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Experimentally Determined Impacts of a Small Suction Gold Dredge on a Montana Stream.

By

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B.A.,University of Colorado ,1979.

Presented in partial fulfillment of
the requirments for the degree
of Master of ~~Arts~~
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Chairman,Board of Examiners

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The Experimentally Determined Impacts of a Small Suction Dredge on a Montana Stream

Director:Andrew L. Sheldon

The use of small, portable, suction gold dredges has greatly increased since 1979, when the price of gold soared. A small suction dredge was operated on Gold Ck.,Missoula Co., Montana, to determine the effects on aquatic insects and stream bottom habitat. A section of stream ten meters long was dredged from bank to bank. Sampling was conducted before dredging and at upstream and downstream stations for control. The entire study was replicated at an upstream site. Significant ($P <.01$) change in aquatic insect abundance was restricted to the dredged area. Downstream areas were not affected ($P > .05$). Recolonization was substantially complete one month after dredging. Intergravel permeability was not significantly ($P > .05$) changed by dredging. Suspended sediment concentrations and turbidity during dredging were highly variable. Highest turbidity measured was 32 NTU at the dredge outflow (upstream level 1.5 NTU). Suspended sediment discharge was a maximum of 1019 mg/l at the outflow. Suspended sediment and turbidity returned to background levels within approximately 30 m. Biological impacts of suction dredging appear to be highly localized. No immediate downstream impacts were recorded other than fine sediment deposition and deposition of unstable gravel beds. Those beds dispersed and were transferred downstream during the next year's peak flows, filling a downstream pool.

ACKNOWLEDGEMENTS

My thanks to Dr. Raymond Murray and the University of Montana for providing financial support for this project. I am also indebted to Dennis Workman and Don Peters for lending me their field assistants and their trailer. Special thanks to Ron Spoon for cheerfully helping me in the field, even on Saturday. There are others who helped me in the field and lent me equipment. In particular I'd like to mention Jan Bonham, Chris Rudd, Bill Schultz, Dr. Andrew Sheldon, and Greg Munther. I would also like to thank Dr. Donald Loftsgaarden for his help with the statistical analysis. Finally, my husband Jed helped me with many of the more tedious chores required for this research. His support and assistance was invaluable.

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INTRODUCTION

The purpose of this research was to determine the impact of suction dredging for gold on the biological and physical characteristics of streams. Suction gold dredges have been in use on western rivers since the 1930's. However, today's dredges are different in that they are smaller, easily portable, and commercially manufactured. The availability of inexpensive, lightweight dredges, combined with recent high gold prices, has resulted in a great increase in suction gold dredge activity (Figure 1).

The effects that these dredges have on the stream environment are largely unknown. The few studies done on dredging operations, particularly in the 1950's, produced alarming results. Studies done in California found chinook salmon (Oncorhynchus tschawytcha) avoided silted areas downstream from mining and concentrated their redds in a clear tributary, resulting in overlapping redds and increased egg mortality. Silted areas also contained 41 to 63 percent fewer aquatic invertebrates than unsilted areas(Sumner and Smith, 1939). Later studies found high mortalities of salmonid fishes and macroinvertebrates downstream from suction gold dredges (Campbell,1953;Campbell, 1954;Casey,1959).

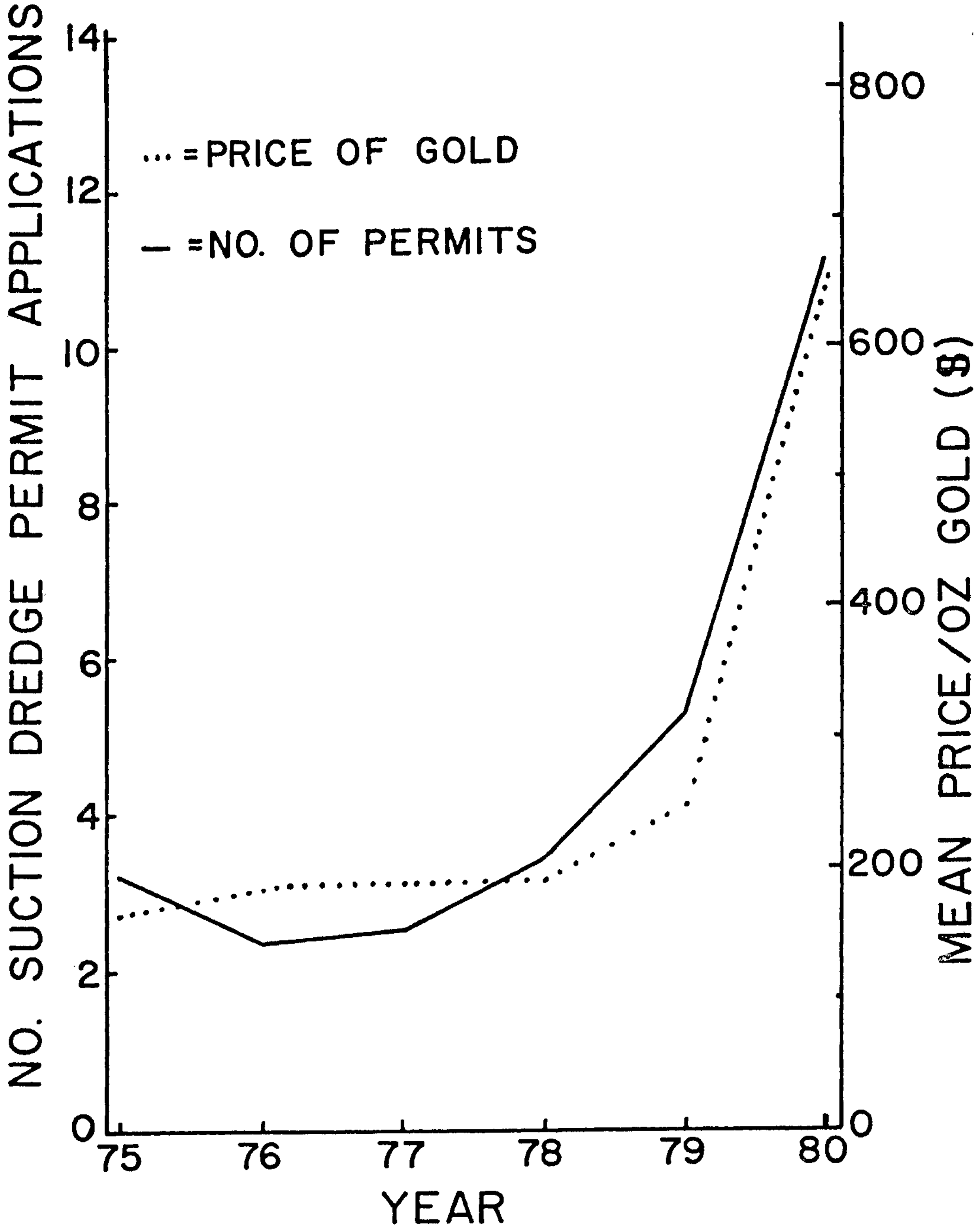

FIGURE 1. Relationship between the mean price of gold and the number of suction dredge permit applications received by the California Department of Fish and Game. Permit numbers (X 1000). Source: Harvey, et.al.,1982.

These studies dealt with fairly large scale operations utilizing heavy equipment. What impact does a small (2.5 inch,6.4 cm.[1]) portable suction dredge have on a Montana stream?

Gold dredges operate by sucking the bottom gravels into a baffle box in which the current is reversed and turbulence increased. Flow then continues past or through a classifier screen, then out through the sluice box and into the river (Figure 2). The heavier materials settle on the bottom, while lighter fines are carried downstream, where they are redeposited.

There are two primary areas of concern. One is the downstream impacts due to the redeposition of fines and increased turbidity. The other is the area actually dredged. Unconsolidated material, including any buried fish eggs and all aquatic invertebrates, are picked up from the bottom and entrained through the dredge. Bottom materials are rearranged and channel morphology could be changed to an unstable form. In addition, periphyton growth is removed from the area dredged.

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1 Samples were, whenever possible, taken in metric units. However, many hydrologic parameters are still commonly given in English units. To avoid confusion, all measurements in this paper are given in English and metric units.

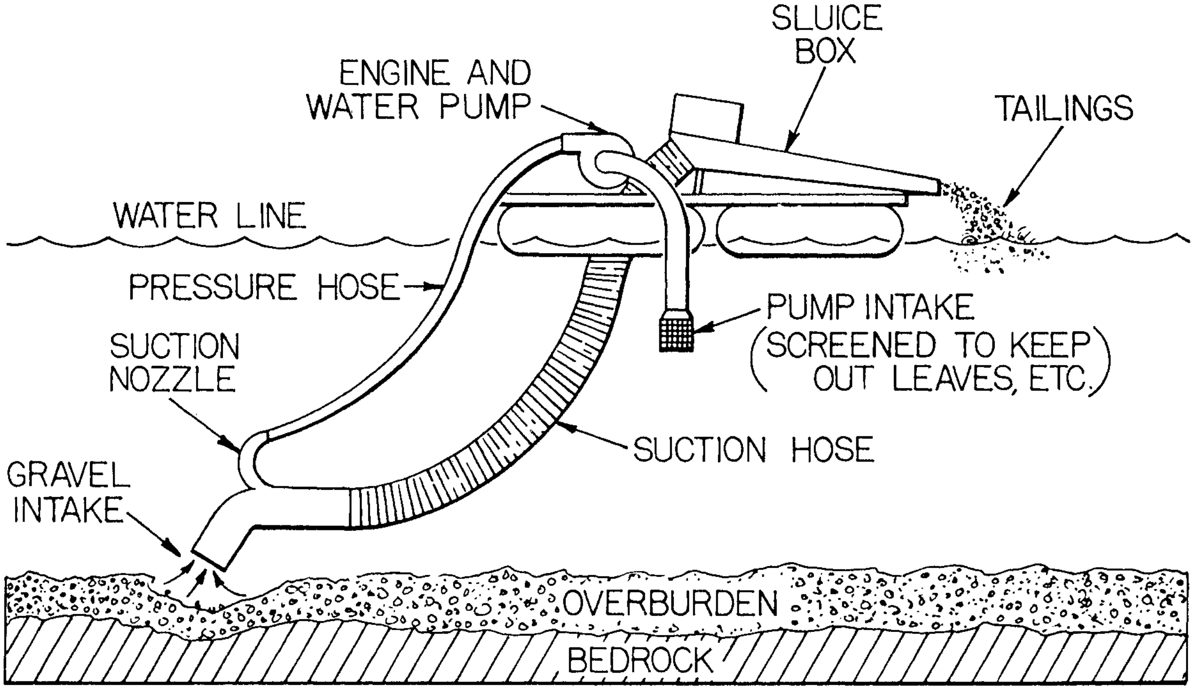


FIGURE 2. Anatomy of a suction gold dredge. Source:Thornton, (1979).

The purpose of this study was to determine the effects a 2.5 inch (6.4 cm) suction gold dredge has on aquatic insects and stream bottom habitat in a small Montana stream. It is hoped that the data will be of use to water resource managers who are in need of sound scientific data on which to base their management decisions. In addition, the laws and regulations governing suction dredging were analyzed and reviewed.

MACROINVERTEBRATES

Aquatic invertebrates are a major component of the aquatic food web. A large scale, long term decrease in invertebrate populations would have far reaching implications, including a decrease in fish productivity. The distribution of benthic insects inhabiting lotic environments is highly dependent on substrate particle size (Cummins and Lauf,1969). Changing the substrate by adding sediments could change the macroinvertebrate diversity and density. McClelland and Brusven (1980) found that increased quantities of sediment in laboratory streams filled substrate interstices and reduced the "effective" size of surface cobbles reducing insect density in the test region. Ambuhl (1959) and others have shown that regions of zero velocity exist at rock-water interfaces and in spaces downstream from and beneath rocks. Many insects utilize these areas when foraging. Bournaud (1963) reported that without these low velocity areas, many insects, even dorsoventrally flattened species, could not maintain their position in the current. Increased quantities of fine sediments effectively eliminate many of these critical static water areas around cobbles and boulders (McClelland and Brusven, 1980). Fine sediments around cobbles produce a "gasket effect" by creating a seal, thereby restricting access to the undersurface of the cobbles or deep sediment except to specialized, burrowing forms (Brusven and Prather, 1974). In addition, many common riffle insects are unable to move upstream on sand substrates. Pebble and cobble may be necessary for upstream movement by most insects even at low water velocities (Luedtke and Brusven, 1976).

Suspended particles may also be an important factor as they may abrade respiratory surfaces or dislodge insects and vegetation. Chutter (1969) found that sediment related changes in the invertebrate faunas of two South African rivers occured without the benthos being smothered with inorganic debris. Many workers (Nuttall and Bielby,1973; Bjornn et.al.,1975; Cordone and Pennoyer,1960 and others) have noted decreased aquatic insect populations below silt outflows.

Is the amount of sediment produced by a 2.5 inch (6.4 cm) suction dredge enough to negatively impact downstream insect populations? If so, how far downstream are populations affected? What is the duration of impact? What are the direct impacts of dredging? These are the questions this section of the study addressed.

FISHES

Sedimentation on the stream substrate, particularly the gravel used for fish spawning, produces significant detrimental effects on the salmonid resources. Sediments have the potential to affect fishes by: 1)clogging and abrading gills and other respiratory surfaces, 2)adhering to the chorion of eggs, 3)providing conditions conducive to the entry and persistence of disease related organisms, 4)inducing behavioral change, 5)entombing different life stages 6)altering water chemistry by the adsorption of chemicals, 7) affecting utilizable habitat by scouring and filling of pools and riffles and changing bedload composition, 8) reducing photosynthesis and primary production, 9) affecting intragravel permeability and dissolved oxygen levels which effect the egg and embryo stages of salmonids which develop within the gravel and, 10)affecting the fishing for and the catchability of sport fishes (Iwamoto,et.al.,1978).

Excessive deposition of sediment in streams results in a decrease in depth and an increase in width. Velocity decreases and the characteristic riffle-pool relationship is altered, decreasing the number and depth of pools (Rulifson,1979). Deep pools are extremely important to stream fishes. Sheldon (1968) found that the number of species of fish was most strongly correlated with stream depth. His work is supported by Inger and Chin (1963) who found that Bornean fishes showed considerable specialization for feeding at particular depths. Large scale filling of pools could be expected to reduce the number of species of fish living in a stream.

For these reasons it is important to quantify the amount of sediment produced by small dredges and determine where it is deposited and how long it remains.

Dredging operations which cut into banks and destroy bankside vegetation are particularly damaging. When bankside vegetation is removed banks may become unstable, resulting in increased bank erosion and increased stream sedimentation. In addition, undercut banks and overhanging vegetation provide cover for fishes. Boussu (1954) found that when undercut banks and overhanging brush were removed from a stream, trout populatons, especially the larger fish, were adversely affected. Warner and Porter (1960) stated that the removal of bank vegetation, overhanging banks, and other shelter destroyed some of Maine's finest trout streams. Gunderson (1968) found that the weight/acre of brown trout (*Salmo trutta*) was 31% greater in an ungrazed section of stream than in a grazed section. He attributed the difference to there being a narrower, deeper channel system, more favorable composition and distribution of water types, and more cover in the ungrazed section because the riparian vegetation had been preserved.

MATERIALS AND METHODS

THE STUDY SITE

The study was conducted on Gold Creek, Missoula County, Montana (T 15 N, R 17 W,sec 36) in July through September, 1980. Gold Creek is a relatively undisturbed,high gradient (average drop 120 feet/mile (22.72 m/km)), third order stream. Typical late summer flows are about 15 cubic feet per second(.42 m^3/sec). No previous mining has taken place in the drainage. Most of the lower drainage basin is owned by the Champion International Corporation, and is managed as a tree farm. The upper portion of the drainage is managed by the U.S. Forest Service and has been in an undeveloped state until recently, when some large timber contracts were let for the area. There are no grazing permits let for Gold Ck., however stray cattle do occasionally wander in from adjacent drainages. Despite extensive clearcutting in the drainage,the riparian zones have been left fairly intact and the stream does not suffer from turbidity and sedimentation problems.

Rock types in the Gold Creek drainage include Precambrian Belt Supergroup sediments, principally Missoula and Wallace formations. The study site is covered by Tertiary alluvial gravel fill. The gravels are probably several hundred feet thick, although no definitive estimate has been made. No gold has yet been found in the stream gravels (J.Thomas,pers.comm.,1982). The streambed is composed of gravel,cobbles and boulders with some sand and silt. Gold Creek supports a good population of cutthroat trout(Salmo clarki) and brook trout (Salvelinus fontinalis) and is a bull trout (Salvelinus confluentus) spawning stream . Gold Creek was chosen as a study site because of its pristine condition and bottom composition.

THE DREDGE

The dredge,manufactured by Keene Engineering, had a 2.5 inch (6.4 cm) diameter nozzle and was powered by a 2 horsepower Briggs and Stratton engine. It is one of the most popular size dredges used by weekend gold dredgers.

STUDY DESIGN

A section of stream 50 meters long was chosen for its relatively uniform character. The site was divided into five 10 meter segments. The upstream most section (section 1) was maintained as a control. The next 10 meters, (section 2), was dredged from bank to bank and to the greatest depth possible (< 1 m.) The lower three sections (sections 3,4 and 5) were studied to determine downstream impacts. An impact study is best designed when it judges impact effects against previously collected baseline data (Green,1979). For this reason ,all parameters were measured before dredging took place. The entire study was replicated at a second site (site B) upstream of the first site (site A).

MACROINVERTEBRATES

Six random samples were taken in each of the five study sections before and after dredging (Figure 3). Randomization was accomplished using a table of random numbers to locate sample sites. Samples were taken with a homemade Hess- type sampler (area 78.5 in^2, .05 m^2)and preserved in the field in 70% ethanol. In the lab a solution of rose bengal stain was added to the samples to facilitate sorting the benthic invertebrates. Rose bengal selectively stains chitin pink while the other debris in the sample retains its natural color (Mason and Yevich, 1967). Samples were sorted to the lowest taxonomic level feasible, usually to genus.

Samples were taken before and immediately after dredging took place. Dredging took approximately two weeks to complete at each site. Griffith and Andrews (1981) found recolonization of dredged plots was substantially complete in 38 days so a complete set of macroinvertebrate samples were taken one month after dredging to determine the degree of recolonization.

Analysis of variance was used to determine the location and magnitude of dredging impacts. In standard analysis of variance the model specifies a number of assumptons which should be tested before proceeding with the analysis. Minor failures in the assumptions do not greatly disturb the conclusions drawn from the standard analysis. Some of the serious failures, if detected, can be treated after the data is collected (Snedecor and Cochran,1980). One of the key

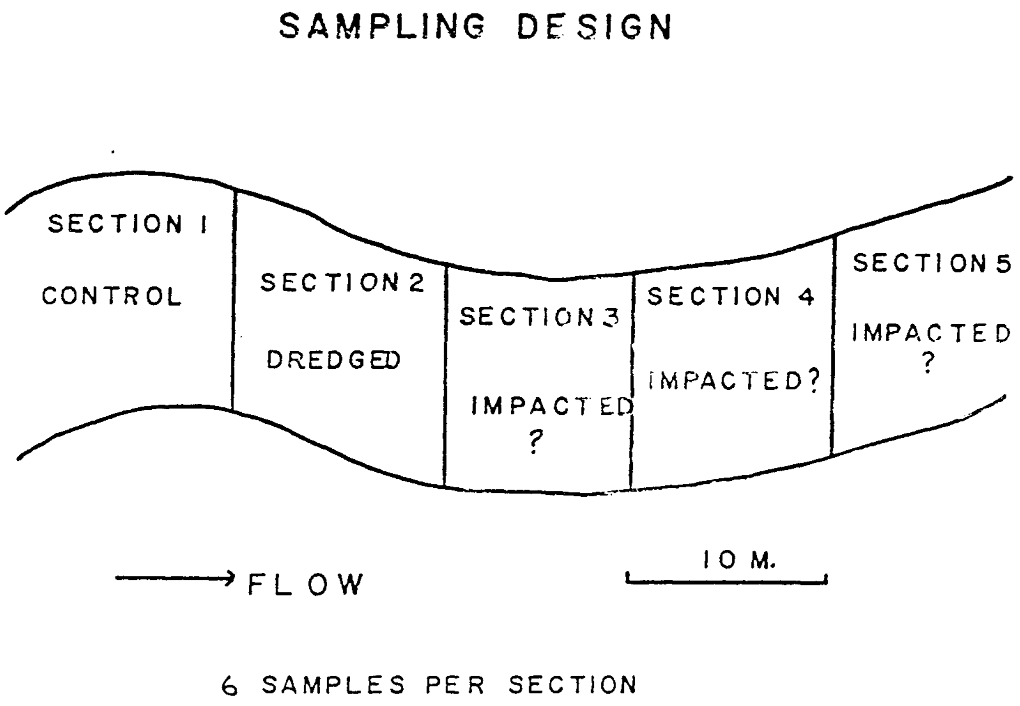


FIGURE 3. Aquatic insects sampling [illegible]. Samples were taken at three times: before, immediately after, and one month after dredging. The study was replicated at an upstream site.

assumptions frequently violated in this type of data is the assumption of independent variances. Often in sampling natural populations, the animals are clumped, rather than normally distributed. The result is that the sample variance is not independent of the sample mean. The simplest test for this violation is a plot of means versus variance. As Figure 4 shows, as the mean number of benthic invertebrates increases, the variance of the counts tends to increase as well. A simple statistical test, the F-max test (Sokal and Rohlf, 1980) can be used to confirm the graphical interpretation. The F-max test is simply the ratio of the largest to the smallest sample variances.

$$\text{F-max, site one} = \frac{s2\ \text{max}}{s2\ \text{min}} = \frac{265{,}905}{72} = 3693.1 \quad P(< .01)$$

Therefore, it is necessary to reject Ho:$o^2 \neq f(u)$.

Heterogeneity of variance can be cured by using a data transformation. The choice of a specific transformation is based on the mean-variance relationship, which in turn is a function of the spatial relationship. Many field distributions of organisms are highly aggregated ($o^2 >> u$) and approach the logarithmic series. In practice, most data from samples of field distributions of organisms may be transformed as $z = \log (x + 1)$, which allows values of zero to be used (Green,1979). This transformation was applied to

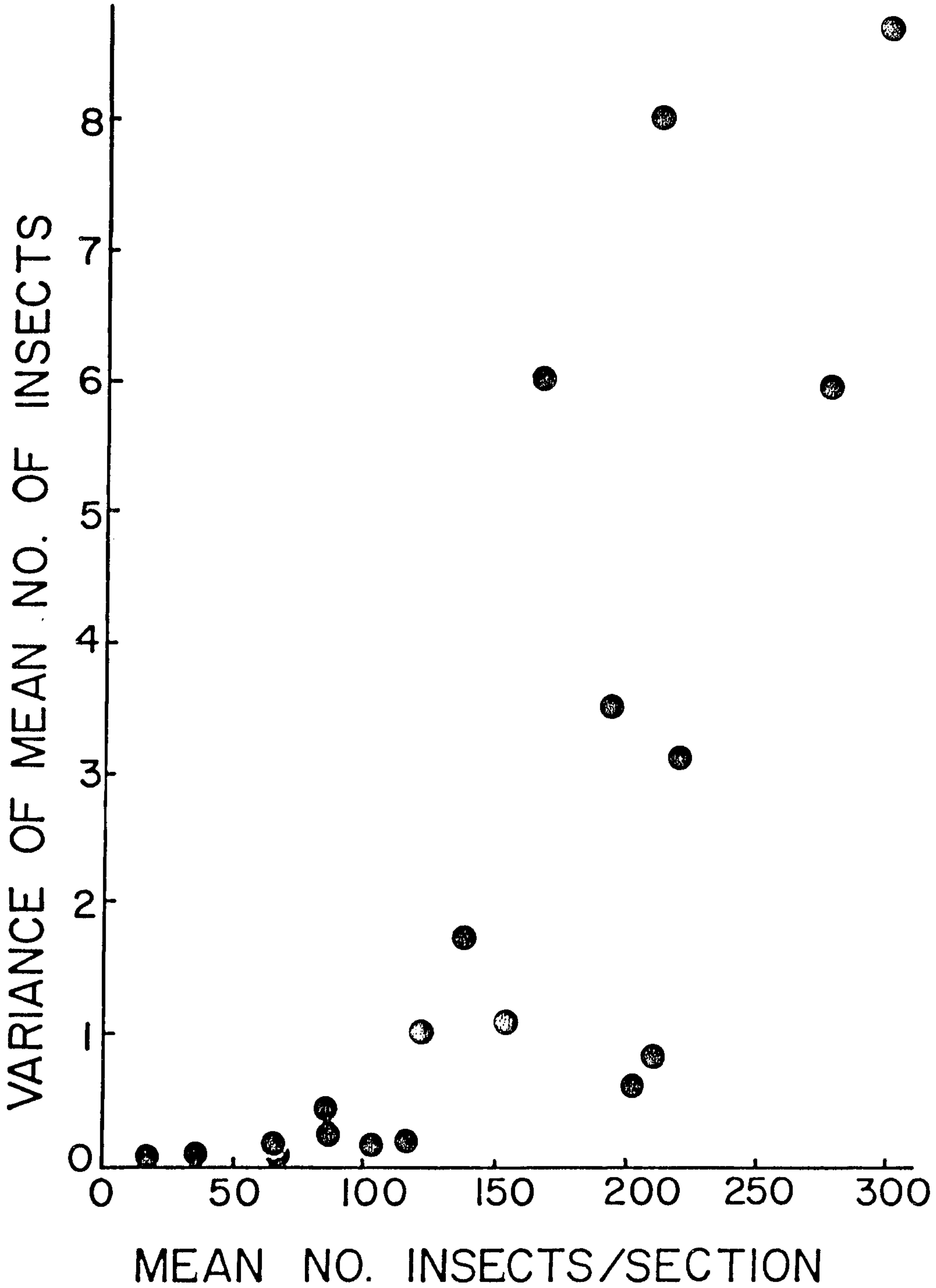


FIGURE 4. Mean - Variance relationship before logarithmic data transformation. Variance (X 10,000).

the counts of aquatic insects before statistical analysis was attempted. Figure 5 confirms that the variance is no longer a function of the mean after data transformation. The F max test also confirms this

$$\text{Fmax, site 2} = \frac{.85}{.02} = 42.5 \quad P(>.01)$$

A 2 X 2 X 5 (site X treatment X section) analysis of variance (ANOVA) was performed on the transformed data using SPSS subprogram ANOVA (Nie,et.al.,1975). One purpose of this analysis was to determine whether dredging effected both sites in the same way. If so,these findings may be applicable to similar streams treated in similar ways. If the results are similar at both sites the three way interaction term (treatment X site X section) should not be significant.

The treatment main effect term is not necessarily indicative of dredging impacts. There was a two week time lag between the before and after samples and significant natural changes in insect abundance could have taken place over that time. There are two periods during the life history of aquatic invertebrates when they are not vulnerable to benthos sampling; adulthood and egg and early instar stage. If large numbers of insects are moving into or out of these phases during the dredging period it would appear as an increase or decrease in the mean numbers of insects over time. Assuming that natural changes in invertebrate density

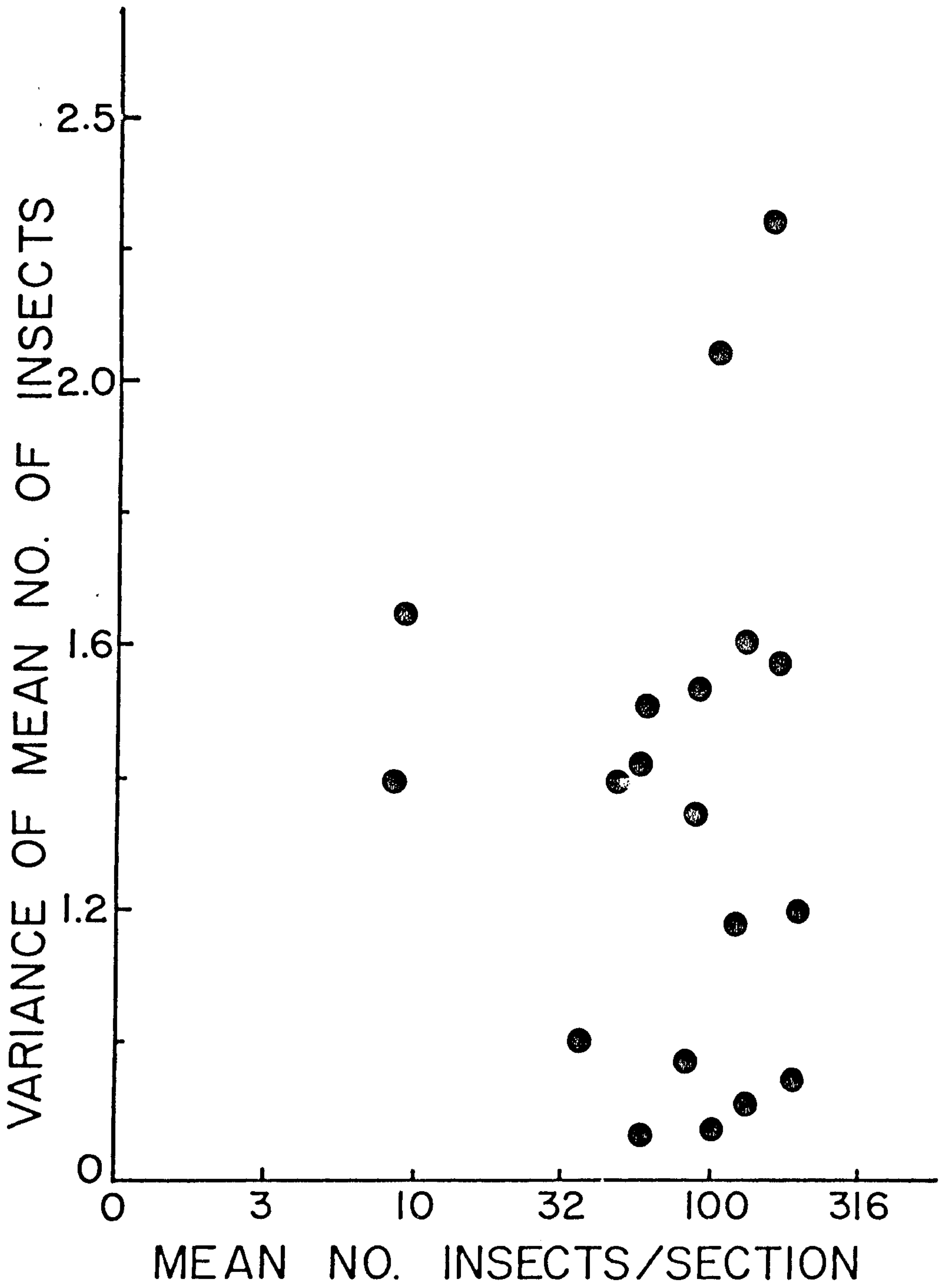


FIGURE 5. Mean - Variance relationship after logarithmic data transformation. (Y = log X + 1).

will occur at an equal rate throughout the stream, then dredging effects can be tested by examining the section X treatment interaction. If significant it would indicate that the density of insects in one or more sections changed relative to the density in other sections.

Although this sampling design produced satisfactory results in this case, this design would not be universally applicable. It is not a balanced design since every section received a different treatment. Consequently, the treatment effects are confounded with time effects. A balanced design would have a control section for each treatment section.

The two way treatment X section interaction was significant but because of the confounding problem, further analysis was necessary to prove dredge impacts. A oneway ANOVA was conducted on the before and after transformed data using SPSS subprogram ONEWAY (Nie, et.al., 1975) to determine which sections were behaving differently. Each site was treated separately. The purpose of these ANOVAs was to determine if the mean number of benthic insects was the same in all sections before dredging and if the means were the same in all sections after dredging. Scheffe's test(Snedecor and Cochran,1980) was computed using SPSS to pick out those sections which were significantly different.

Each taxonomic group was then analyzed separately. Oneway ANOVAs were conducted on each of the common taxonomic groups. Rare genera were ignored because it was not possible to detect any change in their abundance. This portion of the analysis was designed to detect changes in species composition due to suction dredging.

A oneway ANOVA was conducted on the samples taken one month after dredging in sections one, two, and three. ANOVAs were conducted on the total counts and at the ordinal level. These samples were not sorted below the ordinal level.

A two way (section X time) ANOVA compared one-day-after dredging to one- month- after- dredging samples. A significant interaction term would indicate that either the dredged area or the downstream area was behaving differently over time than the control section.

SEDIMENTATION

Suspended sediment was measured with a depth integrating sediment sampler, the DH-48. A depth integrating sediment sampler is designed to accumulate a water sample from a stream vertical at such a rate that the velocity in the nozzle at the point of intake is always as nearly as possible, identical with the mean stream velocity while running the vertical at uniform speed (Guy,1970). Samples of sediment concentration obtained by integration with the flow can then be used with the flow rate in the given cross section to compute the sediment discharge where:

$$Qs = QwCsk$$

Qs = sediment discharge in pounds per day

Qw = water discharge in cfs

Cs = discharge weighted mean concentration in mg/l

k = constant

One sample was taken above the dredge outflow for a control. Directly below the dredge outflow three samples were taken one foot (.3 m) apart. Three more samples were taken five feet below the outflow, two feet (.6 m) apart. Four samples were taken, representing the entire streamflow, twentyfive feet (7.6 m) below the outflow (Figure 6). The object of this sampling design was to map out the plume of suspended sediment. At the point of the outflow the sediment is concentrated in a narrow band. As it flows downstream , it disperses and covers a wider area. The amount of sediment discharged at any moment through a suction dredge is highly variable depending on the type of bottom materials being dredged. Suspended sediment samples were taken when the discharge appeared to be the most murky in order to determine the worst case situation. Sediment samples were filtered (through Whatman #41 filter paper) and the residue was dried for one hour at 100 °C and then

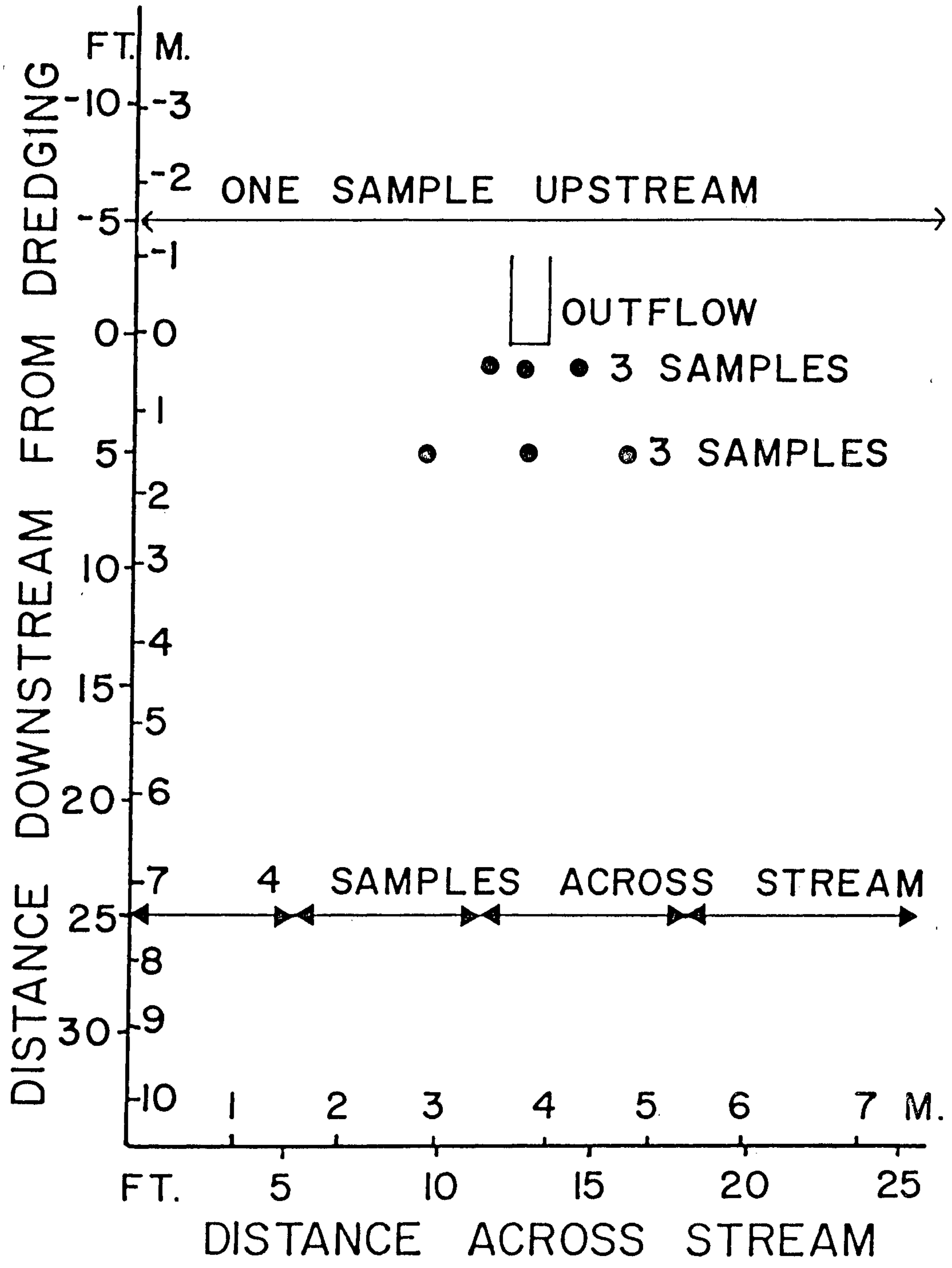


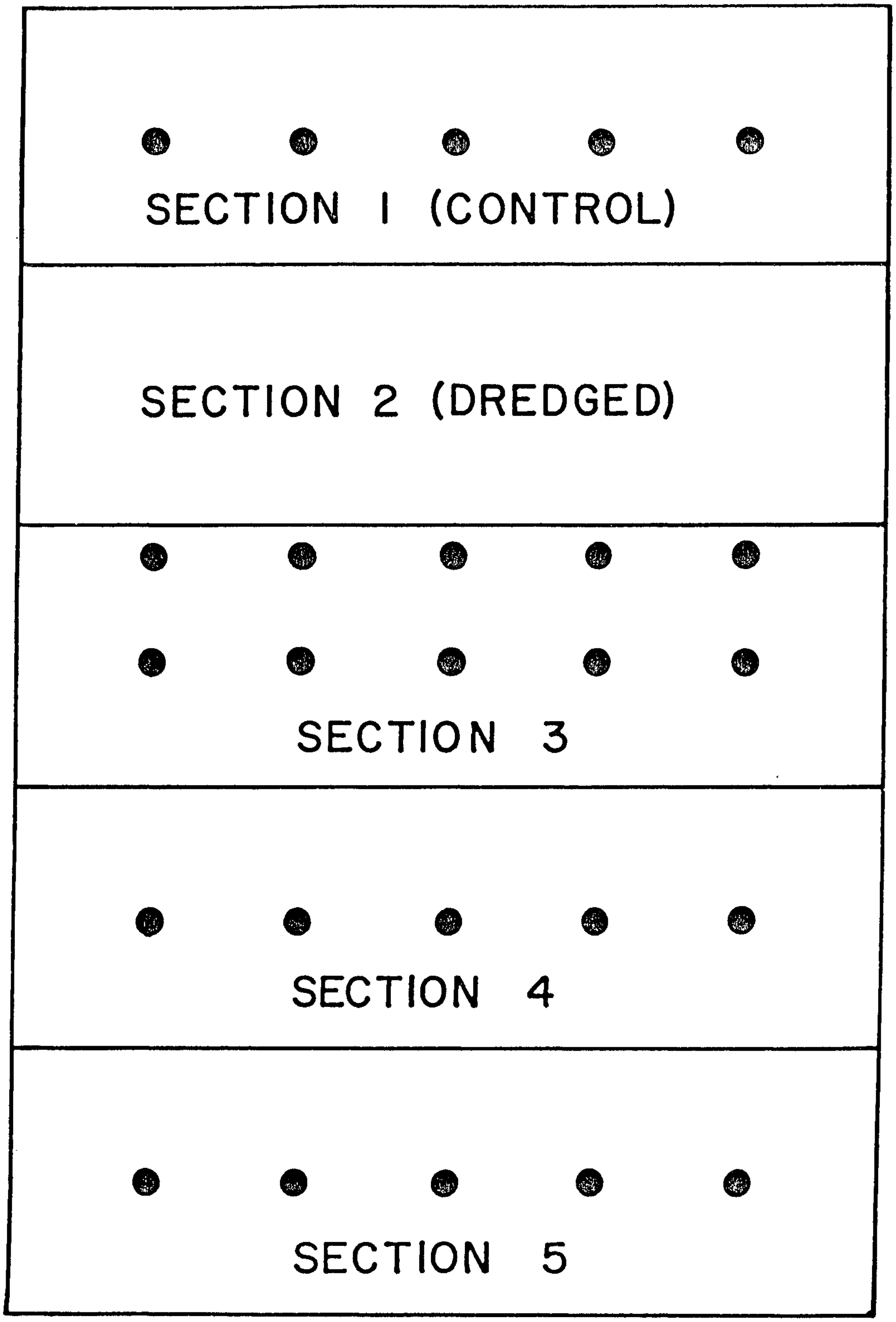
FIGURE 6. Suspended sediment sampling scheme.

weighed. Current velocity and discharge were measured on the same days that suspended sediment samples were taken using a pygmy current meter.

Deposited sediment was measured using a trap similar to that of Welton and Ladle (1979). The trap is made of aluminum beverage cans with the tops cut off. The cans were fitted with nylon rope handles and were placed inside 3 inch diameter PVC pipes which were cut to fit the cans. The cans were filled with washed gravel (gravel too large to go through a size 5 Tyler standard screen (3.962 mm opening). The trap was buried in the stream bottom so the top of the trap was as close to flush with the stream bottom as possible. The PVC pipe facilitates removal and replacement of the trap in the stream bed.

Five sediment traps were equally spaced across the middle of the control section, and the second and third downstream sections. The dredged section did not have any traps since it was to be dredged, but the first downstream section had a row across the top of the section and one across the middle (Figure 7).

Traps were left in place for five days before dredging began. The gravel was then rewashed , the wash water (containing sediments finer than 3.963 mm) was saved for analysis, and the traps replaced in the stream. The same proceedure was followed after dredging. The wash water was filtered through Whatman #41 filter papers, dried, and weighed. The same proceedure was followed after dredging.



● = BURIED SEDIMENT TRAP

FIGURE 7. Deposited sediment sampling scheme.

A curve was fitted to the deposited sediment data using BMDP derivative free non-linear regression (Dixon, 1981). This program uses iteration to find the parameters which solve the problem with the smallest residual sum of squares.

TURBIDITY

Turbidity was measured during dredging upstream and downstream of the dredge. Samples were taken using a DH-48 depth integrating sediment sampler. One sample was taken upstream of the operating dredge, and four were taken 25 ft downstream. Each of the four samples represented approximately 6 ft of the stream's width. Samples were taken when the dredge appeared to be discharging a maximum amount of fine material. Turbidity was determined using a Hach 2100A turbidimeter.

Turbidity measurements are usually used as an index to the quantity of suspended sediment. However, the percentage contribution of settleable solids to turbidity is highly variable. The varying size, shape, specific gravity, and refractive index of sediment in suspension in a stream result in varying correlations between turbidity and suspended sediment (Duchrow and Everhart, 1971). In this study, suspended sediment was measured directly. The primary purpose of taking turbidity measurements was to fulfill the requirements of the Montana stream discharge permit.

GRAVEL PERMEABILITY

Developing salmonid eggs and fry need flowing water to carry away metabolic wastes and to supply them with oxygen (Meehan and Swanson,1977). Reduction in water velocity and dissolved oxygen concentration each result in a longer development period to hatching, smaller embryos,higher prehatching and posthatching mortality, and increased occurance of stucturally abnormal embryos (Silver and Douderoff, 1963). Therefore, high gravel permeability is important to successful salmomid spawning.

Intergravel permeability, at the velocities usually found in stream gravels, is a function of water viscosity and, especially, the composition and degree of packing of the gravel (Pollard,1955). Therefore a layer of fine sediment on the stream bottom gravels can reduce intergravel permeability

Does suction dredging change downstream intergravel permeability? Is there a significant change in the permeability of the area dredged?

Mark VI groundwater standpipes were used to measure intergravel water permeability and dissolved oxygen by the technique described by Terhune (1955). The Mark VI groundwater standpipe consists of a 36 inch length of 1 1/4 inch diameter aluminum standard pipe with a steel point. Forty-eight 1/8 inch diameter holes, evenly spaced above the steel point, allow water to flow into the standpipe. A heavy sledgehammer was used to drive the standpipes 10 inches (.25 m) into the stream. Three standpipes were driven into each of the five sampling locations at each of the study sites.

Water in the pipe is lowered a fixed amount (1 inch) and the resulting inflow rate is measured by pumping water out of the pipe, maintaining the one inch head. Inflow is measured in ml/sec which is converted to permeability in cm/hr using a calibration curve (Terhune,1958).

Intergravel dissolved oxygen was measured either by dropping the probe of a dissolved oxygen meter into the pipe or by withdrawing water with the pump and conducting Winkler titrations on the water. Permeability and dissolved oxygen were measured before and after dredging at both sites.

CHANNEL MORPHOLOGY

Channel morphology was mapped using a Keuffel and Esser transit. One cross section was mapped across the middle of each section at the first study site. The cross sections were mapped before and after dredging took place. At the second study site, more extensive mapping was done. Five cross sections were mapped in the control section and the dredge section. In addition, three longitudinal lines were mapped from the top of the section 1 to the bottom of section 2. The downstream sections; sections 3,4, and 5, were not mapped at site B. Photos were taken of both study sites before and after dredging took place to document any changes.

RESULTS

AQUATIC INSECTS

What immediate impact does dredging have on aquatic insect abundance and where do the impacts occur? A three way (site X treatment X section) factoral analysis of variance (ANOVA) conducted on log transformed data showed no significant three way interactions P(F = .12) (Table 1). The treatment effects found at site A are of the same degree in the same section as the effects at site B. The replication (study site B) substantiates the results from study site A. The treatment by section interaction was significant P(F<.0005)(Table 1). This indicates that dredging has an impact on at least one section. A plot of the mean number of insects found in each section show that, in section 2, the dredged section, mean insect abundance greatly decreased after dredging (Figure 8). Downstream insect abundance does not appear to be altered.

ANOVAs were conducted on the before treatment and after treatment data. Each site was considered separately. At both sites, the mean number of aquatic insects was the same in all five sections before dredging began (P > .05) . After dredging, both sites showed a significant P(F < .01) difference between sections. Scheffe's test was used to determine the sections with significantly different means. At both sites, section two contained significantly fewer

TABLE 1

Three way Time X Section X Site ANOVA

Source of variation	Sum of squares	df	Mean square	F	P(F)
Main effects	8.78	6	1.46	8.39	.00
SITE	1.55	1	1.55	8.92	.00
DAY	1.23	1	1.23	7.06	.01
SECTION	5.84	4	1.46	8.38	.00
2-Way Interactions	6.66	9	.74	4.24	.00
SITE X DAY	.51	1	.51	2.96	.09
SITE X SECTION	1.15	4	.28	1.65	.17
DAY X SECTION	4.82	4	1.20	6.91	.00
3 Way Interactions					
DAY X SITE X SECTION	1.31	4	.32	1.87	.12
Explained	16.75	19	.88	5.05	.00
Residual	16.38	94	.17		
Total	33.14	113	.29		

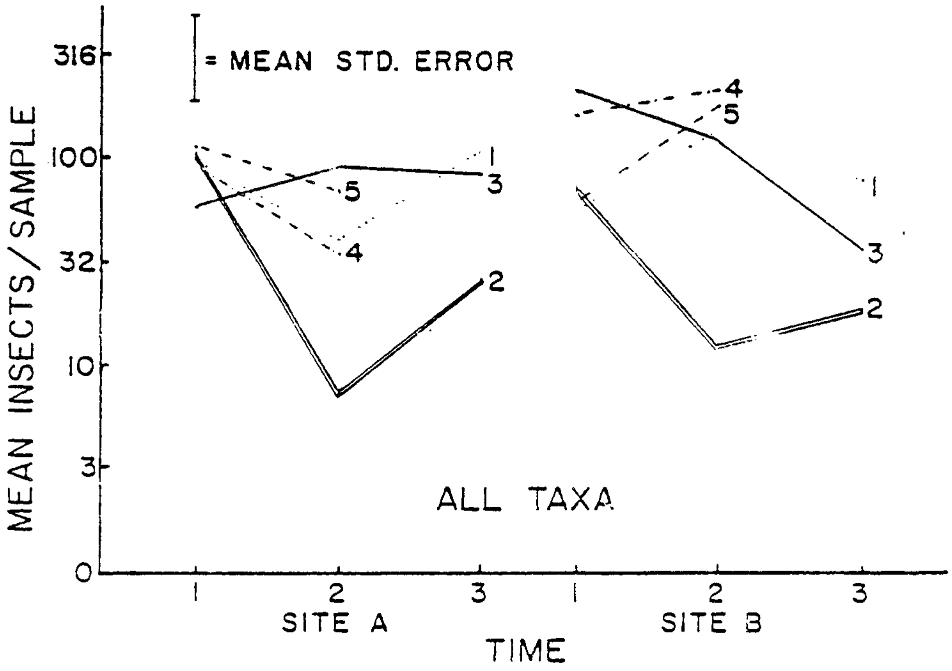


FIGURE 5. Changes in aquatic insect abundance over time. Time 1 = before dredging, Time 2 = 1 day after dredging, Time 3 = 1 month after dredging. Section 1 = control, Section 2 = dredged section, Section 3, 4, 5 = downstream sections.

insects than the control section or the three downstream sections. No change in downstream insect abundance could be detected,relative to the control section. The data show that the immediate impacts of dredging on aquatic insect abundance is limited to the area dredged.

Are there any immediate changes in species composition? Analysis of variance by taxonomic group indicates that , at the second study site, the mean number of insects in each group was the same at all five sections before dredging began (Table 2). After dredging, all groups showed significant P(F < .05) variation between sections. Scheffe's test showed section two, the dredged area, contained significantly fewer organisms than the other sections (Table 2). Although some of the species show increases or decreases in the downstream sites relative to the control, none of these changes are great enough, or consistent enough, to warrent a conclusion that there are any immediate downstream impacts on any of the species. The data at the first study site are less clear. At the ordinal level of taxonomic resolution, it is again fairly clear that the abundance of insects in section two is greatly decreased and in the other sections there are no quantitative changes. However, at finer levels of taxonomic resolution the ability to detect changes in species density becomes weaker. Some of the genera do not show statistically significant differences between sections after dredging. However, in every case except one, section two contains fewer

TABLE 2

Results of oneway analysis of variance

	SITE A			SITE B		
Taxa	Before	After	Significantly Different Groups	Before	After	Significantly Different Groups
Ephemeroptera	NSD	*	2<3	NSD	**	2<1,3,5,4
Heptageniidae	NSD	NSD	NSD	NSD	**	2<3,4,5,1
Epeorus	NSD	*	2<1,3	NSD	**	2<4,3,1,5
Rhithrogena	NSD	**	2,4<3	NSD	*	NSD
Cinygmula	NSD	NSD	NSD	NSD	*	2<3,5,1,4
Ephemerellidae	NSD	NSD	NSD	NSD	**	2<1,3,5,4
Species A	NSD	NSD	NSD	NSD	**	2<1,3,<5,4
Species B	not found at site A			NSd	**	2<1,3,5,4
Trichoptera	NSD	**	2<1	NSD	**	2<5,1,3,4
Brachycentridae	*	NSD	NSD	NSD	**	2,1<5,3,4
Micrasema	*	NSD	NSD	NSD	**	2,1<5,3,4

TABLE 2 (continued)

	SITE A			SITE B		
Taxa	Before	After	Significantly Different Groups	Before	After	Significantly Different Groups
Polycentopus	NSD	*	2<3	NSD	**	2<1,4,3,5
Coleoptera	**	**	2<3,4,5	NSD	**	2<3,1,4,5
Diptera	NSD	NSD	NSD	NSD	**	2<1,3,4,5
Chironimidae	NSD	NSD	NSD	NSD	**	2<1,3,4,5
Plecoptera	NSD	**	2<4,3,5	NSD	**	2<1,3,4,5
Zapada	*	NSD	NSD	NSD	**	2<1,5,3,4
Chloroperlidae	*	**	2<4,3,5	NSD	**	2<3,4,1,5

Before: Probability of mean number of insects equal in each of the five sections before dredging took place

After: Probability of mean number of insects equal in each of the five sections after dredging took place

NSD: No significant difference between sections P(F >.05)

* : P(F < .05), significant difference between sections

**: P(F < .01) highly significant difference between sections

Significantly different groups: sections found to be significantly different (P < .05) using SPSS - Scheffe test.

organisms than any other section after dredging, regardless of the abundance of insects in section two before dredging. The trend for a large decrease in insects in section two after dredging is consistent.

The data suggest that the immediate effect of suction dredging is to reduce the numbers of all species of aquatic insects in the area dredged. The effect is very localized. No significant change in abundance was found downstream from the dredged section for any taxonomic group

Recolonization was substantially complete for most groups of insects one month after dredging. Analysis of variance indicates that the mean number of aquatic insects was not significantly different between sections 1,2,and 3 one month after dredging (Table 3). Only the Trichoptera (caddis flies) had significantly lower numbers in the dredged section than in sections one or three one month later (Figure 9). At site B the mean number of caddisflies downstream of dredging decreased relative to the control section. Both sections 2 and 3 have significantly fewer caddisflies than the control (Figure 9). At site A the caddisflies did not fully recover in the dredged section, but no downstream impacts were indicated.

The Coleoptera (family Elmidae) at site A showed significantly higher numbers in the first downstream section than in section one or two. This result was not substantiated at site B where Elmids did not increase downstream of dredging

TABLE 3

Results of two way ANOVA

	Total		Ephemeroptera		Plecoptera	
	SITE A					
	F	P(F)	F	P(F)	F	P(F)
Main Effects	3.21	.05				
DAY	3.21	.05	3.08	.06	7.48	.00
SECTION	4.56	.02	2.86	.07	5.25	.01
Two Way Interaction	2.66	.05	2.40	.07	2.47	.06
Significantly Different Sections One Month Later	*		NSD		NSD	
	SITE B					
	F	P(F)	F	P(F)	F	P(F)
Main Effects						
DAY	.74	.40	3.35	.08	.01	.93
SECTION	10.08	.00	5.78	.01	9.45	.00
Two Way Interaction	1.67	.21	2.04	.15	.57	.57
Significantly Different Sections One Month Later	NSD		NSD		NSD	

TABLE 3 (cont.)

Results of Two Way ANOVA

	Trichoptera		Coleoptera		Diptera	
SITE A						
	F	P(F)	F	P(F)	F	P(F)
Main Effects						
DAY	11.59	.00	8.86	.00	.62	.54
SECTION	7.71	.00	7.15	.00	2.52	.09
Two Way Interaction	2.65	.05	5.51	.00	1.57	.20
Significantly Different Sections one Month Later	*		**		NSD	
SITE B						
	F	P(F)	F	P(F)	F	P(F)
Main Effects						
DAY	3.29	.08	.01	.93	6.41	.01
SECTION	11.77	.00	3.73	.04	6.96	.00
Two Way Interaction	4.72	.02	.12	.88	1.26	.30
Significantly Different Sections one Month Later	*		NSD		NSD	

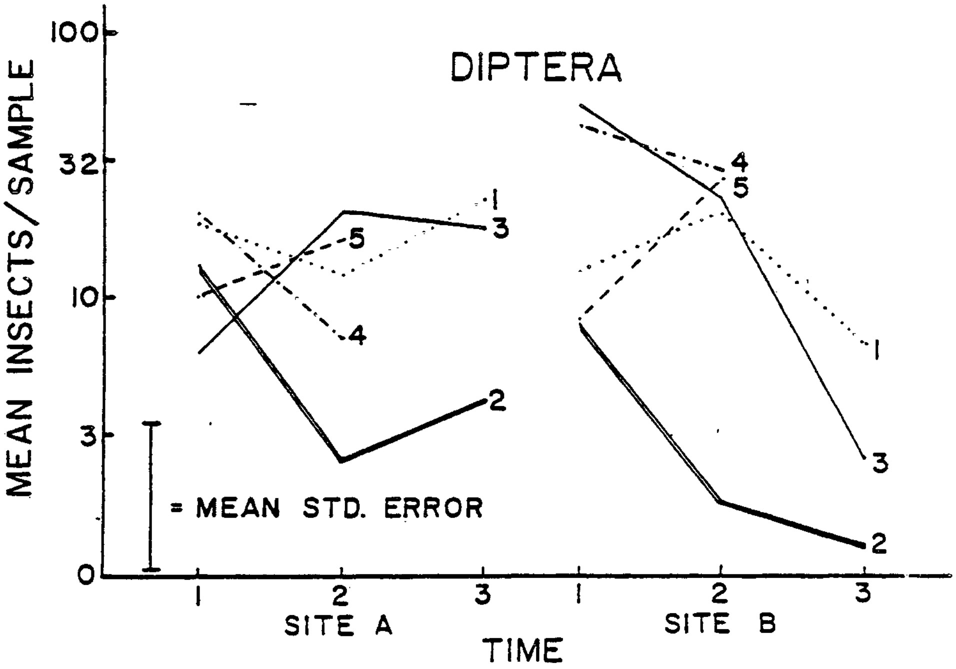
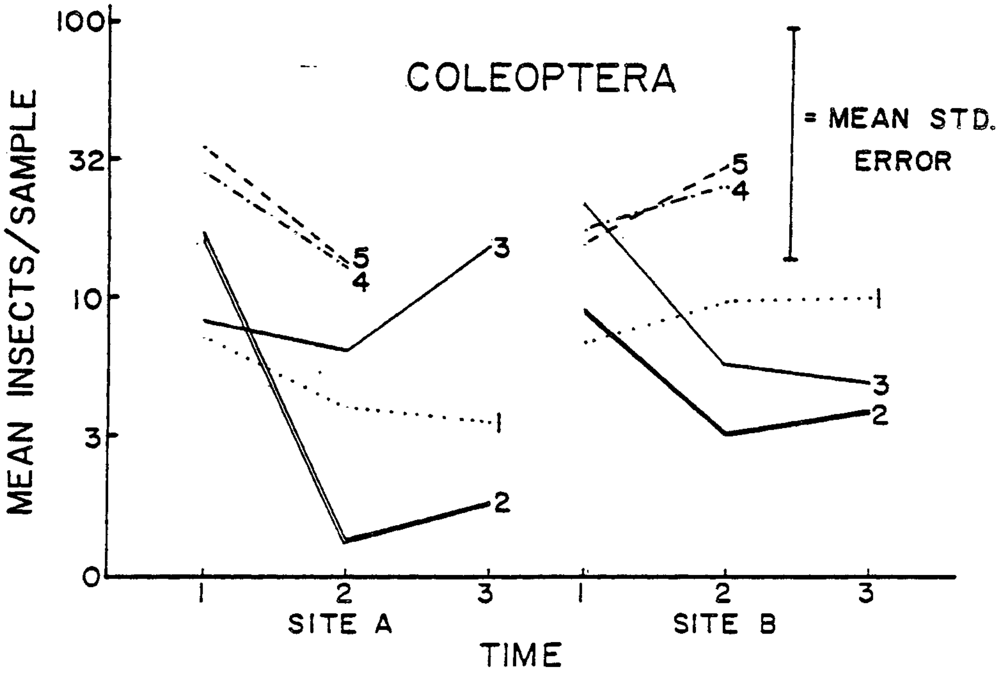
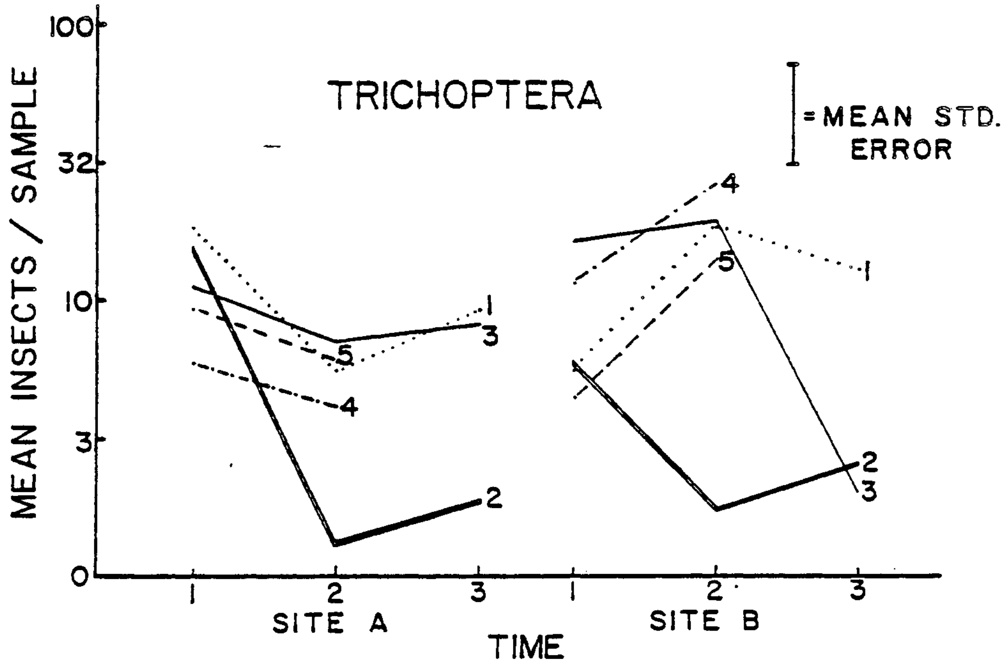
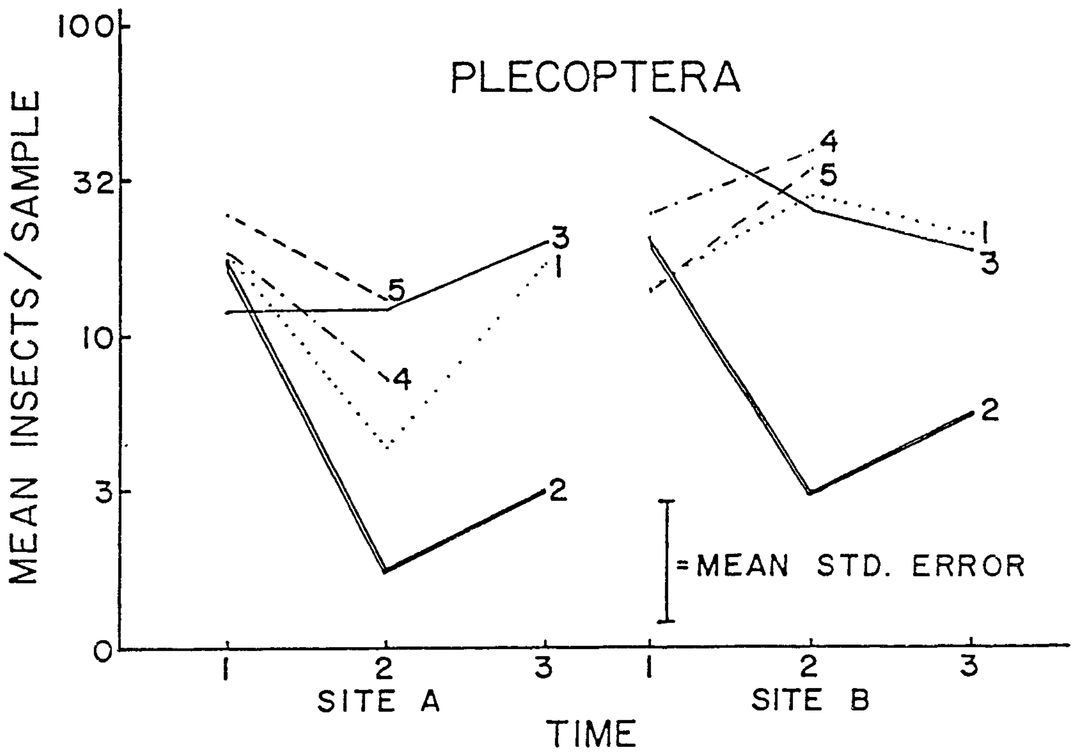
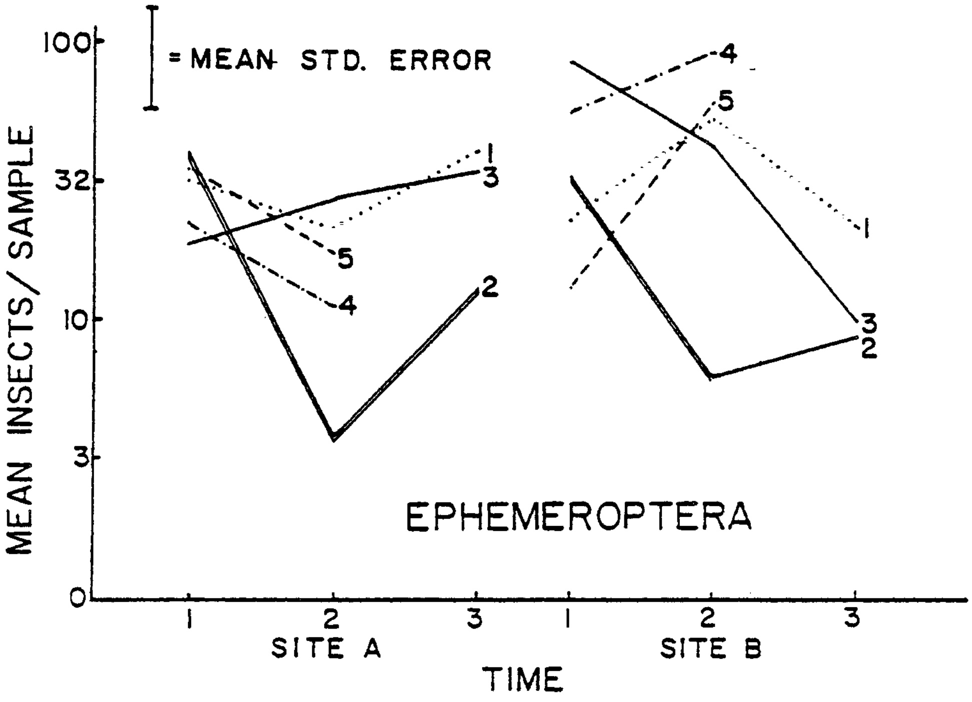


FIGURE 9. Changes in insect abundance over time, by order. Time 1 = before dredging, Time 2 = 1 day after dredging, Time 3 = 1 month after dredging.


COLEOPTERA
= MEAN STD. ERROR
MEAN INSECTS/SAMPLE
100
32
10
3
0
1
2
3
SITE A
1
2
3
SITE B
TIME
5
4
3
2
1
5
4
1
3
2


TRICHOPTERA
= MEAN STD. ERROR
MEAN INSECTS / SAMPLE
100
32
10
3
0
1
2
3
1
2
3
SITE A
SITE B
TIME
1
3
5
4
2
4
5
1
2
3


PLECOPTERA
MEAN INSECTS / SAMPLE
100
32
10
3
0
1
2
3
SITE A
1
2
3
SITE B
TIME
= MEAN STD. ERROR
1
2
3
4
5
1
2
3
4
5


= MEAN STD. ERROR
MEAN INSECTS/ SAMPLE
100
32
10
3
0
1
2
3
4
5
EPHEMEROPTERA
1
2
3
1
2
3
SITE A
SITE B
TIME

and there was no significant difference between sections.

A two way ANOVA comparing the numbers of insects after dredging to the numbers of insects after a recolonization period shows significant time X section interaction only for the caddisflies at site 2 (Table 3). None of the other interaction terms were significant, indicating no significant downstream effects of dredging. It appears that downstream sediment deposition due to dredging may have negatively impacted the caddis flies at site 2. However, since the caddis flies were not impacted at site 1, the evidence is inconclusive.

In every case but one, the number of insects in the dredged section increased after dredging, even when the numbers in the control and downstream sections were decreasing. This indicates the aquatic insects do find dredged areas to be suitable habitat. However, in almost every case the numbers in the dredged section after one month remained below that of the control and downstream sections. It is possible that it takes longer than 30 days for complete colonization to occur or that dredging reduces the carrying capacity of the substrate.

SUSPENDED SEDIMENT

Upstream of the dredge outflow the mean quantity of suspended sediment was 4.56 mg/l. The concentration of suspended sediment was greatest at the dredge outflow and decreased rapidly downstream as the heavier particles settled out and the remaining material dispersed across the width of the stream (Figure 10). One hundred feet (30.5 m) below the dredge, suspended sediment was 1.8 mg/l, indicating a return to ambient levels. The rate of decrease in suspended sediment will vary with stream discharge and particle size.

Sediment discharge measured upstream of the dredge was 651 lbs/day (290 kg/day) on August 21st. The same day sediment discharge was 78,068.3 lbs/day (35076.5 kg/day) at the dredge outflow and 755.8 lbs/day (343.5 kg/day) thirty -five feet (10.7 m.) below the outflow. However, this is a point estimate of the worst sediment discharge experienced in Gold Ck., and not a true representation of the average amount of sediment being discharged during dredging. In order to accurately estimate sediment discharge many samples would have to be taken at the dredge outflow over the course of a day.

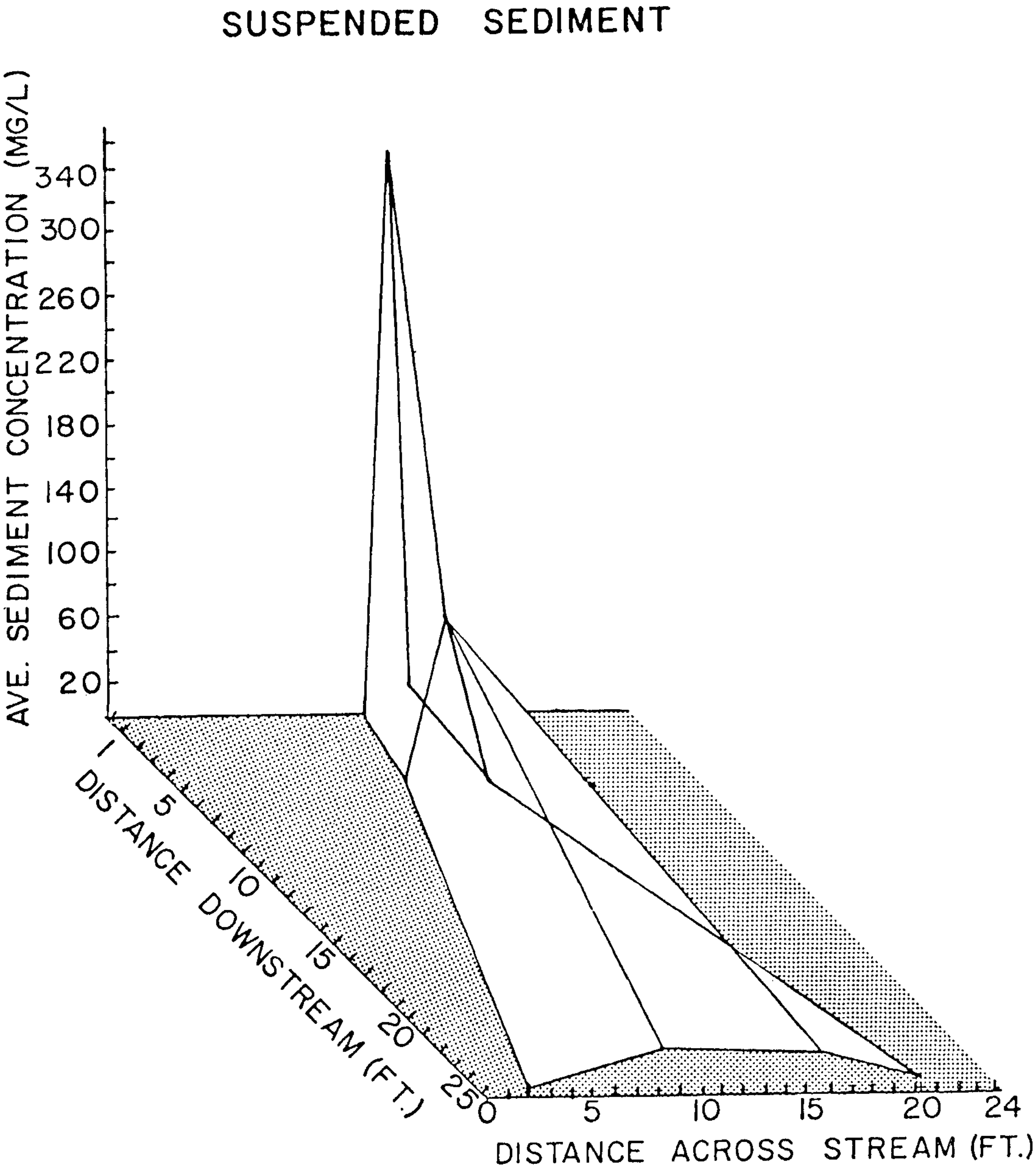


FIGURE 10. Suspended sediment concentration downstream from dredging.

DEPOSITED SEDIMENT

Deposited sediment measured before dredging was equal throughout the stream, with a mean of 1.96 g./trap . After dredging, deposited sediment increased 10 to 20 times over background levels immediately downstream (Figure 11 and 12). Deposited sediment decreased as a power function downstream with the the distance from dredging. Deposited sediment at site A is described by the following equation:

$$Y= 42.43e^{-.067x} \qquad r^{2} = .42$$

and at site B by the equation:

$$Y=34.54e^{-.032x} \qquad r^{2} = .45$$

where Y = deposited sediment and x = distance downstream from dredging. Apparently more sediment was disturbed at site A, but the quantity drops off at a faster rate downstream. Thirty meters downstream site A is actually nearer ambient levels of deposited sediment than site B.

There is a high variance of the downstream deposited sediment measurements primarily because the sediment was not distributed equally across the stream. More of the sediment was distributed near the middle of the stream than near the edges, which received near backround levels of sediment.

The quantities of sediment measured in this experiment are only useful for comparison purposes. Unfortunetly it was

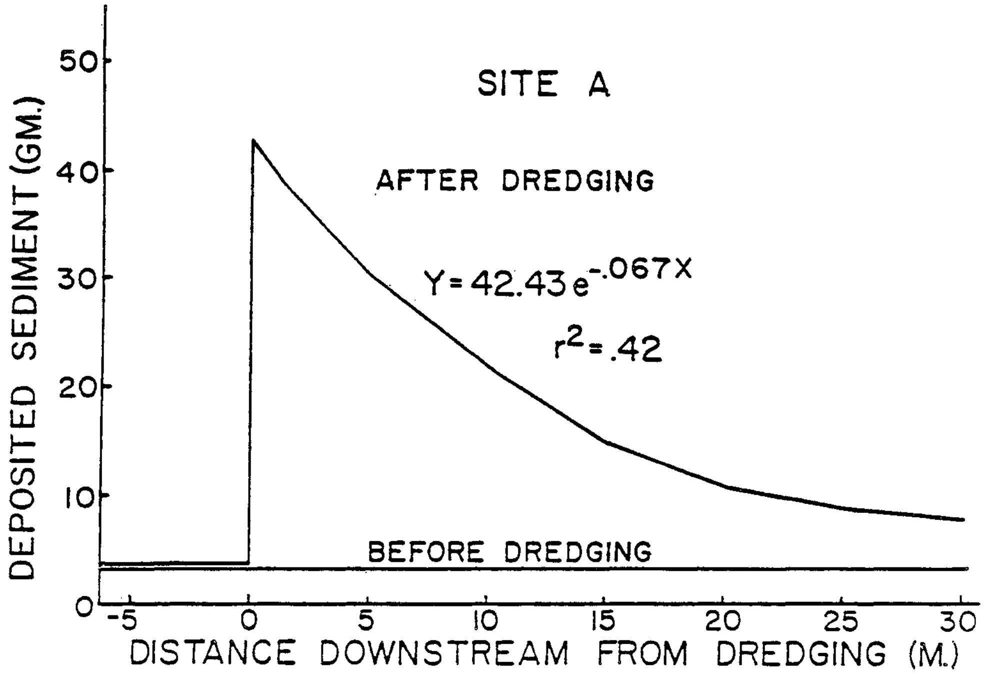


FIGURE 11. Deposited sediment before and after dredging at Site A.

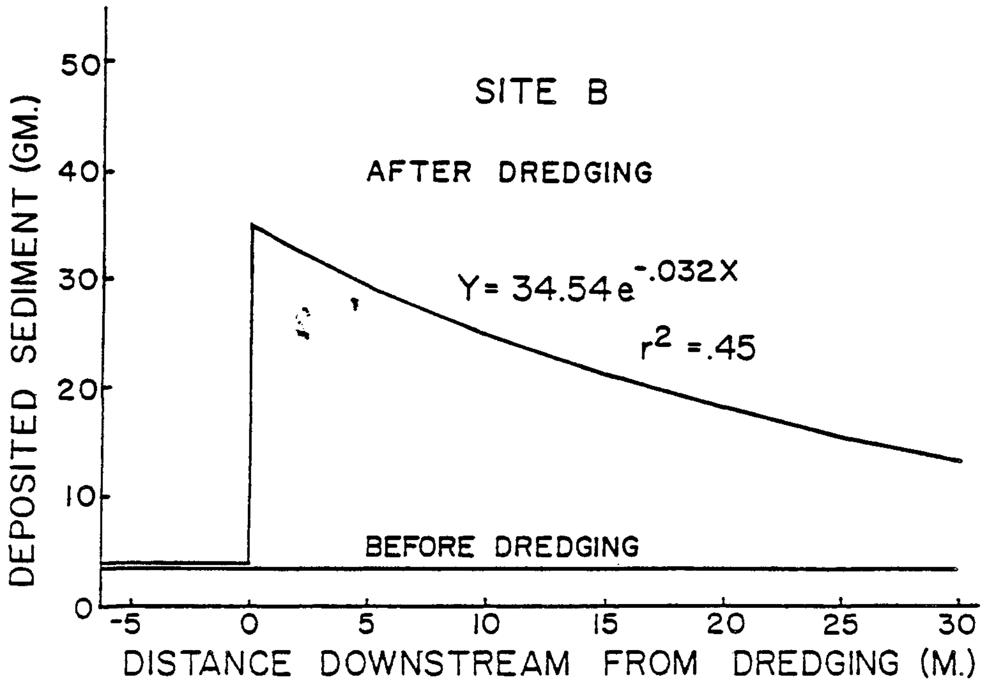


FIGURE 12. Deposited sediment before and after dredging at Site B.

not possible to leave the traps in place for just 24 hours at a time to get a daily rate of sediment deposition. Instead the values measured represent four days sediment deposition.

TURBIDITY

Turbidity samples taken upstream of dredging showed a background turbidity of 1.2 - 1.5 NTU. Turbidity measured 25 ft downstream of the operating dredge showed a mean of 2.4 - 3.9 NTU. Under Montana law it is illegal to cause an increase in turbidity of more than 5 NTU 500 ft downstream from an effluent source. A sample taken at the dredge outflow measured 32 NTU. However, turbidity was highly variable depending on where the samples are taken and the type of substrate being dredged at the time of sampling. If the dredge is working in the middle of the stream a sample taken near the stream banks will not show increased turbidity. Dredging sandy, muddy bottoms increases turbidity a great deal more than dredging gravel. Although the mean turbidity downstream of the dredge was only slightly elevated, the samples ranged from 1.2 NTU (no increase above ambient levels) to 7.7 NTU (a noticable increase above ambient levels). It is apparent that turbidity decreases rapidly downstream of a suction dredge and probably returns to ambient levels across the stream within 100 ft.(30.3 m.). This is despite the effort made to take samples when the dredge outflow was at its dirtiest.

CHANNEL MORPHOLOGY

The results of the channel morphology mapping were very unsatisfactory. A much higher density of transects needed to be mapped. In addition, there was too much error in the transects taken to show the changes that took place.

The dredging technique used by the operator will have a large effect on the types of changes that will occur in channel morphology. A miner who dredges one deep hole will have more impact on channel morphology than a miner who dredges a greater area to a shallow depth. Since most of the gold will be found at or near bedrock, most miners will find it necessary to dig a deep hole with their dredge.

Gravel is deposited in piles immediately downstream of the dredge outflow (Figure 13). These piles could make excellent spawning sites except that they are very unstable. One year after dredging, all the gravel deposited at the dredged area had been moved downstream. In one case, the gravel was moved into a downstream pool, completely filling it up. Bjornn, et.al.(1977) found that when fines were added to pools in a test stream, the abundance of fish decreased proportionally to he decrease in pool volume or area. It is unknown whether or not the pool habitat created upstream by dredging deep holes would compensate for the loss of pool habitat downstream.

Any rock too large to fit through the dredge intake has to be removed from the miner's path. At study site A I moved

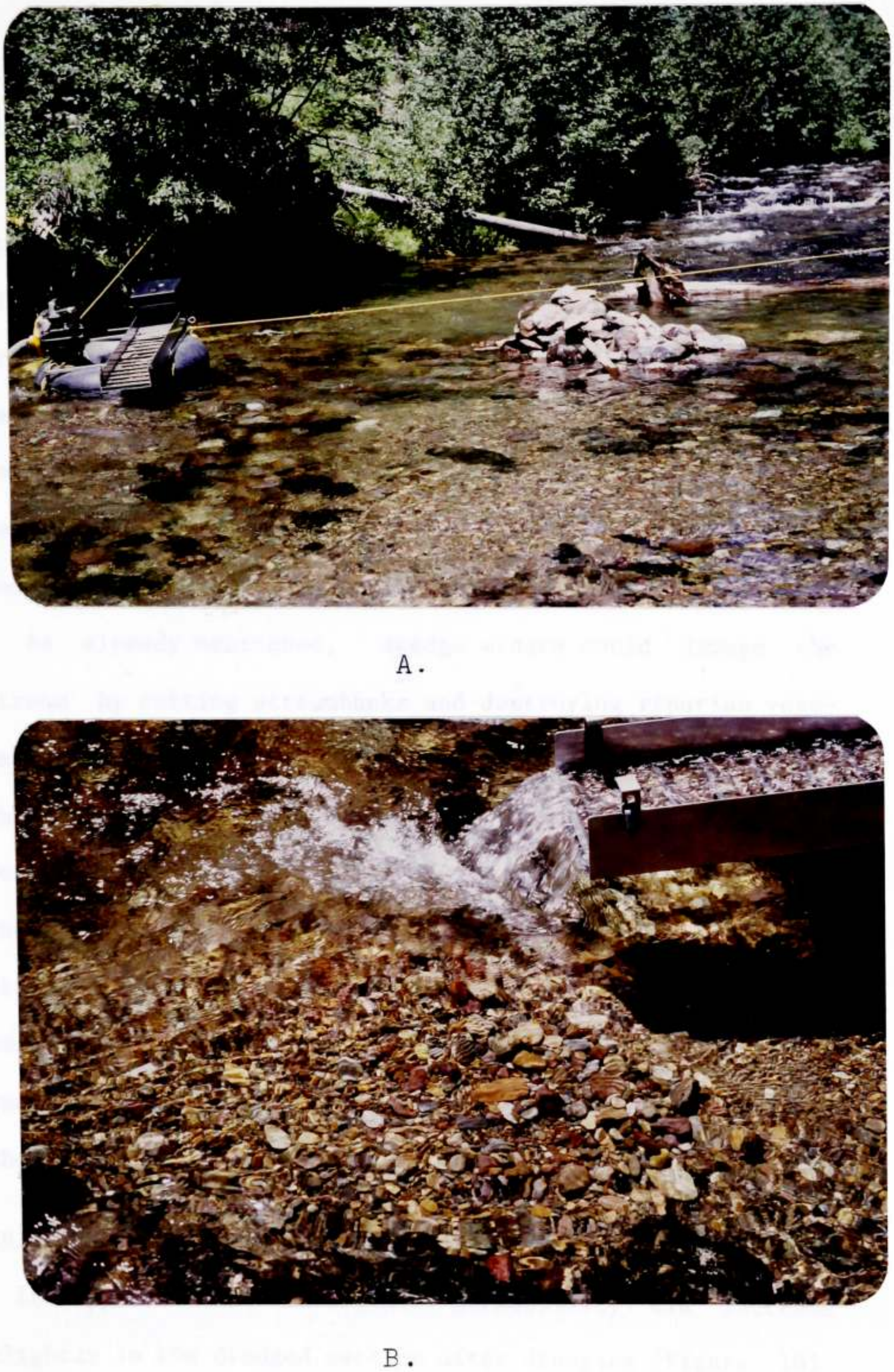


FIGURE 13. A. Gold Ck. during dredge operation. Tailings piles visible just below the dredge and just downstream of the large boulder pile. B. Close up of dredge tailings.

all the boulders into several piles in the middle of the stream. At site B, I moved the boulders to the edge of the stream (Figure 14). From the pictures it is obvious that piling the boulders in the middle of the stream makes a greater impact. Indeed, when I returned to the study site a year after dredging it was difficult to see that dredging had been done at site B. However, at site A the boulder pile remained in the stream, although somewhat reduced in size, despite high spring flows (Figure 15).

As already mentioned, dredge miners could damage the stream by cutting streambanks and destroying riparian vegetation. This is illegal in Montana. I chose not to damage the streambanks in Gold Ck. for this study. It is possible for a suction dredge to make highly localized changes in channel morphology. Pool and riffle configuration can be altered. The degree of damage is largely determined by the amount of material discharged into the stream. Very large quantities of material could fill pools and change a single channel stream into a braided stream.

GRAVEL PERMEABILITY

It appears that intergravel permeability did increase slightly in the dredged section after dredging (Figure 16). However, this difference was not significant ($P > .05$). There does not appear to be any changes in downstream permeability due to silt deposition from suction dredge mining. In addition, no detectable change occured in intergravel

A.

B.

FIGURE 14. A. Site A after dredging. Notice 2 large boulder piles in the stream created by the author during dredging. B. Site B after dredging. Large rocks were piled on the side of the stream (out of view of the picture).

FIGURE 15. Site A one year after dredging. High spring flows reduced the size of the boulder piles but did not remove them.

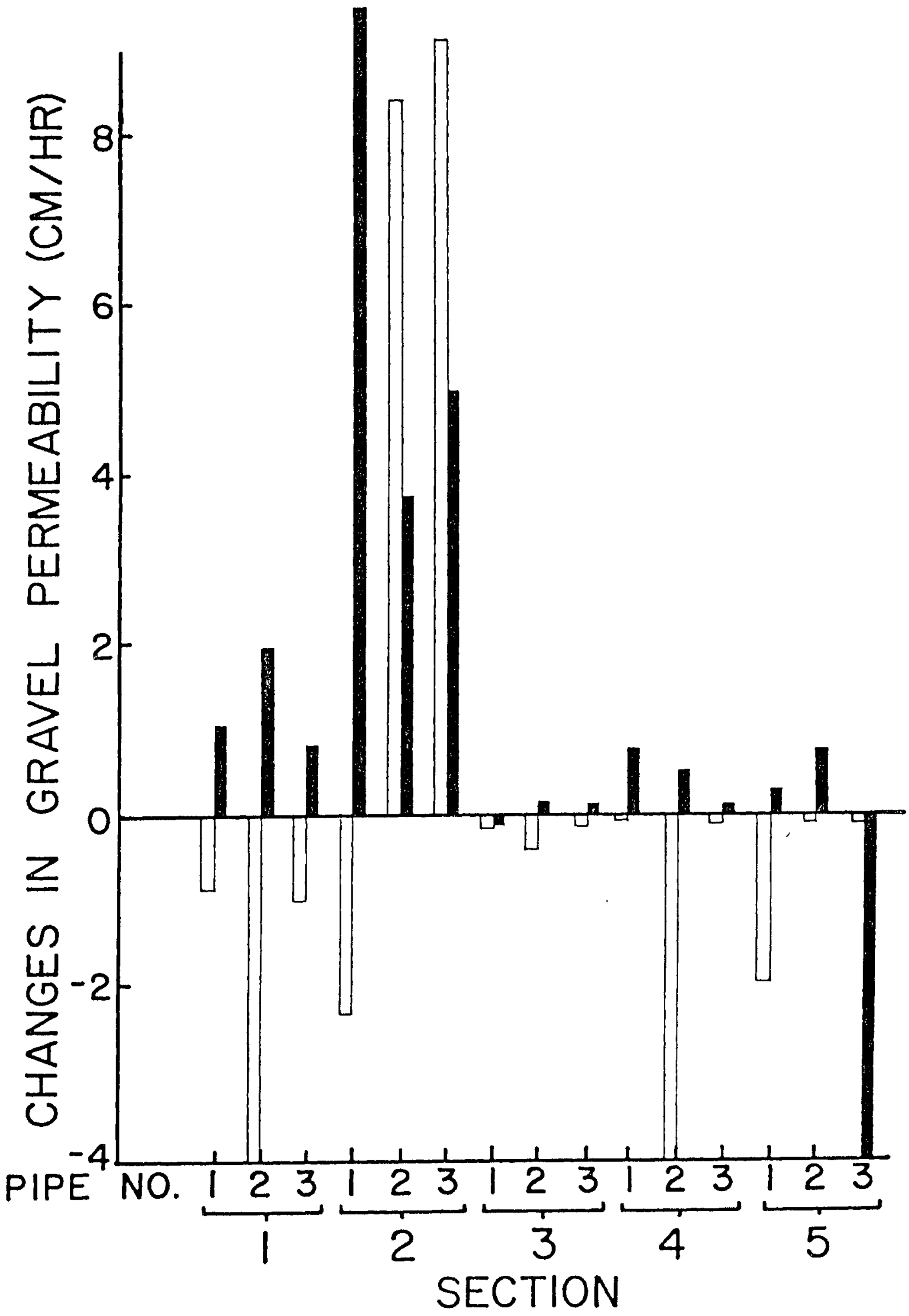


FIGURE 16. Change in gravel permeability (after dredging - before dredging). Solid bars are from site B, open bars are from site A.

water dissolved oxygen. However, the dissolved oxygen meter used was not reliable and it was difficult to obtain a sufficient number of readings using Winkler titrations. It is possible that changes did occur that were not detectable because not enough samples were taken and tested with reliable Winkler titrations. In contrast, Lewis (1962) found an average site improvement of 1 ppm in dissolved oxygen and a threefold improvement in permeability after dredging. However, the stream where he worked was heavily silted and compacted before dredging.

The data indicate that silt depostion from suction dredge mining should not be detrimental to developing salmonid eggs. However, it is possible that harm could be caused if the dredge were larger, the stream smaller, or the substrate more silty. In a stream where intergravel flow and dissolved oxygen were marginal to begin with, a small decrease in permeability could cause a decrease in salmonid growth rate.

DISCUSSION

Griffith and Andrews (1981) found that aquatic invertebrates entrained through a suction dredge have a one percent mortality rate within 24 hours of entrainment. Lewis (1962) found 7.4% benthos mortality after passing through a suction dredge, but thought that figure to be high. In addition, Griffith and Andrews (1981) observed very few insects to have noticable external damage as a result of entrainment and that most of the insects settled to the bottom within 10-20 m. of dredging. However, my study did not find increased densities of insects downstream of dredging. It is possible that the entrained insects are unable to find suitable unoccupied habitat in the immediate downstream area. In addition, insects set adrift in the daytime might be expected to suffer high predation rates. In fact, during dredging, cutthroat trout (*Salmo clarki*) were observed swimming in the area of the dredge outflow, feeding on dislodged invertebrates. Lewis (1962) observed a similar phenomenon, with up to 12 squawfish *(Ptychocheilus sp.)* feeding on insects on the outflow tail.

Although the sediment sampling demonstrated that the bulk of the fines are redeposited within 20 m. of dredging, no immediate downstream decrease in aquatic insect density could be detected. One month after dredging there was no significant difference between the control section and the downstream section except for the caddisflies at site B. McClelland and Brusven (1980) tested several species of

Ephemeroptera, Plecoptera, and Trichoptera to determine their response to introduced sediments. They found the Plecoptera to be the most sensitive, followed by the Trichoptera, with the Ephemeroptera being least sensitive. The lack of response of these orders to sediment introduction in Gold Creek may indicate that the quantity of sediment produced by dredging was not enough to create an impact or that the insect species in Gold Creek (which are not the same ones McClelland and Brusven tested) are more sediment tolerant.

The sides and undersides of cobble size rocks (10 - 15 cm in diameter) are often important habitat for aquatic insects. Unimpacted cobble permits maximum inhabitation around cobbles, particularly to insects that cannot burrow, have exoskeletal armature or body size inhibiting interstitial burrowing, or have the habit of living under or on the surface of cobbles (Brusven and Prather, 1974). The critical factor determining to what degree sediment impacts the stream benthos may be the degree of sealing of undersides of cobbles. As the quantity of sediment increases more of the critical under cobble microhabitat becomes unavailable, thus reducing the percentage of cobbles harboring insects (McClelland and Brusven, 1980).

There are qualitative changes in the stream bottom habitat on the area dredged. As mentioned earlier, the distribution of benthic insects is highly dependent on substrate particle size (Cummins and Lauf, 1969). Dredging removes all the bottom material smaller than the intake nozzle diameter. This should result in changes in species compostion in the area dredged. Dredging also changes water depth. Although the mean depth of the area may or may not have been changed, the variablity of depth was increased by the creation of deep pools and shallow bars where the area was previously a uniform riffle. These changes would also probably lead to a different aquatic insect community. In addition, Hart (1978) found the number of aquatic insect species per area was higher on small rocks (average surface area 95 cm^2) than large rocks (average surface area 602 cm^2). Therefore dredging may decrease the number of species in the area.

However, with a 2.5" (6.4 cm) dredge, cobble size rocks remain in the stream, completely cleaned of any sediment seal. This would have a beneficial effect on the stream benthos. A dredge with a 6 inch nozzle would be capable of removing cobbles from the area dredged. The resulting substrate would either be bedrock or large rocks. This type of bottom would not be quite so favorable.

At study site B where large boulders were piled in the stream, islands were created that would not support any aquatic life. However, dredging does remove the fines from the area which might partially compensate for the negative impacts listed above.

The purpose of this study was to assess the impact of one small dredge operated for a relatively short period of time. The effects seem to be small, very localized habitat modifications which had a minimal effect on the stream community. However, small modifications occuring over time and/or in a number of places within a watershed can often reach levels resulting in major biological and ecological change. For example, the effects of sediment should always be considered in the context of the whole drainage network. Fine sediment exported from high drainage headwater channels deposits downstream where the gradient is lower. Imputs from a large number of disturbed tributaries might overload downstream reaches with sediment and reduce water quality and aquatic productivity (Murphy, et.al.,1981). We are beginning to find out how much sediment deposition streams can handle before serious damage begins to occur (see Bjornn, et.al., 1977 and Brusven and Prather, 1974). We do not know how much suction dredging will produce that quantity of sediment. We do not know at what point dredging begins to have other, non-sediment related impacts. Further research should be directed at defining the threshold of environmental degradation.

LAWS AND REGULATIONS GOVERNING SUCTION DREDGE MINING IN THE STATE OF MONTANA

Under current Federal and Montana state law, a person proposing to dredge for gold needs six different permits, depending on the location of their site. A stream discharge permit is required for gold dredge operations under the Montana Water Quality Act administered by the Montana Department of Health and Environmental Sciences, Water Quality Bureau. A general permit is issued to dredges less than 4 inches in size. The Department of Fish, Wildlife, and Parks makes recommendaions on a season for dredging for these permits. Larger dredge operations are considered individually. The requirements for this permit are the most rigorous. The permit must be applied for 180 days in advance of the proposed operation. The effluent limitation allows for an increase in instream turbidity of 5 NTU. Under the self monitoring requirements instream turbidity must be measured ten feet upstream of the operation and not more than 500 feet below the point of discharge. Turbidity must be measured by grab sample at least once upon start up each year and at least once every fifteen days of actual operation. Samples must be analyzed in the best manner technologically feasible. Results must be reported to the Environmental Protection Agency and the Montana Department of Health and Environmental Sciences every month. There are a number of other regulations that apply to this permit (Appendix A).

Before a person can divert or impound water for a new use or change an established use, they must receive a permit from the Montana Department of Natural Resources and Conservation, Water Rights Bureau. This includes water used for the purposes of suction dredge mining. The granting of the appropriation is contingent upon there being no objections from downstream water users.

The Montana Department of State Lands administers the Metal Mine Reclamation Act which requires licensing of persons engaged in exploration and permits for development of mining properties. An application, bond, and fee are required. Small miner exemptions are granted for persons mining less than 36,500 tons per year and disturbing less than five acres.

Under the state of Montana Natural Streambed and Land Preservaton Act, a miner proposing to work within the high water marks of a perennially flowing stream, must obtain permission from the local Conservation District or the Board of County Commissioners. A "Notice of Proposed Project", with detailed plans, must be submitted. All these permits are first reviewed by the Department of Fish, Wildlife, and Parks. The Department of Fish, Wildlife, and Parks has developed a set of guidelines for reviewing suction dredge permit applications. They are included in Appendix B.

In addition, under the General Mining Law (Mining Law of 1872), a miner working on federally owned lands must obtain a mining claim. Previously unclaimed federal land that has not been withdrawn from mineral entry can be claimed. Mining claims may be recorded by filing an exact copy of the location notice in the County Recorder's Office where the claim is located. Claims on public lands must be recorded with the Bureau of Land Management state office having jurisdiction over the area in which the claim is located. Mining claims are only valid after a valuable mineral deposit has been located.

The Federal Water Pollution Act requires a Department of the Army permit, issued by the Corps of Engineers for the discharge of dredged or fill materials into the waters of the United States or on adjacent wetlands. Some minor activities are allowed by nationwide or general permits.

The Montana Department of Health and Environmental Sciences issues suction dredge licenses. The miners must demonstrate that they are aware of applicable state and federal laws and that they are aware of the rights of existing mining claimants and private landowners.

There are a number of other federal, state, and local laws that may apply to a suction dredge miner depending on the exact location, size of dredge, and type of project to be undertaken.

Although I do not have any data, I strongly suspect that a number of people are operating suction dredges in Montana without the required permits. Many dredge operators may be unaware of the regulations. Others may know the law but feel it is too much trouble to comply. They probably realize the chances of the being caught operating a dredge without a permit is slim. For example, most of the miners who do acquire a stream discharge permit do not file the required selfmonitoring statements. They simply claim they did not operate within the last year. Since it is impossible for the state to check on every dredge miner, there is no choice but to hope that is true. Cooperation of miners is essential to effective protection of the state's waters. There are two ways cooperation could be improved. A public education campaign is needed to inform people of the damage a suction dredge can do and to make them aware of the regulations. In addition, the permitting process could be streamlined.

The state of Washington has published a booklet "Gold and Fish" (Appendix C) which describes the impacts suction dredging can have on streams. It also reviews the permits suction gold dredge operators need and describes the lands and streams where dredging is not allowed. In addition, Washington has classified most of the major streams according to the type of mining activity allowed, the time of year mining is allowed, and the maximum dredge size allowed. The list of classified streams is included in "Gold and Fish". Apparently, the Gold Miners Association of America donated the money for the printing of the pamphlet. In 1981 the state of Montana published a short pamphlet reviewing the laws that apply to dredge operation. The addition of a section describing the impacts suction dredge mining has on the stream environment would be very useful. Many miners may feel that the regulations are needless harassment. If they understood the reasons for the regulations they might be more cooperative. It would also be useful to suggest mining techniques that would minimize dredge impacts.

The permitting process could be streamlined by classifying the major Montana waterways in the same way Washington has. A clear stream by stream policy on dredging would reduce decision making time for the state agencies. Additionally, miners will know at a glance if the area they want to work is open for dredging. The self monitoring requirements of the stream discharge permit are well intentioned but not very effective. It is not known how many miners even try to comply. For those who do take the required samples, the regulations do not state the exact location where the downstream samples must be taken. It would be very easy to take the required samples to the side of the main sediment plume and not show any increase in turbidity. Finally,turbidity meters are not generally available to the general public. The best solution is to have state employees monitor dredge operations. Of course this is a very expensive, and probably not feasible, proposal. Probably the most important goal of the state is to get full compliance with the law. Public education is necessary to acheive that goal.

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APPENDIX A

WATER QUALITY

Sub-Chapter 4

Public Water and Sewer Plans, Cross Connections, and Drilling Water Wells

Sub-Chapter 5 reserved

Sub-Chapter 6

Surface Water Quality Standards

APPENDIX A

WATER QUALITY

Sub-Chapters 7 and 8 reserved

Sub-Chapter 9

Montana Pollutant Discharge Elimination System (MPDES) Permit

Rule 16.20.901 Purpose

16.20.902 Definitions

Rule 16.20.903 reserved

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(6) "Geometric mean" means the value obtained by taking the Nth root of the product of the measured values where zero values for measured values are taken to be the detection limit.

(7) "Intermittent stream" means a stream or reach of a stream that is below the local water table for at least some part of the year, and obtains its flow from both surface runoff and ground water discharge.

(8) "Mixing zone" means the area of a water body contiguous to an effluent with characteristics qualitatively or quantitatively different from those of the receiving water. The mixing zone is a place where effluent and receiving water mix and not a place where effluents are treated. Water quality standards do not apply in the mixing zone for those parameters regulated by a MPDES or NPDES permit.

(9) "MPDES" means the Montana Pollutant Discharge Elimination System.

(10) "NPDES" means the National Pollutant Discharge Elimination System.

(11) "Naturally occurring" means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied. Conditions resulting from the reasonable operation of dams in existence as of July 1, 1971 are natural.

(12) "Nonpoint source" means the source of pollutants which originates from diffuse runoff, seepage, drainage, or infiltration.

(13) "Pesticide" means insecticides, herbicides, rodenticides, fungicides or any substance or mixture of substances intended for preventing, destroying, controlling, repelling, altering life processes, or mitigating any insects, rodents, nematodes, fungi, weeds and other forms of plant or animal life.

(14) "Pollutants" means sewage, industrial wastes and other wastes as defined in sections 75-5-103(1)(2)(3), MCA.

(15) "Sediment" means solid material settled from suspension in a liquid; mineral or organic solid material that is being transported or has been moved from its site of origin by air, water or ice and has come to rest on the earth's surface, either above or below sea level; or inorganic or organic particles originating from weathering, chemical precipitation or biological activity.

(16) "Settleable solids" means inorganic or organic particles that are being transported or have been transported by water from the site or sites of origin and are settled or are capable of being settled from suspension.

(17) "Sewer" means a pipe or conduit that carries wastewater or drainage water.

(i) Fred Burr Lake and headwaters from source to the outlet of the lake (Philipsburg water supply) . . . . A-Closed

(j) South Boulder Creek drainage to the Philipsburg water supply intake A-1

(k) Rattlesnake drainage to the Missoula water supply intake . . . . A-Closed

(l) Packer and Silver Creek drainage (tributaries to the St. Regis River) to the Saltese water supply intake A-1

(m) Ashley Creek drainage to the Thompson Falls water supply intake . . . . A-Closed

(n) Pilgrim Creek drainage to the Noxon water supply intake A-1

(History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2232, Eff. 8/1/80.)

16.20.605 WATER-USE CLASSIFICATIONS -- FLATHEAD RIVER DRAINAGE The water-use classifications adopted for the Flathead River are as follows:

(1) Flathead River drainage above Flathead Lake except waters listed in subsections (1)(a) through (1)(g) B-1

(a) Essex Creek drainage to the Essex water supply intake . . . . A-Closed

(b) Stillwater River (mainstem) from Logan Creek to the Flathead River B-2

(c) Whitefish Lake and its tributaries A-1

(d) Whitefish River (mainstem) from the outlet of Whitefish Lake to the Stillwater River . . B-2

(e) Haskill Creek drainage to the Whitefish water supply intake A-1

(f) Ashley Creek (mainstem) from Smith Lake to bridge crossing on the airport road about one mile south of Kalispell B-2

(g) Ashley Creek (mainstem) from bridge crossing on airport road to the Flathead River . . . C-2

(2) Flathead Lake and its tributaries from Flathead River inlet to U.S. Highway 93 bridge at Polson except Swan River and portions of Hellroaring Creek as listed in subsections (2)(a) through (2)(c) but including Swan Lake proper and Lake Mary Ronan proper A-1

(a) Swan River drainage (except Swan Lake proper) B-1

(b) Hellroaring Creek drainage to the Polson water supply intake . . . . A-Closed

(c) Remainder of Hellroaring Creek drainage . . B-1

(1) Missouri River drainage to and including the Sun River drainage except tributaries listed in subsections (1)(a) through (1)(n) B-1

(a) East Gallatin River (mainstem) from Montana Highway No. 293 crossing about one-half mile north of Bozeman to Dry Creek about five miles east of Manhattan B-2

(b) Lyman and Sourdough (Bozeman) Creek drainages to the Bozeman water supply intakes . . . . A-Closed

(c) Remainder of the Lyman and Sourdough Creek drainages B-2

(d) Hyalite Creek drainage to the Bozeman water supply intake A-1

(e) Big Hole River drainage to Butte Water Company intake above Divide A-1

(f) Rattlesnake Creek drainage to the Dillon water supply intake A-1

(g) Indian Creek drainage to the Sheridan water supply intake A-1

(h) Basin Creek drainage to the Basin water supply intake A-1

(i) McClellan Creek drainage to the East Helena water supply intake A-1

(j) Prickly Pear Creek (mainstem) from the Montana Highway No. 433 crossing about one mile northwest of East Helena to Lake Helena . . . . E

(k) Ten Mile Creek drainage to the Helena water supply intake A-1

(l) Willow Creek drainage to the White Sulphur Springs water supply intake . . . . A-Closed

(m) Muddy Creek drainage (tributary to Sun River) . . . . E

(n) Sun River (mainstem) from Muddy Creek to the Missouri River B-3

(2) Missouri River drainage from Sun River to Rainbow Dam B-2

(3) Missouri River drainage from Rainbow Dam in Great Falls to the Marias River except waters listed in subsections (3)(a) through (3)(d). . B-3

(a) Belt Creek drainage to and including Otter Creek drainage except portion of O'Brien Creek listed in subsection (3)(a)(i) B-1

(i) O'Brien Creek drainage to the Neihart water supply intake A-1

(b) Belt Creek (mainstem) from Otter Creek to the Missouri River B-2

(c) Tributaries to Belt Creek from Otter Creek to the Missouri River B-1

(d) Highwood and Shonkin Creek drainages . . . B-1

(ii) Musselshell River drainage below Deadman's Basin diversion canal above Shawmut except portions of Careless, Swimming Woman, Flatwillow and South Willow Creek drainages listed below C-3

(iii) Careless and Swimming Woman Creek drainage above their confluence north of Ryegate . . B-1

(iv) Flatwillow Creek drainage above U.S. Highway 87 crossing south of Grassrange B-2

(v) South Willow Creek drainage above county road bridge in T10N, R24E, Section 7 . . . . . B-1

(6) Missouri River drainage from Fort Peck Dam to the Milk River B-2

(7) Milk River drainage from source (or from the Glacier National Park Boundary) to the International Boundary B-1

(8) Milk River drainage from the International Boundary to the Missouri River except the tributaries listed in subsections (8)(a) through (8)(c) B-3

(a) Big Sandy Creek drainage to Town of Big Sandy infiltration wells B-1

(b) Beaver, Little Box Elder and Clear Creek drainage (near Havre) B-1

(c) People's Creek drainage to and including the South Fork of People's Creek drainage . . B-1

(9) Missouri River drainage from Milk River to North Dakota boundary except waters listed in subsections (9)(a) through (9)(d) C-3

(a) Missouri River (mainstem) from Milk River to North Dakota boundary B-3

(b) Wolf Creek drainage near Wolf Point B-2

(c) Antelope Creek drainage near Antelope . . . B-3

(d) Poplar River drainage B-2

(History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80.)

16.20.608 WATER-USE CLASSIFICATION -- YELLOWSTONE RIVER DRAINAGE The water-use classifications adopted for the Yellowstone River are as follows:

(1) Yellowstone River drainage to the Laurel water supply intake B-1

(2) Yellowstone River drainage from the Laurel water supply intake to the Billings water supply intake except the tributaries listed in subsections (2)(a) and (2)(b) B-2

(a) Clarks Fork Yellowstone River drainage from source to the Wyoming state line and from

16.20.610 WATER-USE CLASSIFICATIONS -- HUDSON BAY DRAINAGE The water-use classifications for the Hudson Bay drainage are:

(1) All waters outside Glacier National Park B-1

(History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80.)

16.20.611 WATER-USE CLASSIFICATIONS -- NATIONAL PARK, WILDERNESS AND PRIMITIVE AREA WATERS The water-use classifications for all national park, wilderness and primitive area waters are as follows:

(1) All waters even if classifications listed in ARM 16.20.604 through ARM 16.20.610 imply or state otherwise A-1

(History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80.)

Rules 16.20.612 through 16.20.614 reserved

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16.20.617 A-1 CLASSIFICATION (1) Waters classified A-1 are suitable for drinking, culinary and food processing purposes after conventional treatment for removal of naturally present impurities.

(2) Water quality must be suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(3) For waters classified A-1 the following specific water quality standards shall not be violated by any person:

(a) The geometric mean number of organisms in the coliform group must not exceed 50 per 100 milliliters if resulting from domestic sewage.

(b) Dissolved oxygen concentration must not be reduced below 7.0 milligrams per liter.

(c) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 must be less than 0.5 pH unit. Natural pH outside this range must be maintained without change. Natural pH above 7.0 must be maintained above 7.0.

(d) No increase above naturally occurring turbidity is allowed except as permitted in ARM 16.20.631 through 16.20.635 and ARM 16.20.641 and 16.20.642.

(e) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(f) No increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

(g) True color must not be increased more than two units above naturally occurring color.

(h) Concentrations of toxic or other deleterious substances which would remain in the water after conventional water treatment must not exceed the maximum contaminant levels set forth in the 1975 National Interim Primary Drinking Water Standards (40 CFR Part 141) or subsequent revisions or the 1979 National Secondary Drinking Water Standards (40 CFR Part 143) or subsequent revisions. The maximum allowable concentrations of toxic or deleterious substances also must not range of 32° F to 65° F; within the naturally occurring range of 65° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F.

(f) No increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

(g) True color must not be increased more than five units above naturally occurring color.

(h) Concentrations of toxic or other deleterious substances which would remain in the water after conventional water treatment must not exceed the maximum contaminant levels set forth in the 1975 National Interim Primary Drinking Water Standards (40 CFR Part 141) or subsequent revisions or the 1979 National Secondary Drinking Water Standards (40 CFR Part 143) or subsequent revisions. The maximum allowable concentrations of toxic or deleterious substances also must not exceed acute or chronic problem levels as revealed by bio-assay or other methods. The values listed in Quality Criteria for Water published by the Office of Water and Hazardous Materials, EPA, Washington, D.C. (The Red Book) shall be used as a guide to determine problem levels unless local conditions make these values inappropriate. In accordance with section 75-5-306(1), MCA, it is not necessary that wastes be treated to a purer condition than the natural condition of the receiving water. (History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80.)

16.20.619 B-2 CLASSIFICATION (1) Waters classified B-2 are suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(2) For waters classified B-2 the following specific water quality standards shall not be violated by any person:

(a) The geometric mean number of organisms in the fecal coliform group must not exceed 200 per 100 milliliters, nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters.

(b) Dissolved oxygen concentration must not be reduced below 7.0 milligrams per liter from October 1 through June 1 nor below 6.0 milligrams per liter from June 2 through September 30.

16.20.620 B-3 CLASSIFICATION (1) Waters classified B-3 are suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(2) For waters classified B-3 the following specific water quality standards shall not be violated by any person:

(a) The geometric mean number of organisms in the fecal coliform group must not exceed 200 per 100 milliliters, nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters.

(b) Dissolved oxygen concentration must not be reduced below 5.0 milligrams per liter.

(c) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 9.0 must be less than 0.5 pH unit. Natural pH outside this range must be maintained without change. Natural pH above 7.0 must be maintained above 7.0.

(d) The maximum allowable increase above naturally occurring turbidity is 10 nephelometric turbidity units except as permitted in ARM 16.20.631 through 16.20.635 and ARM 16.20.641 and 16.20.642.

(e) A 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 77° F; within the naturally occurring range of 77° F to 79.5° F, no thermal discharge is allowed which will cause the water temperature to exceed 80° F; and where the naturally occurring water temperature is 79.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(i) These allowable increases apply to all waters in the state classified B-3, except for the mainstem of the Yellowstone River from the Billings water supply intake to the water diversion at Intake, where a 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 79° F; within the range of 79° F to 81.5° F, no thermal discharge is allowed which will cause the water temperature to exceed 82° F; and where the naturally occurring water temperature is 81.5° F or greater, the maximum allowable increase in water temperature is 0.5° F.

(ii) From the water diversion at Intake to the North Dakota state line, a 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 82° F; within the range of 82° F to 84.5° F, no thermal discharge is allowed which will cause the water temperature to exceed 85° F; and where the naturally occurring except as permitted in ARM 16.20.631 through 16.20.635 and ARM 16.20.641 and 16.20.642.

(e) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(f) No increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

(g) True color must not be increased more than five units above naturally occurring color.

(h) Concentrations of toxic or deleterious substances must not exceed levels which render the waters harmful, detrimental or injurious to public health. The maximum allowable concentrations of toxic or deleterious substances also must not exceed acute or chronic problem levels as revealed by bioassay or other methods. The values listed in Quality Criteria for Water published by the Office of Water and Hazardous Materials, EPA, Washington, D.C. (The Red Book) shall be used as a guide to determine problem levels unless local conditions make these values inappropriate. In accordance with section 75-5-306(1), MCA, it is not necessary that wastes be treated to a purer condition than the natural condition of the receiving water.

(i) In the segment of the Clark Fork River classified C-1, the parameter limits set forth below apply rather than the limits listed for these parameters in the Red Book:

Parameter	Maximum Instantaneous Concentration ug/l
Total copper	90
Total zinc	300
Total iron	1300
Total lead	100
Total cadmium	10
Total arsenic	50
Total mercury	1

(History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 3/1/80.)

shall be used as a guide to determine problem levels unless local conditions make these values inappropriate. In accordance with section 75-5-306(1), MCA, it is not necessary that wastes be treated to a purer condition than the natural condition of the receiving water.

(i) In the segment of the Clark Fork River classified C-2, the parameter limits set forth below apply rather than the limits listed for these parameters in the Red Book:

Parameter	Maximum Instantaneous Concentration ug/l
Total copper	90
Total zinc	300
Total iron	2200
Total lead	100
Total cadmium	10
Total arsenic	50
Total mercury	1

(History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80.)

16.20.623 E CLASSIFICATION (1) Waters classified E are suitable for agricultural and industrial water uses other than food processing.

(2) For waters classified E the following specific water quality standards shall not be violated by any person:

(a) The geometric mean number of organisms in the fecal coliform group must not exceed 200 per 100 milliliters, nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters.

(b) Dissolved oxygen concentration must not be reduced below 3.0 milligrams per liter.

(c) Hydrogen ion concentration must be maintained within the range of 6.5 to 9.5.

(d) No increase in naturally occurring turbidity is allowed which will or is likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

(e) No increase in naturally occurring temperature is allowed which will or is likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

(f) No increases above naturally occurring concentrations of sediment and settleable solids, oils, or floating solids are allowed which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public

(f) No increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

(g) True color must not be increased more than five units above naturally occurring color.

(h) Concentrations of toxic or other deleterious substances must not exceed levels which render the waters harmful, detrimental or injurious to public health. The maximum allowable concentrations of toxic or deleterious substances also must not exceed acute or chronic problem levels as revealed by bio-assay or other methods. The values listed in Quality Criteria for Water published by the Office of Water and Hazardous Materials, EPA, Washington, D.C. (The Red Book) shall be used as a guide to determine problem levels unless local conditions make these values inappropriate. In accordance with section 75-5-306(1), MCA, it is not necessary that wastes be treated to a purer condition than the natural condition of the receiving water. (History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80.)

Rules 16.20.625 through 16.20.630 reserved

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manner to minimize harmful effects. New water impoundments must be designed to provide temperature variations in discharging water that maintain or enhance the existing propagating fishery and associated aquatic life. As a guide, the following temperature variations are recommended: Continuously less than 40° F during the months of January and February, and continuously greater than 44° F during the months of June through September. (History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80.)

16.20.633 PROHIBITIONS (1) State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will:

(a) Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines;

(b) Create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials;

(c) Produce odors, colors or other conditions as to which create a nuisance or render undesirable tastes to fish flesh or make fish inedible;

(d) Create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; and

(e) Create conditions which produce undesirable aquatic life.

(2) No wastes may be discharged and no activities conducted such that the wastes or activities, either alone or in combination with other wastes or activities, will violate, or can reasonably be expected to violate, any of the standards.

(3) No wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will cause violations of surface water quality standards; provided, a short term exemption from a surface water quality standard may be authorized by the department under the following conditions:

(a) If the Department of Fish, Wildlife and Parks reviews a short-term construction or hydraulic project under section 76-5-501 et seq., MCA, or section 75-7-101 et seq., MCA, an increase in turbidity caused by the project will be exempt from the applicable turbidity standard unless the department is advised by the Department of Fish, Wildlife and Parks that the project may result in a significant increase in turbidity. If the department is advised that the project may cause a significant increase in turbidity, the

(6) Until such time as minimum stream flows are established for dewatered streams, the minimum treatment requirements for discharges to dewatered receiving streams must be no less than the minimum treatment requirements set forth in ARM 16.20.631(2) and (3).

(7) Treatment requirements for discharges to ephemeral streams must be no less than the minimum treatment requirements set forth in ARM 16.20.631(2) and (3). Ephemeral streams are subject to ARM 16.20.631 through 16.20.635 and ARM 16.20.641 and 16.20.642 but not to the specific water quality standards of ARM 16.20.615 through 16.20.624.

(8) Pollution resulting from storm drainage, storm sewer discharges, and non-point sources, including irrigation practices, road building, construction, logging practices, overgrazing and other practices must be eliminated or minimized as ordered by the department.

(9) Application of pesticides in or adjacent to state surface waters must be in compliance with the labeled direction, and in accordance with provisions of the Montana Pesticides Act (Title 80, Chapter 8, MCA) and the Federal Environmental Pesticides Control Act (7 U.S.C. 136 et seq. (Supp. 1973) as amended). Excess pesticides and pesticide containers must not be disposed of in a manner or in a location where they are likely to pollute surface waters.

(10) No pollutants may be discharged and no activities may be conducted which, either alone or in combination with other wastes or activities, result in the total dissolved gas pressure relative to the water surface exceeding 110 percent of saturation.

(11) On all public water supply watersheds, detailed plans and specifications for the construction and operation of logging roads will be submitted to the department for its approval as required by Title 75, Chapter 6, MCA. (History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80.)

16.20.634 MIXING ZONE Discharges to surface waters may be entitled a mixing zone which will have a minimum impact on surface water quality, as determined by the department. (History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80.)

confined bioassays. All bioassay methods and species selections must be approved by the department. (History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80.)

16.20.643 METAL LIMITS IS REPEALED (History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, [REP], 1980 MAR p. 2252, Eff. 8/1/80.)

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MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS
GUIDELINES FOR REVIEW COMMENTS ON
PERMIT APPLICATIONS FOR INSTREAM MINING

Prepared by:

Ecological Services Division and Fisheries Division

INTRODUCTION

These guidelines have been developed for the use of Department of Fish, Wildlife and Parks personnel in fulfilling the department's examination and recommendation responsibilities on permit applications for instream mining proposals. Department responsibility for examination and recommendations on proposed projects is found in the Natural Streambed and Land Preservation Act of 1975, 75-7-701, MCA et seq., and the Stream Protection Act, 85-5-501, MCA et seq. It is clearly stated in these Acts that the State of Montana's policy is to preserve streams in their natural condition and to keep soil erosion and sedimentation to a minimum after due consideration of relevant factors. Other project review responsibilities include those in Montana Surface Water Quality Standards, at Section 16.20, 633 (3a). This requires department review of projects for potential water quality degradation. In addition, the Fish and Wildlife Coordination Act requires consultation with the department when a stream is modified for any purpose whatsoever by the federal government or by any private or public agency under Federal permit or license. The department also has a general responsibility for the overall welfare of fish and wildlife of the state under provisions of 87-1-201 MCA.

The damage which has occurred to the Montana stream resource from past mining activities is obvious in practically all sections of the state, and in some cases this damage is of recent origin. The intent of these guidelines is to meet department responsibilities with the goal of preventing immediate or secondary adverse hydraulic change and erosion of streambeds or banks, protecting riparian vegetation, and preventing sediment pollution, for the purpose of preserving the integrity of natural stream systems on which the fish and wildlife resource depends.

In consideration of fulfilling our responsibilities, the department does object to in-stream mining unless a.) mining conforms with the guidelines, b.) it is shown by the miner or the permit issuing agency that such mining will not adversely affect the stream resource on either a short- or long-term basis, and c.) that the operation complies with other applicable state and federal laws. In addition, the department will not concur in issuance of instream mining permits within any designated Wild, Scenic or Recreational portions of Montana streams, streams within designated Wilderness areas, or Class I trout (Blue Ribbon) streams.

II. GENERAL IMPACTS TO BE CONSIDERED

A stream is a complicated system of interacting parts, and will respond to manipulations within its watershed. The department is herein concerned with alteration of the immediate riparian area of the stream, or the stream itself. Wildlife, as well as fisheries values, should be considered when making recommendations or decisions on permits. Potential impacts fall into three general categories:

(a) Stream mechanics and morphology
(b) Water quality
(c) Biological populations

In addition, impacts on stream systems are largely dependent on the type or size of equipment utilized for mining, and finally, the amount of material moved within or removed from the system.

II. SPECIFIC AREAS OF CONCERN

The following addresses factors which relate to the stability and quality of the stream where mining is proposed to occur.

STREAM MECHANICS AND MORPHOLOGY

Certain types of stream material are obviously more erodible than others. Consideration should be given to the potential for erosion and sediment production when considering permit applications. Mining activities which affect stream stability include:

Mining for Construction Materials

This type of mining requires the extraction of sands or gravel from the river system. Denial of permits for this activity should be recommended unless it has been demonstrated that the removal will facilitate the natural hydraulic function of the stream and will correct an existing stream habitat problem. Further, the need for an instream source should be demonstrated when terrestrial sources are available. Since commercial need for construction material usually requires large quantities of material, and may require streambed disruption over longer periods of time than mining for personal use, permits for commercial mining of this type in streambeds should not be agreed to. Permits for construction material mining for personal use should include conditions to protect fish and wildlife values.

Gold Panning and Hand Rockers

Hand panning of gold will be acceptable only in those streams in which it has been provided that material to be panned is not taken from streambanks and riparian vegetation is not undercut or destroyed. The use of mechanical washers of any type (other than hand rockers) is not considered to be panning. The maximum amount of material panned per 24-hour period should not exceed 2 cubic yards. Other guidelines should be considered when panning is proposed.

Dredging

Information obtained from the Department of Health and Environmental Sciences indicate the potential capacity of various sized suction dredges.

CAPABILITIES OF SUCTION DREDGES UNDER OPTIMUM CONDITIONS

Suction Hose Diameter (In.)	Water Flow (Gal. per Min.)	Cu. Yds. Moved/hr.
2½"	125 gpm	4 cu. yds.
3"	175 gpm	8 cu. yds.
4"	225 gpm	10 cu. yds.
5"	300 gpm	16 cu. yds.
6"	550 gpm	20 cu. yds.
8"	1100 gpm	30 cu. yds.

The maximum sized suction dredge allowed in streams should be limited to a 3" capacity. It is strongly advised that dredging proposals for streams of less than 20 cfs flow should be given careful review, and affirmative recommendations made only with conditions that protect aquatic habitat. This approach provides for some "recreational" types of operations, but restricts dredges capable of significant material movement from operation in smaller streams. Larger units may be permitted in large rivers.

Previously Mined Areas

Some stream sections have been mined and possibly remined or panned several times. Continued panning of localized sites can create adverse effects on a stream system. Locations of any mining or panning activity should be specifically requested and precisely recorded for future reference. Remining should not be agreed to unless the method is more efficient or no additional damage to the stream will occur.

Instream Mechanical or Sluice Dredging

Department personnel should not concur in any dredging proposal which would take place in such a way that the total streambed or streambanks are destroyed or undercut, either by mining action or by rechanneling of the stream. Such actions are clearly not consistent with state policy to preserve streams in their natural state.

WATER QUALITY

Standards Compliance

In Montana Surface Water Quality Standards, Sec. 16.20.633 (3a) requires this Department's cooperation in determining whether turbidity standards will be violated by stream projects. In addition to this cooperation, no permit should be concurred in unless in the reviewing employee's best judgment all standards will be met and there will be no significant damage to aquatic resources. The effect of water withdrawal for placer or washing purposes should be considered as a water quality problem.

Mixing Zone

Mixing zones for turbidity resulting from mining in streams may be permitted by the State Department of Health and Environmental Sciences. At the terminal point of the mixing zone, water quality must meet the standard for the stream, which will be either 5 or 10 nephelometric turbidity units (NTU's) in salmonid streams, over that which exists upstream of the mining activity.

Section 75-5-303 (Nondegradation Policy) of the Montana Water Quality Act states that "... state waters whose existing quality is higher than the established water quality standards be maintained at that high quality unless it has been affirmatively demonstrated to the board that a change is justifiable as a result of necessary economic or social development and will not preclude present and anticipated use of these waters . . ." As a general rule-of-thumb, stream meanders complete their pattern in a length equal to equal to seven (7) times their width. This pattern will include four (4) crossovers of flow direction and will contain (4) riffles or runs. Since mixing will occur in the riffles or runs, a distance of 1.75 times the stream width where the mining will occur could be allowed for mixing so that the high quality upstream of the activity (not the standard) will be maintained. In no case should the mixing zone exceed 500 feet.

BIOLOGICAL POPULATIONS

Resource Value Classification

The Department of Fish, Wildlife and Parks Fisheries Division has developed a rating system for Montana streams which is based on sport fishery potential, and habitat and species value (including fishes of special concern). Ratings are based on a scale of one (1) through six (6), with lower numbers indicating higher quality (six is unclassified). Do not concur with mining in streams with a resource value rating of one (1) or two (2), with the possible exception of warmwater streams which contain species of special concern that are tolerant of, or depend on, sediment within the stream. In addition, mining proposals in class three (3) streams should not be agreed to if they have been identified in the classification system as important to trout recruitment.

Reproduction and Food Organisms

Any mining activity which will result in interference with or the destruction of any stage of game fish spawning, egg incubation or fry development should be opposed. Times of these stages vary considerably according to species and elevation so will not be listed herein.

Instream mining should not occur during the time preceding or during significant hatches of aquatic insects. These insects are particularly vulnerable to sediment pollution prior to becoming terrestrial.

In summary, review comments or recommendations should be in written form unless specific circumstances require verbal comment. Each of the considerations above should be addressed if that particular factor is appropriate to the proposal. If personnel require additional technical expertise or information relating to stream hydraulics, water pollution control standards or aquatic biology, they should contact their appropriate supervisor or the Ecological Services Division for assistance in acquiring such expertise or information.

APPENDIX C

Gold and Fish

OLYMPIA, WASHINGTON

The gold rush of 1900 has seen thousands of prospectors heading for the hills in search of a strike. Every creek, stream, and river holds promise of a little color; men, women, and children armed with shovels, pans, and dredges now enjoy this pastime.

But every creek, stream, and river is also important to the community of plants and animals of an area. What is done by one person, in an afternoon of searching for gold, can affect fish, wildlife, fishermen, hunters, sightseers, and many others.

The Department of Game and Department of Fisheries are responsible for fish and wildlife in Washington. Recreation that depends upon these resources is also a vital concern of these agencies. This pamphlet has been prepared to help prospectors and miners. The goal is to assure that gold prospecting takes place in harmony with other recreation uses in the same waters.

Unde standing stream habitats is the first step in protecting fish. Using required and recommended methods of panning, sluicing, and dredging; following timing or equipment restrictions; obtaining all necessary permits; these are the things that will insure that today's pleasures do not interiere with tomorrow's fish and wildlife.

This pamphlet has been prepared in cooperation with the following:

Washington Department of Game

Washington Department of Fisheries

Washington Department of Ecology

Washington Department of Natural Resources

U.S. Fish and Wildlife Service

U.S. Forest Service

Citizen's Wildlife Heritage Program

Fish and wildlife agencies
in California, Oregon,
Idaho and British Columbia

Special thanks to the Gold Prospector's Association of America for [illegible] donation to meet printing costs of this pamphlet.

The Stream Environment

The stream environment, or "ecosystem", is composed of living and non-living elements which interact with one another, each influencing the other, and each necessary for maintaining the particular character of the system. It can be characterized as a chain: each "link", whether it be fish, insect, plant, or water, is vital. Disturbance of one part inevitably affects all others, as a chain is no stronger than its weakest link. Very often, we may not be able to immediately see the results of a disturbance; however, the long-term or cumulative impacts can be just as severe.

To understand the stream ecosystem, it is best to examine each of its parts. Figure 1 depicts a simple example.

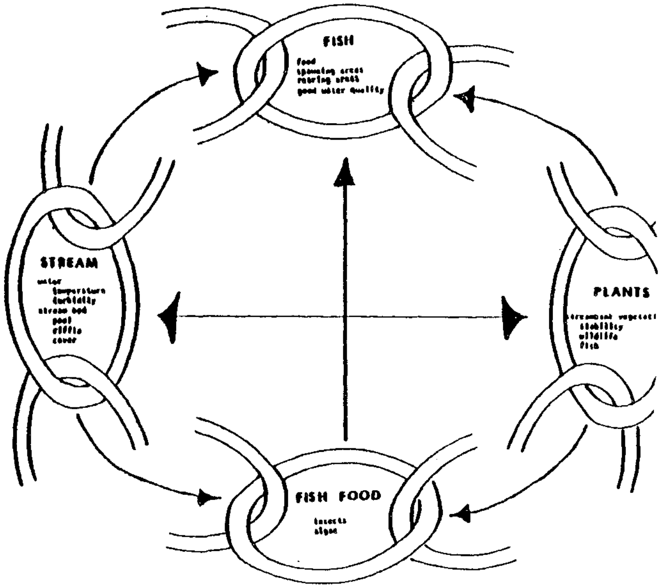

FIGURE 1: Links in the stream ecosystem chain. A disturbance in one can affect all others.

Stream

Water

Temperature and turbidity are probably the two most important water factors affecting the fisheries resource. Cool, relatively constant stream temperatures are ideal. Heat compounds undesirable factors affecting water quality, decreasing the ability of fish to withstand diseases and making them far more sensitive to stress. Their ability to feed, spawn (reproduce), swim or migrate, navigate, escape from predators, and adapt to changes in their surroundings is reduced.

Turbidity – increased particles of dirt and debris suspended in water – can have direct and indirect effects on stream environments. Excessive amounts can:

1. Reduce aquatic and underwater plant numbers and kinds through an abrasive action or through a decrease in the amount of light reaching the bottom of the water.
2. Reduce numbers of bottom-dwelling animals through lowered food supply to aquatic plants, clogging gills and food filters of insects, and physically harming insects.
3. Reduce fish numbers by decreasing food supplies, damaging gills, making it hard to actually see and catch food, and interrupting spawning.

Excessive amounts of dirt and debris which settle on the bottom of streams can also affect the total stream system in many ways:

1. Reduce plant numbers by smothering or changing bottom quality (from gravel to silt)
2. Reduce numbers of bottom-dwelling animals through less food and less living space as areas between rocks are filled by silt, forcing animals into currents.
3. Reduce fish living areas by filling in pools with sediment, or filling in spaces between rocks forcing smaller fish into current.
4. Reduce fish numbers from loss of habitat (number 3), lowered bottom-dwelling food supply (number 2), fewer young fish (fry) due to cementing of gravel nests by deposited sediment, and lower survival rates of developing eggs due to less water flowing through spaces between gravels.

Stream bed

The actual shape of a stream bed is also very important in determining whether the area can support fish, and what uses will be made of it by resident and migratory fish. There are two basic features of a stream: shallow areas and deep areas. (See Figure 2)

This profile of a typical stream shows a series of shallow areas (riffles) and deeper areas (pools) spaced every five to seven channel widths apart. Riffles are stream areas which have a greater than average slope (for the particular section of stream in question), less than average depth, and therefore, are areas of higher water velocity. Because of the faster, shallower water, riffles are recognized as "white water" or turbulent areas of streams. In most streams the larger boulders, rocks, and coarse gravel congregate on bars. Because of the faster water and many living spaces provided among the rocks for insects, riffles are important food producing areas of streams. Riffles are also important as spawning areas.

Pools, in contrast with riffles, are stream areas of deeper, slower water. Under low flow conditions, the water surfaces of pools are generally flat and smooth. Stream bed in pool areas is often composed of smaller rocks, gravel or even sand and silt. Because of the deeper, slower water, pools are the major resting and rearing areas for stream fish.

Cover in smaller streams is provided by undercut banks, large rocks, embedded logs, and low overhanging bank vegetation. Removal or disturbance of these sheltered areas seriously disrupts the capacity of an area to support fish. Removal of large rocks or embedded logs, for example, can reduce the number of pools either by filling or by changing the direction of stream flow.

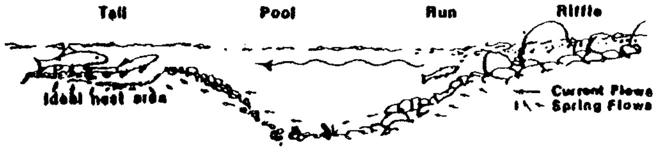

FIGURE 2: Natural nest areas that most spawning trout, steelhead, and salmon use. (Stream cross-section diagram courtesy, Idaho State Fish and Game.)

Fish Food

Fish feed primarily on insects and aquatic plants (algae). Insects and unattached plants are often directly destroyed by dredging activities, particularly by physical injury. Indirect destruction can result from displaced insects, increased competition elsewhere, and from destruction of the food supply. Dredging removes much of the plant life that is eaten by insects which live in stream beds. Consequently, even though natural drift may repopulate an area, the food base may not support a new colony.

Plants

Streambank (riparian) vegetation serves many critical functions in the stream ecosystem (see Figure 3):

1. Stability – While grasses and herbs have the greatest soil binding abilities, woody plants (in particular, their root systems) also protect banks from erosion. Stable banks contribute a minimum of sediment to the stream.
2. Wildlife – Trees, shrubs & other plants provide valuable cover for animals and allow for movement from one place to another. Riparian vegetation includes many different plants, so it is home for many types of insects, birds and small mammals.

3. Fish – Streamside plants contribute protective cover and insects for fish. There appears to be a direct link between the amount of vegetation and total fish production of a stream. Overhanging brush helps keep water temperatures from becoming too high in summer, and also protects fish from sunburn which could kill them.

Any activity which disturbs stream bank vegetation can affect fish populations for many years. Loosening soil around plant roots, for example, may weaken the area sufficiently to cause its loss during the next winter's high water flows or rains. Consequently, while the disturbance may not be immediate, the long-term loss will be just as severe.

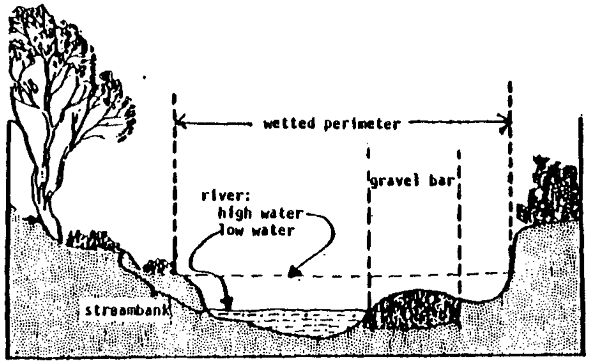

FIGURE 3: Typical stream (cross-section).

Fish

The existence of fish in any stream depends on the quality of all other factors previously mentioned. If any link is weakened, sooner or later fish populations will suffer. Given a supply of cool clear water, enough food, and proper stream bed materials, fish will spawn.

The spawning sites chosen by salmon and trout are as different as the habitat they live in. In general, the preferred spawning sites are in riffles or at the tail or sides of pools. One notable exception to this is in streams with bedrock or large boulder stream beds where the fish tend to spawn in the small patches of gravel located on the downstream side of large boulders. The spawning nests (redds) may be recognized as oval depressions in the gravel which appear brighter or cleaner than the surrounding gravel. The water depth at these sites may vary from barely enough to cover the fish's back to more than five feet; most commonly, redds are covered by six to twelve inches of smoothly flowing water.

Resident trout prefer to spawn in clean gravel that ranges in size from one-half to 1½ inches in diameter. Salmon and steelhead spawn in gravel that is 1½ or more inches in diameter. Steelhead, rainbow and cutthroat trout spawn primarily in the months of April and May and their eggs and fry remain in the gravel until mid-summer. Chinook salmon spawn in August and September and their eggs and fry remain in the gravel until the following spring. Brook trout, brown trout, Dolly Varden, and kokanee spawn from September through December and their eggs and fry also remain in the gravel over winter.

Obviously, the critical time of year for fish protection will differ by stream, depending on the kind of fish, whether spawning areas are present, water flow characteristics, etc. Recreational mining causes several problems not faced by fish managers under normal conditions:

1. People wading in streams may disrupt spawning activities, causing fish to seek other locations. However, there are only a limited number of locations which meet the specific requirements of each kind of fish.
2. Fish eggs or yolk-sac fry can receive physical damage when sucked up by vacuum dredges. This causes mortality.
3. Fine sand and silt deposited over spawning gravels settles into cracks and may either prevent fresh water from reaching eggs (suffocation), or may physically block fry from coming out of the nest.

Some question exists as to possible benefits from mining activities. Two often mentioned are gravel cleaning and raising of fish feeding levels through release of food particles normally unavailable. These may occur; however, we believe several questions need to be answered before we can accept these theories. Firstly, material "cleaned" from gravels is generally deposited elsewhere downstream in the system. Does the cleansing – and this normally includes beneficial materials as well – of one area outweigh potential harm done to another? Secondly, food organisms kicked up would provide feeding for only a limited time and area. Would reduced food levels in dredged area compensate for momentary gains? Studies in California seem to show that return of fish and insects to single-pass dredged area may take up to three years. Most streams would continue to suffer these damages as long as mining activities continue.

Research in California, Oregon, and British Columbia may answer some of these questions. Until then, fish managers must rely on their best professional judgement to protect this valuable fish life.

State and Federal Laws

There are a number of laws which gold seekers should be aware of. For more information on any one, you should contact the administering agency.

Washington Department of Game and Washington Department of Fisheries

Hydraulics Project Approval (HPA), issued jointly by the Departments of Game and Fisheries, is required prior to removal of stream bed material (RCW 75.20.100). You may obtain applications at any regional office or Olympia headquarters. Gold prospecting is divided into three categories:

1. Panning, small sluices (under 2' x 6"), or mini-rocker boxes. HPA's are not required provided you follow the provisions described in this pamphlet (see Table I). You must not operate in Class I (closed) waters.
2. Non-mechanized sluicing. HPA's are required. All excavations must be performed by hand or hand tools. A sluice box may not exceed 18" wide by 60" long, or an area of 7½ square feet. Also, it must not exceed 25% of the width of the wetted perimiter of the stream (see Figure 3 and Table II). You may operate in Class III and IV waters only.
3. Mechanized sluicing and dredging. HPA's are required. You must have a separate permit for each piece of equipment you want to operate in this category. You may operate in Class IV waters only.

Washington Department of Ecology

Shoreline Management Act

The Shoreline Management Act of 1971 recognizes the value of the state's shoreline, both as an important natural resource and as an area of significant public interest. The purpose of this act is to set goals and guidelines for the best management of shorelines rather than unnecessary restrictions of their uses.

Cities and counties have responsibility for locally administering the Act. City and county Shoreline Master Programs discuss mining and dredging activities and promote the wise use of shorelines. They include areas where mining and dredging can or cannot be conducted.

Also, they administer a permit system. Any shoreline development, use, or construction activity valued at $1,000 or more, or which materially interferes with the normal public use of the water or shoreline area requires a permit. The Department of Ecology generally acts in a support role to local government.

All gold dredgers are urged to contact their local permit coordinator (usually the county planning office) before beginning or investing money in gold dredging.

State Water Quality Standards

As with the Shoreline Management Act, the State's Water Quality Standards are designed to protect the many beneficial uses of our lakes, streams, rivers, and marine waters. Standards do not include activities which interfere with or harm beneficial uses. Further, no lessening of water quality is allowed in waters in national parks, national recreation areas, national wildlife refuges, national scenic rivers, or areas of national ecological importance.

The Department of Ecology checks complaints of water quality violations. If such complaints are true, the department can arrest violators.

Washington Parks and Recreation

No unauthorized panning or dredging for gold or other precious metals is permitted within streams or other waterways within the boundaries of any State Park. Also, these activities are not allowed in the State Seashore Conservation Area, which is within the line of extreme low tide to the line of ordinary high water. This area extends from Cape Disappointment to Cape Flattery (RCW 43.51.060(7)).

Washington Department of Natural Resources

The right to mine minerals on land in Washington depends upon the ownership of land. Not all land is automatically "open." Information regarding "open" lands may be obtained from *Mineral Rights and Land Ownership in Washington* (Moen, 1962), a pamphlet available from Department of Natural Resources.

In general, there is no objection to a person examining State lands to determine which area he might want to lease. However, after an area has been selected, a prospecting lease or mining contract is required. Prospecting leases are for two years. The area covered by a lease may not be less than 40 acres (less if a legal government lot) or more than 640 acres (more if a legal section). A mining contract is required when the actual mining starts.

When Washington became a state, Congress granted to it sections 16 and 36 of every township as soon as the land was surveyed. Within the National Forests there are many surveyed school lands. These lands belong to the State and are not open to prospecting and mining, but may be leased from the State.

Even though questions might arise over which lands within the National Forests are open to prospecting and mining, the prospector will be faced with fewer problems within the National Forests than on most other lands. The lands that are withdrawn from mineral entry comprise less than 5 percent of the total area of the National Forests of the State. The locations of these areas are readily available from the U.S. Forest Service.

The beds of non-navigable waters within National Forests are open to prospecting and mining. This applies to the minerals on or under the bottom of the water and not to the rights to appropriate and use the water. A holder of a mining claim with the National Forest, who desires to appropriate water from a stream or lake within a National Forest, must secure a permit from the U.S. Forest Service and another from Department of Ecology.

Navigable stream and lake beds within National Forests, regardless of who owns the surrounding lands, belong to the State and are not open to prospecting. However, they are subject to the mineral leasing laws of the State.

Non-navigable stream and lake beds on private property are not open. They must be leased from the owner or owner of the land that surrounds the body of water. Navigable streams and lake beds are owned by the State and are subject to mineral leasing from the State.

Lands owned by a county may be leased for prospecting and mining through its county commissioners.

"Patented" mining claims occur along several stream courses in Washington. These claims represent parcels of land that have been purchased from the federal government. Patented mining claims are private property; to enter upon them without the consent of the owner is trespassing. The theft of ore, gold dust, or gold nuggets from private property or valid mining claim is called "highgrading." It subjects the violator to criminal and civil actions. The locations of patented mining claims can be obtained from the county assessor for the county where the claim is located as well as from the U.S. Bureau of Land Management, the federal agency which issued the original mining patent. In Washington their address is:

U. S. Bureau of Land Management
Spokane District Office
Room 551 – U.S. Courthouse
Spokane, Washington
Phone (509) 456-2570

Federal Mining Law of 1872

This federal law gives prospectors the right to seek gold on any federal land in the nation. It does not apply to privately owned or State owned property.

This law does not affect any state laws or authorities. Even when prospecting on federal lands, you still must apply for required state permits.

National Parks

No prospecting is allowed within the boundaries of National Parks.

Prospecting and Mining Techniques

Many methods and kinds of equipment are available to the modern gold seeker. However, contrary to the claims of some manufacturers, damages to fish resources can occur even if equipment is properly used. These damages result mainly from prospecting in areas of high sensitivity.

The following tables will help you understand the impacts of common mining activities.

TABLE I

Panning, mini-rocker boxes, and non-mechanized sluice boxes (under 2′ x 6″)

This activity does not require an HPA.

Provision	**Resource Protection**
All work will be performed by hand or hand tools only.	Mechanical and/or bigger equipment have the capacity to move larger amounts of material and have more impact on fish life. These activities are regulated by HPA's issued particularly for them (see Table III)
There will be no disturbance of gravelled spawning areas (see discussion under "The Stream Environment" on how to recognize these).	Fish return to specific areas to lay their eggs. These spawning nests (redds) are found in clean gravel from ½ inch to 4 inches in diameter, depending on the species. Any disturbance of redds may cause abandonment or loss of these valuable reproductive areas. Since only certain areas meet the specific requirements of each species, the fish cannot go elsewhere to lay eggs. Consequently, all future generations of these fish are also lost. If prospecting occurs when eggs are in the redds or just after fry emerge, 100% mortality normally occurs.
There will be no stream bank excavation.	Undercutting streambanks increases instability of these areas. Constant erosion by water, during peak discharge seasons, flooding, or rainy periods results in slumping and eventual loss of plants. Importance of these areas is discussed under "The Stream Environment"
Materials too large to be moved by hand will not be disturbed.	Large boulders often form pools and eddy systems. These areas provide feeding and resting areas for fish.
All pits, furrows and potholes must be filled and leveled before completion of each day's operation.	Fish may enter the hole during periods of higher water. If the water level later drops, fish are often trapped and suffocate from lack of oxygen. Also, other people using the area may fall or otherwise injure themselves by stepping into these holes.
Any siltation in excess of state water quality standards resulting from this project may be considered damaging to fish life, causing operations to be terminated and the HPA cancelled.	Good water quality is essential to maintenance of the fisheries resource. Excess siltation can smother fish eggs, disrupt feeding patterns of young fish, destroy food sources, and cover spawning areas.

TABLE II

Non-mechanized sluicing
Maximum 18″ wide by 60″ long, or 7½ sq. ft. Not to exceed 25% of width of stream.

This activity requires an HPA. A separate application is necessary for each stream and/or tributary with a different classification. Streams with the same classification may be included on the same application.

Provision	Resource Protection
All work will be done by hand or hand tools only	Mechanical or bigger equipment have the capacity to move larger amounts of material and, consequently, may impact resources more. These activities are regulated under special HPA's.
There will be no disturbance of gravelled spawning areas (see discussion under "The Stream Environment" on how to recognize these).	Fish return to specific areas to lay their eggs. These spawning nests (redds) are found in clean gravel from ½ inch to 4 inches in diameter, depending on the species. Any disturbance of redds may cause abandonment or loss of these valuable reproductive areas. Since only certain areas meet the specific requirements of each species, the fish cannot go elsewhere to lay eggs. Consequently, all future generations of these fish are also lost. If prospecting occurs when eggs are in the redds or just after fry emerge, 100% mortality normally occurs.
There will be no streambank excavation.	Undercutting streambanks increases instability of these areas. Constant erosion by water during peak discharge seasons, flooding, or rainy periods results in slumping and eventual loss of plants. Importance of these areas is discussed under "The Stream Environment"
All pits, furrows, and potholes must be filled and leveled before completion of each day's operation.	Fish may enter the hole during periods of higher water. If the water level later drops, fish are often trapped and suffocate from lack of oxygen. Also, other people using the area may fall or otherwise injure themselves by stepping into these holes.
No damming or diversions of the flowing stream will be allowed, unless specifically allowed on HPA.	Any changes in normal stream flow can dry up downstream segments, block normal fish passage, or disrupt feeding areas.
Material too large to be moved by hand will not be disturbed.	Large boulders often form pools and eddy systems. These areas provide feeding and resting areas for fish.
Activities contributing to excess siltation should be avoided.	Siltation can smother eggs in the immediate area and downstream as well. Also, silt interferes with feeding patterns of young fish.

TABLE III

Mechanized sluicing and dredging.

Maximum size of sluicing box 18" wide by 60" long, or 7½ sq. ft. Not to exceed 25% of width of stream.

This activity requires an HPA for each piece of equipment which will be used. A separate application is necessary for each stream and/or tributary with a different classification. Streams with the same classification may be included on the same application.

Provision	Resource Protection
There will be no streambank excavation.	Undercutting streambanks increases instability of these areas. Constant erosion by water during peak discharge seasons, flooding, or rainy periods results in slumping and eventual loss of plants. Importance of these areas is discussed under "The Stream Environment"
There will be no disturbance of gravelled spawning areas (see discussion under "The Stream Environment" on how to recognize these).	Fish return to specific areas to lay their eggs. These spawning nests (redds) are found in clean gravel from ½ inch to 4 inches in diameter, depending on the species. Any disturbance of redds may cause abandonment or loss of these valuable reproductive areas. Since only certain areas meet the specific requirements of each species, the fish cannot go elsewhere to lay eggs. Consequently, all future generations of these fish are also lost. If prospecting occurs when eggs are in the redds or just after fry emerge, 100% mortality normally occurs.

All pits, furrows, and potholes must be filled and leveled before completion of each day's operation.	Fish may enter the hole during periods of higher water. If the water level later drops, fish are often trapped and suffocate from lack of oxygen. Also, other people using the area may fall or otherwise injure themselves by stepping into these holes.
No damming or diversions of the flowing stream will be allowed, unless specifically allowed on HPA.	Any changes in normal stream flow can dry up downstream segments, block normal fish passage, or disrupt feeding areas.
No tracked or wheeled vehicles will be allowed within the wetted perimeter of the stream.	Significant damages occur to the streambed when cats, loaders, RV's, etc. enter the water.
Materials too large to be moved by hand will not be disturbed.	Large boulders often form pools and eddy systems. These areas provide feeding and resting areas for fish.
Extreme care will be taken to assure no gasoline, oil, or other harmful material is allowed to fall, be wasted into, or otherwise enter surface waters.	Gasoline, oil, and other hazardous substances can cause instant death in aquatic organisms. It may take many months for traces of these materials to be washed from the system.
Any siltation in excess of state water quality standards resulting from this project may be considered damaging to fish life, causing operations to be terminated and the HPA cancelled.	Good water quality is essential to maintenance of the fisheries resource. Excess siltation can smother fish eggs, disrupt feeding patterns of young fish, destroy food sources, and cover spawning areas.

Stream Classifications

State waters have been classified by field biologists using the following system. These classifications are effective July 1, 1980 through June 30, 1981.

ACTIVITY

CLASS I – Total Prohibition of Panning, Sluicing and Dredging
CLASS II – Panning Only
*CLASS III – Non-motorized Sluicing
Maximum 18" wide by 60" long or area of 7½' square. Box will not exceed 25% of width of wetted perimeter of stream
*CLASS IV – Motorized Sluicing/Dredging

*A Class III or IV activity includes all lower class activities as well. Unless specifically stated otherwise, timing for Class III will be the same as Class IV, and Class II may be performed any time.

TIMING

1. July through October ONLY
2. June through September ONLY
3. August through September ONLY
4. July through August ONLY
5. July through September ONLY
6. August through October ONLY
7. Year-around

DREDGE SIZE

A. 2" nozzle and hose maximum allowable
B. 4" nozzle and hose maximum allowable
C. 6" nozzle and hose maximum allowable
D. 8" nozzle and hose maximum allowable

EXAMPLES: Class II 4 – Panning Only – July through August
Class III 7 – Non-Motorized Sluicing – year-around
Class IV 6B – Motorized Sluicing/Dredging – August through October 4" nozzle and hose maximum

If a water is not listed, applications will be considered on a case-by-case basis. In order to avoid submitting an application that may be denied, you should contact the applicable Game Department Regional Office. If biologic conditions change, stream classifications may have to be altered. Site-specific timing may be necessary in special conditions.

American River	IV1B
Morse Creek	IV1B
All Other Tributaries	II1
Baker River	IV3B
Rocky Creek	IV3B
Sulphur Creek	IV3B
Roaring Creek Tribs.	III7
All Other Tributaries	II7
Bear River	III1
Greenhead Slough	III1
All Other Tributaries	II7
Beckler River	III1
All Tributaries	III1
Big Sheep Creek	IV1B
Big Quilcene River	
Mouth to Highway 101	III4
Highway 101 to Headwaters	II1
All Tributaries	II1
Black River	IV1B
Mima Creek	IV1A
Waddle Cr. (below Noski Cr.)	IV1A
All Other Tributaries	II7
Bogachiel River	IV4B
All Tributaries	II1
Bone River	II7
All Tributaries	II7
Bumping River	IV1B
All Tributaries	II1
Calawah River	IV4B
North Fork & Albion Cr.	III4
All Other Tributaries	II1
Cannon River	III1
All Tributaries	II7
Canyon River	IV1D
All Tributaries	II7
Carbon River	IV3B
All Tributaries	IV3A
Cascade River	
Mouth to Forks	IV6B
S.F. Cascade	III3
North Fork	I
Middle Fork	III3
Jordan Creek	IV6B
Marble Creek	III3
Boulder Creek	IV6A
Found Creek	III3
Sonny Boy Creek	III3
All Named Tributaries	II7
All Unnamed Tributaries	III3
Cedar River	
Mouth to Landsburg Dam	II6
Landsburg Dam to Headwaters	I
Downs Creek	I
Madson Creek	I
Peterson Creek	I
Rock Creek	I
All Other Tributaries	II6
Chehalis River	IV4B
Charley Creek	III1
Workman Creek	III1
Delezene Creek	III1
Mox Chehalis Creek to Sand Creek	IV1A
Rock Creek to Williams Creek	IV1A
Garrard Creek to S. Fork	IV1A
Independence Creek	III1
Porter Creek to Middle & South Fork	IV1A
Gibson Creek to Thurston Cr.	III1
Cedar Cr. to Sherman Cr.	IV1B
Sherman Cr. to Monroe Cr	IV1A
Sherman Cr. above Monroe Cr.	III1
Harris Cr. to Roundtree Cr.	IV1A
All Other Tributaries	II7
Chelan River	IV7B
Company Creek	I
Twenty-Five Mile Creek Trout Spawning Channel	I
All Other Tributaries	IV4A
Chewack River	II4
Tributaries—See Methow R.	
Chinook River	III1
All Tributaries	III1
Chiwawa River	
Mouth to Phelps Creek	IV4A
Phelps Creek to Headwaters	II7
All Tributaries	II7
Cispus River	IV2B
All Tributaries	IV2B
Clallam River	IV4B
All Tributaries	II1
Clearwater River (Jefferson Co.)	
To Solleks River	IV4B
Solleks R. to Headwaters	II1
All Tributaries	II1
Clearwater River (Pierce Co.)	IV1D
All Tributaries	IV1A

Cle Elum River	IV1B
Fortune Creek	IV1B
Cabin Creek—mouth to L. Cr.	IV1B
All Other Tributaries	III7
Columbia River	
Mouth to Hanford Power Line	IV7D
Hanford Power Line to Wanapum Dam	IV1B
Wanapum Dam to Headwaters	IV7D
Colville River	II7
Hatchery Inlet System	I
Copalis River	
Mouth to Aloha Beach Road	IV1A
Upstream and all Tributaries	II1
Coweeman River	IV2B
All Tributaries	II1
Cowlitz River	
Riffe Lake to Clearfork	IV2B
Blue Creek	I
All other Tributaries	II1
Crab Creek	II1
Deep River	II1
All Tributaries	II1
Deschutes River	IV1B
Little Deschutes River	III1
All other Tributaries	II7
Dewatto River	II4
All Tributaries	II4
Dickey River	
To Forks	IV4B
West Fork to Middle Fork	III1
East Fork to Skunk Creek	III1
All Other Tributaries	II1
Dosewallips River	II4
All Tributaries	II1
Douglas Creek.	II4
Duckabush River	
Mouth to Forest Service Bridge	III4
Forest Service Bridge to National Park	II1
All Tributaries	II5
Dungeness River	
Mouth to Gold Creek	II4
Gold Creek to Headwaters	III1
All Tributaries	II1
Elk River	
Mouth to Middle Branch	III1
All Other Tributaries	II7
Elochoman River	IV2B
All Tributaries	II1
Elwha River	IV4B
All Tributaries	II1
Entiat River	
Mouth to Mad River	IV7B
Mad River to Forks	IV1A
All Tributaries	III1
Fall River	
Mouth to Dean Creek	III1
Dean Creek to Headwaters	II7
Raimie Creek to Forks	III1
All Other Tributaries	II7
Grande Ronde River	II7
All Tributaries	II7
Grays River	II1
All Tributaries	II1
Grey Wolf River	II1
All Tributaries	II1
Green River (S.W. Washington)	I
All Tributaries	I
Green River (King Co.)	IV5B
All Tributaries	IV5A
Greenwater River	IV5B
All Tributaries	IV5A
Hamma Hamma River	
Mouth to Falls	III4
Falls to Lena Creek	IV1A
Lena Creek to Park Boundary	III1
All Tributaries	II4
Hoh River	IV4B
South Fork Hoh River	III4
All Tributaries	II1
Hoquiam River	
Mouth to Forks	IV1A
North & South Forks	II1
W. Fork-mouth to 101 Bridge	IV1A
Remainder and all Tribs.	II1
Humptulips River	
Mouth to Forks	IV1A
Remainder and all Tribs.	II1
Icicle River	III1
All Tributaries	III1
Johns River	
Mouth to Forks	IV1B
South Fork to Archer Cr.	IV1A

Lewis River	
Mouth to Merwin Dam	IV2B
E. Fork Mouth to Sunset Falls	IV2B
Cougar Creek	I
Panamaker Creek	I
Remainder and All Tribs.	II1
Lilliwaup River	II4
All Tributaries	II4
Little River	II1
All Tributaries	II1
Little Quilcene River	II4
Donavan Creek	II5
Ludlow Creek	II1
Tarboo Creek	I
Thorndyke Creek	I
All Other Tributaries	II1
Lost River	II4
Tributaries—See Methow R.	
Lyre River	II1
All Tributaries	II1
Mad River	III1
All Tributaries	II7
Mashel River	IV5B
All Tributaries	IV5A
Methow River	II4
Andrews Creek	III1
Beaver Creek	III1
Benson Creek	III4
Boulder Creek	III1
Buttermilk Creek	III1
Cedar Creek	III3
Crater Creek	III4
Eightmile Creek	III4
Falls Creek	III1
Goat Creek	III1
Lake Creek	III4
Little Bridge Creek	III1
South Fork above Archer Cr.	III1
Remainder and All Tribs.	II7
Kachess River	III1
All Tributaries	II7
Kalama River	II1
Gobar Creek	I
All Other Tributaries	II1
Kettle River	
Mouth to Barstow Bridge	IV1B
Toroda Creek	II4
All other Tributaries	II7
Klickitat River	II1
All Tributaries	II1

South Creek	III1
War Creek	III1
Cub Creek	II4
Early Winters Creek	II4
Libby Creek	II4
South Fork Gold Creek	II4
Wolf Creek	II4
Gold Creek	I
All Other Tributaries	IV4A
Miller River	III4
All Tributaries	III4
Moclips River	IV1A
All Tributaries	II1
Naches & Little Naches Rivers	IV1B
Wide Hollow Creek	IV1B
Rattlesnake Creek	III1
All Other Tributaries	II7
Naselle River (North & South Fks.)	III1
Upper Salmon Creek	III1
Alder Creek	III1
All Other Tributaries	II7
Nemah River (North, South, & Middle)	III1
Williams Creek	III1
All Other Tributaries	II7
Nespelem River	IV1B
All Tributaries	IV1B
Newaukum River	II1
All Tributaries	IV1B
Niawiakum River	II7
All Tributaries	II7
Nisqually River	IV1C
Edna Creek	III1
East Creek	I
Yelm Creek & Ditch Above Yelm	III1
All Other Tributaries	II7
Nooksack River	
Mouth to Forks	IV1C
Canyon Creek	III6
Racehorse Creek	III6
Cutter Creek	III6
All Other Tributaries	II7
South Fork Nooksack River	IV1B
Sugotowitz Creek	III3
Hutchinson Creek	III3
Henderson Creek	III1
Anderson Creek	III1
Skookum Creek	III3
Howard Creek	IV6B
Ennis Creek	III6
All Other Tributaries	II7

Middle Fork Nooksack River	IV1B
Canyon Creek	IV3A
Falls Creek	III3
Clearwater Creek	IV3A
Galbraith Creek	IV3A
Warm Creek	III3
All Other Tributaries	II7
North Fork Nooksack River	IV1B
Racehorse Creek	III1
Cutter Creek	III1
West Corner Creek	III1
Cornel Creek	III1
Aldrich Creek	III1
Glacier Creek	IV3B
Deadhorse Creek	IV3B
Gallup Creek	III6
Wells Creek	IV6A
Swamp Creek	IV4B
All Other Tributaries	II7
North River	IV1B
Lower Salmon Creek	III1
Little North R. to Beck Cr.	III1
Vesta Creek to Forks	IV1A
All Other Tributaries	II7
Okanogan River	III4
Bonapart Creek	II4
Salmon Creek	II4
Sinlahekin Creek	II4
Cecile Creek	II4
All Other Tributaries	III4
Palix River—North, South & Middle Forks	III1
All Tributaries	II7
Palouse River	IV7B
Cow Creek	III4
All Tributaries	II7
Pend Oreille River	IV7D
Sullivan Creek	IV1B
Harvey Creek	I
Kings Lake Inlets	I
All Other Tributaries	II7
Pilchuck River	III4
All Tributaries	III4
Pratt River	
To Mouth of Tuscohatchie Cr.	III6
Tuscohatchie Cr. to headwaters	IV6B
All Tributaries	II6
Puyallup River	IV6B
All Tributaries	IV5A

Puget Sound & Hood Canal Streams	
California Creek	III1
Dakota Creek	III1
Chuckanut Creek	IV1A
Whatcom Creek	I
Oyster Creek	III6
Big Gulch Creek	II3
Lund's Gulch Creek	II3
Shell Creek	II6
Picnic Creek	IV7A
Piper's Creek	IV7A
Shellberger	IV6A
McAllister Creek	III1
Medicine Creek	II7
Eaton Creek	I
Woodland Creek	III1
Woodward Creek	III1
Indian Creek	IV7A
Moxlie Creek	IV7A
McLane Creek	III1
Perry Creek	II7
Schneider Creek	III1
Kennedy Creek	III1
Skookum Creek	III1
Little Creek	II7
Mill Creek	III1
Goldsborough Creek	IV1A
N.Fork Goldsborough Cr.	III1
S.Fork Goldsborough Cr.	III1
Coffee Creek	II7
Winter Creek	II7
Canyon Creek	II7
Shelton Creek	II7
Chimacum Creek	I
Snow Creek	I
Salmon Creek	I
Jimmie Come Lately Creek	I
Andrews Creek	I
Trappers Creek	I
Queets River	IV4B
All Tributaries	II7
Quillayute River	IV4B
All Tributaries	II7
Quinault River	IV4B
All Tributaries	II7
Raft River	IV4B
All Tributaries	II7
Raging River	
Mouth to I-90	II6
I-90 to Deep Creek	III6
Deep Creek to Forks	I
Forks to Headwaters	III6

Canyon Creek	III6
Icy Creek	III6
All Other Tributaries	II6
Rapid River	III1
All Tributaries	II7
Rex River	II6
All Tributaries	II6
Ross Lake	I
All Tributaries	I
Salmon River	IV4B
All Tributaries	II7
Samish River	
Mouth to Hwy 9	IV1A
Hwy 9 to Headwaters	I
Parsons Creek	III1
Dry Creek	III1
All Other Tributaries	II7
Sammamish Lake	
Sammamish River	II4
Carey Creek	I
16 Mile Creek	I
Holder Creek	I
Issaquah Creek	I
All Other Tributaries	II4
San Poil River	III4
All Tributaries	II7
San Juan Islands Streams	IV7B
Cascade Mountain Lake Tribs.	I
Satsop River	
Mouth to Forks	III1
Remainder and all Tribs.	II1
Sauk River	IV4B
N.Fork Sauk River	III4
S.Fork Sauk River	III4
76 Gulch Creek	IV3B
All Other Tributaries	II7
Seiku River	IV4B
All Tributaries	II7
Similkameen River	
Mouth to Enloe Dam	III4
Dam to Headwaters	IV4C
Toats Coulee Cr.	III4
All Tributaries	IV1B
Skagit River	IV4B
Bacon Creek	IV3B
Sky Creek	IV6A
Copper Creek	IV6A
Alma Creek	IV6A
Gilligan Creek to Mt. Vernon Water Diversion	IV1B
Gilligan Creek above Diversion	I
Grandy Creek	IV6A
Finney Creek	IV6A
Day Creek	III1
Presentine Creek	III6
Jackman Creek	III6
Barr Creek	III6
Illabot Creek	III6
Alber Creek	I
All Other Tributaries	II7
Skokomish River	
Mouth to N.Fork	III3
N.Fork Skokomish River	II1
S.Fork Skokomish Mouth to Rule Creek	III1
S.Fork Skokomish Rule Cr. to Headwaters	II1
All Tributaries	II1
Skookumchuck River	IV1B
All Tributaries	II7
Skykomish River	
Mouth to Forks	IV4D
N.Fork Skykomish	IV4B
S.Fork Skykomish	
Mouth to Eagle Falls	IV4B
Eagle Falls to Headwaters	III4
All Tributaries	III4
Snake River	II7
All Tributaries	II7
Snohomish River	
Mouth to Highway 9	IV1D
Highway 9 to Forks	IV4D
All Tributaries	III4
Snoqualmie River	
Mouth to High Bridge	II7
Bridge to Falls	I
Falls to Forks	IV3B
Cherry Creek	I
Coal Creek	II3
Griffen Creek	I
Hannan Creek	III6
Harris Creek	I
Kimball Creek	II3
Patterson Creek	I
Tokul Creek	II3
All Other Tributaries	II6
North Fork Snoqualmie River	
Mouth to Black Canyon	III3
Black Canyon	IV6B
Black Canyon to River Mile 13	III6
River Mile 13 to 18	II6
River Mile 18 to 21	I
River Mile 21 to Headwaters	II6
Tate Creek	II3
Cougar Creek	III6
Illinois Creek	III6
Big Creek	III6
Bear Creek	IV7A
All Other Tributaries	II6
Middle Fork Snoqualmie River	
Mouth to Burntboot Cr.	II6
Burntboot Cr. to Headwaters	III6
Big Creek	IV7A
Burntboot Creek	III6
Crawford Creek	IV7A
Cripple Creek	III6
Dingford Creek	III6
Granite Creek	III6
Goat Creek	III6
Hardscrabble Creek	IV7A
Heater Creek	IV7A
Kaleetan Creek	III6
Kulla Kulla Creek	IV7A
Marten Creek	III6
Quartz Creek	III6
Rock Creek	IV7A
Thompson Creek	III6
Thunder Creek	IV7A
Tuscohatchie Creek	IV7A
Wildcat Creek	IV7A
All Other Tributaries	II6
South Fork Snoqualmie River	
Mouth to Twin Falls	II3
Twin Falls to Headwaters	III6
Alice Creek	III6
Carter Creek	III6
Change Creek	IV7A
Commonwealth Creek	III6
Denny Creek	III6
Hall Creek	IV7A
Hansen Creek	III6
Harris Creek	III6
Humpback Creek	IV7A
Mason Creek	IV7A
Mine Creek	III6
Rock Creek	III6
Rockdale Creek	IV7A
Wood Creek above R.R. tracks	IV6A
All Other Tributaries	II6
Soleduck river	IV4B
All Tributaries	III1
Sollecks River	IV4B
All Tributaries	III1
Spokane River	II7
Ford Hatchery Inlet	I
Spokane Hatchery Inlet	I
Waikiki Hatchery Inlet	I
Stehekin River	IV7B
All Tributaries	II7
Stillaguamish River	
Mouth to Forks	IV4D
North Fork Stillaguamish River	
Mouth to Falls	IV4D
Falls to Headwaters	III4
Deer Creek and Tributaries	II June-September
South Fork Stillaguamish River	
Mouth to Granite Falls	IV4D
Granite Falls to Headwaters	IV4B
Canyon Creek to Forks	IV4B
Forks to Headwaters	III1
Jim Creek	III4
All Other Tributaries	III4
Suiattle River	
Mouth to Milk Creek and Tributaries	III4
Milk Creek to Headwaters	III4
Canyon Creek	III5
Dolly Creek	III5
Small Creek	III5
Miners Creek	III5
All Other Tributaries	IV5B
Sultan River	
Mouth to Spada Lake	IV4B
Spada Lake to Headwaters	II7
All Tributaries	II7
Sumas River	III7
All Tributaries	II7
Tahuya River	II4
All Tributaries	II4
Taylor River	III6
Thompson Creek	III6
Thunder Creek	IV7A
Tuscohatchie Creek	IV7A
Wildcat Creek	IV7A
All Other Tributaries	II6
Teanaway River	
Mouth to North Fork	IV1A
North Fork	IV4A
All Tributaries	III7
Tieton River	IV7C
All Tributaries	II
Tilton River	III1
All Tributaries	III1
Connolly Creek	I

Toll River	
Mouth to Forks	II7
North Fork Toll	II6
South Fork to Falls	II3
Falls to Headwaters	III6
Dry Creek, North Fork Creek, Yellow Creek	III6
Langlois Creek, Stossel Cr.	I
Titicaca Creek	III6
All Other Tributaries	II6
Touchet River	IV1B
All Tributaries	II7
Toutle River	
All "Red Zone waters temporarily closed	
Tucannon River	IV1B
Tucannon Hatchery Inlet	I
All Tributaries	II7
Twisp River	IV4A
All Tributaries	IV4A
Tye River	III4
All Tributaries	III4
Union River	II5
All Tributaries	II5
Vashon Island Waters	
Judd Creek	I
Shingle Mill Creek	I
Christianson Creek	II3
Tahlequah Creek	II3
All Other Streams	IV7A
Walla Walla River	IV1B
All Tributaries	II7
Wallace River	IV4D
All Tributaries	III4
Wallicut River	II1
All Tributaries	II1
Lake Washington Tributaries	
(Big) Bear Creek	I
Coal Creek	I
Cottage Lake Creek	I
Evans Creek	I
Forbes Creek	I
Kelsey Creek	I
Little Bear Creek	I
Lyon Creek	I
May Creek	I
McAleer Creek	I
North Creek	I
Scriber Creek	I
Seider Creek	I
Struve Creek	I
All Other Tributaries	II1

Washougal River	II1
All Tributaries	II1
Wenatchee River	
Mouth to Icicle Creek	IV4B
Icicle Creek to Chiwaukum Creek	III7
Chiwaukum Cr. to Lake Wenatchee	IV1A
Mission Creek, Peshastin Creek, mouth to Ingalls Creek	IV1A
Ingalls Creek	III1
Peshastin Creek	IV7C
Little Wenatchee River	III4
Twin Lakes, Tributaries, & Outlet stream	I
All Other Tributaries	IV4A
White River	II7
All Tributaries	IV6A
Whitechuck River	IV4B
All Tributaries	II7
White Salmon River	II1
All Tributaries	II7
Willapa River	
Mouth to Patton Creek	IV1A
South Fork Willapa above Minnie Cr., Ward Cr., Wilson Cr., Mill Cr., Fork Cr., Smith Cr.	III1
All other Tributaries	II7
Wind River	II1
Falls Creek	IV2B
Wishkah River	
Mouth to Forks	IV1A
All Other Tributaries	II1
Wynoochee River	
Mouth to Dam	III1
All Other Tributaries	II1
Yakima River	
In Yakima & Benton Counties	IV1B
Elsewhere	IV4A
Swauk Creek	
Mouth to SR131	IV4A
Above SR131	IV7C
Rattlesnake Cr.	III1
Wide Hollow Creek	IV7B
All Other Tributaries	II1

Ralph W. Larson, Director
THE DEPARTMENT OF GAME

WASHINGTON GAME COMMISSION

Frank L. Cassidy, Jr., Chairman
Archie U. Mills
Elizabeth W. Meadowcroft
Tom Nelson
Marlin Pedersen
Vern E. Ziegler

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Spokane, WA 99218

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Ephrata, WA 98823

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2802 Fruitvale Boulevard
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905 East Heron
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On Chelan Highway
Wenatchee, WA 98801

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Vancouver, WA 98663

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Burlington Industrial Park
Burlington, WA 98233

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Forks, WA 98331

Montesano District Office
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Montesano, WA 98563

Vancouver District Office
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