WATER QUALITY SUMMARY REPORT NO. 27

IN-STREAM SEDIMENT AND FISH POPULATIONS IN THE LITTLE NORTH FORK CLEARWATER RIVER
Shoshone and Clearwater Counties, Idaho
1988 - 1990

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ABSTRACT

The Little North Fork Clearwater River and ten tributaries in Shoshone and Clearwater Counties, Idaho were monitored for sediment and fish population densities in 1988 through 1990. In-stream sediment was not related to natural erosion rates estimated from U.S. Forest Service soils data (r^2=0.07). Road densities and in-stream sediment exhibited a correlation coefficient of r^2=0.70. The correlation coefficient (r^2) for in-stream sediment and percent watershed harvested was 0.83. Fish population densities in the main-stem of the Little North Fork averaged 2.6 cutthroat trout, 1.3 rainbow trout, 0.4 bull trout, and 11.2 whitefish per riffle/pool transect. Low fish population densities in the river may be attributed to high fishing pressure. Cutthroat trout population densities in the tributaries were related to interstitial space indices (ISI) (r^2=0.59). Tributaries with ISI's less than 2.5 m/m^2 (> 50% cobble embeddedness) had no cutthroat trout. Based on the results of this study the Local Working Committee under the state Anti-degradation process established two water quality objectives: maintain or improve water quality of the Little North Fork Clearwater River and improve water quality of the tributaries. Monitoring of sediment and fish population densities will continue under the Antidegradation process.

INTRODUCTION

BACKGROUND

The Little North Fork of the Clearwater River in Shoshone and Clearwater Counties, Idaho is a watershed of mixed land ownership. The watershed is made up of land administered by the Bureau of Land Management, the U.S. Forest Service, the Idaho Department of Lands, and private land. It includes the Floodwood State Forest, the Mallard-Larkin Wilderness Area, and a portion of the Panhandle National Forest (Figure 1). Much of the watershed has undergone extensive road building and timber harvest over several decades. There is a growing public perception that forest practices in the drainage are degrading water quality and impacting beneficial uses.

Fish species in the Little North Fork drainage are predominantly native west slope cutthroat trout Oncorhynchus clarki lewisi, rainbow trout Oncorhynchus mykiss, bull trout Salvelinus confluentus, and mountain whitefish Prosopium williamsoni. Introduced eastern brook trout Salvelinus fontinalis also inhabit the Little North Fork and tributaries. Kokanee salmon Oncorhynchus nerka migrate upstream from Dworshak Reservoir during the fall to spawn in the Little North Fork streams. These streams have not had steelhead trout Oncorhynchus mykiss or chinook salmon Oncorhynchus tshawytscha runs since Dworshak Dam was constructed in 1971.

Though fish population trend data are scarce in this drainage there is concern that populations are decreasing and species composition is shifting to more sediment tolerant species (N. Horner, IDF&G, personal communication). In 1987 Leo Crane of Clearwater Outfitters requested the Division of Environmental Quality to investigate the question of sediment and how it affects fish populations in the Little North Fork. Clearwater Outfitters have been guiding fishermen in the Little North Fork for more than twenty years and they feel that fish numbers have declined and suspended sediment (muddy spring flows) have increased.

Before this study there was little research information on the sediment conditions of streams in the drainage. Streams in heavily roaded and harvested sub-drainages appeared to have large quantities of deposited sediment. The Idaho Batholith (a large igneous intrusion) and metamorphic mica schist (precambrian) are two of many geologic parent materials making up this region (Rember and Bennett 1979). The U.S. Forest Service has identified over 50 different land types throughout the Little North Fork drainage (J. Nieholff, USFS, personal communication). These large number of land types as well as variations in slope steepness, exposure, vegetation cover, and natural fire damage make it difficult to separate effects of forest practices from natural differences in watersheds.

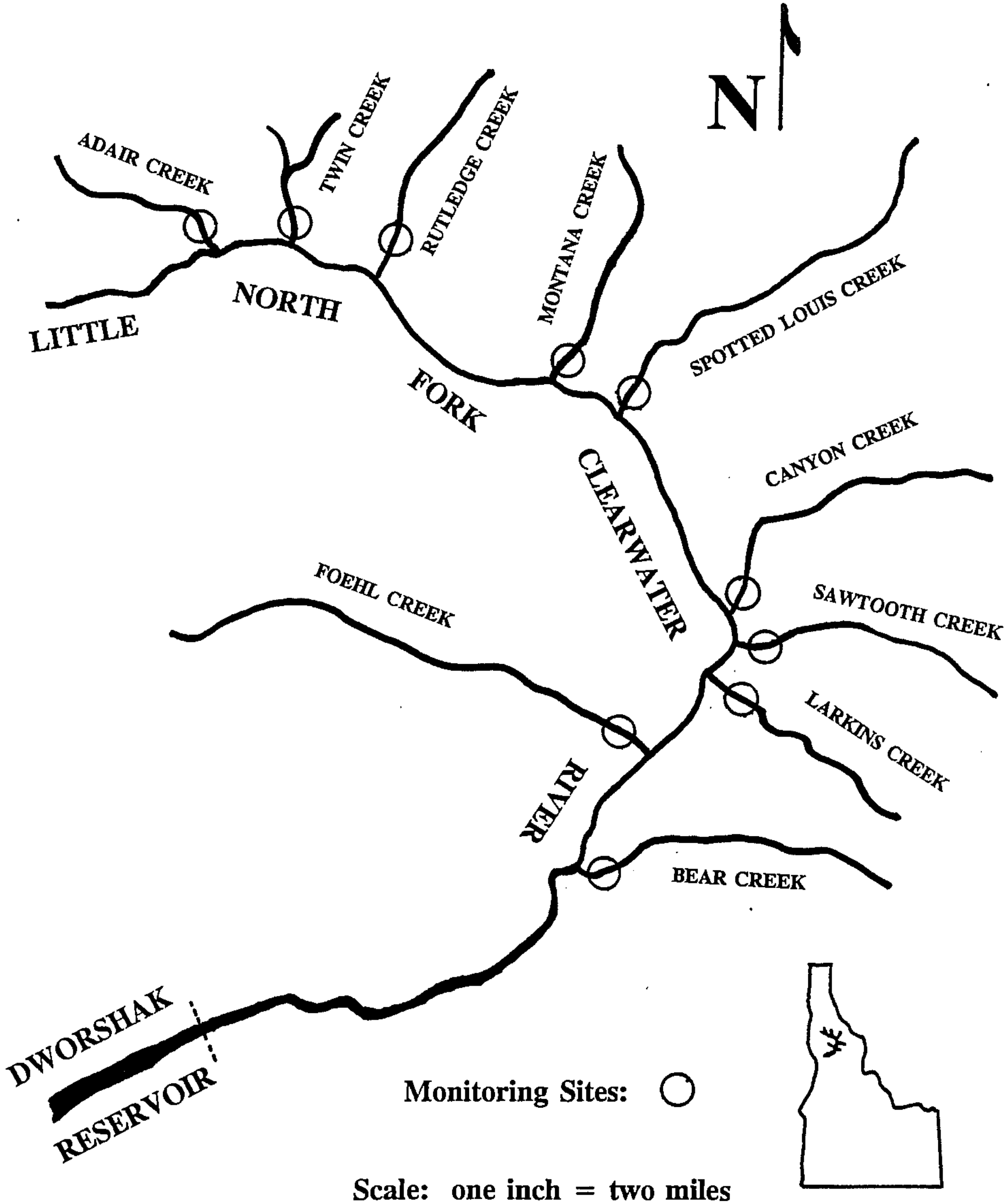

Figure 1. Map of the Little North Fork Clearwater River watershed study area.

PURPOSE

In 1988, the Division of Environmental Quality saw a need to determine baseline (natural) sediment levels for streams in the Little North Fork followed by an evaluation of sediment deposition in streams which have been harvested and roaded. The initial approach was to establish baseline sediment levels during the first year (1988) of the study followed by several years of monitoring to evaluate the effectiveness of best management practices (BMPs). This type of monitoring is part of the "feed-back loop" concept designed to make changes in the Forest Practice Rules and Regulations (Clark 1990).

In 1990 the study took on an additional purpose when the Little North Fork Clearwater River from Foehl Creek upstream to the Little North Fork headwaters and Buck Creek were chosen as a Stream Segments of Concern (SSOC) under the Antidegradation process. The Antidegradation process called for the establishment of a Local Working Committee (LWC)(Dunn 1990). This committee was made up of twenty-two members representing land- owners in the watershed, environmental groups, timber industry, and state and federal agencies (Cuvala 1991). The committee's tasks were to:

-identify and verify beneficial uses of the streams

-identify the current condition of the streams

-identify the desired future condition of the streams (water quality objectives)

-develop site specific BMPs to meet the water quality objectives

OBJECTIVES

Original Study Objectives

1) To determine baseline instream sediment levels (deposited sediment)

2) To relate forest practice activities and natural watershed characteristics to deposited sediment levels

3) To monitor temporal instream deposited sediment changes in disturbed and undisturbed (control) watersheds

Antidegradation Monitoring Objectives

1) To identify beneficial uses (fish species present)

2) To determine the current condition of the beneficial uses (fish populations)

3) To evaluate the effectiveness of site specific best management practices (SSBMPs)

MATERIALS AND METHODS

The cobble embeddedness method modified by Skille and King (1989) was used to quantify sediment in stream reaches throughout the watershed. Sediment in six tributaries and seven mainstem Little North Fork reaches was quantified in 1988. An additional six tributaries and three mainstem reaches were monitored in 1989. These monitoring sites included all the major tributaries to the Little North Fork. In 1988 and 1989 sampling was done during August and September when stream flows were at the summer minimums.

Adequate sample sizes (number of hoops) based on the variation between hoops were calculated in the field using the equation described by Skille and King (1989). The number of hoops measured for cobble embeddedness ranged from nine to thirty and averaged eighteen. In 1989 two undisturbed stream reaches were re-measured to provide an estimation of monitoring variation.

The cobble embeddedness method required the following equipment and material:

- -metal sampling hoop (60 cm inside diameter)
- -plexiglass cobble measuring ruler
- -100 foot fiberglass measuring tape
- -pry bar for dislodging cobble
- -programmable hand calculator for generating random numbers and calculating sample sizes needed

Stream reach locations, transect locations, and sample hoop locations were determined using the "DEQ" cobble embeddedness method (Burton and Harvey 1990). The DEQ method was also used to calculate interstitial space indices (ISI's) from cobble embeddedness field data. Interstitial space indices can be visualized as the inverse of cobble embeddedness. Cobble embeddedness is a measure of rocks buried in fines and ISI is a measure of rocks exposed or available for fish and insect habitat. The ISI is calculated by summing the vertically exposed rock heights for all rocks within a hoop and dividing by the surface area of the hoop. Interstitial space indices are expressed in meters per square meter (m/m^2).

In the summer of 1988, Idaho Fish and Game Department personnel used the snorkel transect method (Johnson 1985) to survey the main stem Little North Fork for fish population estimates. Transects started at the bottom of a riffle and continued upstream to the head of the next pool and varied in length. This survey was made from the mouth of Bear Creek upstream to the mouth of Canyon Creek.

In 1990 the IDF&G expanded the fish population survey to ten Little North Fork tributaries and quantified the surveys to fish per 100 m^2. This was a cooperative effort between DEQ and IDF&G to evaluate the relationship between deposited sediment and fish populations.

In 1990 the Idaho Panhandle National Forest completed mapping of soils throughout the Little North Fork watershed. They provided this study with aerial photos delineating 64 soil types in the watershed. Within each sub-watershed corresponding to streams monitored for sediment and/or fish populations 24 soil types which the USFS soils scientist estimated to have natural erosion rates greater than 40 tons per square mile were quantified as a percent of total sub-watershed area. These percentages were used to relate natural erosion differences between watersheds to sediment quantities in streams.

Road densities (miles/square mile) and harvest areas (percent of total watershed) were obtained from U.S. Forest Service timber sale records. The data reflect relations between roads or harvest areas and instream deposited sediment.

RESULTS AND DISCUSSION

BASELINE SEDIMENT LEVELS

Interstitial space indices (ISI's) are a measure of exposed stream-bottom rock. The index is calculated from cobble embeddedness measurements by summing the exposed heights, in meters, of embedded cobbles for each hoop and dividing the sum by the area of the hoop in meters. The ISI is more reflective of changes in sediment than percent cobble embeddedness (Kramer, 1989). Also, the relationship of percent cobble embeddedness to ISI does not appear to be a linear relationship. As the Little North Fork stream ISI values become smaller (less habitat) the percent cobble embeddedness values increase at a faster rate (Figure 2). In this study ISI is used as an indicator of fish habitat quality, macroinvertebrate habitat quality, relative quantities of sediment between stream reaches, and changes in these values over time.

ISI's in the Little North Fork streams ranged from a high of 6.66 m/m^2 (good habitat and small quantities of deposited sediment) to a low of 0.45 m/m^2 (lack of habitat and large quantities of sediment). ISI values measured in ten tributaries during 1988 and 1989 averaged 3.09 m/m^2. ISI values at ten mainstem Little North Fork reaches averaged 4.61 m/m^2 during these two years. As with percent cobble embeddedness values ISI values should only be compared within a watershed or watersheds of similar geology, soil types, aspect, vegetation type and cover, etc. Baseline values should be established for stream reaches with similar geomorphology and stream power.

FISH DENSITIES

The Idaho Department of Fish and Game used the snorkel transect method to estimate relative fish populations in 1988 and 1990 in the Little North Fork watershed. Thirty-four transects in the mainstem Little North Fork were snorkeled from the mouth of Minnesaka Creek to the mouth of Larkins Creek in 1988. Average fish densities (fish per transect) in this section were: 2.6 cutthroat trout, 1.3 rainbow trout, 0.4 bull trout, and 11.2 whitefish. This section of stream had good fish habitat with adequate pools, riffles, and runs and no indications of major sediment or bedload problems. The fish densities in this section of the Little North Fork are low compared to similar streams in the region which have low fishing pressure. For example, Kelly Creek, also a tributary to the North Fork of the Clearwater River, is a catch-and-release fishery and has cutthroat densities of approximately 12 fish per transect (C. Robertson, Idaho Department of Fish and Game, personal communication). The 1988 IF&G snorkel survey and habitat evaluation concluded that the main stem of the Little North Fork has low trout densities due to fishing pressure (Robertson 1988).

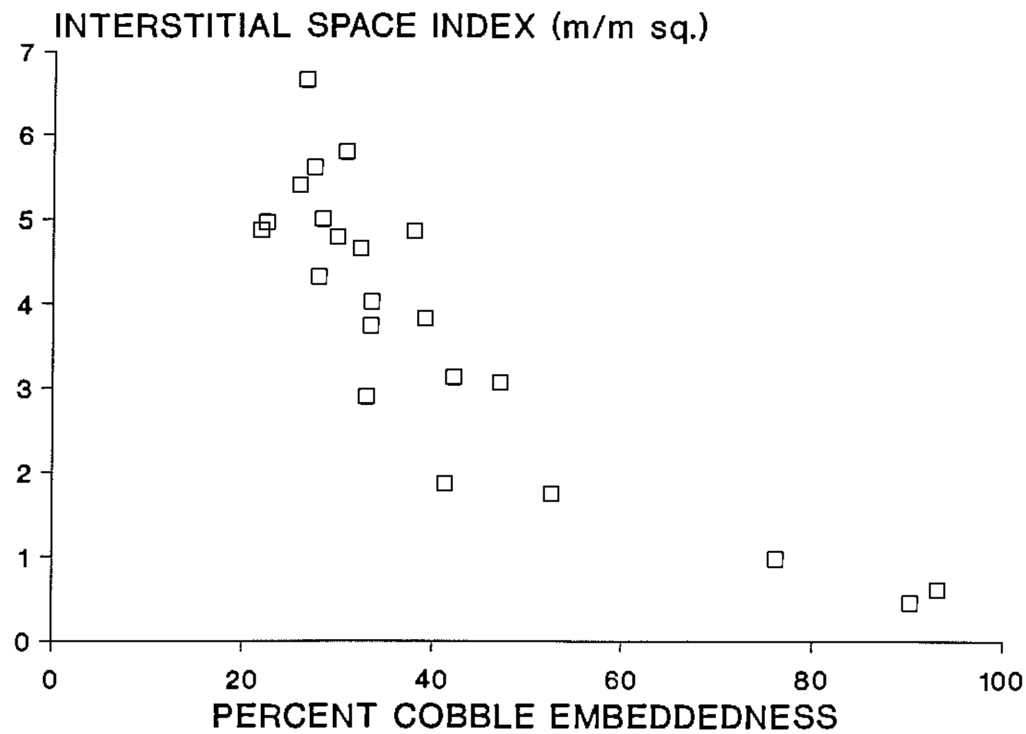

Figure 2. A comparison of interstitial space indices (ISIs) and percent cobble embeddedness at 22 river and tributary sites in the Little North Fork Clearwater River watershed from 1988 through 1989.

In 1990 the IF&G expanded the fisheries evaluation to include ten Little North Fork tributaries (Cochnauer 1990). These tributaries were chosen because they had previously been monitored for cobble embeddedness. Total fish densities ranged from zero fish in Twin Creek to 24.6 trout per 100 m^2 in Bear Creek (table 1). Rainbow trout densities had no apparent relation to sediment quantities in these ten tributaries. However, cutthroat trout densities exhibited a direct correlation (r^2=0.59) to the interstitial space indices (ISI's) of these streams (Figure 3). The four tributaries with ISI values of less than 2.5 m/m^2 (cobble embeddedness of approximately 50 percent, figure 2) had no cutthroat trout.

SOURCES OF INSTREAM SEDIMENT

Between-stream differences in instream deposited sediment quantities are a function of many stream morphology components, watershed characteristics, plus natural and man caused disturbances. The ultimate objective of this study is to gain insight into the relative instream sediment contribution from forest practices. This forest practices v.s. stream sediment relationship is critical in assessing the adequacy of Best Management Practices (BMP).

Natural soil erodibility, road densities, and percent area harvested were quantified for several sub-watersheds in the Little North Fork drainage. Their relative importance in contributing sediment to streams is evaluated by comparing cobble embeddedness values to these parameters.

Watershed Erodibility and Instream Sediment

The total area of naturally erosive soils (greater than 40 tons per square mile) within each Little North Fork sub-watershed was compared to the total sub-watershed area to give a percent area of highly erodible soils. The area of high erodibility in eight sub-watersheds ranged from 1.6 percent in Spotted Louis Creek to 30.2 percent in Canyon Creek. Percent area of high erodible soils has no apparent relationship to sediment quantities in these eight tributaries. The correlation coefficient (r^2) for erodibility verses interstitial space index is 0.067 (Figure 4).

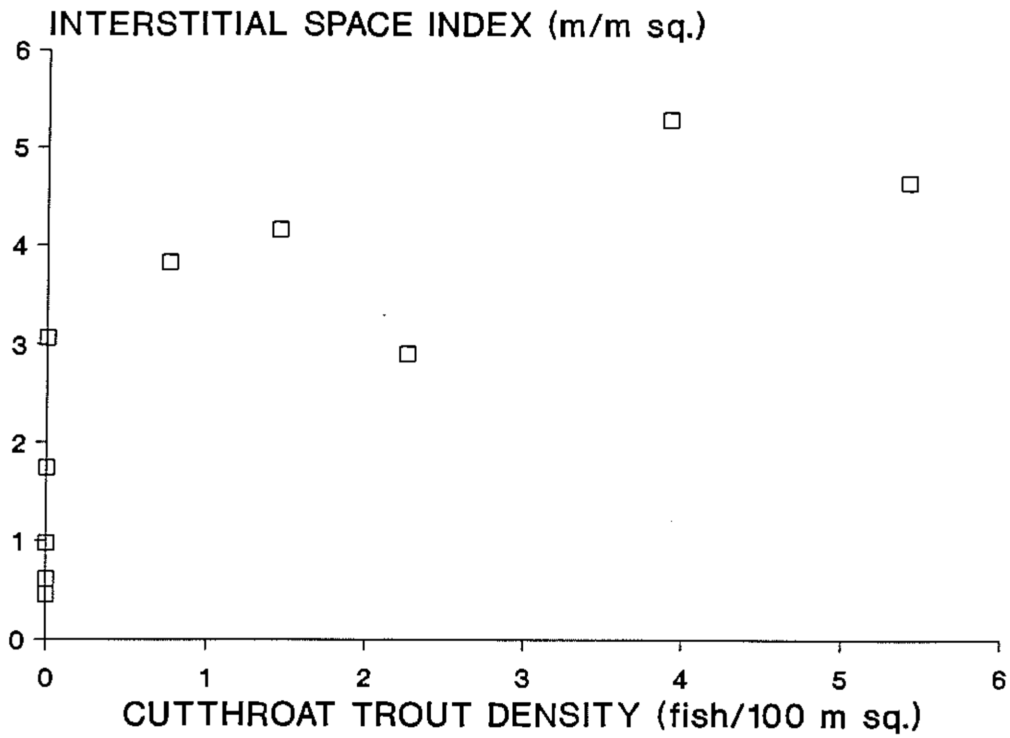

Figure 3. Interstitial space indices (1988-89) and cutthroat trout densities (1990) in Adair, Bear, Canyon, Foehl, Larkins, Montana, Rutledge, Sawtooth, Spotted Louis, and Twin Creeks (r^2=0.59).

Table 1. Westslope cutthroat trout and rainbow trout densities, interstitial space indices (ISI), and cobble embeddedness (CE) in 1988 and 1989; percent watershed harvested and road densities since 1976; and percent of watershed with highly erodible soils in Adair, Bear, Canyon, Foehl, Larkin, Montana, Rutledge, Sawtooth, Spotted Louis, and Twin Creek watersheds. Fish data are from Idaho Department of Fish and Game, 1990.

Stream	Cutthroat (#/100 m^2)	Rainbow (#/100 m^2)	ISI (m/m^2)	CE (percent)	Area harvested (percent)	Road density (mi/mi^2)	Erodible soils (percent)
Adair	0.0	1.1	0.4	90.2	6.1	4.07	-
Bear	0.0	24.6	1.7	52.5	-	-	-
Canyon	1.4	0.4	4.2	27.8	-	0.27	30.2
Foehl	2.3	0.4	2.9	33.0	-	0.69	29.5
Larkins	0.0	11.6	3.1	47.0	-	-	17.2
Montana	0.8	0.0	3.8	39.1	1.5	3.42	9.2
Rutledge	0.0	9.8	0.6	93.1	9.3	4.74	9.6
Sawtooth	3.9	2.8	5.3	29.8	-	0.19	26.7
Spotted Louis	5.4	1.9	4.6	32.2	1.3	1.35	1.6
Twin	0.0	0.0	1.0	76.2	9.3	4.74	12.6

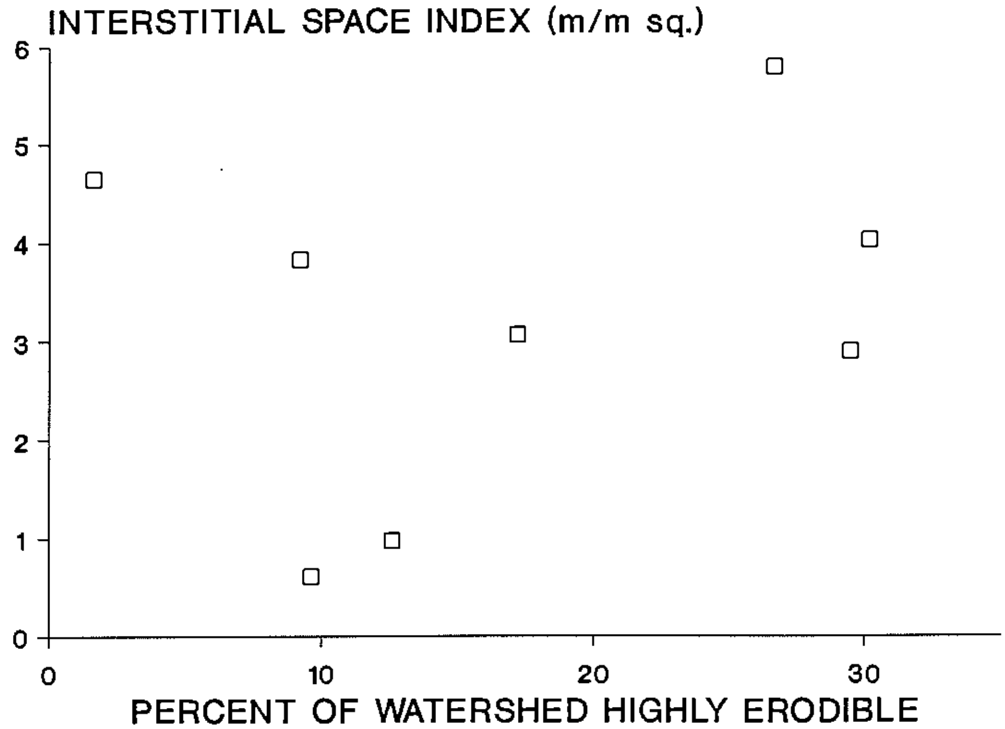

Figure 4. Interstitial space indices (ISIs) and percent area of watershed with highly erodible soils in Canyon, Foehl, Larkins, Montana, Rutledge, Sawtooth, Spotted Louis, and Twin Creeks from 1988 through 1989 (r^2=0.067).

Road Density and Instream Sediment

Road density (mi/mi^2) information was obtained from timber sales records of the St Maries Ranger District, Idaho Panhandle National Forest. This includes active U.S. Forest Service and Plum Creek Timber Company roads that have not been ripped, revegetated, or have had culverts removed. These roads vary in size and standards from main haul roads to small spur roads with different types of surfacing. Bear Creek and Larkin Creek have no roads and the other drainages vary from road densities of 0.19 mi/mi^2 in Sawtooth to 4.74 mi/mi^2 in Twin Creek. The correlation coefficient (r^2) for road density verses interstitial space index in the eight roaded watersheds is 0.70 (Figure 5).

Timber Harvest and Instream Sediment

Total watershed acres and acres harvested information was also obtained from records of the St. Maries Ranger District, Idaho Panhandle National Forest and include harvest data on Plum Creek Timber Company land. Percent of watershed harvested since 1976 was calculated from this information. Earlier complete harvest records are not available and harvests older than 12-15 years can be considered revegetated and stable. U.S. Forest Service harvest information for Adair, Twin, and Rutledge watersheds was grouped and percent of watershed harvested was estimated based on relative sizes of the watersheds. Foehl, Canyon, Sawtooth, Larkins, and Bear Creeks were considered non-harvested watersheds. The correlation coefficient (r^2) for percent watershed harvested verses interstitial space index in the five harvested watersheds is 0.83 (Figure 6).

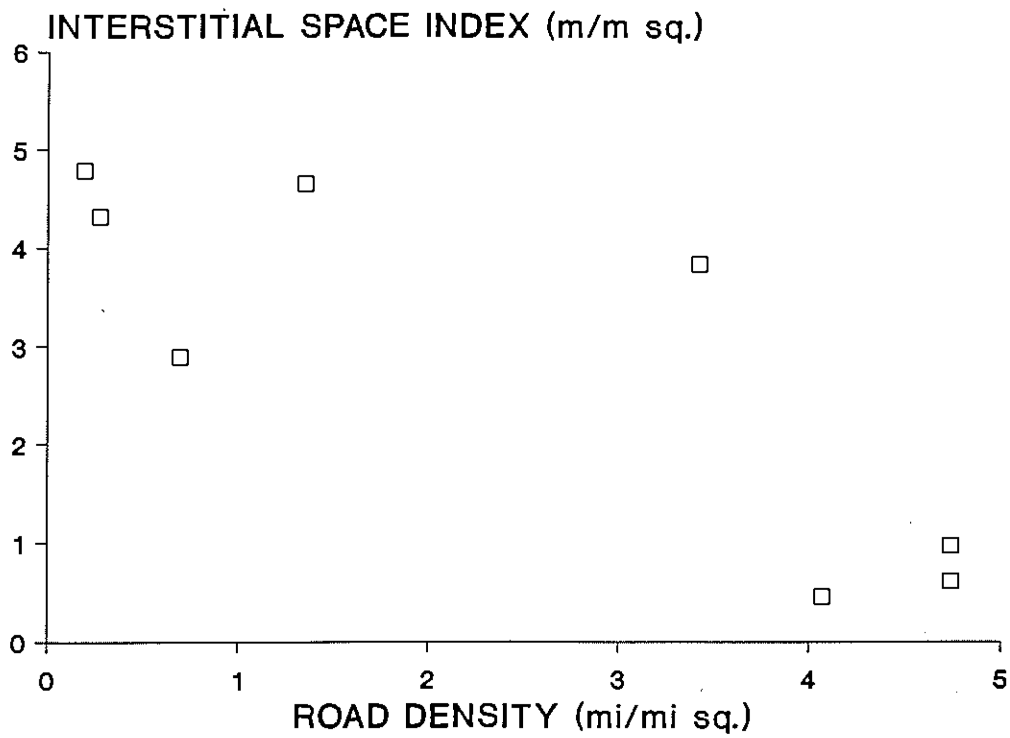

Figure 5. Interstitial space indices (ISIs) and road densities in Adair, Canyon, Foehl, Montana, Rutledge, Sawtooth, Spotted Louis, and Twin Creeks from 1988 through 1989 (r^2=0.43).

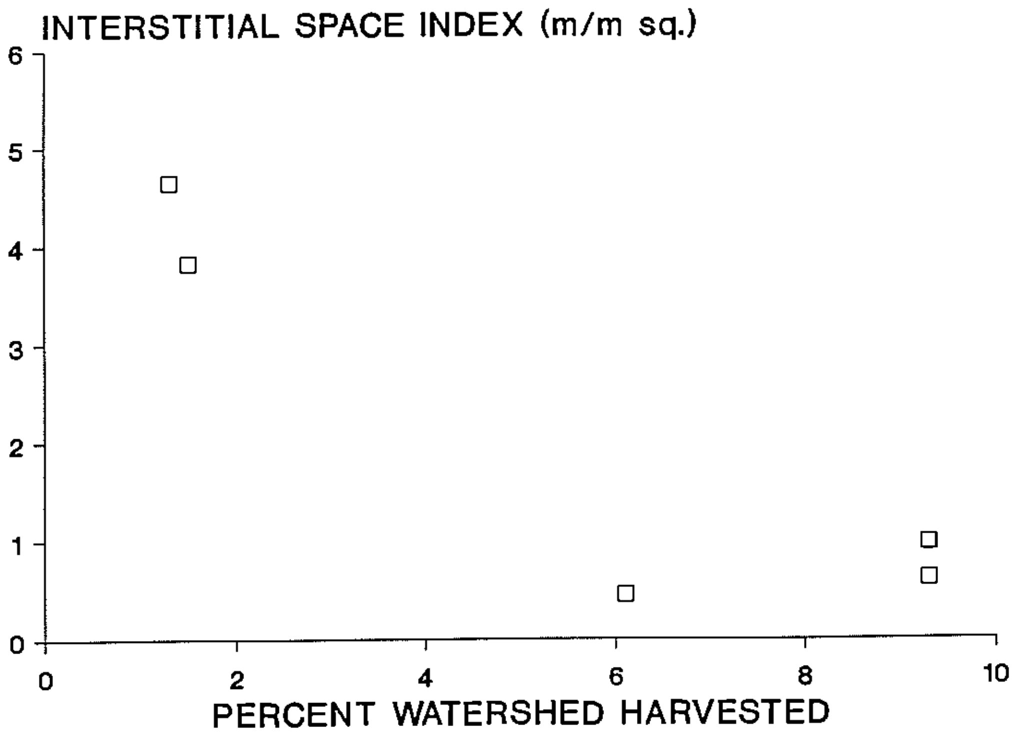

Figure 6. Interstitial space indices (ISIs) and percent area of watershed harvested in Adair, Montana, Rutledge, Spotted Louis, and Twin Creeks from 1988 through 1989 (r^2=0.83).

CONCLUSIONS

1. Stream sediment levels calculated as interstitial space indices in the mainstem of the Little North Fork Clearwater River ranged from 1.86 m/m^2 or 41.2 % cobble embeddedness (CE) in the lower reaches (above new Cedar Creek bridge) to 6.66 m/m^2 (26.4 % CE) in the upper reaches (above the mouth of Lund Creek). ISI's averaged 4.61 m/m^2 (30.6 % CE) over ten mainstem sites.

2. Sediment levels in ten major tributaries to the Little North Fork ranged from 0.45 m/m^2 (90.2 % CE) in Adair Creek to 5.79 m/m^2 (30.7 % CE) in Sawtooth Creek. ISI's averaged 3.09 m/m^2 (48.7 % CE) in the ten tributaries. The five unharvested/unroaded watersheds averaged 3.36 m/m^2 (36.3 % CE). The five roaded/harvested watersheds averaged 2.09 m/m^2 (66.2 % CE).

3. Differences in instream sediment between watersheds was not related to natural erosion rates based on soil types, $r^2 = 0.07$.

4. Differences in instream sediment between watersheds was related to road densities, $r^2 = 0.70$, and percent of watershed harvested, $r^2 = 0.83$.

5. Fish densities in the Little North Fork Clearwater River are low compared to streams of similar size and habitat and low fishing pressure. The Idaho Fish and Game Department attributes the low fish numbers to fishing pressure in the Little North Fork.

6. Major tributaries to the Little North Fork with ISIs less than 2.50 m/m^2 (more than 50 % CE) had no cutthroat trout. Rainbow trout densities did not appear to be related to sediment.

RECOMMENDATIONS

The 1988 and 1989 sediment monitoring and fish population results from this study were made available to the Stream Segment of Concern Local Working Committee (LWC). With these results the committee was able to identify the following beneficial uses of special concern:

-salmonid spawning

-cold water biota (benthic invertebrates and salmonid rearing)

-secondary recreation (fishing)

The Local Working Committee used the results of the study to establish the following water quality objectives:

-maintain or improve water quality of the Little North Fork

-improve the water quality of the tributaries

The Anti-degradation process is also part of the "feed-back loop" concept and has its own monitoring requirements. Under this process the U.S. Forest Service (administrator of the largest tract of land in the watershed) is the lead agency for monitoring. As a follow-up to this study it is recommended that they continue monitoring to evaluate the effectiveness of Site Specific BMPs in meeting the water quality objectives established by the LWC.

ACKNOWLEDGEMENTS

This study is dedicated to the memory of Dee Thomas. Dee helped get this study off the ground and spent many long days in the field collecting the data, traveling by pack-string, and being a fine companion and friend.

Thanks is extended to Hudson Mann and Steve Bauer who helped with the field work, to Scott Crane, Clearwater Outfitters, who made the long horse trips into the LNF safe and enjoyable, and to Scott McQuarrie who quantified the soils data.

Appreciation is extended to Jerry Nieholff, Panhandle National Forest, for providing soils information and to Kent Dunstan, Avery District Ranger, for providing road and harvest information.

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