cm in depth. Rorippa and Hippuris were present but not abundant in all three sections.

Fish

By November 20, numbers of trout in the upstream test section were 10-15 times greater than those in control sections. A total of 73 trout were observed while snorkeling in the test area with the majority being greater than 13 cm in length (Table 1). Trout were distributed throughout the section, but 77% were present in a deep pool (max. depth 1.3 m), at the upper edge of the test area. Brook trout also utilized undercut banks exposed by dredging while rainbow trout were clustered in the pool. Sampling on 2 October with electroshocking gear revealed similar results except the difference in total number of trout was not as extreme between test and control sections. However, trout greater than 13 cm in length were more abundant in the test section by at least five-fold. In October 1981, an average of approximately

Table 1. Numbers of trout found in study sections of the upstream Mud Creek site before and after sediment removal, 1982. The 8 June sample was taken before dredging; all others were taken following dredging.

Date	upper control section				test section				lower control section			
	brook trout		rainbow trout		brook trout		rainbow trout		brook trout		rainbow trout	
	< 13 cm	> 13 cm	< 13 cm	> 13 cm	< 13 cm	> 13 cm	< 13 cm	> 13 cm	< 13 cm	> 13 cm	< 13 cm	> 13 cm
8 June	24	2	0	0	24	6	1	0	8	4	0	0
25 June	6	0	0	0	6	6	0	0				
13 July	25	1	0	0	8	10	0	0	24	2	0	0
29 July	21	0	2	0	12	8	0	0	20	3	0	0
9 August	20	0	0	0	6	7	0	1	10	1	0	0
20 August	27	0	1	0	15	6	2	0	8	0	0	0
2 October	21	8	14	2	12[b]	40[b]	5[b]	5[b]	21	6	3	0
20 November	3[a]	1	6[a]	1	18	48	0	7	5	1	12	0

[a] five additional young-of-year seen but not identified to species.
[b] these are underestimates; several fish escaped during electrofishing.

60 trout were found in 6 study sections of Mud Creek (Griffith, et al. 1982). Our results are comparable. It does not appear that trout are stressed to the point of leaving sections of Mud Creek until possibly late October-early November when water temperatures drop below 4°C. The disparity in numbers of trout between test and control sections at 20 November emphasizes the later observation.

Numbers of young-of-the-year brook trout declined in this test section following dredging. Prior to dredging there were 24 present and this number dropped to an average of 6 throughout the summer. Numbers of young-of-the-year brook trout in the test section were similar in October and November. Young-of-the-year numbers remained relatively constant at approximately 23 and 17 in the upper and lower control sections, respectively, during the summer and into October. Numbers declined to 9 in the upper control in November while young-of-the-year trout remained stable at 17 in the lower control. Rainbow trout young-of-the-year increased in abundance in test and control sections.

Trout numbers have not changed appreciably in the downstream test section following dredging in June. No trends for fish $\geq$ 13 cm to increase in abundance in the test section have been found. One exception was the increase in abundance of young-of-the-year brook trout in the upper control section following dredging. However, this section of stream was more heterogeneous physically than the test or lower control sections and may have provided more suitable habitat for young-of-the-year trout.

Aquatic Invertebrates

Only preliminary analysis has been completed to date. Data from the middle site where sediment was removed from gravel along one side of the channel, are complete for before dredging (June) and several months after (October). Before dredging, samples from each side of the channel were very similar, as would be expected (Table 2). In October, several differences are apparent. There was a strong increase in test section numbers of *Hydropsyche* and *Helicopsyche* caddisfly larvae, which are valuable food items for larger trout. Numbers of Chironomidae and *Simulium* showed strong declines in the dredged area in October, and numbers of *Gammarus*, *Tubifex* and the molluscs *Pisidium* and *Flumenicola* showed moderate, possibly nonsignificant, declines.

Table 2. Mean number of aquatic invertebrates in test and control portions of the gravel study site before and after dredging. Four $1/16m^2$ Hess net samples were averaged in each mean value.

ORDER	TAXA	Control 6/29/82	Control 10/2/82	Test 6/29/82	Test 10/2/82
Ephemeroptera	Baetis parvus/tricaudatus	6	48	4	46
	Ephemerella inermis	7	0	4	0.5
	Tricorythodes minutus	6	4	5	0.3
	Paraleptophlebia debilis	0	0.3	0	0
	Others	0	3	0	0.5
Trichoptera	Hydropsyche sp.	3	18	4	65
	Helicopsyche borealis	1	3	2	20
	Hydroptila sp.	4	0	4	0.3
	Oecetis sp.	2	2	1	0
	Others	1	0	6	0
Odonata	Ophiogomphus occedentis	0.3	0.3	0	0.3
	Ischnura sp.	0	1	0	0
Coleoptera	Optioservus quadrimaculatus	1	15	1	4
	Haliplus sp.	0	1	0	0
Diptera	Chironomidae	92	115	83	16
	Tipulidae	2	5	0.3	2
	Simulium sp.	0.3	27	0	1
	Bezzia sp.	2	1	1	0.3
	Euparyphus sp.	0.3	5	0.3	1.5
Hemiptera	Corixidae	0	0.3	0	0
Hymenoptera	Formicidae	0	0	0.3	0.3
Amphipoda	Gammarus lacustris	7	11	19	1
	Hyalella azteca	0	2	0	0
Hydracarina		0	6	0	6
Haplotaxida	Tubifex tubifex	9	20	4	11
Oligochaeta	Lumbriculus sp.	0.3	0	0.3	1
Hirudinea		0.3	14	1	1.5
Unionoida	Pisidium sp.	4	31	2	1
Basommatophora	Flumenicola sp.	13	48	18	12
	Gyraulus sp.	3	5	4	2
	Physa sp.	0.5	0.5	0	0
Total		165.0	386.4	164.2	193.5

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