Fisheries Habitat and Aquatic Environment 1989 and 1990 Monitoring Report

Lolo and Deerlodge National Forests

FISHERIES HABITAT AND AQUATIC ENVIRONMENT MONITORING REPORT

LOLO AND DEERLODGE NATIONAL FORESTS

1989 AND 1990

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1991

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Introduction

In 1985 the Deerlodge, Bitterroot and Lolo National Forests in western Montana began a fisheries habitat monitoring program. Personnel from the Lolo Forest were responsible for the collection and analysis of the data from all three forests. In 1989 the Bitterroot National Forest took over the responsibility for the monitoring program on its forest and therefore, data collected from the Bitterroot will not be addressed in this report. The objectives of the monitoring plan were to collect baseline data for comparisons over time of the condition of the aquatic habitat both within a single drainage and between drainages (undeveloped vs developed). In addition to monitoring aquatic and riparian habitat on selected streams, fish and aquatic insect (i.e. macroinvertebrates) communities were sampled to determine densities, community composition and biomass. For a complete review of the macroinvertebrate results the reader is referred to the macroinvertebrate analysis annual progress report for the individual Forests (Mangum 1989, Int. Mtn. Reg. USDA-FS). In 1986 the monitoring of fish populations was discontinued due to encountered sampling problems. However, during the 1989 field season, fish population sampling was reinitiated in conjunction with stream habitat inventories on selected streams. The final sampling procedure involved monitoring substrate sediment levels in selected streams on the two Forests. It was thought that this level of inventories could help answer some of the questions regarding the type and magnitude of responses by fish to habitat modifications and thus were incorporated into the monitoring program. ?

All streams transport sediment during spring runoff and storm events. The amount of sediment transported by the stream is dependent upon both the amount of sediment delivered to the stream and the stream's inherent sediment transport capabilities. An equilibrium exists between that amount of sediment transported through and the amount retained within the system. If forest activities such as timber harvest and its associated road building significantly increase the yearly sediment import level beyond the equilibrium point to where increased sediment storage results, adverse impacts to the aquatic resources may result.

The purpose of monitoring selected streams on the two Forests was to detect any significant increases in stream substrate sediment levels due to Forest Service activities. Since 1985, percent cobble embeddedness (PCE) was measured using the measured hoop method. In 1988 problems with the method were detected and it was determined that the technique might not possess the required sensitivity (Vadeboncoeur et al, 1989). In lieu of these problems a new index, interstitial space index (ISI), was developed using the percent cobble embeddedness data. While ISI was certainly an improvement over PCE, it also possessed inherent problems and therefore was not considered to be the perfect and final solution for the monitoring of stream substrate sediment.

A method was sought that required minimal equipment, was relatively quick and was non-destructive to study sites. Percent surface fines seemed a good parameter in that it could be measured in such a way that met all these qualifications. If the bottom of the stream is viewed as a two dimensional surface, percent surface fines is that percent of the area composed of particles less than 0.25 inches in diameter. Torquemada and Platts (1988) used an occular method for measuring embeddedness that was in reality a measure of percent surface fines. This occular measurement was estimated by the observer as the percent of the area within the PCE hoop composed of fine sediment. Such a method introduces a high degree of "between observer" variation or error. In order to reduce this observer error it was decided to incorporate a metal grid with 25 intersections to measure percent surface fines (PSF). The methodology involved: (1) tossing the grid randomly onto a site and counting the number of intersections that lay above fine sediments, (2) divide the number of counted intersections by the total available intersections (i.e. 25). The resulting percentage is expressed as percent surface fines (i.e. 5 intersections = 20% surface fines). Based on further analysis (Chapter 3), it was decided to use a 49 intersection grid to achieve the desired precision.

The following report describes the analysis performed on the percent surface fines methodology and the results of the 1989-1990 monitoring.

Chapter 1

Percent Surface Fines - Hydrological and Geological Correlations

Introduction

Although the grid methodology met the desired criteria and should be repeatable among observers, the question remained as to whether it could be used to monitor sediment in a meaningful and useful way. Several approaches are possible to answer this question.

One possible way to test the usefulness of this method is to compare PSF calculated in the field using the grid method with factors that are known to affect sediment loading and retention in streams. They fall into two broad categories and are not constant across the drainages. The first category includes characteristics of the entire drainage site such as erosivity of the geologic parent material in the basin, road density and road encroachment on the stream. The second category includes local site factors which might affect sediment loading and retention at a particular site. These include maximum discharge and gradient at the site. Morphology of stations within sites is also a local determinant of sediment retention. Of the three habitat types measured (riffles, runs and pool-tailouts), only riffles are erosional (i.e. sediment tends to be transported out of riffles). Pools are areas of deposition, though most of this does not occur in the tail-out. Runs are intermediate between pools and riffles. They have a low gradient, which favors deposition, but unimpeded flow; which favors erosion. Riffles are expected to be the least sensitive to changes in sediment loading. Because they are erosional, increased sediment would not tend to accumulate in riffles until loads increased dramatically. Pools retain sediments and naturally have a high percentage of surface fines. Pools may be particularly influenced by local changes in sediment loading (i.e. slumping banks or high road encroachment). Because of high natural sediment levels, PSF levels in pools may not vary much among streams. Therefore they may be poor habitats for monitoring sediment. Runs should be more sensitive to changes in sediment loading in the drainages than riffles and not quite as sensitive as pools to local changes in sediment loading.

In this study, the dependence of PSF on basin-wide and local characteristics is tested. A multiple regression equation is constructed with PSF as the dependent variable and gradient, two year maximum discharge, road encroachment per mile of stream, road density, jammer road density and relative erosivity of the parent material are the independent variables. Separate regression equations were run for riffles, runs and pool-tailouts. The purpose is to determine if variables that are known to affect sediment in streams vary in a logical way with PSF. Percent surface fines was expected to increase with increasing erosivity of parent material, road encroachment, road density and jammer road density. Percent surface fines was also expected to increase with decreasing discharge and decreasing gradient. If these relationships emerge, then PSF can be considered as a possible method for long-term sediment monitoring in the Lolo National Forest.

Methods

In 1985, 1986 and 1987 permanent sampling sites were established on 11 streams in the Lolo National Forest for long-term monitoring of percent cobble embeddedness. Percent cobble embeddedness did not prove to be a useful index for monitoring sediment in streams (Vadeboncoeur et.al. 1989) and in 1989 a method for measuring percent surface fines (PSF) was tested using the sites already established for embeddedness. The criteria used to select sites for embeddedness are not necessarily similar to those that would ideally be used for the new method, however, this was considered unimportant for this trial. If this method is used in future years, new site selection criteria will be developed.

A brief description of the configuration of sites sampled this year is necessary. Embeddedness sites were established in drainages with differing levels of impact from roading and logging. Some of the drainages had highly erosive granitics as parent material and others were dominated by the harder Belt Series parent material. Each sampling site on a stream consisted of several stations located in an area of stream up to about a third of a mile long. Each station was categorized by morphology as either a riffle, a run or a pool-tailout. Between zero and four stations of each morphology were established at any site. Some streams (Petty Creek and Twelvemile Creek) have an upstream and a downstream site, each with several stations.

The new method measured Percent Surface Fines (PSF). We used a square grid 26.4 cm on each side with a total of 25 intersections. The grid was made of 3/16 inch steel bar and each intersection was about 0.25 inches in diameter. Fine sediment was defined as being less than or equal to 0.25 inches in diameter so the grid provided built in reference points that controlled for the effect of magnification by the water. The grid was tossed randomly into the station, and using a square piece of clear plexiglass to reduce surface turbulence, the number of intersections that rested on fine sediment were counted. The grid was tossed ten times at each station. For each toss, percent surface fines was calculated as s/25, where s is equal to the number of intersections that intercepted fine sediment.

We measured average gradient at most sites using a clinometer. At sites where gradient was not measured a gradient was determined from a map and confirmed using previous records. Maximum discharge at each site was not measured directly because most of the streams are not gauged. Maximum two year flood was calculated based on drainage area, maximum channel length and change in elevation according to the methods of Johnson and Omang (1976). We do not assume that this is actually the flow that occurred in these drainages during 1989, however this should give the best available estimate of relative differences in flow magnitude among sites.

Roads are a major source of sediment in developed drainages (Megahan, 1972). In this study two types of roads were considered: main roads and jammer roads. Jammer roads are closely spaced temporary roads used on clearcuts. Jammer roads have not been constructed in the Lolo National Forest since the early 1970's. Many of the jammer roads shown on maps may be revegetated. We measured total length of jammer roads off 7.5 minute maps using a digitizer. Because of time limitations we did not consult aerial photographs to distinguish revegetated jammer roads from those that are still exposed. Revegetated roads would probably not be a significant source of sediment. Total length of jammer roads was divided by watershed area to calculate the variable **jammer road density** (JRD) in miles per square mile. Total length of primary and secondary roads excluding jammer roads was also measured using 7.5 minute maps and a digitizer. Total length of roads was divided by watershed area to calculate the variable **road density** (RD) in miles per square mile. At no time was jammer road density included in road density because we felt relatively certain that all secondary and primary roads are still potential sources of sediment and the same cannot be said for jammer roads. We did not wish to introduce such uncertainty into a variable which is believed to be critical to sediment loading in streams. A third variable concerning roads is **road encroachment**(RE). A road was considered to be encroaching on the stream if it was located within one 40 foot contour line of the stream. Road encroachment was measured off 7.5 minute maps and calculated as the total length of stream with road encroachment divided by the total length of active stream.

Monitored drainages differ in geologic parent material and this could affect sediment loading into streams. Sasich and LaMotte-Hagen (1989) developed a Land System Inventory in which the entire Lolo Forest is broken down according to geologic parent material. Resolution is good with some landtypes mapped in units as small as 15 acres. Each geological land type was rated in erosivity relative to granitics, which had a value of 1.0. The following landtypes were encountered in the monitored drainages.

Parent Material	Geology Group	Erosivity
Granitics	G,K	1.0
Metasedimentary Rocks		
Weakly Weathered	Q	0.2
Moderately Weathered	M	0.23
Highly Weathered	J	1.2
Lacustrine and Valley Fill	J	1.2
Glacial Tills	O	0.35
Volcanics	P	1.0
Mica Schist	S	1.0
Undifferentiated	U	1.0

Using a digitizer and 7.5 minute maps we measured the area of each geology group in the drainage basin above the site. A weighted average of the geology groups termed an **erosivity index** (EI) was derived for each site using the following equation:

$$EI = \frac{a_g + a_k + (a_q x.2) + (a_m x.23) + (a_j x1.2) + (a_o x.35) + a_p + a_s + a_u}{a_g + a_k + a_q + a_m + a_j + a_o + a_p + a_s + a_u}$$

where: a_g = area of the drainage consisting of geology group G.
a_k = area of the drainage consisting of geology group K, etc.

A multiple regression equation was constructed with Percent Surface Fines (PSF) as the dependent variable and gradient (GR), two year maximum discharge (Q_2), road density (RD), jammer road density (JRD), road encroachment (RE) and erosivity index (EI) as independent variables (Table 1-1 and 1-2). Separate regressions were run for riffles, runs and pool tailouts. The values of more than one riffle, run or pool-tailout within a site could not be entered into the equation without violating assumptions of independence of samples. Therefore if more than one station of a given morphology was sampled at a site, a mean value of PSF was calculated for the site, and it was this mean value that was entered into the equation.

All independent variables were entered into the equation at once and then those with the least effect on the regression were removed. The criteria for removal was a probability of F of greater than 0.10 associated with the independent variable.

Results

When the multiple regression equation was run using PSF as the dependent variable the residuals suggested that variance increased with increasing values of PSF. This violates the assumption of homogeneity of variance that is critical for using multiple regression. The data were therefore log transformed and a new dependent variable $\log_{10}$ of Percent Surface Fines (LPSF) was used in the equation (Table 1-1). Similarly, the distribution of the erosivity index (EI) suggested that it should be log transformed, so a new variable LEI ($\log_{10}$EI) was created.

Riffles: Log percent surface fines was significantly correlated only with log erodibility index (LEI) and jammer road density (JRD). Log percent surface fines (LPSF) increased with increases in LEI and JRD.

Runs: The final regression equation for runs includes three independent variables, gradient (GR), two year maximum discharge (Q_2), and RD. Percent surface fines increase with increasing road density and decrease with increasing gradient and discharge. The adjusted R^2 value for the equation is 0.66 ($F=6.948$, $p<0.023$). Regression statistics, covariance and beta coefficients are shown in table 1-3.

Pool-Tailouts: The final multiple regression equation was not significant for pool-tailouts ($F = 6.542$, $p < .137$, $df=4,2$). All independent variables were highly correlated with each other, with correlation coefficients ranging from .93 - .97. Because of this, no relationship between PSF and the independent variables can be determined.

Table 1-1. Percent surface fines and log percent surface fines for 1989.

Watershed	Riffles		Runs		Pool-tailouts	
	PSF	LPSF	PSF	LPSF	PSF	LPSF
Cinnamon-bear Ck.	5.4	0.81	8.4	0.97	--	--
Schwartz Ck.	14.0	1.18	45.2	1.16	--	--
West Fork Lolo Ck.	32.4	1.52	--	--	--	--
East Fork Lolo Ck.	6.4	0.87	43.6	1.65	--	--
Granite Ck.	--	--	20.5	1.33	--	--
Lolo Ck.	5.0	0.78	8.9	1.00	14.0	1.18
Upper Petty Ck.	1.6	0.41	24.2	1.40	17.4	1.26
Lower Petty Ck.	17.2	1.26	21.7	1.36	19.6	1.31
Upper 12-mile Ck.	2.6	0.56	--	--	9.0	1.00
Lower 12-mile Ck.	5.6	0.82	--	--	11.4	1.09
West Fork Big Ck.	0.0	0.0	3.6	0.66	--	--
Big Ck.	1.9	0.46	6.7	0.88	5.0	0.78
West Fork Packer Ck.	4.6	0.75	6.2	0.86	11.2	1.09

Table 1-2. Independent variables for watersheds.

Watershed	Area (miles)^2	Q_2 (cfs)	GR (%)	EI	RD mi/mi^2	JRD mi/mi^2	RE %
Cinnamon-bear Ck.	7.3	25	3.0	0.32	2.1	2.5	11.8
Schwartz Ck.	17.0	42	2.0	0.26	3.4	6.4	30.0
West Fork Lolo Ck.	16.6	241	0.5	0.96	3.5	0.5	60.5
East Fork Lolo Ck.	32.6	322	0	0.94	2.6	1.2	60.9
Granite Ck.	19.7	279	1.0	0.83	3.1	1.4	71.1
Lolo Ck.	110.9	775	0.5	0.67	2.5	1.0	56.9
Upper Petty Ck.	30.2	205	0.5	0.33	1.7	0.3	26.3
Lower Petty Ck.	67.2	360	1.5	0.31	1.8	0.4	39.5
Upper 12-mile Ck.	5.6	81	2.5	0.24	4.7	1.4	39.7
Lower 12-mile Ck.	21.5	186	2.5	0.25	4.2	3.7	41.4
West Fork Big Ck.	8.3	87	3.0	0.27	1.7	0.2	20.2
Big Ck.	38.1	310	2.0	0.27	2.2	2.1	46.5
West Fork Packer Ck.	7.2	74	2.0	0.55	1.4	0.2	53.3

Table 1-3. Regression coefficients.

Variable	B (partial regress. coeff.)	s.e. B	Beta	Partial correlation coefficient	t	sig t
<u>Riffles:</u>						
Erosivity Index	1.1582	.50877	.6395	.60450	2.277	.0488
Jammer Road Density	.1120	.06219	.5057	.51453	1.800	.1054
<u>Runs</u>:						
Gradient	-.2909	.08663	-.8674	-.8079	-3.358	.0153
2 Year Max. Discharge	-.000924	.00039	-.5929	-.6927	-2.352	.0569
Road Density	.2441	.10750	.4523	.6799	2.271	.0636

Discussion

The results of the multiple regression suggest that percent surface fines are significantly correlated with parameters such as gradient, discharge, erosivity of parent material and road densities. All these are known to affect sediment levels in streams. This suggests that measuring PSF with these methods may prove to be a useful monitoring tool. That the independent variables that were correlated with $\log_{10}$ percent surface fines (LPSF) differed between riffles and runs probably reflects on the functional difference between the two habitat types rather than on problems with the methods. Riffles are areas of degradation, whereas runs are somewhat depositional.

Riffles

In riffles, percent surface fines were correlated with the erosivity of the parent material and jammer road density. The adjusted value of R^2 in the equation is an estimate of the amount of variation in the dependent variable (LPSF) explained by the independent variables (LEI and JRD). The R^2 value indicates that 27% of the variation in percent surface fines measured in riffles is explained by the variation in the erosivity of parent material and/or jammer road density in the drainage. It is significant at $p < .10$. This could be interpreted in that there is less than a 10% chance that there is no linear relationship between LPSF and the independent variables. This is a tolerably low probability, so we instead conclude that there is a correlation between the variables.

As stated previously, percent surface fines is dependent upon the erosivity of the parent material in riffles. If our methods are detecting a true relationship between percent surface fines in riffles and parent material, then the relationship is probably causal; i.e. increased erosivity in a drainage causes an increase in surface fines in riffles. Intuitively this makes sense and is the relationship we expected to find. No matter how great flushing flows are in a stream, if the drainage consists almost entirely of highly erosive granitics, the stream substrate may contain a comparatively high amount of fines in all habitat types.

According to this equation, jammer road density also affects PSF. However, the significance of B, the partial regression coefficient is > 0.1. This casts in doubt how and to what degree jammer road densities affect PSF. Conclusions should not be drawn until future monitoring either supports or invalidates the results of this analysis.

The lack of relationship with gradient and discharge is indicative of the nature of riffles as erosional areas. The higher the gradient, the greater the power of the stream, and hence the greater the streams ability to move sediment. Intuitively we would expect an inversely proportional relationship between gradient and PSF. The lack of an apparent relationship between PSF and gradient might be due to the relatively low gradient of all sites (GR $\leq$ 3.0%). Whereas runs and pools are by definition low gradient habitat types, gradients in riffles can range from zero up to about 10% gradient. If sites included a greater range of gradients of riffles, a relationship might emerge. However, we would not expect such a relationship to be very strong. Percent surface fines in riffles tend to be close to zero and our method is probably not sensitive enough to detect slight differences in low values of PSF. The lack of relationship with discharge is important. As maximum discharge increases the ability of the stream to move sediment should also increase. However, riffles are areas of erosion and tend not to collect fine sediment even in small streams, unless, as these results support, the geology of the drainage basin produces large amounts of fine sediment.

Runs

In runs, percent surface fines is correlated with gradient, discharge and road density. The direction of change of PSF with each variable is as predicted. Percent surface fines decreases with increasing discharge and gradient, and PSF increases with increasing road density. Looking at the adjusted R^2 value in table 1, we see that 66% of the variation in surface fines can be explained by differences in gradient, discharge and road densities among the sites. The regression is significant ($p < .024$). Given the high variability in streams, we consider this a large amount of explained variance. Gradient has the highest partial correlation coefficient (-.81). The square of the partial correlation coefficient is equal to .66 and is the proportional reduction in variation in LPSF accounted for by gradient, when the other independent variables are accounted for. So, if road density and discharge are "held constant", 66% of the remaining variation in LPSF could be explained by changes in gradient (the highest possible value for a partial regression coefficient is 1.0 or -1.0 and would indicate perfect correlation between the two variables). The negative sign indicates the slope of the regression line is negative, i.e. as gradient increases, PSF decreases. However, because of the high correlation between gradient and discharge (.63), the actual magnitude of the effect of gradient is difficult to interpret. Another potential problem is that measuring gradients with a clinometer or off a map is not very accurate.

Increased road density was correlated with increased surface fines in runs. The relationship is not as strong as that for gradient and discharge (partial regression coefficient = .45). That the partial correlation coefficient is lower for roads than for gradient and discharge is expected. Gradient and discharge are characteristics of the stream that directly impact sediment transport and retention. Road density only influences the relative sediment delivery to the stream. The impact of a given road on a stream depends on many factors such as its proximity to the stream, its age and how the road was built. The variable "road density" does not weight roads according to their probable impact on a stream, and therefore we would not expect as strong a correlation with PSF as is seen with gradient and discharge.

Pools

There are several possible reasons why no significant regression could be calculated between PSF in pool-tailouts and the independent variables. The most important reason is that only seven of the streams sampled have sites that are pool-tailouts. Until more pools are sampled, nothing can be concluded about trends in PSF in pools.

Recommendations for Future Monitoring

These results are promising and suggest that the grid method is a good way to monitor percent surface fines and that percent surface fines may be a good index of sediment dynamics in streams. We were seeking evidence that PSF as measured with the grid varied in a logical way with factors that affect sediment level in streams. It appears to do so in runs, and to a lesser extent in riffles. We expected riffles to have low values of PSF, pools to have the highest values and runs to have intermediate values of PSF. In any given stream, the mean value of PSF in riffles was lower than that in runs and pool-tailouts. However, there were only two creeks in which PSF for pool-tailouts was higher than that of runs (only five of the eleven sites had both pool-tailouts and runs, see table 1-1). The values for pool tailouts are lower than would be expected based on the assumption that pools are depositional zones. However, the tailout is the least likely part of the pool in which sediment would be deposited. In the future, the entire pool should be monitored. Also, a greater sample size of pools is required before conclusions can be drawn as to whether PSF in pools is correlated to drainage basin characteristics such as the independent variables in this study.

The selection of sites for this study was based on previous years embeddedness monitoring and is not optimal. One problem is that the incorporation of upper and lower drainages on a single stream probably violates the assumption of independence of observations in multiple regression. The value for road density, jammer road density and erosivity index for a lower site includes data used for the upper site. It is essential that before final conclusions are made concerning how these independent variables affect PSF, that a similar regression is run on streams with only one site per watershed.

The establishment of permanent stations within a site has several drawbacks. It takes time to establish these stations. It is also time consuming to find them again in future years and to ensure that all sampling is done in the original sites. Streams change over time and the original habitat type attributed to a station may no longer apply. For instance some of the "permanent" pool-tailout sites are now in the center of the pool. The present embeddedness stations were not randomly selected and it is unclear what criteria were used to select them. We therefore do not know what bias is introduced by the methods used to select stations. The present sites have various numbers of each of the three habitat types, and some sites have no pool-tailouts or runs. This lack of consistency complicates statistical analysis.

An alternative method of monitoring would be to establish a permanent monitoring site on a stream but have no permanent stations within that site. Based on the data from this study and from the Lolo National Forests 1989 stream inventory, we could determine the optimal number of each habitat type (morphology) to monitor per site. Say, for example that we calculate, based on within stream variability, that we should measure PSF at 10 runs within a site. For simplicity let us assume that we should also measure 10 riffles and 10 pools. The length of the entire site would then have to be large enough to include at least these 30 habitat units. Riffles and pools are usually more common than runs. A site that contained 10 runs, might plausibly include 30 pools and 20 riffles. So some decision would have to be made about whether to sample the "extra" riffles and pools in the site. Possible options for sampling the site include the following:

1) Sample every habitat unit until 10 of one habitat type (e.g. pools) are sampled. From then on only riffles and runs would be sampled until 10 riffles had been sampled. After that only runs would be sampled.

2) Sample habitat units based on the riffle to run to pool ratio of the stream. In the above example, the observer would monitor PSF on every third pool, every other riffle and every run.

3) Sample every habitat unit in the site and so monitor unequal numbers of riffles, runs and pools.

4) Sample only runs.

A disadvantage of option #1 is that the most abundant habitat types would be monitored in bunches whereas the least abundant would be evenly sampled throughout the site. This would introduce error caused by heterogeneity of the site.

The main disadvantage of the second option is that the riffle:run:pool ratio must be known before the site is monitored. Also measuring every x number of habitats may not result in the same number of each habitat type being measured and is similar to option 3.

Option 3 has the disadvantage that unequal numbers of each habitat unit would be measured. However from year to year within site comparisons this should not be a problem. Similar numbers of pools should be measured each year unless the stream changes dramatically. Pools will only be compared to pools from year to year so this should not present a problem for statistical analysis. The same holds true for riffles and runs. An advantage is that little time would be spent determining which units to measure. More importantly the only source of error between years would be the way different observers identified habitat units. In options 1 and 2, in addition to the interobserver error, there is a an error of monitoring only a sample of habitat types on the site rather than the entire population. If the entire site is measured every year, one source of variability is eliminated.

Option 4 would not be advisable at this point because the method is new and we need more information on its sensitivity and usefulness. However, we suspect that runs will be the most useful habitat type in which to detect long-term changes in percent surface fines.

Chapter 2

Percent Surface Fines - Technique Sensitivity

Introduction

The determination of the percentage of substrate composition attributed to the size range classified as fines (<0.5mm) is an essential measurement in any evaluation of fisheries habitat. The ability to accurately measure, as opposed to a visual estimate, is critical in attaining statistically reliable results. The amount of fines in a stream's substrate has been shown by numerous investigators to adversely affect various life stages of salmonid populations as well as aquatic invertebrate community composition and distribution. Spawning potential, over-wintering habitat, and egg and fingerling survival are all decreased by increasing substrate fines. The relationship between surface fines, cobble embeddedness, interstitial spaces, and particle size distribution as determined, for example by core samples, is very complex and poorly understood. A recent investigation of the cobble embeddedness technique by personnel on the Forest revealed an inherent error that could potentially distort the actual embeddedness value. These findings, along with several questions concerning the methodology's precision and accuracy, led to this technique being dropped as a monitoring tool by the Forest. In lieu of an adequate understanding of sediment transport and storage in streams and the aforementioned relationships, the Lolo National Forest felt that the best possible methodology would be one in which an accurate measurement of surface fines was attainable. The rational being that substantial increases in surface fines could indicate detrimental changes in aquatic habitat. A methodology was developed that we feel should give consistent and accurate measurements and meet the requirements of (1) being quick and easy to do and (2) be shown to be statistically reliable and accurate over a large range of substrates. It was felt that collection of measurements of surface fines could, once sediment responses are more thoroughly understood, allow re-analysis of the existing data base. In the meantime, percent surface fines would be used in current inventory procedures and associated analysis. This method was developed exclusively for the measurement of surface fines in an attempt to monitor changes in stream substrate composition from year to year and no predictive response(s) by the respective biological communities is implied.

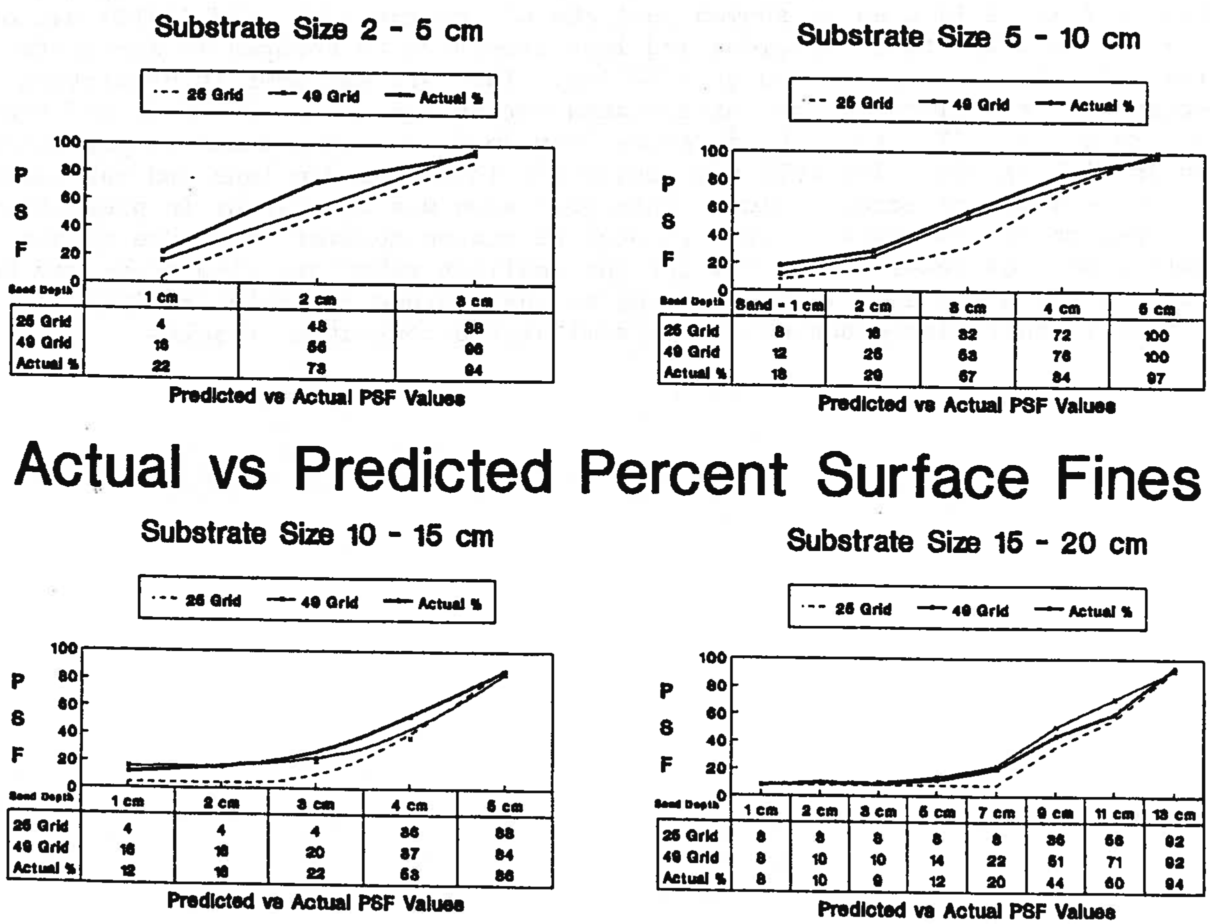
Methods

During the summer of 1989 a square metal grid containing 25 intersections was employed by field crews during fisheries habitat monitoring on the Lolo National Forest. The method consisted of randomly placing the grid on the substrate of streams stratified by habitat type and counting the number of intersections on the grid which lay above an area composed of fines. It was thought that a relationship existed between the percentage of intersections lying over fine materials and the percent surface fines in the substrate (i.e. 5/25 intersections = 20% surface fines). Concerns were expressed over the sensitivity of this technique especially with regards to different substrate sizes (i.e. boulder vs cobble/gravel). An analysis was done over the winter to determine the predictive capability of this technique with known areas of surface fines and substrate sizes.

Four substrate sizes ranges were selected: 2-5, 5-10, 10-15 and 15-20 cm. Rocks corresponding to the four ranges were placed in a square box and a quantity of fine sand was added to various known depths (1-13cm). At specific depths of sand a black and white photograph of the mixture was taken directly overhead. By utilizing a digitizer on the photographs an accurate calculation of the area composed of the respective rock substrate and surface fines was obtained. Once the calculations were made a comparison was done to assess the predictive capability of the method. A evaluation was also done utilizing a grid of 49 intersections to assess if further sensitivity was gained by increasing the number of intersections.

Results

Results (Fig. 2-1) clearly showed that the 49 intersection grid (49IG) was much more accurate in its predictions and less sensitive to changes in substrate size than the 25 intersection grid (25IG). The 25IG was poor in predicting percent surface fines at low surface area percentages (i.e. 0 - 50%) and small substrate sizes (2-5 cm). Differences between predicted and actual percentages ran as high as 25%. The 49IG was consistent in its predictions and was usually within 3-5% of the actual value. This grid also was consistent in predictions with regard to substrate sizes. It must be stated however, that due to the small number of observations (3) for the smallest substrate size there may be some loss of accuracy. It is anticipated that future scheduled additional testing in this size group will show similar and consistent results.



Substrate Size 2 - 5 cm

Sand Depth	1 cm	2 cm	3 cm
25 Grid	4	48	88
49 Grid	16	56	96
Actual %	22	73	94

Substrate Size 5 - 10 cm

Sand Depth	Sand - 1 cm	2 cm	3 cm	4 cm	5 cm
25 Grid	8	16	32	72	100
49 Grid	12	26	53	76	100
Actual %	18	29	67	84	97

Substrate Size 10 - 15 cm

Sand Depth	1 cm	2 cm	3 cm	4 cm	5 cm
25 Grid	4	4	4	36	88
49 Grid	16	16	20	37	84
Actual %	12	16	22	53	86

Substrate Size 15 - 20 cm

Sand Depth	1 cm	2 cm	3 cm	5 cm	7 cm	9 cm	11 cm	13 cm
25 Grid	8	8	8	8	8	36	66	92
49 Grid	8	10	10	14	22	51	71	92
Actual %	8	10	9	12	20	44	60	94

Figure 2-1. Percent surface fines with 25 intersection grid, 49 intersection grid and actual.

While neither method is totally accurate at all substrate sizes and percent surface fine it is apparent that the 49IG method is preferable to the 25IG method. It gives more accurate predictions and appears not overly sensitive to substrate size while still not requiring that much more effort. It should be noted that the 49IG gave excellent results in the smaller substrate size groups which would normally be the size groups found in lower gradient streams where deposition would most likely occur. With regard to the additional effort required for the 49IG methodology; the time it takes to count 49 intersections versus 25 is inconsequential. One would have to balance out the time and necessity of incorporating still a larger number of intersections per grid (i.e. 64, 81 etc.) versus predictive accuracy. We feel that the 49IG is probably the most efficient size but we will be further evaluating it this summer. One must be aware of a particular phenomena in this technique regarding the sensitivity of different substrates to increasing sediment deposition. When examining surface fines in substrates of large diameters one must be aware of the small change in percent surface fines relative to the depth of sediment deposition (Fig. 2.2). A change in sand depth from 1 to 3 inches in the smallest size (2-5cm) substrate shows a corresponding increase in percent surface fines from 16 to 96 percent while the same change in the depth of sand deposition in the larger size (15-20cm) substrate shows only a two percent increase (i.e. 8 to 10%). It is obvious that care must be given to examining relative changes as well as actual changes in percent surface fines when looking for possible detrimental effects upon aquatic systems.

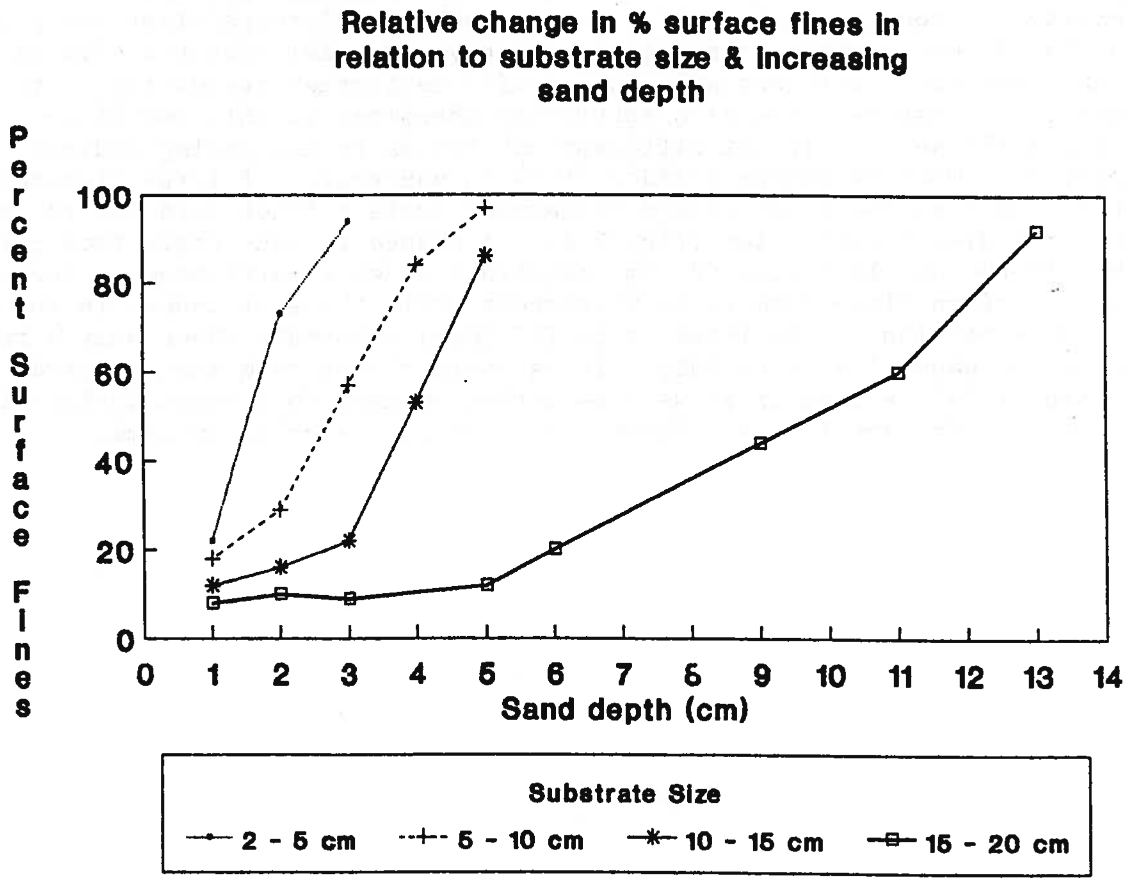


Figure 2-2. Relative change in percent surface fines in relation to substrate size and increasing sand depth.

Chapter 3

1989-1990 Sediment Monitoring Report

Introduction

During 1989 and 1990 a total of 19 streams on the Lolo and Deerlodge National Forests were monitored to assess changes in stream substrate sediment levels. The method currently being evaluated on the Forest is a measure of substrate percent surface fines.

Methods

The method currently being used and evaluated on the two Forests is a measurement of the percent of the total stream substrate area composed of material less than 0.25 inches. A total of 19 streams encompassing 100 individual sites were sampled during the summer of 1990. The specific habitat types sampled were respectively: 45 riffles, 32 runs and 23 pool tail-outs. A square grid with 25 intersections in 1989 and 49 intersections in 1990 were thrown randomly onto the sample site a total of ten times. At each throw the number of intersections that lay over substrate material with a diameter of less than 0.25 inches were counted. A simple percentage was then calculated for each respective throw as to the ratio of fine material to the total area enclosed by the square. The value reported is an overall mean for that particular habitat type (i.e. mean of riffle site (1,2...n)/n) within that drainage.

Results

Deerlodge National Forest

Sand Basin Creek

Sand Basin Creek is a tributary to the West Fork of Rock Creek managed by the Phillipsburg Ranger District. Study site 1 (Fig.3-1) has a drainage area of 11.1 square miles with 12.8 miles of road. Road density is 1.2 miles per section. All of these roads were constructed from 1960-1965. The study area drains primarily Idaho Batholith derived soils, but also contains some Missoula group and glacial tills. Site 1 is located approximately 1/4 mile upstream from the confluence of the West Fork. The channel is type C.

Sand Basin is the smallest creek sampled for embeddedness on the Deerlodge. Riffle and pool-tailout sites showed decreases in PSF while the run sites showed increases (Fig. 3-2).

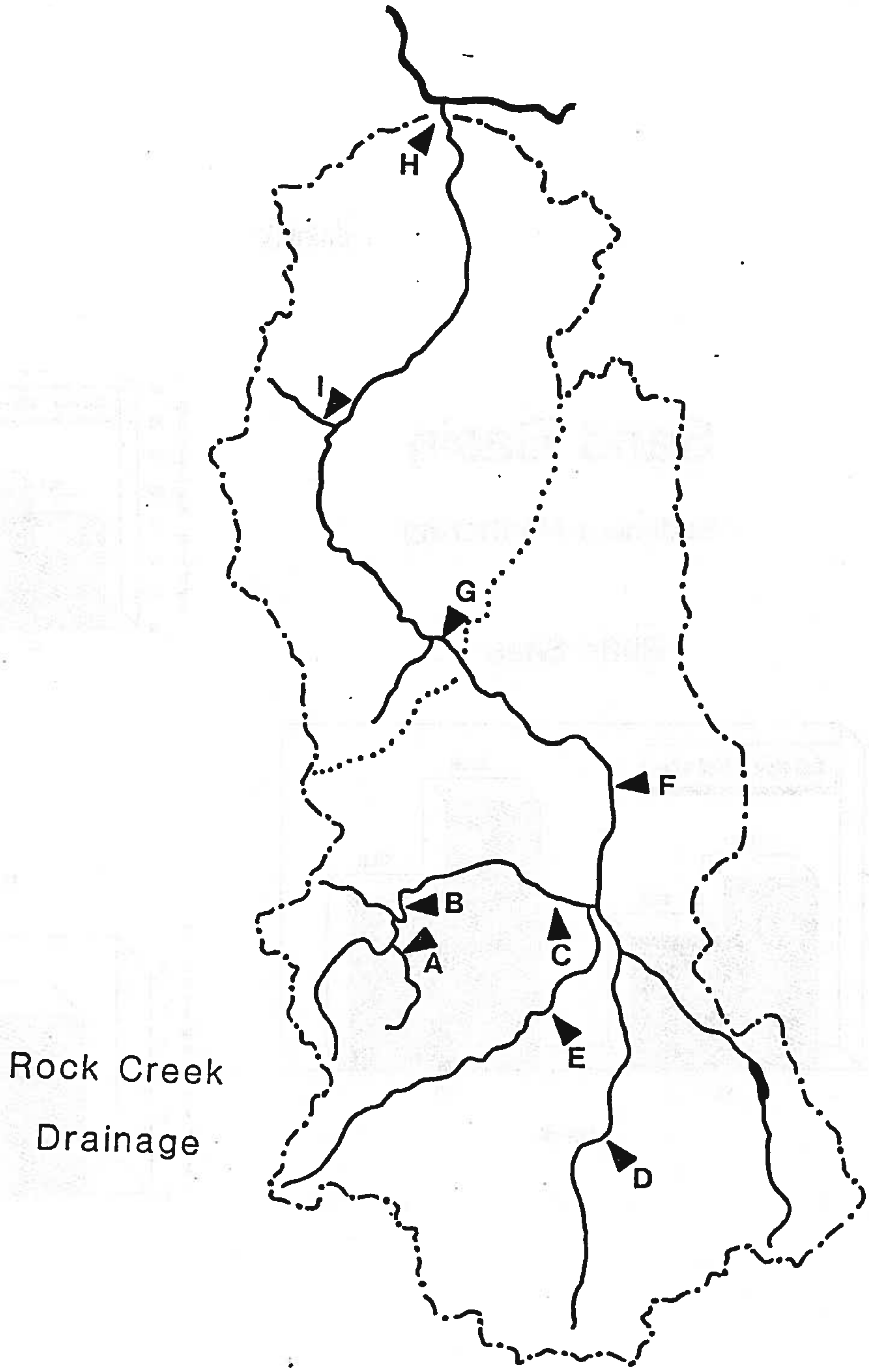
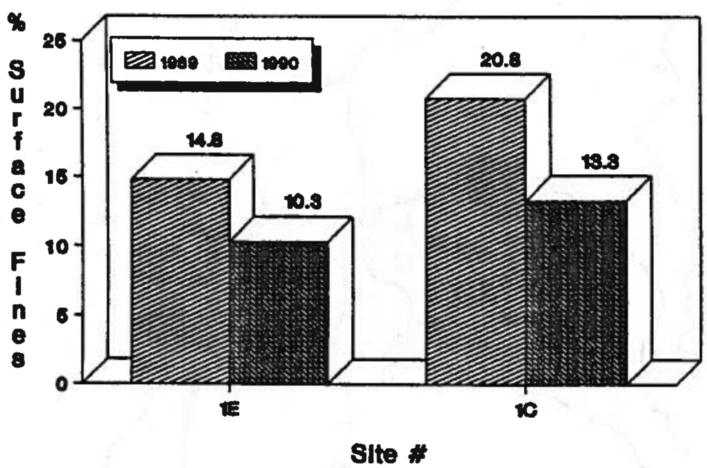


Figure. 3-1. Sampling sites for Rock Creek and its tributaries on the Lolo and Deerlodge National Forests. A - Sand Basin Creek; B - Upper West Fork Rock Creek; C - Lower West Fork Rock Creek; D - Middle Fork Rock Creek; E - Ross Fork Rock Creek; F - Upper Rock Creek (Deerlodge NF); G - Middle Rock Creek (Lolo NF); H - Lower Rock Creek (Lolo NF); I - Cinnamon Bear Creek.

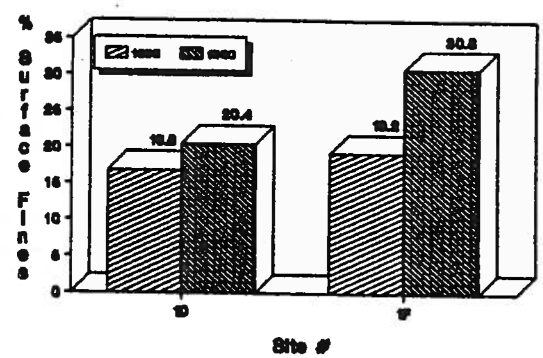
Sand Basin

Sediment Monitoring

Riffle Sites



Run Sites



Pool - Tailouts

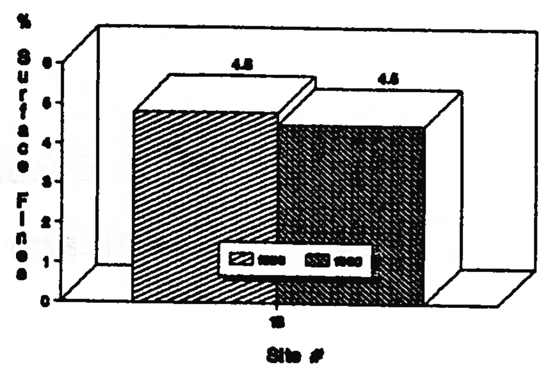


Figure 3-2. PSF for Sand Basin Creek for 1989 and 1990.

West Fork Rock Creek

Upper Stations

West Fork of Rock Creek is located on the Philipsburg Ranger District. Five sites were chosen for evaluation on the West Fork of Rock Creek. Site one (Figure 3.1) has a drainage area of 39.8 square miles with 73 miles of road, or 1.8 miles of road per section. With the exception of 1.6 miles, all of these roads were constructed prior to 1970, with most being constructed in the period 1960-1970. The Study Site drains Idaho batholith, Missoula group and glacial till soils. The channel is type C, and the average active channel width is 38 feet at the site. An analysis is currently underway in this drainage (Stoney EIS) to consider further development.

No consistent variations in PSF were seen in the seven sites between 1989 and 1990 except in pool-tailouts in which there were increases (Figure 3-3).

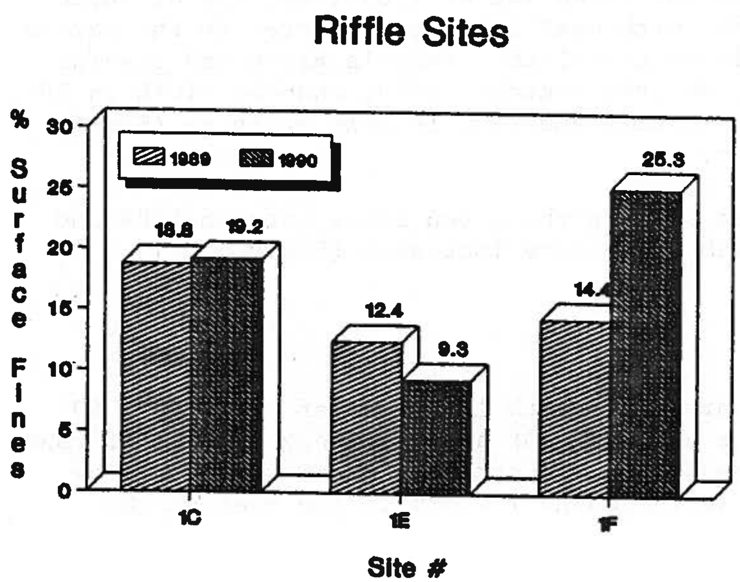
Lower Stations

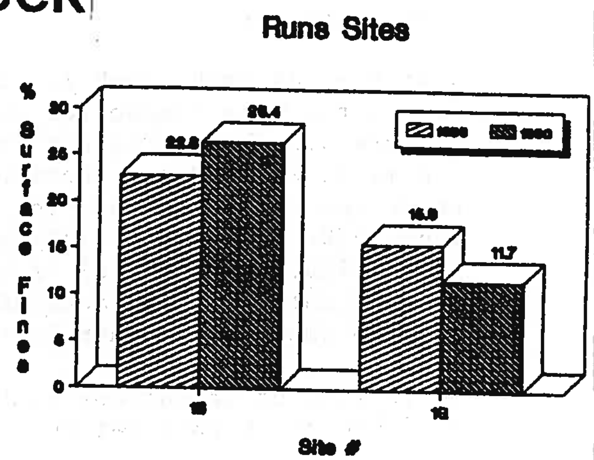
Site 2 (Figure 3-1) drains 86.3 square miles with 121 miles of road, or 1.40 miles of road per section. With the exception of approximately 6 miles of road constructed in 1978 and 1984, the roads were constructed prior to 1970. The channel is type C, and the average active channel width is 130 feet at the study site.

No consistent changes were observed at all six monitoring sites between 1989 and 1990. (Figure 3-4).

Upper West Fork Rock Creek

Sediment Monitoring





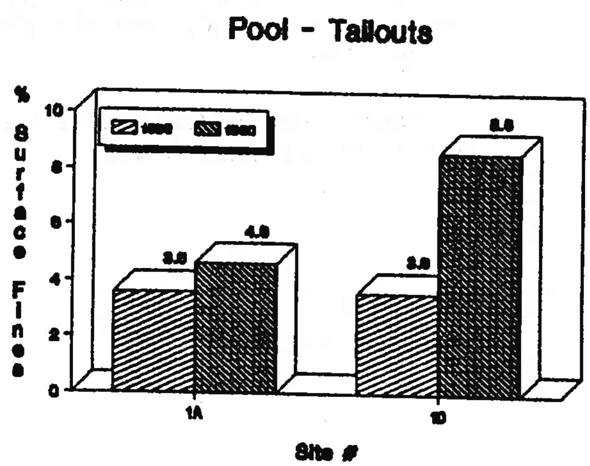
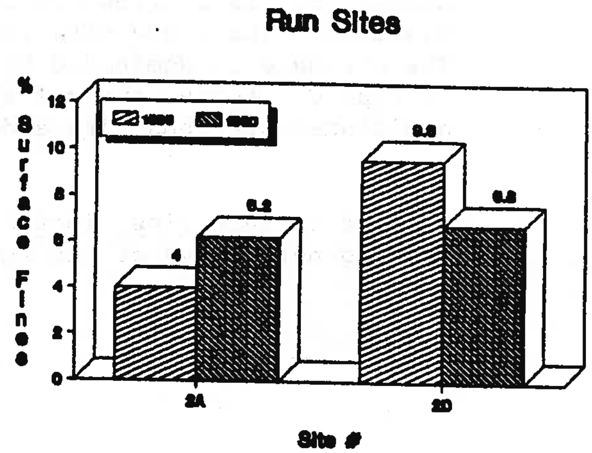
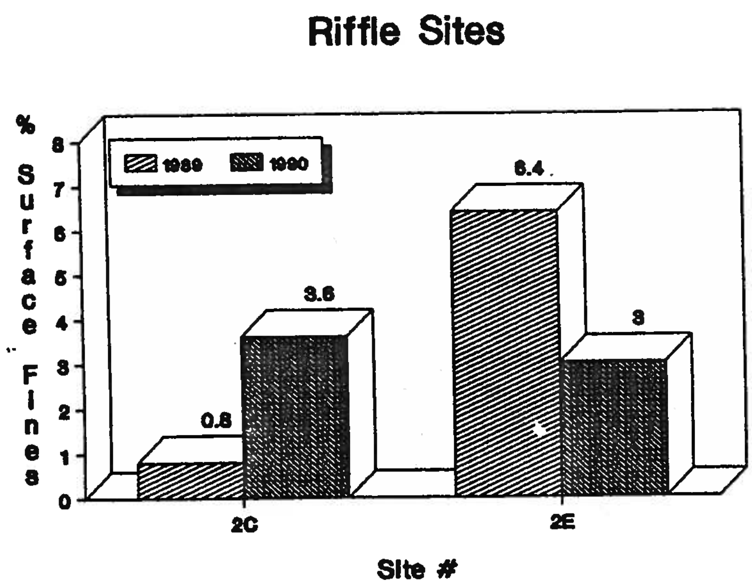


Figure 3.3. PSF for Upper West Fork Rock Creek for 1989 and 1990.

West Fork Rock Creek

Sediment Monitoring





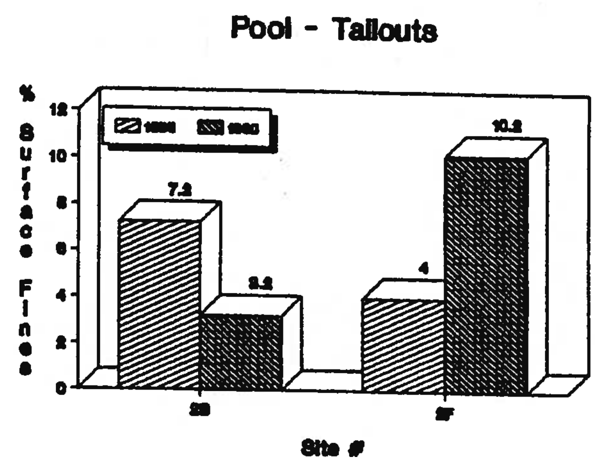


Figure 3-4. PSF for lower West Fork Rock Creek for 1989 and 1990.

Middle Fork Rock Creek

Middle Fork is a tributary to Rock Creek managed by the Philipsburg Ranger District. The study site (Figure 3-1) has a drainage area of 98 square miles. The drainage is dominated by soils derived from the Belt Series. The channel is type C. Active channel width was 47 feet at the study site. Three additional stations were added in 1986.

Percent Surface fines increased slightly at the riffle and pool-tailout sites with no net change at the run site (Figure 3-5).

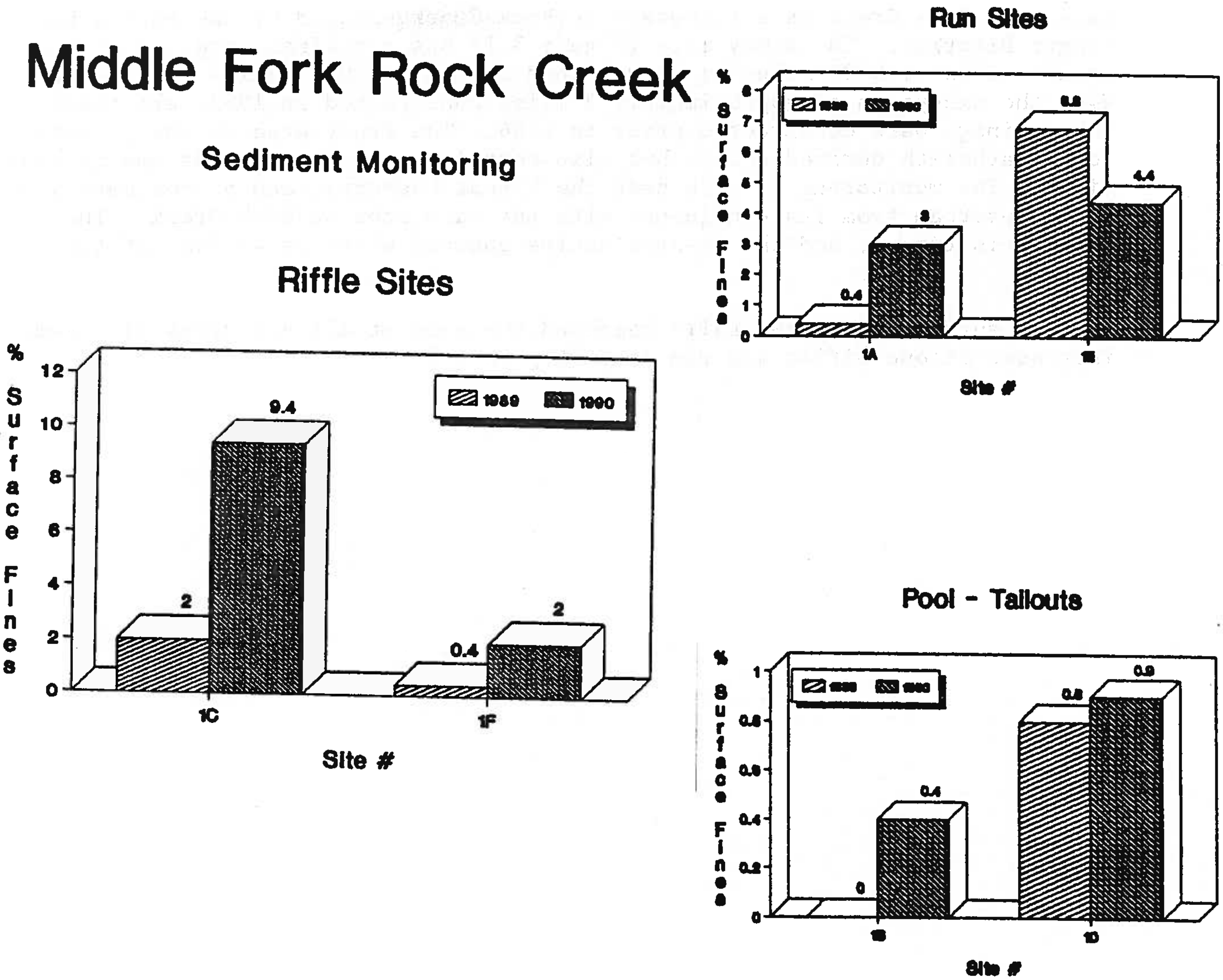


Figure 3-5. PSF for Middle Fork Rock Creek for 1989 and 1990.

Ross Fork Rock Creek

Ross Fork Rock Creek is a tributary to Rock Creek managed by the Philipsburg Ranger District. The study site (Figure 3.1) has a drainage area of 71.6 square miles with 24 miles of road. Road density is 0.34 miles per section. With the exception of approximately 3 miles constructed in 1982, all roads in the drainage were constructed prior to 1966. The study area drains primarily Idaho Batholith derived soils, but also contains some Belt series and glacial tills. The monitoring site is near the Forest boundary, and approximately 6 miles upstream from its confluence with the main stem of Rock Creek. The channel is type C, and the average active channel width is 41 feet at the study site.

Percent surface fines generally remained the same at all six sites with some increases at one riffle and run site (Figure 3-6).

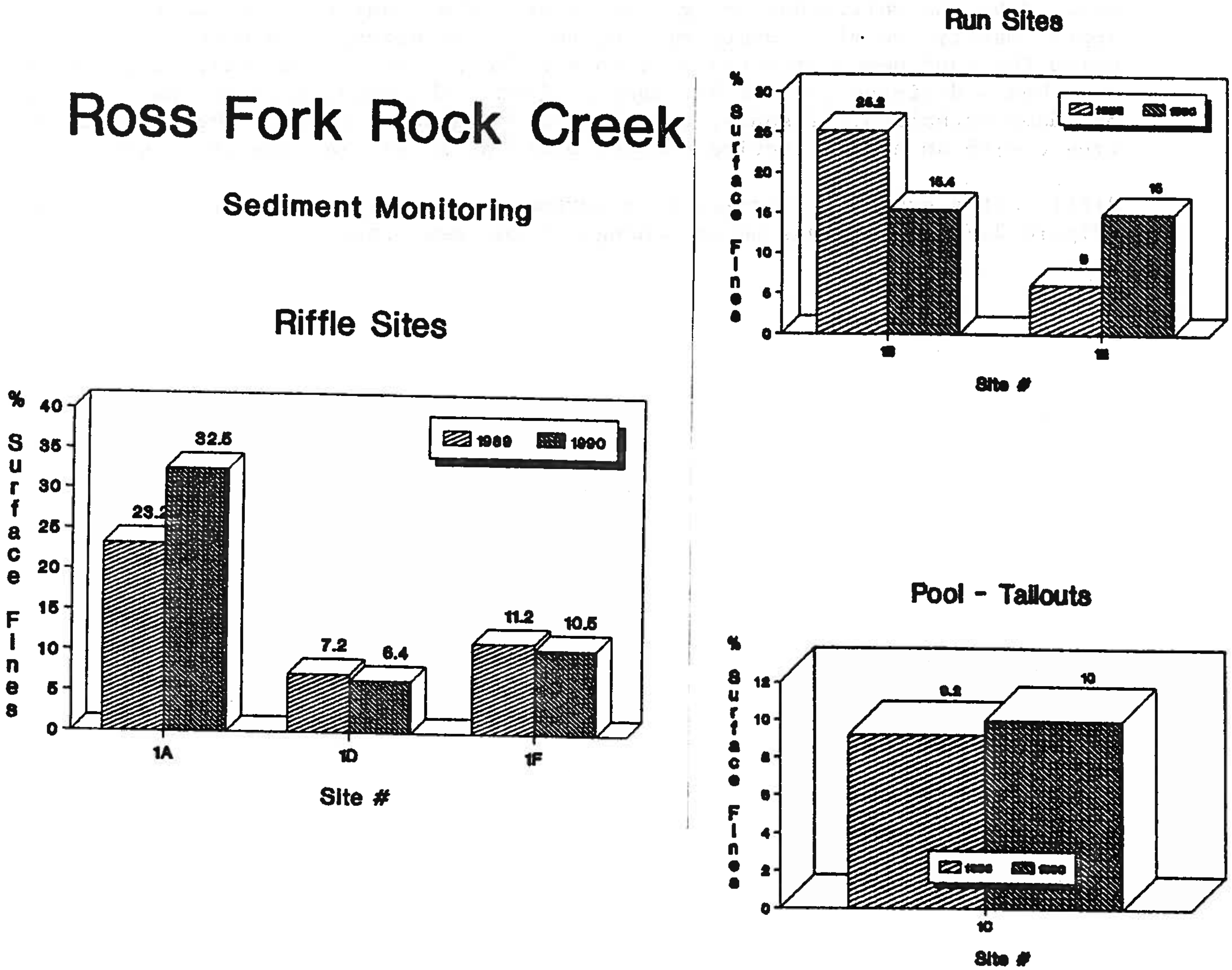


Figure 3.6. PSF for Ross Fork Rock Creek for 1989 and 1990.

Upper Main Stem of Rock Creek (Deerlodge)

Rock Creek is a tributary to the Clark Fork River and the upper portion is managed by the Philipsburg Ranger District. The study site is located approximately two miles upstream from the Gilles Bridge, and about 5 miles below the confluence with the West Fork of Rock Creek. The study site (Figure 3-1) has a drainage area of 457 square miles. The study area drains a mixture of Idaho Batholith, Missoula, Belt Series and glacial tills. The channel is type C with an average active channel width of 75 feet at the study site.

Riffle sites exhibited increases in surface fines while pool-tailouts decreased (Figure 3-7). There was no net change at the new sites.

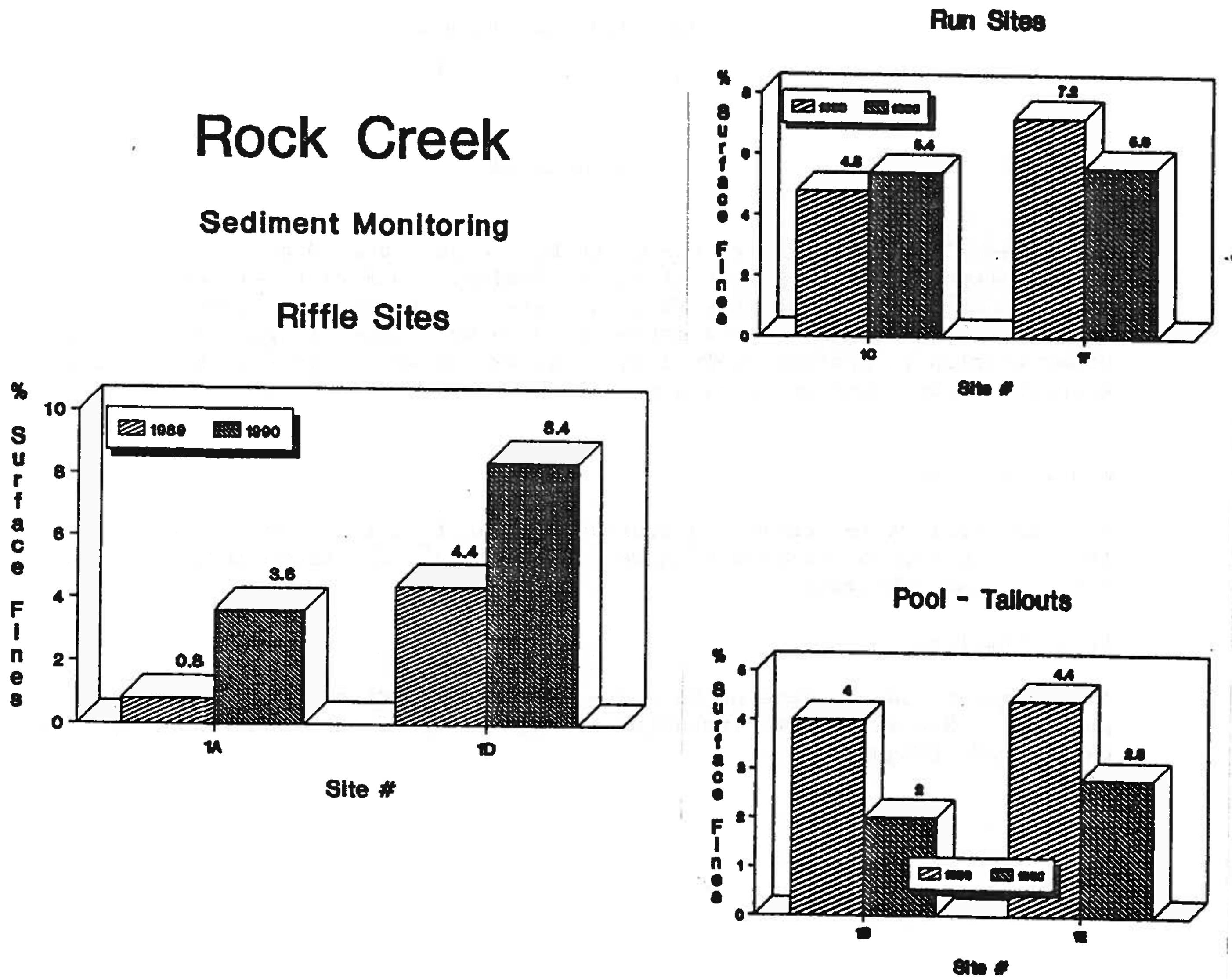


Figure 3.7. PSF for upper Rock Creek (Deerlodge) for 1989 and 1990.

Lolo National Forest

Rock Creek

Rock Creek is a tributary to the Clark Fork River located on the Missoula Ranger District. The upper half of the drainage on Forest Service land is administered by the Deerlodge National Forest. In the Lolo National Forest, upper and lower stations were established on Rock Creek (Figure 3.1). The upper station is approximately 2 miles below the Deerlodge-Lolo National Forest boundary. The lower stations are near the mouth of Rock Creek.

Middle Stations

Run and riffle sites exhibited decreases in surface fines while one pool tail-out showed an increase (Figure 3-8). Overall the trend indicates less fines in the substrate.

Lower Stations

The long-term lower sites on Rock Creek had to be dropped due to access problems. New sites were installed at the Valley of the Moon. No comparisons can be made (Figure 3-9).

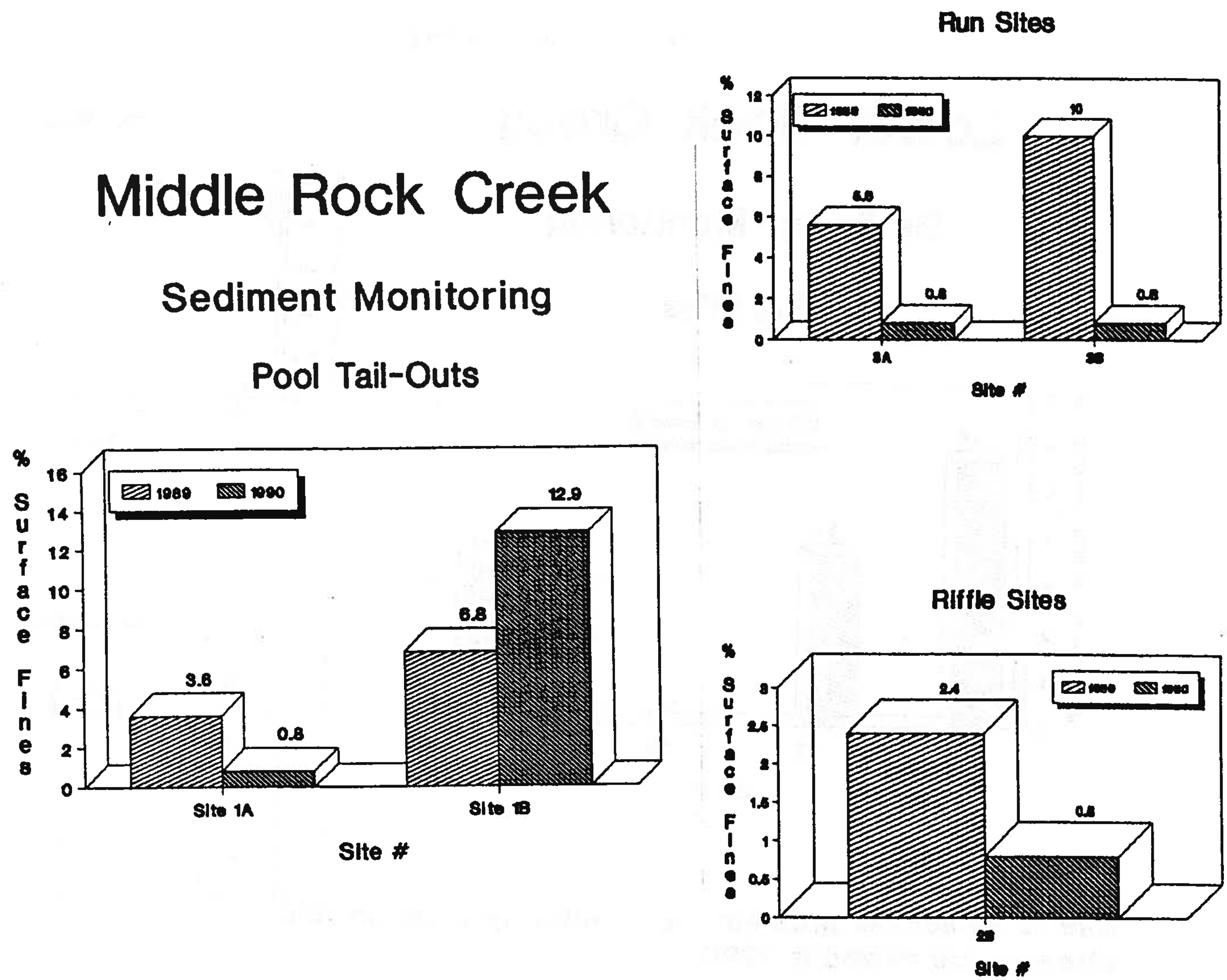
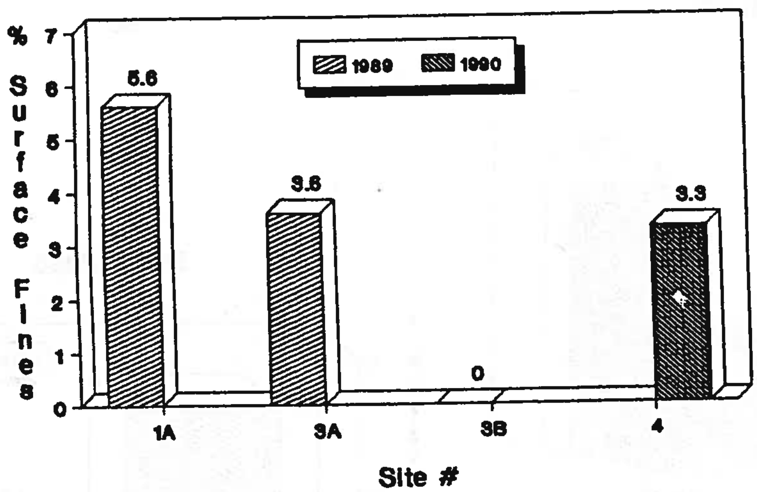


Figure 3.8. PSF for middle Rock Creek on the Lolo National Forest for 1989 and 1990.

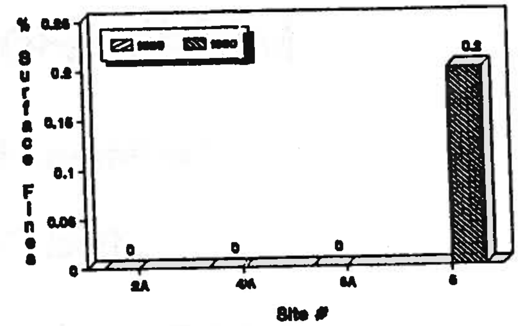
Lower Rock Creek

Sediment Monitoring

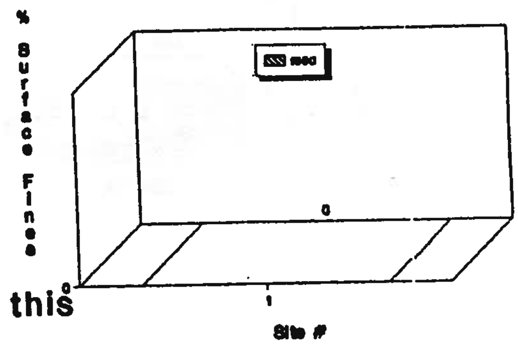
Run Sites



Riffle Sites



Pool Tail-Outs



Due to an access problem the monitoring sites on this stream were moved in 1990.

Figure 3.9. PSF for lower Rock Creek on Lolo National Forest for 1989 and 1990.

Cinnamon Bear Creek

Cinnamon Bear Creek is a tributary to Rock Creek on the Missoula Ranger District. The study site is located approximately 300 feet above the mouth (Figure 3-1).

This is a small creek that flows into Rock Creek. Roading is moderate to heavy in the upper half of the drainage, and this includes old jammer roads. The sampling stations are about 300 feet above its confluence with Rock Creek. There are roads in the upper half of its drainage. Two sites had a decrease in PSF and one riffle had a slight increase (Figure 3-10). Pat Gulch Post and Pole is a timber sale currently being analyzed in the upper half of the drainage.

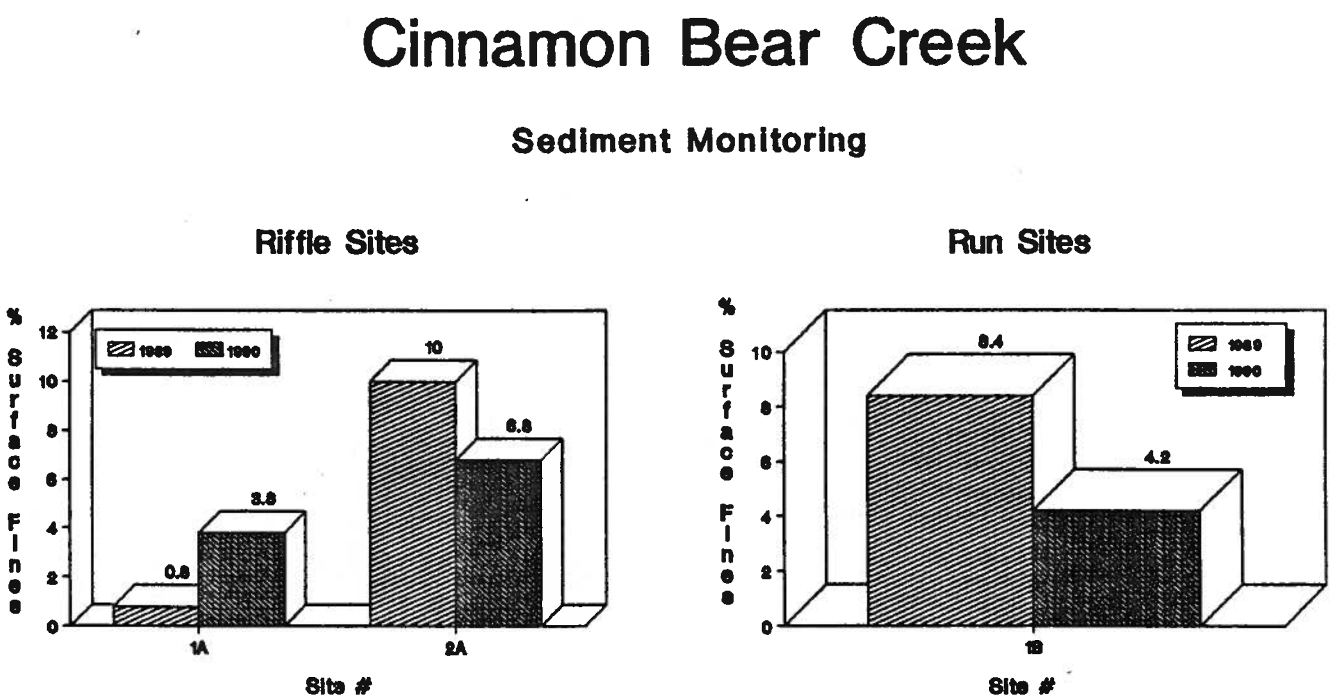


Figure 3-10. PSF for Cinnamon Bear Creek for 1989 and 1990.

Schwartz Creek

Schwartz Creek, a tributary to the Clark Fork, is located on the Missoula Ranger District (Figure 3-11). This is a small stream with an average width of five to six feet. Roading in the upper drainage is moderate. Many jammer roads are in the upper drainage from when it was logged in the 1960's. The area is recovering well. A road runs along 75% of the length the stream. The riparian area is thickly vegetated with alder and maple.

In the lower reaches the road encroaches on the stream in some places. The stream is subjected to grazing. We did not notice any severe impact by the cows on the riparian vegetation, but the cows were causing some destruction of the stream banks. All three stations exhibited a decrease in PSF between 1989 and 1990 (Figure 3-12).

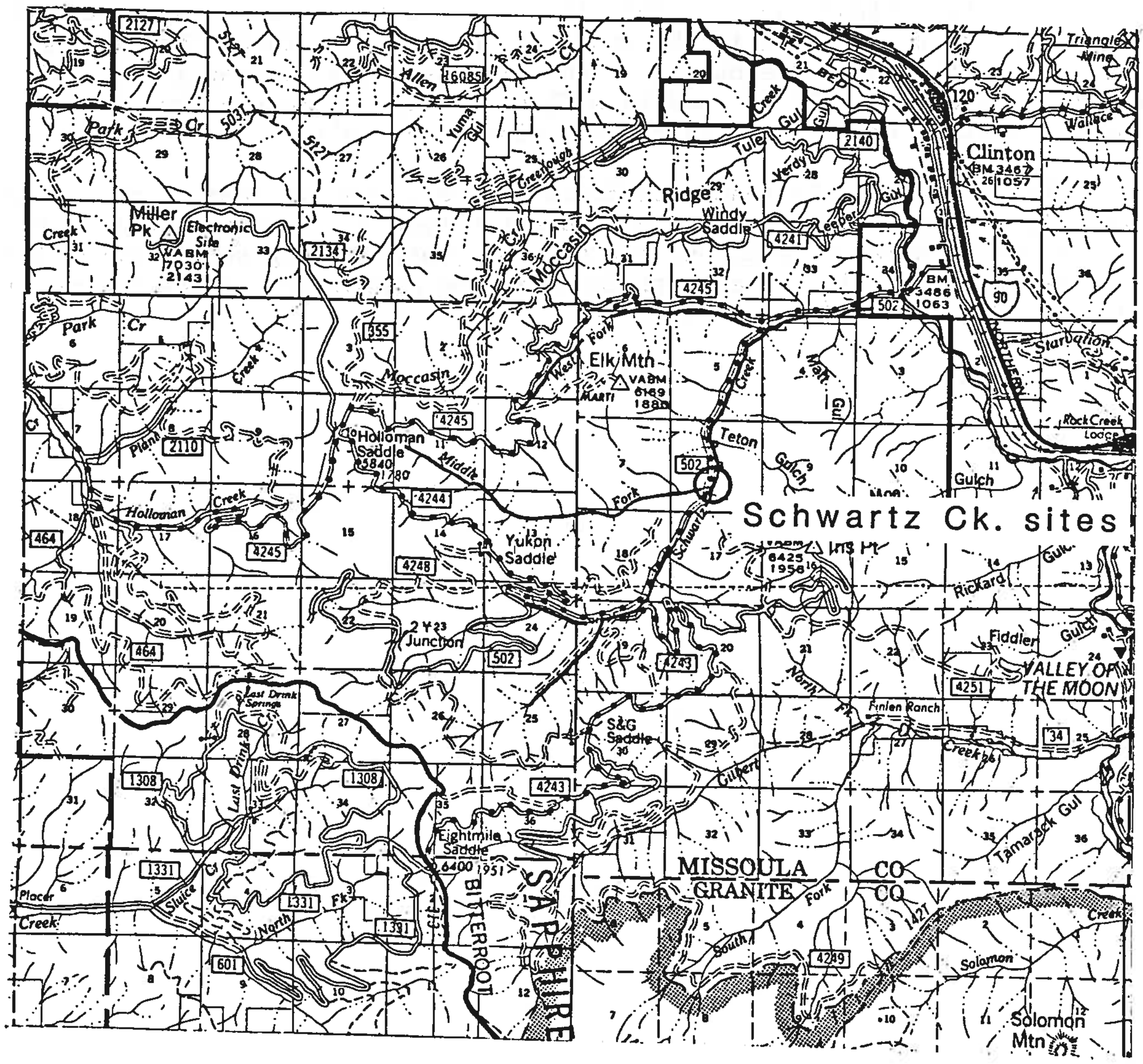


Figure 3-11. Location of sampling sites in Schwartz Creek.

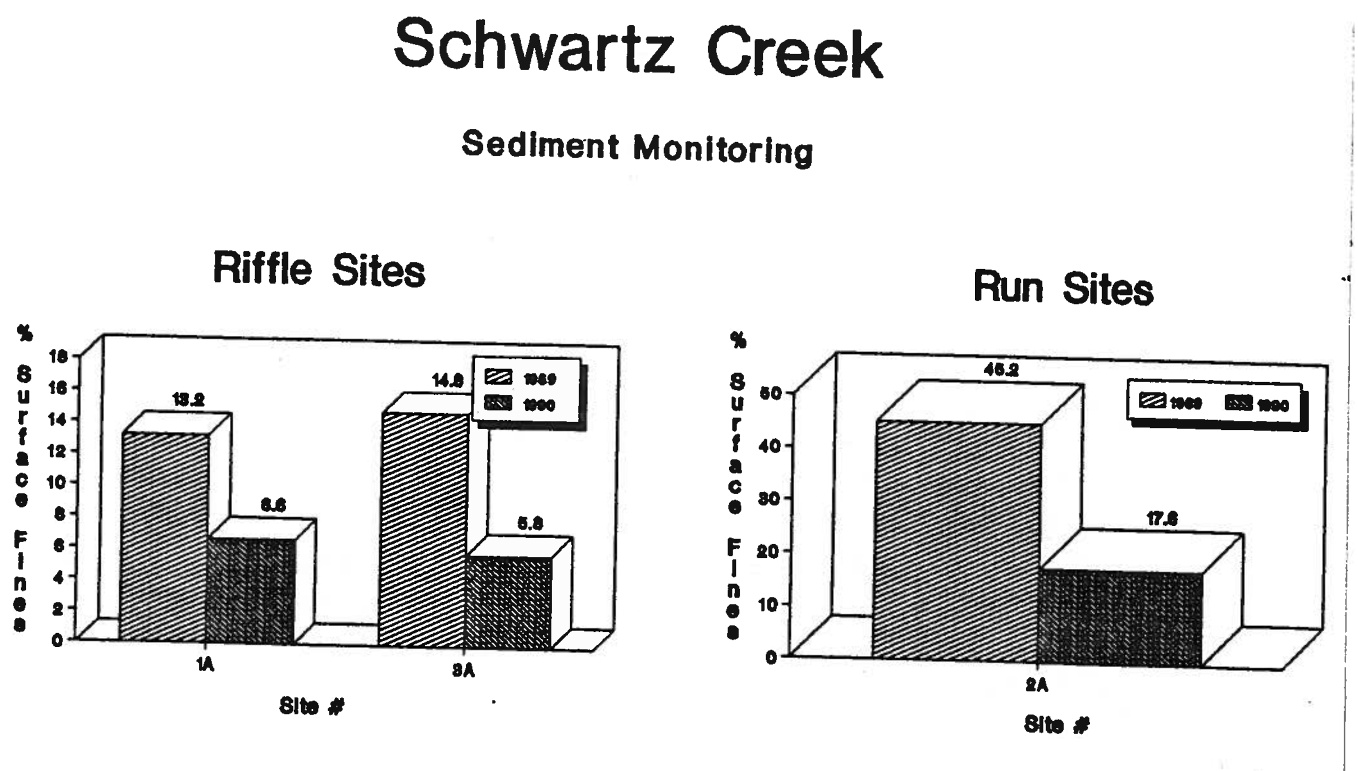


Figure 3-12. PSF for Schwartz Creek for 1989 and 1990.

East Fork Lolo

This is a moderate sized creek that flows through a wide, flat-bottomed canyon (Figure 3-13). The upper drainage has been logged and road density is moderate to heavy. Roads are evenly distributed throughout the drainage, and some run along tributaries to East Fork Lolo Creek. There is a lot of beaver activity in the vicinity of the stations. One station has been abandoned because of this. All sites exhibited a decrease in PSF (Figure 3-14).

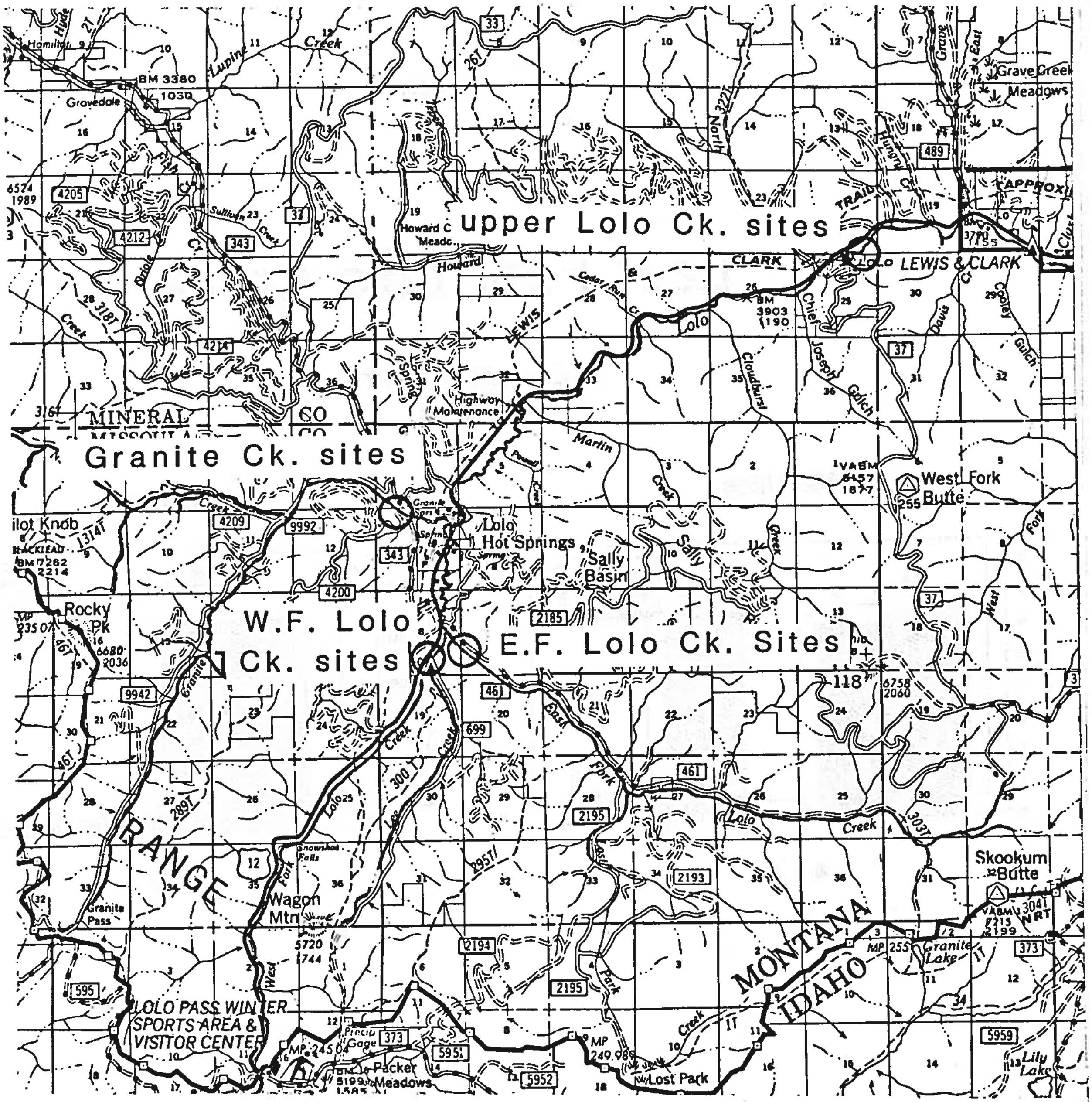


Figure 3-13. Location of sampling sites on Upper Lolo Creek and its tributaries.

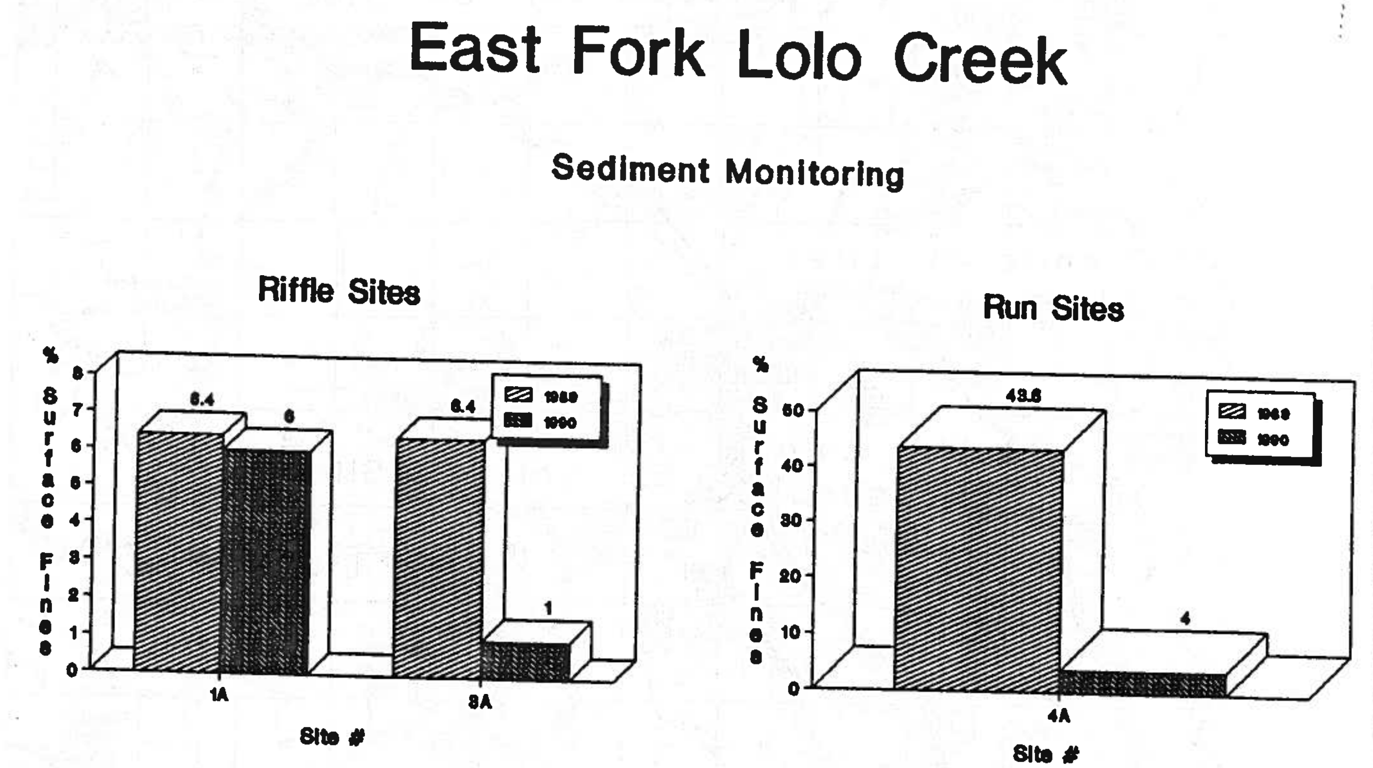


Figure 3-14. PSF for East Fork Lolo Creek for 1989 and 1990.

West Fork Lolo Creek

West Fork Lolo Creek is a moderate sized creek that flows parallel to State Highway 12 (Figure 3-13). Slumping from over-steepened banks from the road are common (from 1979 survey). Roads are of moderate density, but exist throughout the entire drainage. All three stations on this stream are riffles. All sites exhibited substantial decreases in PSF (Figure 3-15).

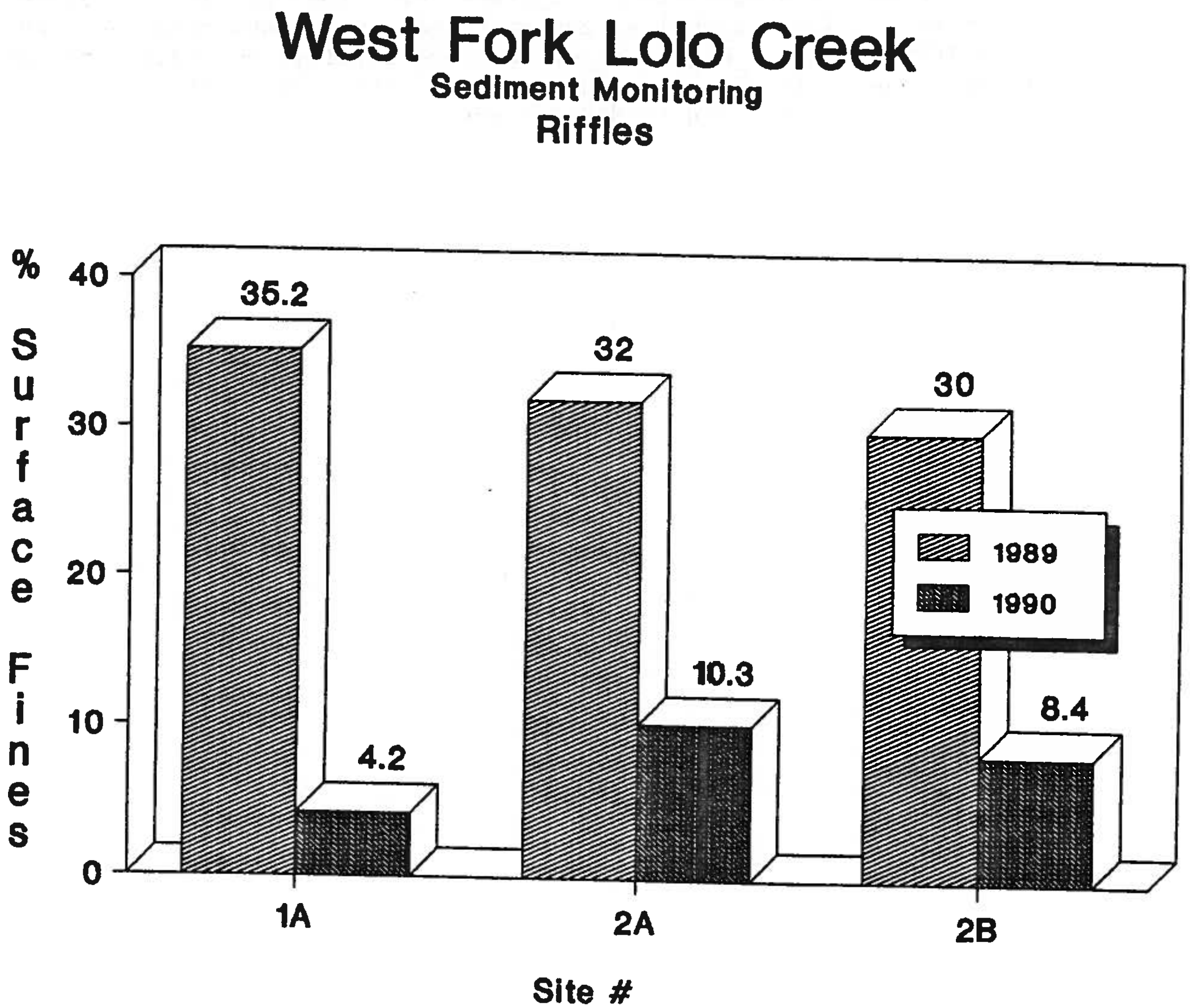


Figure 3-15. PSF for West Fork Lolo Creek for 1989 and 1990.

Granite Creek

Granite Creek is a moderate sized tributary to Lolo Creek (Figure 3-13). Road density is moderate to heavy throughout the drainage. The upper and middle parts of the drainage have been logged extensively because of a mixture of private and National Forest land. Debris loading in the lower reaches of the stream is low (1979 stream survey). The substrate consists of sand and fairly large cobbles with attached moss. All three stations are runs and showed decreases in <u>PSF</u> (Figure 3-16).

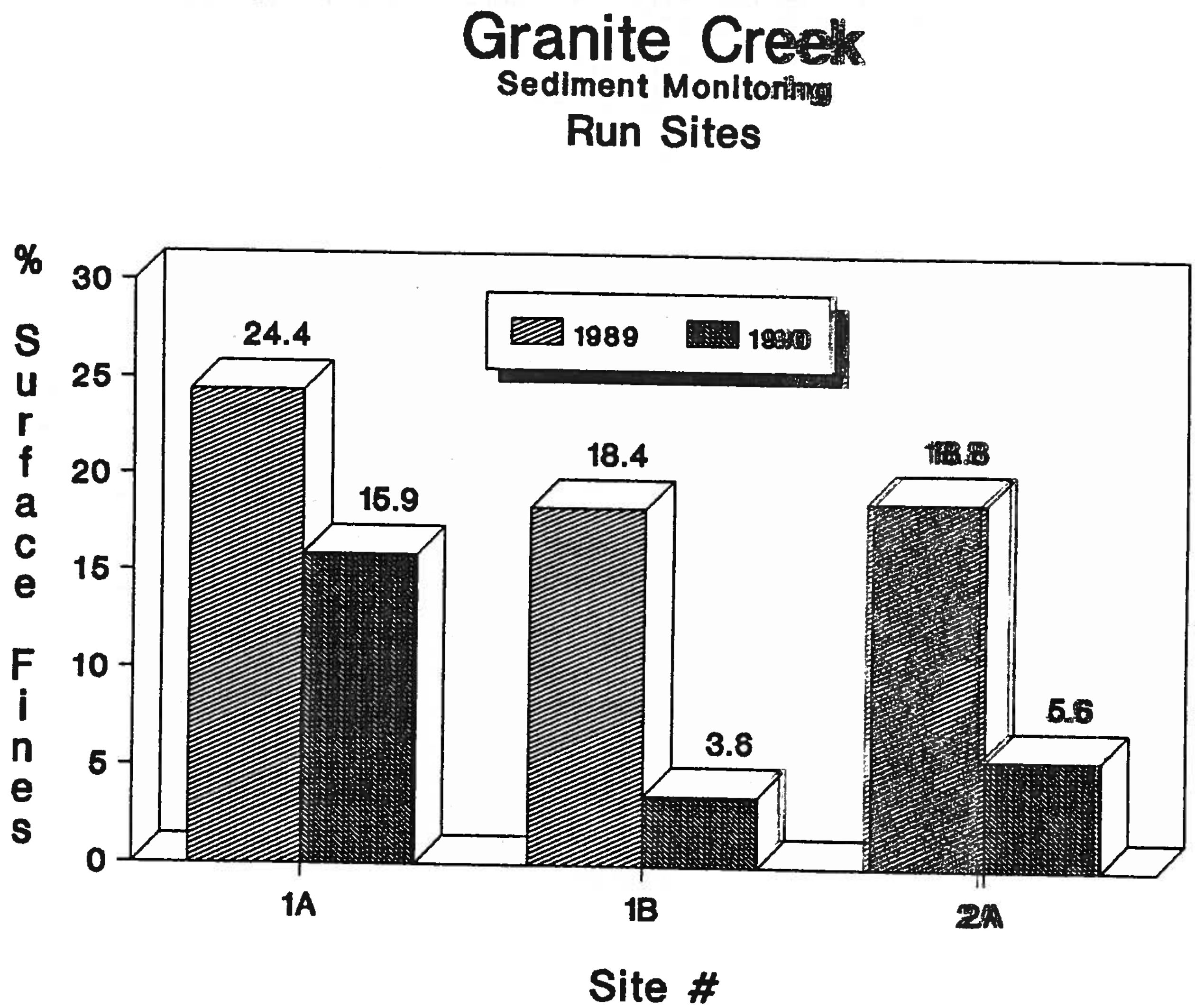


Figure 3-16. PSF for Granite Creek for 1989 and 1990.

Lolo Creek

There are 10 stations on this stream. One is located at Fort Fizzle (Figure 3-17), and the other nine are by the Lolo Work Center (Figure 3-13). The run and pool-tailout sites decreased in <u>PSF</u> between 1989 and 1990 (Figure 3-18). Two of the 9 riffle sites increased in <u>PSF</u> but the rest decreased.

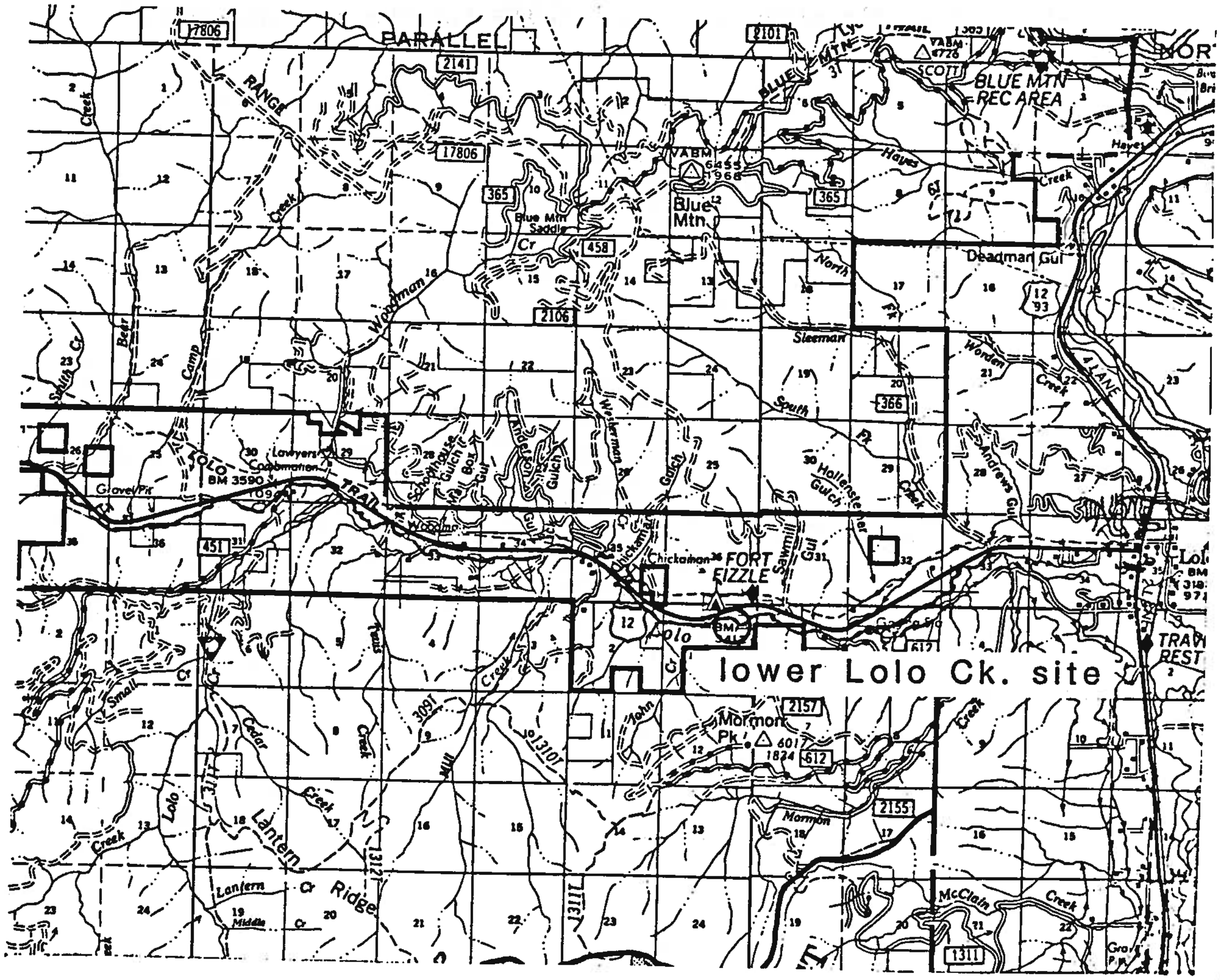


Figure 3-17. Location of sampling sites in Lower Lolo Creek.

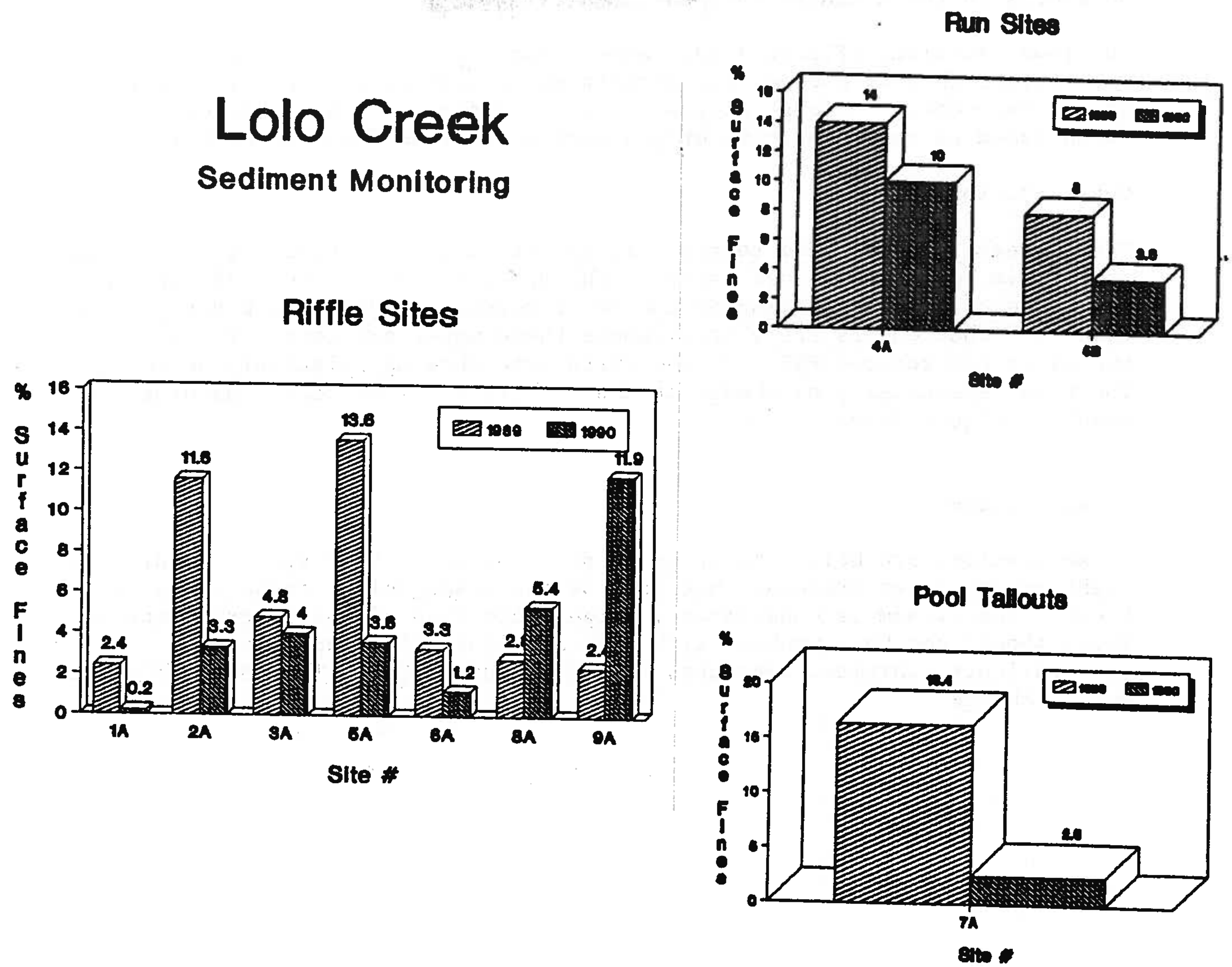


Figure 3-18. PSF for Lolo Creek main for 1989 and 1990.

Petty Creek

Petty Creek is on the Ninemile District and is a tributary to the Clark Fork River. Petty Creek was chosen as a long-term monitoring drainage because it is an important trout spawning stream and there was additional development scheduled in the drainage near Deer Peak.

The lower stations (Figure 3-19), approximately 1 mile below the West Fork, were established to monitor the activities of development in the Deer Peak area. The upper stations (Figure 3-19), near the mouth of Johns Creek, were established as representative of the stream upstream from the Deer Peak.

Upper Stations

Petty Creek is a moderate to small sized stream at the upper stations. Road density is heavy on the west side of the upper drainage. The 1980 stream survey reported mass wasting in the lower reaches of South Fork Petty Creek, a tributary that enters Petty Creek above these upper stations. Two of the three run sites had reduced **PSF** with the third site showing relatively no change. There was essentially no change at the two riffle sites when combining the results (Figure 3-20).

Lower Stations

These stations are below the proposed development at Deer Peak. Roading is light in the lower drainage, but most of the roads follow tributaries of Petty Creek. The stream is considerably larger here than at the upstream stations. There should not be a problem with over sampling. All run sites and pool-tailouts exhibited decreases in **PSF** (Figure 3-21). The one riffle site had no change.

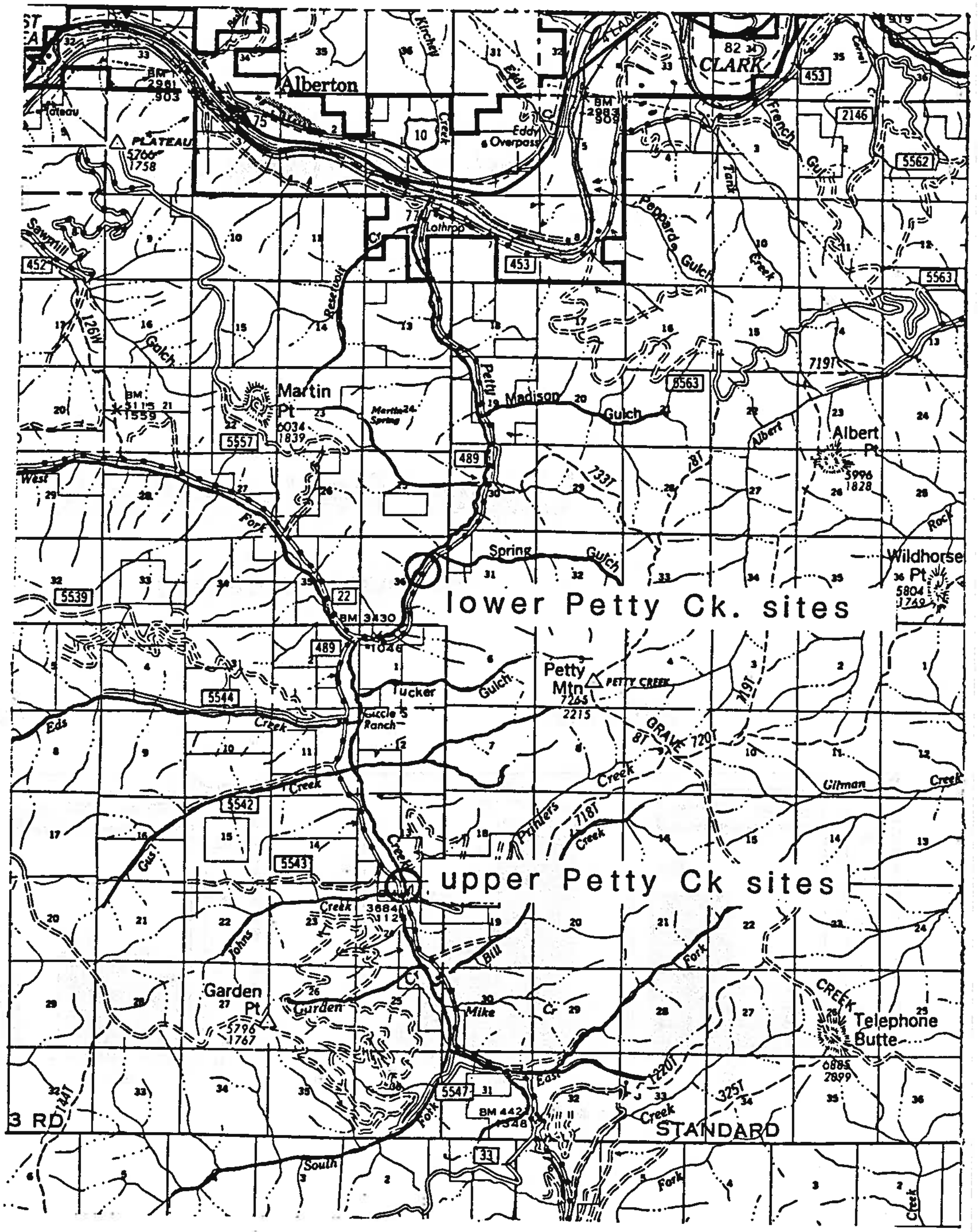


Figure 3-19. Location of sampling sites in Petty Creek.

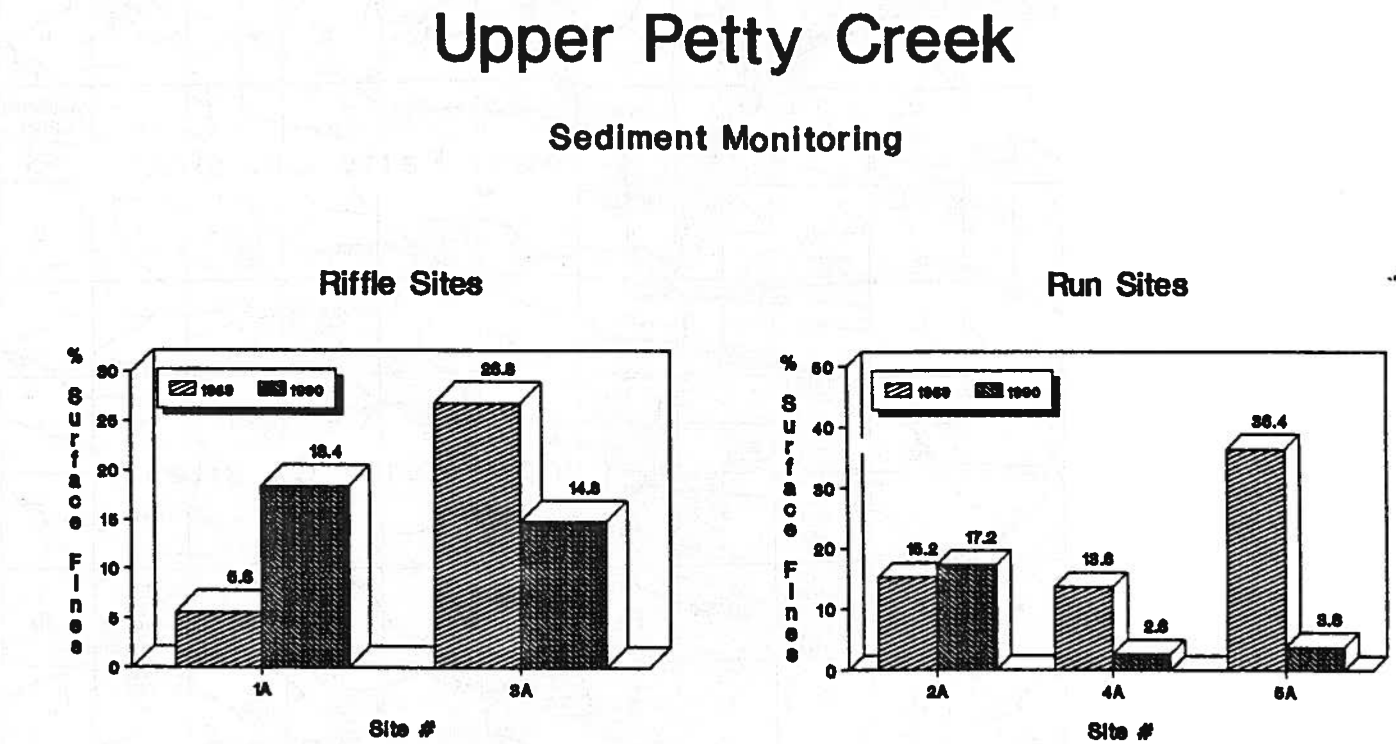


Figure 3-20. PSF for upper Petty Creek for 1989 and 1990.

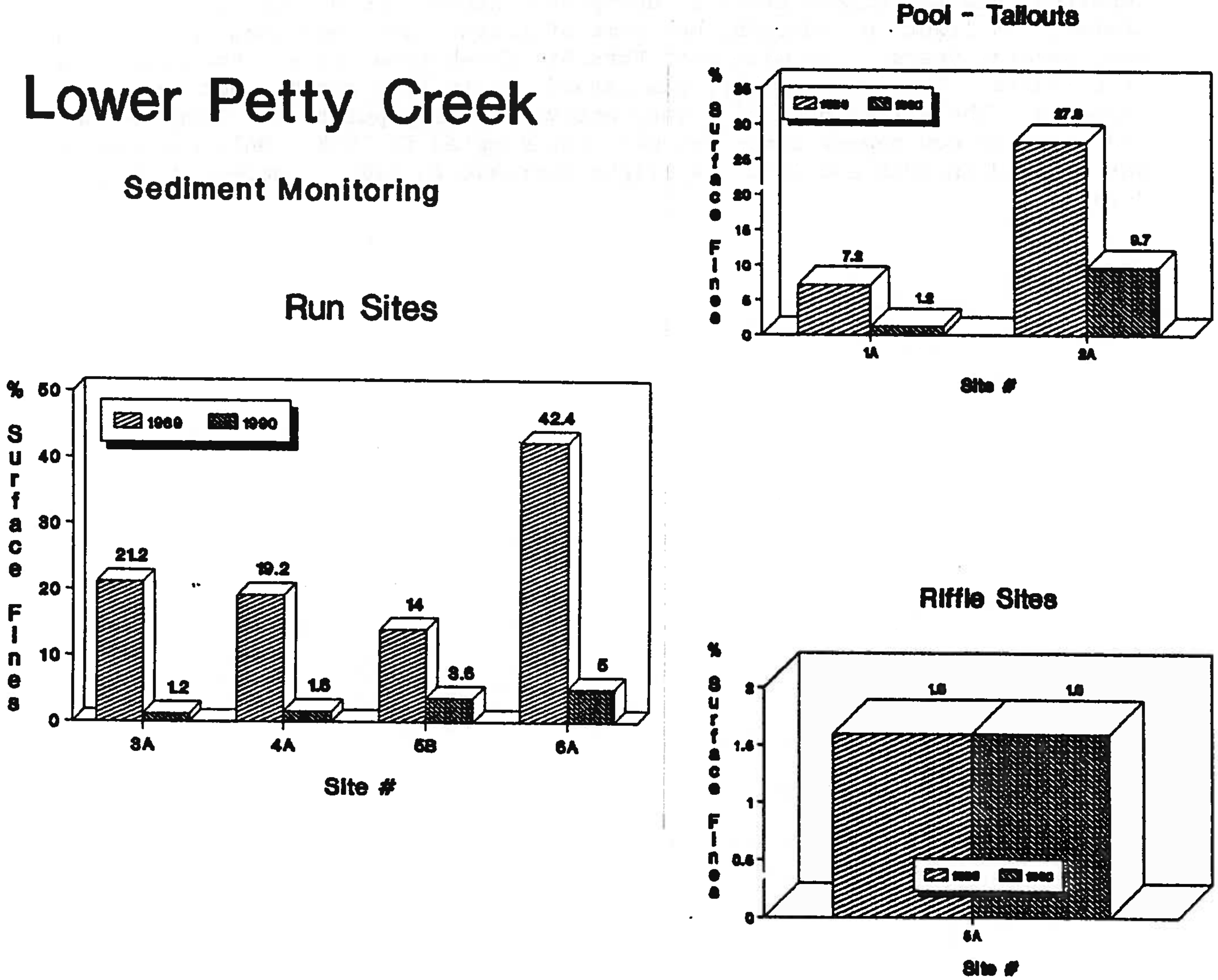


Figure 3-21. PSF for lower Petty Creek for 1989 and 1990.

West Fork Big Creek

West Fork Big Creek (Figure 3-22) is a moderate to small sized stream. In 1985 during road construction in the drainage a large amount of sediment was imported into the stream after an unexpected storm. Road density in the drainage is light to moderate, but some of these roads have been built in the past several years. The main West Fork Big Creek road crosses the stream twice at culverts. The lower culvert was washed out in 1986 and has not been replaced. The stream now has a very active beaver population. Three of the stations are now beaver ponds and were not sampled in 1988. Only one run site was sampled in 1989 and 1990. A slight increase in PSF was detected (Figure 3-23).

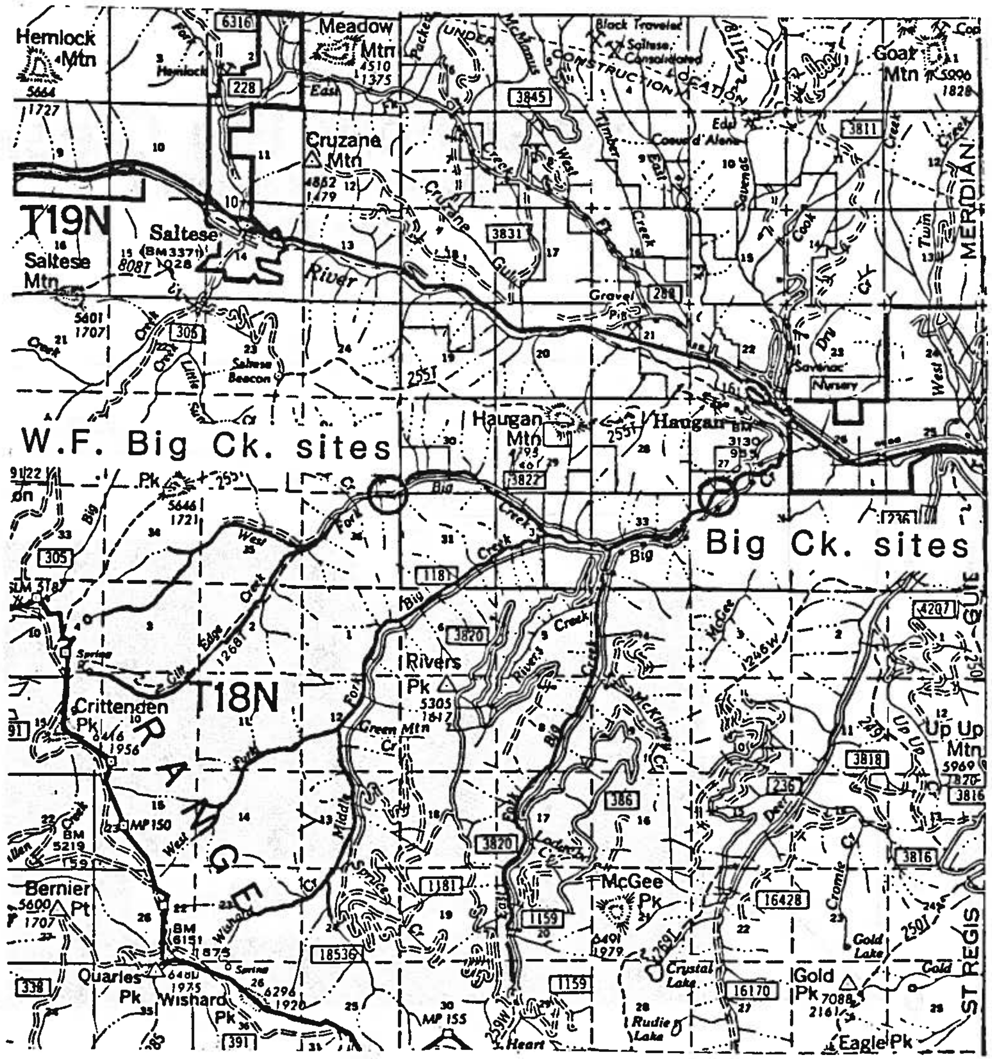


Figure 3-22. Location of sampling sites in West Fork Big Creek.

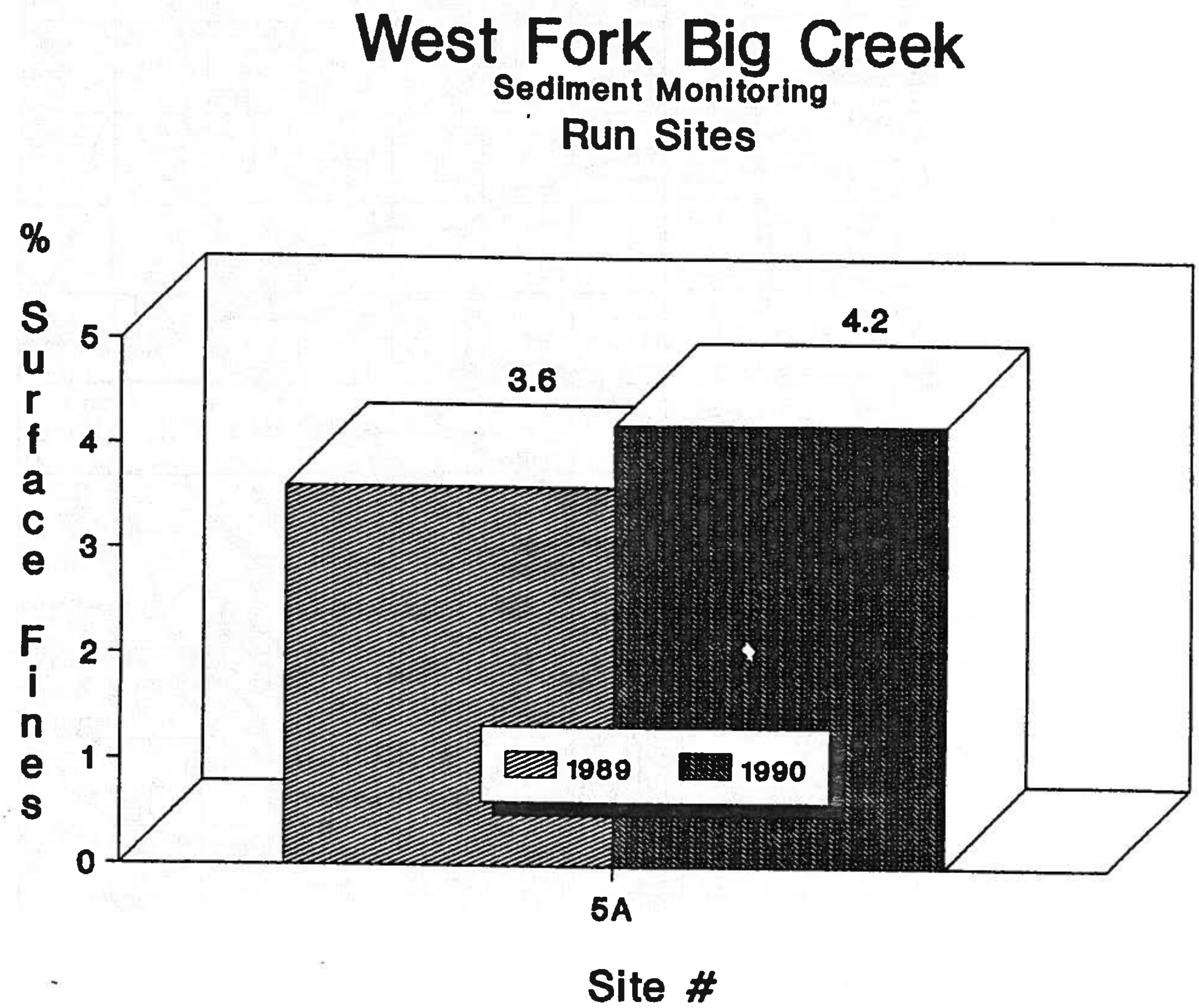


Figure 3-23. PSF for West Fork Big Creek for 1989 and 1990.

Big Creek

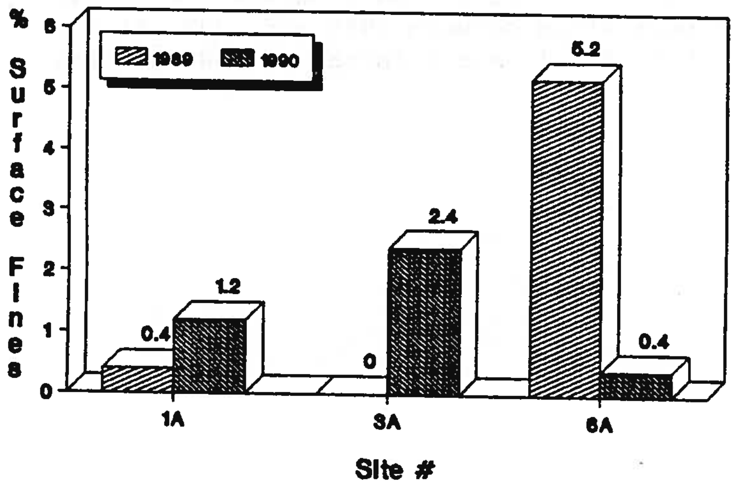
Big Creek is on the Superior Ranger District, and is a tributary to the St. Regis River (Figure 3-22). Big Creek and the West Fork monitoring sites were chosen to represent Belt derived soil types. The West Fork is largely undeveloped, except for a recently constructed capital investment road. Development along this road system is expected in the next decade. Other forks of Big Creek have varying levels of development, but the Big Creek site offers an opportunity to evaluate cumulative effects of management activities on a major stream draining Forest lands.

Big Creek is a relatively large stream compared with other streams sampled on the Lolo National Forest. The Big Creek stations are approximately 1 mile upstream from its mouth. The creek runs along a road. Road density is high in the East Fork Big Creek drainage and moderate on the Middle Fork Big Creek. A road runs along Big Creek but there is a good buffer zone, and the road does not seem to encroach on the stream. However, the stream does have very steep banks in some areas which may possibly be severely eroded during high flows (1979 stream survey). PSF changes were mixed between 1989 and 1990 (Figure 3-24). Pool tail-outs decreased, while riffle sites increased and run site decreased in PSF in general.

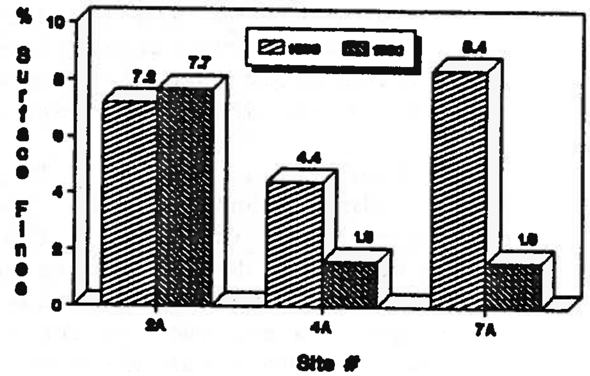
Big Creek

Sediment Monitoring

Riffle Sites



Run Sites



Pool - Tailouts

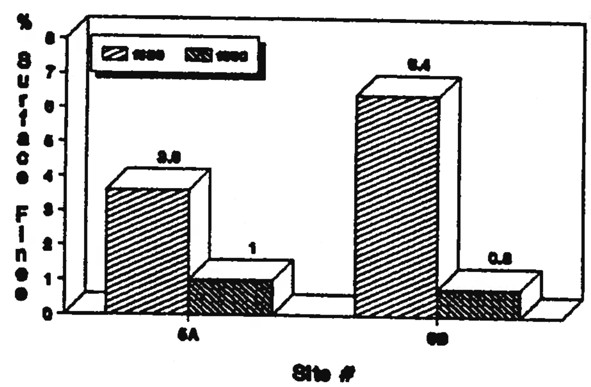


Figure 3-24. PSF for riffles in Big Creek for 1989 and 1990.

West Fork Packer Creek

West Fork Packer Creek was chosen as a site for a long-term monitoring effort because it is one of the few largely undeveloped drainages on the Lolo, and it represents drainages with Belt derived soils. Development in the drainage has not occurred previously because much of the timber is young and has only recently reached a size suitable for harvest. Further development is expected in the near future.

The monitoring stations are immediately upstream from the forest boundary (Figure 3-25). The entire drainage upstream from the monitoring stations is managed by the Forest Service. West Fork Packer Creek is a moderate sized stream. Roading in the drainage is light. A road runs along the creek with only a few areas of extreme encroachment. The stream seems to be changing quite a bit. Just upstream from one station a large part of the bank had caved into the stream. At another station, a pool tailout, the stream had moved so that the old tailout station is now the main part of the pool. We moved the station boundaries and monitored the new tailout in 1988. Pool tailouts and run sites all showed general decreases in PSF but 3 of the 5 riffle sites increased (Figure 3-26).

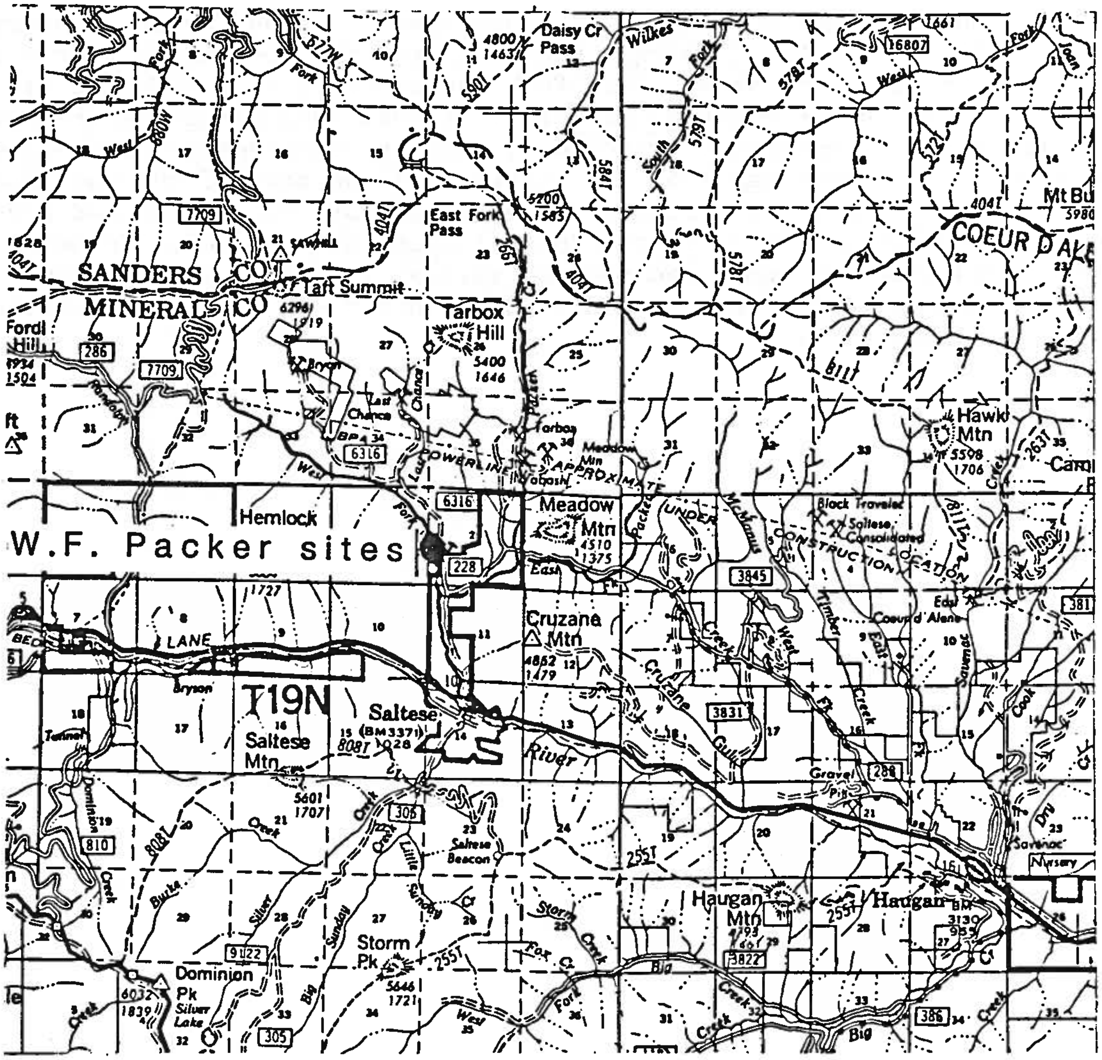
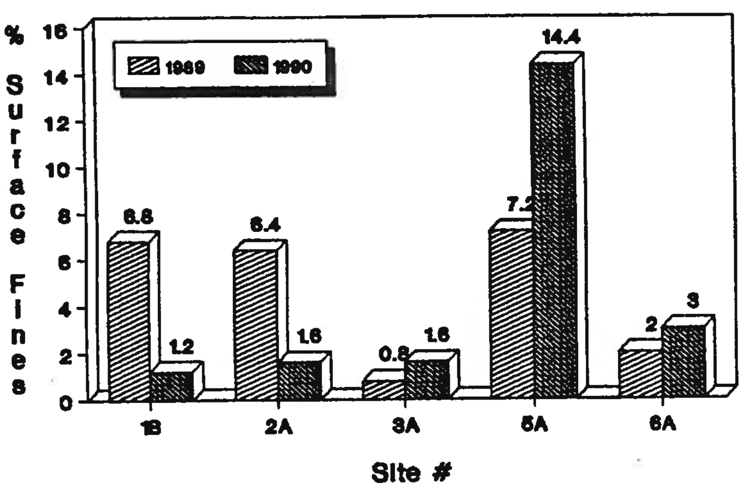


Figure 3-25. Location of sampling sites in West Fork Packer Creek.

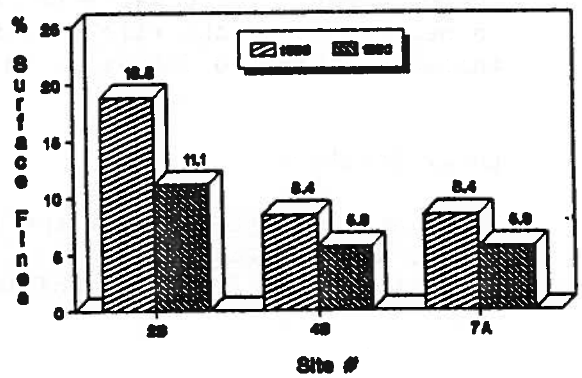
West Fork Packer Creek

Sediment Monitoring

Riffle Sites



Pool - Tailouts



Run Sites

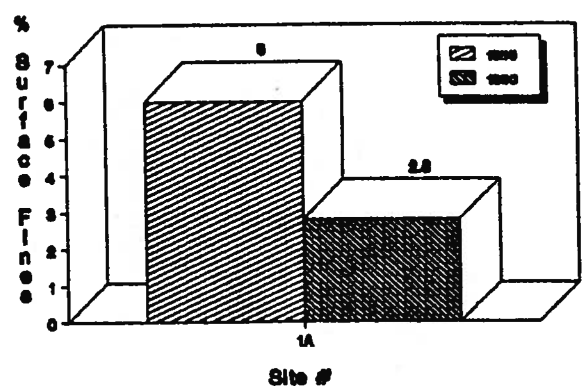


Figure 3-26. PSF for West Fork Packer Creek for 1989 and 1990.

Twelve Mile Creek

Upper Stations

Twelve Mile Creek (Figure 3-27) is a moderate sized creek. A considerable amount of road construction has occurred in this drainage, and road density is heavy throughout. A road runs along the stream with some areas of encroachment. The upper site had two riffles and two pool tailouts. There was no net change at the riffle sites between 1989 and 1990 however the pool tailouts exhibited decreases in PSF (Figure 3-28).

Lower Stations

There are four stations at the lower stations on Twelve Mile Creek (Figure 3-27), two riffles and two pool tailouts. Three of the four sites increased in PSF with one riffle site exhibited a decrease (Figure 3-29).

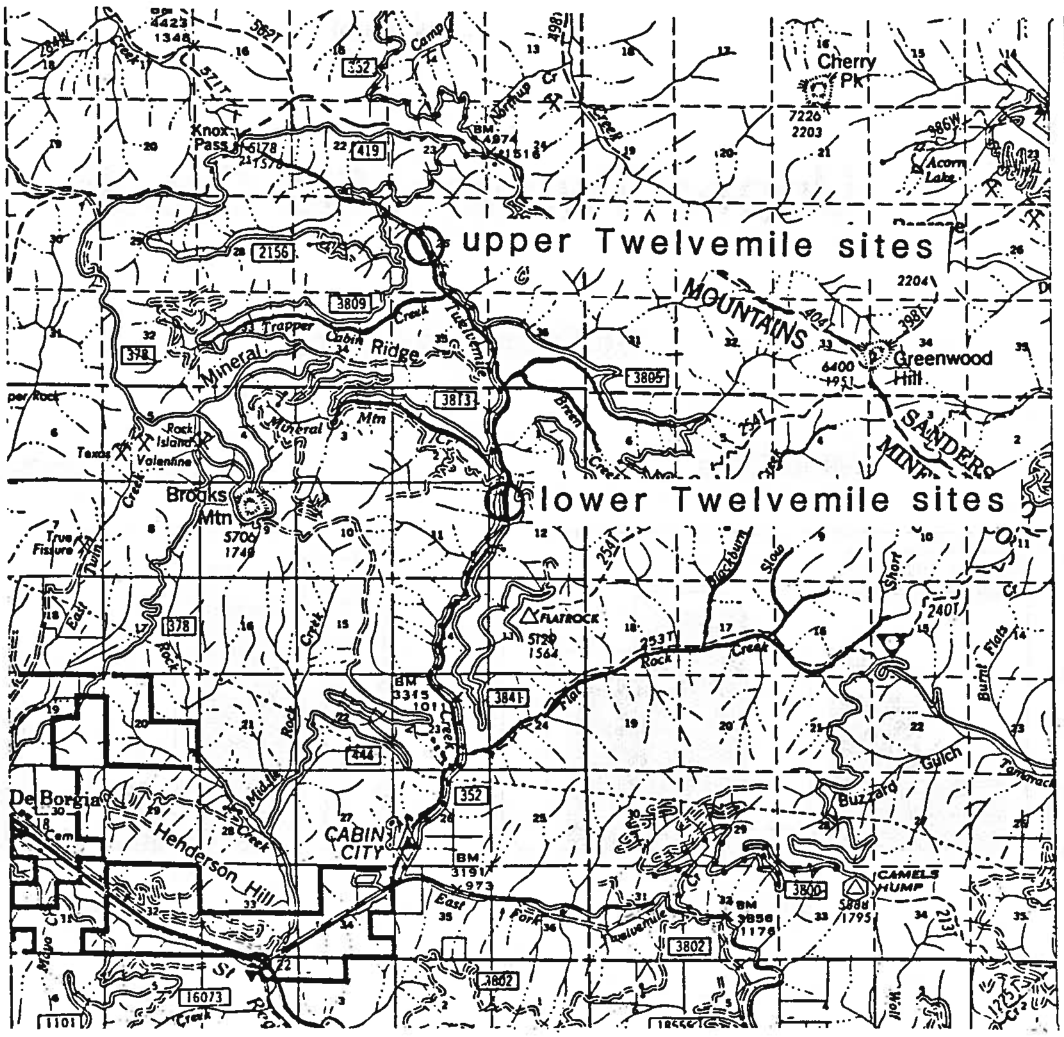


Figure 3-27. Location of sampling sites in Twelve Mile Creek.

Upper Twelve-Mile Creek

Sediment Monitoring

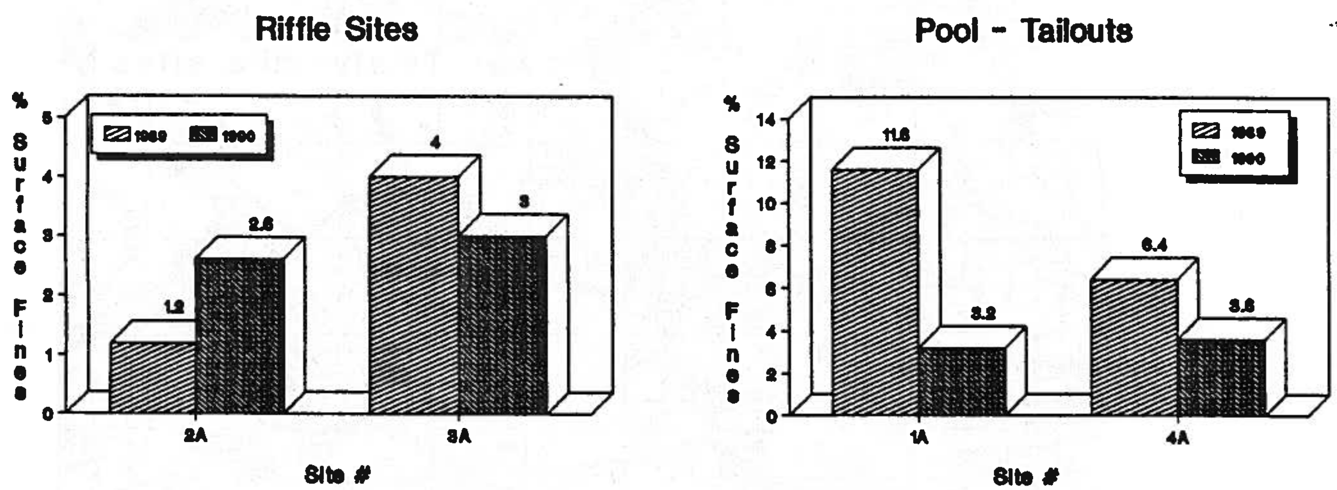


Figure 3-28. PSF for upper Twelve Mile Creek for 1989 and 1990.

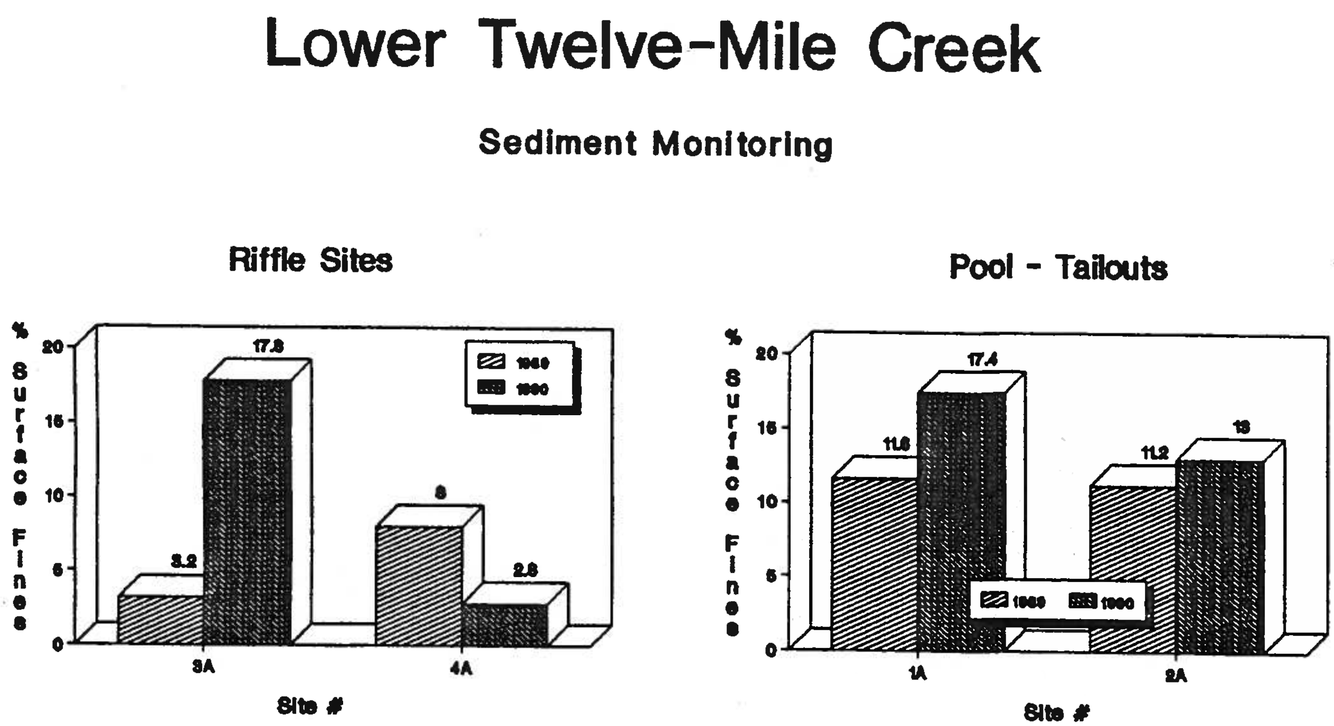


Figure 3-29. PSF for lower Twelve Mile Creek for 1989 and 1990.

Table 3-1 displays percent surface fines by habitat type for 1989 and 1990. Tables 3-2 list the relative change in percent surface fines for the 19 streams monitored on the Lolo and Deerlodge National Forests from 1989 to 1990.

Table 3-1. Percent surface fines for 1989 and 1990.

Watershed	Riffles PSF 1989	Riffles PSF 1990	Runs PSF 1989	Runs PSF 1990	Pool-tailouts PSF 1989	Pool-tailouts PSF 1990
LOLO NATIONAL FOREST						
Schwartz Ck.	14.0	6.2	45.2	17.6	--	--
West Fork Lolo Ck.	32.4	7.6	--	--	--	--
East Fork Lolo Ck.	6.4	3.5	43.6	4.0	--	--
Granite Ck.	--	--	20.5	8.4	--	--
Lolo Ck.	5.0	4.3	8.9	6.8	14.0	2.6
Upper Petty Ck.	1.6	16.6	24.2	7.9	17.4	--
Lower Petty Ck.	17.2	1.6	21.7	2.9	19.6	5.5
Upper 12-mile Ck.	2.6	2.8	--	--	9.0	3.4
Lower 12-mile Ck.	5.6	--	--	--	11.4	--
West Fork Big Ck.	0.0	--	3.6	4.2	--	--
Big Ck.	1.9	1.3	6.7	3.6	5.0	0.9
West Fork Packer Ck.	4.6	4.3	6.2	2.8	11.2	7.4

Table 3-1 Continued.

Watershed	Riffles PSF 1989	Riffles PSF 1990	Runs PSF 1989	Runs PSF 1990	Pool tailouts PSF 1989	Pool tailouts PSF 1990
Cinnamon-bear Ck.	5.4	5.3	8.4	4.2	4.2	--
Rock Ck. Lower	3.5	3.3	0.0	0.2	NA	0.0
Rock Ck. Middle	7.8	0.8	2.4	0.8	5.2	6.8
DEERLODGE NATIONAL FOREST						
Rock Ck. Upper	2.6	6.0	6.0	5.8	4.2	2.4
Ross FK. Rock CK.	15.2	16.5	15.6	15.2	10.2	10.0
West FK. Rock Ck. (Youth Camp)	2.4	3.3	6.8	6.5	7.2	6.7
Up. West Fk. Rock Ck.	15.6	17.9	18.6	19.1	3.6	6.6
Middle Fk. Rock Ck.	1.2	5.7	3.6	3.7	0.0	0.7
Sand Basin	17.8	11.8	18.0	25.6	4.8	4.5

Table 3-2. Relative change in Percent Surface Fines from 1989 - 1990

Watershed	Riffles PSF	Runs PSF	Pool-Tailouts PSF
	LOLO NATIONAL FOREST		
Schwartz Ck.	-7.8	-27.6	---
West Fk Lolo Ck.	-24.8	---	---
East Fk. Lolo Ck.	-2.9	-39.6	---
Granite Ck.	----	-12.5	---
Lolo Ck.	-0.7	-2.1	-11.4
Upper Petty Ck.	+15.0	-16.3	---
Lower Petty Ck.	-15.6	-18.8	-14.1
Upper 12-mile Ck.	+0.2	---	-5.6
West Fk. Big Ck.	---	+0.6	---
Big Ck.	-0.6	-0.3	-4.1
West Fk Packer Ck.	-0.3	-3.5	-3.8
mean	-4.2	-13.3	-7.8
Cinnamon Bear Ck.	0.1	-4.2	---
Lower Rock Ck.	-0.2	0.2	---
Middle Rock Ck.	-0.7	-1.6	1.6
mean	-0.3	-1.9	1.6

Table 3-2 Continued

Watershed	Riffles PSF	Runs PSF	Pool-Tailouts PSF
	DEERLODGE NATIONAL FOREST		
Rock Ck. (upper)	+3.4	-0.2	-1.8
Ross Fork Rock Creek	+1.3	-0.4	-0.2
West Fork Rock Creek	+0.9	-0.3	-0.5
Up West Fork Rock Creek	+2.3	+0.5	+3.0
Middle Fork Rock Creek	+4.5	+0.1	+0.7
Sand Basin	-6.0	+7.6	-0.3
mean	+1.1	+1.2	+.15

Discussion

Lolo National Forest Streams

In 1990 mean percent surface fines decreased by an average of 5.8% in riffles, 12.7% in runs and 7.8% in pool-tailouts in streams on the Lolo National Forest. These results may or may not represent actual decreases in surface fines and might be explained by several factors.

Firstly, in terms of total annual stream discharge, the Rock Creek drainage showed an approximate increase of 22 percent from 1989 to 1990 (Figure 3-30). While it is realized that the Rock Creek drainage represents only a small portion of the Lolo Forest, it is being shown here as an indicator of an overall increase in total stream discharge that was thought to occur throughout the Forest for 1990. It is also assumed that the sediment transport capability of a stream is enhanced with higher discharge. The reported values are consistent with this theory.

Secondly, a refinement of the measuring technique in 1990 (the mesh was increased to 49 intersections) enabled a more statistically accurate analysis of the sediment. This technique allowed more sensitivity especially with regard to low values of percent surface fines (see discussion chapter 3). Most reported values for the Lolo streams were less than 15% surface fines. The reported decreases may in fact be a function of this overall increase in sensitivity.

Deerlodge National Forest

The mean overall change in percent surface fines from 1989 to 1990 in streams on the Deerlodge National forest was an increase of 1.1% in riffles, 1.2% in runs and 0.2% in pool-tailouts. All monitoring sites for the Deerlodge Forest are in the upper Rock Creek drainage. Total yearly flow discharge for the upper drainage increased by 67 percent from 1989 to 1990.

While unlike the streams on the Lolo National Forest, Deerlodge National Forest streams while not declining showed an insignificant increase in percent surface fines. The reported values are certainly within the range of Lolo Forest reported values and are probably a reflection of statistical averaging and not a reflection of overall stream substrate condition. The two factors previously mentioned as possible explanations for the Lolo National Stream data are applicable to the Deerlodge data also.

Overall Stream Condition

The overall effects of this apparent decrease in substrate surface fines to the aquatic biota of the two Forests' is unknown. A general statement could be made as noting no significant deleterious effects to the streams were identified for this year. Presumably decreases in percent surface fines should be to the benefit of several of the communities of the streams. Macroinvertebrate communities should respond positively to this decrease as more interstitial spaces are available for habitat. Fish communities should benefit from increases in winter fry habitat, increased spawning gravel condition and increased food sources (i.e. macroinvertebrates). It is doubtful however, that these responses could be accurately quantified with any degree of reliability other than long term trend data. No other data gathered on these two forests has generated any apparent contradictions with this analysis.

Recommendations

1) The technique of measuring percent surface fines should continue on both Forest with further necessary developments and refinements.

2) Where applicable, additional data (i.e. fish populations, macroinvertebrate analysis) should be coupled with the surface fines data to ascertain long-term changes in the aquatic biota and habitat of these two Forests.

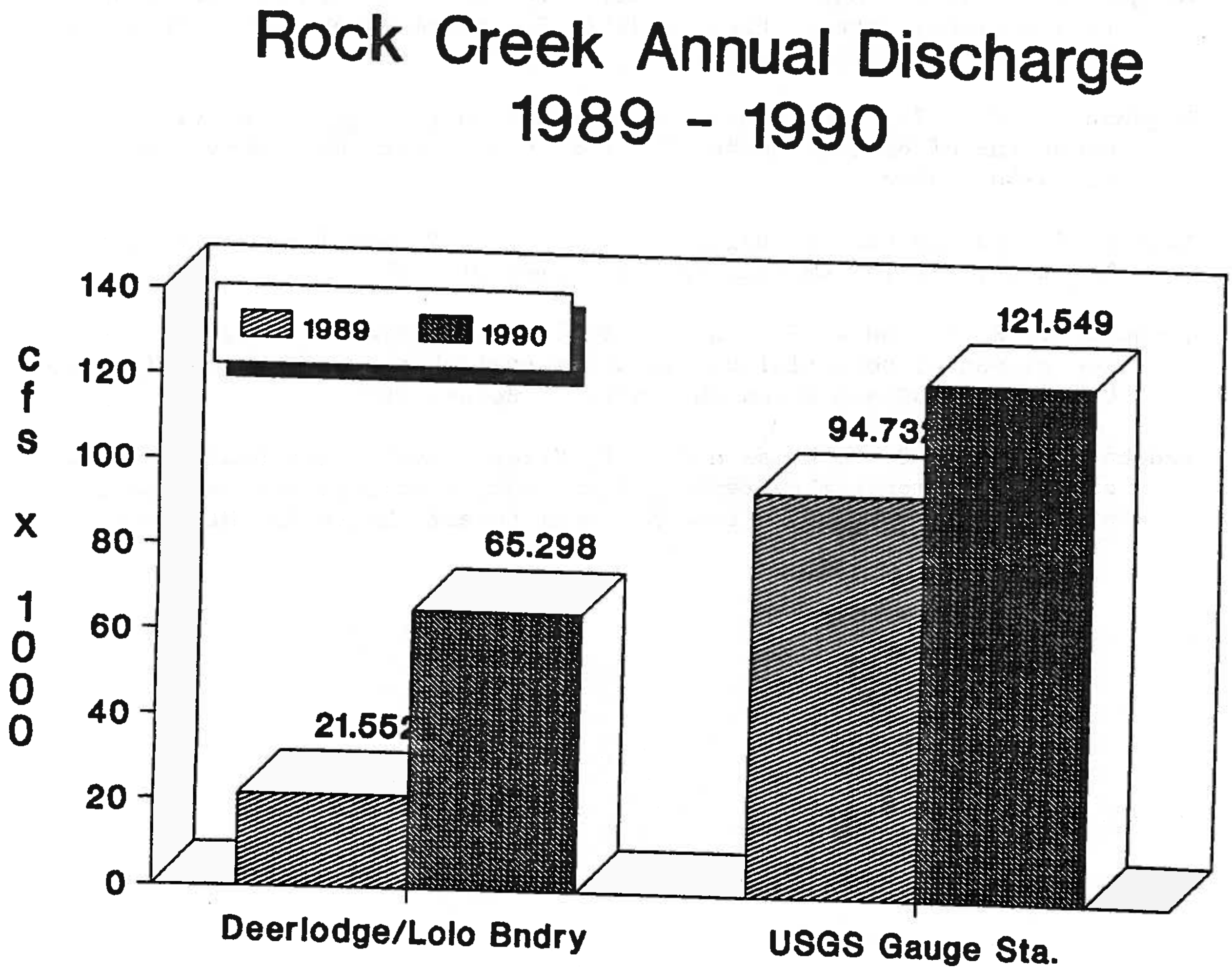


Figure 3-30. Annual discharge for Rock Creek during 1989 and 1990 at the mouth and at the Lolo N.F./ Deerlodge boundary.

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