ROCK CREEK

RURAL CLEAN WATER PROGRAM

COMPREHENSIVE WATER QUALITY MONITORING REPORT

1981-1986

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ABSTRACT

Water quality monitoring was initiated by the Idaho Department of Health and Welfare, Division of Environment in 1981 and is in its sixth year. To monitor the water quality, weekly sampling is done through the irrigation season (April-October) on the subbasin drains for suspended sediment, nutrients and bacteria. Rock Creek is sampled for additional parameters to monitor any changes in stream quality. Our studies have shown a direct correlation between the subbasins with the greatest percentage of best management practices implemented and greatest reductions in suspended sediment and other agricultural pollutants. Suspended sediment, the key parameter examined, has shown a significant decrease in five of the six subbasins studied since the beginning of the project. Suspended sediment loadings in Rock Creek itself have been erratic and were seriously impacted by the 100-year flood event of Spring 1984. Some severe streambank erosion sites exist on the upper reaches of Rock Creek and are masking some of the effects of the sediment reductions which are occurring in the drains. These unstable banks contributed an estimated 20, 668 tons of fine sediment and 54,716 tons of total sediment to Rock Creek during 1986. Analysis of substrate in Rock Creek reveals that all sample stations are impacted by fine sediments. All of the sample sites along Rock Creek are impacted by fine sediment. Cobble embeddedness was 20 percent above the project area, and ranged from 35-64 percent in the project area with the most impacted sites found in the upper areas of unstable stream banks. The total amount of fine sediments in Rock Creek increase from a site above the project area (25.6 percent) towards the confluence with the Snake River (47 percent midway and 44 percent at the mouth).

Three of the subbasins show significant reductions in organic nitrogen. Nitrate nitrogen has not been reduced by the project. Fourteen of 16 subbasin stations did show an improvement in fecal coliform density for the period 1981-1986. The two drains that did not improve have livestock operations present on them. Pesticides are present in low concentrations in the water column, sediment and fish tissue. Quality assurance is an important part of both the field research and the laboratory analyses. Quality control check samples for suspended sediment and nutrients demonstrated high precision. Precision and accuracy is excellent to good for most parameters. Our water quality research has revealed that benthic macroinvertebrates show greatest diversity at upstream Rock Creek stations. Wild trout populations have increased significantly at half of the Rock Creek stations since the beginning of the project.

EXECUTIVE SUMMARY

Water quality monitoring for the Rock Creek Rural Clean Water Program (RCWP), Twin Falls County, Idaho was initiated by the Idaho Department of Health and Welfare, Division of Environment in 1981 and is in its sixth year. The objectives of the water quality monitoring program are to determine the water quality of the irrigation drains in the subbasins under study as well as in the receiving stream, Rock Creek; and to quantify changes in water quality related to land management activities in the agricultural drains and in Rock Creek. To monitor the water quality, weekly sampling is done through the irrigation season (April-October) on the subbasin drains for suspended sediment, nutrients and bacteria. Rock Creek is sampled for sediment, nutrients, bacteria, metals, minerals, pesticides, streambank erosion, cobble embeddedness, stream bottom composition, macroinvertebrate populations and fish populations to quantify the off site impacts of the changes in irrigation drain water quality.

The results, to date, suggest that best management practices (BMPs) implemented under the RCWP in the project area have improved water quality in Rock Creek. The results show that BMPs have significantly reduced sediment and other pollutants to the agricultural drains studied. The subbasins with the greatest percentage of best management practices implemented also show the greatest reductions in suspended sediment and other agricultural pollutants.

Suspended sediment, the key parameter examined, has shown a significant decrease in five of the six subbasins studied since the beginning of the project. Examination of monthly suspended sediment loadings and of suspended sediment concentrations since the beginning of the project have shown a substantial reduction in the irrigation drains. Suspended sediment loadings in Rock Creek itself have been erratic and were seriously impacted by the 100-year flood event of Spring 1984. Even so, sediment reductions in Rock Creek are becoming evident. The 1982 suspended sediment contribution of Rock Creek to the Snake River was approximately 65,986 tons compared with 22,448 for 1986, representing a twothirds reduction since the beggining of the project. Some severe streambank erosion sites exist on the upper reaches of Rock Creek and are masking some of the effects of the sediment reductions in the drains. Fortyeight percent of the stream reaches in the project have substantial stream bank erosion problems. These unstable banks contributed an estimated 20,668 tons of fine sediment and 54,716 tons of total sediment to Rock Creek during 1986. Even so, the sediment reductions in the subbasin drains are quite significant to the overall ecology of Rock Creek. Biota which are present in watersheds having increased sediment concentrations during spring runoff (such as Rock Creek) are severely impacted when the high concentrations continue through the spring and summer resulting from man's activities. Thus, the reduction of sediment and associated pollutants in the subbasin drains reduces the impact of chronic sediment pollution.

Analysis of substrate in Rock Creek reveals that all sample stations are impacted by fine sediments. The upper stations are more impacted than previously documented. Cobble embeddedness was 20 percent, a good background level, above the project area. Embeddedness ranged from 35-64 percent in the project area with the most impacted sites found in the upper areas of unstable stream banks. The total amount of fine sediments in Rock Creek increase from a site above the project area towards the confluence with the Snake River.

Three of the subbasins show significant reductions in organic (total Kjeldahl) nitrogen. Nitrate nitrogen has not been reduced by the project. Two stations show significant decreases for total phosphorus while only one station each showed reduced dissolved ortho-phosphate and fecal coliform bacteria through 1984. Fourteen of 16 subbasin stations did show an improvement in fecal coliform density for the period 1981-1986. The two drains that did not improve have livestock operations present on them.

Pesticides are present in low concentrations in the water column, sediment and fish tissue. DDT and its analogs, PCBs, dieldrin, nonachlor, and pentachlorophenol, are the most common organic chemicals encountered. The levels appear to be below those of health and fishery significance. DDT has shown a significant reduction at the upper Rock Creek sample station indicating past residues are breaking down and new sources are not being introduced. Significant changes in pesticides at the other monitoring stations have not been documented. With the changes in BMPs emphasizing more use of conservation tillage, increased pesticide use may be expected in the watershed.

Quality asssurance is an important part of both the field research and the laboratory analyses. Quality control check samples for suspended sediment and nutrients demonstrated high precision. Spiked samples showed excellent recovery (accuracy) for suspended sediment. This gives a high degree of confidence in the reported values for suspended sediment. Accuracy was also excellent for spiked samples of total Kjeldahl nitrogen, nitrate, total phosphorus, magnesium, sodium, calcium, potassium, and chloride. Recoveries were not as good for dissolved ortho-phosphate during 1985 but were improved during 1986. Recovery of spiked samples for fluoride was very poor, indicating a natural interference present in surface water. Precision between split samples was best for total Kjeldahl nitrogen, suspended sediment, and total phosphorus. Precision was good for total Kjeldahl nitrogen, suspended sediment, nitrate and total phosphorus. The precision was poor for duplicate samples of dissolved ortho-phosphate and fecal coliform bacteria during 1985 but improved to good in 1986. The quality assurance research begun in 1985 gives excellent validity to the water quality data. The quality assurance work will continue until the end of the project.

Our water quality research has revealed that benthic macroinvertebrates show greatest diversity at upstream (higher quality) Rock Creek stations and lowest diversity at the middle and lower (lower quality) stream stations. In addition, a higher number of "clean water" organisms are found at the upstream stations and a greater number of "pollution tolerant" organisms are found at the lower stations.

Fish populations in Rock Creek have increased since the beginning of the project. Game fish (trout) populations have increased significantly at most Rock Creek sample stations since 1981. Wild trout populations have increased significantly at half of the Rock Creek stations since the beginning of the project. The resuslts of our stream substrate analysis on Rock Creek in the study area suggests that the entire reach is severely impacted by fine sediment. Further improvements in the Rock Creek fishery may not be possible until additional sediment loads are reduced and stream gravels have had time to be cleaned by hydrologic processes.

INTRODUCTION

PROJECT BACKGROUND

Rock Creek, in Twin Falls County, Idaho, has long been recognized as one of the most severely degraded streams in the State (Idaho Department of Health 1960; Idaho Department of Fish and Game 1971; Kuska, et al. 1974; U. S. Environmental Protection Agency 1973; Clark 1975; and Idaho Soil Conservation Commission 1979). Both point and nonpoint sources of pollution contributed to this problem. The 1972 Federal Water Pollution Control Act (Public Law 92-500) stimulated ongoing pollution abatement efforts, and since then, both state and federal programs have been directed toward pollution abatement in Rock Creek. Through the National Pollution Discharge Elimination System program, point source discharges from food-processing plants, fish hatcheries, and the Twin Falls sewage treatment plant have essentially been eliminated from Rock Creek. With the removal of these point sources, improvements in aesthetics, bacterial contamination, dissolved oxygen, and nutrient loading were seen in Rock Creek.

However, nonpoint sources within the Rock Creek drainage continue to cause severe pollution problems. The major nonpoint source pollutants are sediment and associated pollutants contributed by irrigation return flows. During the irrigation season (April-October), the confluence of Rock Creek with the Snake River could be easily traced as a brown muddy streak. Due to the continuing water quality problems, the Idaho Soil Conservation Commission (1979) identified Rock Creek as a top priority stream segment. Subsequently, the Snake River and Twin Falls Soil Conservation Districts (SCDs) were given a 208 grant to develop a detailed water pollution abatement plan for Rock Creek.

An irrigation return flow study was carried out from 1976 through 1980 by USDA-Agricultural Research Service (ARS) and the University of Idaho-Agricultural Engineering (UI-Ag Eng), in conjunction with the Snake River SCD, IDHW-DOE, and U. S. Environmental Protection Agency (EPA) (Brockway, et al. 1980). Best management practices (BMPs) were developed for reducing sediment and nutrients in irrigation return flows and these practices were applied to a small drain, the "LQ," which is adjacent to Rock Creek and empties directly into the Snake River. Because of BMP implementation, the sediment discharged to the Snake River was reduced by 80 percent from 10,000 tons/year in 1977 to 2,000 tons/year in 1979. At the end of the contracting, implementation, and cost-share period the more expensive BMPs to maintain (especially sediment ponds) were discontinued. Since that time the suspended sediment loadings have climbed up to around 5,000 tons/year. The hope is that with the extended contract/implementation phase for Rock Creek, the BMPs will become part of the routine of the landowners. The change from the more expensive "structural" practices to conservation tillage and other inexpensive BMPs should also make it easier to continue practicing soil conservation after the RCWP has ended. Irrigation water management can also have a significant effect on the quality of the water leaving the field. U. S. Bureau of Reclamation (1978) found decreases of nutrients and sediment in irrigation drain waters in the Boise Valley during the 1977 "drought year".

The pollution abatement plan developed under the 208 planning project was implemented in 1980 when RCWP funds were obligated for the Rock Creek project. The goals of the Rock Creek RCWP were to reduce the amount of sediment and sediment-related pollutants entering Rock Creek from agricultural lands with the application of BMPs and to reduce the amount of animal wastes entering Rock Creek by applying animal waste management systems. With the application of BMPs, the pollution reduction within sub-watersheds was estimated to be 70% for sediment, 60% for phosphorus, 40% for the total nitrogen, and 70% for fecal coliform.

The implementation aspect of the RCWP is administered by the USDA-Agricultural Stabilization and Conservation Service (ASCS) and technical assistance is provided by the USDA-Soil Conservation Service (SCS), Snake River and Twin Falls SCDs, and the Twin Falls County Extension Service (CES).

The monitoring component of the Rock Creek RCWP is quite comprehensive. IDHW-DOE is the principal agency monitoring drainage water quality and the beneficial uses of Rock Creek by measuring trends in water chemistry, changes in stream substrate composition, benthic macroinvertebrates, and game fish populations. This paper presents the trends in water quality that are being seen after six years of implementation of BMPs.

Other aspects of the monitoring program include an evaluation of the social and economic impacts of BMP installation on the landowners, an erosion and sediment transport model for the irrigation tract, and an evaluation of individual BMP effectiveness. These tasks are being carried out respectively by the USDA-Economic Research Service (ERS), the UI-Ag Eng, and the USDA-ARS.

Cost sharing is provided to farmers under the RCWP for installing BMPs. The BMPs are individually selected for each farm and together constitute a water quality plan. BMPs used within the project include practices aimed at preventing soil erosion and BMPs designed to desilt water after the erosion has taken place. The most popular practices include irrigation system improvements and reorganization because the landowner can see an immediate benefit for the cost and effort expended. Some of the most effective BMPs include sediment basins, mini-basins, I-slots, and buried pipe runoff control systems.

WATER QUALITY MONITORING BACKGROUND

Description of study area

Rock Creek is located in the south central part of Idaho in Cassia and Twin Falls Counties. Headwaters for Rock Creek are in the Sawtooth National Forest in western

Cassia County. The creek flows northwesterly, approximately 67 kilometers, through Twin Falls County to the Snake River north of the City of Twin Falls (Figure 1) at Snake River Mile 606.4, 5.4 river miles downstream from the Perrine Bridge (U. S. Highway 93)(Pacific Northwest River Basins Commission 1976). The watershed covers a total of 80,292 hectares, of which 21,003 hectares are irrigated cropland. Elevation within the watershed varies from 2,432 meters at the headwaters to 912 meters at the mouth.

Soils in the lower watershed from the mouth to river kilometer 40 can be generally described as thin, light colored, medium textured surface soils and very strongly calcareous silty subsoils. These soils vary in total depth and are underlain by fractured basalt. The soils were formed under arid conditions and are low in organic material. They are highly productive and also highly erosive. The deeper soils (40-60 inches to bedrock) are termed Portneuf Series and the more shallow soils (10-20 inches to bedrock - commonly old shield volcanos which form much of the topography) are known as Trevino Series (Barker et al. 1983).

The climate of the area below river kilometer 40 is semi-arid with moderately cold winters and hot summers. Annual precipitation averages about 9" (Ralston and Young 1971) for the period of record, but has averaged 11.56" for the period of the present study, with a low average temperature of -3°C. in January and a high average temperature of 23°C. in July. The growing season is about 120 days.

Rock Creek was historically fed by snow melt in the higher watershed. It was characterized by low summer and fall stream flows and high flows in the spring from winter runoff. When the area was developed for irrigated agriculture, this activity changed the historical flows. Irrigation return flows were added to Rock Creek, which greatly increased the summer stream flow. Stream flows now peak in September. The average discharge for Rock Creek at Poleline Road (S-2) for the 25 year period 1923-46 and 1984 was 213 cfs (154,300 acre-ft/year) with a maximum of 983 cfs (September 21, 1927) and a minimum of 90 cfs (March 28, 1941)(USGS 1985). The maximum reported during the 100 year flood of 1984 was 876 cfs (May 15)(USGS 1985). The stream gradient of Rock Creek is fairly constant up to river kilometer 40; from there the slope substantially increases with the last 1.5 kilometers before the confluence with the Snake River being the steepest.

The Rock Creek watershed contains approximately 350 farm units. The basic crops grown are dry beans, dry peas, sugar beets, corn, small grains, and alfalfa. All crops are irrigated because of the low annual precipitation. Irrigation water is diverted from the Snake River and is delivered to the farms through a network of canals and laterals owned by the Twin Falls Canal Company. Irrigation water is delivered to individual farms at constant flow from about April 15 through October 15. Water is now increased in Rock Creek beginning in March for hydroelectric energy production.

When the irrigation tract was developed, natural streams and drainage patterns were used as much as possible to deliver water to the fields and to carry excess water away. Water is diverted from the main canal to the lateral; this lateral is the head of the drain which eventually delivers irrigation return flows to Rock Creek. Water is diverted from the lateral to the first field, and excess water from the first field is used on the next field with whatever additional water is needed from the lateral. This system continues through the length of the drain until it empties into Rock Creek.

It has been estimated that on an average 50 percent of the water delivered to a field drains off as excess surface flow. This water is reused where possible for further irrigation. For the entire Twin Falls tract, Carter, et al., (1971), estimated that, of the irrigation water and precipitation which is available, 36 percent is lost to evapotranspiration, 50 percent to subsurface drainage, and the remaining 14 percent returns to surface streams by way of irrigation drainage. These drains carry off irrigation return flows that deliver sediment and associated pollutants to Rock Creek.

Natural drainage over most of the tract has been sufficient to prevent harmful salt accumulations. However, high water tables occurred in localized areas. To drain these areas, horizontal tunnels were excavated into the basalt. The tunnels are approximately 1-2 meters wide by 2 meters high and may be from 0.8 to 2.4 kilometers in length. The water in these tunnels is generally high in quality and constant in temperature. The high quality of water is shown by the number of trout farms which utilize this resource.

The objectives of the present report are: 1) to give an update of 1986 water quality monitoring data,2) to summarize the water quality data from 1981 through 1986, and 3) to assemble the literature concerning the water quality of Rock Creek.

Water quality information

The water quality data for Rock Creek is scattered through the literature. The Idaho Department of Health and Welfare-Division of Environment (IDHW-DOE) has conducted several water quality studies over the years in Rock Creek. An initial survey in 1960 identified public health problems (Idaho Department of Health 1960). Water quality studies from 1972 to 1974 were reported in a 1975 report (Clark 1975). This study identified the impact of point source discharges in the Twin Falls area on Rock Creek. A water quality survey in 1977 recorded the status of the upper stream segment from the townsite of Rock Creek to the Forest Service boundary (Schaefer and Bauer 1979). Wroten and Clark (1980) surveyed the channel stability of Rock Creek. In addition, a water quality trend station was sampled monthly by Idaho Department of Health (later Department of Health and Welfare) and by the U.S. Geological Survey on a continuous basis from 1969 to 1983 when a hydroelectric project was completed just above the USGS stream gauging station. The flow (discharge) and water quality data collected by USGS was reported as part of the 208 Planning for Implementation Project. The U. S. Geological Survey (USGS) established a monitoring program in Rock Creek which started in October 1979 and continued for a two-year period. Edwards et al. (1982) and Frenzel and Jones (1985) list water quality data collected on Rock Creek and some of the subbasin stations between 1979 and 1981. Flow (discharge) measurements have been reported for a variety of stations on Rock Creek since at least 1961 (U.S. Geological Survey 1961-1986). Sterling (1983) examined the stream channel response and sediment relationships in Rock Creek.

The main sources for water quality data for the Rock Creek Rural Clean Water Program are Martin and Bauer (1982), Martin (1983a, 1983b, and 1984), Clark (1985c), and the present report. In addition the Annual Progress Reports produced by the Rock Creek Technical Advisory Committee contain information concerning BMPs, economic considerations, as well as other aspects of the total project. The water quality reports mentioned above (Martin and Bauer 1982; Martin 1983a, and 1984; and Clark 1985c) appear as appendicies to the annual progress reports. The National Water Quality Evaluation Project (1985a and 1985b) has evaluated Rock Creek RCWP data and has made comparisons with other similar projects. The National Water Quality Evaluation Project also does separate analysis of selected water quality data.

The Snake River Conservation Research Center (U.S.D.A., Agricultural Research Service) located in Kimberly has conducted many studies on agriculture in the Twin Falls area. Many of the resulting publications considered BMP effectiveness and various aspects of crop irrigation including agricultural return water quality (Berg and Carter 1980; Bondurant et al. 1978; Brockway et al. 1983; Carter 1976a, 1976b; Carter and Robbins 1978; Robbins 1977; Robbins and Brockway 1978; Robbins and Carter 1980; Robbins and Smith 1977; Smith and Douglas 1973; and Worstell 1976, to name a few). Publications dealing with water quality and Rock Creek include (Brown et al. 1974; Carter et al. 1971, 1973, and 1974; Robbins and Carter 1975; and Smith et al. 1972).

Additional water quality for Rock Creek may be found in the following Crosthwaite (1969), Kuska et al. (1974); Ralston and Young 1971; Thomas (1969), and U. S. Environmental Protection Agency (1975). Walker et al. (1985) concluded that "onsite productivity damage of erosion may exceed offsite sediment damage in dollar value". They noted that cost effective practices to prevent erosion were needed to enhance the benefit-cost ratio for the project. The Rock Creek RCWP Technical Committee believes that conservation tillage will fill that need.

Recently water quality data concerning the Rock Creek RCWP has been presented at a variety of national, regional and state conferences (Clark 1985a, 1986; Bauer et al. 1986a; Jamieson et al. 1986; Neubeiser 1985, and National Water Quality Evaluation Project 1986) In addition, water quality information has been presented in local newspapers, on local television and radio programs, and in the *Rock Creek Review Project Newsletter* published by the Twin Falls-Snake River Soil Conservation Districts; *Idaho Clean Water,* the newsletter of the Idaho Water Quality Bureau; and in *NWQEP Notes*, the newsletter published by the National Water Quality Evaluation Project.

MATERIALS AND METHODS

The water quality survey was designed and modified, in part, using the following: (Canter 1985; Champlin et al. 1974; Cross 1975; Environment Canada 1983; Kittrell 1969; Mills et al. 1986; Schilperoort and Groot 1983; Shirley et al. 1976; and U. S. Environmental Protection Agency 1977, 1982b). Idaho Department of Health and Welfare, Division of Environment, survey design and sample procedures were followed during the survey. The water quality monitoring schedules for 1984-1987 are listed in Tables 3-6, respectively.

SAMPLE STATIONS

Two sets of stations with different functions were established in 1981, ambient and intensive. The ambient stations on Rock Creek are designed to measure the long term impact of the project on receiving water quality.

There are six stations on Rock Creek and a station (no longer sampled) on the Twin Falls Main Canal (Figure 1, Table 1). These stations were established by the U.S. Geological Survey (USGS) under the 208 project and were continued in this project. The rationale for placement of these stations is as follows:

S-1: near mouth - integrates all pollution sources flowing into Rock Creek and measures the pollutant load that goes into the Snake River (RM 0.75), elevation 975 m (3200'). Water quality, benthic macroinvertebrates and fisheries data being collected. This site was a previous Network Station and later a Trend Station (IDHW 1982). The site has been severely altered by a hydroelectric project established in 1983. The U.S. Geological Survey gauging station has been removed. A second hydroelectric project has been approved and will be constructed above the existing one. Stream bottom core samples and cobble embeddedness measurements were begun in 1986. The total influence of Rock Creek is now estimated by adding the contribution of subbasin 1 (station 1-2) to S-2.

S-2: at Poleline Road - a benthic invertebrate and fisheries monitoring site as well as water quality (RM 3.75), elevation 1067 m (3500'). This now represents our main "*mouth*" station. Only subbasin one enters Rock Creek below this point. A U. S. Geological Survey gauging station was established here during 1983. To obtain the total flow and impact of the Rock Creek project at the mouth data from subbasin station 1-2 is added to Rock Creek station S-2. Stream bottom core samples and cobble embeddedness measurements were begun in 1986.

S-3: above Highway 93 - below the confluence of the high agricultural priority drains and the City of Twin Falls urban runoff (RM 7.3), elevation 1128 m (3700'). Water quality, benthic macroinvertebrates and fisheries data being collected. Stream bottom core samples and cobble embeddedness measurements were begun in 1986. Two stream bank erosion sites (Magic Canyon and Jay Moyle) were established below this station during 1986.

S-4: at Twelvemile Road - above the influence of Twin Falls urban area and the high priority drains (RM 13.5), elevation 1158 m (3800'). Water quality, benthic macroinvertebrates and fisheries data being collected. The site is below the major areas of stream bank erosion. Stream bottom core samples and cobble embeddedness measurements were begun in 1986.

S-5: at 3500 East Road - a benthic invertebrate and fisheries monitoring site only (RM 21.1), elevation 1219 m (4000'). Beginning in 1986 this station was added for analysis of water quality parameters and to assist in defining the impacts of stream bank erosion. The station (Kerr Landand Livestock) is within an area of severe stream bank erosion and a site has been established here to monitor the erosion. An additional stream bank erosion site was located below this station and above S-4 during 1986 on the Richard Stafford property. Stream bottom core samples and cobble embeddedness measurements were begun in 1986.

S-6: near Rock Creek townsite - measures the quality of the "natural" surface water above the irrigation tract (RM 30.3), elevation 1331 m (4368'). Some human impacts other than agricultural (silviculture, roads, grazing, etc.) occur above this station. Water quality, benthic macroinvertebrates and fisheries data are collected here. Stream bottom core samples and cobble embeddedness measurements were begun in 1986.

S-6A: located at the Harrington Fork of Rock Creek, approximately 5.3 miles above station 6 (RM 35.6), elevation 1445 m (4740'). Established during 1986 for stream substrate sampling (core samples and cobble embeddedness) to assist in defining background conditions for Rock Creek. This station is not shown on Figure 1 but is located just south of station S-6.

S-6B: located on upper Rock Creek approximately 0.25 miles below the confluence of the Fourth Fork of Rock Creek, approximately 9.1 miles above S-6 and 3.8 miles above station S-6A (RM 39.4), elevation 1567 m (5140'). Established during 1986 for stream substrate sampling (core samples and cobble embeddedness) to assist in defining background conditions for Rock Creek. This station is not shown on Figure 1 but is located just south of stations S-6 and S-6A.

C-1: Twin Falls Main Canal - source of water for the irrigation tract. Water quality data collected only. The water quality data at Station C-1 was collected by U.S. Geological Survey in1980-1981 and DOE in 1982 and discontinued in 1983. This was due to the constant nature of the water quality from year to year and because incoming water quality was also being monitored at the upstream sites for each subbasin (used in upstream vs. downstream analyses).

Intensive monitoring stations were placed on irrigation drains to track changes in sediment load and associated pollutants as close to their sources and the solutions (BMPs) as possible. In this way, changes in water quality due to the RCWP could be more easily and quickly detected. Twenty-one stations were located in six subbasins (Figure 1, Table 2). Stations measure the source of water to the subbasins (7-1, 5-1, 4-1, 4-3, 2-1, and 1-1), the input of the subbasins to Rock Creek (10-1, 7-7, 7-4, 5-2, 4-2, 4-3, 2-5, 2-4, 2-3, 2-2, and 1-2), and key intermediate sites (7-2, 7-3, and 7-6). Additional stations were added in other subbasins as they were needed during 1983 (2-3, 2-4, and 10-1). During 1984 Station 2-5 (Wonderlich Drain) and during 1985 Station CW-3 (Cottonwood Creek) were added to the survey because of their impacts on Rock Creek. Cottonwood Creek is also the site of two stream bank erosion study areas: one on the lower portion of the stream (Kerr Land and Livestock)(added in 1985) and one on the upper portion (Roy Jesser)(added in 1986) (Figure 1).

WATER CHEMISTRY

The five Rock Creek stations were sampled monthly from April to October (the irrigation season), and once in December and February, 1981-1985. In 1986 S-5 was also sampled along with the other stations. The USGS sampled these stations from October 1979 to September 1981, and DOE assumed this sampling responsibility in October 1981. Parameters measured include nutrients, bacteria, suspended sediment, oxygen, pH, temperature, specific conductance, common ions, trace metals, flow and pesticides. In addition, Rock Creek was sampled biweekly by DOE during the irrigation season for flow, total phosphorus, dissolved ortho-phosphate, suspended sediment, and fecal coliform bacteria. During 1986 volatile suspended solids was added to help define the impacts of confined livestock feeding operations. Beginning in 1986 dissolved ortho-phosphate was analysed from both field-filtered and laboratory filtered samples. Selenium was checked three times for all Rock Creek stations and once for the subbasin stations during 1986 to define levels for the Rock Creek watershed.

Since the intensive monitoring project is focusing on total phosphorus, dissolved ortho-phosphate, and suspended sediment, the methods for their specific chemical analyses are given:

Total phosphorus (mg/L) - All of the phosphorus present in the sample regardless of form, as measured by the persulfate digestion procedure (EPA STORET #09665). The digested sample is then analyzed by direct colorimetry: Ammonia molybdate and antimony potassium tartrate react in an acid medium with dilute solutions of phosphorus to form an antimonly-phosphomolybdate complex. This complex is reduced to a blue colored complex by ascorbic acid. The color is proportional to the phosphorus concentration. Only ortho-phosphate forms a blue color in this test.

Dissolved ortho-phosphate (mg/L) - All of the phosphorus present in the filtrate of a sample filtered through phosphorus-free Schleicher and Schuell 0.45 micron membrane filters (EPA STORET #00671). Some phosphorus contamination was discovered by the State Laboratory on random new filters. During 1986 Micron Sep™ Magna Nylon 66 Membrane Filters (available from Fisher Scientific as Cat. No. NO4SP02500). These filters are routinely checked for contamination and have been found to be phosphorus free. The field sampling of this parameter was changed in June 1985 to allow for field filtration (described in more detail later). Beginning in 1986 both lab-filtered and field filtered samples were analysed so that continuity would not be lost with previous year's samples. The filtered sample is then analyzed by direct colorimetry as in total phosphorus above.

Suspended sediment (mg/L) - The suspended sediment is measured as nonfilterable residue. A well mixed sample is filtered through a glass fiber filter, and the residue retained on the filter is dried to constant weight at 103-105°C.

All chemical analyses are performed in accordance with U.S. EPA (1979) and American Public Health Association (1980 and 1985). Both field and laboratory quality assurance procedures are followed and are described later in this section.

The subbasin stations were sampled biweekly from April 1-May 15; then weekly from May 15-July 31, 1984; and May through August, 1985 and 1986; then biweekly thru the end of the irrigation season (October 15). Parameters measured include flow, total phosphorus, dissolved ortho-phosphate, suspended sediment, and fecal coliform bacteria. Biweekly samples (May-August) also included nitrate + nitrite and total Kjeldahl nitrogen. Beginning in 1986 both inorganic and organic nitrogen were sampled weekly along with the other parameters mentioned above.

Field parameters were determined with the use of portable meters. Dissolved oxygen, temperature and specific conductance were measured with Yellow Springs Instrument Company Model 54A and Model 33 SCT meters respectively. The pH was determined with a Sargent-Welch Model BPL pH meter. The meters were calibarated at the beginning of each survey and checked for accuracy several times during each survey.

Water collection techniques follow: Bellinger 1980; Canter 1985; Champlin 1974; Cross 1975; Curtis et al. 1986; Environment Canada 1983; Rainwater and Thatcher 1960; Ralston and Browne (1976); Shirley et al., 1976; U.S. Department of the Interior

(1977); and U. S. Environmental Protection Agency (1977, 1982). All chemical samples were collected as grab samples or with DH-48 or DH-59 suspended sediment samplers (U.S. Interagency Committee on Water Resources 1963; Guy and Norman 1970; and Thomas 1985). Composite samples were collected into a churn splitter (Pickering 1978). Sub-samples were then dispensed into new one liter cubitainers. One liter was preserved with two ml of concentrated H_2SO_4 for analysis of nutrients (except for dissolved ortho-phosphate). Water for dissolved ortho-phosphate analysis was field filtered (after June 1985) with the use of polypropylene syringes, Gelman® Delrin™ syringe-type membrane filter holders and 0.45 micron membrane filters as mentioned above. The sample was then filtered into Corning™ 16 x 125 mm polystyrene disposable culture tubes. On sample runs where metals were examined, a liter cubitainer was preserved with 10 ml (later in the survey 2 ml) of 1:1 redistilled HNO_3. All samples were stored and transported to the laboratory on ice to reduce the sample temperature to 4°C.

FLOW

Flow was measured using standard techniques (Leupold and Stevens 1978; Rantz 1982a, 1982b; Van Haveren 1986; and U. S. Bureau of Reclamation 1967). Flow (discharge in cubic feet per second) was measured with a Marsh-McBirney Model 201 portable water current meter. A bridge board and winch were used with the meter during high flows on the Rock Creek stations.

Flow has historically been monitored by the U.S. Geological Survey near the mouth of Rock Creek and at other miscellaneous stations over the past few decades (see discussion in Introduction). During this project the U. S. Geological Survey operated a gauging station at the mouth of Rock Creek (station S-1) until 1983 when a hydroelectric facility was built just above it. The gauging station was then moved to Poleline Road (station S-2) and will remain at that site at least until the end of the water quality monitoring portion of this project ends in 1990. The station is serviced and calibrated by the U. S. Geological Survey to their standards and specifications. The station supplies daily flow data.

STREAM BANK EROSION

Eight sites at seven different localities were selected for stream bank erosion measurements, six on Rock Creek (at five locations) and two on Cottonwood Creek (Fig. 1). Sites were selected that appeared to be in the active erosion or mass wasting process. The areas selected have been previously noted as sites of significant stream bank erosion (Hedrick 1969 and Wroten and Clark 1980). Representative reaches were chosen for measurement, with the starting point being randomly selected. Two of the locations (Stricker Cabin and 3500 East Road, Kerr Land and Livestock) on Rock Creek have been monitored in the past for stream bank erosion estimations (Martin 1983a, 1984; and Clark 1985c). Additional sites added include two on Cottonwood Creek (Cottonwood Creek Lower; Kerr Land and Livestock; and Upper, the Roy Jesser property); and four on Rock Creek (an additional site at Stricker Cabin; a site on the

Richard Stafford property below S-5; Magic Canyon Arabians, the Marvin Spacek property; and a site on the Jay Moyle property, both below S-3(Fig. 1).

Transects 300'(91.5m) in length were established parallel to and what was considered a "safe" distance from the stream bank to be measured (Figure 3).

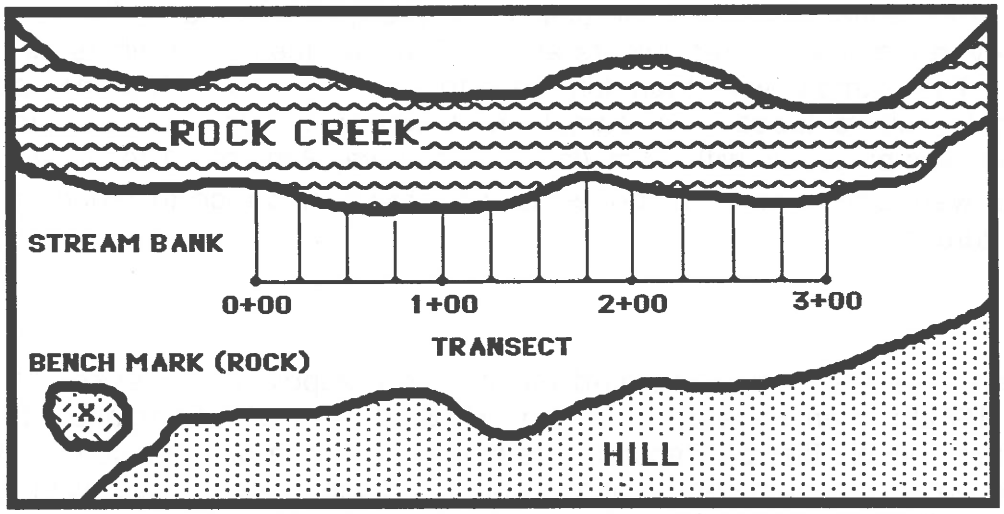

Figure 3. Diagramatic representation of a stream bank erosion transect on Rock Creek. Transect and subtransects are shown as well as the lines of measurement at 90° angles to the transect line at each 7.6 m increment. The numbered points are permanent markers.

Because of problems of high water washing out survey stakes (Martin 1984), we established permanent bench marks (usually large lava rocks) some distance from the stream bank. With the use of an engineering level we located our 0 stake at the beginning of the transect. In the event that the transect stake (or stakes) are washed out or otherwise destroyed, the transect can be easily relocated. A wooden stake was placed at each 100'(30.5m). A nylon cord fitting tightly over a nail in the top center of each wooden stake gives a straight subtransect to conduct measurements. The cord is marked in 25'(7.6m) increments. Starting at the 0 point, a measurement was taken each 7.6m, for a total of 13 measurements per transect. The observer (same person used each time for relative consistency) stands near the line and sights along the transect with a Leitz® double pentaprism. The prism allows the observer to see at right angles and center a marker held by a second person at a point on the stream bank to be measured. Once the point was established the distance was measured from the marked cord to the edge of the stream bank. The stream bank is assumed to be vertical, thus averaging out the situations where undercutting is a problem or where the toe of the bank is wider because of fallen bank material. Height of the bank was determined at each measurement point (7.6m) with the level and a surveyor's rod. Color photographs were taken of the various stream bank sites and of the verticle soil profile at the cut bank. Bulk densities of the stream bank (alluvial material) were estimated by sampling 30 cm^3 of each obvious layer with an Eley® volumeter. Oven dry weights were then obtained and bulk densities calculated for each layer. The bulk density values were averaged for each site. This allows for erosion/unit area calculations to be made as follows:

$$V = W \times H \times L; \qquad SBE = V \times BD$$

where: V = Volume of stream bank eroded

W = Width of stream bank eroded

H = Height of stream bank eroded

L = Length of stream bank eroded

and: SBE = stream bank erosion in tons

BD = Bulk Density

Once the contribution of sediment was calculated for a specific site, the information was extrapolated for Rock Creek and Cottonwood Creek using the map produced by Hedrick (1969).

STREAM CHANNEL SUBSTRATE ANALYSIS

The locations selected for embeddedness and core sampling is a nonrandom activity. Since specific microhabitats are selected by salmonids for spawning and rearing activities, we must select similar areas for substrate analysis. In addition to accessing fish spawning and rearing conditions, I plan to use the following methods to monitor changes in the stream channel for the duration of the study. Most of the techniques used are described in Levinski's (1986) review of the literature.

Embeddedness

Cobble embeddedness was measured during fall low flow beginning in 1986 at each Rock Creek sample station (Kelly and Dettman 1980; Platts et al. 1983; and Burns 1984, 1985). A 60 cm steel hoop is randomly thrown into an area of the stream meeting the following requirements: areas that appear to be summer and winter salmonid rearing habitats; float time across the 60 cm hoop is between 0.9 and 2.5 seconds; water depth is between 15 and 45 cm; must not be in an eddy caused by a pool or large boulder; and particles measured must be between 4.5 and 30 cm. The amount of embeddedness of the cobble in fine sediment is measured with a plexiglass measuring device to the nearest mm and compared with the total diameter of the particle at a right angle to the plane of deposition of the fine sediments. From this a percent embeddedness value is obtained. A minimum of 100 particles are measured per station.

Core sampling

Core sampling was done to access salmonid spawning habitat (Platts et al. 1983; and Rainville personal communication). Samples were taken during fall low flow beginning in 1986 at each Rock Creek sample station. Ten samples were taken at each station. Samples were collected from a 6"(15cm) diameter tube pushed into the substrate. Substrate is scooped out by hand and placed in the top of a 6" (15cm) diameter 9.5mm soil sieve. When the sieve volume is filled with substrate the sample is wet sieved on site. A lid is placed over the sieve to prevent any loss of material. A 6.35mm and 0.85mm sieve are placed beneath the 9.5mm sieve. The sieves are then placed into a coffee can and shaken as about 700-800 ml of water is added. The liquid (fine sediment and water) is then placed in an Imhoff cone and allowed to stand for approximately 15-20 minutes. The coffee can is then filled with water, set in a level area, and allowed to drain from a spout located near its top. The contents of each screen is then added carefully to the container of water and the overflow is collected into a graduated cylinder. The volume of each screen is then recorded. The amount of sediment that passed through the 0.85mm sieve and settled into the bottom of the cone is also recorded. By this means percent fine sediment can be estimated.

BACTERIA

Bacterial grab samples were collected according to Greeson, et al. (1977) into sterile 250 ml Nalgene™ polyethylene bottles. All samples were placed on ice to cool to 4°C and shipped to the State laboratory on the same day as sampled. Analyses were conducted by the Bureau of Laboratories (American Public Health Association 1980 and 1985).

BENTHIC MACROINVERTEBRATES

Benthic macroinvertebrates were monitored and data analysed (Cairns and Dickson 1973; Greeson et al. 1977; Pascoe and Edwards 1984; Weber 1973; and Winget and Mangum 1979). The benthic organisms were sampled on Rock Creek in March, June, August, and November with a Hess sampler ($0.10m^2$). The November and March samples measure the benthic community response to approximately five months of "background" water. June and August are taken during the irrigation season, a time of high sediment concentrations. Three samples were collected at six stations on Rock Creek on each collection date. Samples were preserved in 70% isopropyl alcohol. Identifications were made by the State Department of Health and Welfare, Bureau of Laboratories, and taxonomic specialists where needed. Voucher specimens have been deposited in the College of Idaho Museum of Natural History, Caldwell (CIDA).

FISHERIES

The fish (game and nongame) populations of Rock Creek were sampled at six locations during the first year of the project and again during March 1985. Electrofishing was the capture method utilized (Reynolds 1983) at the same six locations used for benthic organism collection. Electrofishing was used because it is nonconsumptive and provides the necessary data for determining relative fish population abundance and length-weight data to determine age, growth and size class distribution of fish in Rock Creek. The four-step removal depletion method described by Zippin (1958) was used on 100 meter transects. Voucher specimens have been deposited in the College of Idaho Museum of Natural History, Caldwell. Habitat Evaluation Procedures (HEP) analysis was conducted in 1982 and 1984. See also stream channel substrate analysis discussed below.

Fish tissue was analyzed by the State of Idaho Bureau of Laboratories for organo-phosphorus insecticides and triazine herbicides from two locations sampled in March 1982 (S-1 and S-6) and at four (S-1, S-2, S-3, and S-6) Rock Creek stations during March 1985.

STATISTICS

Statistical and data analysis methods follow Dixon (1953), Sokal and Rohlf (1969), Youden and Steiner (1975), Ponce (1980), SAS Institute (1982), U. S. Environmental Protection Agency (1982a), and NCASI (1985).

QUALITY ASSURANCE

Quality assurance (quality control) is standard operating procedure for both the laboratory and the field portions of the research. Quality assurance for the field work is outlined above and follows U.S. Environmental Protection Agency (1985), Bauer (1986), and Bauer et al. (1986) guidelines. Laboratory quality assurance follows Idaho Department of Health and Welfare (1984) and U.S. Environmental Protection Agency (1983) guidelines.

Two specific quality assurance methods are outlined below:

Precision

Duplicate (split) samples are taken at subbasin station 7-4 on each survey date for each parameter. Chemical samples are divided with the churn splitter. Duplicate bacterial grab samples are taken as close together (in time and space) in the stream as possible. These data are then treated following guidelines to determine the relative range of the precision of the duplicate samples U.S. Environmental Protection Agency (1983).

Accuracy

Field spiked samples were collected for the first time during 1985. Three sets of spiked samples were collected for all Rock Creek stations and for most (20) of the subbasin stations. Chemical spikes for the following parameters (ortho-phosphate, total phosphorus, nitrate, total Kjeldahl nitrogen, calcium, fluoride, chloride, potassium, sodium and magnesium) were prepared in the laboratory and were sealed in Kimble™ 10 ml borosilicate glass ampules. Celite was used for suspended solids spiking and was contained in polypropylene vials. The spike containers were placed into cubitainers containing 900 ml of sample water. The glass ampules were rinsed in sample water before opening. Percent recovery is calculated according to the known amount of the material in the spike by subtracting the "background" values determined by the analysis of split unspiked samples.

MISCELLANEOUS

Color photographs were taken of each sample station during each survey for comparison with other sample dates and to help show the progress of the Rural Clean Water Program. The photographs make a permanent record of visual water quality, riparian conditions, sediment deposits, and other important features.

Complete water quality data for this survey are on file with the U.S. Environmental Protection Agency (STORET) and the Idaho Department of Health and Welfare, Division of Environment, 450 W. State Street, Boise Idaho 82720.

RESULTS AND DISCUSSION

FLOW (DISCHARGE)

Background data on flows in the subbasins and in Rock Creek have been given in Martin and Bauer (1982); Martin (1983a and 1983b); Martin (1984) and Clark (1985c). Flows for 1981-1984 for the major subbasin stations (upstream and downstream) were presented in Clark (1985c). U. S. Geological Survey (1977-1985) gives flows for stations S-1 and S-2 as appropriate. U. S. Geological Survey (1962-1976) gave flow data for Rock Creek near Rock Creek (S-6). The dominant flow incident of the study was the 100 year runoff event of 1984 (Martin 1984 and Clark 1985c). This event influenced the hydrogaraph in Rock Creek during May and June 1984 and effectively masked any influence in the stream of BMPs implemented in the subbasins.

Rock Creek was historically fed by snow melt in the higher watershed. It was characterized by low summer and fall stream flows and high flows in the spring from winter runoff. When the area was developed for irrigated agriculture, this activity changed the historical flows. Irrigation return flows were added to Rock Creek (early April annually), which greatly increased the summer stream flow. Stream flows now peak in September. Additional water is now added in mid March for hydropower production. The average discharge for Rock Creek at Poleline Road (S-2) for the 25 year period 1923-46 and 1984 was 213 cfs (154,300 acre-ft/year) with a maximum of 983 cfs (September 21, 1927) and a minimum of 90 cfs (March 28, 1941)(USGS 1985). The maximum reported during the 100-year flood of 1984 was 876 cfs (May 15)(USGS 1985). The stream gradient of Rock Creek is fairly constant up to river kilometer 40; from there the slope substantially increases with the last 1.5 kilometers before the confluence with the Snake River being the steepest.

The precipitation for 1963-1983 is listed in Table 7 to show the annual variation for the area. Precipitation for the Rock Creek RCWP collected at the Twin Falls weather station is listed in Tables 8-13 and covers from 1981 through September 1986. The 1981-1984 data was obtained through the HISARS system at the University of Idaho, Moscow (Molnau 1983) and the 1985-1986 data from National Oceanic and Atmospheric Administration (1985, 1986). Precipitation has varied over the life of the project with a low of 7.89" recorded for 1985 and a high of 15.90" in 1983. The year of the 100 year runoff event (1984) had 11.29" of total precipitation. The years 1981-1985 had a mean annual precipitation value of 11.56". The 1986 record is incomplete but as of the end of September, 10.37" of precipitation had fallen.

SEDIMENT

Suspended sediment

Suspended sediment consists of solid material (mineral or organic) that is in suspension and is being transported by water 3 in (7.5 cm) above the stream bottom to the top of the water column. Suspended sediment is used as an indicator or key parameter for water quality studies involving agricultural return flows (Clark and Bauer 1982 and 1983) and is important to land management agencies, landowners, and the State's Division of Environment. Soil retained on the land will benefit the landowner and the stream water quality.

Suspended sediment has shown a significant decrease in five of the six subbasins examined (Clark 1985c). Monthly suspended sediment loadings for selected subbasins are shown in Figures 4-7. Some stations show significant suspended sediment reductions when comparing 1984 and 1985 data with 1981 values. Some stations show excellent reductions, for example: 2-2, 4-3, 5-2 and 7-4 (Figures 4 and 5). Others show more variation in the results. Some stations (2-3, 2-4, 7-7 and 10-1) do not show much, if any, reduction in suspended sediment (Figures 6 and 7) which relates directly to the progress of the installed BMPs.

Suspended sediment loadings were compared for the critical irrigation (and sediment production) months of May through August 1981-1985 for the subbasin stations entering Rock Creek (Table 14) and for Rock Creek itself (Table 15). Substantial reductions in suspended sediment are shown at subbasin stations 1-2, 2-2, 4-2, 4-3, 5-2, and 7-4 (Table 14). Some of these reductions are quite dramatic: 99% for subbasin 4-3 in August; 94% for subbasin 5-2 in August; 93% and 94% for subbasin 7-4 in July and August respectively (Table 14). Other reductions in suspended sediment are less dramatic but still substantial, such as 75% and 55% respectively for station 7-4 May and June. Some subbasin stations are erratic or actually show an increase in suspended sediment (1-2 , May; 2-3; 7-7; and 10-1, all months examined) (Table 14). It is interesting to note that the largest reductions in suspended sediment (1981 vs. 1985) occurred during the months of July and August (see data for subbasins 2-2, 4-3, 5-2, and 7-4 for example).

Rock Creek's response to the sediment reduction is less dramatic than that of the subbasin drains because of dilution by the receiving waters and "background levels" of sediment present. Some of the improvements may be masked by stream bank erosion. There is a definite trend of sediment reductions when comparisons are made between the baseline year and 1986 (Table 15). Station S-6 and station S-2 show a more erratic response. Station S-6 is above the BMP treatments. Station S-2 lacks 1981 and 1982 data since it was only recently established. These factors may influence the appearance of the data. The dominant feature of the Rock Creek suspended sediment picture is that of the 1984 100-year runoff event (Martin 1984). The 1984 suspended sediment data, especially for May and June, are a major feature and may mask some of the sediment reductions resulting from BMP implementation. Station S-2, for example, has its greatest suspended sediment loads for each month during 1984.

Suspended sediment loadings of agricultural origin (irrigation season) are compared with those during the non-irrigation season (Table 16). Table 15 shows the progress made by the RCWP on Rock Creek's suspended sediment load. Sediment is decreasing at most sample stations. These data help substantiate Sterling's (1983) contention that little sediment is stored in Rock Creek.

Log concentrations of suspended sediment for subbasin 1 (sites 1-1 and 1-2), subbasin 2 (sites 2-1, 2-2), subbasin 4 (sites 4-1, 4-2; and 4-3, 4-4), subbasin 5 (sites 5-1, 5-2), and subbasin 7 (sites 7-1, 7-3; and 7-1, 7-4) were presented in Clark (1985c). These data show the change in sediment concentrations between the upstream and downstream sites on a drain over time (1981-1984). These graphs are useful because they show the increases in suspended sediment within a selected priority subbasin as the water travels through the system. They also show changes through the irrigation season and make comparisons between years. Five of the subbasin stations sampled showed significant (four stations at $p<0.01$) reductions in suspended sediment from 1981 to 1983.

Sterling (1983) concluded the following concerning the sediment relationships in Rock Creek: 1) improvement in water quality should correspond closely to the effectiveness of BMPs implemented; 2) fine sediments leaving the farm land should be washed through and not deposited in Rock Creek; 3) existing sediment deposits in the stream will be scoured out by high water; 4) the amount of sediment stored in the stream is about equal to the annual sediment load; and 5) that the best available sediment transport models are not satisfactory for simulating the behavior of Rock Creek. Sterling went on to suggest that the effectiveness of on-farm sediment control and treatment practices can be predicted by: 1) studying sediment size; 2) observing existing sediment deposits for change in size; 3) and studying the flow rate and sediment concentration records to determine this relationship.

Because of differences in the actual water quality monitoring results and the linear programming (LP) model developed by Dr. David Walker (University of Idaho, Moscow)(Kasal and Magleaby 1985) projections concerning the amount of sediment reduction in the subbasin drains, the following explaination is offered:

1) The water quality monitoring measures concentration (mg/L) of sediment..This can be converted to sediment loading, but the basic measure is sediment concentration. The LP model measures volume (tons) of sediment.

2) The water qualitdy monitoring measures sediment in the drains and in Rock Creek. The LP model measures sedimentd leaving the individual fields. The LP model is not affected by channel and stream bank erosion, as is the water quality monitoring.

3) The water quality monitoring portrays actual circumstances in a given year and reflects annual variability in parameters that affect sediment concentration, such as stream flow, ambfent quality of inflow water, precipitation and number of irrigatioins, and crop mix. Irrigation water managaement and the quality of BMP implementation. LP reflects an average measure that levels out annual variability.

4) The water quality data reflects any acerage diversin associated with other government programs. The LP model does not include acreage diversions. These affects should not be allowed to confound the analysis of BMP implemnation from RCWP with the LP model.

Sediment reduction coefficients are given in Table 46. These show the effeciencies of the various BMPs in reducing suspended sediment leaving the fields.

Stream bank erosion

Stream bank erosion is a natural phenomenon in the scour and fill processes of a river (Leopold and Maddock 1953; Emmett and Thomas 1978; and Andrews 1982). Stream bank erosion was again estimated for two areas along Rock Creek during 1985. The results show stream bank erosion values for the spring runoff period (April-May) for an area in the Stricker Cabin area and near Station S-5 (3500 East Road) (Clark 1985c). At the Stricker Cabin site 900 lineal feet of stream bank was measured. The area lost an estimated 1,920 tons of sediment during the study period for an average of 213.3 tons/100 feet of stream bank. At S-5 a total of 426 tons was lost in 400 feet of stream bank for an average of 106.5 tons/100 feet of stream bank. If we assume these sample sites representative of the two areas on Rock Creek, we find the area at Stricker Cabin eroding twice that of station S-5.

Wroten and Clark (1980) reported the channel of Rock Creek as "severely unstable and subject to continuous bank cutting and eroding" after walking the length of the stream from the U.S. Forest Service boundary to the confluence of the Snake River. The authors noted that continued erosion would occur especially at high flows unless positive bank stabilizing steps were taken. Sterling (1983) stated that although unstable, eroding stream banks contributed some sediment, "this is probably a very small amount." The data presented by Martin (1983a and 1984), Clark (1985b), and the present report contradict Sterling's assumption.

Martin (1983a) found that the Stricker Cabin site had a greater stream bank problem also. However, Martin (1984), reporting the results of the 100-year runoff event, found nearly a 38,000 ton loss from the 3500 East Road site and 24,000 ton loss from the Stricker Cabin site (a 463 percent increase over 1983). Martin (1984) reported that this material averages 39 percent sand and gravel and 61 percent silt loam. The sand and gravel portion would become part of the bedload sediment of Rock Creek and the remaining silt loam portion will become part of the suspended sediment fraction. From the data, an estimated 1,431 tons of suspended sediment was contributed to Rock Creek during the spring of 1984 along 1,300 feet of stream bank. For comparison, Clark (1985b) reported 29,000 tons of sediment from 13 miles of Weiser River stream bank for 1983.

The results of the study of five stream bank erosion sites in 1986 are presented in Tables 17 and 18. They show that over 50 percent of the length of Rock Creek has stream bank erosion problems. An estimated 20,065 tons of potential suspended sediment (silt-clay size fraction) were calculated from these preliminary measurements. During 1987 results will be presented for the data gathered at all eight study sites. Bulk densities of the stream banks are listed in Table 19. They give and indication of the erosive nature of the banks. The higher the bulk density value the more resistant the soil is to erosion. Bulk densities below 1.0 are rare in nature, yet a few are found on Rock Creek (Table 19). These bulk densities indicate that these soils have a high content of volcanic ash. They will erode easily. The ash is to be expected because of the volcanic nature of the area. If the layer of lower bulk density material is at a point where the water concentrates, the material will erode out and undercut the bank. The undercut bank will break off as large chunks adding to the load of sediment in the stream. Once in suspension a large portion will stay in suspension because of the steep gradient of the stream. At many of the sites there are lenses and layers of sand and gravel intermixed with the silt loams. These sand and gravel layers will often erode first (differential erosion) and thus cause undercutting and sloughing of the normally more durable layers. Examination of the gravel bars in Rock Creek indicates that their composition is coarse. Thus the fine material from the eroded stream banks is becoming suspended sediment (at least under suitable flows) and becoming part of the wash load. Since only very fine sediment is eroded from the farmland in the Rock Creek RCWP (Sterling 1983) we can assume that the coarse sands and gravels in the stream originated in the bank or bottom material.

Binns (1986) gives excellent examples of stream bank erosion and illustrates and describes methods for the stabilization of those banks. Precautions are given to those attempting bank stabilization since the application of improper methods can lead to more damage to the banks and the stream itself.

Stream channel substrate

The physical characteristics of the Rock Creek stations such as depth, width, gradient, and elevation are given in Table 20. These data are useful in interpretation of the embeddedness and substrate composition data.

Embeddedness

Cobble embeddedness was measured during fall low flow beginning in 1986 at each Rock Creek sample station (Kelly and Dettman 1980; Platts et al. 1983; and Burns 1984, 1985). Embeddedness values are given in Table 21 and compared with core sample results in Figure 8. Station S-6A has a mean embeddedness of 20 percent which will serve as background for the watershed. The 20 percent value is consistent with value reported by Burns (1984) and Burns and Edwards (1985) or Idaho batholith streams. Stations S-6 and S-5 had values of 56 percent and 64 percent, respectively, indicating a high degree of disturbance in those areas. Station S-6 is highly impacted by roads and stream encroachments while station S-5 is in an area of active stream bank erosion. Embeddedness between stations S-4 to S-2 is fairly constant and ranges from 40 to 45% indicating an area of relative stability but still considered too impacted to have good spawning and rearing areas for trout. Future sampling will show if the reduced sediment entering Rock Creek via improvements made in the irrigation return flow water will improve the cobble embeddedness.

Substrate composition

Core samples were taken of the stream channel at all six Rock Creek stations to determine the composition of fine sediments present. Areas which appeared to be potential salmonid spawning sites were selected. The results of the core sampling for 1986 are shown in Tables 22 and 23. These data will form a background for future comparison. The upper Rock Creek stations (S-6 and S-5) have relatively high background levels of fine sediment (31.1 and 29.7 percent respectively). No significant differences existed between these two stations (p=<0.05). The new stations S-6A and S-6B also show high levels for background (31.1 and 25.6% respectively) (Table 23). Stations S-4 downstream to S-1 vary from 47.1 to 36.9% in total fines (Table 23).

Don Martin sampled the substrate at S-1, S-3, S-4, and S-6 during 1982. A comparison is made of that data and the 1986 data in Table 24. Little can be conluded from the comparison except that both show substantial amounts of fine sediment at those sites. The 1982 sample size was small in relation to the 1986 sample size which makes correlations difficult.

Tappel and Bjornn (1983), Bjornn (1969) and Irving and Bjornn (1984) give data which relate substrate composition (amount of fines) and fish survival. The Rock Creek data will receive further analysis during 1987 and future years to compare with literature values. Corley and Newberry (1982) present substrate composition for the South Fork Salmon River in Idaho for 1981. This will also be compared with Rock Creek data, although would be expected to differ since different geologies are involved. Future sampling will show if the reduced sediment entering Rock Creek via improvements made in the irrigation return flow water will improve the substrate composition and yield cleaner gravels and less total fines.

PESTICIDES

A variety of pesticides have been sampled for and found in sediment (1983), water (1983) and fish tissue (1982 and 1985) in the Rock Creek watershed. Pesticides are commonly used in agricultural practices and are, thus, logical to investigate in environmental samples. Fish tissue is an excellent indicator of pesticide usage since the organisms bioaccumulate pesticides and thus show presence during the year rather than just following a chemical application. The edible portion of fish tissue was used since the results are then comparable to U. S. Food and Drug Administration standards (FDA 1979) and have public health implications. Sediment samples are another means of determining past pesticide use since the chemicals adhere to the particles. Water column samples are probably the least useful as pesticide indicators since the chemicals are only in the water of a given stream reach for a brief time.

Pesticide monitoring is important so that any reduction in their concentrations related to BMP implementation can be documented. In addition, with the renewed importance being placed on resource management and conservation tillage as a BMP, pesticide use is likely to increase. Sound background monitoring is required then to help determine if environmental levels of pesticides have been changed.

Martin and Bauer (1982) and Martin (1983) reported the results of the pesticide analyses from Rock Creek stations S-1 (mouth) and S-6 (upper station). DDT, PCB, toxaphene, and dieldrin were reported from the fish samples and were below the limits set for human health (FDA 1979) and for impact on the fishery (Thurston et al. 1979). Toxaphene and dieldrin which were not detectable at S-6 were found at S-1 (Tables 25, 28, 29, and 30). Clark (1985c) lists pesticides found in the bottom sediments of four of the major subbasin drains during October 1983. DDT and/or its analogs were found at all stations. The low ratio of DDT to its breakdown products indicates that the chemical is not now being used in the Rock Creek area but that residuals persist. Pentachlorophenol was identified at one station (5-2), and traces of dicamba and 2, 4, 5-T were found at one station (7-4). The water column at the same subbasin stations, as well as Rock Creek at Poleline Road, were sampled at the same time for pesticides. All five stations were below detectable limits for endrin, lindane, methoxychlor, toxaphene, 2, 4-D, and silvex (2, 4, 5-TP)(Clark 1985c). PCBs were found in trace amounts at stations 4-2, 4-3, and 5-2. A trace of DDE was also detected at station 4-3. Future sampling will be done early in the irrigation season (early May) in order to quantify the pesticides associated with the soil particles present at that time.

On 18 June 1985 a fish kill occurred on Cottonwood Creek, a tributary to the upper part of Rock Creek. The fish kill was apparently caused by an algicide which leaked into the creek from an irrigation canal. The event offered an opportunity to examine additional fish for pesticides (Clark 1985c). Moderate amounts (ppm) were found of DDT and its analogs, dieldrin, heptachlor, heptachlor epoxide (the breakdown product of heptachlor), HCB, lindane, T-nanachlor, and ∂-BHC with a trace of toxaphene. The highest concentration of a pesticide was 14.86 ppm for ronnel, which is an insecticide (systemic) used with livestock. Ronnel has a fairly high toxicity (LD_{50} >1700) (Berg 1983) and was probably not a factor in the fish kill.

Analysis of the 1985 fish pesticide data shows small concentrations of the following: PCBs; dieldrin; DDT and its analogs; pentachlorophenol; nonachlor; hexachlorocyclohexane; oxychlordane; heptachlor epoxide; and ß-BHC fish tissue in Rock Creek (Tables 25-30). Of these only DDT, PCBs, dieldrin, as well as toxaphene, were reported for 1982 fish data (Clark 1985c). Data on 23 specimens from four Rock Creek stations were reported in Clark (1985b). The values found were not of major public health or of major impact on the fishery (Food and Drug Administration 1979; and Thurston et al. 1979). DDT and dieldrin levels in fish increased between 1982 and 1985 at Rock Creek at the mouth (S-1)(Clark 1985c). An additional 11 fish specimens were analysed from three of the stations too late to be included in Clark (1985c). They have been added to the tables and discussion to give more complete results for pesticides in Rock Creek. An additional 7 are added to S-2; one to S-3; and 3 to S-6.

Some comparison of organic chemical data can be made with information collected between 1969 and 1980 by the U. S. Fish and Wildlife Service, National Contaminant Biomonitoring Program, Columbia, MO (unpublished data, 1985) for a Snake River station at Hagerman, ID. The Snake River fish had higher amounts of dieldrin, nonaclor, and DDT (and analogs) than did the Rock Creek samples. Rock Creek had oxychlordane and heptachlor present, but the compounds were not found in the Snake River samples. Endrin was detected once in the Snake River but not in Rock Creek (Tables 25-30).

Following is a list of pesticides commonly used in the Rock Creek, Twin Falls County, area (see Table 31) for a list of the pesticides including other names commonly used, chemical names, and use information):

	TRADE NAME	COMMON NAME
Insecticide:		
	Cygon	dimethoate
	Diazinon	diazinon
	Di-syston	disulfoton
	Furadan*	carbofuran
	Guthion	azinphosmethyl
	Malathion	malathion
	Sevin*	carbaryl
	Thimet	phorate
	Pounce*	permethrin
Herbicide:		
	Atrazine	atrazine
	Avenge*	difenzoquat methyl sulfate
	Banvel	dicamba
	Eptom*	EPTC
	Kerb*	pronamide
	Lasso	alachlor
	Ro-neet*	cycloate
	Roundup*	glyphosate
	Simizine	simazine
	Sonalan	ethalfluralin
	Surflan*	oryzalin
	Tillam*	pebulate
	Treflan	trifluralin
	Velpar	hexazinone
	2, 4-D	2,4-D
Fungicide:		
	Bayleton*	triadimefon
	Benomyl	benomyl
	Captan	captan
	Polyram*	metiram

Algicide:

	copper sulfate	copper sulfate
	xylene	xylene

* - State laboratory does not have capability to analyze these compounds (8/26/86).

In addition, the following organic compounds (mainly pesticides) have been detected by the State of Idaho Bureau of Laboratories from fish samples collected in Rock Creek (several have had use cancelled in the United States and were persistent in the environment, hence the discrepancies between the two lists):

	TRADE NAME	COMMON NAME
Insecticide:		
	DDT	DDT
	o.p. DDT	DDT
	p.p' DDT	DDT
	p.p' DDD	analog of DDT
	p.p' DDE	analog of DDT
	Dieldrin	dieldrin
	Hexachlor	beta BHC
	Hexachlorobenzene	hexachlorobenzene
	Lindane	gamma BHC
	Nonachlor	nonachlor
	Ronnel	ronnel
	Toxaphene	toxaphene
Fungicide:	Pentachlorophenol	penta
Coolant:	PCBs	aroclor

Table 32 lists more detailed information concerning these compounds.

NUTRIENTS

Nutrients are a major concern when examining the water quality of a stream. An excess supply of nutrients may cause a "polluted" stream containing an over-abundance of plant and animal biomass, especially of undesirable species or communities. The nutrients examined during this survey are phosphorus and nitrogen.

One of the most visible and important contributors of nutrients to the subbasins and to Rock Creek itself are confined livestock facilities. One example of this importance is shown below in a set of samples taken at station 7-4 during a rainfall event (0.02 inches, Table 12). Runoff from a small "feedlot" containing no livestock at the time was sampled. Samples were taken at 7-4 which is just below the confluence of the runoff drainage. The results are shown below:

Parameter (mg/L)	Sample Site: 7-4 Background July 1985	Feedlot Runoff July 31, l985	7-4 below Feedlot July 31, 1985
Total phosphorus	0.51	5.05	0.82
Dissolved ortho-phoshate	0.38	4.09	0.120
Total ammonia	n/a	2.23	n/a
Nitrate-nitrite	0.116	0.489	0.237
Total Kjeldahl nitrogen	0.79	12.65	n/a

The runoff from this small feedlot nearly doubled the total phosphorus and nitrate-nitrite of 7-4. The dissolved ortho-phosphate concentration was increased by three times. All of the values reported for the feedlot runoff are high (higher than instream concentrations). The Soil Conservation Service currently plans to address the problem of confined livestock facilities more fully. The results of this attention should be substantially reduced nutrient and bacterial contamination entering the subbasin drains and Rock Creek itself.

Phosphorus

To prevent the development of biological nuisances and to control accelerated or cultural eutrophication, total phosphorus as phosphorus (P) should not exceed 0.05 mg/L in a stream where it enters a lake or reservoir (U.S. Environmental Protection Agency 1977). Since the water will enter the Snake River and eventually several reservoirs, this criteria could have some significance. A desired goal for the prevention of plant nuisances in streams or other flowing waters not discharging directly to lakes or impoundments is 0.1 mg/L total phosphorus (MacKenthun 1973). Although instream criteria are difficult to obtain and may not apply equally to all surface waters, a range of 0.05-0.01 mg/L of total phosphorus may be a good indicator concentration for Rock Creek.

Total phosphorus values for subbasins 1, 2, 4, 5 and 7 exceed these recommended criteria (Clark 1985c). The significance of our phosphorus values have been discussed under the section on quality assurance. Total phosphorus is showing some reduction in concentration in the subbasins when comparing recent with 1981 data (Table 33). Total phosphorus loadings in Rock Creek for irrigation vs. non-irrigation seasons for the years 1981-1986 are presented in Table 33.

Ortho-phosphate is important to monitor because it is the biologically available form of phosphorus. Ortho-phosphate appears to have decreased slightly since the beginning of the project (Clark 1985c). Ortho-phosphate generally increases in concentration between the upper and lower sample stations in subbasins (Clark 1985c). Ortho-phosphate has been discussed in the quality assurance section.

Because the field method for dissolved ortho-phosphate has been changed, it appears that from June 1985 forward the values will be a mean 47% higher than samples taken from 1981 through May 1985 (Clark 1985c). This gives a more accurate value for dissolved ortho-phoshpate. The difference is due to field filtering of the sample which prevents further biological and/or chemical changes in the ortho-phosphate concentration. The difference will have to be considered in any comparisons of past data with 1985 and future data. Ortho-phosphate continues to be a puzzel in 1986. Table 34 shows the mean differences between the field and lab filtered samples for all stations for 1986. There little of any pattern to the results. The total mean difference between the samples was 58.8% higher for the lab filtered samples. The Rock Creek stations had lower percent differences than the subbasin stations (Table 34). One explanation for higher laboratory results is that the samples have time to hydrolize and give off more ortho-phosphate into the sample container as compared with the samples that are filtered in the field.

Nitrogen

Nitrogen (both inorganic and organic forms) is still considered to be a pollutant in the Rock Creek RCWP. The major source of inorganic nitrogen (nitrate) is from the production (and eventual plowout) of alfalfa (Medicago sativa L.) in this area (Robbins and Carter 1980). At least 50 percent of the nitrate present in groundwater is the result of plowout of alfalfa (Robbins and Carter 1980). Carter (pers. comm. 1985) believes that up to 70 percent of the nitrate in the groundwater of the Rock Creek watershed is attributable to alfalfa and other leguminous crop plowout. Carter et al. (1973) have shown that the mean concentration of nitrate nitrogen in the subsurface water Twin Falls irrigation tract is 3.24 mg/L. In contrast, organic nitrogen (total Kjeldahl nitrogen) is mostly associated with the sediment. Sediment reduction will therefore reduce the organic (and total) nitrogen. We have shown this with significant reductions of organic nitrogen in half of the subbasins examined. Inorganic nitrogen is not significantly reduced by available BMPs (Clark and Bauer 1982 and 1983; and Martin 1983; 1984 and Clark 1985c).

The Rock Creek Technical Advisory Committee proposes that we continue to concentrate on sediment reduction as the key method of total nitrogen reduction. Improved surface irrigation water management would also reduce the amount of inorganic nitrogen leached into subsurface water. Martin (1983a) gives an excellent discussion of the Rock Creek RCWP nitrogen situation. For the purpose of the study, fertilizer is not considered a major source of nitrogen to water (Robbins and Carter 1980). Since the subsurface levels of nitrate are high and will continue to be high as long as the current crop rotation involving leguminous crops exists, we will continue to concentrate on suspended sediment reduction and the associated organic nitrogen reduction.

Inorganic Nitrogen

Nitrogen is another important nutrient and can cause water quality problems when it occurs in excess. A concentration of total inorganic nitrogen (nitrate, nitrite and ammonia) of 0.3 mg/L is considered the limit for preventing the development of biological nuisances and the acceleration of cultural eutrophication (IDHW 1980c). Nitrate usually comprises the major portion of total inorganic nitrogen and is often the only form of nitrogen considered when evaluating the 0.3 mg/L limit. The agricultural inflows often exceed the 0.3 mg/L limit. Past studies have indicated that little can be done to reduce inorganic nitrogen (dissolved form) loss from irrigated lands (Clark and Bauer 1982 and 1983; and Martin 1983a and 1984).

In most cases inorganic nitrogen is higher at the mouth of the subbasin drains and generally has not decreased during the project (Clark 1985c).

Organic Nitrogen

Organic nitrogen is usually associated with suspended sediment and thus reaches surface waters via irrigation return flows. Three subbasin stations show significant reductions in organic nitrogen (total Kjeldahl nitrogen) (Clark 1985c). Total Kjeldahl nitrogen is discussed in the quality assurance section. Upstream and downstream values for organic nitrogen were presented in Clark (1985c). Data for 1981-1986, a comparison of irrigation and non-irrigation season, is presented in Table 35.

METALS

Metals are not examined on the subbasin stations but are monitored on Rock Creek itself. Iron and boron are found in the greatest concentrations and are ubiquitous in the drainage (Table 36). In order of frequency of occurrence and magnitude of concentration are iron, boron, manganese, arsenic, and zinc. Chromium, copper, lead, and mercury are found at very small levels near the detection limits of the laboratory (Table 36). Cadmium was not detected and selenium is discussed below. For this reason I recommend that the water quality monitoring program discontinue further analysis of cadmium, chromium, copper, lead, mercury, and selenium in the water column. The remaining metals are still useful in trend analysis.

Metals were analyzed in fish (rainbow and brown trout) tissue at stations S-6, S-3, S-2, and S-1 in 1985 (Table 37). Zinc was the metal found in the highest concentrations at all stations (sampled for fish levels) and appears to be uniformly distributed in the watershed. In addition, in fish tissue, copper, manganese, and mercury were detected, but in levels not of concern for human consumption (Food and Drug Administration 1979).

In the water column zinc toxicity depends on water hardness. For the range of hardness values found in Rock Creek (most fall between 100-200 mg/L) the criteria for zinc is between 320 and 570 µ/L (U. S. Environmental Protection Agency 1986). The highest mean values for zinc on Rock Creek were found at station S-2, 11.02µ/L, far below the recommended criteria. The other metals of major environmental concern (chromium, copper, lead, and mercury) were not found in significant concentrations.

Selenium

Recent national concern over concentrations of selenium in the environment (especially in water draining agricultural lands)(Sacramento Bee 1985; and U. S. Department of Interior 1985) prompted study in 1986 to define the level for the Rock Creek watershed. Selenium is a naturally occurring element, is rare in many areas, and in excessive amounts is linked to livestock disease (Hem 1985). Selenium has also been found to be a dietary essential for animal life and deficiencies are common (Oldfield 1972; Stiles 1946).

Selenium was analyzed in water samples taken on June 2, July 29, August 11, and September 30, 1986 on Rock Creek and during the July and September surveys for all subbasin stations. No selenium was found in these samples (n=72). The detection limits of the laboratory were 5 µg/l (5 ppb). Hem (1985) reports average stream values for selenium in the 0.1-0.2 µg/l range.

BACTERIA

Fecal coliform bacteria are found in the intestinal tracts of warm-blood animals and are, therefore, used as indicators of contamination and the possible presence of other disease-causing organisms. Fecal coliform bacteria for upstream and downstream sample sites on subbasins 1, 2, 4, 5 and 7 were presented in Clark (1985c). Variation and change within a year and between the years 1981 and 1984 can be seen. The bacterial community is quite variable. Except for subbasin 1 the upstream stations usually have substantially less bacteria than the downstream stations (Clark 1985c). More detailed analysis will be done on bacteria for the next report. Reduction of pollution from confined livestock areas should improve the bacterial contamination reaching Rock Creek. Coliform numbers are compared for the project (1981-1986) in Tables 38 and 39.

FISHERIES

Fisheries data for 1981-82 were discussed by Martin (1982). Martin was able to sample Rock Creek station S-3 through S-6 in the fall of 1981 and S-1 and S-2 during March 1982. These data are combined to provide the baseline for fish populations for Rock Creek. All six Rock Creek stations were resampled during March 1985. Because of high flows during the winter and spring of 1986 we were unable to resample.

Much can be learned about Rock Creek by examination of the fisheries throughout the life of the project. Also the value of the urban fishery to the local residents in the Twin Falls area is substantial. Decreased pollution entering Rock Creek and a resultant improved fishery would be a valuable and measurable benefit to improved water quality.

The total fish populations of Rock Creek during 1981 and 1985 were given in Clark (1985c). Most fish live above station S-4. Station S-1 (Rock Creek mouth) increased by 1300%; Station S-4 by 800%; and Station S-6 increased by 66%. More data are needed to draw a clear relationship here, but reduced pollutants from the subbasins could be playing a part in the apparent improvement in the fisheries at station S-1 (Clark 1985c). Platts and Nelson (*In Press)* have shown wide annual fluctuations in trout numbers and biomass in the West and suggest long-term studies to avoid this bias. Suggestions have been made that the increased trout numbers during 1985 were due to increased fish planting efforts by the Idaho Department of Fish and Game. Clark (1985c) indicates that this is not the case and shows significant wild trout population increases at S-1, S-4, and S-6. In addition, hatchery trout are still good indicators of stream habitat and water quality. Hatchery trout usually do not survive over winter, so they do not replace the native wild trout in the stream.

The high numbers of nongame fish and the dearth of gamefish at station S-5 tells much about the habitat in that area. The area does not have good food (macroinvertebrate) production (Clark 1985c); the area has little riparian vegetation to shade the stream (hence higher temperatures are found in this reach); and sediment forms the stream bottom. The unstable streambanks in this area contribute substantially to this condition. The nongame species that are numerous at site S-5 are the more temperature tolerant species (especially mountain suckers and speckled dace). Since macroinvertebrate habitat is not good and production is low at S-5, trout production is also very low (Clark 1985c). Improved habitat at this site and a reduction in sediment to Rock Creek in this reach would result in increased game fish production. Additional biological information was included in (Clark 1985c), such as length, weight, condition factor, standing crop and biomass. The biomass for rainbow trout increased at four of the six Rock Creek stations.

MACROINVERTEBRATES

Macroinvertebrates are the larger (>thirty mesh) invertebrates (predominantly insects, but including such groups as snails and worms) found living in streams and rivers. They are important as water quality indicators since they spend all or part of their life cycles in the water and thus reflect long-term conditions. They are also important because they process organic matter in the stream and, in turn, become food for other organisms such as some of the fish species. Although accurate for many situations, chemical and physical analysis alone can't give enough biological information to predict long-range effects or to monitor change over time.

Macroinvertebrates have been sampled at the six Rock Creek stations since 1981 (Table 40 and Figures 9-14). The highest diversity of macroinvertebrates (35 taxa) is found at the upper station (Station 6) indicating that the highest water quality is at that site. The majority of pollution intolerant organisms (Plecoptera for example) are found at this station. The lowest diversity and largest group of pollution tolerant organisms are found at Station 1 (mouth of Rock Creek). A better discussion of the significance of these organisms can be made when more of the groups have been identified to species.

QUALITY ASSURANCE

Quality assurance is essential to any monitoring program for data integrity. The results of the quality assurance testing done between 1984 and 1986 aid greatly in the interpretation of the water quality data collected during the Rock Creek RCWP. The description of results in relative terms - excellent, good, fair, and poor - are personal value judgements of the author of acceptable data quality for purposes of water pollution assessment and may vary depending on the survey objectives or the desires of the investigator (Bauer et al. 1986 [*In Press]*). Outliers in the data were excluded using Dixon's "Criterion for Rejection of Outlying Measurements" (Youder and Steiner 1975).

Precision

Precision is a measure of agreement among individual measurements of the same property, under prescribed similar conditions (US EPA 1983). Precision is expressed in terms of concentration units (range of duplicates or standard deviation) or as it is related to the mean concentration (relative range or average coefficient of variation) (Bauer 1986; Bauer et al. *In Press*; and US EPA 1983). Precision has been studied since 1984 with duplicate samples being taken at subbasin 7-4 for each sample run during 1984-1986 and for Rock Creek Station S-2 (Poleline Road) during 1986, so that an estimate of precision is obtained. Precision was good for suspended sediment, total Kjeldahl nitrogen, total phosphorus and nitrate-nitrite with mean relative ranges of 9.7, 9.9, 11.8 and 17.4 percent, respectively, for 1984-85 data. During 1986 the average relative ranges for Stations S-2 and 7-4 (combined) were 8, 14.6, 11.8, and 25.5 percent for the same parameters, respectively. For 1986, the values for suspended sediment, total Kjeldahl nitrogen, nitrate-nitrite nitrogen, total phosphorus, and dissolved ortho-phosphate are considered good (Clark 1985c). Precision was poor in 1984-85 for dissolved ortho-phosphate and fecal coliform bacteria (mean relative ranges 23.2 and 44.8 percent, respectively) but was good in 1986 with relative ranges of 17.8 and 18.8 percent, respectively (Clark 1985c).

Additional parameters were examined on Rock Creek itself and data for Station S-2 show excellent precision for minerals: hardness, total alkalinity, bicarbonate alkalinity, potassium, sodium, and magnesium (2% relative range or less) and good to poor precision for trace metals (Table 43). The poor precision for metals in Rock Creek may be partly because of the low number of samples [less than the 10 recommended by Bauer (1986)] and by the fact that metal levels are so near their detection limits that small differences in value become large differences in average relative range. Precision for metals in fish tissue was good (Table 37) but was not calculated because of the small sample size.

Accuracy

Accuracy is a measure of the closeness of an individual measurement or an average of a number of measurements to the true value. Accuracy includes both precision and recovery (or bias) and can be expressed as a percent recovery (or percent bias) interval (US EPA 1983). Accuracy is expressed in mean percent recovery.

During 1985 the mean percent recovery for suspended sediment was excellent at 101% (95% confidence interval between 96 and 107%) (Table 44). Excellent recovery was also found for total Kjeldahl nitrogen (99%, ±2%), calcium (94.4%, ±5%), magnesium (99.9%, ±10%), sodium (98.5%, ±0.3%), total phosphorus (106.6%, ±5%) and potassium (109%, ±3%). Recovery was good for chloride (89.7%, ±1.4%) and fair for nitrate (92.4%, ±36%). Recovery was poor for fluoride (12.5%) on all samples (Table 44). Evidently there is interference in surface water resulting to the poor recovery. Results for ortho-phosphate were erratic (Table 44). Some random contamination evidently occurred in June (±51% confidence interval) but was apparently corrected in July (±10.6 confidence interval) and August (±7.3 confidence interval) (Table 44).

Accuracy sampling was reduced during 1986 but the minimum number of samples suggested by Bauer (1986) was maintained (Table 45). Only the key parameters (suspended sediment and nutrients) were sampled. The accuracy for some other parameters was established during 1985. Excellent recovery was found for all parameters (suspended sediment, 94%, ±5.3%; total phosphorus, 105.7%, ±4.1%; ortho-phosphate, 107.3%, ±8.6%; nitrate-nitrite, 106%, ±3.9%; and total Kjeldahl nitrogen, 102.5%, ±6.9%). The random contamination problems reported for dissolved ortho-phosphate during 1985 (Clark 1985c) have apparently been corrected. Random phosphorus contamination was found by the Idaho Department of Health and Welfare, Bureau of Laboratories, in the Schleicher and Schuell® filters used. In 1986 the laboratory began using Micron Sep™ filters with excellent results as seen in the above data. Continued testing of the filters has found no phosphorus contamination.

The results of the quality assurance work on Rock Creek show that the data are precise and accurate. The problems with fecal coliform bacteria are to be expected, since they represent a dynamic biological community. The problem with dissolved ortho-phosphate has been corrected. The problem with fluoride encountered during the 1985 survey has been attributed to natural interference in the water in Rock Creek by the Idaho Department of Health and Welfare, Bureau of Laboratories. The results of the fluoride analyses are not critical to the Rock Creek RCWP.

WATER QUALITY - BMP - CROP RELATIONSHIPS

The relationships between changes in water quality in a receiving stream and BMPs implemented on farm land is often hard to link (National Water Quality Evaluation Project 1986). In the Rock Creek watershed, subbasin 7 has shown the greatest reduction in suspended sediment and had the greatest percentage of implemented BMPs (Clark 1985c) and this trend continues.

The first year of intensive water quality monitoring (1981) also showed the highest concentrations and loadings of suspended sediment. We examined the relationship between that high sediment production and type of crops grown. Examination of crop data for beans, corn, and sugar beets (the most erosive types of row crops) showed that during 1981 production of that class of crops was lower than or equal to subsequent years in all subbasins. These data indicate that the 1981 high sediment year was not just a time of erosive crops and that subsequent reductions in suspended sediment concentrations and loadings are positively correlated to BMP implementation. The precipitation for 1981 was at the mean (11.44in vs. the mean of 11.56in) for the study period (1981-1986) and did not appear to differ in distribution enough to cause the high sediment values for the year (Tables 8-13).

Additional analysis is needed concerning these relationships. This work is planned for the next report.

CONCLUSIONS AND RECOMMENDATIONS

The Rock Creek Rural Clean Water Program is reducing agricultural water quality pollutants in the subbasin drains significantly with sufficient BMP implementation. Improvements in Rock Creek itself are beginning to be quantified. The fishery in Rock Creek appears to be responding positively to the reduced sediment loadings. All Rock Creek sample stations show severe impact by fine sediments. The history of erosion from farm ground and the problems with unstable stream banks appear to be the sources for these sediments.

Because BMP implementation will continue for another five years, it is therefore necessary to continue the current (or higher) level of water quality monitoring in order to adequately quantify water quality changes and associate them with the implemented BMPs. The quality assurance work is vital to the research and will continue. The additional studies involving stream bank erosion, cobble embeddness, and substrate composition show potential for helping explain the sediment situation on Rock Creek and will continue. Analysis for the metals: cadmium, copper, chromium, lead, mercury, and selenium in the water column will be discontinued. After six years of sampling we have adequate background data for those parameters. We will continue to sample all other parameters as was done during 1986. Because of the proposed changes in BMP direction toward more use of conservation tillage, pesticide monitoring will continue and possibly increase.

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LITERATURE CITED

American Public Health Association. 1980. Standard methods for the examination of water and wastewater. American Public Health Association, American Water Works Association, & Water Pollution Control Federation, Washington, D.C. 1,134 pp.

_______. 1985. Standard methods for the examination of water and wastewater. American Public Health Association, American Water Works Association, & Water Pollution Control Federation, Washington, D.C. 1,268 pp.

Andrews, E. D. 1982. Bank stability and channel width adjustment, East Fork River, Wyoming. Water. Resour. Res. 18: 1184-1192.

Baker, R. J., R. E. McDole, and G. H. Logan. 1983. Idaho soils atlas. Univ. ID Press, Moscow. 148 pp.

Bauer, S. B. 1986. Pilot study of quality assurance sample procedures 1986. Water Qual. Bur. Rpt., IDHW-Div. of Environ., Boise. 41 pp.

_______, W. H. Clark, and J. A. Dodds. 1986a. Quality assurance sample procedures for water quality surveys. Abstract. Retort 22(3): 7.

_______.1986b. Quality assurance sample procedures for water quality surveys. Jour. ID Acad. Sci. 22. *In Press.*

Bellinger, W. Y. 1980. Runoff monitoring. Dept. Transportation, FHA, Arlington, VA. 127 pp.

Berg, G. L. Editor. 1983. Farm chemicals handbook. Meister Publ. Co., Willoughby, OH. 530 pp.

_______. 1986. Farm chemicals handbook. Meister Publ. Co., Willoughby, OH. 540 pp.

Berg, R. D., and D. L. Carter. 1980. Furrow erosion and sediment losses on irrigated cropland. Jour. Soil Water Conserv. 35: 267-270.

Binns, N. A. 1986. Stabilizing eroding stream banks in Wyoming. WY Game Fish Dept., Cheyenne, WY. 42 pp.

Bjornn, T. C. 1969. Embryo survival and emergence studies. Salmon and steelhead investigations. Job Complet. Rpt., Project F-49-R-7. ID Dept. Fish Game, Boise. 9 pp.

Bondurant, J. A., C. E. Brockway, and M. J. Brown. 1978. Predicting irrigation return flow rates. Trans. ASAE 21: 1142-1143.

Brockway, C. E., F. J. Watts, C. W. Robison, R. P. Sterling, and V. L. Watkins. 1983. Development of a sediment generation and routing model for irrigation return flow. Annual report. ID Water Energy Resour. Res. Inst., Moscow. 69 pp.

Brown, M. J., D. L. Carter, and J. A. Bondurant. 1974. Sediment in irrigation and drainage waters and sediment inputs and outputs for two large tracts in Southern Idaho. Jour. Environ. Qual. 3: 347-351.

Burns, D. C. 1984. An inventory of embeddedness of salmonid habitat in the South Fork Salmon River Drainage, Idaho. U.S. Dept. Agric., Forest Serv., McCall, ID. 30 pp.

_______, and R. E. Edwards. 1985. Embeddedness of salmonid habitat of selected streams on the Payette National Forest. U.S. Dept. Agric., Forest Serv., McCall, ID. 39 pp.

Cairns, J., Jr., and K. L. Dickson, eds. 1973. Biological methods for the assessment of water quality. Amer. Soc. Test. Mater., Spec. Publ. 528. Philadelphia, PA. 256 pp.

Canter, L. W. 1985. River water quality monitoring. Lewis Publ., Inc., Chelsea, MI. 170 pp.

Carter, D. L. 1976. Guidelines for sediment control in irrigation return flow. Jour. Environ. Qual. 5: 119-124.

_______, and J. A. Bondurant. 1976. Control of sediments, nutrients, and adsorbed biocides in surface irrigation return flows. EPA-600/2-76-237. U. S. Environ. Protection Agency, Ada, OK. 53 pp.

Carter, D. L., J. A. Bondurant, and C. W. Robbins. 1971. Water-soluble NO_3-nitrogen, PO_4-phosphorus, and total salt balances on a large irrigation tract. Soil Sci. Soc. Amer. Proc. 35: 331-335.

Carter, D. L., M. J. Brown, C. W. Robbins, and J. A. Bondurant. 1974. Phosphorus associated with sediments in irrigation and drainage waters for two large tracts in Southern Idaho. Jour. Environ. Qual. 3: 287-291.

Carter, D. L., and C. W. Robbins. 1978. Salt outflows from new and old irrigation lands. Soil Sci. Soc. Amer. Jour. 42: 627-632.

_______, and J.A. Bondurant. 1973. Total salt, specific ion, and fertilizer element concentrations and balances in the irrigation and drainage waters of the Twin Falls Tract in Southern Idaho. ARS-W-4, USDA Agric. Res. Ser. 37 pp.

Champlin, R. L. 1974. Introduction to monitoring and surveillance of the environment. U. S. Environ. Protec. Agency, Washington, D. C. 346 pp.

Clark, W. H. 1975. Water quality status report, Rock Creek, Twin Falls County, Idaho, 1972-74. Water Quality Series 18, IDHW-Div. Environ., Boise. 69 pp.

________. 1985a. Rock Creek Rural Clean Water Program: An overview. Proc. WA State Entomol. Soc. 47: 756-758.

________. 1985b. Water quality status report, Lower Weiser River, Washington County, Idaho. Water Quality Series 53, IDHW-Div. Environ., Boise. 81 pp.

________. 1985c. Rock Creek Rural Clean Water Program comprehensive monitoring and evaluation, annual report. IDHW-Div. Environ., Boise. 153 pp.

________. 1986. Rock Creek Rural Clean Water Program. Abstract. Retort 22(3): 7.

________, and S. B. Bauer. 1982. Water quality status report, Conway Gulch, Canyon County, Idaho. Water Quality Series 49, IDHW-Div. of Environ., Boise. 61 pp.

________. 1983. Water quality status report, Lower Boise River Drains, Canyon County, Idaho. Water Quality Series 50, IDHW-Div. Environ., Boise. 101 pp.

Corley, D. R., and D. D. Newberry. 1982. Fishery habitat survey of the South Fork Salmon River - 1981. U. S. Forest Service, Boise, ID. 83 pp.

Cross, F. L., Jr. 1975. Water pollution monitoring. Environ. Mono. Ser. 1. Technomic Publ. Co., Inc., Westport, CT. 38 pp.

Crosthwaite, E. G. 1969. Water reasources in the Goose Creek-Rock Creek Basins, Idaho, Nevada and Utah. Water Infor. Bull. 8. ID Dept. Reclam., Boise. 73 pp.

Curtis, W. R., K. L. Dyer, and G. P. Williams, Jr. 1986. A manual for training reclamation inspectors in the fundamentals of hydrology. U. S. Dept. Agric., Forest Serv., Berea, KY. 56 pp.

Dixon, W. J. 1953. Processing data for outliers. Biometrics, 9: 74-89.

Edwards, T. K., M. L. Jones, and H. R. Seitz. 1982. Water-quality monitoring in the Marsh Creek, Rock Creek, and Cedar Draw areas, Bannock and Twin Falls Counties, Southern Idaho. U. S. Geol. Surv. Open-File Rpt. 51 pp.

Emmett, W. W., and W. A. Thomas. 1978. Scour and deposition in Lower Granite Reservoir, Snake and Clearwater Rivers near Lewiston, Idaho. Jour. Hydraul. Res. 16: 327-345.

Environment Canada. 1983. Sampling for water quality. Water Qual. Branch, Inland Waters Directorate. Ottawa, Ontario, Canada. 55 pp.

Food and Drug Administration. 1979. Action levels for poisonous or deleterious substances in human food and animal feed. FDA, Washington, D.C. 13 pp.

Frenzel, S. A., and M. L. Jones. 1985. Water-quality data for Marsh Creek, Rock Creek, and Cedar Draw, Southern Idaho, 1970-81. U. S. Geol. Surv. Open-File Rpt. 85-159. 43 pp.

Greeson, P. E., T. A. Ehlke, G. A. Irwin, B. W. Lium, and K. V. Slack, eds. 1977. Methods for collection and analysis of aquatic biological and microbiological samples. Chapter A4, Techniq. Water-Resour. Invest. U. S. Geol Surv., Book 5 Lab. Analysis. U. S. Geol. Surv., Washington, D. C. 332 pp.

Hamilton, K., and E. P. Bergersen. 1984. Methods to estimate aquatic habitat variables. U. S. Bur. Reclam., Denver, CO. 365 pp.

Hedrick, W. 1969. Map of Rock Creek stream bank erosion areas. Soil Cons. Svce., Twin Falls, ID. 2 pp.

Hem, J. D. 1985. Study and interpretation of the chemical characteristics of natural water. U. S. Geol. Surv. Water-Supply Pap. 2254: 1-264.

Idaho Department of Fish and Game. 1971. Wildlife habitat obituary - Rock Creek. ID Wildlife Rev. 1 pp.

Idaho Department of Health. 1960. Report on pollution problems in Rock Creek, Cassia and Twin Falls Counties, Idaho, 1959. ID Dept. Health, Boise. 30 pp.

Idaho Department of Health and Welfare. 1980a. Idaho water quality standards and wastewater treatment requirements. IDHW-Div. Environ., Boise. 62 pp.

________. 1980b. Rural clean water project monitoring plan Rock Creek, Twin Falls County, Idaho Soil Cons. Svce., Econ. Statis. Svce., IDHW-Div. Environ., Sci. Education Admin., Boise. 34 pp.

________. 1980c. Idaho water quality status report. 1980. IDWH-Div. Environ., Boise. 65 pp.

________. 1982. Water quality surveillance network stations by river basin. IDHW-Div. Environ., Boise. 19 pp.

________. 1983. Idaho water quality status. 1982. IDHW-Div. Environ., Boise. 101 pp.

________. 1984. Quality assurance plan for laboratory testing. IDHW Bur. Lab., Boise. 56 pp.

________. 1985. Idaho water quality standards and wastewater treatment requirements.

IDHW-Div. Environ., Boise. 72 pp.

Irving, J. S., and T. C. Bjornn. 1984. Effects of substrate size composition on survival of kokanee salmon and cutthroat and rainbow trout embryos. Tech. Rpt. 84-6, ID Coop. Fish. Resear. Unit, Univ. ID, Moscow. 21 pp.

Jamieson, C. A., J. Spooner, R. P. Maas, and M. D. Smolen. 1986. The use and effectiveness of nonpoint source control in four western USA agricultural watersheds. Paper presented at 6th Annual International Symposium, Lake and Reservoir Management: Influences of Nonpoint Source Pollutants and Acid Precipitation. Portland, OR. 15 pp.

Kasal, J., and R. Magaleby. 1985. Economic evaluation progress report for FY85, Rock Creek, Idaho, RCWP project. U. S. Dept. Agric., Econ. Res. Svce. 30 pp

Kelley, D. W., and D. H. Dettman. Relationships between streamflow, rearing habitat, substrate conditions, and juvenile steelhead populations in Lagunitas Creek, Marin County, 1979. Marin Munic. Water Dist., San Francisco, CA. 24 pp.

Kittrell, F. W. 1969. A practical guide to water quality studies of streams. U. S. Dept. Interior, FWPCA, Washington, D. C. 135 pp.

Kuska, J. J., W. H. Snyder, and R. Wells, eds. 1974. Rock Creek recreational resource inventory and analysis. Comm. Develop. Center, Univ. ID., Moscow. 97 pp.

Leopold, L. B., and T. Maddock, Jr. 1953. The hydraulic geometry of stream channels and some physiographic implications. U.S. Geol. Surv. Prof. Pap. 252. 57 pp.

Leupold and Stevens, ed. 1978. Stevens water resources data book. Leupold and Stevens, Inc., Beaverton, OR. 154 pp.

Levinski, C. L. 1986. Technical assessment of alternative techniques for evaluating the impacts of stream sedimentation of fish habitat. Water Qual. Bur. Rpt., IDHW-Div. Environ., Boise. 53 pp.

Mackenthun, K. M. 1973. Toward a cleaner environment. U.S. Environmental Protection Agency, Washington, D.C. 290 pp.

Martin, D. M. 1983a. Rock Creek Rural Clean Water Program-comprehensive monitoring and evaluation, annual report. IDHW-Div. of Environ., Boise, Idaho. 85 pp.

_______. 1983b. Rock Creek Rural Clean Water Program-Idaho. American Society of Agricultural Engineers, 1983 Winter Meetings, Chicago, IL. No. 83-2549. 74 pp.

_______. 1984. Rock Creek Rural Clean Water Program comprehensive monitoring and evaluation, annual report. IDHW-Div. of Environ., Boise, Idaho. 151 pp.

Martin D.M. and S. Bauer. 1982. Water quality monitoring assessment of the rural clean water program: First year baseline report, Rock Creek, water year 1981. IDHW-Div. of Environment, Boise. 68 pp.

Mills, W. B, G. L. Bowie, T. M. Grieb, K. M. Johnson, and R. C. Whittemore. 1986. Stream sampling for waste load allocation applications handbook. EPA/625/6-86/013. U. S. Environmental Protection Agency, Washington, D. C. 69 pp.

Molnau, M. 1983. Climate and hydrology data for Idaho. Misc. Ser. 32. Dept. Agric. Eng., Univ. ID, Moscow. 116 pp.

National Oceanic and Atmospheric Administration. 1985. Climatological data, Idaho. Vol. 88. U. S. Dept. Commerce, Nation. Oceanic Atmos. Admin., Asheville, NC. 336 pp.

________. 1986. Climatological data, Idaho. Vol. 89. U. S. Dept. Commerce, Nation. Oceanic Atmos. Admin., Asheville, NC. 252 pp.

National Water Quality Evaluation Project. 1986. Summary of the 1986 Rural Clean Water Program Data Analysis Workshop. U. S. Environmental Protection Agency, Washington, D. C. 162 pp.

NCASI. 1985. Groundwater quality data analysis. Tech. Bull. 462. Natl. Council Pap. Indust. Air Stream Improve., Inc., New York, NY. 237 pp.

Neubeiser, M. J. 1985. Rock Creek Rural Clean Water Program: The experiment continues, pp. 391-396, IN: U. S. Environmental Protection Agency, Perspectives on nonpoint source pollution. U.S. Environmental Protection Agency, Washington, D.C. 514 pp.

Oldfield, J. E. 1972. Selenium deficiency in soils and its effect on animal health. Geol. Soc. Amer. Bull. 83: 173-180.

Pacific Northwest River Basins Commission. 1976. River mile index Snake River. Part II, Snake River above Weiser. Hydrol. Hydraul. Comm., Pac. NW Riv. Basins Comm., Portland, OR. 49 pp.

Pascoe, D., and R. W. Edwards. 1984. Freshwater biological monitoring. Pergamon Press, Oxford. 167 pp.

Pickering, R. J. 1978. Churn splitters. Qual. Water Branch Tech. Memo. 78.03. U. S. Geol. Surv., Reston, VA. 4 pp.

Platts, W. S., W. F. Megahan, and G. W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. Gen. Tech. Rpt. INT-138. U. S. Dept. Agric., Forest Serv., Ogden, UT. 70 pp.

Platts, W. S., and R. L. Nelson. (*In Press*). Implications of fluctuations in trout populations when evaluating land use impacts. Trans. Amer. Fish. Soc.

Ponce, S. L. Statistical methods commonly used in water quality data analysis. WSDG Tech. Pap. WSDG-TP-00001. U. S. Dept. Agri., Forest Serv., Fort Collins, CO. 149 pp.

Rainwater, F. H., and L. L. Thatcher. 1960. Methods for collection and analysis of water samples. Geol. Surv. Water-Supply Pap. 1454. U. S. Geol. Surv., Washington, D. C. 301 pp.

Ralston, D., and N. C. Young. 1971. Water resources of the Twin Falls tract, Twin Falls County, Idaho. Water Info. Bull 22. ID Dept. Water Admin. 66 pp.

Ralston, G. and M. Browne. 1976. Technical procedures manual for water quality monitoring. IDHW-Div. of Environ., Boise. 94 pp.

Rantz, S. E. 1982a. Measurement and computation of streamflow: Volume 1. Measurement of stage and discharge. U. S. Geol. Sur. Water-Supply Pap. 2175: l-284.

________. 1982b. Measurement and computation of streamflow: Volume 2. Computation of discharge. U. S. Geol. Sur. Water-Supply Pap. 2175:285-631.

Reynolds, J.B. 1983. Electrofishing, pp. 147-163, IN: Nielsen, L.A., and D.L. Johnson, eds., Fisheries techniques. American Fisheries Society, Bethesda, MD. 468 pp.

Robbins, C. W. 1977. Hydraulic conductivity and moisture retention characteristics of southern Idaho's silt loam soils. Res. Bull. 99, Agric. Expt. Sta., Univ. ID, Moscow. 13 pp.

________., and C. E. Brockway. 1978. Irrigation water salt concentration influences on sediment removal by ponds. Soil Sci. Soc. Amer. Jour. 42:478-481.

Robbins, C.W. and D.L. Carter. 1975. Conservation of sediment in irrigation runoff. Jour. Soil Water Conserv. 30: 134-135.

________. 1980. Nitrate-nitrogen leached below the root zone during and following alfalfa. Jour. Environ. Qual. 9: 447-450.

Robbins, C. W., and J. H. Smith. 1977. Phosphorus movement in calcareous soils irrigated with waste water from potato processing plants. Jour. Environ. Qual. 6: 222-225.

Sacramento Bee, ed. 1985. Selenium. Reprinted articles from Sept. 8-10, 1985. The Sacramento Bee, Sacramento, CA. 16 pp

SAS Institute. 1982. SAS user's guide: Statistics. Statistical Analysis System Institute, Cary, N.C. 584 pp.

Schaefer, A., and S.B. Bauer. 1979. Water quality status report 1976-77, Upper Rock Creek. Water Quality Series No. 38, IDHW-Div. of Environ., Boise. 29 pp.

Schilperoort, T., and S. Groot. 1983. Design and optimization of water quality monitoring networks. Publ. 286. Delft Hydraul. Lab., Netherlands. 18 pp.

Shirley, E. C., R. B. Howell, and K. D. Kerri. 1976. Water quality manual. Volume I: Planning, conducting, analyzing and reporting water quality studies for transportation projects. Implementation Package 77-1, Volume 1. U. S. Dept. Transportation, Washington, D. C. 148 pp.

Smith, J. H., and C. L. Douglas. Microbiological quality of surface drainage water from three small irrigated watersheds in Southern Idaho. Jour. Environ. Qual. 2: 110-112.

________., and J. A. Bondurant. 1972. Microbiological quality of subsurface drainage water from irrigated agricultural land. Jour. Environ. Qual. 1: 308-311.

Sokal, R.R., and F.J. Rohlf. 1969. Introduction to biostatistics. W.H. Freeman Co., San Francisco. 368 pp.

Spencer, E. Y. 1982. Guide to the chemicals used in crop protection. Publ. 1093, Agric. Canada, Ottawa. 595 pp.

Sterling, R. P. 1983. Stream channel response to reduced irrigation return flow sediment loads. M. S. Thesis, Univ. ID, Moscow. 113 pp.

Stiles, W. 1946. Trace elements in plants and animals. MacMillian Co., New York, NY. 189 pp.

Tappel, P. D., and T. C. Bjornn. 1983. A new method of relating size of spawning gravel to salmonid embryo survival. Amer. Jour. Fish. Manage. 3: 123-135.

Thomas, C. A. 1969. Inflow to the Snaker River between Milner and King Hill, Idaho. Water Infor. Bull. 9, ID Dept. Reclam., Boise. 39 pp.

Thomas, R. B. 1985. Measuring suspended sediment in small mountain streams. Gen. Tech. Rpt. PSW-83, U. S. Dept. Agric., Forest Serv., Berkeley, CA. 9 pp.

Thurston, R.V., et. al., Editors. 1979. A Review of the EPA red book: Quality criteria for water. American Fisheries Society, Bethesda, MD. 313 pp.

U.S. Department of Interior. 1977. National handbook of recommended methods for water-data acquisition. Two volumes. Office of Water Data Coordination, Geological Survey, Reston, Virginia. 862 pp.

_______. 1985. Preliminary evaluation of selenium concentrations in ground and surface water, soils, sediment, and biota from selected areas in the western United States. U. S. Dept. Interior, Washington, D.C. 126 pp.

U. S. Bureau of Reclamation. 1978. Drought effect on water quality, Boise Valley, 1977. U. S. Bureau of Reclamation, Boise, ID. 141 pp.

U.S. Environmental Protection Agency. 1973. Report on effects of waste discharges on water quality of the Snake River and Rock Creek, Twin Falls area, Idaho. U. S. Environmental Protection Agency, Denver, CO. 25 pp.

_______. 1975. Inventory of significant discharge points for irrigation return flow, Middle and Upper Snake River Basins. Volumes 2, 4, 5, and 6. U. S. Environmental Protection Agency, Seattle, WA.

_______. 1977. Basic water monitoring program. EPA-440/9-76-025. U. S. Environmental Protection Agency, Washington, D.C. 51 pp.

_______. 1979. Methods for chemical analysis of water and wastes. EPA-600/4-79/200, U. S. Environmental Protection Agency, Washington, D.C. 296 pp.

_______. 1982a. Handbook water quality control information system (STORET). Two Volumes U. S. Environmental Protection Agency, Washington, D. C.

_______. 1982b. Handbook for sampling and sample preservation of water and wastewater. EPA-600/4-82-029, U.S. Environmental Protection Agency, Environ. Monitoring Support Lab., Cincinnati, OH. 402 pp.

_______. 1983. Calculation of data quality indicators. U.S. Environmental Protection Agency, Environ. Monitoring Support Lab., Cincinnati, OH. 38 pp

_______. 1985. North slope ambient water quality survey. U.S. Environmental Protection Agency, Seattle, WA. 12 pp.

_______. 1986. Quality criteria for water, 1986. EPA 440/5-86-00l. U.S. Environmental Protection Agency, Washington, D. C.

U. S. Geological Survey. 1962. Surface water records of Idaho, 1961. U.S.G.S., Boise, ID. 277 pp.

_______. 1963. Surface water records of Idaho, 1962. U.S.G.S., Boise, ID. 291 pp.

_______. 1964. Surface water records of Idaho, 1963. U.S.G.S., Boise, ID. 290 pp.

_______. 1965. Surface water records of Idaho, 1964. U.S.G.S., Boise, ID. 291 pp.

_______. 1966. Water resources data for Idaho, 1965. Part 1, Surface water records. Part 2, Water quality records. U.S.G.S. , Boise, ID. 327 pp.

_______. 1967. Water resources data for Idaho, 1966. Part 1, Surface water records. Part 2, Water quality records. U.S.G.S. , Boise, ID. 347 pp.

_______. 1968. Water resources data for Idaho, 1967. Part 1, Surface water records. Part 2, Water quality records. U.S.G.S. , Boise, ID. 357 pp.

_______. 1969. Water resources data for Idaho, 1968. Part 1, Surface water records. Part 2, Water quality records. U.S.G.S. , Boise, ID. 374 pp.

_______. 1970. Water resources data for Idaho, 1969. Part 1, Surface water records. Part 2, Water quality records. U.S.G.S. , Boise, ID. 299 and 83 pp.

_______. 1971. Water resources data for Idaho, 1970. Part 1, Surface water records. Part 2, Water quality records. U.S.G.S. , Boise, ID. 295 and 109 pp.

_______. 1972. Water resources data for Idaho, 1971 Part 1, Surface water records. Part 2, Water quality records. U.S.G.S. , Boise, ID. 301 and 145 pp.

_______. 1973. Water resources data for Idaho, 1972. Part 1, Surface water records. Part 2, Water quality records. U.S.G.S. , Boise, ID. 289 and 243 pp.

_______. 1974. Water resources data for Idaho, 1973 . Part 1, Surface water records. Part 2, Water quality records. U.S.G.S. , Boise, ID. 289 and 247 pp.

_______. 1975. Water resources data for Idaho, 1974. Part 1, Surface water records. Part 2, Water quality records. U.S.G.S. , Boise, ID. 295 and 297 pp.

_______. 1976. Water resources data for Idaho, water year 1975. U.S.G.S. Water-Data Rpt. ID-75-1, Boise, ID. 684 pp.

_______. 1977. Water resources data for Idaho, water year 1976. U.S.G.S. Water-Data Rpt. ID-76-1, Boise, ID. 634 pp.

_______. 1978. Water resources data for Idaho, water year 1977. U.S.G.S. Water-Data Rpt. ID-77-1, Boise, ID. 634 pp.

_______. 1979. Water resources data for Idaho, water year 1978. U.S.G.S. Water-Data Rpt. ID-78-1, Boise, ID. 457 pp.

_______. 1980. Water resources data for Idaho, water year 1979. U.S.G.S. Water-Data Rpt. ID-79-1, Boise, ID. 385 pp.

_______. 1981. Water resources data for Idaho, water year 1980. U.S.G.S. Water-Data Rpt. ID-80-1, Boise, ID. 375 pp.

_______. 1982. Water resources data, Idaho, water year 1981. U.S.G.S. Water-Data Rpt. ID-81-1, Boise, ID. 447 pp.

_______. 1983. Water resources data, Idaho, water year 1982. U.S.G.S. Water-Data Rpt. ID-82-1, Boise, ID. 332 pp.

_______. 1984. Water resources data, Idaho, water year 1983. U.S.G.S. Water-Data Rpt. ID-83-1, Boise, ID. 515 pp.

_______. 1985. Water resources data, Idaho, water year 1984. U.S.G.S. Water-Data Rpt. ID-84-1, Boise, ID. 447 pp.

_______. 1986. Water resources data, Idaho, water year 1985. U.S.G.S. Water-Data Rpt. ID-85-1, Boise, ID. *In Press.*

Van Haveren, B. P. 1986. Water resosurce measurements, a handbook for hydrologists and engineers. Amer. Water Works Assoc., Denver, CO. 132 pp.

Walker, D. J. 1985. Costs and benefits of improving irrigation return flow water quality in the Rock Creek, Idaho, Rural Clean Water Project. Res. Bull. 139. Agric. Expt. Sta., Univ. ID, Moscow. 30 pp.

Weber, C. I., ed. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. EPA-670/4-73-001. U. S. Environmental Protection Agency, Cincinnati, OH. 195 pp.

Winget, R. N., and F. A. Mangum. 1979. Biotic condition index: Integrated biological, physical, and chemical stream parameters for management. U. S. Forest Service, Ogden, UT. 51 pp.

Worstell, R. V. 1976. An experimental buried multiset irrigation system. Trans. ASAE 19: 1122-1128.

Wroten, J., and W. H. Clark. 1980. Stream channel stability evaluation for Rock Creek, Twin Falls County, Idaho. IDWH-Div.Environ., Boise. 11 pp.

Youden, W. J., and E. H. Steiner. 1975. Statistical Manual of the Association of Official Analytical Chemists. Assoc. Official Analy. Chem., Washington, D. C. 88 pp.

Zippen, C. 1958. The renewal method of population estimation. Jour. Wildlife Manage. 22: 82-90.

TABLE 1. List of Rock Creek RCWP monitoring stations, Twin Falls County, Idaho.

Rock Creek	Description	Latitude/ Longitude	River Mile	Elevation	STORET No.
S-1	Rock Creek near Mouth near Twin Falls	42°37'25"/ 114°31'58"	324.3/606.4/0.75	3,200'	2060146
S-2	Rock Creek at Pole Line Road Crossing	42°35'20"/ 114°31'45"	324.3/606.4/3.7	3,500'	2060148
S-3	Rock Creek above State Hwy. 93 Crossing near Twin Falls	42°33'45"/ 114°29'39"	324.3/606.4/7.3	3,700'	2060145
S-4	Rock Creek at Twelvemile near Twin Falls	42°31'21"/ 114°25'11"	324.3/606.4/13.5	3,800'	2060144
S-5	Rock Creek at 3500 East Road Crossing	42°27'17"/ 114°21'52"	324.3/606.4/21.1	4,000'	2060147
S-6	Rock Creek near Rock Creek	42°21'17"/ 114°18'15"	324.3/606.4/30.3	4,368'	2060143
S-6A	Rock Creek, Harrington Fork confluence	42°18'28"/ 114°15'12"	324.3/606.4/35.6	4,740'	2060149
S-6B	Rock Creek, below confluence of Fourth Fork Rock Creek	42°15'25"/ 114°14'55"	324.3/606.4/39.4	5,140'	2060150
C-l*	Twin Falls Main Canal near Hansen	42°31'08"/ 114°16'31"	None	4,100'	2060142

*Discontinued

TABLE 2. List of Rock Creek RCWP subbasin monitoring stations.

Subbasin No.	Description	Latitude/ Longitude	River Mile	Elevation	STORET No.
1-1	Coulee at N 4200 Rd. E. of 2600 E. Rd.	42°36'30"/ 114°32'17"	None	3,590'	2060137
1-2*	Coulee near Rock Creek Mouth (2600 E. Road)	42°37'12"/ 114°32'05"	None	3,550'	2060138
2-1	Q-Coulee at Hwy. 30/93 near KTFI Radio	42°33'26"/ 114°32'30"	None	3,700'	2060135
2-2*	Q-Coulee near Mouth	42°35'00"/ 114°31'45"	None	3,600'	2060136
2-3*	Major drain on East side of Rock Creek	42°35'15"/ 114°31'25"	None	3,600'	2060139
2-4*	Drain from Subbasin 3	42°35'20"/ 114°32'05"	None	3,600'	2060140
2-5*	Wonderlich Drain	42°34'43"/ 114°31'36"	None	3,635'	2060240
4-1	L-Coulee at Low Line Canal	42°30'27"/ 114°30'20"	None	3,930'	2060131
4-2*	L-Coulee at Rock Creek Park near Mouth	42°33'50"/ 114°30'35"	None	3,650'	2060132
4-3*	O-Coulee at Monroc near Mouth	42°33'35"/ 114°30'25"	None	3,680'	2060133
4-4	O-Coulee at Low Line Canal	42°3l'57"/ 114°32'35"	None	3,920'	2060134
5-1	K-Coulee at Low Line Canal	42°30'45"/ 114°28'55"	None	3,930'	2060129
5-2*	K-Coulee at Golf Course near Mouth	42°33'10"/ 114°29'50"	None	3,700'	2060130
7-1	I-Coulee below Highline Canal	42°29'45"/ 114°29'05"	None	4,060'	2060123
7-2	I-Coulee below Low Line Canal	42°30'30"/ 114°27'35"	None	3,920'	2060124
7-3	I-Coulee above Confluence with 7-6	42°31'10"/ 114°26'40"	None	3,847'	2060125
7-4*	I-Coulee at Hillcrest Rd. near Mouth	42°31'50"/ 114°/26'50"	None	3,800'	2060126
7-6	H-Coulee before Confluence with I-Coulee at 7-3	42°31'10"/ 114°26'30"	None	3,847'	2060127
7-7*	Drain near Mouth of I-Coulee, Sec. 27	42°31'50"/ 114°27'12"	None	3,820'	2060128
10-1*	Drain at 3600 East Rd. on East Side	42°27'30"/ 114°20'30"	None	4,000'	2060141
CW-3*	Cottonwood Creek, below drain below 3100 N. Rd.	42°26'40"/ 114°22'15"	None	3,920'	2060245

*Discharge into Rock Creek

TABLE 3. 1984 water quality monitoring schedule for the Rock Creek Rural Clean Water Program, Twin Falls County, Idaho.

JANUARY	- No field activities.
FEBRUARY	
7, 8	- Ambient monitoring on Rock Creek (total parameter package)[1] Cedar Draw monitoring (10 parameters only)[2]
MARCH	
12, 13, 14, 15, 16	- Benthic macroinvertebrate sampling and electrofishing Rock Creek and Cedar Draw, collect substrate samples at Cedar Draw.
20, 21	- Intensive fecal coliform bacterial survey of Rock Creek.
APRIL	
16, 17, 18	- Rock Creek (total)/Subbasin (5)[3] plus nitrogen[4]/Cedar Draw (10 plus nitrogen)[4]) monitoring
MAY	
1, 2, 3	- Rock Creek (total)/Subbasin (5)/Cedar Draw (10 plus nitrogen)
15, 16	- Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring.
22, 23	- Subbasin monitoring (5)
29, 30	- Subbasin monitoring (5)
JUNE	
4, 5, 6, 7	- Rock Creek (total)/Subbasin (5)/Cedar Draw (10 plus nitrogen) Benthic macroinvertebrate sampling Rock Creek/Cedar Draw
12, 13	- Subbasin (5) monitoring
19, 20	- Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring
26, 27	- Subbasin (5) monitoring
JULY	
2, 3	- Rock Creek (5)/Subbasin (5)/Cedar Draw (10 plus nitrogen)
10, 11	- Subbasin (5) monitoring
16, 17, 18	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring and HEP analysis
24, 25	- Subbasin (5) monitoring
30, 31	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring and HEP analysis

TABLE 3. (continued). 1984 water quality monitoring schedule for the Rock Creek Rural Clean Water Program, Twin Falls County, Idaho.

AUGUST	
6, 7, 8, 9	- Rock Creek (total)/Subbasin (5)/Cedar Draw (10 plus nitrogen) Benthic macroinvertebrates sampling Rock Creek/Cedar Draw
21, 22	-Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen) monitoring
SEPTEMBER	
4, 5, 6	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10 plus nitrogen
18, 19	- Rock Creek (5)/Subbasin (5) monitoring
OCTOBER	
2, 3	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10 plus nitrogen
15, 16	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (5) monitoring
NOVEMBER	
5, 6, 7	- Benthic macroinvertebrate sampling Rock Creek/Cedar Draw
DECEMBER	
4, 5	- Rock Creek (total)/Cedar Draw (5) monitoring

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[1] (total) = total parameter package

[2] (10) = 10 parameters - flow, fecal coliform bacteria, t-PO_4, Ortho-PO_4, suspended sediment, pH, dissolved oxygen, turbidity, temperature, thalweg depth

[3] (5) = 5 parameters - flow, fecal coliform bacteria, t-PO_4, Ortho-PO_4, suspended sediment

[4] plus nitrogen - $NO_2 + NO_3$ and Total-Kjeldahl

TABLE 4. 1985 water quality monitoring schedule for the Rock Creek Rural Clean Water Program, Twin Falls County, Idaho.

<u>JANUARY</u>	- No field activities.
<u>FEBRUARY</u>	
11, 12	- Ambient monitoring on Rock Creek (total parameter package)[1] Cedar Draw monitoring (10 parameters only)[2]
<u>MARCH</u>	
11, 12, 13, 14, 15	- Benthic macroinvertebrate sampling and electrofishing Rock Creek and Cedar Draw, collect substrate samples at Cedar Draw.
18	- stream bank erosion study
<u>APRIL</u>	
15, l6, l7	- Rock Creek (total)/Subbasin (5)[3] plus nitrogen[4]/Cedar Draw (l0 plus nitrogen)[4]) monitoring
29, 30	- Rock Creek (5 plus nitrogen)/Subbasin (5)/Ceadar Draw (10 plus nitrogen)
<u>MAY</u>	
13, 14, 15	- Rock Creek (total)/Subbasin (5)/Cedar Draw (l0 plus nitrogen)
20, 21	- Subbasin monitoring (5)
27, 28, 29	- Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring.
<u>JUNE</u>	
3, 4, 5, 6	- Rock Creek (total)/Subbasin (5)/Cedar Draw (10 plus nitrogen) Benthic macroinvertebrate sampling Rock Creek/Cedar Draw
10, 11	- Subbasin (5) monitoring
17, 19	- Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring
24, 25	- Subbasin (5) monitoring
<u>JULY</u>	
1, 2, 3	- Rock Creek (5)/Subbasin (5)/Cedar Draw (10 plus nitrogen)
9, 10	- Subbasin (5) monitoring
15, 16, 17	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring and HEP analysis
23, 24	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring and HEP analysis
29, 30, 31	- Subbasin (5) monitoring

TABLE 4. (continued). 1985 water quality monitoring schedule for the Rock Creek Rural Clean Water Program, Twin Falls County, Idaho.

AUGUST	
5, 6, 7, 8	- Rock Creek (total)/Subbasin (5)/Cedar Draw (10 plus nitrogen) Benthic macroinvertebrates sampling Rock Creek/Cedar Draw
12, 13	- Subbasin (5) monitoring
19, 20	-Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen) monitoring
26, 27	- Subbasin (5) monitoring
SEPTEMBER	
3, 4	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10 plus nitrogen
16, 17, 18	- Rock Creek (5)/Subbasin (5) monitoring
OCTOBER	
30, 1, 2	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10 plus nitrogen
14, 15, 16	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (5) monitoring
22	- Remeasure stream bank erosion areas
NOVEMBER	
5, 6, 7	- Benthic macroinvertebrate sampling Rock Creek/Cedar Draw
?	- Survey stream bank erosion areas, establishs permanent reference points
DECEMBER	
9, 10, 11	- Rock Creek (total)/Cedar Draw (5) monitoring

[1](total) = total parameter package

[2](10) = 10 parameters - flow, fecal coliform bacteria, t-PO_4, Ortho-PO_4, suspended sediment, pH, dissolved oxygen, turbidity, temperature, thalweg depth

[3](5) = 5 parameters - flow, fecal coliform bacteria, t-PO_4, Ortho-PO_4, suspended sediment

[4]plus nitrogen - NO_2 + NO_3 and Total-Kjeldahl

TABLE 5. 1986 water quality monitoring schedule for the Rock Creek Rural Clean Water Program, Twin Falls County, Idaho.

JANUARY	
20, 21	- Rock Creek (total)/Cedar Draw (5) monitoring
FEBRUARY	
11, 12	- Stream bank erosion study
18, 19	- Ambient monitoring on Rock Creek (total parameter package)[1] Cedar Draw monitoring (10 parameters only)[2]
24-28	-Electrofishing Rock Creek and Cedar Draw, pesticides (fish tissue)
MARCH	
10-12	- Benthic macroinvertebrate sampling Rock Creek and Cedar Draw
24-28	- Alternate electrofishing period
APRIL	
14-16	- Rock Creek (total)/Subbasin (5)[3] plus nitrogen[4]/Cedar Draw (I0 plus nitrogen) monitoring
28-29	- Rock Creek (5 plus nitrogen)/Subbasin (5)/Cedar Draw (10 plus nitrogen)
MAY	
5, 6	- Rock Creek/Subbasin/Cedar Draw - pesticides (water column)
12-15	- Rock Creek (total)/Subbasin (5)/Cedar Draw (I0 plus nitrogen)/ Quality Assurance[5]
19, 20	- Subbasin monitoring (5)
27-29	- Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring.
JUNE	
2-6	- Rock Creek (total)/Subbasin (5)/Cedar Draw (10 plus nitrogen) Benthic macroinvertebrate sampling Rock Creek/Cedar Draw
9, 10	- Subbasin (5) monitoring
16-18	- Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring
23, 24	- Subbasin (5) monitoring

TABLE 5. (continued). 1986 water quality monitoring schedule for the Rock Creek Rural Clean Water Program, Twin Falls County, Idaho.

JULY	
1, 2, 3	- Rock Creek (5)/Subbasin (5)/Cedar Draw (10 plus nitrogen)
8, 9	- Subbasin (5) monitoring
14-16	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring/Quality Assurance
21, 22	- Subbasin (5) monitoring
28-30	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring
AUGUST	
4-7	- Rock Creek (total)/Subbasin (5)/Cedar Draw (10 plus nitrogen) Benthic macroinvertebrates sampling Rock Creek/Cedar Draw/ Quality Assurance
11, 12	- Subbasin (5) monitoring
18, 19	-Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen) monitoring
25, 26	- Subbasin (5) monitoring
SEPTEMBER	
2, 3	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10 plus nitrogen
9, 10	- Remeasure stream bank erosion sites
15-17	- Rock Creek (5)/Subbasin (5) monitoring
29, 30, 1	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10 plus nitrogen
OCTOBER	
13-15	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (5) monitoring
NOVEMBER	
4-6	- Benthic macroinvertebrate sampling Rock Creek/Cedar Draw
DECEMBER	
8-10	- Rock Creek (total)/Cedar Draw (5) monitoring

[1](total) = total parameter package

[2](10) = 10 parameters - flow, fecal coliform bacteria, t-PO_4, dissolved Ortho-PO_4, suspended sediment, pH, dissolved oxygen, turbidity, temperature, thalweg depth

[3](5) = 5 parameters - flow, fecal coliform bacteria, t-PO_4, dissolved Ortho-PO_4, suspended sediment

[4]plus nitrogen = $NO_2 + NO_3$ and Total-Kjeldahl

[5] Quality Assurance = Field spiked samples for suspended sediment, dissolved Ortho-PO_4,nitrate and total Kjeldahl nitrogen.

TABLE 6. 1987 water quality monitoring schedule for the Rock Creek Rural Clean Water Program, Twin Falls County, Idaho.

JANUARY	
26,27	- Rock Creek (total)/Cedar Draw (5) monitoring
FEBRUARY	
9,10,11,12,13	- Electrofishing Rock Creek and Cedar Draw, pesticides (fish tissue)
16,17	- Ambient monitoring on Rock Creek (total parameter package)[1] Cedar Draw monitoring (10 parameters only)[2]
23,24,25,26,27	- Alternate electrofishing period
MARCH	
9 ,10,11	- Benthic macroinvertebrate sampling Rock Creek and Cedar Draw
17, 18	- Rock Creek (total)/Cedar Draw (10 plus nitrogen)
APRIL	
13,14,15	- Rock Creek (total)/Subbasin (5)[3] plus nitrogen[4]/Cedar Draw (10 plus nitrogen)
27,28	- Rock Creek (5 plus nitrogen)/Subbasin (5)/Cedar Draw (10 plus nitrogen)
MAY	
4,5,6,7	- Rock Creek/Subbasin (5)/Cedar Draw - pesticides (water column)
11,12	- Subbasin monitoring (5)
18,19,20,21	- Rock Creek (total)/Subbasin (5)/Cedar Draw (10 plus nitrogen)/ Quality Assurance[5]
26,27,28	- Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring
JUNE	
1,2,3,4,5	- Rock Creek (total)/Subbasin (5)/Cedar Draw (10 plus nitrogen) Benthic macroinvertebrate sampling Rock Creek/Cedar Draw
8,9	- Subbasin (5) monitoring
15,16,17	- Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring
22,23	- Subbasin (5) monitoring
29,30	- Rock Creek (5)/Subbasin (5)/Cedar Draw (10 plus nitrogen)
JULY	
6,7	- Subbasin (5) monitoring
13,14,15	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring/Quality Assurance
20,21	- Subbasin (5) monitoring
27,28	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10) monitoring

*Schedule subject to change.

TABLE 6. (continued). Water quality monitoring schedule for the Rock Creek Rural Clean Water Program, Twin Falls County, Idaho.

AUGUST	
3,4,5,6	- Rock Creek (total)/Subbasin (5)/Cedar Draw (10 plus nitrogen) Benthic macroinvertebrates sampling Rock Creek/Cedar Draw/ Quality Assurance
10,11	- Subbasin (5) monitoring
17,18	- Rock Creek (5 plus nitrogen)/Subbasin (5 plus nitrogen) monitoring
24,25	- Subbasin (5) monitoring
SEPTEMBER	
1,2	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10 plus nitrogen
8,9,10,11	- Remeasure stream bank erosion sites
14,15,16	- Rock Creek (5)/Subbasin (5) monitoring
28,29,30	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (10 plus nitrogen
OCTOBER	
13,14	- Rock Creek (total)/Subbasin (5 plus nitrogen)/Cedar Draw (5) monitoring
19,20,21,22	- Rock Creek substrate sampling
NOVEMBER	
4,5,6	- Benthic macroinvertebrate sampling Rock Creek/Cedar Draw
16,17	- Rock Creek substrate sampling
DECEMBER	
7,8,9	- Rock Creek (total)/Cedar Draw (5) monitoring

[1] (total) = total parameter package

[2] (10) = 10 parameters - flow, fecal coliform bacteria, t-PO_4, dissolved Ortho-PO_4 suspended sediment, pH, dissolved oxygen, turbidity, temperature, thalweg depth

[3] (5) = 5 parameters - flow, fecal coliform bacteria, t-PO_4, dissolved Ortho-PO_4, suspended sediment

[4] plus nitrogen = NO_2 + NO_3 and Total-Kjeldahl

[5] Quality Assurance = Field spiked samples for suspended sediment, dissolved Ortho-PO_4, nitrate and total Kjeldahl nitrogen

TABLE 7. Annual Precipitation for Twin Falls, Idaho, 1963-1983.

YEAR	TOTAL ANNUAL PRECIPITATION (inches)
1963	9.70
1964	12.53
1965	8.29
1966	4.11
1967	9.01
1968	13.16
1969	6.09
1970	13.77
1971	13.68
1972	11.52
1973	11.46
1974	7.75
1975	13.80
1976	9.22
1977	9.71
1978	10.18
1979	8.29
1980	12.71
1981	11.44
1982	11.27
1983	15.90

MEAN ANNUAL PRECIPITATION (1963-83): 10.85 Inches

TABLE 8. Daily Precipitation (inches) for Twin Falls, Idaho, 1981.

DATE	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1				0.01								T
2				0.04	0.01	T						0.08
3						0.02				0.01		
4	0.13			0.01								
5	T											
6	T	T	0.02				T					0.01
7					T		0.01					
8						T				0.15		
9						0.26						
10						T		T		0.03		
11					0.05					0.29		
12		T								0.05		
13						T				0.18	0.21	0.01
14		0.03								0.19	0.01	0.08
15		0.09			0.36					0.09	0.01	0.43
16			0.05								0.15	0.12
17		0.25	0.22									
18												
19		T		0.05	0.03				T			0.38
20		0.05	0.10	1.30	0.10			T			T	0.23
21			0.24	0.14	T			T			0.09	0.76
22			T	T	0.03						0.46	T
23											0.13	
24	0.12										0.51	
25	0.02				T				0.20		0.11	0.11
26		0.02	0.45		0.06		T		0.09			0.01
27	T		0.12	0.37							T	0.30
28	0.05		0.02								0.04	T
29	T									0.12		0.01
30	0.15		0.11						0.06	0.10	T	0.38
31	0.04				0.12							
MONTHLY TOTALS	0.51	0.44	1.33	1.92	0.76	0.28	0.01	0.00	0.35	1.21	1.72	2.91

T = Trace

Total Annual Precipitation = 11.44

TABLE 9. Daily Precipitation (inches) for Twin Falls, Idaho,1982.

DATE	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	0.10	T		0.36		T	0.10			0.11		0.16
2			0.33	0.04	T	0.41	0.05			0.02		T
3			0.07	0.01		T	0.05					T
4	0.21		0.04	0.04		T	T					
5	0.19		T	T		0.04	0.21			T		
6	0.02			T								0.33
7				0.05			T			T		T
8		0.03		0.01		0.02	0.02			T		
9		0.01			0.03		T	0.01			T	
10		0.02									0.07	
11			T	0.35	0.15						T	
12	0.01		0.01	0.03	0.01				0.02			
13	T					0.01	T					0.08
14		0.20	0.01			T	T		0.29			T
15		0.19	0.33	0.05		T			T			0.11
16		0.31	T						T			0.27
17	T	0.15	0.13						T			T
18	T	0.04	T		0.20			T			T	0.15
19	T	T	0.05		T			0.04	0.03		0.24	
20	T	0.13	T						0.07		0.03	
21	0.01	T	T				T		0.18		0.02	0.02
22	0.10					T				0.04	0.06	0.09
23	0.05	T				T				0.04	T	T
24	T	T				T	0.01			0.03		0.02
25	T					0.02	T		0.02	0.02		
26	T		0.05			0.02			0.85	0.17		T
27	0.08				T					0.29		T
28			0.02				T				0.01	T
29			0.33	T			0.26			0.09	0.13	T
30			0.01					0.38	T	0.72	0.20	0.01
31			T							0.07		
MONTHLY TOTALS	0.77	1.08	1.38	0.94	0.39	0.52	0.70	0.43	1.46	1.60	0.76	1.24

T = Trace

Total Annual Precipitation = 11.27

TABLE 10. Daily Precipitation (inches) for Twin Falls, Idaho,1983.

DATE	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1			0.04		0.34	T		0.15		0.04	T	0.34
2			T	0.03	0.11	0.03	0.13		0.03	0.09	0.10	0.12
3				0.21			0.04	0.02			T	0.03
4	0.06		T			0.23		0.08				0.28
5	0.08		0.01		0.14			0.02			0.06	T
6	0.01		T		0.03		0.08				0.01	T
7	0.06	0.09	0.11		T		0.02				0.06	0.18
8	0.01	0.13	0.05					0.06	T			0.07
9	0.04	T			T	0.04		0.07	0.01	0.14		T
10		0.25			T		0.14	0.01	T	0.09		0.12
11		0.07	0.01		0.43	0.18		T		0.01	0.03	0.03
12			0.05		0.05	0.02		T			0.14	0.16
13		0.01	0.11	0.01	T	T					0.09	0.09
14		0.38	0.42	T				0.03		0.19	0.14	0.09
15					0.01					0.06		0.35
16		T			0.24	T		0.05				
17	0.07		T		T						0.16	0.01
18	T	T	0.05		0.01						1.01	T
19	T	0.02	0.01	T	0.01						0.01	0.06
20	0.16			0.08			T	0.19			0.30	0.07
21	0.01			0.06		0.05		0.06				T
22	T							T			T	T
23	0.09		0.19					0.10		T	0.01	
24			0.06				0.02			0.05	0.15	0.13
25	0.08	0.05	0.15	0.09							0.28	0.15
26		0.27	0.06	T								0.18
27	T	0.01		0.06		0.24			0.48			0.12
28	0.03	0.08	0.09	T		0.05			T			0.04
29			T	0.12					0.18		0.06	T
30	0.08		0.14	0.03		T			0.25	T	0.02	0.08
31			0.55							0.11		0.43
MONTHLY TOTALS	0.78	1.36	2.10	0.69	1.37	0.84	0.43	0.84	0.95	0.78	2.63	3.13

T = Trace

Total Annual Precipitation = 15.90

TABLE 11. Daily Precipitation (inches) for Twin Falls, Idaho,1984.

DATE	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1			T	0.02	0.30				0.01	0.01		0.05
2			T		0.14					0.03		
3					0.08			0.12			0.25	
4	T				0.08			0.05			0.01	
5	T		T		T	0.35		0.02	T			
6	T			0.10		0.21		T	0.08			
7				0.06		0.04	0.02		T		0.11	
8						0.01	T				0.07	
9	T		T	0.04			T				0.11	
10	T	0.26		T		0.22					0.34	
11	0.02		0.09	0.28	T	0.34		0.01		T	0.42	0.08
12				0.01	0.04	T				0.36	0.02	0.13
13	T	0.13				0.02				0.10		T
14	0.06	0.38	0.04		0.02	0.01		0.06		0.08	0.02	
15	0.02		0.01		0.32	0.16		0.22	T			
16	T	0.37	0.06		0.02	0.04		0.02			0.02	0.12
17	0.04	0.44	0.14		0.05					0.06		
18			0.03	0.10		T				0.16		
19				0.02		T				0.06	0.02	
20				0.01		0.26	T		T	T		
21			T	0.01		0.06	0.08		0.42	T		0.03
22		T	0.01				0.07			T		
23	0.11		T				0.03	T		T		
24	0.02		0.01				0.04				0.11	
25	T	0.07	0.01	T		T					0.10	
26	0.04	T	0.03	0.04				0.03		0.01	T	
27			0.02	T			0.02			0.27		
28				T			0.05				0.03	0.02
29			0.01	0.07		0.02	0.02			0.10	0.08	
30			T	T			T	0.01		T		0.08
31			T		T			0.36				0.14
MONTHLY TOTALS	0.31	1.65	0.46	0.76	1.05	1.74	0.33	0.90	0.51	1.24	1.69	0.65

T = Trace

Total Annual Precipitation = 11.29

TABLE 12. Daily Precipitation (inches) for Twin Falls, Idaho,1985.

DATE	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1						0.16						
2		0.02				0.18			0.09			0.13
3		0.05	0.13		T							0.18
4		0.06	0.27									0.01
5												
6		0.06	0.02			T			0.01			
7	T		0.03		T		T		0.01	0.29		0.02
8	0.16		0.01	0.02					0.07	0.11	0.05	0.15
9	0.10	0.10							0.50		0.04	0.29
10	T				0.05				0.03		0.06	0.01
11	T			0.03	0.05				0.01		0.12	
12	T	0.53					0.04		0.08		0.17	
13	0.01										0.35	
14	0.01											
15					0.05							
16					0.02							
17					0.09						0.02	
18									0.02		0.05	
19					0.07						0.03	
20		0.09		0.01	0.01						0.01	
21	0.04		0.02	0.06	0.09						0.03	
22	0.03			0.13						0.13		
23			0.02	0.02			0.09			0.36		
24				0.09	T		T			0.07	0.03	
25					0.02	T					0.54	
26				T	0.09	T						
27					0.02							
28			0.11		T						0.01	
29	0.01		0.16				0.02					0.18
30					0.06							
31							0.02					
MONTHLY TOTALS	0.36	1.01	0.77	0.43	0.55	0.34	0.17		0.82	0.96	1.69	0.79

Annual Precipitation = 7.89

TABLE 13. Daily Precipitation (inches) for Twin Falls, Idaho, January-September 1986.

DATE	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1		T										
2	0.06	T		0.36	T							
3	0.05	0.27		T		0.08						
4		0.09			0.02							
5	0.09	T		0.01		0.39						
6	0.19	0.17		0.01	0.07	T						
7		0.02	T	0.03	T	0.04	0.01					
8		T	0.19	0.10	0.12	0.64	T		0.03			
9		T	0.11	0.08	0.13	0.13		T	0.06			
10		T	T	T	0.02				0.16			
11		T	0.16	0.31	0.13							
12		T	0.07	T				T				
13		0.51	0.09	0.07								
14		0.03	T		T	0.10			0.05			
15		0.14	T			0.01			0.22			
16	0.04	T	0.01	0.01								
17	0.27	0.18	0.01									
18		1.60							T			
19		0.22				0.01			T			
20	0.02	0.24						T	0.01			
21		0.15			0.06			0.03	T			
22		0.11		T	0.32							
23	0.04	0.21		T			0.13					
24	0.09			T	T		0.01					
25			0.02	0.08			0.01		0.05			
26				0.12			0.01		0.13			
27				T					0.05			
28				0.02					0.02			
29	T					T	0.03	0.03				
30	T							0.14	0.12			
31	.15		T									
MONTHLY TOTALS	1.00	3.94	0.66	1.20	0.87	1.40	0.20	0.20	0.90			

T = Trace

Total Precipitation to Date = 10.37

TABLE 14. Monthly suspended sediment loadings for Subbasin stations discharging to Rock Creek, May-August, 1981-1986. Results in tons/month.

	Year					
Station	1981	1982	1983	1984	1985	1986
1-2						
May	178.8	1248.6	476.5	658.3	349.6	332.1
June	193.4	235.8	559.3	271.6	131.6	241.7
July	664.0	556.0	485.7	267.6	474.0	769.2
August	740.5	301.7	868.2	277.0	107.8	130.7
TOTALS	1776.7	2341.5	2389.7	1474.5	1063.0	1473.7
2-2						
May	234.2	62.5	32.8	66.3	28.9	53.9
June	165.5	126.4	58.4	21.2	20.2	19.8
July	157.3	240.8	269.8	83.9	96.8	49.7
August	600.9	439.5	156.8	30.5	37.7	61.7
TOTALS	1157.9	869.2	517.8	201.9	183.6	185.1
2-3						
May	--	--	32.0	47.1	42.3	225.3
June	--	--	14.6	7.1	49.4	68.3
July	--	--	56.3	101.2	130.0	49.7
August	--	--	24.3	318.4	5.3	61.7
TOTALS			127.2	473.8	227.0	384.1
2-4						
May	--	--	60.4	55.5	210.8	163.4
June	--	--	111.3	114.8	168.4	116.5
July	--	--	317.7	309.0	220.3	309.0
August	--	--	179.7	105.6	64.7	67.6
TOTALS			669.1	584.9	664.2	656.5
2-5						
May	--	--	--	--	160.2	115.9
June	--	--	--	193.5	226.0	256.2
July	--	--	--	287.9	1863.9	666.2
August	--	--	--	--	32.6	67.2
TOTALS				481.4	2282.7	1105.5

TABLE 14. (continued). Monthly suspended sediment loadings for Subbasin stations discharging to Rock Creek, May-August, 1981-1986. Results in, tons/month.

Station	Year 1981	1982	1983	1984	1985	1986
4-2						
May	164.4	135.3	22.7	114.0	21.0	76.3
June	139.8	190.2	68.3	46.5	31.8	51.6
July	195.2	146.1	221.5	105.2	78.4	21.1
August	334.8	245.0	373.2	346.7	201.6	112.3
TOTALS	834.2	716.6	685.7	612.4	332.8	261.3
4-3						
May	312.5	113.0	102.6	140.3	173.8	303.4
June	327.4	303.4	26.0	469.5	497.5	258.2
July	650.9	454.0	172.6	66.4	139.1	78.3
August	1428.9	540.1	220.8	62.9	20.1	287.4
TOTALS	2719.7	1410.5	522.0	739.1	830.5	927.3
5-2						
May	108.7	84.0	18.8	33.2	37.1	81.7
June	164.0	148.6	131.3	38.3	34.1	26.1
July	331.3	133.5	111.1	70.7	44.8	33.6
August	737.0	247.6	83.7	164.2	28.9	64.0
TOTALS	1341.0	613.7	844.9	306.4	144.9	205.4
7-4						
May	411.0	189.8	59.1	182.1	135.7	230.5
June	249.8	296.4	375.6	150.5	122.6	109.9
July	1512.6	346.9	304.9	219.5	110.3	64.2
August	1234.7	264.3	462.0	285.7	75.0	738.2
TOTALS	3408.1	1097.4	1201.6	837.8	443.6	1142.8
7-7						
May	16.0	14.5	24.2	20.1	36.8	5.5
June	28.7	18.4	69.3	5.5	14.9	4.5
July	31.1	122.1	17.7	36.4	8.5	11.8
August	14.8	5.8	10.8	20.0	9.7	12.7
TOTALS	90.6	160.8	122.0	82.0	69.9	34.5

TABLE 14. (continued). Monthly suspended sediment loadings for Subbasin stations discharging to Rock Creek, May-August, 1981-1986. Results in tons/month.

	Year					
Station	1981	1982	1983	1984	1985	1986
10-1						
May	--	--	14.1	12.0	11.7	34.6
June	--	--	8.8	7.3	4.5	9.7
July	--	--	6.2	6.5	3.7	0.4
August	--	--	3.1	5.4	22.5	5.6
TOTALS			32.2	50.5	42.4	50.3
CW-3						
May	--	--	--	--	120.4	97.6
June	--	--	--	--	--	18.9
July	--	--	--	--	983.3	20.0
August	--	--	--	--	40.5	7.4
TOTALS					1144.2	143.9

--data not available

TABLE 15. Monthly suspended sediment loadings for Rock Creek, May-August, 1981-1986. Results in tons/month.

Station	Year 1981	1982	1983	1984	1985	1986
S-1						
May	--	12,426.9	8,385.5	37,463.5	2,546.1	816.4
June	--	2,985.7	3,812.4	10,007.1	669.4	487.5
July	--	7,689.4	2,239.3	1,536.5	1,502.2	1,716.5
August	--	6,714.2	2,923.1	1,105.0	676.7	506.0
TOTALS		29,816.2	17,363.0	50,112.1	5,394.4	3,526.4
S-2						
May	--	--	7,751.1	31,558.0	8,500.5	2,531.4
June	--	--	3,548.2	21,000.0	2,695.0	1,637.7
July	--	--	1,934.3	4,051.5	2,639.1	2,736.7
August	--	--	2,080.8	2,864.7	682.3	2,457.2
TOTALS			15,314.3	59,474.2	14,516.9	12,099.7
S-3						
May	--	10919.2	2269.5	65069.0	2261.2	1,498.0
June	--	760.1	536.2	12586.0	449.2	672.2
July	1507.0	918.0	482.1	1558.5	601.2	1,646.1
August	--	2178.6	781.8	1308.7	376.8	1,183.2
TOTALS	1507.0	29,816.2	4,069.6	80,522.2	3,688.4	4,999.5
S-4						
May	--	3,024.4	1,404.3	41,742.0	2,161.6	920.9
June	--	122.5	1,054.3	4,658.4	248.1	201.0
July	574.7	893.1	227.2	888.9	202.8	1,175.3
August	--	793.1	286.6	128.8	141.5	217.4
TOTALS	574.7	4,833.1	297.4	47,418.1	2,754.0	2,514.6

--Data not available

TABLE 15. (continued). Monthly suspended sediment loadings for Rock Creek, May-August, 1981-1986. Results in tons/month.

Station	Year 1981	1982	1983	1984	1985	1986
S-5						
May	--	--	--	--	--	294.9
June	--	--	--	--	--	77.8
July	--	--	--	--	--	127.7
August	--	--	--	--	--	0.4
TOTALS						500.8
S-6						
May	--	1,078.0	562.8	43,726.0	676.1	492.1
June	--	70.1	426.9	2,997.0	48.2	122.3
July	--	29.0	13.2	64.1	19.5	12.5
August	--	79.1	10.1	18.0	3.2	11.4
TOTALS		1,256.2	1,013.0	46,805.1	747.0	638.3

--Data not available

TABLE 16. Comparison of irrigation season vs. nonirrigation season suspended sediment loadings (tons/day) in Rock Creek, 1981-1986.

	IRRIGATION (1 April-1 Nov.)				NONIRRIGATION (2 Nov-31 March)			
YEAR	N	MAX	MIN	MEAN	N	MAX	MIN	MEAN
Rock Creek near Rock Creek (S-6)								
1981	2	0.08	0.05	0.06	2	4.60	0.39	2.49
1982	12	34.78	0.06	4.58	2	.94	0.49	0.72
1983	12	26.57	0.06	4.33	2	1.10	0.94	1.02
1984	16	3315.00	0.19	458.68	1	0.18	0.18	0.18
1985	15	46.83	0.05	4.83	1	1.08	1.08	1.08
1986	13	21.84	0.10	5.41	sampling not complete			
Rock Creek at 3500 East Road (S-5)								
1981	--	--	--	--	--	--	--	--
1982	--	--	--	--	--	--	--	--
1983	--	--	--	--	--	--	--	--
1984	--	--	--	--	--	--	--	--
1985	--	--	--	--	--	--	--	--
1986	13	49.64	0.01	8.69	sampling not complete			

TABLE 16. (Continued). Comparison of irrigation season vs. nonirrigation season suspended sediment loadings (tons/day) in Rock Creek, 1981-1986.

	IRRIGATION (1 April-1 Nov.)				NONIRRIGATION (2 Nov-31 March)			
YEAR	N	MAX	MIN	MEAN	N	MAX	MIN	MEAN
Rock Creek at 12 Mile (S-4)								
1981	2	18.54	0.92	9.73	2	200.39	0.88	100.63
1982	12	97.56	2.02	27.36	2	2.26	0.97	1.62
1983	13	59.25	0.91	18.96	2	36.18	6.34	21.26
1984	14	2256.00	2.68	333.19	1	4.93	4.93	4.93
1985	15	195.88	2.52	31.52	1	18.46	18.46	18.46
1986	13	93.32	3.28	25.96	sampling not complete			
Rock Creek above Hwy. 93 (S-3)								
1981	2	48.62	1.94	25.28	2	270.62	12.11	141.36
1982	12	604.00	7.89	89.43	2	3.15	1.35	2.25
1983	13	276.43	6.30	46.21	2	20.39	2.53	11.46
1984	13	4121.50	5.59	483.60	1	2.11	2.11	2.11
1985	15	398.32	3.29	51.34	1	24.16	24.16	24.16
1986	12	97.86	6.15	40.97	sampling not complete			

TABLE 16. (Continued). Comparison of irrigation season vs. nonirrigation season suspended sediment loadings (tons/day) in Rock Creek, 1981-1986.

	IRRIGATION (1 April-1 Nov.)				NONIRRIGATION (2 Nov-31 March)			
YEAR	N	MAX	MIN	MEAN	N	MAX	MIN	MEAN
Rock Creek at Pole Line Road (S-2)								
1981	--	--	--	--	--	--	--	--
1982	--	--	--	--	1	5.86	5.86	5.86
1983	17	411.00	27.67	106.06	2	29.14	9.52	19.33
1984	13	1868.50	17.35	442.35	1	4.43	4.43	4.43
1985	15	404.50	9.71	120.17	1	28.32	28.32	28.32
1986	11	135.75	19.03	72.65	sampling not complete			
Rock Creek near Mouth (S-1)								
1981	--	--	--	--	1	751.00	751.00	751.00
1982	41	534.00	27.94	215.78	1	7.54	7.54	7.54
1983	14	423.78	31.46	133.49	1	1.57	1.57	1.57
1984	12	231.55	8.37	281.11	1	0.98	0.98	0.98
1985	15	185.89	3.70	46.94	2	92.42	5.10	48.76
1986	13	63.43	13.27	28.98	sampling not complete			

TABLE 17. Estimates of total sediment and suspended sediment from unstable stream bank study sections on Rock Creek during 1986.

Study Site	Total Sediment (tons/100m)	Suspended Sediment (tons/100m)
Rock Creek (Upper)		
Stricker Cabin, East	329.0	125.0
Stricker Cabin, West	203.0	78.0
Kerr Land & Livestock (S-5)	295.0	112.0
Rock Creek (Lower)		
Stafford	56.0	20.0
Cottonwood Creek		
Kerr Land & Livestock	62.4	24.5

TABLE 18. Estimated total and suspended sediment contributed to Rock Creek from unstable stream banks during 1986.

Stream Reach	Reach Length (mi.)	Stream Bank Erosion Length (mi.)	Steam Bank Contribution Total Sediment (Tons)	Suspended Sediment (Tons)
Rock Creek				
Mouth to S-2	3.70	0.00	0	0
S-2 to Lowline Canal	14.00	4.30	4,238	1,514
Lowline Canal to S-6	12.60	9.70	46,675	17,741
S-6 to USFS Boundary	3.75	2.30	2,268	810
TOTAL ROCK CREEK	34.05	16.30	53,181	20,065
Cottonwood Creek	2.60	1.40	1,535	603
GRAND TOTALS	36.65	17.70	54,716	20,668

TABLE 19. Bulk densities of soil cores from stream bank erosion sites on Rock Creek and Cottonwood Creek. The bulk densities represent oven dry weights of 30cm^3 cores taken from each visible soil layer in the exposed profile.

SAMPLE SITE	SAMPLE NO.	LAYER THICKNESS (ft.)	OVEN DRY WEIGHT (g)	BULK DENSITY	MEAN BULK DENSITY
ROCK CREEK					
Stricker Cabin West	1	1.0	26.0	0.87	
	2	1.0	32.7	1.09	
	3	3.5	35.2	1.17	
	4	2.0	32.1	1.07	1.05
Stricker Cabin East	1	1.0	29.4	0.98	
	2	1.0	31.4	1.05	
	3	2.0	33.3	1.11	
	4	3.0	38.8	1.29	1.11
3500 East Road (Kerr)	1	1.0	29.4	0.98	
	2	1.0	34.4	1.45	
	3	2.0	37.3	1.24	
	4	2.0	32.1	1.07	1.19
Richard Stafford	1	1.0	31.5	1.05	
	2	1.5	32.6	1.09	
	3	1.5	30.5	1.02	1.05
Magic Canyon (Marvin Spacek)	1	{*	35.1	1.17	
	2	{4.0	38.0	1.27	1.22
Jay Moyle	1	1.0	36.2	1.21	
	2	2.0	32.9	1.1	
	3	3.0	37.7	1.26	1.19
COTTONWOOD CREEK					
Lower (Kerr)	1	1.0	29.6	0.99	
	2	1.5	33.6	1.12	
	3	2.0	37.3	1.24	
	4	3.0	36.0	1.20	1.14
Roy Jesser	1	1.0	31.8	1.06	
	2	3.0	31.6	1.20	
	3	3.0	30.64	1.02	1.09

*No visible layers.

TABLE 20. Physical characteristics of Rock Creek sample stations.

Station No.	Stream Channel Width* (ft.)	Depth* (ft.)	Gradient * (%)	Elevation ft. (m)
S-1	28.5	0.8	1.6	3200 (975)
S-2	72.0	1.17	1.3	3500 (1067)
S-3	53.0	0.83	0.7	3700 (1128)
S-4	30.0	0.93	1.5	3800 (1158)
S-5	19.5	0.59	0.8	4000 (1219)
S-6	21.0	0.94	1.1	4368 (1331)
S-6A	21.0	0.77	1.2	4740 (1445)
S-6B	18.0	0.72	1.4	5140 (1567)

*data collected November, 1986.

TABLE 21. Cobble embeddedness for Rock Creek, 1986.

Station	N	Mean Embeddedness (%)
S-6A	116	20
S-6	134	56
S-5	112	64
S-4	107	45
S-3	104	40
S-2	111	43
S-1*	104	35

*Below hydro diversion

TABLE 22. Streambed core sample results for Rock Creek, 1986, particle size (volume of water displaced in ml).

		MATERIAL RETAINED (PARTICLE SIZE, Displacement in ml.)			
SAMPLE SITE	SAMPLE NO.	9.5mm	6.3mm	0.83mm	Imhoff Cone
S-6B	1	550	50	140	28
	2	460	79	160	45
	3	435	50	200	65
	4	550	31	110	47
	5	515	51	140	73
	6	485	60	150	50
	7	420	63	135	35
	8	560	55	170	25
	9	510	80	150	40
	10	490	37	135	20
S-6A	1	550	50	335	100
	2	335	25	195	80
	3	540	40	175	35
	4	520	70	180	51
	5	650	35	75	17
	6	305	110	470	120
	7	510	70	150	46
	8	480	65	220	69
	9	705	35	50	10
	10	465	110	170	125

TABLE 22. (continued). Streambed core sample results for Rock Creek, 1986, particle size (volume of water displaced in ml).

		MATERIAL RETAINED (PARTICLE SIZE, Displacement in ml.)			
SAMPLE SITE	SAMPLE NO.	9.5mm	6.3mm	0.83mm	Imhoff Cone
S-6	1	355	80	230	50
	2	500	70	170	30
	3	440	20	30	35
	4	380	85	300	125
	5	405	80	200	100
	6	470	60	198	95
	7	520	70	165	63
	8	515	50	150	130
	9	670	10	65	22
	10	395	90	210	92
S-5	1	560	50	140	55
	2	490	69	205	100
	3	540	60	95	79
	4	550	35	85	70
	5	545	50	110	70
	6	450	60	180	130
	7	480	65	85	83
	8	400	110	190	140
	9	470	60	140	100
	10	455	70	215	100
S-4	1	450	120	240	140
	2	490	95	125	205
	3	410	100	230	210
	4	370	120	320	180
	5	580	95	145	175
	6	320	150	250	235
	7	400	100	250	197
	8	370	120	285	175
	9	480	165	75	48
	10	460	137	100	200

TABLE 22. (continued). Streambed core sample results for Rock Creek, 1986, particle size (volume of water displaced in ml).

SAMPLE SITE	SAMPLE NO.	MATERIAL RETAINED (PARTICLE SIZE, Displacement in ml.) 9.5mm	6.3mm	0.83mm	Imhoff Cone
S-3	1	290	120	320	205
	2	550	65	115	145
	3	430	100	220	120
	4	350	90	270	200
	5	370	70	275	190
	6	465	70	100	180
	7	370	70	200	175
	8	380	100	270	200
	9	460	65	115	48
	10	370	90	285	150
	11	340	110	170	140
S-2	1	520	35	100	127
	2	490	110	130	150
	3	455	75	200	210
	4	550	90	175	150
	5	480	85	150	180
	6	390	120	185	135
	7	600	100	300	180
	8	580	105	200	200
	9	470	100	150	145
	10	350	70	135	225
S-1	1	370	120	210	210
	2	320	135	200	155
	3	350	150	195	150
	4	410	115	240	230
	5	375	140	150	150
	6	335	100	280	210
	7	380	80	200	250
	8	450	120	175	225
	9	420	125	160	195
	10	390	100	230	180

TABLE 23. Streambed core sample results for Rock Creek, 1986, particle size (percentage of each category).

SAMPLE SITE	SAMPLE NO.	MATERIAL RETAINED (PARTICLE SIZE, percentage of total.) 9.5mm	6.3mm	0.83mm	Imhoff Cone	TOTAL FINES (0.83mm + cone)
S-6B	1	72	6	18	4	22
	2	62	11	21	6	27
	3	58	7	27	8	29
	4	75	4	15	6	21
	5	66	7	18	9	27
	6	65	8	20	7	27
	7	64	10	21	5	26
	8	69	7	21	3	24
	9	66	10	19	5	24
	10	72	5	20	3	23
MEAN	(n=10)	66.9	7.5	20.0	5.6	25.6
				STANDARD DEVIATION		2.5
				COEFFICIENT OF VARIATION		9.8
S-6A	1	53	5	32	10	42
	2	53	4	31	12	43
	3	68	5	22	5	27
	4	63	9	22	6	28
	5	84	4	10	2	12
	6	30	11	47	12	59
	7	66	9	19	6	25
	8	58	8	26	8	34
	9	88	5	6	1	7
	10	53	13	20	14	34
MEAN	(n=10)	61.6	7.2	23.5	7.6	31.1
				STANDARD DEVIATION		15.1
				COEFFICIENT OF VARIATION		49

TABLE 23. (Continued). Streambed core sample results for Rock Creek, 1986, particle size (percentage of each category).

		MATERIAL RETAINED (PARTICLE SIZE, percentage of total.)				
SAMPLE SITE	SAMPLE NO.	9.5mm	6.3mm	0.83mm	Imhoff Cone	TOTAL FINES (0.83mm + cone)
S-6	1	50	11	32	7	39
	2	65	9	22	4	26
	3	84	4	6	6	12
	4	53	9	34	14	48
	5	52	10	25	13	38
	6	57	7	24	12	36
	7	64	8	20	8	28
	8	61	6	18	15	33
	9	87	1	9	3	12
	10	50	11	27	12	39
MEAN	(n=10)	62.3	7.6	21.7	9.4	31.1
			STANDARD DEVIATION			11.8
			COEFFICIENT OF VARIATION			38
S-5	1	70	6	17	7	24
	2	56	8	24	12	35
	3	70	8	12	10	22
	4	74	5	11	10	22
	5	70	7	14	9	23
	6	55	7	22	16	38
	7	67	9	12	12	24
	8	47	13	23	17	40
	9	61	8	18	13	31
	10	54	8	26	12	38
MEAN	(n=10)	62.4	7.9	17.9	11.8	29.7
			STANDARD DEVIATION			7.5
			COEFFICIENT OF VARIATION			25

TABLE 23. (Continued). Streambed core sample results for Rock Creek, 1986, particle size (percentage of each category).

SAMPLE SITE	SAMPLE NO.	MATERIAL RETAINED (PARTICLE SIZE, percentage of total.) 9.5mm	6.3mm	0.83mm	Imhoff Cone	TOTAL FINES (0.83mm + cone)
S-4	1	47	13	25	15	40
	2	54	10	14	22	36
	3	43	11	24	22	46
	4	37	12	33	18	51
	5	58	9	15	18	33
	6	33	16	26	25	51
	7	42	11	26	21	47
	8	39	13	30	18	48
	9	63	21	10	6	16
	10	52	15	11	22	33
MEAN	(n=10)	46.8	13.1	21.4	18.7	40.1
				STANDARD DEVIATION		11.0
				COEFFICIENT OF VARIATION		27
S-3	1	31	13	34	22	56
	2	63	7	13	17	30
	3	49	12	25	14	39
	4	38	10	30	22	52
	5	41	8	30	21	51
	6	57	9	12	22	34
	7	45	9	25	21	46
	8	40	11	28	21	49
	9	67	9	17	7	24
	10	41	10	32	17	49
	11	45	14	22	19	41
MEAN	(n=11)	51.7	11.2	26.8	20.3	47.1
				STANDARD DEVIATION		10.1
				COEFFICIENT OF VARIATION		21

TABLE 23. (Continued). Streambed core sample results for Rock Creek, 1986, particle size (percentage of each category).

		MATERIAL RETAINED (PARTICLE SIZE, percentage of total.)				
SAMPLE SITE	SAMPLE NO.	9.5mm	6.3mm	0.83mm	Imhoff Cone	TOTAL FINES (0.83mm + cone)
S-2	1	66	5	13	16	29
	2	56	12	15	17	32
	3	49	8	21	22	43
	4	57	9	18	16	34
	5	54	9	17	20	37
	6	47	15	22	16	38
	7	51	9	25	15	40
	8	54	10	18	18	36
	9	54	12	17	17	34
	10	45	9	17	29	46
MEAN	(n=10)	53.3	12.5	18.3	18.6	36.9
			STANDARD DEVIATION			5.1
			COEFFICIENT OF VARIATION			14
S-1	1	41	13	23	23	46
	2	39	17	25	19	44
	3	41	18	23	18	41
	4	41	12	24	23	47
	5	47	17	18	18	36
	6	36	11	30	23	53
	7	42	9	22	27	49
	8	47	12	18	23	41
	9	46	14	18	22	40
	10	43	11	26	20	46
MEAN	(n=10)	42.3	13.4	22.7	21.6	44.3
			STANDARD DEVIATION			4.9
			COEFFICIENT OF VARIATION			11

TABLE 24. Percent fines (>0.83mm) in substrate samples at Rock Creek sample stations for the years 1982 and 1986. Samples taken in best available spawning gravels.

SAMPLE STATION	PERCENT FINES	
	1982	1986
S-1	41	44
S-3	30	47
S-4	34	40
S-6	22	31

S-2 and S-5 were not sampled in 1982 and S-6A and S-6B were not yet established. Sample size in 1982 was 3 per station and 10 per station during 1986.

TABLE 25. Pesticide residues in rainbow trout from Rock Creek, station S-6, March 1985. Results in ppm.

Pesticide	Rainbow Trout #1	#2	#3	#4	#5
Total PCBs	--	--	--	--	--
PCB 1260	--	--	--	--	--
PCB 1242	--	--	--	--	--
Dieldrin	--	--	--	--	--
Total DDT & Analogs	--	--	0.005	--	0.002
o.p. DDT	--	--	--	--	--
p.p' DDT	--	--	--	--	--
p.p' DDE	--	--	0.005	--	0.002
p.p' DDD	--	--	--	--	--
Pentachlorophenol	0.045	--	--	--	--
Oxychlordane	--	--	--	--	--
Nonachlor, trans isomer	--	--	--	--	--
Heptachlor epoxide	--	0.002	--	--	--
BHC, beta form	--	--	--	--	--
Lindane	--	--	--	--	--
Toxaphene	--	--	--	--	--
Malathion	--	--	--	--	--

-- = Below Detectable Limits

TABLE 25. (continued). Pesticide residues in rainbow trout from Rock Creek, station S-6, March 1985. Results in ppm.

Pesticide	Rainbow Trout #6	#7	#8	#9	#10
Total PCBs	--	--	--	--	--
PCB 1260	--	--	--	--	--
PCB 1242	--	--	--	--	--
Dieldrin	--	--	--	--	--
Total DDT & Analogs	0.010	0.009	0.002	0.007	0.003
o.p. DDT	--	--	--	--	--
p.p' DDT	--	--	--	--	--
p.p' DDE	0.010	0.009	0.002	0.007	0.003
p.p' DDD	--	--	--	--	--
Pentachlorophenol	--	--	0.005	0.006	0.006
Oxychlordane	--	--	--	--	--
Nonachlor, trans isomer	--	--	--	--	--
Heptachlor epoxide	--	--	--	--	--
BHC, beta form	--	--	--	--	--
Lindane	--	--	--	--	--
Toxaphene	--	--	--	--	--
Malathion	--	--	--	--	--

-- = Below Detectable Limits

TABLE 26. Pesticide residues in rainbow trout from Rock Creek, station S-3, March 1985. Results in ppm.

Pesticide	Rainbow Trout #1	#2	#3	#4	#5
Total PCBs	--	0.030	--	--	--
PCB 1260	--	--	0.018	--	0.007
PCB 1242	--	--	0.027	--	--
Dieldrin	--	0.003	--	--	--
Total DDT & Analogs	0.031	0.111	0.070	1.727	0.045
o.p. DDT	0.002	--	0.029	0.047	--
p.p' DDT	0.005	0.008	0.020	0.054	--
p.p' DDE	0.019	0.099	0.021	1.626	0.045
p.p' DDD	0.005	0.004	--	--	--
Pentachlorophenol	--	0.011	--	--	0.001
Oxychlordane	--	0.001	--	--	--
Nonachlor, trans isomer	0.004	0.002	0.091	--	--
Heptachlor epoxide	0.003	--	0.014	--	--
BHC, beta form	0.007	--	--	--	--
Lindane	--	0.002	--	--	--
Toxaphene	--	--	--	--	--
Malathion	--	--	--	--	--

-- = Below Detectable Limits

TABLE 27. Pesticide residues in rainbow trout from Rock Creek, station S-2, March 1985. Results in ppm.

	Rainbow Trout				
Pesticide	#1	#2	#3	#4	#5
Total PCBs	--	0.012	--	--	--
PCB 1260	--	--	--	--	--
PCB 1242	--	--	--	--	--
Dieldrin	--	0.003	--	--	--
Total DDT & Analogs	0.076	0.051	0.029	0.126	0.120
o.p. DDT	--	--	--	--	--
p.p' DDT	0.005	0.003	--	--	0.006
p.p' DDE	0.068	0.046	0.029	0.126	0.107
p.p' DDD	0.003	0.002	--	--	0.007
Pentachlorophenol	0.023	0.029	--	0.003	0.003
Oxychlordane	--	--	--	--	--
Nonachlor, trans isomer	0.003	0.003	--	--	0.003
Heptachlor epoxide	--	--	--	--	--
BHC, beta form	--	--	--	--	--
Lindane	0.019	--	--	--	--
Toxaphene	--	--	--	--	--
Malathion	--	--	0.108	--	--

-- = Below Detectable Limits

TABLE 27. (continued). Pesticide residues in rainbow trout from Rock Creek, station S-2, March 1985. Results in ppm.

Pesticide	Rainbow Trout #6	#7	#8	#9	#10
Total PCBs	0.008	--	--	--	--
PCB 1260	--	--	--	--	--
PCB 1242	--	--	--	--	--
Dieldrin	0.002	0.003	--	--	--
Total DDT & Analogs	0.058	0.023	0.008	0.454	--
o.p. DDT	--	--	--	--	--
p.p' DDT	0.003	--	--	--	--
p.p' DDE	0.052	0.023	0.008	0.454	--
p.p' DDD	0.003	0.002	--	--	--
Pentachlorophenol	0.006	0.004	0.004	0.006	0.003
Oxychlordane	--	--	--	--	--
Nonachlor, trans isomer	0.003	--	--	--	--
Heptachlor epoxide	--	--	0.010	--	0.007
BHC, beta form	--	--	--	--	--
Lindane	0.019	--	--	--	--
Toxaphene	--	--	--	--	--
Malathion	--	--	--	--	--

-- = Below Detectable Limits

TABLE 28. Pesticide residues in rainbow trout from Rock Creek, station S-1, March 1985. Results in ppm.

Pesticide	Rainbow Trout #1	#2	#3	#4	#5
Total PCBs	--	0.029	0.008	--	--
PCB 1260	0.026	--	--	--	--
PCB 1242	--	--	--	--	--
Dieldrin	0.003	0.005	--	0.011	0.003
Total DDT & Analogs	0.067	0.161	0.047	0.106	0.073
o.p. DDT	--	0.006	0.002	0.003	--
p.p' DDT	--	0.021	0.0050	0.008	--
p.p' DDE	0.067	0.134	0.040	0.091	0.073
p.p' DDD	--	--	--	0.004	--
Pentachlorophenol	0.014	0.009	0.032	--	0.05
Oxychlordane	--	--	--	--	--
Nonachlor, trans isomer	--	0.007	--	0.004	--
Heptachlor epoxide	--	--	--	0.007	--
BHC, beta form	--	--	--	--	--
Lindane	--	--	0.020	--	--
Toxaphene	--	--	--	--	--
Malathion	--	--	--	--	--

-- = Below Detectable Limits

TABLE 29. Pesticide residues in brown trout from Rock Creek, station S-1, March 1985. Results in ppm.

Pesticide	Brown Trout #1	#2
Total PCBs	--	--
PCB 1260	--	0.010
PCB 1242	0.063	--
Dieldrin	--	--
Total DDT & Analogs	0.158	0.060
o.p. DDT	--	--
p.p' DDT	--	--
p.p' DDE	0.158	0.060
p.p' DDD	--	--
Pentachlorophenol	0.023	0.026
Oxychlordane	--	--
Nonachlor, trans isomer	--	--
Heptachlor epoxide	--	--
BHC, beta form	--	--
Lindane	--	--
Toxaphene	4.911	--
Malathion	--	--

-- = Below Detectable Limits

TABLE 30. Pesticide residues in carp from Rock Creek, station S-1, March 1985. Results in ppm.

Pesticide	Carp #1	Carp #2
Total PCBs	--	--
PCB 1260	0.012	--
PCB 1242	--	--
Dieldrin	0.011	0.001
Total DDT & Analogs	0.350	0.158
o.p. DDT	0.004	--
p.p' DDT	0.014	0.011
p.p' DDE	0.314	0.137
p.p' DDD	--	0.010
Pentachlorophenol	0.005	0.005
Oxychlordane	--	--
Nonachlor, trans isomer	0.006	0.003
Heptachlor epoxide	--	--
BHC, beta form	--	--
Lindane	--	--
Toxaphene	--	--
Malathion	--	--

-- = Below Detectable Limits

TABLE 31. Pesticides known to be used in the Rock Creek watershed. Trade names, common and other names, chemical names, most common usage, and date first available for use given when available. Information follows Berg (1983 and 1986) and Spencer (1982).

Trade Name	Common Name	Other Names (Selected)	Chemical Name	Common Usage (Selected)	Date Available for Use
<u>Insecticide:</u>					
Cygon	dimethoate	AC-18682, Daphene, Dimet hogen, Rebalte, Rogodial, Rogor, Roxion, Trimethian	O,O-Dimethyl S-(methylcarbamoylemthyly) phosphorodithioate	systemic for insects and mites	1956
Diazinon	diazinon	Dianon, Basudin, Diazajet, Diazide, Diazatol, Diazol, Dazzel, Dizinon, Dyzol	O,O-Diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate	control of soil insects and nematodes	1952
Di-syston	disulfoton	dithiodemeton, dithiosystox, Frumin AL, Solvirex	O,O-Diethyl S-2(ethylthio)ethyl phosphorodithioate	systemic for insects and mites	1956
Furadan	carbofuran	curaterr, Yaltox	2,3-Dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate	corn, alfalfa, potato pest control	1966
Guthion	azinphos-methyl	Carfene, cotnion-Methyl, Crysthyon 2L	O,O-Dimethyl S-[(4-oxo-1,2,3-benzotriazin-3(4H)-yl) methyl]phosphorodithioate	general, broad spectrum	1954
Malathion	malathion	Cythion, Extra, For-Mal, Malaspray, Malamar, Malatol, Malmed, Zithiol	O,O-Dimthyl S-1,2-di(ethoxycarbonyl)ethyl phosphorodithioate	gemeral, broad spectrum	1950
Sevin	carbaryl	Dicarbam, Hexavin, Karbaspray, Nac, Denapon, Ravyon, Septene, Tercyl, Tricarnam	1-Naphthyl methylcarbamate	general, broad spectrum	1956
Thimet	phorate	Rampart	O,O-Diethyl S-1(ethylthiomethyl) phosphorodithioate	general use, soil and systemic	1954
Pounce	permethrin	Ambush, Ectiban	3-Phenoxybenzyl(±)cis,trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylate	ground or air applications against lepidopterous pests	1973
<u>Herbicide:</u>					
Atrazine	atrazine	Gesaprim, Primatol, Atred	2-Chloro-4-ethylamino-6-isopropylamino-l,3,5-triazine	weed control	1958
Avenge	Difenzoquat methyl sulfate	Finaven	1,2-dimethyl-3,5-2disphenyl-1H-pyrazolium methyl sulfate	wild oat herbicide	1972
Banvel	dicamba, dianat	Banex, Banvel D, Brush Buster, mediben	2-Methoxy-3, 6-dichlorobenzoic acid or 3,6,Dichloro-o-anisic acid	Brush control; some weeds	
Eptam	EPTC	Eradicane, Knoxweed	S-Ethyl dipropylthio-carbamate	control of grass and weeds	1954
Kerb	pronamide, propyzamide	n/a	N-(l,l-Dimethylpropynyl)-3,5-dichlorobenzamide	weed and grass control in small seeded legumes	1969
Lasso	alachlor	Alanex, La20, acetanilide	2-Chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl)acetamide	weed and grass control	1967
Ro-neet	cycloate, hexylthiocarbam	R-2063	S-ethylcyclohexylethlthio-carbamate	annual grass control on sugar beets	

TABLE 31. (Continued).Pesticides known to be used in the Rock Creek watershed. Trade names, common and other names, chemical names, most common usage, and date first available for use given when available. Information follows Berg (1983 and 1986) and Spencer (1982).

Trade Name	Common Name	Other Names (Selected)	Chemical Name	Common Usage (Selected)	Date Available for Use
Roundup	Glyphosate	Rodeo, Kleenup	N-(phosphonomethyl) glycine	grass and weed control	1971
Simadex	Simazine	G 27692, Gesatop, Primatol, Princep, Framed, Simanex	2-Chloro-4,6-bis-ethylamino-S-triazine	annual grass and weed control	1956
Sonalan	ethalfluralin	El-161	N-Ethyl-N-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoro methyl) benzenamine	preemergence control of grasses and weeds in dry beans	
Surflan	oryzalin	Ryzelan, Rycelan, Ryzelon, Dirimal	3,5-Dinitro-N4,N4-diprophysulfanilamide	grass and weed control	1969
Tillam	pebulate	PEBC, R-2061	S-Propyl butylethylthiocarbamate	controls grass and weeds on sugar beets	1954
Treflan	trifluralin	Crisalin, Digermin, Elancolan, Ipersan, Trefancoide, Triflurex	a,a, a-Trifluoro-2,6-dintro-N, N-dipropyl-p-toluidine	preemergence control of weeds in potatoes, beans and winter wheat	1960
Velpar	hexazinone	DPX 3674	3-Cyclohexyl-6-dimethylamino-1-methyl-1,3,5-triazine-2,4-dione	weed killer	1976
2, 4-D	2, 4-D	Weedone, Salvo, Weeder, Chloroxone, Hedanol	(2,4-dichlorophenoxy)acetic acid	weed control on corn	1923
Fungicide:					
Bayleton	triadimefon	MEB 6447, Amiral	1- (4-chloro-phenoxy)-3, 3-dimethyl-1-(1,2,4-triazol-1-y1)-butan-2-one	Mildew and rust control on grain	1976
Benlate	benomyl	Tersan	Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate	wide range disease control	1968
Captan	captan, captane, Orthocide 406	Merpan, Orthocide, Vondcaptan	N-Trichloromethylmercapto-4-cyclohexene-1,2-dicarboximide	used on fruits and vegetables	1949
Polyram	metiram, maneb, thiram, zineb	various compounds	various compounds	wide range disease control	1931-1960
Algicide:					
Copper sulfate	copper sulfate	bluestone, blue vitriol, Triangle	cupric culfate pentahydrate	fungicide and algicide	1807
Xylene	Xylene	Xylol	dimethyl benzene	solvent and algicide	

TABLE 32. Organic chemicals (mainly pesticides) found in Rock Creek in addition to those of known usage (see Table 31). Information follows Berg (1983 and 1986) and Spencer (1982).

Trade Name	Common Name	Other Names (Selected)	Chemical Name	Common Usage	Date Available for Use
Coolant:					
Total PCBs	Aroclor		Polychlorinated biphenyl	Coolant	1929
PCB 1242	Aroclor		Polychlorinated biphenyl	Coolant	1929
PCB 1260	Aroclor		Polychlorinated biphenyl	Coolant	1929
Insecticide:					
Dieldrin	dieldrin	HEOD, Octalox, Dieldrex, Dieldrite, Panoram D-31	1,2,3,4,10,10-hexachloro-exo-6,7-expoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, exo-5,8-dimethanonaphthalene	Use cancelled in U.S.	1948
DDT	DDT, Zeidane	Dicophane, Chlorophenothane, Zerdane, Neocid, Anofox Genitox	Dichloro diphenyl trichloroethane	Use cancelled in U.S., 1972	1944
o.p.DDT	DDT			A form of DDT	1944
p.p'DDT	DDT			A form of DDT	1944
p.p'DDE			Dichlorodiphenyldichloroethylene	Breakdown product of DDT	N/A
p.p'DDD				Breakdown of product of DDT	N/A
Heptachlor	heptachlor	heptox, Drinox, Heptamul	1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-endomethanoindene	Agricultural use and termite control	1940s
Heptachlor epoxide				Breakdown prodcut of Heptachlor	N/A
BHC, beta form	BHC, hexachlor	HCH, 666, FBHC, Benzene hexachloride	1,2,3,4,5,6-Hexachlorocyclohexane	Use cancelled in U.S.	1940
Lindane	lindane	gamma-BHC, gamma-HCH	r-1,2,3,4,5,6-hexachlorocyclohexane forms a part of BHC, is the gamma isomer of hexachlor	Seed protectant systemic	1940
Hexachloro-benzene	hexachloro-benzene	Anticarie, No Bunt, HCB, perchlorobenzene	Perchlorobenzene	Seed protectant	1945
Oxcghlordane	chlordane		1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene	Use cancelled in U.S. A constituent of chlordane	1945
Nonachlor, trans isomer	nonachlor		1,2,3,4,5,6,7,8,8-Nonachloro-3a,4,7,7a-tetrahydro-4,7-methanoindan	A constituent of chlordane	1948
Ronnel	ronnel	Ectoral, Etrolene, Nankor, Korlan, Trolene, Viozene	O,O-Dimethyl O-2,4,5,-trichlorophenyl phosphorothioate	Contact and systemic for livestock pests	1954
Toxaphene	toxaphene	polychlorocamphene, camphechlor, 3956	Chlorinated camphene	Control of livestock pests	1948
Fungicide:					
Penta-chlorophenol	PCP, penta	Pentachlorol, Dowicide F, Dowicide G, Santophen 20, Santobrite, Chlorophen	Pentachlorophenol	Wood preservative	1936

TABLE 33. Comparison of irrigation season vs. nonirrigation season total phosphorus loadings (lbs/day) in Rock Creek, 1981-1986.

	IRRIGATION (1 April-1 Nov.)				NONIRRIGATION (2 Nov-31 March)			
YEAR	N	MAX	MIN	MEAN	N	MAX	MIN	MEAN
Rock Creek near Rock Creek (S-6)								
1981	2	3.43	0.27	1.85	2	29.30	9.80	19.56
1982	12	99.35	2.78	18.46	2	7.01	4.94	5.97
1983	12	99.03	2.37	24.01	2	13.97	9.71	11.84
1984	13	8710.94	3.88	773.69	1	4.85	4.85	4.85
1985	15	174.22	1.40	27.59	1	6.74	6.74	6.74
1986	12	300.97	9.17	57.31	sampling not complete			
Rock Creek at 3500 East Road (S-5)								
1981	--	--	--	--	--	--	--	--
1982	--	--	--	--	--	--	--	--
1983	--	--	--	--	--	--	--	--
1984	--	--	--	--	--	--	--	--
1985	--	--	--	--	--	--	--	--
1986	12	95.47	3.78	34.97	sampling not complete			

TABLE 33. (Continued). Comparison of irrigation season vs. nonirrigation season total phosphorus loadings (lbs/day) in Rock Creek, 1981-1986.

	IRRIGATION (1 April-1 Nov.)				NONIRRIGATION (2 Nov-31 March)			
YEAR	N	MAX	MIN	MEAN	N	MAX	MIN	MEAN
Rock Creek at 12 Mile (S-4)								
1981	2	59.33	23.48	41.40	2	576.35	23.86	300.11
1982	12	210.70	15.53	97.13	2	18.79	13.52	16.15
1983	13	160.52	19.96	71.40	2	120.61	34.36	77.48
1984	14	5339.83	17.15	689.11	1	31.55	31.55	31.55
1985	15	317.64	29.13	83.25	1	68.82	68.82	68.82
1986	12	171.52	30.74	77.85	sampling not complete			
Rock Creek above Hwy. 93 (S-3)								
1981	2	140.82	38.34	89.58	2	1068.35	127.16	597.76
1982	12	1014.95	12.28	288.89	2	33.01	13.60	23.31
1983	13	532.64	46.28	156.55	2	107.61	41.53	74.57
1984	13	8837.15	46.06	1143.25	1	31.55	31.55	31.55
1985	15	555.45	46.06	149.87	1	83.06	83.06	83.06
1986	12	310.68	40.99	158.58	sampling not complete			

TABLE 33. (Continued). Comparison of irrigation season vs. nonirrigation season total phosphorus loadings (lbs/day) in Rock Creek, 1981-1986.

	IRRIGATION (1 April-1 Nov.)				NONIRRIGATION (2 Nov-31 March)			
YEAR	N	MAX	MIN	MEAN	N	MAX	MIN	MEAN
Rock Creek at Pole Line Road (S-2)								
1981	--	--	--	--	--	--	--	--
1982	--	--	--	--	1	48.13	48.13	48.13
1983	12	392.40	79.29	240.16	2	149.62	94.34	121.98
1984	12	4539.39	101.19	1460.70	1	67.31	67.31	67.31
1985	15	1839.87	64.73	418.72	1	100.81	100.81	100.81
1986	11	835.71	126.86	340.23	sampling not complete			
Rock Creek near Mouth (S-1)								
1981	--	--	--	--	1	2455.35	2455.35	2455.35
1982	13	899.95	145.85	422.64	1	93.15	93.15	93.15
1983	11	858.58	189.86	394.65	1	7.34	7.34	7.34
1984	12	2498.40	43.69	514.88	1	9.22	9.22	9.22
1985	15	656.96	23.79	135.28	2	253.83	29.13	141.48
1986	13	231.93	27.51	100.32	sampling not complete			

TABLE 34. Field filtered vs. lab filtered ortho-phosphate for all Rock Creek stations during 1986.

SAMPLE STATION	ORTHO-PHOSPHATE Mean Difference (mg/l)*	ORTHO-PHOSPHATE % Mean Difference
Subbasins		
1-1	0.0165	80.9
1-2	0.0206	78.3
2-1	0.0058	47.2
2-2	0.0117	52.9
2-3	0.0157	189.2
2-4	0.0107	66.5
2-5	0.0164	28.5
4-1	0.0063	86.3
4-2	0.0136	57.4
4-3	0.0234	117.0
4-4	0.0045	68.2
5-1	0.0058	78.4
5-2	0.0081	32.3
7-1	0.0069	76.7
7-2	0.0399	67.9
7-3	0.0335	99.1
7-4A } split samples	0.0274	65.9
7-4B } split samples	0.0285	69.2
7-6	0.0331	54.1
7-7	0.0079	19.1
10-1	0.0085	41.7
CW-3	0.0081	38.9

TABLE 34. (continued). Field filtered vs. lab filtered ortho-phosphate for all Rock Creek stations during 1986.

SAMPLE STATION	ORTHO-PHOSPHATE Mean Difference (mg/l)*	ORTHO-PHOSPHATE % Mean Difference
Rock Creek		
S-2	0.0128	35.4
S-2A } split samples	0.0079	28.2
S-2B } split samples	0.0073	25.7
S-3	0.0066	28.3
S-4	0.0082	29.5
S-5	0.0054	7.9
S-6	0.0058	34.1
Total Mean for All Sites		**58.8**

* n = 17 for subbasin sites
  n = 12 for Rock Creek sites

TABLE 35. Comparison of irrigation season vs. nonirrigation season total Kjeldahl organic (nitrogen) loadings (lbs/day) in Rock Creek, 1981-1986.

	IRRIGATION (1 April-1 Nov.)				NONIRRIGATION (2 Nov-31 March)			
YEAR	N	MAX	MIN	MEAN	N	MAX	MIN	MEAN
Rock Creek near Rock Creek (S-6)								
1981	1	16.18	16.18	16.18	2	97.68	37.04	67.36
1982	6	116.37	6.36	53.08	2	35.60	19.74	27.67
1983	10	237.87	5.93	48.74	2	61.87	51.78	56.82
1984	13	23058.40	15.10	2016.55	1	13.59	13.59	13.59
1985	12	490.83	5.29	74.28	1	35.06	35.06	35.06
1986	12	254.86	9.71	81.45	sampling not complete			
Rock Creek at 3500 East Road (S-5)								
1981	--	--	--	--	--	--	--	--
1982	--	--	--	--	--	--	--	--
1983	--	--	--	--	--	--	--	--
1984	--	--	--	--	--	--	--	--
1985	--	--	--	--	--	--	--	--
1986	12	362.79	20.01	158.89	sampling not complete			

TABLE 35. (continued). Comparison of irrigation season vs. nonirrigation season total Kjeldahl organic (nitrogen) loadings (lbs/day) in Rock Creek, 1981-1986.

	IRRIGATION (1 April-1 Nov.)				NONIRRIGATION (2 Nov-31 March)			
YEAR	N	MAX	MIN	MEAN	N	MAX	MIN	MEAN
Rock Creek at 12 Mile (S-4)								
1981	1	152.64	152.64	152.64	2	2134.64	186.12	1160.38
1982	6	374.76	155.34	272.32	2	110.68	57.93	84.30
1983	10	468.18	79.29	240.94	2	371.09	134.79	252.94
1984	14	14951.50	114.35	1881.73	1	161.98	161.98	161.98
1985	12	902.92	129.50	358.03	1	397.31	397.31	397.31
1986	12	671.47	183.01	335.34	sampling not complete			
Rock Creek above Hwy. 93 (S-3)								
1981	1	321.12	321.12	321.12	2	4737.03	717.17	2727.10
1982	8	3339.50	197.90	881.97	2	99.03	75.73	87.38
1983	10	2224.93	154.26	655.51	2	407.77	224.27	316.02
1984	13	21816.70	263.22	2723.18	1	196.60	196.60	196.60
1985	12	1680.97	258.58	501.43	1	430.42	430.42	430.42
1986	12	1274.28	196.77	611.52	sampling not complete			

TABLE 35. (continued). Comparison of irrigation season vs. nonirrigation season total Kjeldahl organic (nitrogen) loadings (lbs/day) in Rock Creek, 1981-1986.

	IRRIGATION (1 April-1 Nov.)				NONIRRIGATION (2 Nov-31 March)			
YEAR	N	MAX	MIN	MEAN	N	MAX	MIN	MEAN
Rock Creek at Poleline Road (S-2)								
1981	--	--	--	--	--	--	--	--
1982	--	--	--	--	1	397.63	397.63	397.63
1983	8	1093.37	436.46	746.32	2	748.12	583.17	665.65
1984	12	11348.50	491.48	3774.50	1	403.89	403.89	403.89
1985	12	2692.57	213.59	964.800	1	691.27	691.27	691.27
1986	11	1774.55	570.88	1023.41	sampling not complete			
Rock Creek near Mouth (S-1)								
1981	--	--	--	--	1	6517.29	6517.29	6517.29
1982	7	3178.55	698.49	1392.85	1	508.09	508.09	508.09
1983	6	1838.20	381.56	964.90	1	33.23	33.23	33.23
1984	12	5933.68	247.57	1134.35	1	43.20	43.20	43.20
1985	12	879.29	113.65	275.51	2	994.29	164.56	579.43
1986	13	905.94	132.04	349.65	sampling not complete			

TABLE 36. Log mean concentrations for trace metals on Rock Creek, 1981-1986.

METAL (μ/L)	STATION S-6	S-5*	S-4	S-3	S-2**	S-1
Arsenic	9.99	10.00	10.04	10.48	11.25	11.05
Boron	42.73	55.32	130.78	169.85	173.77	171.23
Chromium	48.28	50.00	50.00	50.00	50.00	50.00
Copper	10.89	10.00	10.61	10.89	10.71	11.26
Iron	269.12	443.40	812.42	919.14	1392.08	1547.32
Lead	49.01	50.00	50.19	50.20	50.00	50.00
Manganese	14.32	26.29	48.37	54.79	56.78	77.29
Mercury	0.53	0.51	0.51	0.51	0.51	0.50
Zinc	2.50	3.67	6.00	8.68	11.02	10.20

* 1986 data only.
** 1983-1986 data.

TABLE 37. Metals in fish tissue, Rock Creek, March 1985 (concentration in PPM).

SAMPLE NO. / SPECIES		% MOISTURE	CONCENTRATION (micrograms/gram wet weight) As.	Cd.	Cr.	Pb.	Cu.	Mn.	Zn.	Hg.
Rock Creek near Rock Creek (S-6)										
1	RT**	79.0	<0.10	0.003	<0.01	<0.01	0.33	0.23	4.62	0.26
2	RT	80.0	<0.10	<0.001	0.03	<0.01	0.38	0.18	4.94	0.25
3	RT	78.4	<0.01	0.003	<0.01	<0.01	0.58	0.20	3.89	0.09
4	RT	78.8	<0.01	0.003	0.02	<0.01	0.47	0.25	4.45	0.07
5	RT	78.3	<0.10	0.006	0.04	<0.01	0.41	0.24	3.91	0.12
6	RT	79.7	<0.10	0.003	0.03	<0.01	1.23	0.35	4.38	0.09
7	RT	82.2	<0.10	0.001	0.01	<0.01	0.74	0.33	4.13	0.06
8	RT	78.6	<0.10	0.008	0.03	0.01	0.81	0.48	7.07	0.10
9	RT	77.1	<0.10	0.009	0.02	<0.01	0.70	0.29	7.17	0.07
10	RT	74.4	<0.10	0.009	0.06	0.08	0.81	0.42	5.74	0.06
Rock Creek at 3500 East Road (S-5)										
no samples										
Rock Creek at 12 Mile (S-4)										
no samples										
Rock Creek above Hwy. 93 (S-3)										
1	RT	75.8	<0.10	<0.001	0.06	<0.01	0.59	0.12	3.81	0.07
2	RT	78.1	0.34	<0.001	0.05	<0.01	0.67	0.07	5.21	0.08
3	RT	76.8	<0.10	<0.001	0.04	<0.01	0.68	0.21	4.75	0.14
4	RT	79.4	0.33	0.003	0.15	<0.01	0.58	0.21	4.49	0.05
5	RT	75.3	<0.10	0.003	0.09	<0.01	0.65	0.17	5.31	0.02

* Brown Trout
** Rainbow Trout

TABLE 37. (Continued). Metals in fish tissue, Rock Creek, March 1985 (concentration in PPM).

SAMPLE NO. / SPECIES	% MOISTURE	CONCENTRATION (micrograms/gram wet weight) As.	Cd.	Cr.	Pb.	Cu.	Mn.	Zn.	Hg.
Rock Creek at Pole Line Road (S-2)									
1 RT**	76.7	<0.10	<0.001	0.07	<0.01	0.78	0.19	4.93	0.04
2 RT	76.8	<0.10	0.005	0.07	<0.01	0.29	0.17	4.55	0.01
3 RT	78.8	<0.10	0.003	0.09	0.04	1.25	0.21	2.00	0.02
4 RT	79.7	0.58	<0.001	0.15	0.01	0.35	0.18	3.56	0.01
5 RT	78.3	<0.10	<0.001	0.04	0.01	0.70	0.28	4.53	0.06
6 RT	77.7	<0.10	<0.001	0.40	0.08	0.51	0.31	5.66	0.02
7 RT	77.3	<0.10	<0.001	0.07	<0.01	0.58	0.20	4.97	0.02
8 RT	76.8	<0.10	<0.001	0.24	<0.01	0.32	0.26	4.79	0.02
9 RT	77.6	<0.10	<0.001	0.04	<0.01	0.62	0.27	4.65	0.02
10 RT	79.2	<0.10	<0.001	0.07	<0.01	0.47	0.14	3.93	0.06
Rock Creek near Mouth (S-1)									
1 BT*	75.4	<0.10	<0.001	<0.01	<0.01	0.36	0.14	5.04	0.02
2 BT	77.6	<0.10	0.004	<0.01	<0.01	0.96	0.28	4.62	0.01
3 Carp	78.2	<0.10	0.005	0.12	0.06	0.76	0.32	6.68	0.05
4 Carp	77.4	<0.10	0.003	0.02	0.04	1.11	0.26	9.32	0.06
1 RT	77.1	<0.10	0.004	0.09	0.02	0.35	0.21	4.13	0.10
2 RT	76.4	<0.10	<0.001	0.05	0.02	0.75	0.51	0.15	0.07
3 RT	76.5	<0.10	0.005	0.02	<0.01	0.53	0.41	5.05	<0.01
4 RT	74.6	<0.10	0.002	0.02	<0.01	1.09	0.37	4.28	0.04
5 RT	76.5	<0.10	0.004	<0.01	<0.01	0.68	0.24	4.70	0.11

* Brown Trout
** Rainbow Trout

TABLE 38. Fecal coliform densities (#/100 ml, geometric means) for subbasin stations, 1981-1986.

YEAR	N	MAX	MIN	MEAN
Coulee at N 4200 Rd. E. of 2600 E. Rd. (1-1)				
1981	21	7100	12	278
1982	19	1200	3	212
1983	19	1800	10	240
1984	19	1000	27	284
1985	20	2100	10	129
1986	20	540	20	117
Coulee near Rock Creek Mouth (1-2)				
1981	21	13000	20	518
1982	20	3500	100	381
1983	20	23200	40	517
1984	19	5500	39	411
1985	21	6000	10	233
1986	22	1400	4	132
Q-Coulee at Hwy. 30/93 near KTFI Radio (2-1)				
1981	21	850	4	51
1982	19	800	8	86
1983	20	1350	10	74
1984	20	1600	10	66
1985	20	2200	10	35
1986	22	1300	10	103

TABLE 38. (continued). Fecal coliform densities (#/100 ml, geometric means) for subbasin stations, 1981-1986.

YEAR	N	MAX	MIN	MEAN
Q-Coulee near Mouth (2-2)				
1981	21	10000	30	551
1982	19	2700	8	432
1983	20	6500	20	423
1984	18	4700	16	372
1985	19	3000	10	164
1986	22	3600	10	127
Major Drain on East Side of Rock Creek (2-3)				
1981	--	--	--	--
1982	--	--	--	--
1983	18	2500	20	285
1984	18	3100	67	289
1985	19	1100	20	147
1986	18	700	10	136
Drain from Subbasin 3 (2-4)				
1981	--	--	--	--
1982	--	--	--	--
1983	18	1400	50	313
1984	18	1400	69	337
1985	19	600	10	170
1986	21	700	20	149

TABLE 38. (Continued). Fecal coliform densities (#/100 ml, geometric means) for subbasin stations, 1981-1986.

YEAR	N	MAX	MIN	MEAN
Wonderlich Drain (2-5)				
1981	--	--	--	--
1982	--	--	--	--
1983	4	900	10	232
1984	14	7000	69	829
1985	20	11000	90	599
1986	21	5000	20	335
L-Coulee at Low Line Canal (4-1)				
1981	19	200	6	25
1982	17	560	10	29
1983	18	80	3	20
1984	18	100	10	34
1985	20	40	1	12
1986	19	200	10	15
L-Coulee at Rock Creek Park near Mouth (4-2)				
1981	21	6000	120	1147
1982	19	8300	70	1152
1983	20	13000	45	764
1984	19	5900	55	667
1985	21	2300	8	368
1986	21	4500	10	327

TABLE 38. (Continued). Fecal coliform densities (#/100 ml, geometric means) for subbasin stations, 1981-1986.

YEAR	N	MAX	MIN	MEAN
O-Coulee at Monroc near Mouth (4-3)				
1981	21	8000	80	1597
1982	19	12000	200	1990
1983	20	5500	40	508
1984	19	9700	150	1084
1985	21	4500	10	328
1986	22	8300	10	243
O-Coulee at Low Line Canal (4-4)				
1981	19	200	5	30
1982	18	530	10	31
1983	18	130	6	37
1984	19	250	20	49
1985	19	70	10	19
1986	22	50	10	17
K-Coulee at Low Line Canal (5-1)				
1981	21	60	1	11
1982	18	480	2	22
1983	19	50	2	12
1984	19	150	1	24
1985	18	70	10	16
1986	21	200	10	17

TABLE 38. (Continued). Fecal coliform densities (#/100 ml, geometric means) for subbasin stations, 1981-1986.

YEAR	N	MAX	MIN	MEAN
K-Coulee at Golf Course near Mouth (5-2)				
1981	21	1200	10	243
1982	20	17000	1	333
1983	20	3400	70	378
1984	18	1600	160	504
1985	20	2100	30	210
1986	21	4200	10	196
I-Coulee below Highline Canal (7-1)				
1981	20	320	2	16
1982	18	500	6	29
1983	18	330	3	19
1984	18	400	7	31
1985	20	120	1	11
1986	22	400	1	12
I-Coulee below Low Line Canal (7-2)				
1981	20	5500	70	738
1982	17	16000	120	830
1983	18	20000	90	663
1984	19	5600	34	615
1985	20	2300	10	317
1986	21	4300	50	337

TABLE 38. (Continued). Fecal coliform densities (#/100 ml, geometric means) for subbasin stations, 1981-1986.

YEAR	N	MAX	MIN	MEAN
I-Coulee above Confluence with 7-6 (7-3)				
1981	21	6600	10	233
1982	17	1200	1	186
1983	17	5500	10	154
1984	19	1900	8	185
1985	19	2700	20	216
1986	19	300	10	70
I-Coulee at Hillcrest Rd. near Mouth (7-4)				
1981	21	3300	10	349
1982	18	1700	90	339
1983	18	3100	50	531
1984	19	4350	39	491
1985	20	14600	20	387
1986	21	2250	10	260
H-Coulee before Confluence with I-Coulee at 7-3 (7-6)				
1981	20	3800	10	474
1982	18	1600	1	181
1983	18	1900	20	356
1984	18	940	9	258
1985	19	13000	30	483
1986	20	2500	10	187

TABLE 38. (Continued). Fecal coliform densities (#/100 ml, geometric means) for subbasin stations, 1981-1986.

YEAR	N	MAX	MIN	MEAN
Drain near Mouth of I-Coulee, Sec. 27 (7-7)				
1981	18	2000	30	255
1982	17	13000	75	549
1983	13	4600	10	431
1984	18	4000	14	375
1985	18	4700	20	350
1986	21	5000	10	152
Drain at 3600 East Rd. on East Side (10-1)				
1981	--	--	--	--
1982	--	--	--	--
1983	19	2200	10	338
1984	17	2700	56	347
1985	22	1100	30	219
1986	22	520	30	148
Cottonwood Creek, below Drain below 3100 N. Rd. (CW-3)				
1981	--	--	--	--
1982	--	--	--	--
1983	--	--	--	--
1984	--	--	--	--
1985	20	1100	10	98
1986	22	3300	10	153

TABLE 39. Fecal coliform densities (#/100 ml, geometric means) Rock Creek stations, 1981-1986.

YEAR	N	MAX	MIN	MEAN
Rock Creek near Rock Creek (S-6)				
1981	3	300	7	61
1982	15	90	1	16
1983	15	650	3	24
1984	15	1900	1	28
1985	16	600	10	50
1986	15	50	10	18
Rock Creek at 3500 East Road (S-5)				
1981	--	--	--	--
1982	--	--	--	--
1983	--	--	--	--
1984	--	--	--	--
1985	--	--	--	--
1986	14	1700	10	68
Rock Creek at 12 Mile (S-4)				
1981	3	550	20	82
1982	15	3000	10	241
1983	15	1000	30	247
1984	14	2600	40	304
1985	16	1800	30	260
1986	15	600	20	132

TABLE 39. (Continued). Fecal coliform densities (#/100 ml, geometric means) Rock Creek Stations, 1981-1986.

YEAR	N	MAX	MIN	MEAN
Rock Creek above Hwy. 93 (S-3)				
1981	3	2000	210	796
1982	15	2800	170	693
1983	15	700	60	306
1984	13	1900	60	244
1985	16	3600	10	336
1986	14	1000	70	243
Rock Creek at Pole Line Road (S-2)				
1981	--	--	--	--
1982	--	--	--	--
1983	15	1300	4	163
1984	15	2000	50	349
1985	16	2200	10	216
1986	14	1500	70	243
Rock Creek near Mouth (S-1)				
1981	--	--	--	--
1982	15	1800	100	398
1983	10	1200	100	412
1984	16	9000	50	511
1985	16	2300	10	180
1986	15	740	30	163

TABLE 40. Checklist of benthic macroinvertebrates from the six Rock Creek stations, 1981-1986.

TAXON	SAMPLE STATION* 1	2	3	4	5	6
TURBELLARIA						
Tricladida						
Planariidae	X	X	X			
NEMATODA	X	X			X	X
ANNELIDA						
Oligochaeta						
Tubificidae						
Tubifex sp.	X	X	X	X	X	X
Hirudinea	X			X	X	
CRUSTACEA						
Amphipoda						
Talitridae						
Hyalella azteca	X	X	X	X	X	X
Decapoda						
Astacidae						
Pacifastacus gambelii					X	
Isopoda						
Asellidae						
Caecidotea communis				X	X	
Ostracoda	X				X	
INSECTA						
Ephemeroptera						
Baetidae						
Baetis tricaudatus	X	X	X	X	X	X
Ephemerellidae						
Ephemerella grandis						X
Ephemerella inermis	X					X
Heptageniidae						
Cinygmula sp.	X					
Epeorus longimanus						X
Rhithrogena hageni	X	X		X		X

TABLE 40. (Continued). Checklist of benthic macroinvertebrates from the six Rock Creek stations, 1981-1986.

TAXON	SAMPLE STATION* 1	2	3	4	5	6
Leptophlebiidae						
Paraleptophlebia heteronea					X	X
Polymitarcidae						
Ephron album	X		X	X		
Tricorythidae						
Tricorythodes minutus	X	X	X	X	X	
Odonata						
Coenagrionidae						
Ishnura sp.				X		
Gomphidae						
Ophiogomphus sp.		X	X	X	X	X
Plecoptera						
Capniidae						
Capnia sp.					X	X
Chloroperlidae						X
Perlidae						
Hesperoperla pacifica						X
Perlodidae						
Isoperla sp.			X			X
Isogenus sp.				X		X
Pteronarcidae						
Pteronarcys californica					X	X
Trichoptera						
Brachycentridae						
Amiocentrus aspilus		X			X	
Brachycentrus sp.	X	X	X	X	X	X
Oligoplectrum sp.		X				
Glossosomatidae						
Glossosoma sp.						X
Helicopsychidae						
Helicopsyche borealis		X				X
Hydrospychidae						
Hydrospyche sp.	X	X	X	X	X	X

TABLE 40. (Continued). Checklist of benthic macroinvertebrates from the six Rock Creek stations, 1981-1986.

TAXON	SAMPLE STATION* 1	2	3	4	5	6
Hydroptilidae						
Hydroptila sp.			X			
Leucotrichia sp.	X		X		X	X
Lepidostomatidae						
Lepidostoma sp.				X		
Leptoceridae						
Mystacides sp.			X	X		
Nectopsyche sp.	X	X	X	X		
Limnephilidae						
Limnephilus sp.						X
Philopotamidae						
Wormaldia sp.						X
Rhyacophilidae						
Rhyacophila sp		X				
Lepidoptera						
Pyralidae						
Parargyractis sp.			X	X		X
Coleoptera						
Elmidae						
Optioservus sp.	X	X	X	X	X	X
Psephenidae						
Psephenus falli						X
Diptera						
Ceratopogonidae						
Bezzia sp.				X	X	X
Chironomidae	X	X	X	X	X	X
Empididae						
Hemerodromia sp.	X	X	X	X	X	
Psychodidae						
Pericoma sp.		X				
Simuliidae						
Simulium bivittatum		X	X			
Simulium vittatum (?)				X		
Simulium (Eusimulium) sp.					X	
Simulium sp.		X	X	X	X	X

TABLE 40. (Continued). Checklist of benthic macroinvertebrates from the six Rock Creek stations, 1981-1986.

TAXON	SAMPLE STATION* 1	2	3	4	5	6
Stratiomyidae						
Euparyphus sp.	X					
Tipulidae						
Antocha sp.				X		X
Hexatoma sp.						X
Tipula sp.		X	X		X	X
ACARI	X	X	X	X	X	
MOLLUSCA						
Gastropoda						
Hydrobiidae						
Flumniacola virens		X	X	X		
Fontelicella sp.						X
Lymnaeidae						
Fossaria sp.					X	
Lymnaea sp.		X			X	
Physidae						
Physa sp.	X	X		X		
Planorabidae						
Gyraulus sp.	X	X				
Parapholyx effusa						X
Pelecypoda						
Sphaeriidae						
Sphaerium sp	X	X	X	X	X	X
Piscidium sp.	X	X	X			
TOTAL TAXA/STATION	**25**	**29**	**25**	**28**	**28**	**35**

TABLE 40. (Continued). Checklist of benthic macroinvertebrates from the six Rock Creek stations, 1981-1986.

*Rock Creek station locations:

STATION NUMBER	LOCATION	RIVER MILE
S-1	Mouth Rock Creek	0.75
S-2	Poleline Road	3.7
S-3	Hwy. 93	7.3
S-4	12 mi. Road	13.5
S-5	3500 E. Road	21.1
S-6	near Rock Creek townsite	30.3

SAMPLE PERIODS

March
June
August
November

TABLE 41. Precision of split samples for Rock Creek station S-2 and 7-4 (combined), 1986.

PARAMETER	PRECISION	
	N	AVERAGE RELATIVE RANGE (%)
Suspended Sediment	33	8.0
volatile Suspended Solids	27	25.0
Total Kjeldahl Nitrogen	34	14.6
Nitrate-Nitrite	33	19.4
Total Phosphorus	32	11.8
Dissolved Ortho-phosphate	34	17.8
Fecal Coliform Bacteria	27	18.8

TABLE 42. Precision of split samples for subbasin station 7-4, 1984-1986 irrigation seasons.

PARAMETER	PRECISION 1984 N	1984 Average Relative Range(%)	1985 N	1985 Average Relative Range(%)	1986 N	1986 Average Relative Range(%)
Suspended Sediment	13	11.2	14	8.2	21	4.3
Total Kjeldahl Nitrogen	15	9.9	--	--	21	17.2
Nitrate-Nitrite	15	14.1	6	20.7	20	29.8
Total Phosphorus	15	12.6	14	10.9	21	7.8
Dissolved Ortho-phosphate	14	19.5	14	26.9	21	20.4
Fecal Coliform Bacteria	17	37.4	14	52.1	20	23.1
Volatile Suspended Solids	n/a	n/a	n/a	n/a	16	16.3

-- = inadequate sample size

n/a = not sampled during 1984/85

TABLE 43. Precision of split samples for Rock Creek station S-2, 1986.

PARAMETER	PRECISION	
	N	AVERAGE RELATIVE RANGE (%)
Suspended Sediment	12	11.7
Volatile Suspended Solids	7	26.9
Turbidity	7	13.8
Total Kjeldahl Nitrogen	13	12.1
Nitrate-Nitrite	13	9.0
Total Phosphorus	11	15.8
Dissolved Ortho-phosphate	13	15.2
Hardness, as Ca CO_3	7	2.0
Total Alkalinity, as Ca CO_3	7	1.1
Bicarbonate Alkalinity	7	0.9
Calcium	7	5.7
Potassium	7	0.0
Sodium	7	0.1
Magnesium	7	0.7
Sulphate, as SO_4	7	4.0
Arsenic, Total	6	13.0
Boron, Total	7	20.0
Iron, Total	7	9.6
Manganese, Total	7	14.0
Zinc, Total	7	64.5
Fecal Coliform Bacteria	11	21.3

TABLE 44. Accuracy (% recovery) for Rock Creek and subbasin stations. June, July and August 1985.

		ACCURACY		
Parameter	N	Average % Recovery		95% CI
Suspended Sediment	52	98.2		± 2.1
Total Phosphorus	79	101.9		± 2.1
Ortho-phosphate*:				
June	*25*	*93.9*	*± 51*	
August	24	93.2	± 6.5	
September	27	87.8	± 7.3	
Aug./Sept. pooled	51	90.3		± 4.1
Nitrate	54	99.1		± 4.4
Total Kjeldahl Nitrogen	39	96.2		± 1.7
Calcium**	15	93.1		± 2.6
Magnesium**	15	100.7		± 3.5
Sodium**	15	99.1		± 0.8
Potassium**	15	110.7		± 3
Chloride**	15	91.2		± 3.2
Fluoride**	15	20.7		± 5.8

* June ortho-phosphate precision samples appeared to be randomly contaminated and are therefore excluded from the pooled estimate.

** Analyzed on Rock Creek Stations Only

TABLE 45. Accuracy (% recovery) for Rock Creek and subbasin stations. May, July and August 1986.

		ACCURACY	
Parameter	N	Average % Recovery	95% CI
Suspended Sediment	29	94.0	± 5.3
Total Phosphorus	10	105.7	± 4.1
Ortho-phosphate	29	107.3	± 8.6
Nitrate-Nitrite	29	106.0	± 3.9
Total Kjeldahl Nitrogen	29	102.5	± 6.9

TABLE 46. Sediment reduction coefficients for Rock Creek RCWP best management practices (data from Dr. David Carter, ARS, Kimberly, Idaho).

BMP	% Sediment Reduction
Vegetative filter strip	55%
Mini-basin	85%
I-slot	75%
Sediment basin	80-92%
Buried pipe runoff	90%
Sediment basin & vegetative filter strip	80-92%
Dirt ditch to siphon tube conversion	25%
Dirt ditch to gated pipe conversion	5%
Conservation tillage	60-90%*

* up to 100% may be achieved with no till practices

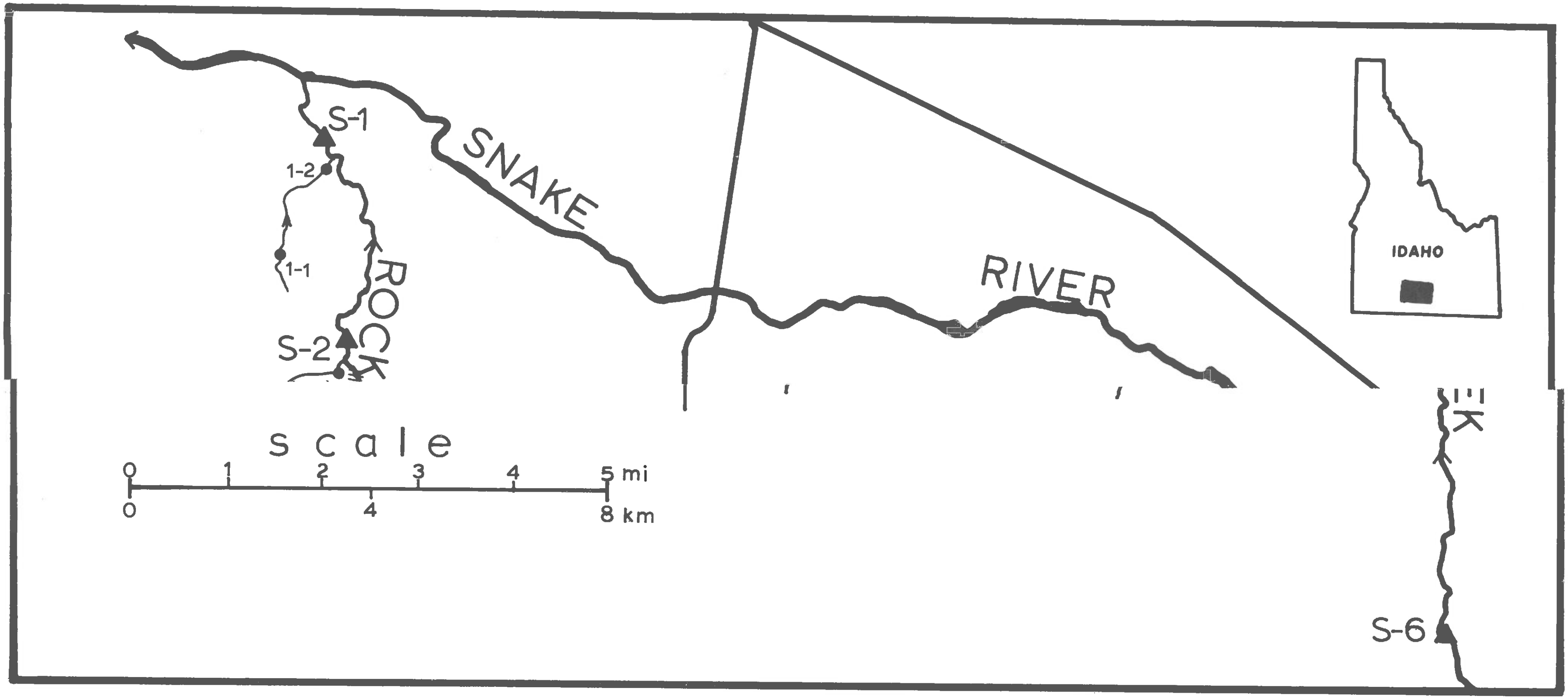


Figure 1. Map of the Rock Creek Rural Clean Water Program study area, Twin Falls County, Idaho. Rock Creek and subbasin sample stations are shown as well as the areas selected for stream bank erosion study.

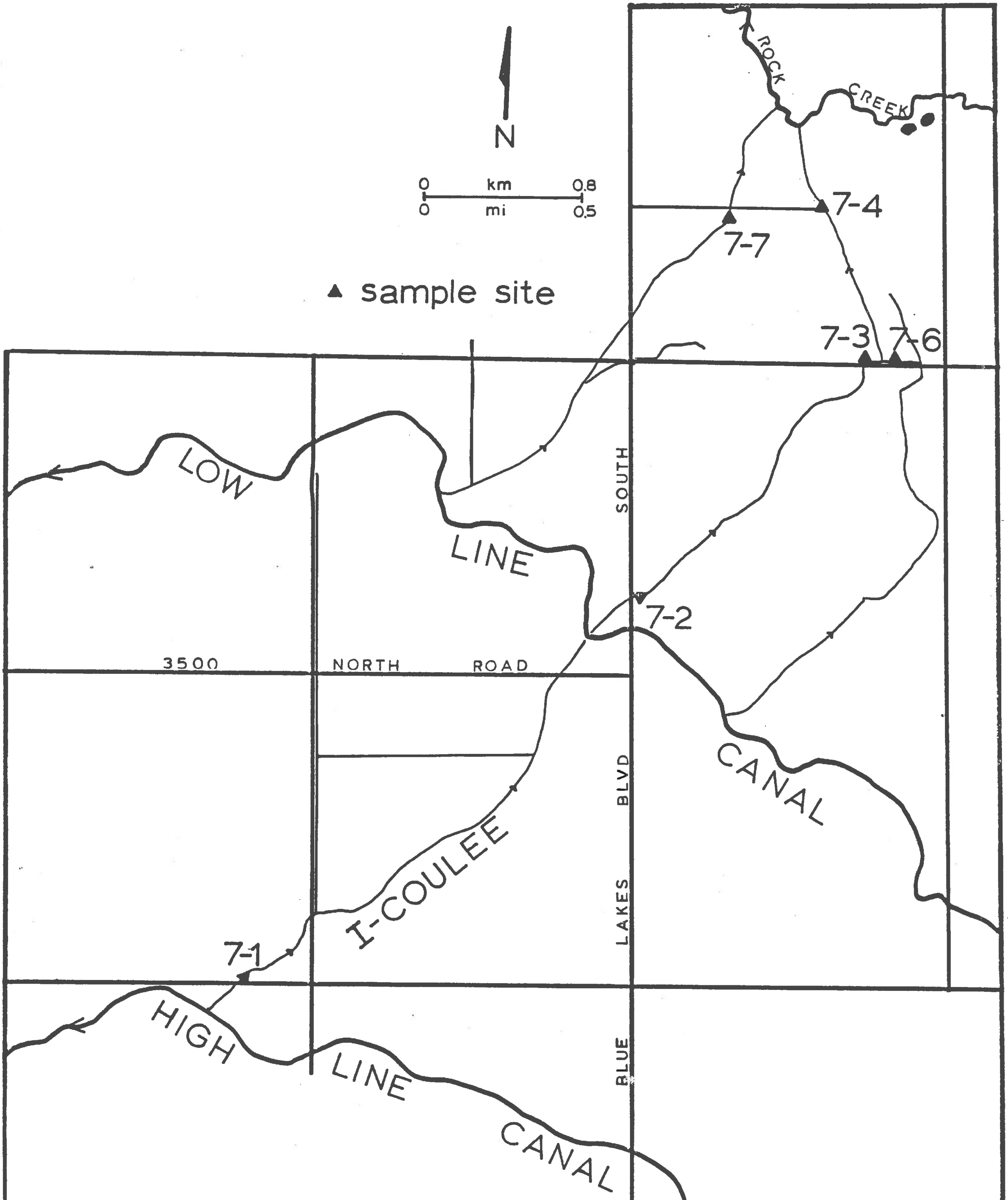


Figure 2. Detailed map of subbasin seven showing the location of the sample stations in relation to the canal systems, Rock Creek, and major roads in the area.

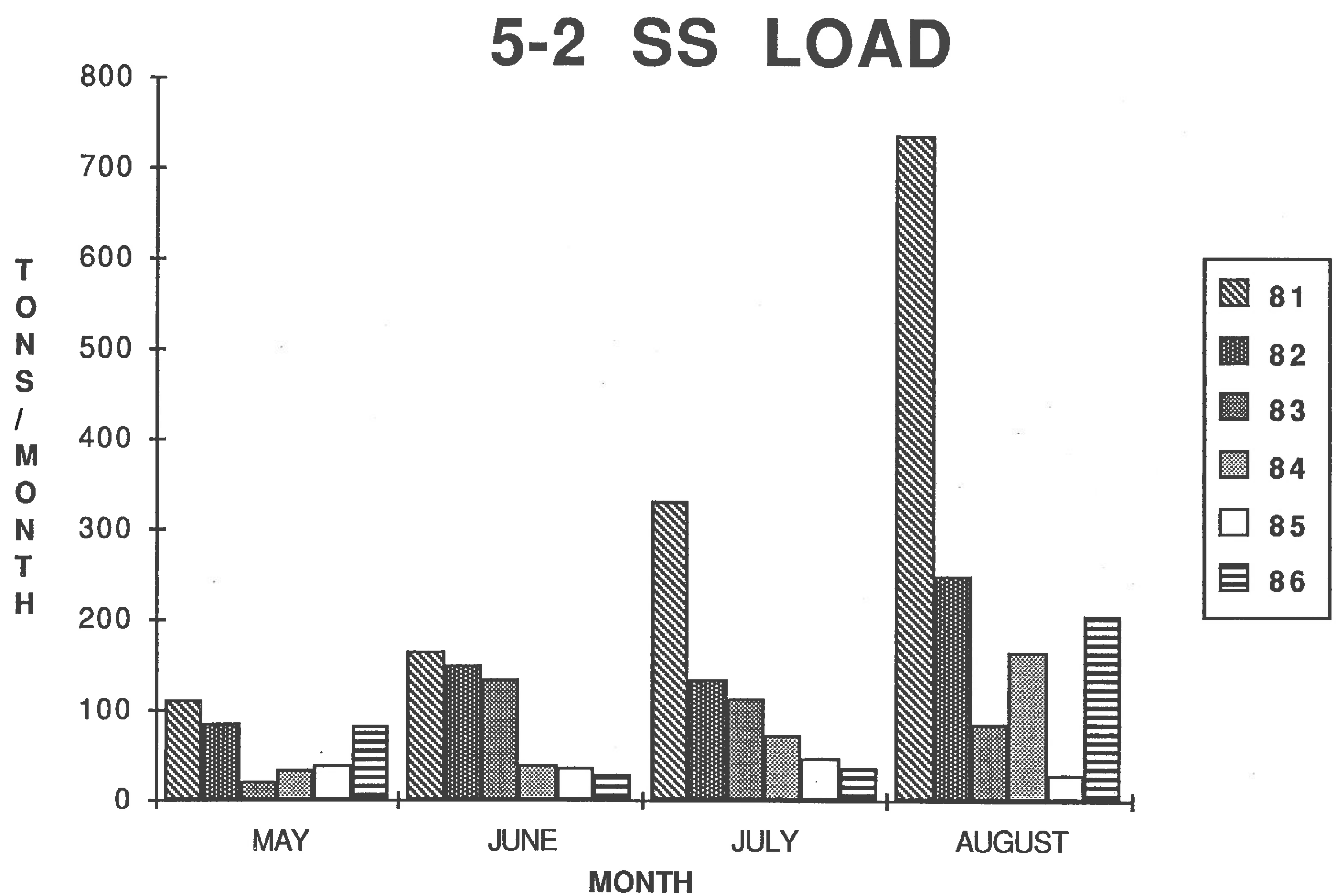


Figure 4. Suspended sediment loadings (monthly) for subbasin station 5-2, 1981-1986.

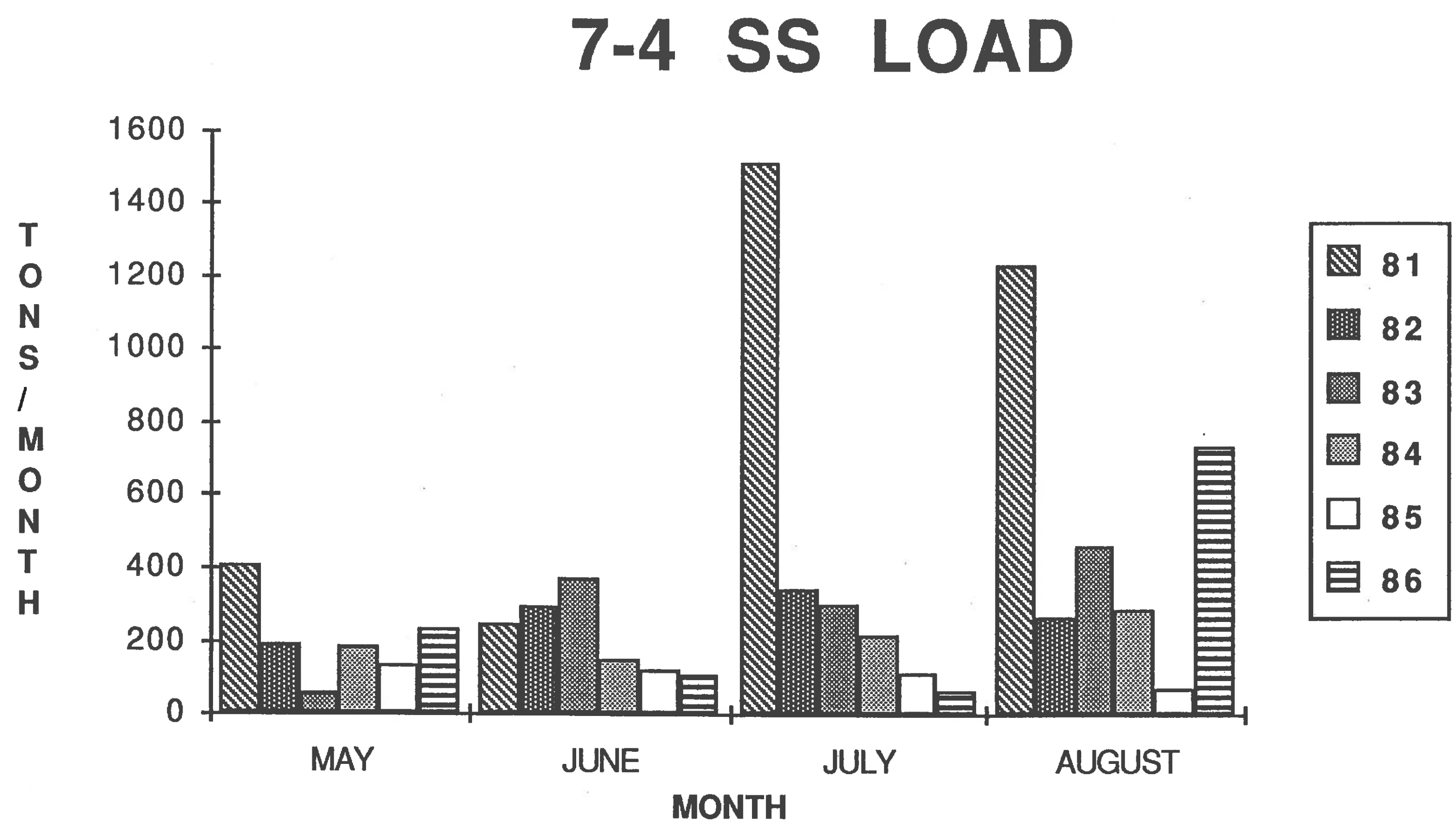


Figure 5. Suspended sediment loadings (monthly) for subbasin station 7-4, 1981-1986.

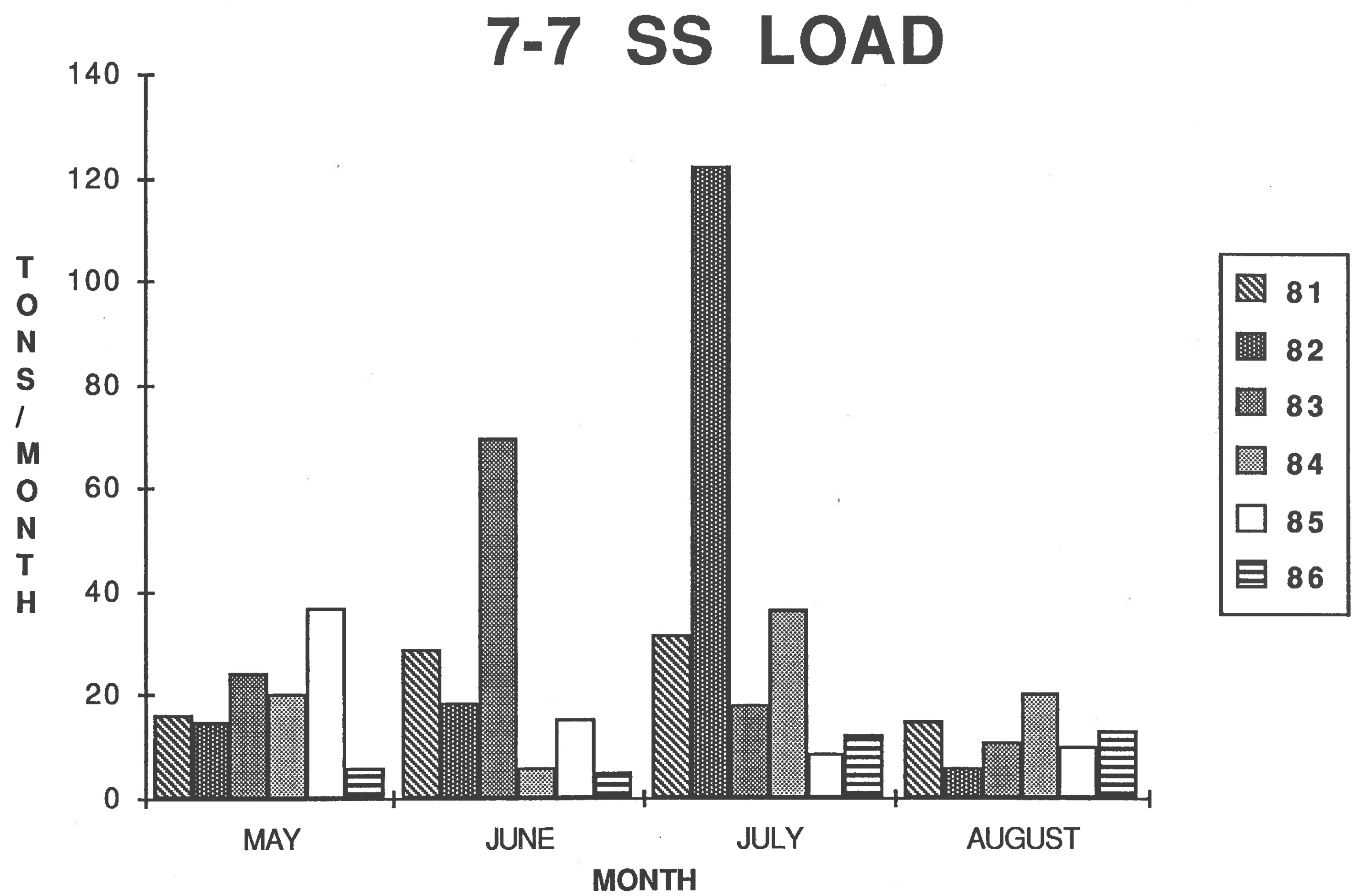


Figure 6. Suspended sediment loadings (monthly) for subbasin station 7-7, 1981-1986.

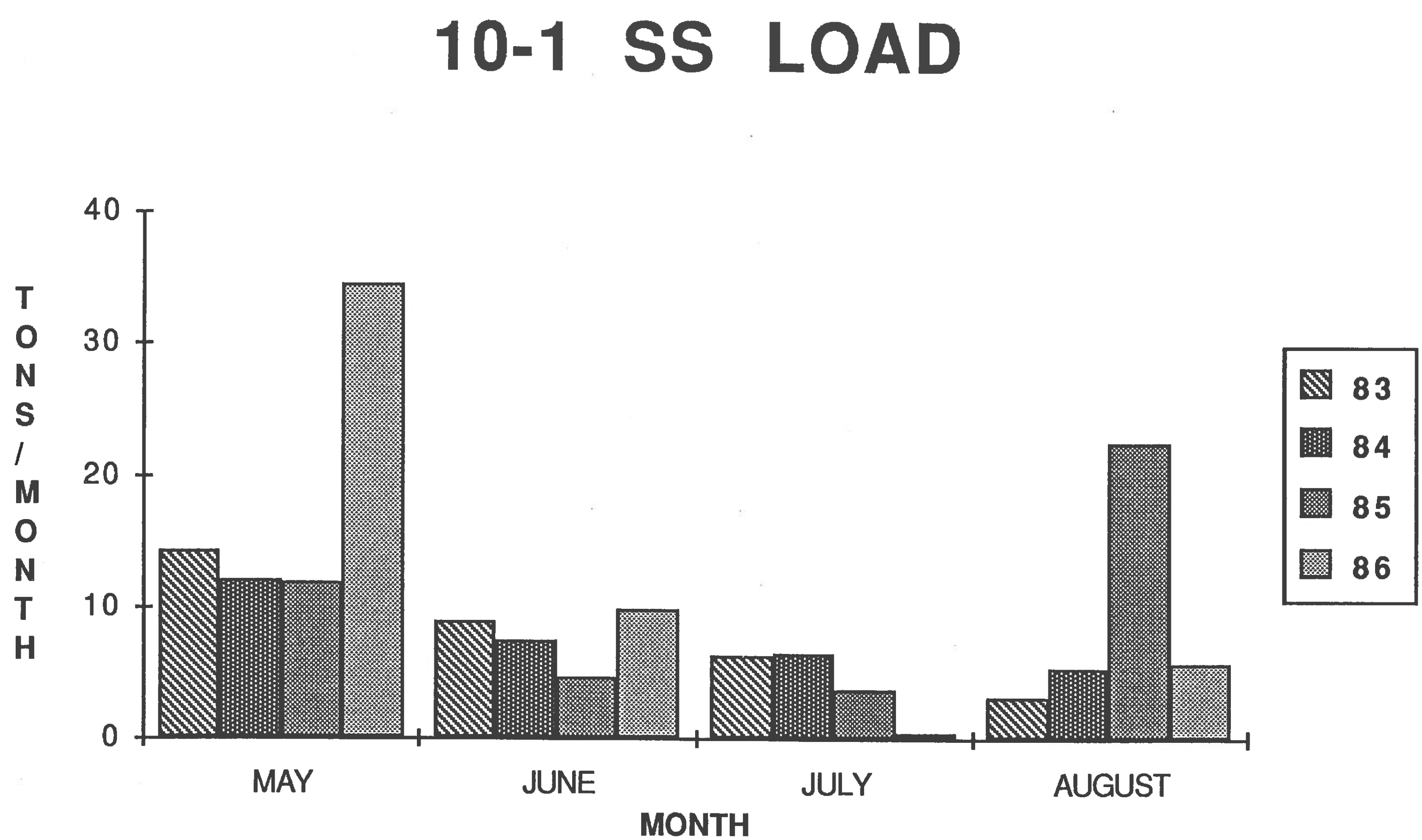


Figure 7. Suspended sediment loadings (monthly) for subbasin station 10-1, 1983-1986.

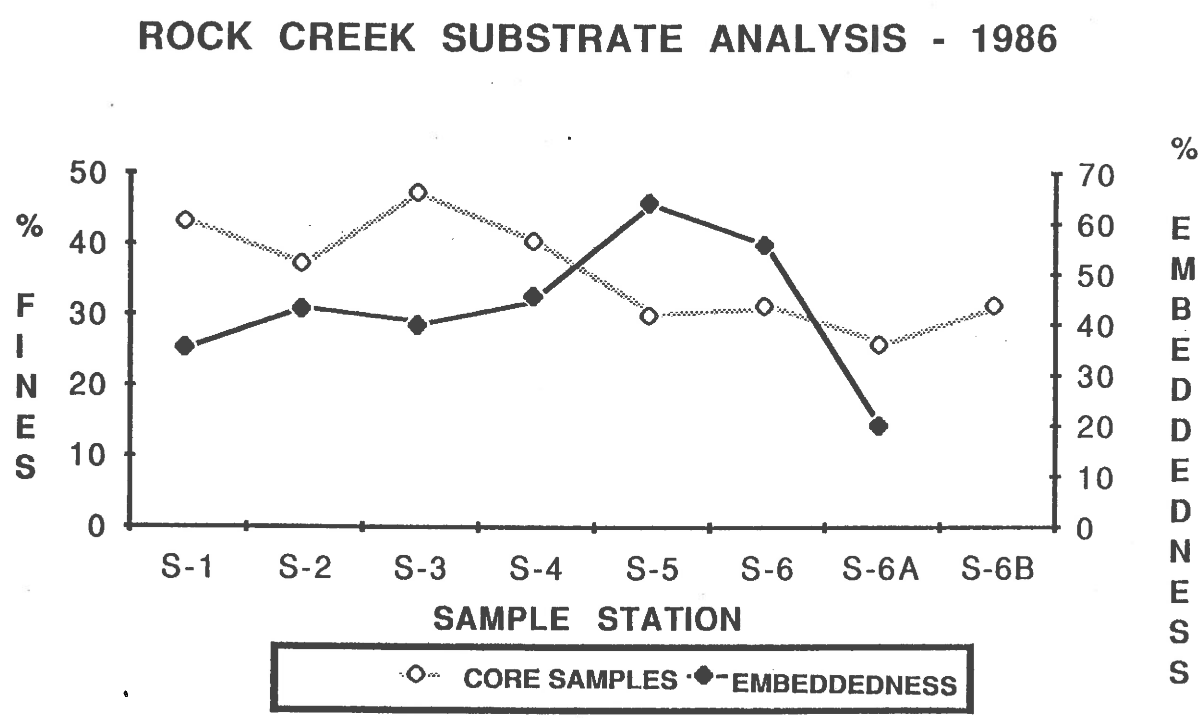


Figure 8. Rock Creek substrate analysis, Rock Creek, 1986.

ROCK CREEK S-6

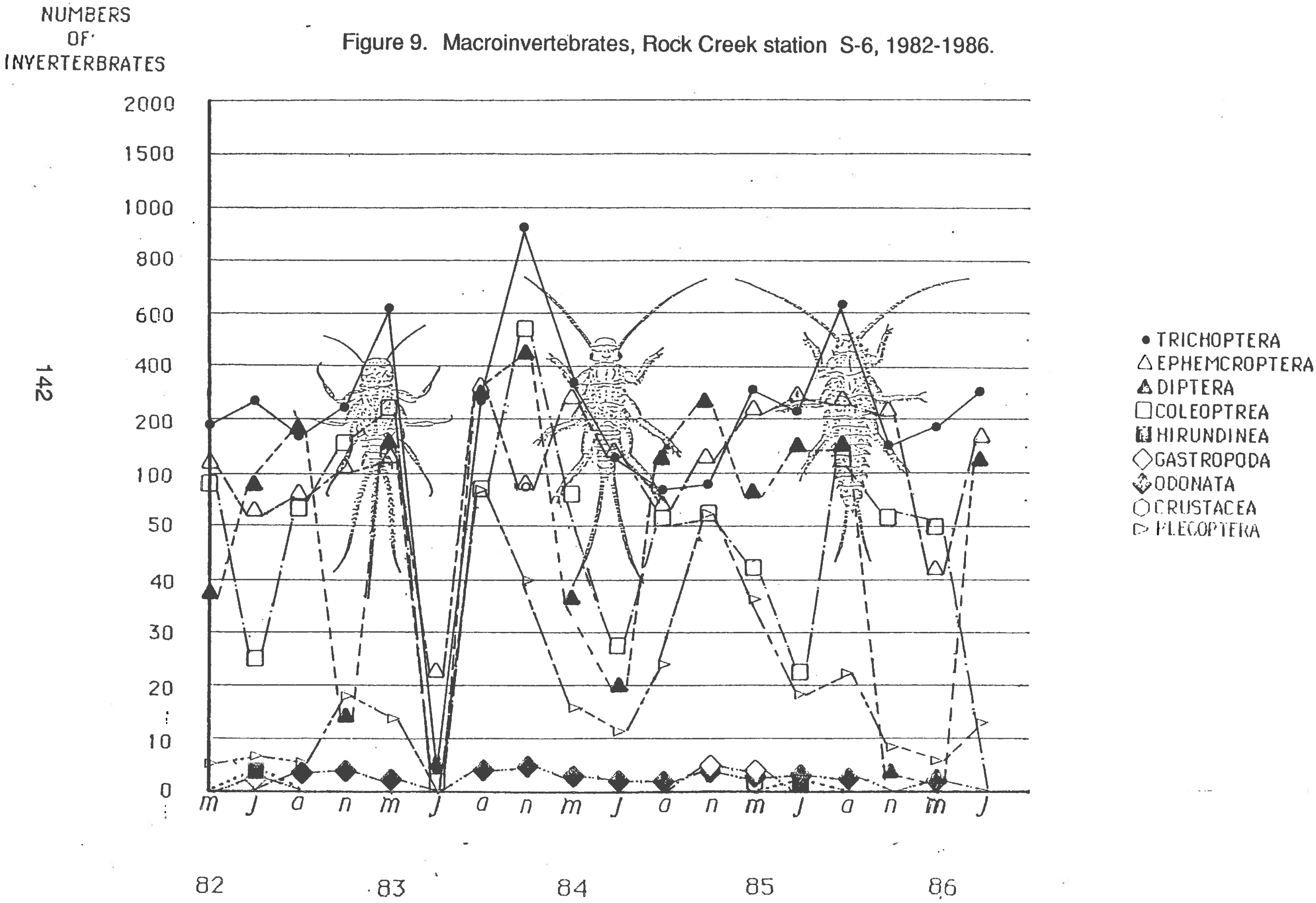
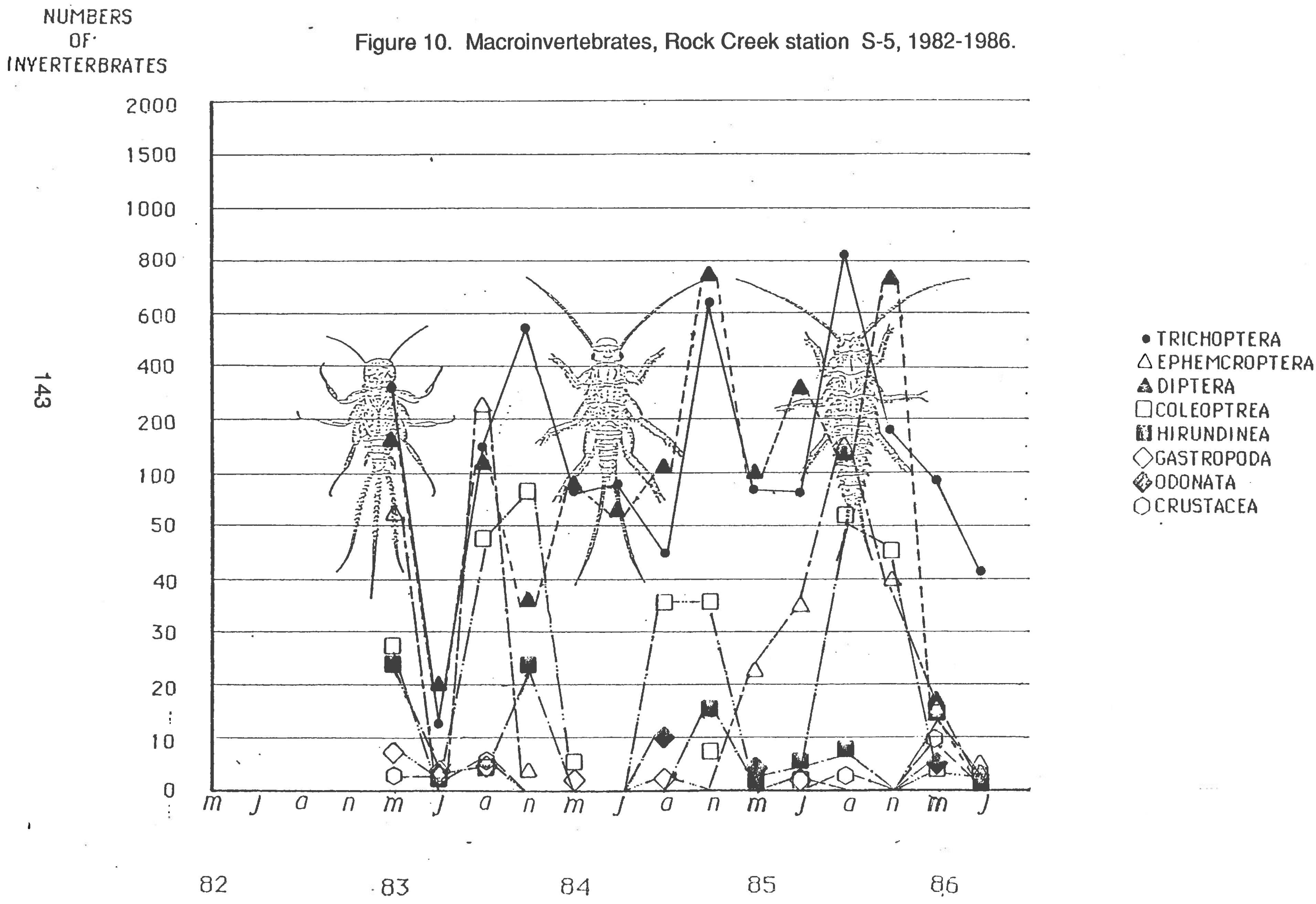


Figure 9. Macroinvertebrates, Rock Creek station S-6, 1982-1986.

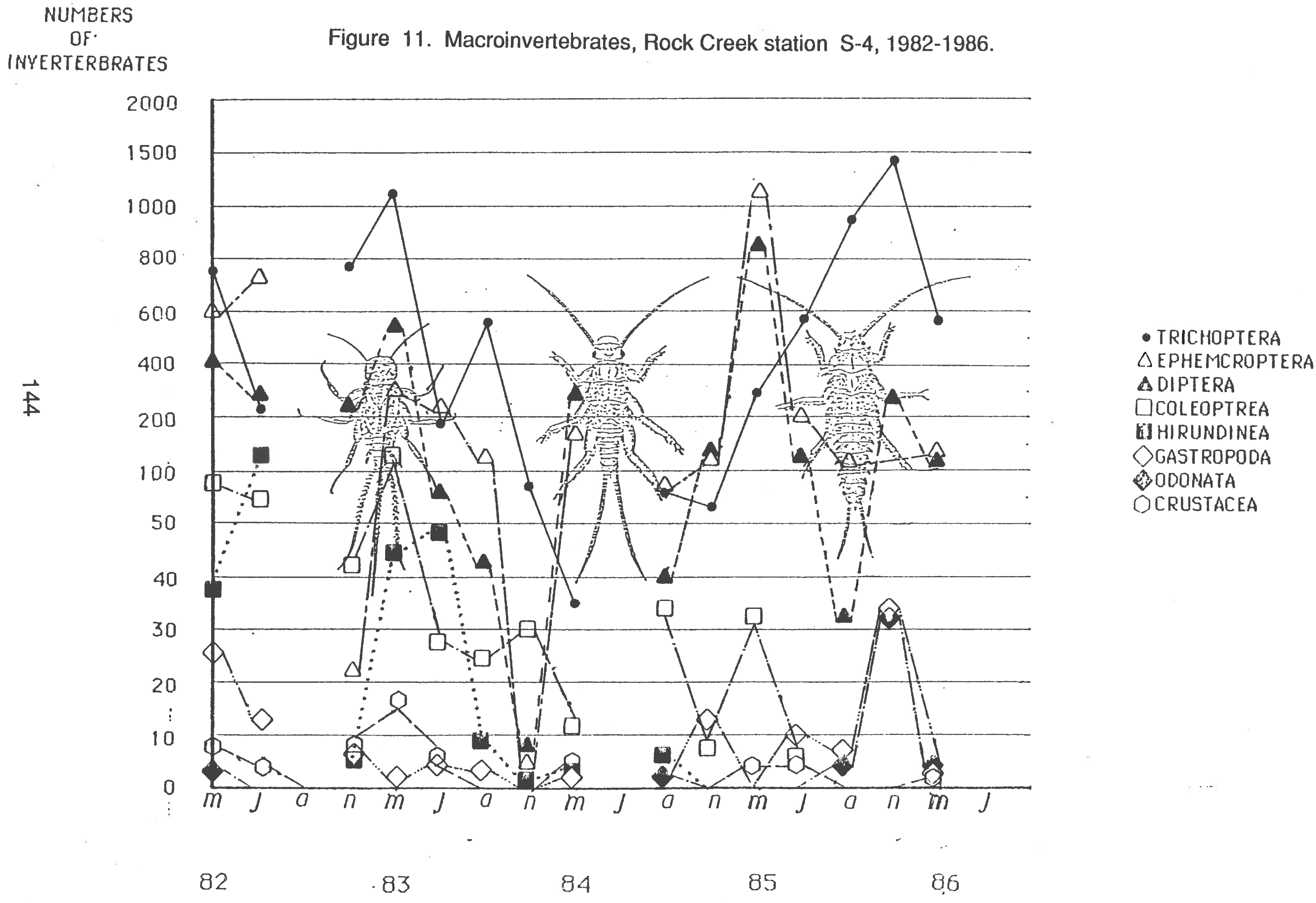
ROCK CREEK S-5

Figure 10. Macroinvertebrates, Rock Creek station S-5, 1982-1986.



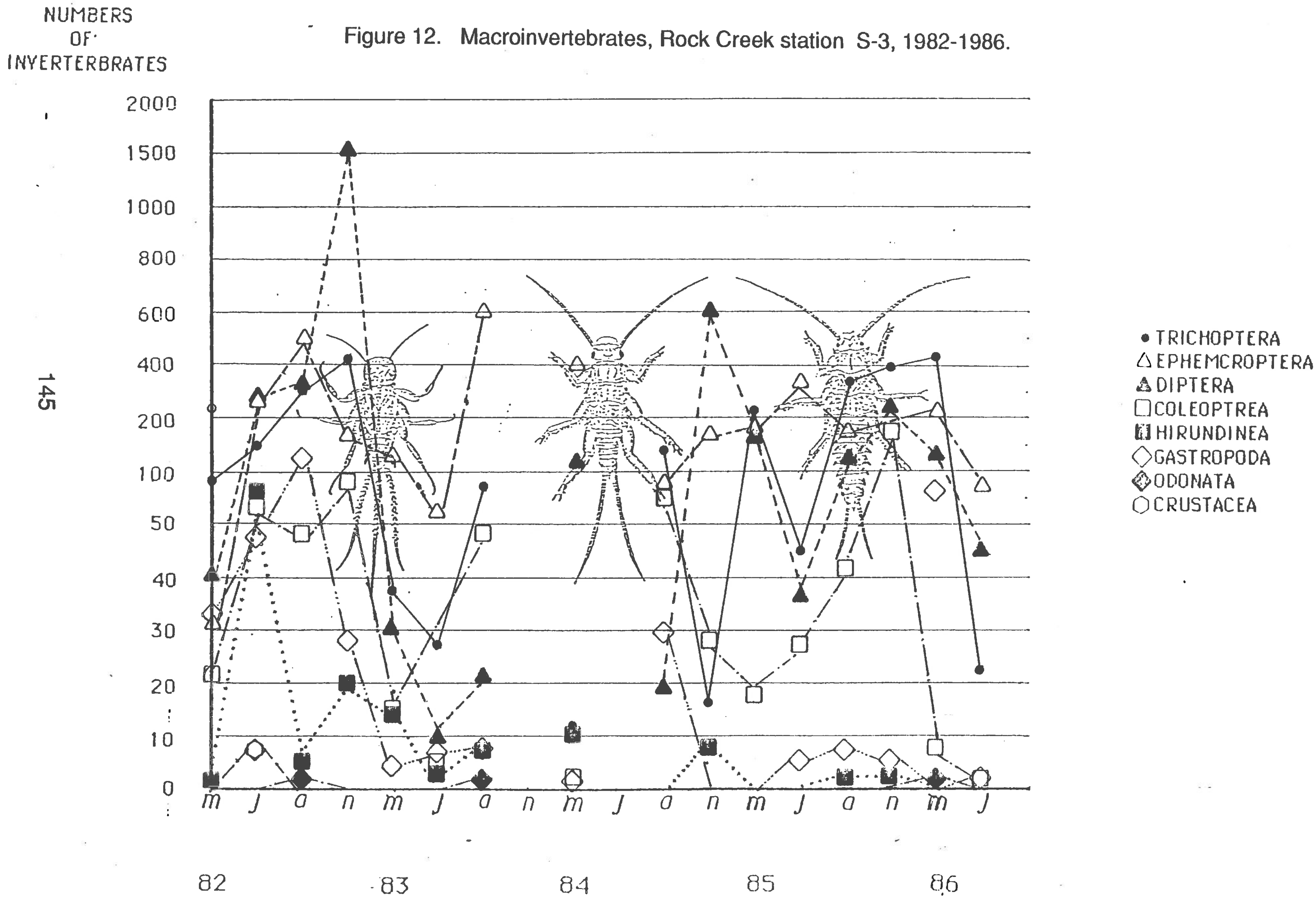
ROCK CREEK S-4

Figure 11. Macroinvertebrates, Rock Creek station S-4, 1982-1986.



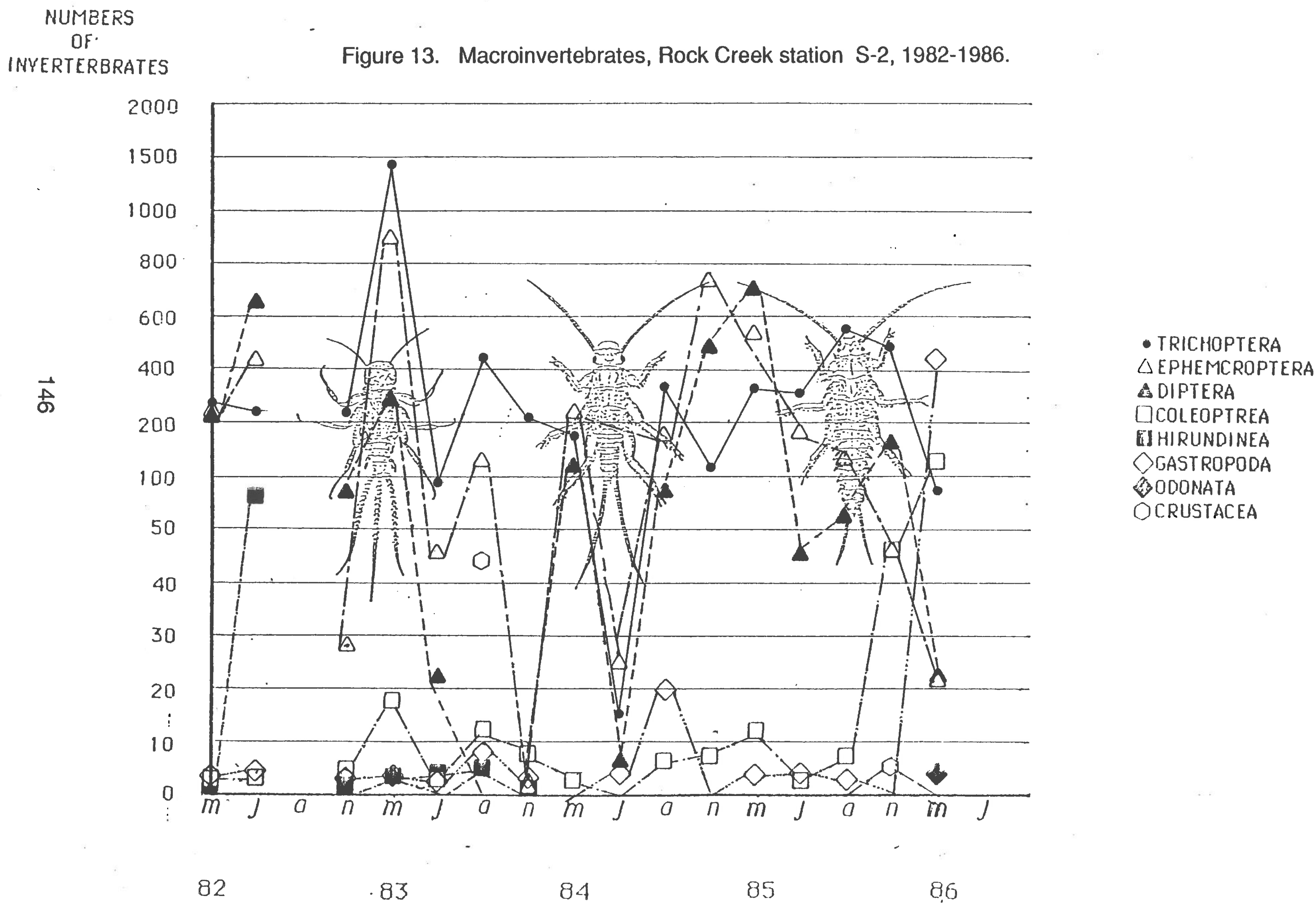
ROCK CREEK S-3

Figure 12. Macroinvertebrates, Rock Creek station S-3, 1982-1986.



ROCK CREEK S-2

Figure 13. Macroinvertebrates, Rock Creek station S-2, 1982-1986.



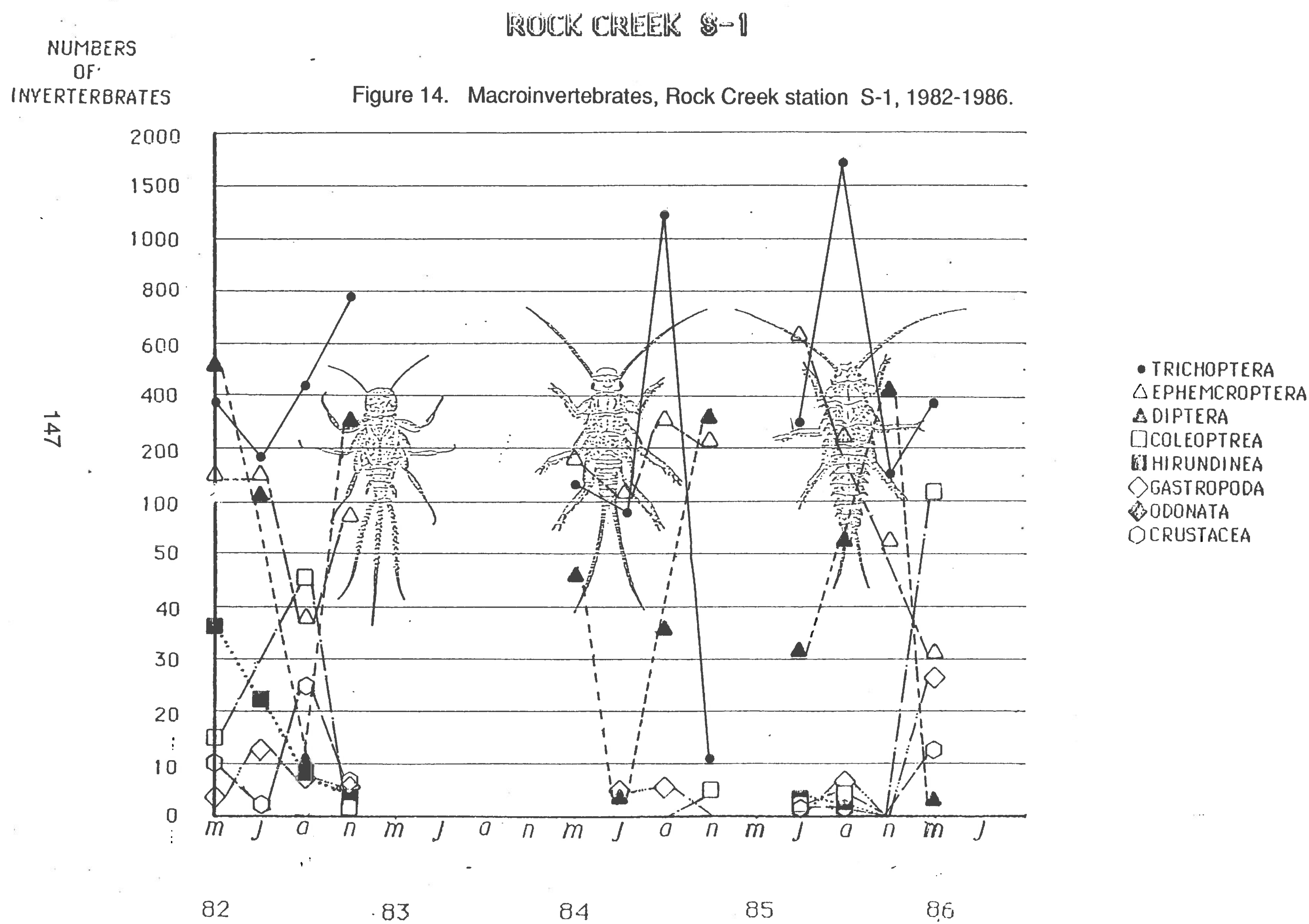


Figure 14. Macroinvertebrates, Rock Creek station S-1, 1982-1986.