The Aquatic Resources of Three Mackenzie River Tributaries to be Crossed During Highway Construction, 1976 Data

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THE AQUATIC RESOURCES OF THREE MACKENZIE RIVER TRIBUTARIES TO BE CROSSED DURING HIGHWAY CONSTRUCTION, 1976 DATA

by

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ABSTRACT

McKINNON, G.A., B.G. SUTHERLAND, and P.R. ROBINSON. 1982. The aquatic resources of three Mackenzie River tributaries to be crossed during highway construction, 1976 Data. Can. Data Rep. Fish. Aquat. Sci. 323: v + 104 p.

Data from the second year of a proposed four year study of the effects of culvert construction on three streams to be crossed by the Mackenzie Highway, Northwest Territories are presented.

Preconstruction data was collected on selected water quality parameters, stream hydraulics, the diversity and standing crop of benthic invertebrates and the species composition of fish and their utilization of stream habitat in 1976.

This study was terminated at the end of the 1976 field season as a result of the discontinuation of Mackenzie Highway construction.

Key words: Arctic zone, highway construction; environmental impact; aquatic environment; fishery resources; fishery biology; benthos; stream flow; chemical analysis; monitoring.

RESUME

McKINNON, G.A., B.G. SUTHERLAND, and P.R. ROBINSON. 1982. The aquatic resources of three Mackenzie River tributaries to be crossed during highway construction, 1976 Data. Can. Data Rep. Fish. Aquat. Sci. 323: v + 104 p.

L'ouvrage présente les données recueillies durant la deuxième année (d'une étude proposée de quatre ans) sur les répercussions de la construction, sur trois ruisseaux, de ponceaux sur lesquels l'autoroute Mackenzie doit passer dans les Territoires du Nord-Ouest.

Avant le début des travaux de construction, on a recueilli diverses données: les paramètres de la qualité des eaux, l'hydraulique des ruisseaux, la diversité et la biomasse des invertébrés benthiques, l'énumération des espèces de poissons qui ont choisi les ruisseaux comme habitat, et l'utilisation qu'ils en font en 1976.

L'étude s'est terminée à la fin de la campagne d'exploration de 1976, étant donné que la construction de l'autoroute Mackenzie a été discontinuée.

Mots-clés: Zone arctique; construction d'autoroute; répercussions écologiques; environnement aquatique; ressources halieutiques; limnologie; benthos; écoulement fluviatile; analyse chimique; observation.

INTRODUCTION

Road construction in or near streams and rivers can affect aquatic resources in several ways including disruption of fish migrations, destruction or siltation of vital habitats and alteration of water quality parameters. Increased suspended or deposited sediments in streams can reduce light penetration, cause mechanical abrasion of fish gills and produce changes in substrate. A review of literature on the effects of increased sedimentation on aquatic biota is presented in Brunskill et al. (1973) and Rosenberg and Snow (1975). The long-term effects of culvert stream crossings are of particular concern. Studies have shown that small northern tributaries can provide important spawning, nursery and overwintering areas for indigenous fish (Jessop et al. 1974; Slaney and Co. 1974). Brunskill et al. (1975) have suggested that small streams and rivers will be more affected by terrain disturbance than larger streams since construction will affect a larger proportion of drainage area.

The present report deals with the second year of a proposed four-year study on the effects of culvert construction on streams crossed by the Mackenzie Highway, Northwest Territories. Based on construction schedules available in the spring of 1975, three streams along a section of the highway route were chosen for study: Creek Mile 422.7, Creek Mile 426.5 and Smith Creek (Mile 430). Preliminary data were collected in 1975 and as a result, these three streams were considered to be suitable for further study (McKinnon et al. 1978).

The objectives of the study, as set out in 1975, were to obtain data on the diversity and standing crop of benthic invertebrate communities, to determine the species composition of fish and their utilization of the stream systems and to identify changes in selected water quality parameters and stream hydraulics. As highway construction proceeded past each stream, the short-term effects of construction on stream water quality and other ecosystem parameters were to be investigated. The field program was to continue after completion of construction in order to study long-term effects, if any. However, in 1977 construction of the Mackenzie Highway was discontinued indefinitely and this study was terminated at the end of the 1976 field season.

DESCRIPTION OF STUDY AREA

Three streams were chosen for study along the proposed Mackenzie Highway south of Wrigley, NWT (Figs. 1 and 2). These streams (Mile 422.7, Mile 426.5 and Smith Creek (Mile 430)) provide drainage for a 225 km^2 area comprised of both mountain and lowland terrain. The lowland area is covered with a continuous mantle of glacial and post-glacial deposits overlaying Devonian shale and limestone. Smith Creek forms a boundary between a glacial outwash plain to the north and a glaciolacustrine plain to the south. The mountain areas (McConnell Range) are composed of thrust masses of Silurian-Ordovician dolomites, limestones and shales overlain for the most part by a shallow veneer of glacial drift deposits.

The climate of the region is semi-arid and subarctic to cold temperate in type. The mean annual precipitation is close to 33 cm, 18 to 20 cm of which falls as rain in the summer months. Mean annual temperature is approximately -5°C.

The study area is located in the Boreal forest region; vegetation is mainly white and black spruce, balsam poplar, pine and aspen on degraded eutric brunisal soil. Undergrowth ranges from grasses, sedges and Sphagnum moss on low-lying areas to lichen and rock flora on mountain terrain. The area is one of discontinuous permafrost.

Creek Mile 422.7 (63°06'N, 123°16'W) is a cobble bottom, clear stream with alternating riffles and pools draining a generally low relief spruce forest. It is well contained within a deep gorge from the highway right-of-way to its confluence with the Mackenzie River, a distance of 2.9 km. The drainage area is approximately 75 km^2 of which one-third is mountainous terrain.

Creek Mile 426.5 (63°09'N, 123°18'W) has a boulder and gravel bottom, clear water and flows through a gully between sloping moss-covered hills. The channel is not well defined above the highway right-of-way and is overgrown with stands of black spruce and tamarack. The drainage area is approximately 20 km^2 of generally lowland area and the highway right-of-way is located 3.1 km upstream from the confluence with the Mackenzie River. This creek drains a number of small lakes, the largest being approximately 22 hectares in area.

Smith Creek (Mile 430) (63°10', 123°20'W) drains an area of approximately 130 km^2, one-half of which is mountainous terrain and one-half glaciolacustrine plain with bogs and lakes. The channel is generally well defined with large riffle areas of rock and gravel. A series of waterfalls is located approximately 5 km upstream from the mouth. Groundwater flow into Smith Creek is substantial throughout the year and is responsible for keeping portions of the stream open during the winter. The highway right-of-way is located 0.76 km from the confluence with the Mackenzie River and is characterized by a very large ancient bi-modal land flow on the south bank of the creek. This landslide is now inactive and the head scarp is heavily vegetated (McRoberts and Morgenstern 1973).

METHODS AND MATERIALS

PHYSICAL AND CHEMICAL STUDIES

Physical characteristics and hydraulics

Metric staff gauges were reinstalled at all stations established in 1975, i.e. 1, 2, 3, 4, 5, 6, 7, 8 and 11. Additional staff gauge locations were established near the mouth of Creek Mile 426.5 (loc. 9) and at the proposed highway crossing of Creek Mile 426.5 (loc. 10). Staff gauges consisted of 1 m enamelled plates which were screwed into 5.08 cm x 10.16 cm (2" x 4") wooden studs. Approximately 1/2 of the staff gauges used were driven into the ground using 1.83 cm (6 ft) steel posts. Other gauges were cemented in concrete blocks and set upright on the stream bottom. Levels were run to bench marks using Helger Watt Aritoset and Kern GK1 levels. Gauges were read three times daily during high water periods and twice daily thereafter until July 18, 1976. From this point on, they were read biweekly until October 14, 1976. In addition long-term stage recorders were established on Creek Mile 422.7 and Smith Creek in conjunction with the Glaciology Division of Fisheries and Environment Canada.

Current metering was conducted at all locations across established cross-sections throughout the 1976 field season. Water velocity measurements were made using a full sized Ott current meter hand-held on a wading rod. For water depths greater than 0.3 m (1 ft) the 0.2 - 0.8 method was used to estimate the mean velocity through a stream section. For depths less than 0.3 m, the 0.6 method was used (U.S. Dep. of the Interior 1967). Thirty-second readings were taken. Discharge was calculated using the mid section method (U.S. Dep. of the Interior 1967). Most data were collected in English units and were later converted into metric equivalents. An effort was made to measure the flow over as wide a range as possible.

Stage discharge relationships were developed by plotting log stage versus log discharge and deriving the line of best fit for the points and the correlation coefficient. This same procedure was used to develop stage-mean velocity and stage-hydraulic radius relationships.

Stream bed profiles were run from the Mackenzie River at Creek Mile 422.7, Creek Mile 426.5 and Smith Creek up to locations 4, 11 and 8 respectively in June, 1976. Water depths, water surface slopes, stream channel sizes and slopes and bank characteristics were noted. A detailed description was made of the bed material at each discharge station was conducted and bed material samples were taken using a shovel. Distances were measured by tape and stadia.

Stream bed material samples were analysed for grain size by sieving. The sieve stack consisted of the following sieves; 3" (7.52 cm), 1" (2.54 cm), .5" (1.27 cm), #4, #10, #20, #40, #60, #100, and #200. Cobbles were removed from the bed material sample prior to sieve shaking, their weight was determined and their dimensions and general shape recorded. The sieve stack was then shaken for 8 minutes on a sieve shaker. The total weight of soil retained on sieves (including any cobbles) was used in the calculation of the "percent finer than" for each sieve. This "percent finer than" calculation was subsequently plotted against sieve opening size with any cobbles being included as being retained on the largest sieve in the stack.

Water chemistry

Water temperature and conductivity measurements were made on site at each location. Water temperatures (± 1.0°C) were determined with a hand-held pocket thermometer and conductivity was measured by means of a YSI Model 33 conductivity meter. Dissolved oxygen and pH measurements were made on site at each stream location. Dissolved oxygen was measured directly by means of a YSI Model S4 Oxygen meter. Most pH determinations were made by using a Hach water analysis kit (Model AL36WR); however in some cases a Fisher Accumet 150 pH meter was utilized. Continuous recording Ryan submersible thermographs Model G15 were located in each stream and read approximately biweekly.

Water samples were collected approximately biweekly throughout the study period for analysis of ions, nutrients and suspended sediments by means of a USDH 48 integrated water sampler in mid-stream. Water from the sampler unit was then transferred to pre-washed 1 L Nalgene brand bottles and samples were then shipped (refrigerated) to the Freshwater Institute, Water Chemistry Laboratory, Analytical Unit in Winnipeg. Analytical methods were according to Stainton et al. (1974).

BIOLOGICAL STUDIES

Benthos

Benthic invertebrate communities were sampled by means of a Surber sampler on Creek Mile 422.7 and Smith Creek. No sampling of invertebrate communities was attempted on Creek Mile 426.5.

A permanent benthic sampling transect was established at each sampling location on the two creeks sampled. Six Surber samples were collected at equal distances across each transect. Four complete sets of Surber samples were collected at approximately monthly intervals until late August.

The Surber sampler consisted of a one-foot square metal frame to which was attached a Nitex net, also one foot square at the open end. All samples were taken using a fine mesh (200 micron) net. In using the sampler, the open frame was placed on the stream bottom with the net extending downstream. All larger rocks enclosed within the frame were picked up by hand, washed in front of the net and discarded. The remaining fine material was stirred to a depth of 5 to 10 cm to dislodge any organisms. The organisms were then collected from the net and preserved in 70% ethyl alcohol solution. After sampling the area was returned to its natural state by replacing substrate materials.

Preserved benthic samples were stained with a solution of rose bengal (100 mg rose bengal per litre of 95% ethyl alcohol diluted to 70%) then sorted, identified to family and enumerated. Sorting was accomplished with the aid of a 3x magnifying illuminator and binocular microscope.

Standing crops were calculated as mean number of organisms m^{-2} for each location on each date. Ninety-five percent confidence limits for these means were then calculated. Two way analyses of variance between locations and over time were performed on the standing crop data followed by selected comparisons of location means. All statistical tests were according to Snedecor and Cochran (1967).

Fish

Trap and fence: Fish fences and traps were installed at the proposed highway crossing of Creek Mile 422.7 and Smith Creek in the spring of 1976. In both cases the traps consisted of a frame 1.5 m (5 ft) long, 1.22 m (4 ft) deep and 1.22 m (4 ft) wide, constructed of 5.1 cm x 10.2 cm (2 in x 4 in) lumber. A plywood bottom was attached and the sides, back and funnel were covered with wire mesh fabric (2.54 cm^2 (1 in^2) mesh size) stapled to the frame. The fences leading to the traps were 1.5 m (5 ft) high and made of mesh fabric (2.54 cm, 1 in) with a 0.3 m (1 ft) mesh skirting attached to the bottom at a right angle. The fence was installed in the channel using 1.83 m (6 ft) steel posts spaced approximately 1.2 m (4 ft) apart and embedded in the stream bottom to a depth of 0.6 m (2 ft). The wire mesh fence was attached to these posts with wound wire and weighted down by placing rock-filled burlap bags on the fence skirting. A fish holding pen of similar dimensions and material as the traps were placed alongside the upstream traps.

Both an upstream and a downstream trap were utilized in Smith Creek and Creek Mile 422.7. Fences were then constructed joining the traps and extending to the banks in such a way as to block fish movement completely and at the same time to act as leads for the capture of both upstream and downstream moving fish.

Traps were checked two or three times daily at which time fish were removed and data collected from each specimen. Each trap check was performed by two persons, one working inside the trap and the other serving as recorder. Handling of fish was minimized by using a scoop constructed of PVC pipe and rochelle netting. Fish were passed through the fence in the direction in which they were moving.

The fence was examined daily for holes and cleaned as required.

The traps and fences were installed in Smith Creek on April 21, 1976 and became operational on April 22. High flood waters washed out the fence on April 25 and the upstream trap and fence did not operate again until May 7. The downstream trap became functional again on May 10. The fence again washed out on May 28 and subsequently was not operational until June 3.

The traps and fences were installed in Creek Mile 422.7 on May 9, 1976, and were operational without interruption until May 31.

Sampling consisted of floy tagging, fin-clipping, dead sampling or simply counting and releasing fish captured. Generally fish with fork lengths greater than 300 mm were tagged by means of inserting sequentially numbered floy tags. These were inserted into the left side of the fish near the base of the dorsal fin by means of a tagging gun. No anaesthetic was used, and the risk of infection was minimized by rinsing the tagging gun in disinfectant and in fresh water before insertion. For each fish tagged, fork or total length was recorded according to species and a small sample of scales was taken where possible. Weights of some fish were recorded. Arctic grayling and northern pike captured were squeezed anterior to the vent to determine the degree of ripeness of sexual products and to determine sex.

For those fish which had a fork length less than 300 mm fin-clipping was utilized as a tagging method. Each day of fin-clipping was assigned a clipping code. The structures utilized included the pectoral fins, pelvic fins, anal fin, dorsal fin, and both the upper and lower lobe of the caudal fin. Single fin-clipping or combinations of the clipping of two fins were performed. As was the case with floy tagging, fork or total length was subsequently recorded, scales were removed and the fish were released in their intended direction of travel. If a fish showed signs of stress subsequent to handling it was placed in a holding pen protected from the current of the river for a period of six hours.

Small numbers of fish were sacrificed for life history analysis. Fork or total length was measured to the nearest 1 mm and weight (± 25 g) were recorded for each fish. Sex and state of maturity were determined by examination of the gonads. A fish was considered to be mature if it appeared that it would spawn or had already spawned in the year of capture. A ripe fish was a mature fish whose gonads were close to spawning condition and from which sexual products could be expressed by application of pressure to the abdomen. A spent or spawned out fish was a mature fish which had obviously spawned shortly before it was captured.

Stomachs were removed and most were preserved in 10% formalin for a detailed assessment of food habits. In the laboratory stomach content organisms were enumerated and identified to family where possible. Some stomach contents were field identified, mainly those of northern pike.

Scales were removed from the appropriate body location (Hatfield et al. 1972) for ageing of Arctic grayling and northern pike. Otoliths were removed from burbot for aging purposes. No attempt was made to age longnose suckers. Prior to analyses, otoliths were transferred to a benzylbenzoate methyl salicylate clearing medium. Otoliths were read under reflected light using a 20 to 40x magnification of a binocular dissecting microscope. Scales were read utilizing a 50x microprojector.

General: In addition to the counting fence on Creek Mile 422.7 and Smith Creek, and exclusively on Creek Mile 426.5, fish were collected by various methods depending on the nature of the stream at each location. A 9.2 m beach sieve of 3.2 mm mesh as well as fry traps were utilized at all sampling locations. The fry traps consisted of fry drift nets (1 m long cone of 0.6 cm mesh) attached at one end to a 20 x 50 cm (7.8 x 19.7 in) wooden frame and at the other end to a fry holding box similar to Porter's (1973) design. The traps were set in riffle areas with the funnel facing upstream. Angling was utilized as a capture technique on Smith Creek. Spin-casting rods and reels and a variety of Mepp's brand lures were used. Electroshocking with a Coffelt brand backpack electroshocker was utilized on a limited basis in Smith Creek.

Seining and fry-trapping were employed weekly at sampling locations while crews manned the fence operations and thereafter were employed biweekly. Electrofishing, angling, and gillnetting were utilized on an irregular basis throughout the period of study.

After capture, fish were generally divided into two groups (ie. those with fork or total length greater than 100 mm and those with fork or total length less than 100 mm). This was necessary due to difficulties in preserving large fish for subsequent laboratory examination.

Upon collection, fish with a fork or total length greater than 100 mm were measured to the nearest 1 mm using a calibrated measuring board. Weight was measured to 5 g on a 1 kg capacity Chatillon brand hanging brass tubular scale. Otoliths and/or scales were removed for age determination. Stomachs were removed, preserved in 10% formalin and returned to the lab for later analysis.

Small fish were preserved whole in 10% formalin for later laboratory analyses. In the laboratory, fish were identified to species, fork or total length and weight were measured to the nearest 1 mm and 0.1 g respectively, and sexual maturity as determined by gonadal development was recorded.

Otoliths were removed from Arctic grayling, trout-perch, walleye, round whitefish and mountain whitefish for age determination. They were stored in glycerin-filled vials prior to analysis. Scales were removed from some Arctic grayling and all least cisco for age determination.

RESULTS

PHYSICAL AND CHEMICAL CONDITIONS

The spring flood in the study area (Figs. 1 and 2) began in earnest around April 20 when minimum daily air temperatures rose to or above the freezing point. Stream flows peaked between April 28 and 30 in response to maximum daily air temperatures of about 20°C (Figs. 3, 4, 5). Peak flows in Smith Creek were approximately one to two weeks earlier than recorded during 1973 to 1975 (Fig. 6). Spring flood recession began when temperatures fell between April 30 and May 5. Cool dry weather conditions prevailed until late May when a major rainstorm produced 20-40 mm of precipitation in the Wrigley area. Response of stream flow to this storm varied with rapid increases in flow for mountainous catchments such as Smith Creek but only minor response for flatter, more densely vegetated catchments such as Creek Mile 422.7.

Creek Mile 422.7

Physical characteristics: Extensive icings were present in the stream channel of Creek Mile 422.7 during the freshet period in 1976. Flow occurred over and around iced areas and flow was not confined to the normal channel boundaries until early May. Consequently it was not possible to collect many of the hydraulic measurements desired.

The stream bed profile for Creek Mile 422.7 is presented in Fig. 7. The stream channel downstream of the proposed highway crossing is laden with debris jams in many locations. Bed material analyses of all locations sampled are provided in Appendices 1,2, 3 and 4.

Temperature and conductivity measurements are provided in Table 1. Daily water temperature variation as measured by a continuously recording submersible thermograph situated at loc. 4 is provided in Fig. 12.

Hydraulics: Flow summary tables are provided in Appendices 5, 6, 7 and 8. Because of icing conditions prior to May 6, accurate measurements were difficult; however a discharge of 2.21 m^3/s over ice was recorded on April 29 at loc. 4.

Velocity cross-sections for locs. 1, 2, 3 and 4 are provided in Figs. 8, 9, 10 and 11. Representative high, medium and low flows are plotted. Because of the ice conditions present during the freshet, high flows encountered at this time are not represented, instead the flow caused by a late May rainstorm is provided. This, however, cannot truly be considered as indicative of high flows in the stream.

Water chemistry: Results of field water chemistry analyses for pH and O_2 are provided in Table 1.

Water chemistry data for fourteen parameters are provided in Appendix 9. A summary of analysis of variance and comparison of location means for these parameters is found in Table 2.

Creek Mile 426.5

Physical characteristics: Icings, although not as extensive as in Creek Mile 422.7 were present in the stream channel of Creek Mile 426.5 during the spring of 1976.

The stream bed profile for Creek Mile 426.5 is presented in Fig. 13. The stream bed below the proposed highway crossing has many debris laden areas and boulder riffles are common. Bed material analysis of all locations sampled is provided in Appendices 10, 11 and 12.

Temperature and conductivity measurements are provided in Table 3. Daily water temperature fluctuation at loc. 10 is provided in Fig. 12.

Hydraulics: Flow summary tables are provided in Appendices 13, 14 and 15. As was the case with Creek Mile 422.7, accurate measurements were made difficult in the early part of the spring as a result of icing in the channel and consequently measurements of all parameters provided here were not begun until May 5.

Velocity cross-sections for locs. 9, 10 and 11 are presented in Figs. 14 through 16. Again as was the case with Creek Mile 422.7, the true high flow condition in Creek Mile 426.5 is not represented here. However post-freshet high, medium and low flows are plotted.

Water chemistry: Results of field water chemistry analyses for pH and O_2 are provided in Table 3.

Detailed water chemistry data are provided in Appendix 16. A summary of analysis of variance and comparison of location means for all chemical parameters measured is found in Table 4.

Smith Creek

Physical characteristics: Some channel ice was present in Smith Creek downstream of loc. 6 during the freshet of 1976; however for the most part this did not hamper our program.

The stream bed profile for Smith Creek from its mouth to a point just upstream of loc. 8 is provided in Fig. 17. The stream has generally a gravel and cobble substrate with alternating pools and riffles. No probable obstructions to fish movement were noted in the section surveyed. Bed material analyses of all locations sampled are provided in Appendices 17, 18, 19 and 20.

Temperature and conductivity measurements are provided in Table 5. Daily water temperature variation at loc. 6 is shown in Fig. 12.

Hydraulics: Flow summary tables are provided in Appendices 21, 22, 23 and 24. Accurate determinations were made for most locations from April 12 on. The maximum recorded discharge measured was 6.15 m^3/s on May 2 at loc. 8.

Velocity cross-sections for locs. 5, 6, 7 and 8 are provided in Figs. 18 through 21. Representative high, medium and low flows are plotted.

Water chemistry: Results of field water chemistry analyses for pH and O_2 are provided in Table 5.

Detailed water chemistry data are provided in Appendix 25. A summary of analysis of variance and comparison of location means for all chemical parameters measured is found in Table 6.

BIOLOGICAL CONDITIONS

Creek Mile 422.7

Benthos: The results of Surber samples collected from Creek Mile 422.7 during 1976 are presented in Fig. 22, as percent composition by each of the major invertebrate taxa (i.e. a major taxon occurred as 1% or more of total abundance).

Standing crop increased steadily at all sampling locations over the period of study. Analysis of variance revealed that location had a significant effect on six of the eleven groups tested (Table 7). These groups are Chironomidae, Copepoda, Other Diptera, Plecoptera, Trichoptera and Total.

Date produced a significant effect in all groups except Simulidae and other Diptera. Number of organisms m^{-2} for all groups generally tended to increase over time; however, no general statistical spatial trends were evident.

Similar comparisons of location means were performed on the data from Creek Mile 422.7 as were performed on Smith Creek. Only two groups of invertebrates showed a significant difference in numbers of invertebrates per m^2 between loc. 1 and 2. Copepods showed greater abundance at loc. 2 than loc. 1 and Simulidae vice versa.

Three groups showed significant differences between loc. 3 and 4. All three groups (other Diptera, Plecoptera and Trichoptera) had a significantly greater abundance at loc. 4 than at loc. 3.

Comparison of loc. 3 and 4 to loc. 1 and 2 revealed a larger number of significant differences between groups. Six of the eleven groups showed significant differences in abundance for locations upstream of the proposed highway crossing as compared to locations downstream (Chironomidae, Copepoda, other Diptera, Plecoptera, Trichoptera and total). In five of the six cases (Copepoda the exception) abundance was greater at upstream locations than at downstream locations. The reason for greater abundance at upstream locations is probably due to groundwater recharge. The abundance of Copepoda at loc. 2 seems to be a consequence of the nature of the bed material.

Fish: Three species of fish were collected from Creek Mile 422.7 during the period May to October, 1976. All were caught as a result of fry traps, electrofishing and gillnets at established sampling locations. The trap and fence, operated from May 9 to May 31, caught no migrants of any species moving either upstream or downstream.

SLIMY SCULPIN: A total of 176 slimy sculpin were captured from Creek Mile 422.7 in 1976. Of these, 89 were retained for analysis. Slimy sculpin were caught at all sampling locations. The length-weight relationship for 83 slimy sculpin is described by the linear regression

$$\log(\text{weight}) \doteq -5.0163 + 3.0444 \log(\text{total length})$$
$$C.I. = 2.9334 - 3.1554$$
where C.I. = 95% confidence interval of b

Length frequency data are presented in Table 8. Otolith ages ranged up to six years with age 3 fish being the most abundant (Table 9). Six specimens which were obviously newly hatched and from which individual total lengths and weights were recorded were automatically aged at 0^+.

Five ripe sculpin (four females and one male) were captured between May 13 and 18. The females ranged in total length from 58 to 81 mm and ranged in weight from 2.3 to 6.1 g. The male had a fork length of 55 mm and a weight of 1.7 g.

Diptera and Ephemeroptera larvae were important items in the diet over all length classes; however, sculpin became increasingly pisciverous with increasing total length (Table 10).

LAKE CHUB: A total of 95 lake chub were captured from all sampling locations on Creek Mile 422.7, 1976. Eighteen lake chub were retained for subsequent analysis.

The length-weight relationship for 18 lake chub is expressed by the linear regression

$$\log(\text{weight}) = -3.9619 + 2.3655 \log(\text{fork length})$$
$$C.I. = 1.9958 - 2.7352$$
where C.I. = 95% confidence interval of b

Length frequency data are provided in Table 11. The majority of specimens (83%) were young-of-the-year (Table 12).

The stomachs from all 18 lake chub were analysed for content. Ten were found to be empty. The remainder contained 11 Diptera, two Ephemeroptera, and one Hemiptera.

ARCTIC GRAYLING: Four arctic grayling were captured from loc. 1 on Creek Mile 422.7 in 1976 by means of gillnets. One additional specimen was captured at loc. 2.

Fish varied in fork length from 150 to 222 mm, in weight from 43.2 to 119.3 g and in age from 2 to 4 years (Table 13). One ripe male with a fork length of 212 mm and a weight of 100 g was caught on June 1, 1976.

Creek Mile 426.5

Fish:

LAKE CHUB: Eighteen lake chub were captured in Creek Mile 426.5 in 1976 and all were retained for analysis. The length-weight relationship for 18 lake chub is expressed by the linear regression

$$\log(\text{weight}) = -4.5974 + 2.8168 \log(\text{fork length})$$
$$C.I. = 2.6109 - 3.0235$$
where C.I. = 95% confidence interval of b

Length frequency data are presented in Table 14. Otoliths from 11 of the collected lake chub were read for age determination. Age frequency data are presented in Table 15. Two-year-old lake chub were most abundant in the catch. Stomach content analysis from 18 lake chub are presented in Table 16. Data are presented for four fork length intervals.

LONGNOSE SUCKER: Nine longnose sucker were collected from Creek Mile 426.5 in 1976. Length frequency data for these are presented in Table 17. All fish collected (n=9) were determined to be 1^+ year old. The stomachs of all collected specimens were examined for content. Three were found to be empty and two contained unidentifiable remains. The most abundant food items were Diptera larvae (61.5%), Trichoptera larvae (15.4%), Ephemeroptera (8.7%) and Coleoptera (8.7%).

SLIMY SCULPIN: Five slimy sculpin were captured from Creek Mile 426.5 in 1976 and all were retained for analysis. Fork length ranged from 18 to 74 mm with a mean of 50.8 mm and weight ranged from 0.1 to 5.1 g with a mean of 2.2 g. Otolith ages of four specimens ranged from one to four years (Table 18).

Stomachs were removed from all specimens and analysed for content. The most abundant food items were Plecoptera (50.0%) and Diptera (36.4%). Ephemeroptera and Trichoptera were found less frequently.

NORTHERN REDBELLY DACE: Four northern redbelly dace were collected from Creek Mile 426.5 in 1976. Fork length ranged from 33 to 62 mm with a mean of 45.3 mm and weight ranged from 0.5 to 3.3 g with a mean of 1.5 g. Otolith ages ranged from one to two years (Table 18). Stomachs were examined and all were found to be empty.

BURBOT: Three burbot were captured from Creek Mile 426.5 in 1976. Fork length ranged from 119 to 134 mm with a mean of 125.0 mm and weight ranged from 11 to 17 g with a mean of 13.3 g (Table 18). Stomach contents included one frog, one lake chub, the remains of one unidentified fish, five Plecoptera nymphs and one Ephemeroptera.

ARCTIC GRAYLING: One young-of-the-year Arctic grayling with a fork length of 56 mm and a weight of 2.2 g was taken from Location 9 on August 7, 1976. The stomach was found to be empty.

LAKE WHITEFISH: One young-of-the-year lake whitefish with a fork length of 38 mm and a weight of 0.4 g was taken from loc. 9 on July 18, 1976. The stomach contained two Chironomidae larvae and one Ephemeroptera nymph.

MOUNTAIN WHITEFISH: One young-of-the-year mountain whitefish with a fork length of 28 mm and a weight of 0.2 g was collected from Location 9 on July 18, 1976. The stomach contained five Chironomid larvae and unidentifiable insect remains.

Smith Creek

Benthos: The results of Surber samples taken in Smith Creek during 1976 are presented in Fig. 23 as percent composition by each of the major invertebrate taxa (ie. a major taxon occured as 1% or more of total abundance). Mean numbers m^{-2} increased steadily over the period of study.

Analyses of variance revealed that overall numbers of all major taxa of invertebrates except Copepoda, Simulidae, and other Diptera were significantly different by location (Table 19). Date produced a significant effect in all but one major taxa (Copepoda). The number of organisms m^{-2} tended to increase in an upstream direction in Smith Creek and also through time. Simulidae are the major exception to this general rule and results here are inconclusive.

Comparisons of location means were performed on all major taxa of invertebrates regardless of whether location showed a significant effect in the analysis of variance. In all groups there were no significant differences between the mean number of invertebrates m^{-2} collected from loc. 5 and 6. Six groups namely Chironomidae, Ephemeroptera, Hydracarina, Nematoda, Trichoptera and Total showed a significant difference in abundance between loc. 7 and loc. 8. All taxonomic groups with the exception of Copepoda and Simuliidae showed a significant difference in abundance between the pooled mean of locations upstream of the proposed highway crossing versus the pooled mean of downstream locations.

The greater numbers of organisms at upstream locations relative to those at downstream locations is probably due in large measure to groundwater recharge in the vicinity of loc. 8. Water temperatures were generally warmer in this area than in reaches further downstream.

Fish:

ARCTIC GRAYLING:

Trap and fence: A total of 143 Arctic grayling were recorded migrating upstream at the fence location of Smith Creek in 1976 (Fig. 24). Ninety-six percent of these migrated during a span of 22 days from the time of fence installation to flooding of the stream which washed out the weir on May 29. Of the Arctic grayling captured in the upstream trap, a total of 115 were subsequently released and 28 were dead sampled. Of the grayling released, 94 were fin-clipped and nine tagged.

Breakdown of the upstream migration by fork length and age is given in Fig. 25. The migration was dominated numerically throughout by three-year-old fish. No major temporal segmentation of the Arctic grayling migration according to fork length is apparent.

Growth data for upstream migrants are presented in Table 20. The length weight relationship for 140 Arctic grayling is expressed by the linear regression

log (weight) = -4.5466 + 2.8183 log (fork length).
C.I. = 2.5991 - 3.0375
where C.I. = 95% confidence interval of b.

Dead sample analysis of 28 upstream migrants (17 female and 11 male) indicated that the age of first gonadal maturity was age 3 for males and age 4 for females (except for one female age 3). This agrees with results from external analysis of live specimens from which sex products could be expelled during trap checks.

The fence operation appeared to be successful in capturing Arctic grayling over approximately 200 mm in fork length. The migration of small grayling upstream may occur but was not detected.

The downstream migration of Arctic grayling in Smith Creek began on June 4 and continued until July 8 although there were few downstream migrants after June 22. A total of 144 Arctic grayling were captured migrating downstream. Of these, there were 46 fin-clip recaptures recorded and six tag recaptures.

The fork length and age composition of the downstream migrating fish differed little from the upstream migration. This suggests that grayling which may have migrated upstream while the trap was not in operation did not represent any particular segment of the population.

Analysis of the downstream migration by fork length and age over time is given in Fig. 26. As was the case with the upstream migration no temporal trends according to fork length or age are apparent.

Growth data for downstream migrants are presented in Table 20. The length-weight relationship for 135 downstream migrants is expressed by the equation

log (weight) = -4.9699 + 2.9966 log (fork length)
C.I. = 2.7996 - 3.1936
where C.I. = 95% confidence interval of b.

Stomach content analysis for upstream and downstream migrants combined is presented in Table 21. By far the largest constituent of the diet for migrating Arctic grayling was comprised of Amphipoda.

An analysis of tag and recapture data revealed that 50.5% of those tagged and fin clipped moving upstream were subsequently recaptured in the downstream trap. An analysis of the number of days spent upstream is presented in Fig. 27 for these recaptures.

General:

Fork length > 100 mm: A total of ten Arctic grayling with a fork length greater than 100 mm were captured from various locations including established sampling locations on Smith Creek in 1976. All were caught by means of gillnets.

Six specimens were subsequently dead sampled and of these four stomachs were analysed for content (Table 25).

Fork length < 100 mm: A total of 94 juvenile Arctic grayling were captured by means of seine nets and fry traps set at sampling locations on Smith Creek. Of these 44 were retained for analysis. The length-weight relationship for 44 juvenile Arctic grayling is expressed by the equation

log (weight) = -4.8627 + 2.9741 log (fork length)
C.I. = 2.8052 - 3.1430
where C.I. = 95% confidence interval of b.

Length frequency data is presented in Table 22. Age was determined for 43 of the specimens collected. The otoliths from 35 of these were removed and inspected for annuli then cross-checked by scale reading. Otoliths from eight specimens were not obtained and for these scale ages only were determined. A summary of growth in length and weight by age for small Arctic grayling 100 mm fork length) is provided in Table 23. A more detailed summary of growth for young-of-the year grayling in 1976 is provided in Table 24.

Stomach content analysis was performed on all small fish sampled (Table 25). The fish were assigned into four length classes prior to analysis. The most abundant food items were Dipterans which comprised over 52% of all organisms identified. There were no empty stomachs.

NORTHERN PIKE:

Trap and fence: A total of 92 northern pike were recorded migrating upstream at the fence location on Smith Creek in 1976 (Fig. 24). Eighty-nine percent of these migrated during a span of 20 days beginning as soon as the fence was operational on May 6. For two days prior to the wash-out of the fence on May 29 there were no upstream migrants. A total of 76 individuals were tagged and subsequently released upstream, 13 were dead sampled and one was counted only and released.

An analysis of the upstream migration according to fork length and age is provided in Fig. 28. Males were generally smaller than females for a given age and migrated earlier. The migration was dominated numerically throughout by three-year-old fish.

Growth data for upstream migrants are presented in Table 26. The length-weight relationship for 87 northern pike is expressed by the linear regression

log (weight) = -5.3711 + 3.0746 log (fork length)
C.I. = 2.8793 - 3.2699
where C.I. = 95% confidence interval of b.

Gonadal maturity of upstream migrants was determined by expression of sex products. This was found to be an effective technique when used on migrating pike, the majority of which were close to spawning at the time of capture. Gonadal maturity and sex were determined for 77 specimens overall including dead samples. The age of first gonadal maturity was determined to be age 2 for males and age 3 for females.

Stomach content analyses were performed on the 13 dead samples obtained. Eight stomachs were found to be empty, the rest contained fish remains, mainly Arctic grayling.

A total of 46 northern pike was detected moving downstream during the fence operation. The first downstream migrant was recorded on June 11 and pike moved downstream through the trap system sporadically until July 17. The traps were removed on this date but it is likely that the downstream movement of northern pike continued after this date. Of the 46 fish recorded, 36 were tag recaptures from the upstream trap.

A breakdown of the downstream migration according to fork length and age is presented in Fig. 29.

An analysis of tag and recapture data revealed that 47.4% of the northern pike tagged at the upstream trap were subsequently recaptured in the downstream trap. A graphic representation of the number of days spent upstream is presented in Fig. 30.

Growth data for downstream migrants are presented in Table 26. The length-weight relationship for 44 northern pike is expressed by the linear regression equation

log (weight) = -4.8054 + 2.8610 log (fork length)
C.I. = 2.4911 - 3.2309
where C.I. = 95% confidence interval of b.

General:
Fork length > 100 mm: A total of 17 pike were captured from Smith Creek by means of gillnets set periodically from July 10 to October 14, 1976. Sampling took place at all established sampling locations (i.e. loc. 5 through 8) and as well near the mouth of Smith Creek and upstream of loc. 8. Of the 17 individuals captured, 12 were recaptures from the spring tagging operation. Eleven specimens were dead sampled subsequent to capture; of these five had empty stomachs and six contained fish remains including lake chub and white sucker.

Fork Length < 100 mm: No pike with a fork length less than 100 mm were captured from Smith Creek in 1976.

LONGNOSE SUCKER:
Trap and fence: A total of 23 longnose sucker were captured in the upstream trap at Smith Creek in 1976 (Fig. 24). The first migrant was captured on May 6 which was the first day of fence operation. The migration then continued until two days prior to the fence washout on May 29. No further upstream migrants were captured after the fence became operational again on June 3. Of the total captured, 12 were tagged and released, seven fin-clipped and released and four were dead sampled.

Twenty-seven longnose suckers were captured in the downstream trap from May 10 to July 10. Of these 10 were recapture tagged fish and two were recapture fin-clipped fish. Of the remainder seven were counted and released, 10 were tagged and two were dead sampled. Many of the fish captured in the downstream trap were still in a ripe condition and so it appears that the fish captured did not represent a post spawning downstream migration.

Age analysis was not performed on longnose suckers captured in the traps on Smith Creek. Length frequency data is summarized in Table 27 for both upstream and downstream migrants. Breakdown of the upstream and downstream migrations by fork length is provided in Fig. 31. The length weight relationship for 21 upstream migrants is expressed by the equation

log (weight) = -4.8531 + 2.9741 log (fork length)
C.I. = 2.4092 - 3.5390
where C.I. = 95% confidence interval of b

and for 25 downstream migrants by the equation

log (weight) = -4.8627 + 2.9741 log (fork length)
C.I. = 2.1382 - 3.8100
where C.I. = 95% confidence interval of b.

The sex of 16 individuals caught in the upstream trap was determined by means of expression of sexual products at the time of capture. Nine of these were females and seven were males.

Stomach analysis was not performed on any longnose suckers captured.

General:
Fork length > 100 mm: No longnose suckers with a fork length greater than 100 mm were captured from Smith Creek by means other than the trap and fence operation.

Fork length < 100 mm: A total of 460 juvenile longnose suckers (i.e. fork length<100 mm) were captured from Smith Creek by means of seines, fry traps and electrofishing. Of these 87 were retained for analysis. The length-weight relationship for 69 juvenile longnose sucker is expressed by the equation

log (weight) = -5.1006 + 3.1176 log (fork length)
C.I. = 2.9550 - 3.2802
where C.I. = 95% confidence interval of b.

Length frequency data is presented in Table 28.

Stomach content analysis was performed on all small fish sampled (Table 29). The fish were assigned in four length classes prior to analysis. Chironomidae comprised by far the largest constituent of diet for all length classes.

BURBOT:
Trap and fence: Three burbot were captured in the upstream trap on Smith Creek (Fig. 24). One individual was tagged (fork length 300 mm, weight 125 g), one was fin-clipped (fork length 297 mm, weight 150 g) and one was dead sampled (fork length 292 mm, weight 100 g). Analysis of the stomach contents of the latter specimen revealed an empty stomach. No burbot were captured in the downstream trap on Smith Creek.

General: Eight burbot were captured in various locations on Smith Creek throughout the summer by gillnets, fry traps and electrofishing.

Fork lengths ranged from 69 to 237 mm with a mean of 151 mm. Weight ranged from 2.1 to 101 g with a mean of 30.6 g. Otolith ages ranged from 2 to 5 years (Table 30). Eight stomachs were examined for content, all contained food. Slimy sculpins accounted for 47.1% of identifiable food organisms while the remainder of the contents was comprised of lake chub (20.6%), Plecoptera (14.7%), longnose sucker (8.9%), Ephemeroptera (5.9%) and chironomid larvae (2.9%). Slimy sculpin occurred in three of the stomachs examined and lake chub occurred in four.

SLIMY SCULPIN: A total of 222 slimy sculpin were captured at various locations on Smith Creek in 1976. Of this total, 35 were retained for analysis. The length-weight relationship for 35 slimy sculpin from Smith Creek is expressed by the equation

log (weight) = -4.8414 + 2.9466 log (total length)
C.I. = 2.7089 - 3.1845
where C.I. = 95% confidence interval of b.

Length frequency data is presented in Table 31. The modal fork length class was from 20 to 29 mm. Age analysis is based on otoliths read from 29 specimens. The numerically dominant age class was age 0+ (Table 32).

Stomach content analyses were performed on all fish retained above (Table 33). The data are presented based on the division of the sample into three fork length categories. Diptera larvae comprised the most abundant food item for all three groups, however Ephemeroptera also occupied an important role in the diet of slimy sculpins with fork length from 51 - 75 mm. Empty stomachs accounted for 14.3% of all stomachs examined.

LAKE WHITEFISH: A total of 165 lake whitefish were caught with 32 retained for detailed analyses. The length-weight relationship for 32 lake whitefish is described by the regression equation

log (weight) = -4.9589 + 3.0180 log (length)
C.I. = 2.8793 - 3.1567
where C.I. = 95% confidence interval of b.

Length frequency data are presented in Table 34. The dominant class numerically is from 40 to 49.9 mm. Scales from 32 lake whitefish were read for age determination. Age frequency data are presented in Table 35. The results of stomach content analyses are presented in Table 36. Data are presented for three length intervals. Diptera were found to be the most abundant food item over all intervals. Empty stomachs accounted for 16.1% of all stomachs examined.

LAKE CHUB: A total of 64 lake chub were caught at Smith Creek in 1976; of these 34 were retained for analysis. The length-weight relationship for 34 lake chub is expressed by the linear regression

log (weight) = -4.9935 + 3.0871 log (length)
C.I. = 2.9355 - 3.2387
where C.I. = 95% confidence interval of b.

Length frequency data are presented in Table 37. The modal fork length class is 40 to 49 mm. Otoliths from 29 lake chub were removed and read for age determination. Age frequency data are presented in Table 38. Stomach content analyses from 34 lake chub are presented in Table 39. Data are presented for three fork length intervals. Dipterans comprised 100% of the diet of the two lake chub which had a fork length greater than 76 mm.

LONGNOSE DACE: Thirteen longnose dace were captured from various locations in Smith Creek in 1976. Eight of these were retained for detailed analysis (Table 40). Fork length ranged from 24 to 117 mm with a mean of 45.8 mm. Weight ranged from 0.1 to 18.3 g with a mean of 4.3 g.

Ages of longnose dace were not determined. Eight stomachs were examined for content. Six were found to be empty. Simuliidae larvae accounted for 80% of the identifiable remains with Ephemeroptera, Trichoptera, Nematoda and Hymenoptera accounting for the remainder.

NORTHERN REDBELLY DACE: A total of five northern redbelly dace were taken from Smith Creek in 1976. Fork length ranged from 26 to 37 mm with a mean of 32.2 mm. Weight ranged from 0.2 to 0.7 g with a mean of 0.48 g. All specimens were found to be age 1+.

Four of the five northern redbelly dace stomachs examined contained some food. Food items consisted exclusively of Chironomidae larvae (63.6%) and Simuliidae larvae (36.4%). One stomach was empty.

MOUNTAIN WHITEFISH: Three mountain whitefish were collected from Smith Creek in 1976.

The ages of two specimens were determined by otolith inspection. Both were one year old.

Stomachs were removed from all three specimens and analysed for content. Ephemeroptera and Simuliidae larvae comprised 50% and 44.2% respectively of the diet while Plecoptera, Chironomidae and miscellaneous other Diptera made up the remaining 5.8% of diet.

YELLOW WALLEYE: One yellow walleye (age 1+) with a fork length of 55 mm and a weight of 20 g was taken from Smith Creek near the mouth on August 17, 1976. The stomach contained the remains of one unidentifiable fish.

LEAST CISCO: One least cisco (age 1+) with a fork length of 73 mm and a weight of 3.8 g was taken from Smith Creek on September 28, 1976. The stomach contained three adult Diptera, two Trichoptera, one Plecoptera and one Chironomidae pupa.

ROUND WHITEFISH: One round whitefish with a fork length of 52 mm and a weight of 1.3 g was taken from Smith Creek on August 17, 1976. The age of the specimen as determined by otolith inspection was age 1+. Stomach contents consisted of four Chironomidae larvae and one Corixidae.

TROUT PERCH: One trout perch with a fork length of 24 mm and a weight of 0.2 g was taken from Smith Creek on August 17, 1976. The specimen was determined to be age 1+. The stomach contained a Trichoptera larva and four Chironomidae larvae.

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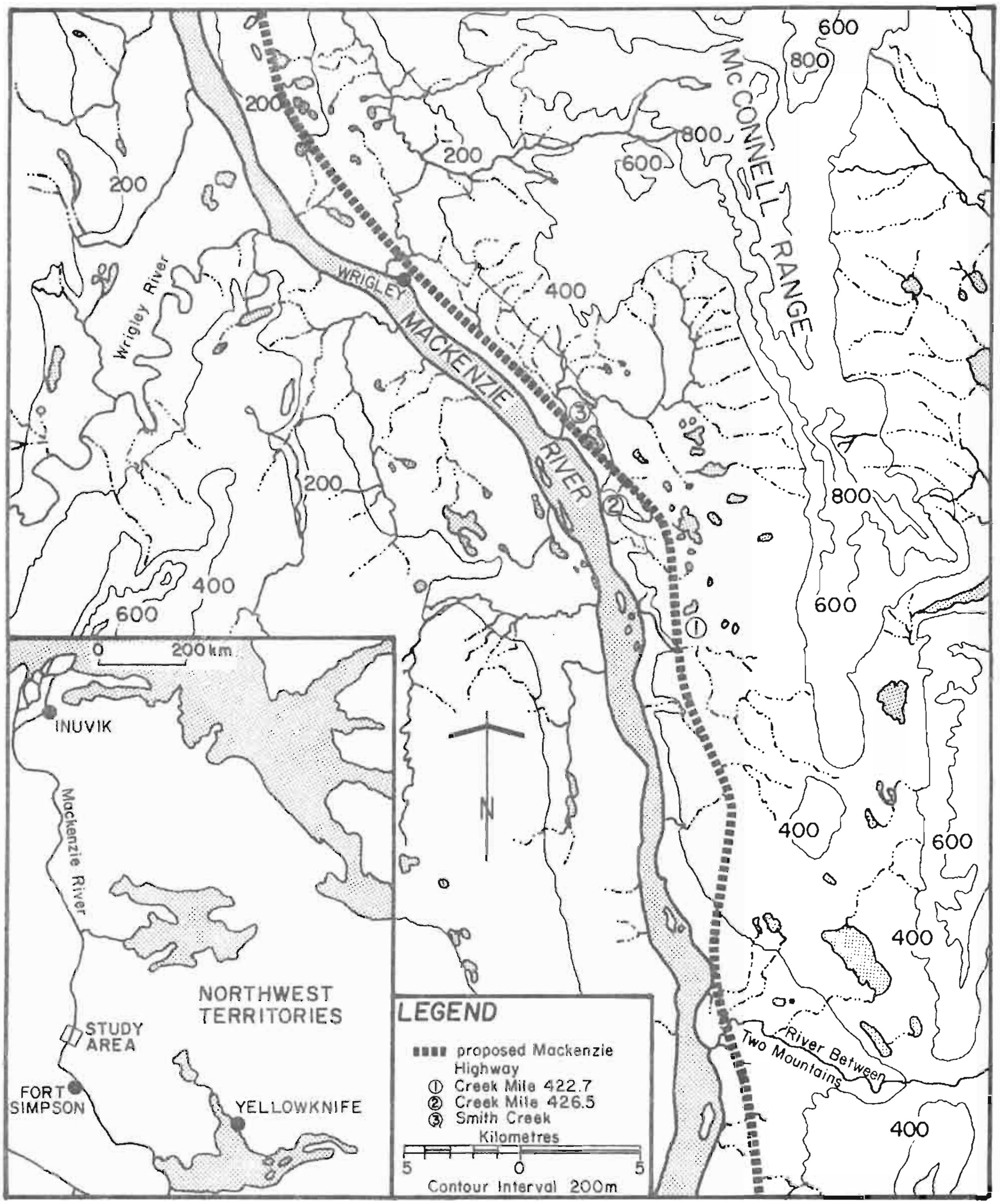


Fig. 1. Map of study area showing proposed Mackenzie highway route.

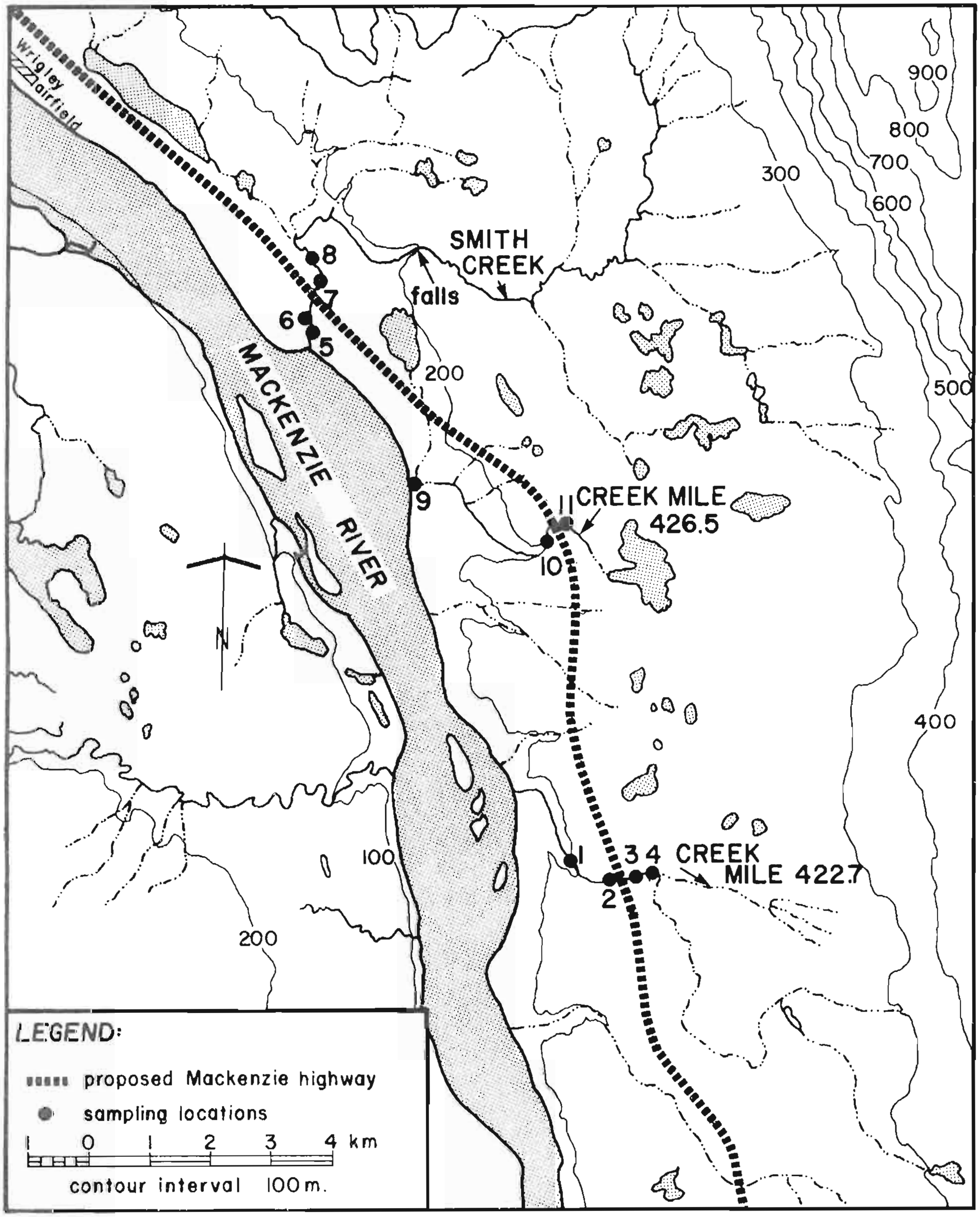


Fig. 2. Map of study area showing sampling locations.

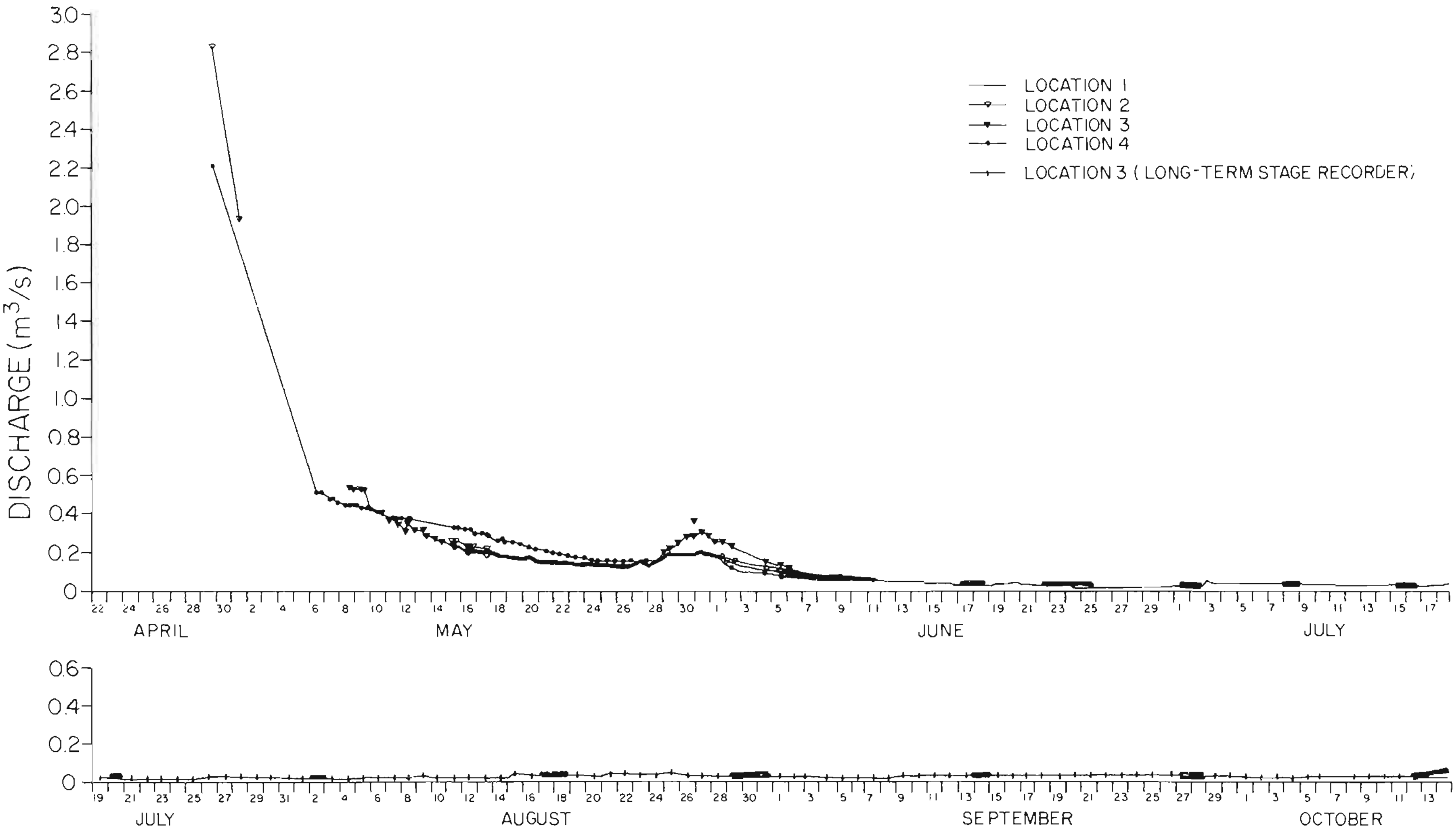


Fig. 3. Creek Mile 422.7 hydrograph, 1976.

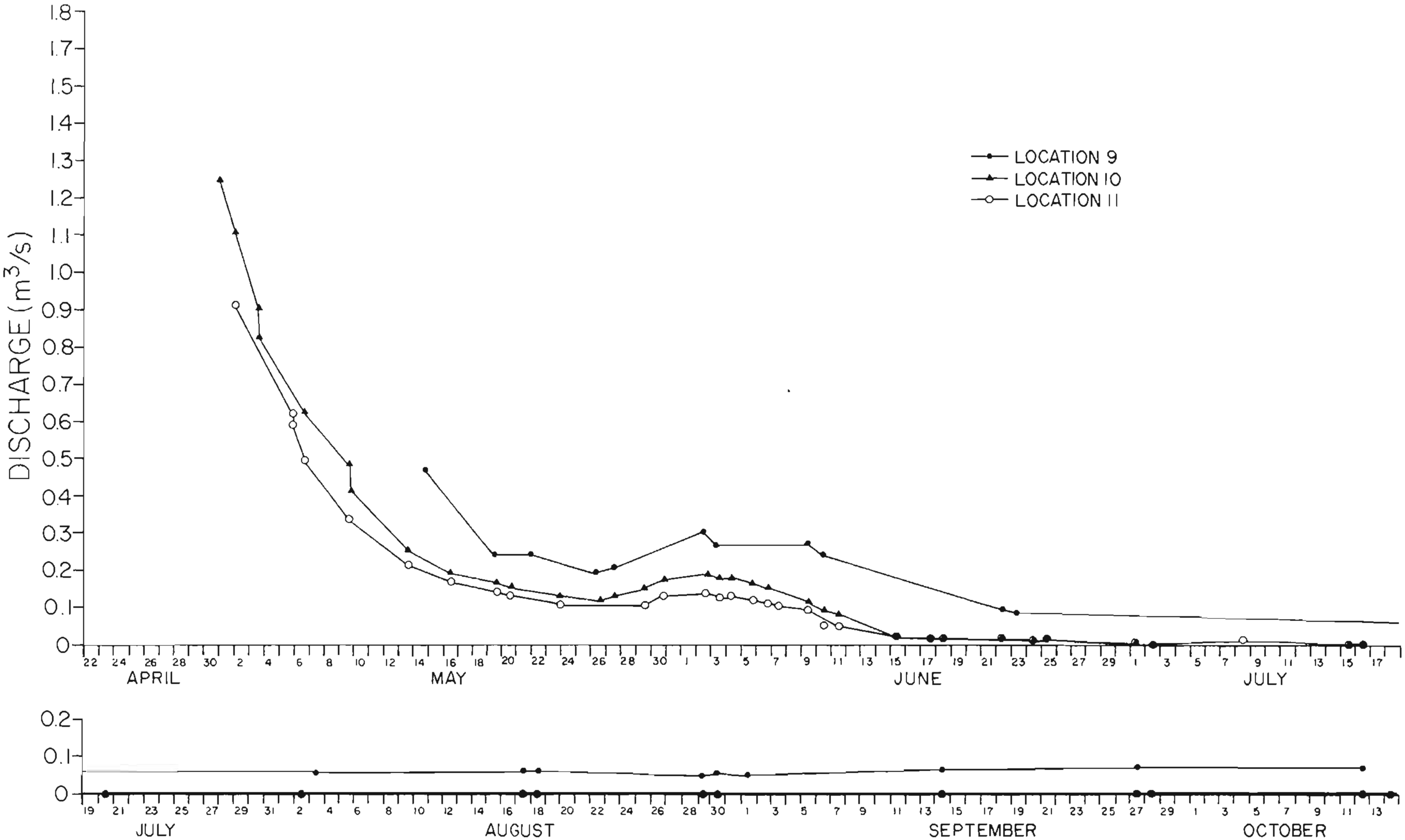


Fig. 4. Creek Mile 426.5 hydrograph, 1976.

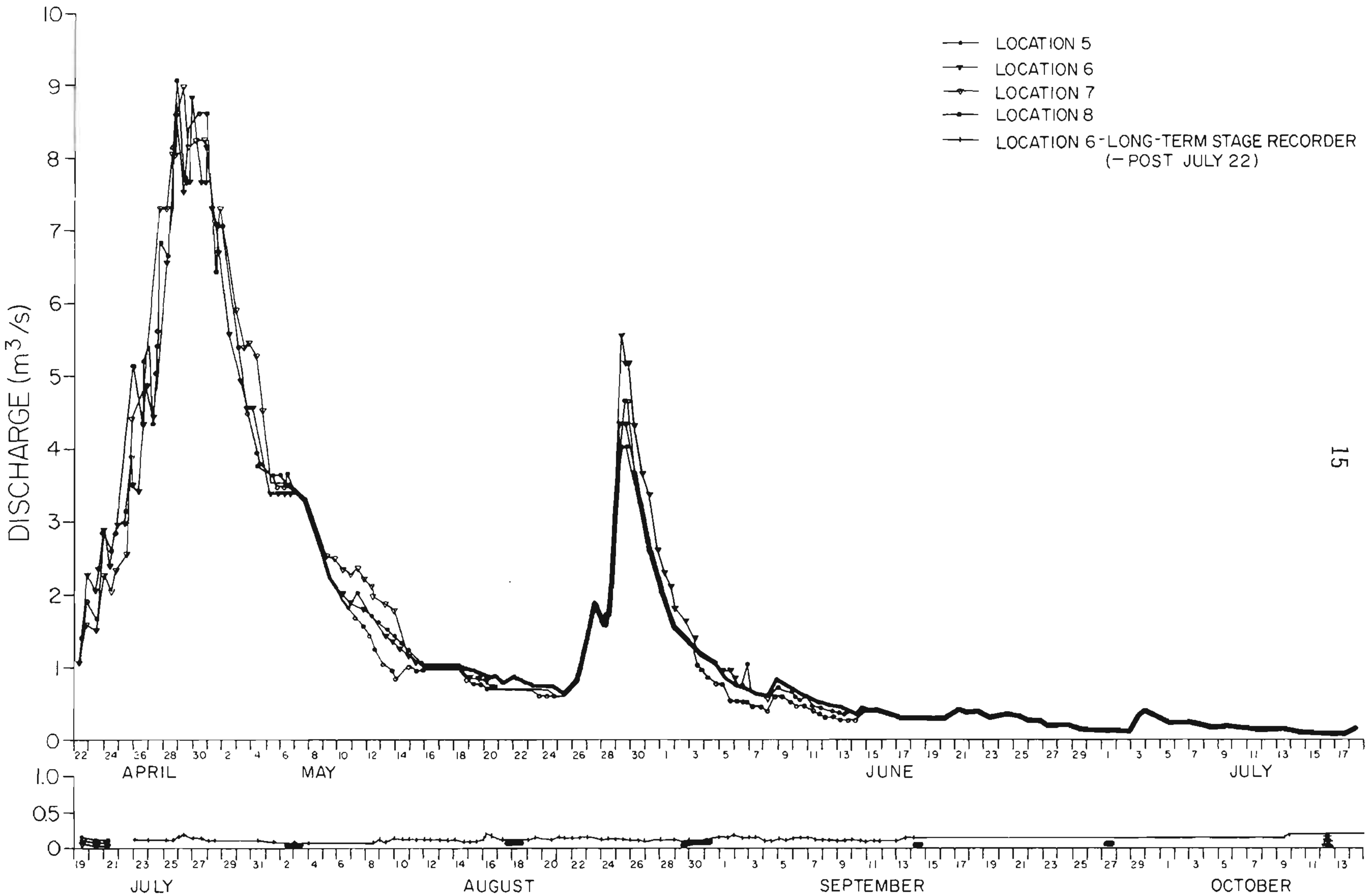


Fig. 5. Smith Creek hydrograph, 1976.

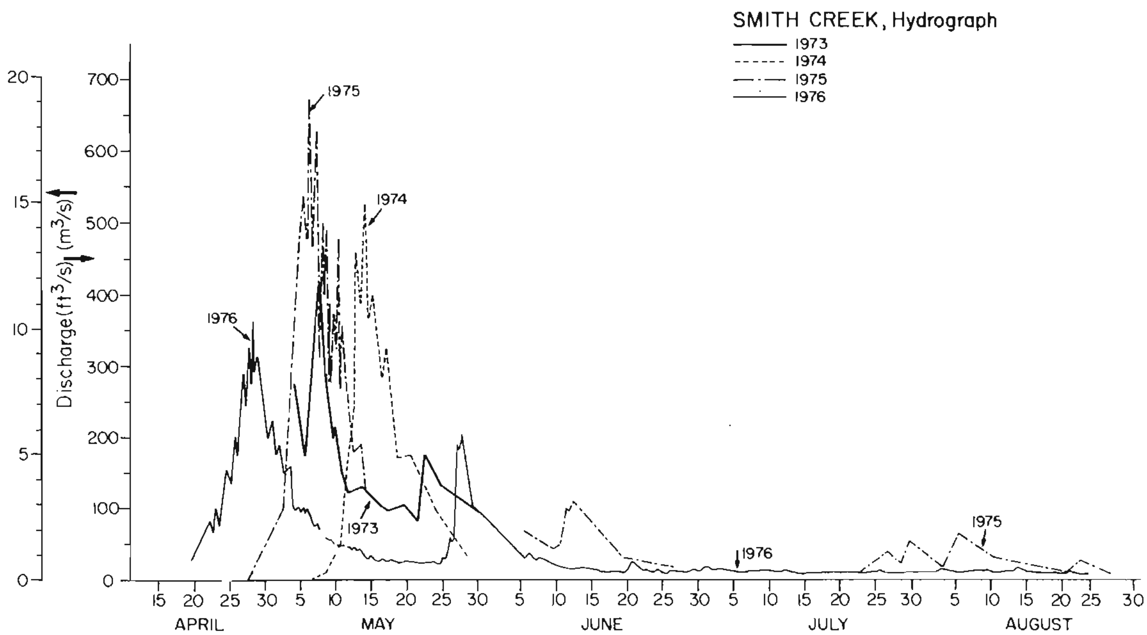
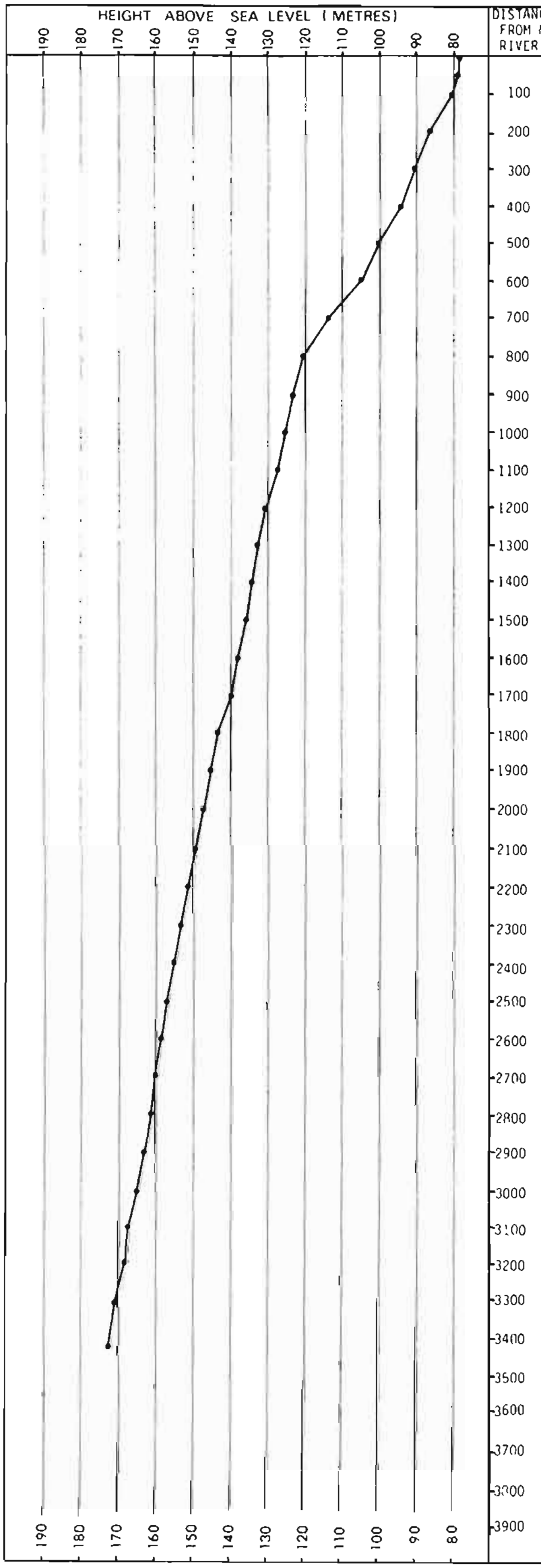


Fig. 6. Smith Creek hydrographs, 1973-1976.



DISTANCE UPSTREAM FROM MACKENZIE RIVER (METRES)	DESCRIPTION OF SUBSTRATE, BANKS ETC.
0-490	Continuous riffle over boulders and cobbles.
180	Slumping and some debris in stream.
490-600	Debris jams, cobble and coarse gravel substrate.
600-695	Steep section. Large boulders, cobble bed. Gravel and silt between boulders and cobbles, not much debris. Icing present on north-east side.
695-820	Debris jams, large boulders. Some gravel and mud flats.
730	Gravel bed.
725-755	Slumping cut bank.
820-915	Much debris in channel. Large boulder substrate.
915-1020	Sand substrate, organic banks.
1020-1090	Silty gravel bed.
1070	Debris jam.
1090-1380	Cobble, coarse gravel substrate.
1225	Debris jam.
1240-1270	Debris jams.
1330	Debris jam.
1370	Debris jam.
1380-1630	Narrow cobble riffles, occasional beds of sand and gravel.
1550	Debris jam.
1630-1670	Many debris jams.
1670-1730	Narrow boulder riffles. Coarse gravel between, some silt on surface of gravel.
1730-1890	Cobble, boulder riffle.
1730	Location 1 - Staff gauge.
1735	Location 1 - Discharge Station.
1890-1910	Pools with some sand areas over cobble bed.
1900	Location 1 - Biological.
1910-2110	Open, wide cobble riffle area.
2110-2190	Large cobble riffle.
2190-2250	Gravel substrate between boulders.
2250-2280	Fallen logs and debris over a cobble riffle bed.
2280-2420	Wide cobble riffle.
2420	Small cut bank south shore.
2420-2480	Narrow channel, heavily over grown banks.
2480-2530	Wide cobble riffle.
2530-2690	Narrow boulder riffles and pools between heavily vegetated banks.
2690-2785	Small cobbles, some boulders, some coarse gravel sections, more diverse bed types.
2700	Small cut bank into sand, cobbles along south shore.
2785-2885	Cobble bottom with occasional banks and bars of find sand - some vegetated sand bars.
2885-3040	Narrow cobble riffle between vegetated banks.
3040-3280	Wide cobble bed, riffles.
3100	Location 2 - 1976 Discharge section.
3120	Location 2 - 1975 Discharge section.
3190	Proposed highway crossing.
3280-3325	Pool over cobble bed.
3322	Location 3 - Discharge section.
3335	Location 3 - Staff gauge.
3325-3405	Narrow riffle section over cobble bed.
3405	Glaciology - Discharge section.
3430-3440	C.N.T. winter road crossing.
3460	Sand banks and cobble bottom - Discharge section, Location 4.

Fig. 7. Stream bed profile for Creek Mile 422.7.

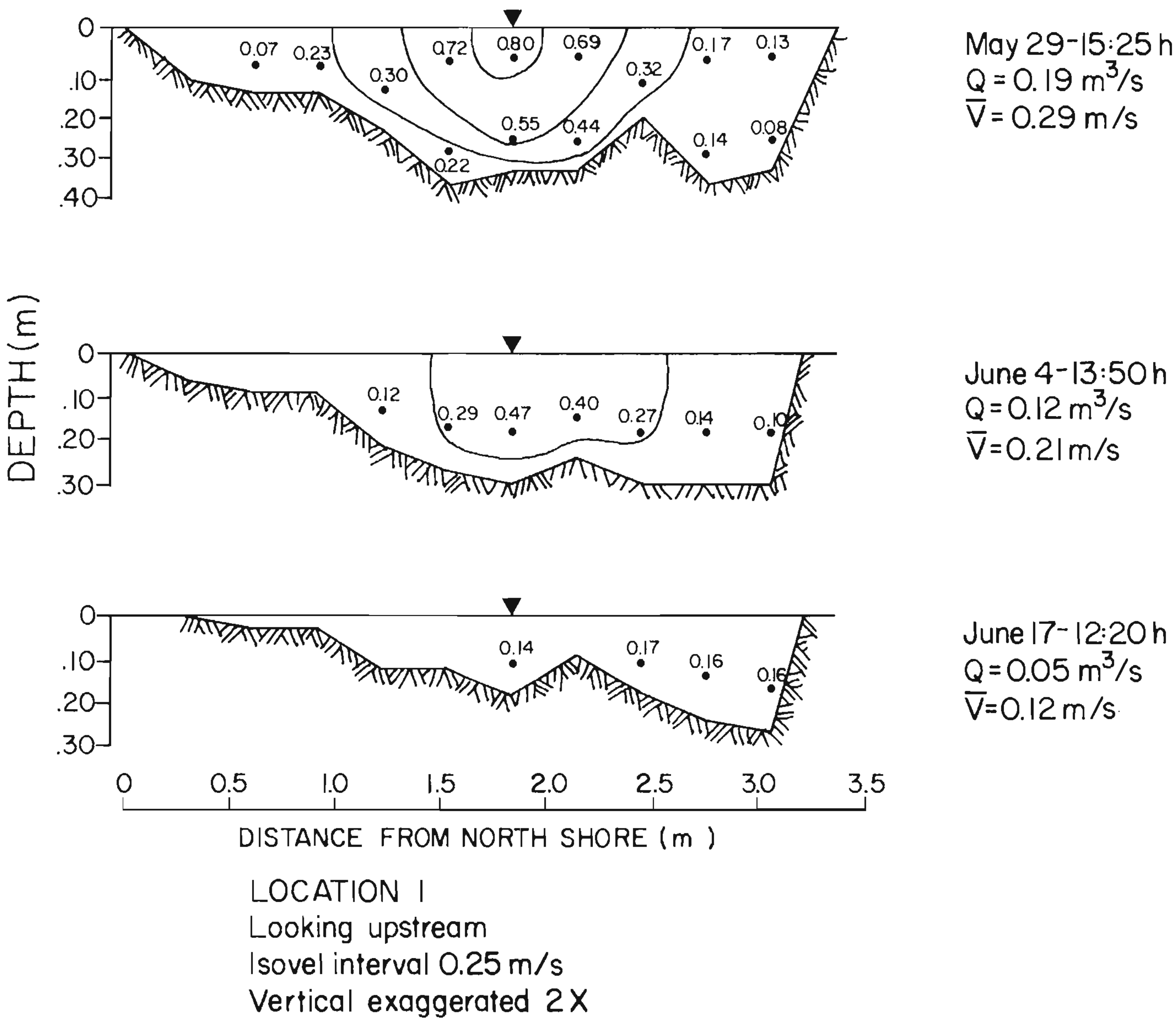


Fig. 8. Stream velocity cross-section profiles for Location 1, Creek Mile 422.7.

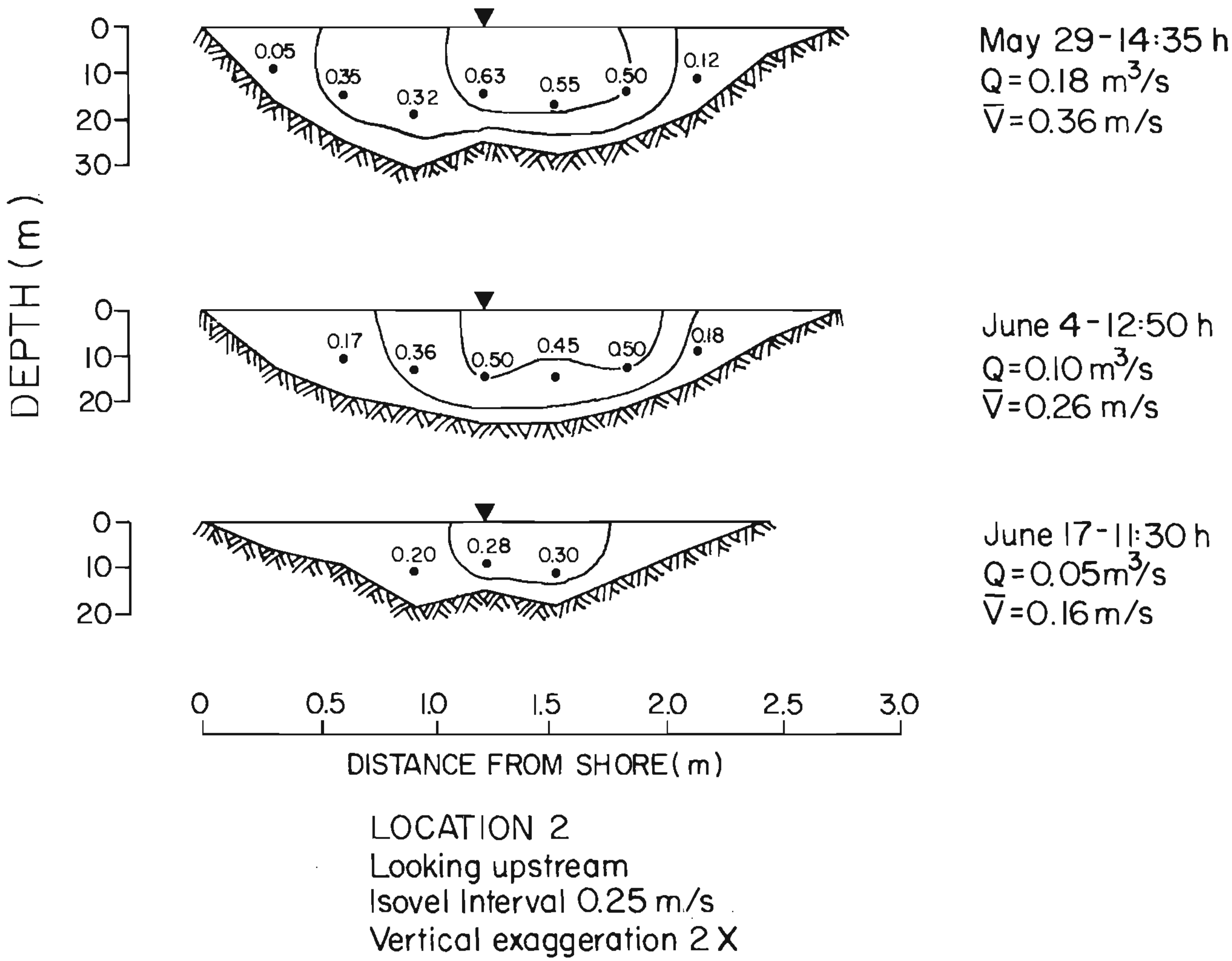


Fig. 9. Stream velocity cross-section profiles for Location 2, Creek Mile 422.7.

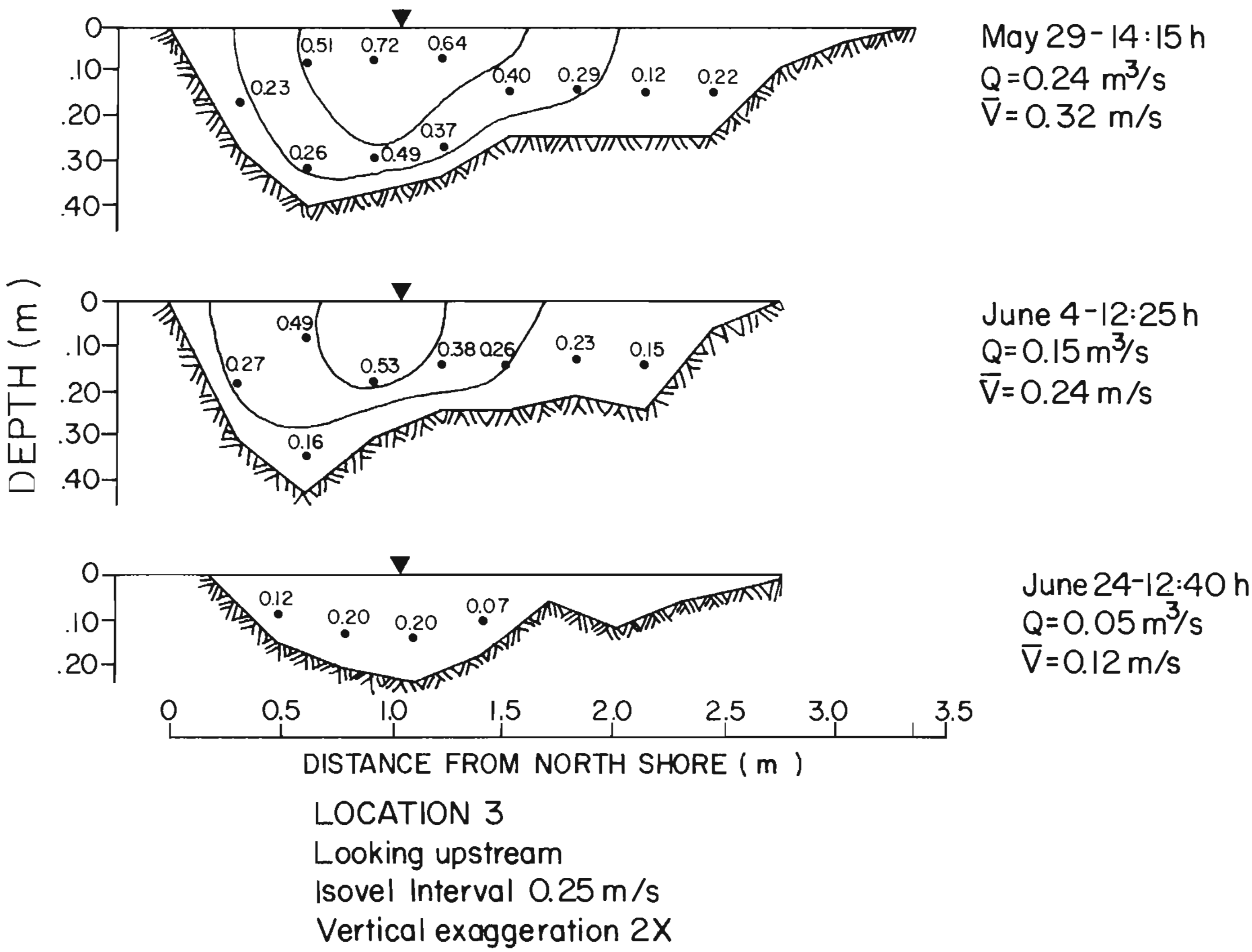


Fig. 10. Stream velocity cross-section profiles for Location 3, Creek Mile 422.7.

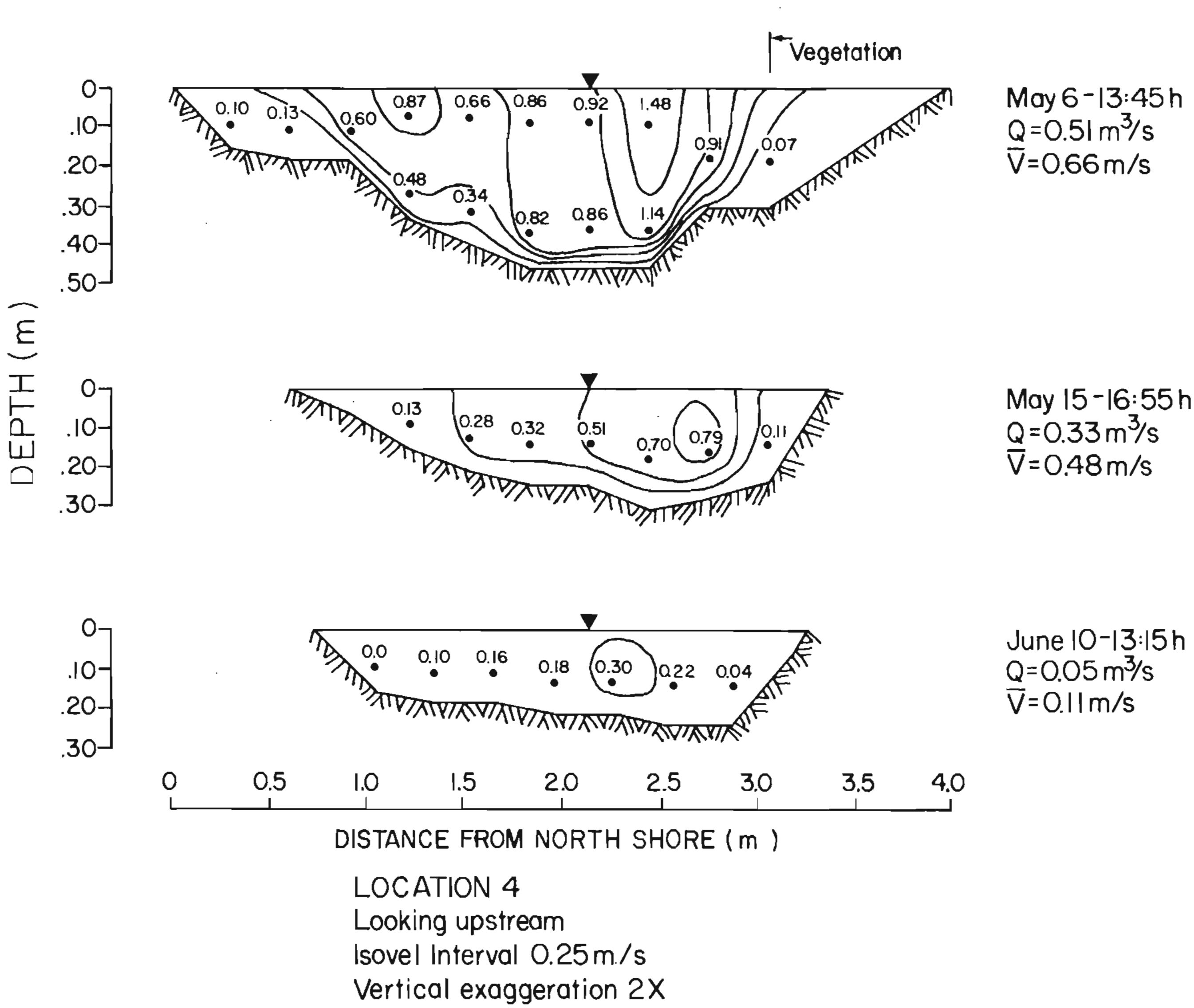


Fig. 11. Stream velocity cross-section profiles for Location 4, Creek Mile 422.7.

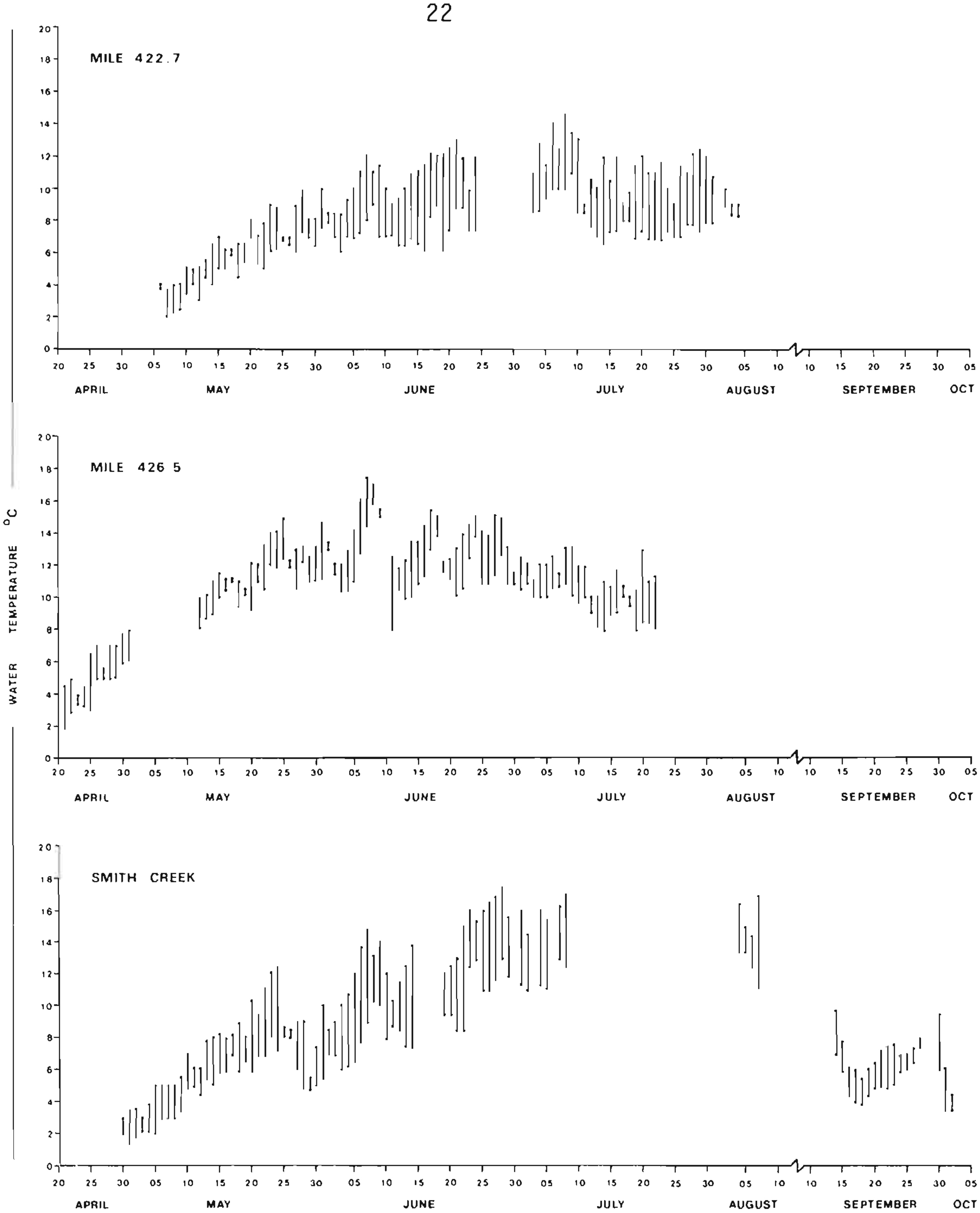
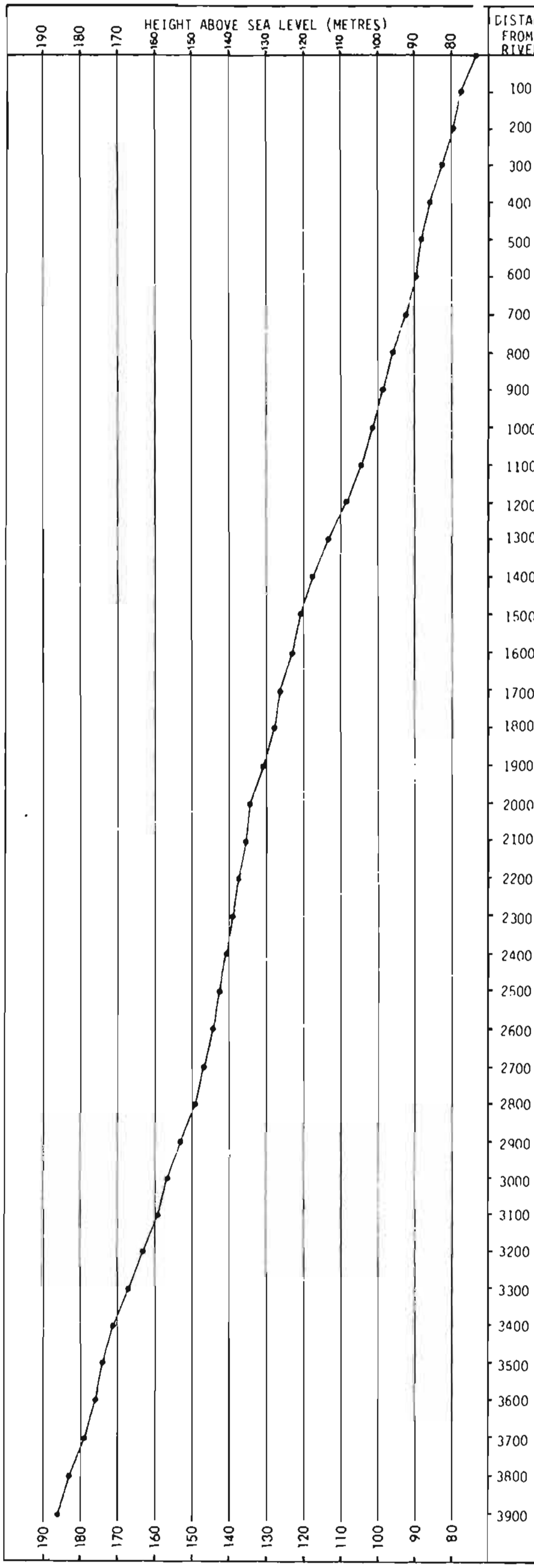


Fig. 12. Daily water temperature fluctuations for Creek Mile 422.7, Creek Mile 426.5 and Smith Creek, 1976.



DISTANCE UPSTREAM FROM MACKENZIE RIVER (METRES)	DESCRIPTION OF SUBSTRATE, BANKS ETC.
0	Mackenzie River highwater.
5	Staff guage Location 9.
10	Discharge Station, Location 9.
420-460	Many debris jams.
490	Debris on south shore.
500-530	Well defined channel, boulder riffles.
545-575	Many logs across channel.
575	Massive debris jam.
770-790	Boulder rapids.
805-830	Rapids, gravel substrate.
870	Cold springs on north side.
980-1020	Boulder and debris substrate.
1080	Tributary enters from north shore.
1155-1200	Steep grade, boulder substrate, wide bed with many channels.
1220-1280	Riffle, debris, boulder and gravel bottom.
1335-1370	Steep banks on south side, a few gravel areas, debris.
1430	Debris jam.
1485	Channel braided. A number of high flood channels present - boulder, debris and mud substrate.
1515-1550	Thick willows, debris in channel.
1570-1610	Much debris in channel.
1610-1645	Many clear cold springs enter from south side.
1715	Turbid stream enters from north side.
1840-1850	Marshy area - silt gravel substrate.
1860	Bank slump south side.
1870	Gravel bottom.
1870-2010	Boulder riffles.
1940	Much debris in channel.
1970	Bank slump.
2010-2160	Mud banks and substrate, low velocity flow.
2100-2305	Boulder, cobble and gravel substrate, mud banks.
2305-2560	Boulder and cobble substrate with silt between. All covered with a thin layer of mud. This mud is particularly evident downstream of bank slumps.
2470	Small bank slump on south shore.
2640	Many fallen trees in stream.
2650-2655	Debris laden channel, boulder and silt substrate.
2655-2820	Patches of gravel and cobble substrate.
2808	Bank slumping, debris jam along south side.
2820-3280	Small boulder and cobble substrate.
2870	Debris jam in stream.
2900	Two small debris jams.
3265	Vetetated silty sand terrace bank.
3280-3380	Substrate composed of large cobble with silt.
3380-3600	Some pools with silty-sand substrate.
3410	Bank slumping on north side.
3600-3770	Stream is quite straight in places. Many boulders with cobbles and sand between.
3770	Debris jam.
3785	B.M. Location 10.
3770-3980	Boulder bottom with sand between. Heavy vegetative cover.
3980	Discharge Station, Location 11.

Fig. 13. Stream bed profile for Creek Mile 426.5.

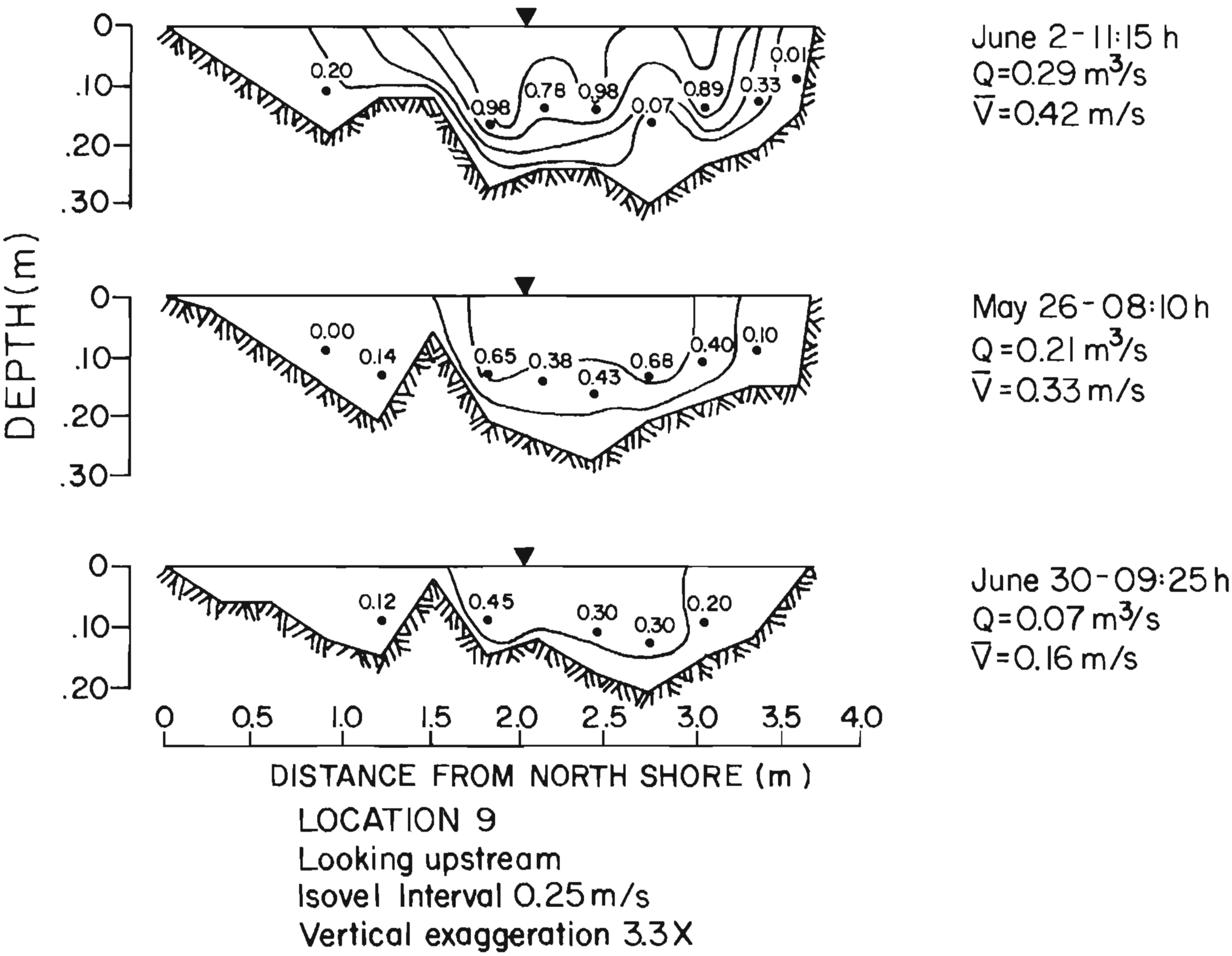


Fig. 14. Stream velocity cross-section profiles for Location 9, Creek Mile 426.5.

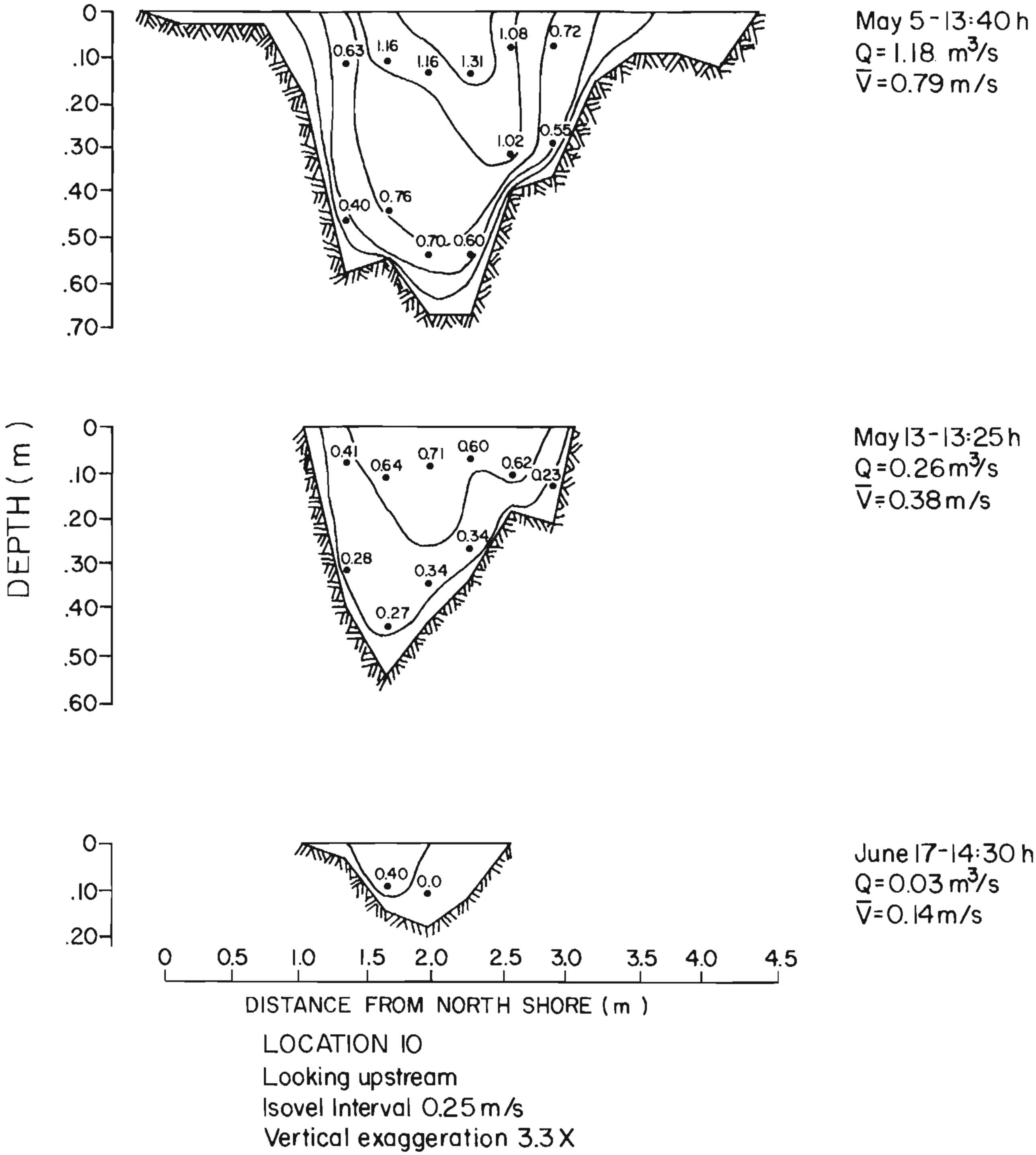


Fig. 15. Stream velocity cross-section profiles for Location 10, Creek Mile 426.5.

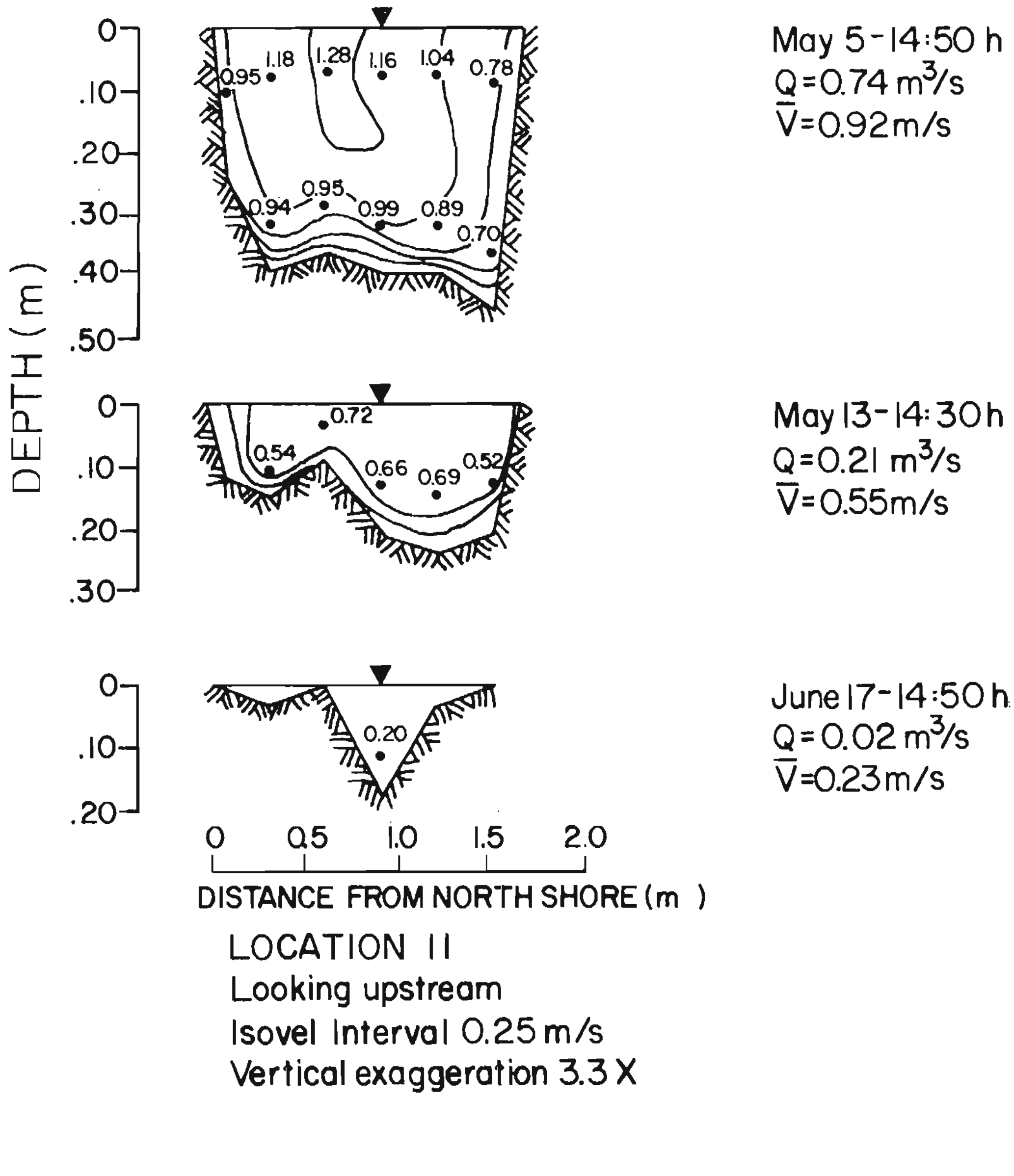
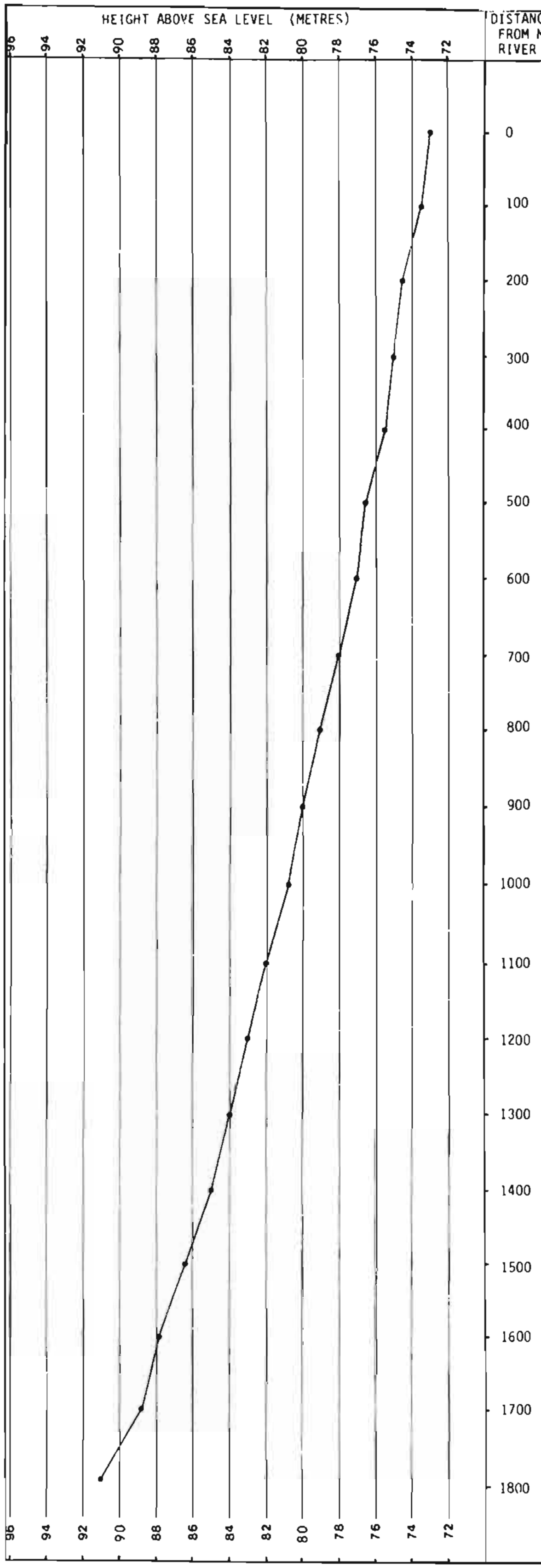


Fig. 16. Stream velocity cross-section profiles for Location 11, Creek Mile 426.5.



DISTANCE UPSTREAM FROM MACKENZIE RIVER (METRES)	DESCRIPTION OF SUBSTRATE, BANKS ETC.
0-330	Coarse gravel beds - shallow channel, slight riffle.
260	Cut bank north shore.
330-390	Cobbles - sand beds north shore. Organic slumping, cutbank, debris main channel.
390	Location 5.
390-450	Riffle over cobble substrate.
450	Oebris jam.
450-610	Wide shallow area - substrate composed of cobbles and gravel.
610-730	Cobble-gravel bed south side. Steep gravel cut bank north side.
730-743	Small boulders over gravel.
743	Location 6.
743-855	Boulder - cobble riffle.
855-925	Cobble-gravel substrate
890	B.M. Location 6.
925-1027	Gravel beds on south side. Low organic cut bank on north side.
930	Fish trap and fence.
1027-1050	Deep pool - boulders.
1050-1105	Cobble and coarse gravel bed. Gravel cut bank on south shore.
1105-1175	Gravel beds. Debris jam both sides.
1175-1205	Boulder and cobble substrate.
1205-1285	Cobble substrate.
1275	Debris jam south side.
1285-1345	Cobble substrate.
1345-1410	Small boulders present. Gravel bottom covered with layer of silt. Gravel beds on both sides. Steep gravel cut banks, north side.
1410-1502	Many large boulders in channel and on banks. Narrow straight section.
1502-1545	Gravel bottom covered with silt.
1560	B.M. Location 7.
1545-1790	Substrate composed of gravel and cobbles with occasional boulders. Banks are strewn with boulders with occasional pockets of fine sand and gravel. Many springs seeping out of both banks.
1790	B.M. Location 8.

Fig. 17. Stream bed profile for Smith Creek.

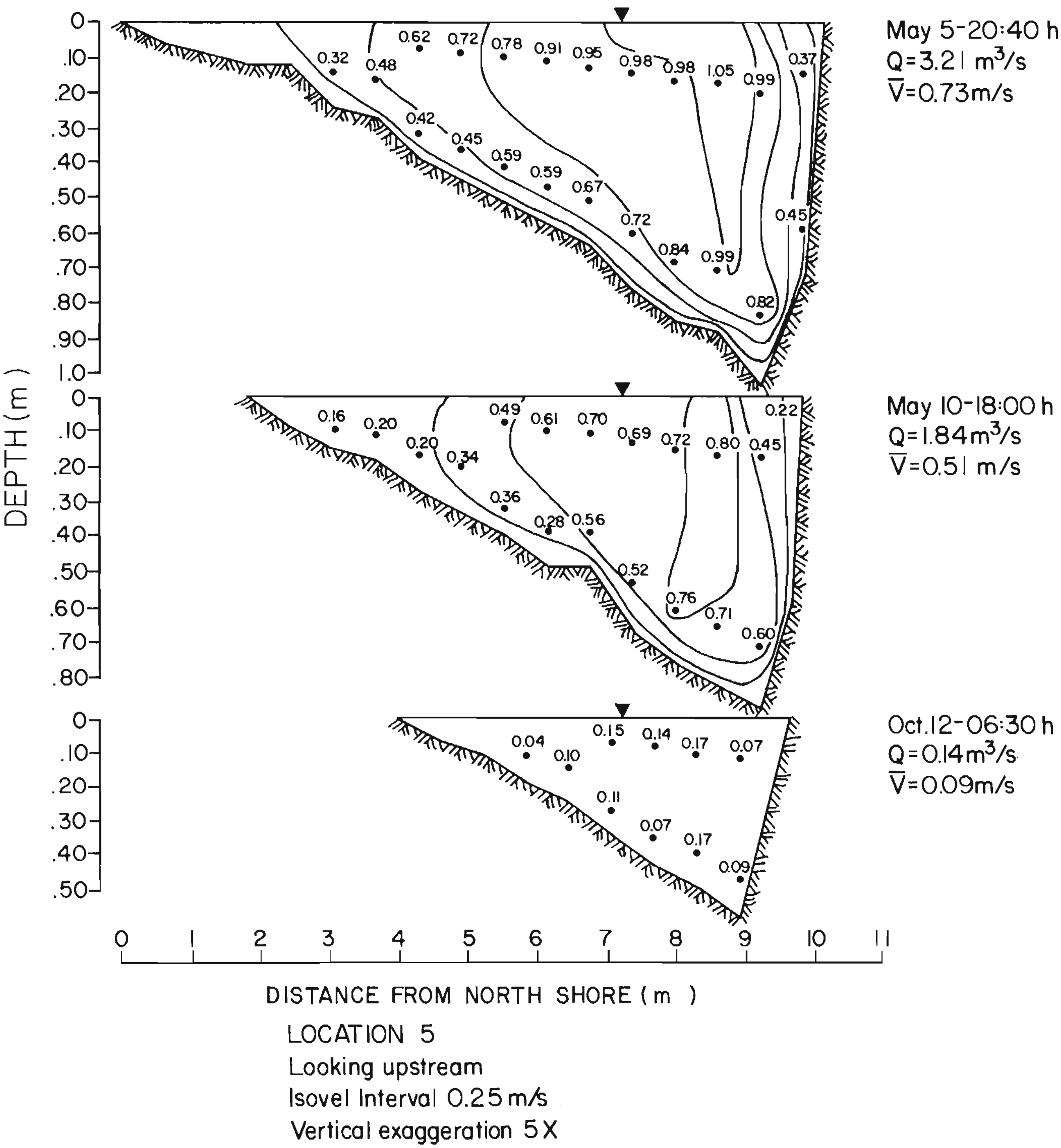


Fig. 18. Stream velocity cross-section profiles for Location 5, Smith Creek.

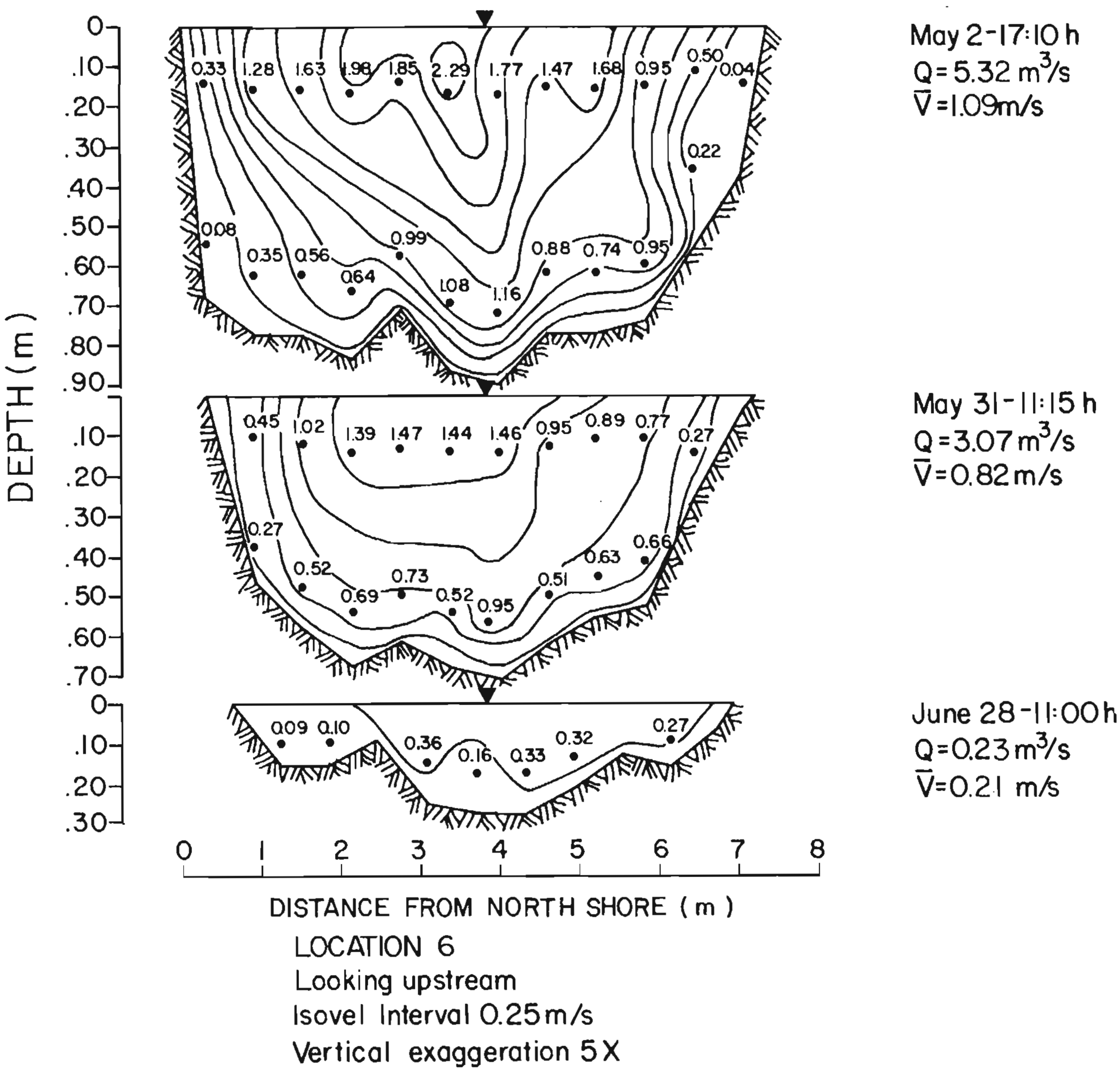


Fig. 19. Stream velocity cross-section profiles for Location 6, Smith Creek.

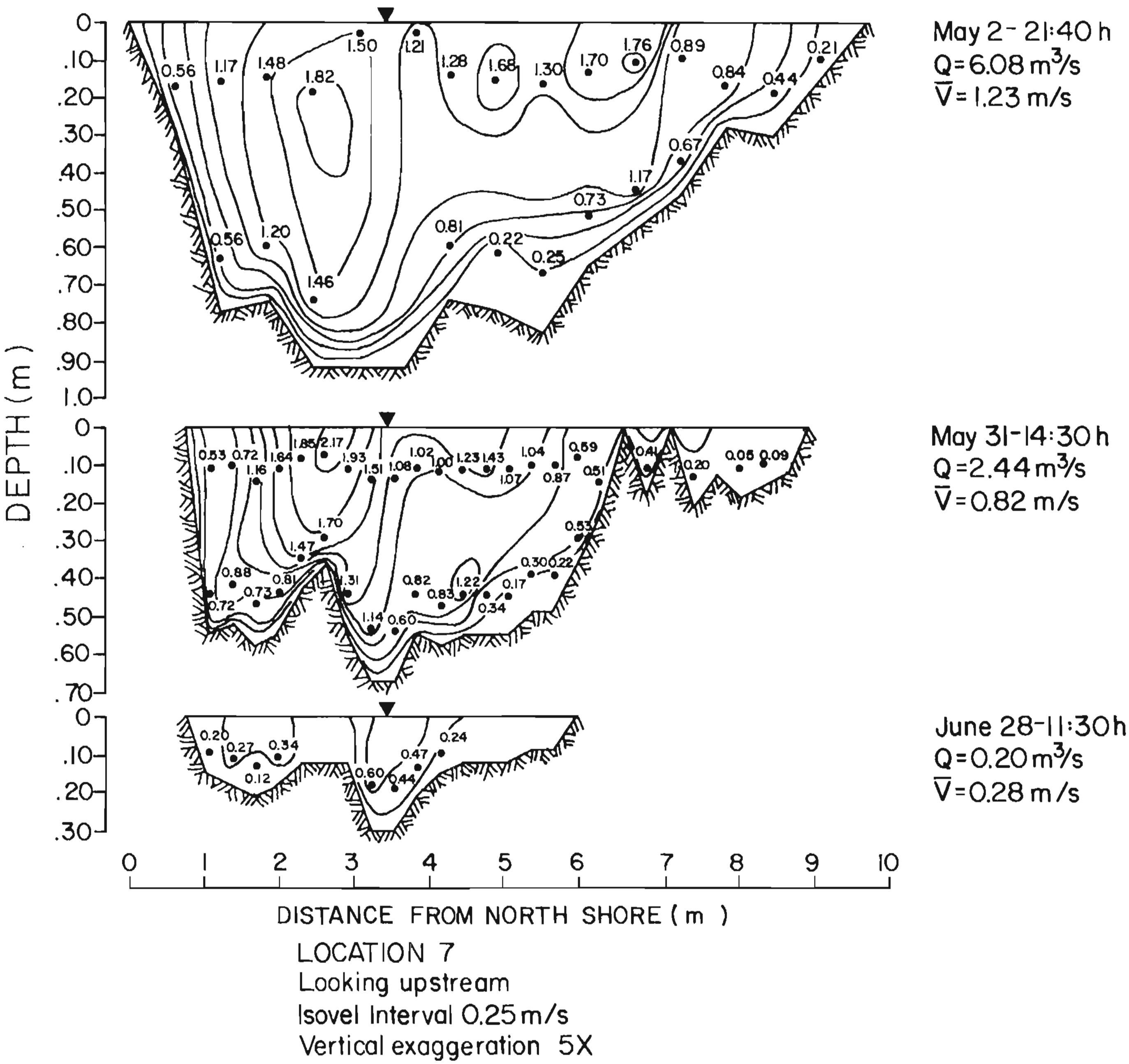


Fig. 20. Stream velocity cross-section profiles for Location 7, Smith Creek.

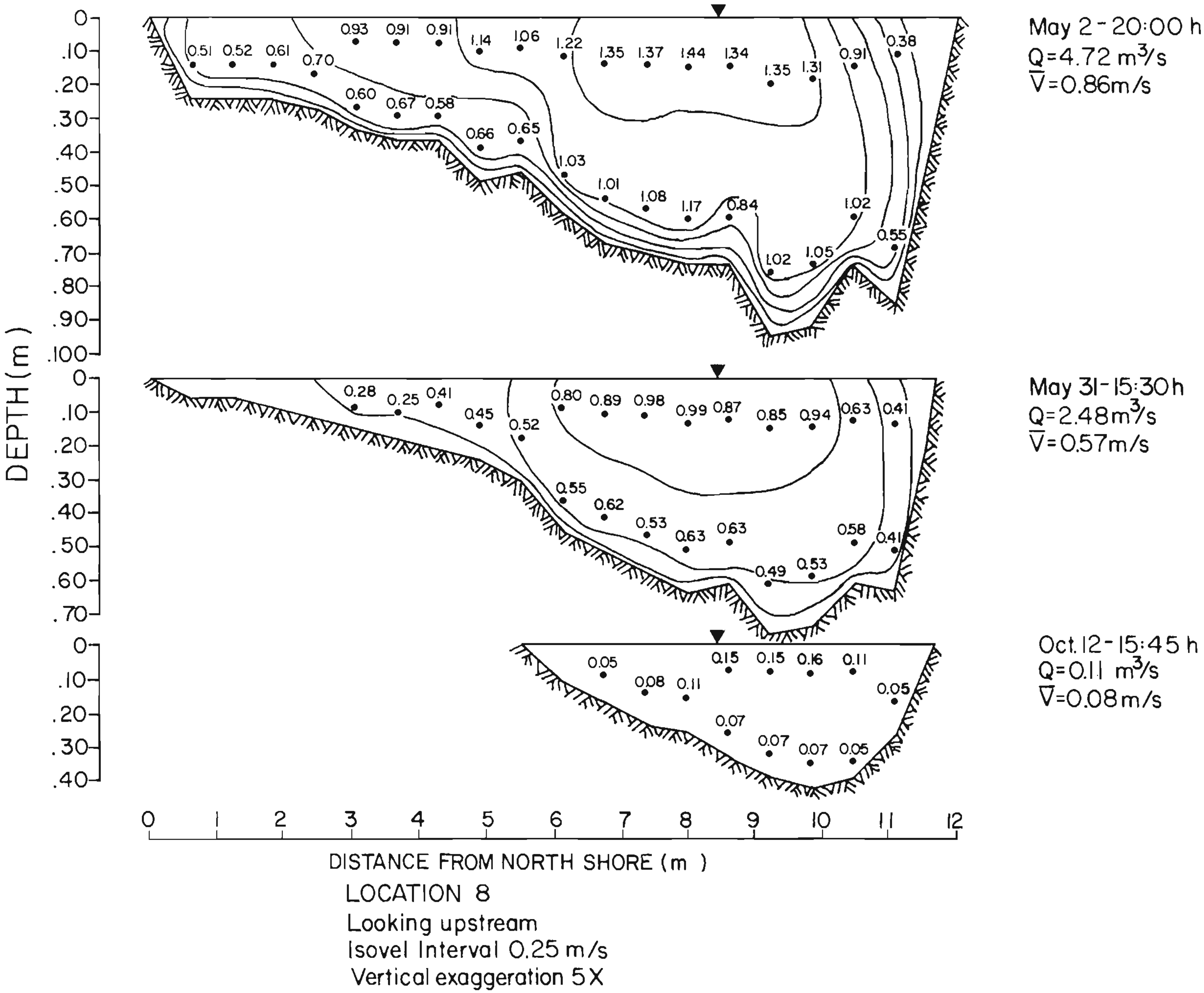


Fig. 21. Daily water temperature fluctuations for Creek Mile 422.7, Creek Mile 426.5 and Smith Creek, 1976.

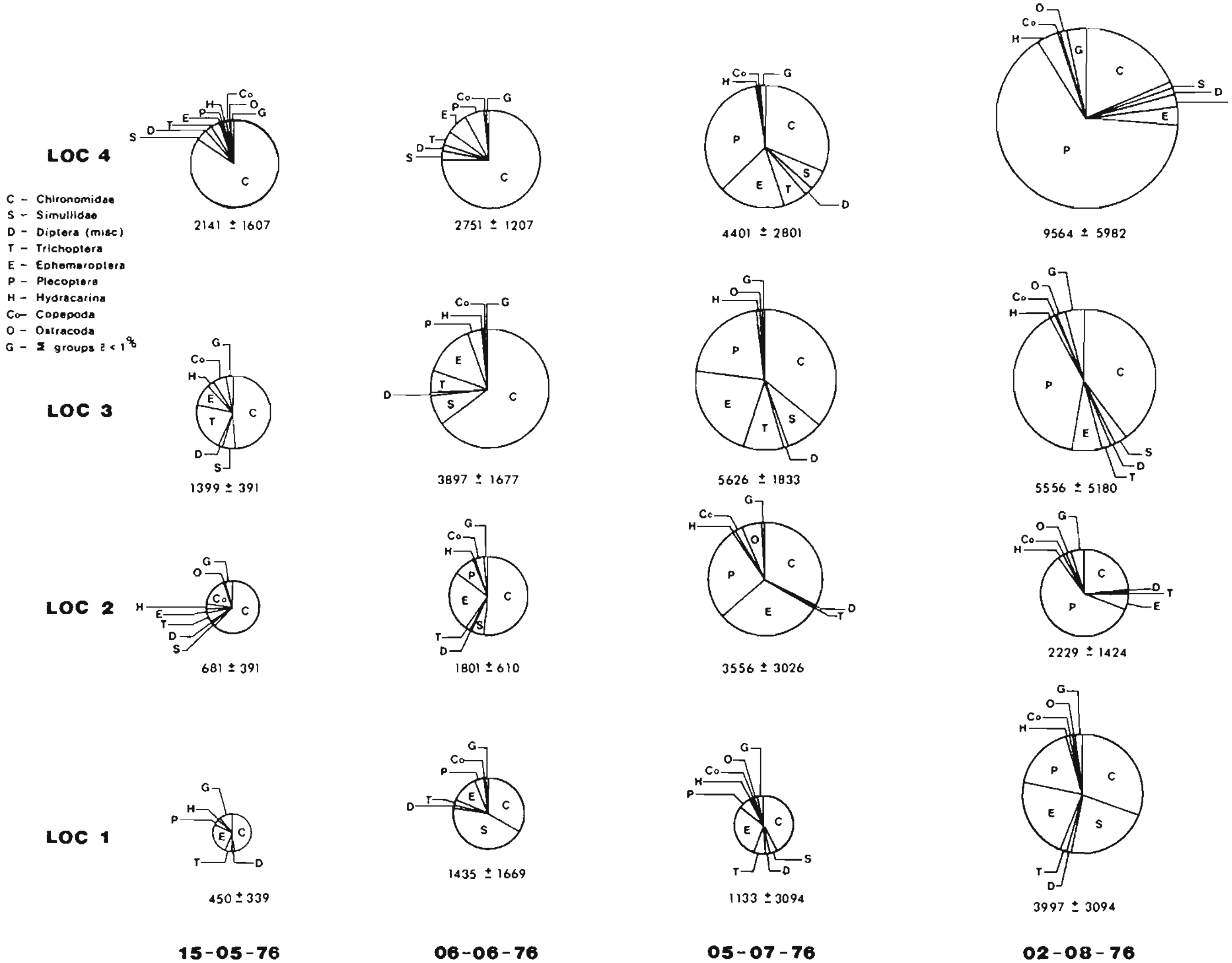


Fig. 22. Standing crops (number m^{-2}) and percent occurrence of major taxa of invertebrates in Creek Mile 422.7, 1976.

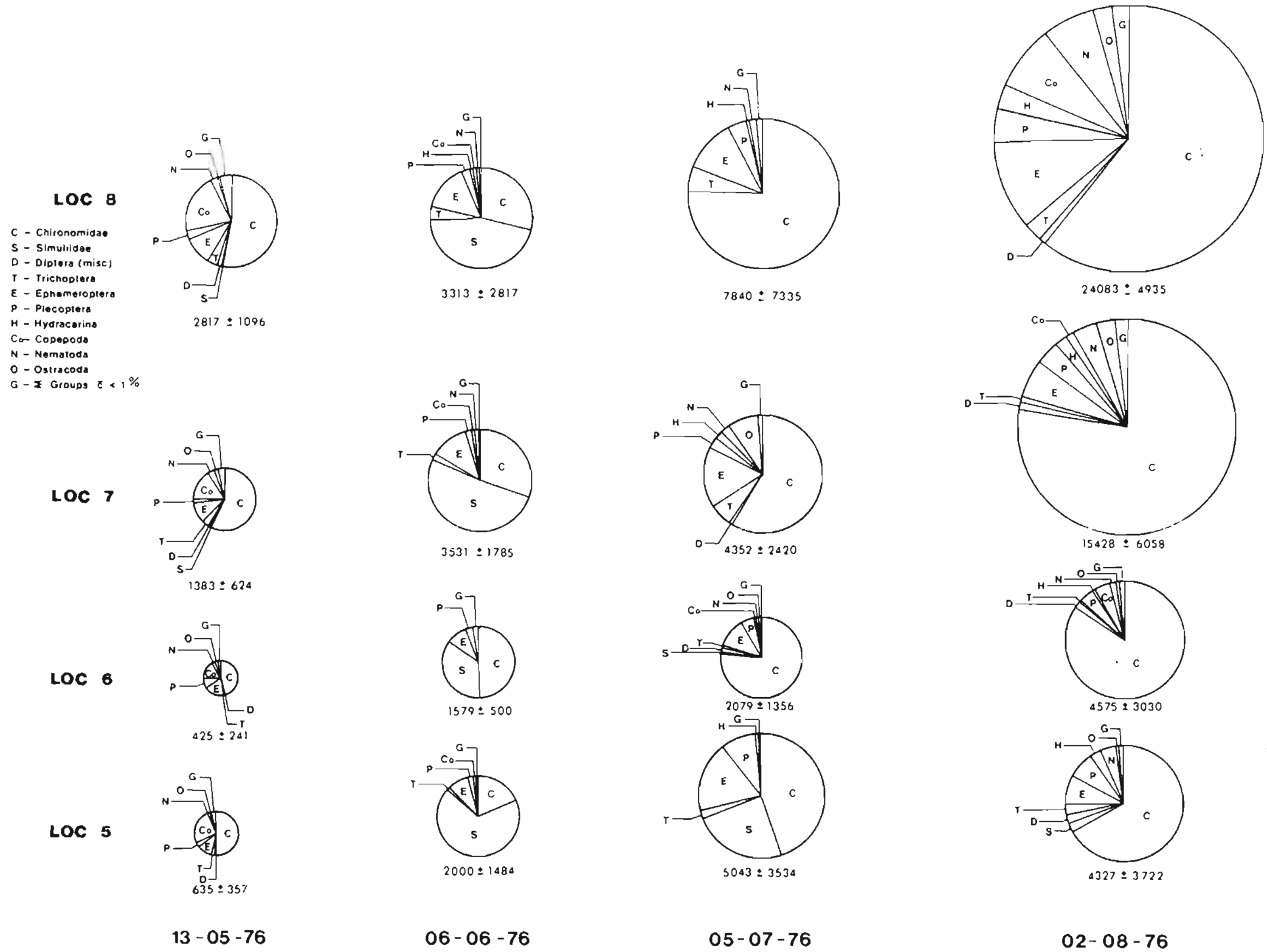


Fig. 23. Standing crops (number m^{-2}) and percent occurrence of major taxa of invertebrates in Smith Creek, 1976.

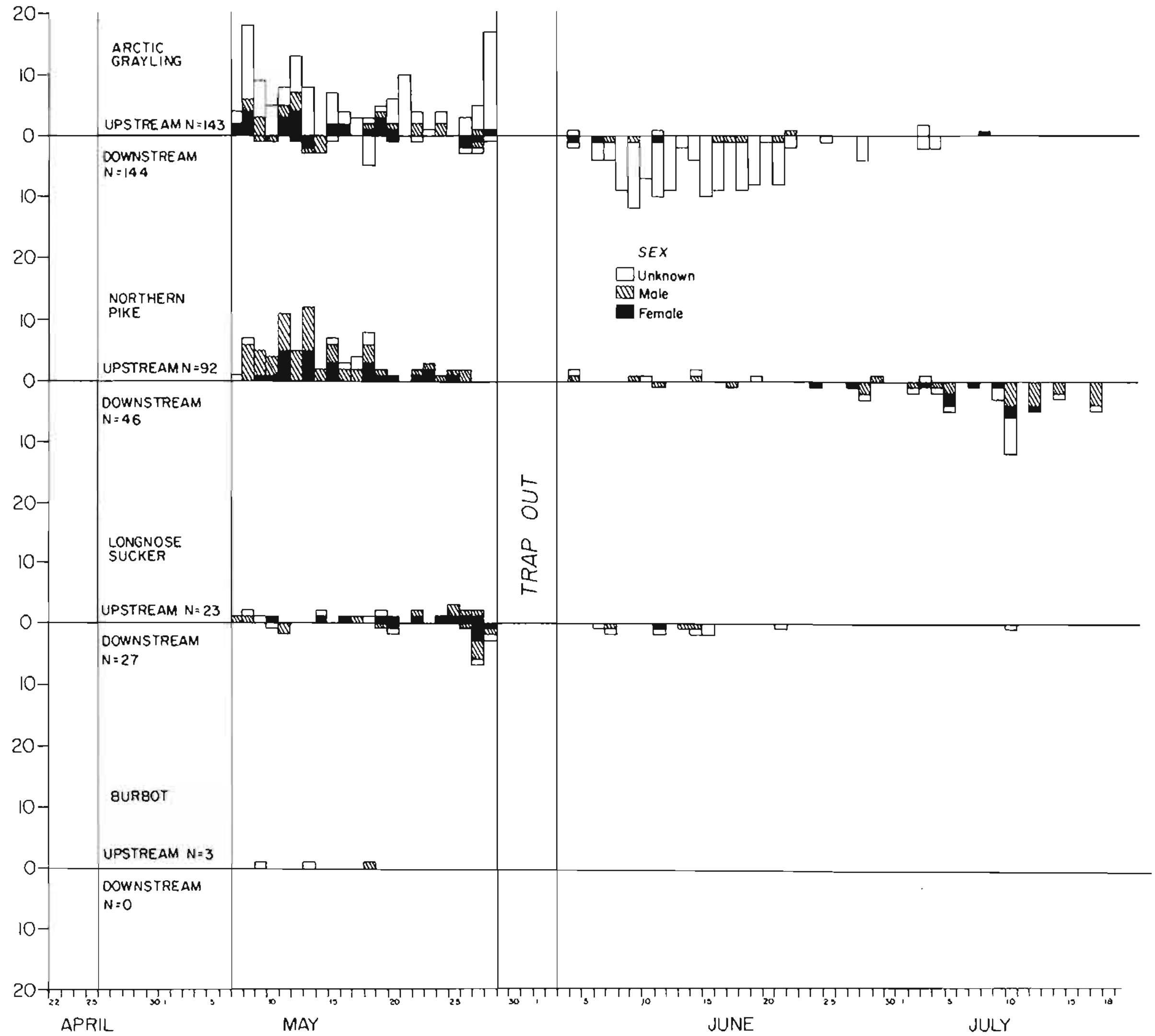


Fig. 24. Summary of fish movement past the counting fence on Smith Creek, 1976.

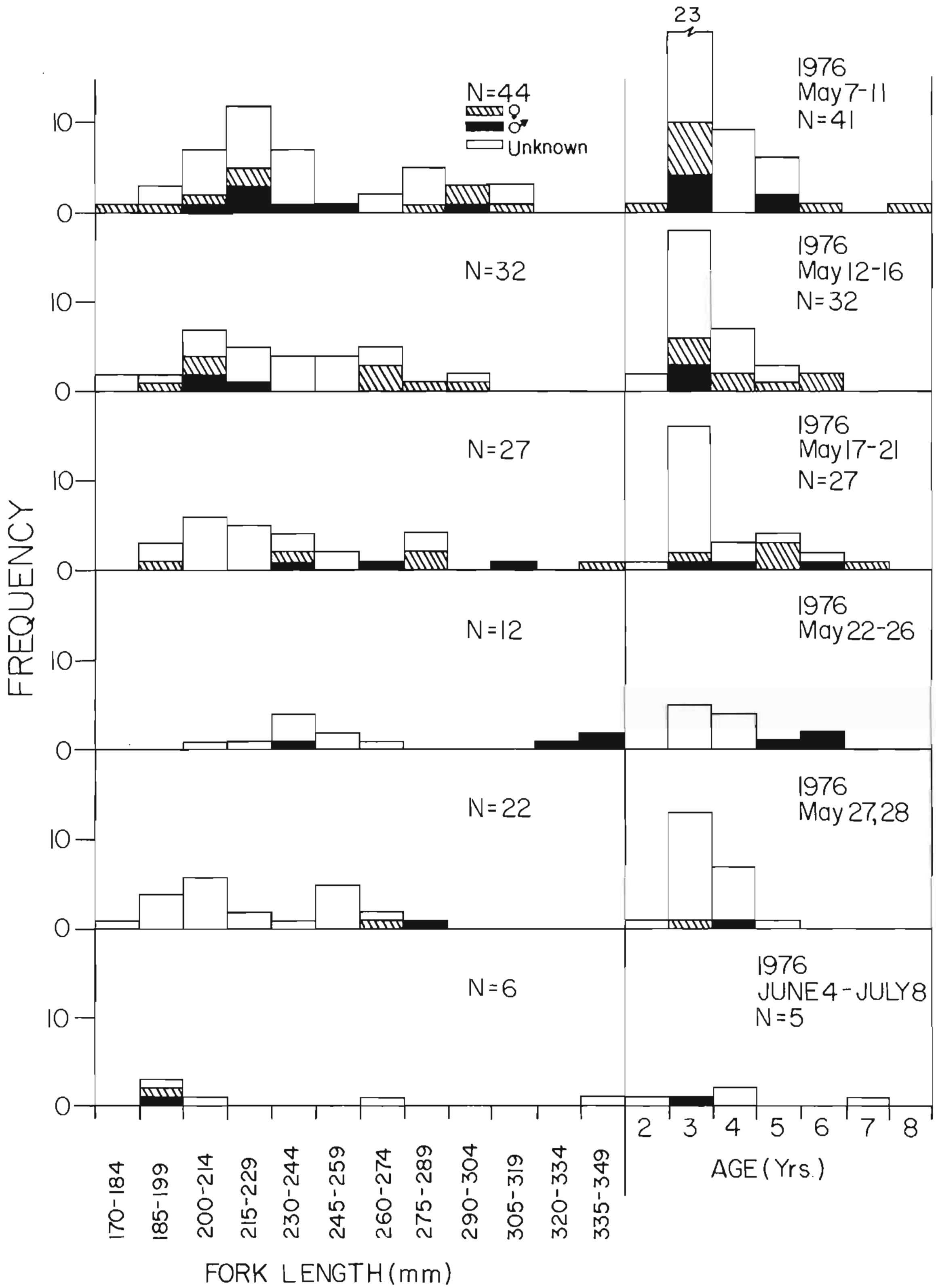


Fig. 25. Temporal length and age frequency summary for upstream migrating Arctic grayling from Smith Creek, 1976.

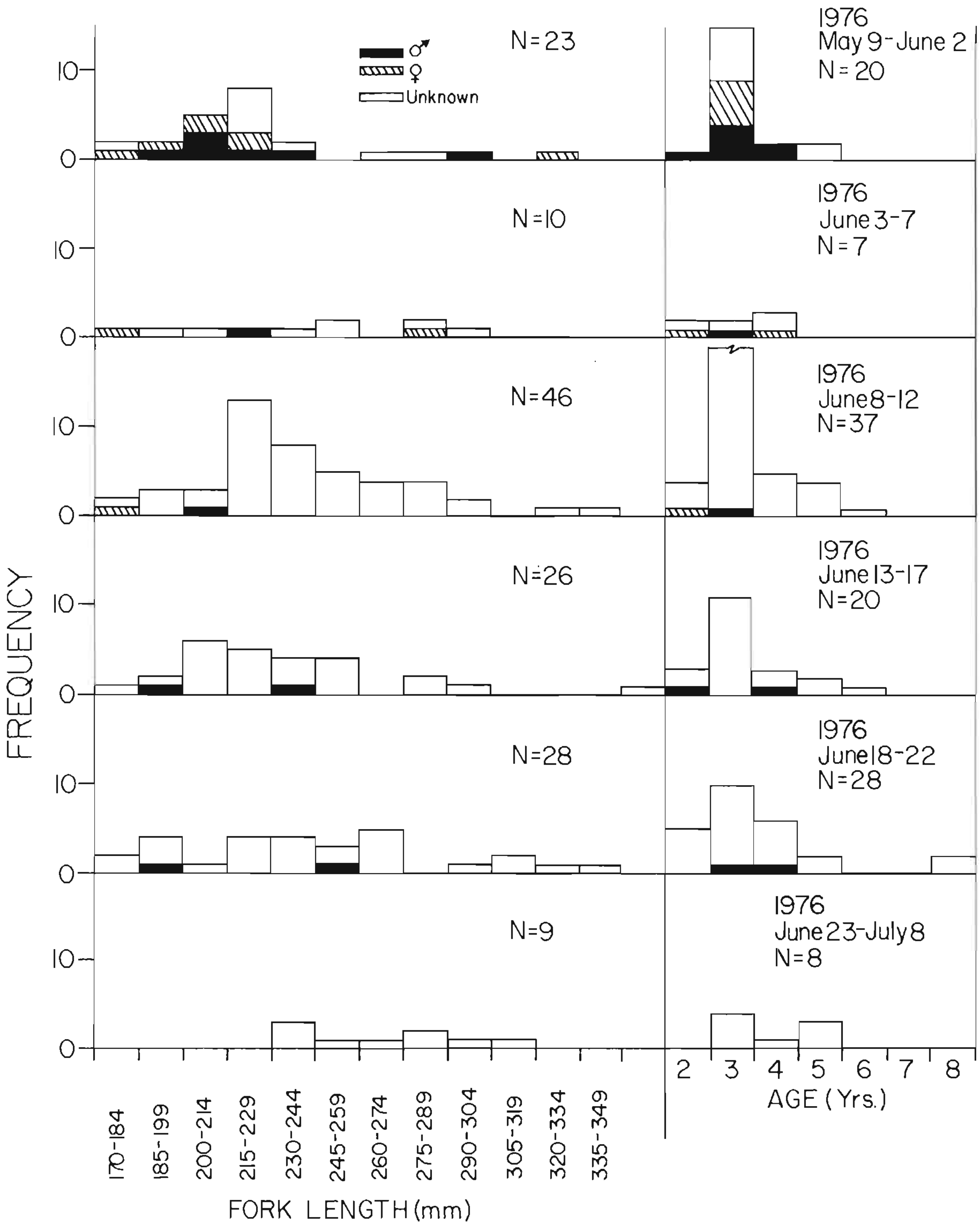


Fig. 26. Temporal length and age frequency summary for downstream migrating Arctic grayling from Smith Creek, 1976.

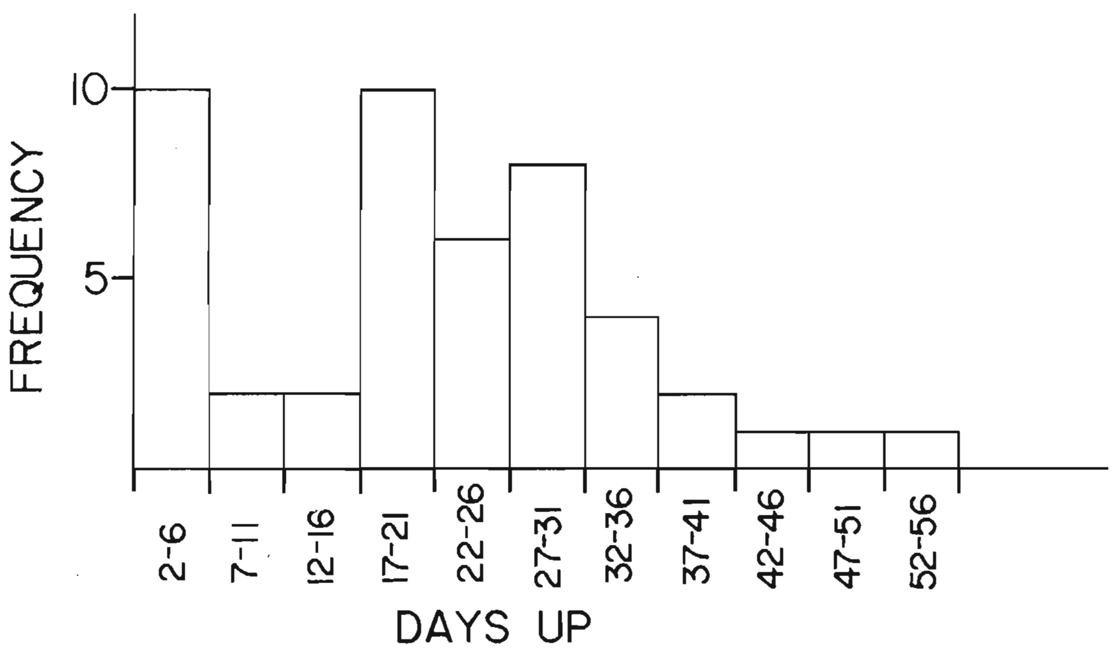


Fig. 27. Summary of time spent above counting fence for Arctic grayling tagged in upstream trap and subsequently recaptured in the downstream trap (one day recaptures not included).

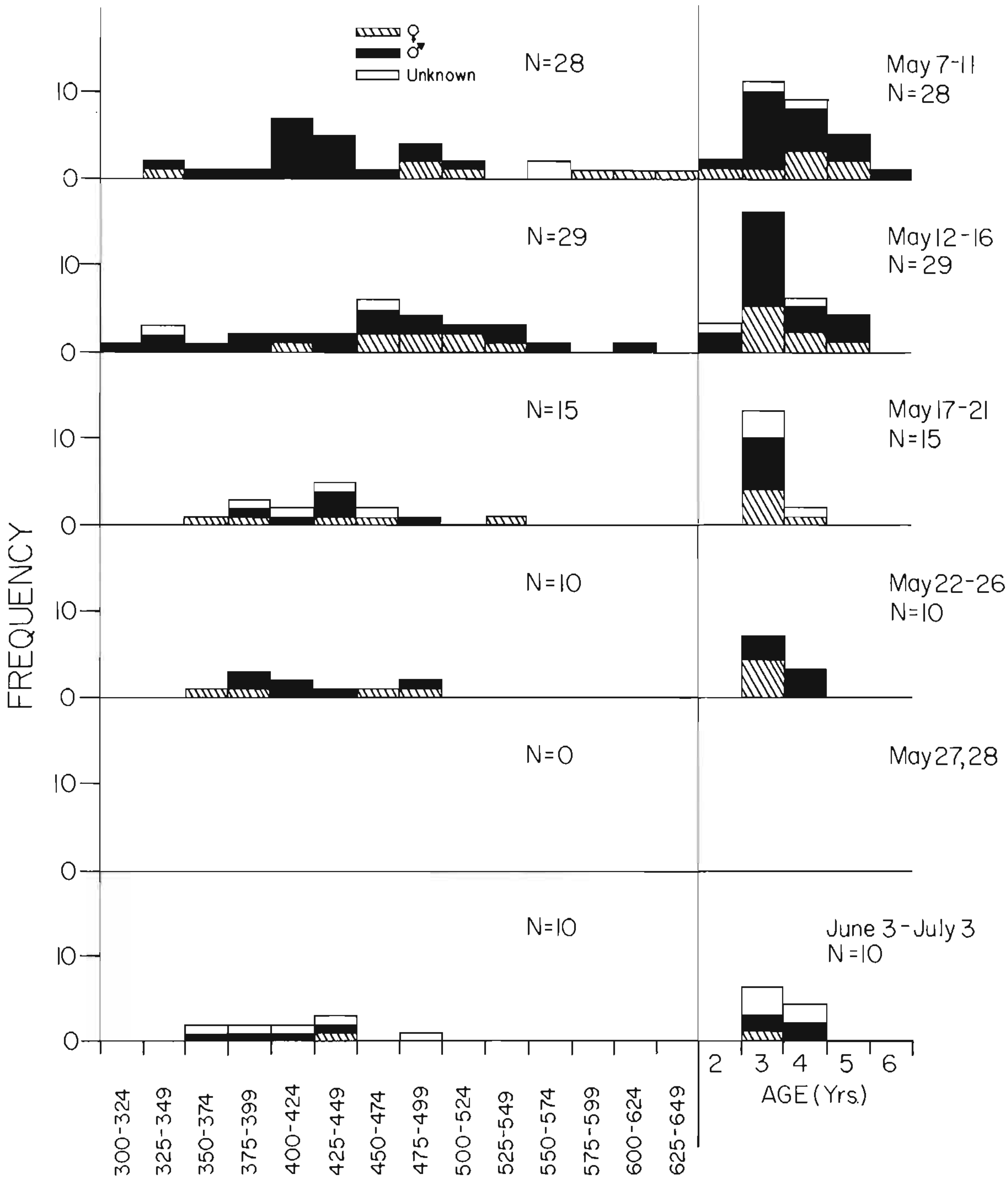


Fig. 28. Temporal length and age frequency summary for upstream migrating northern pike from Smith Creek, 1976.

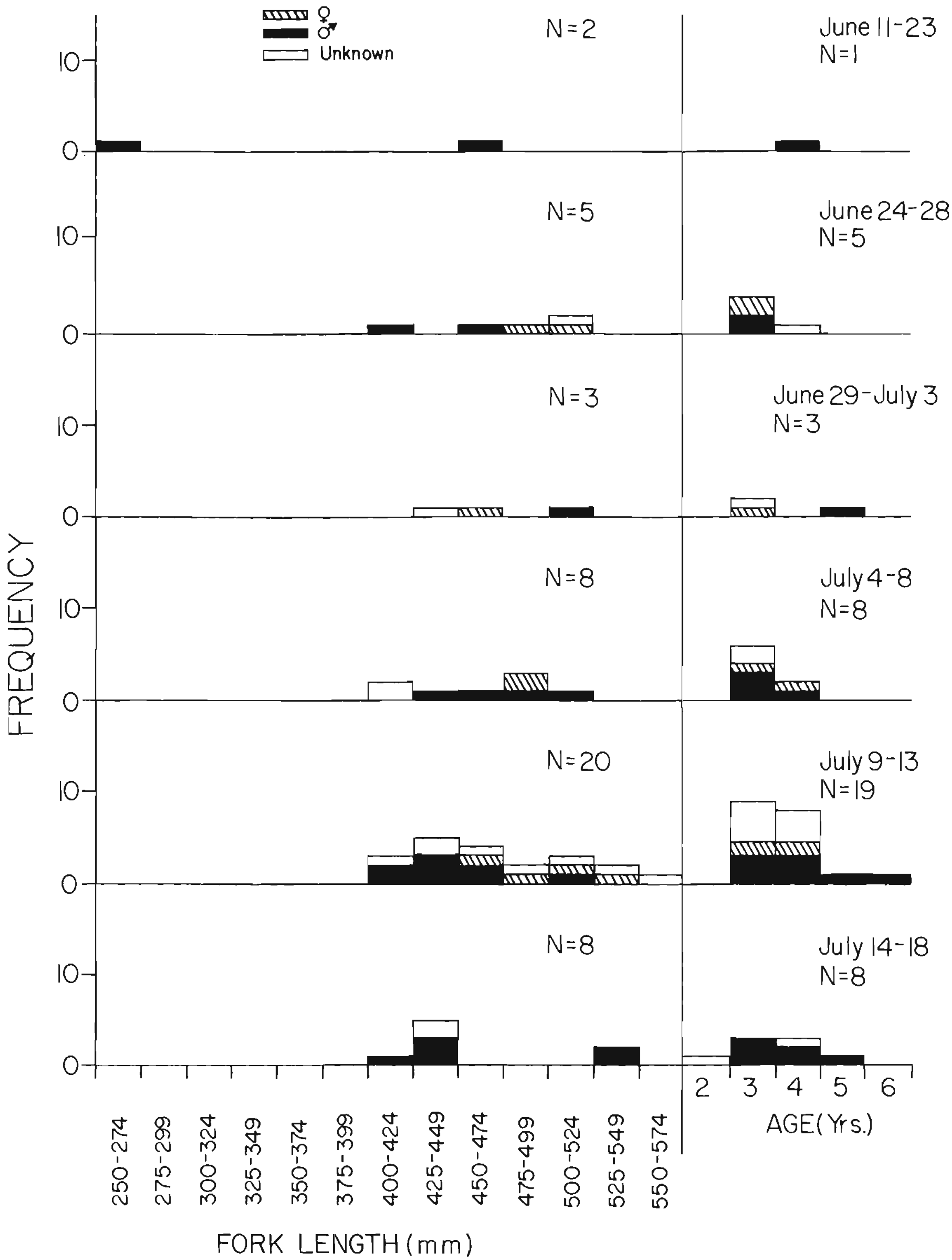


Fig. 29. Temporal length and age frequency summary for downstream migrating northern pike from Smith Creek, 1976.

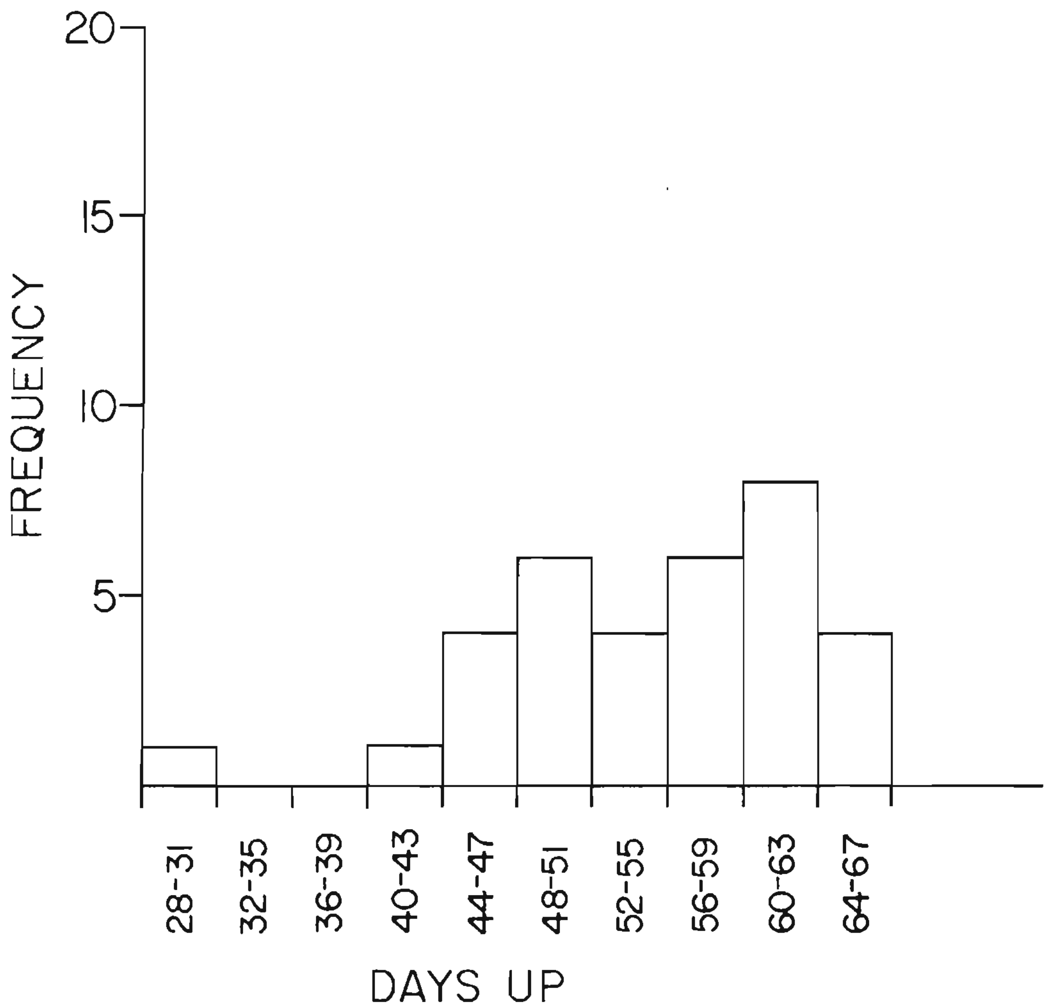


Fig. 30. Summary of time spent above counting fence for northern pike tagged in upstream trap and subsequently recaptured in the downstream trap (one day recaptures not included).

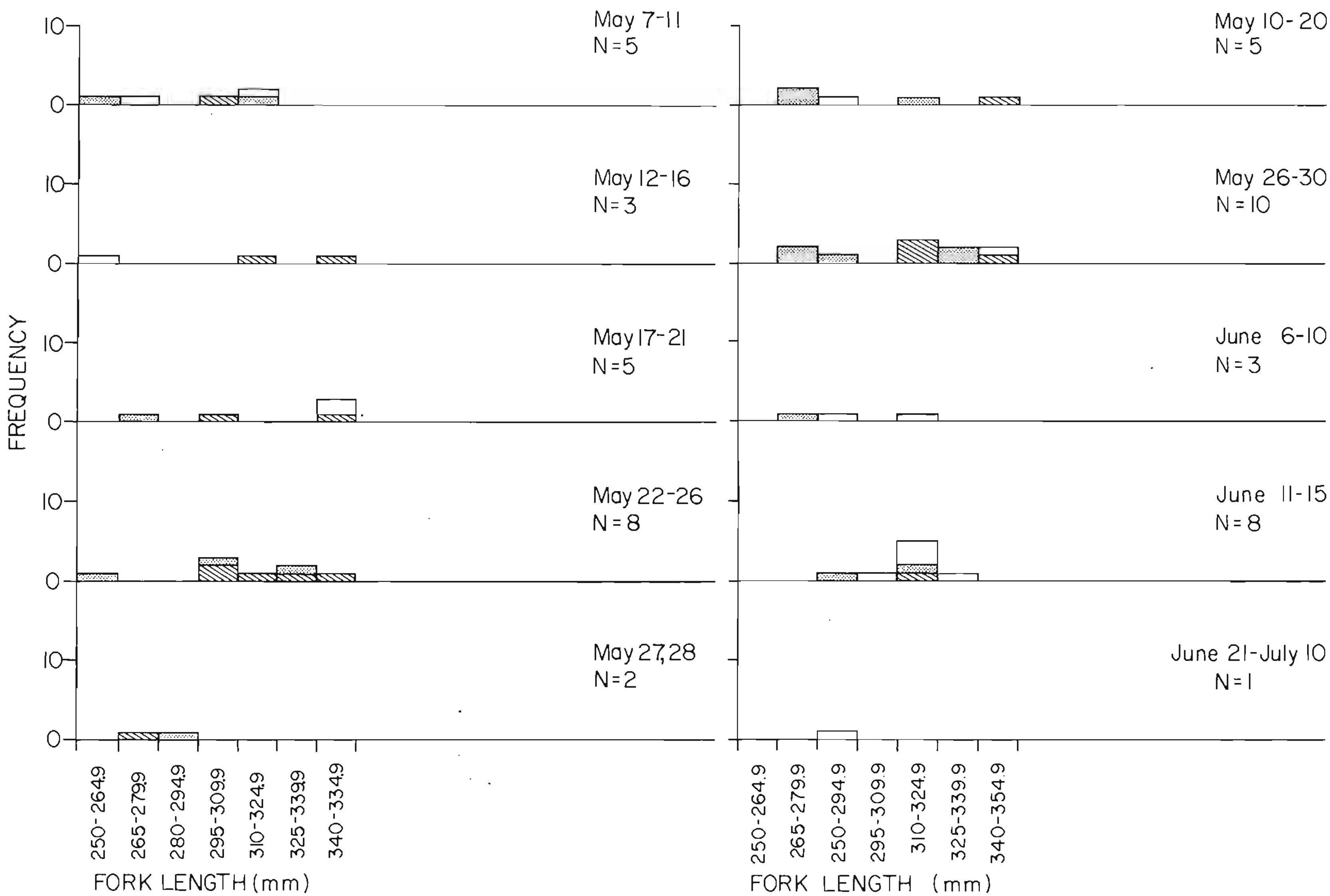


Fig. 31. Temporal length frequency summary for upstream and downstream migrating longnose sucker from Smith Creek, 1976.

Table 1. Field Water Chemistry Data for Creek Mile 422.7, 1976.

Analysis	Location	April 28	May 12	May 31	June 9	June 23	July 6	July 20	Aug. 3	Aug. 18	Aug. 31	Sept. 15	Sept. 28	Oct. 14
		Date												
pH	1	7.5	8.0	8.0	8.5	8.5	7.8*	8.5	8.5	8.5	8.5	NA	NA	NA
	2	7.5	7.5	8.0	8.0	8.0	7.4*	8.5	8.5	8.5	8.5	NA	NA	NA
	3	7.5	7.5	8.0	8.0	8.5	7.4*	8 5	8.0	8.5	8.5	NA	NA	NA
	4	7.5	7.5	8.0	8.0	8.5	7.7*	8.5	8.0	8.0	8.5	NA	NA	NA
O_2 (mg/L)	1	14.0	11.0	10.7	9.7	9.3	9.2	9.4	8.5	10.6	11.1	11.1	10.9	13.6
	2	12.0	10.8	10.8	9.6	10.0	9.5	9.8	9.4	10.4	11.2	10.8	11.2	13.4
	3	12.0	10.5	10.5	9.4	10.0	9.5	10.0	9.4	10.5	11.2	11.0	11.2	12.8
	4	12.0	10.2	10.4	9.5	10.2	9.7	9.9	9.6	10.4	11.1	10.8	11.1	12.8
Conductivity (µmho/cm)	1	50	119	150	200	250	269	330	320	280	265	300	260	200
	2	51	115	149	198	280	269	275	295	256	265	213	248	210
	3	51	115	149	198	240	260	262	290	269	262	235	248	210
	4	51	115	143	197	250	260	260	285	251	262	238	250	210
Temperature (°C)	1	1.0	4.0	8.9	10.3	15.0	15.0	14.5	15.0	10.2	9.1	6.5	8.0	0.0
	2	1.0	3.2	7.3	9.5	11.5	12.5	12.0	12.0	9.2	8.0	5.0	6.5	0.0
	3	1.0	3.5	7.3	9.5	10.5	11.8	10.5	11.0	8.9	7.9	5.0	6.5	0.0
	4	0.5	4.0	7.3	10.2	11.5	11.5	10.1	10.5	8.9	7.9	5.0	6.8	0.0

NA - no analysis.

* pH determination by Fisher Accumet 150 pH meter.

Table 2. Summary of Analysis of Variance and Comparison of Location Means For Water Chemistry Analyses, Creek Mile 422.7, 1976.

	Analysis of Variance Effect of Location		Comparison of Location Means Locations Compared					
			Location 1 to 2		Location 3 to 4		Locations 1 & 2 to 3 & 4	
Parameter	F Value (df)	Significant Effect	t Value (df)	Significant Difference	t Value (df)	Significant Difference	t Value (df)	Significant Difference
Suspended N	0.42 (3,27)	No	0.55 (27)	No	0.89 (27)	No	0.40 (27)	No
Total Dissolved N	0.11 (3,30)	No	0.21 (30)	No	0.52 (30)	No	0.07 (30)	No
Suspended P	2.01 (3,30)	No	1.64 (30)	No	0.57 (30)	No	2.05 (30)	Yes
Total Dissolved P	2.23 (3,30)	No	1.03 (30)	No	0.52 (30)	No	2.31 (30)	Yes
Suspended C	0.96 (3,27)	No	0.16 (27)	No	0.97 (27)	No	1.38 (27)	No
Si	0.93 (3,30)	No	0.69 (30)	No	0.94 (30)	No	1.13 (30)	No
Cl	2.41 (3,30)	No	2.51 (30)	Yes	0.63 (30)	No	0.74 (30)	No
SO_4	11.87 (3,30)	Yes	4.43 (30)	Yes	0.00 (30)	No	3.99 (30)	Yes
Total Suspended Solids	1.90 (3,30)	No	1.34 (30)	No	0.62 (30)	No	1.87 (30)	No
Total Dissolved Solids	1.25 (3,30)	No	1.37 (30)	No	0.24 (30)	No	1.35 (30)	No
Na	10.73 (3,30)	Yes	3.90 (30)	Yes	0.77 (30)	No	4.04 (30)	Yes
K	13.89 (3,30)	Yes	4.18 (30)	Yes	1.91 (30)	No	4.54 (30)	Yes
Ca	0.51 (3,30)	No	0.99 (30)	No	0.73 (30)	No	0.02 (30)	No
Mg	0.84 (3,30)	No	1.51 (30)	No	0.29 (30)	No	0.38 (30)	No

Table 3. Field Water Chemistry Data for Creek Mile 426.5, 1976.

		Date												
Analysis	Location	April 28	May 12	May 31	June 9	June 23	July 6	July 20	Aug. 3	Aug. 18	Aug. 31	Sept. 15	Sept. 28	Oct. 14
pH	9	7.5	8.0	8.0	8.5	8.5	NA	8.5	8.5	8.5	8.5	NA	NA	NA
	10	7.5	7.5	7.5	8.0	8.0	7.2*	8.0	8.0	8.0	8.0	NA	NA	NA
	11	7.5	7.5	7.5	8.0	8.0	7.2*	8.0	8.0	8.0	8.0	NA	NA	NA
O_2 (mg/L)	9	11.0	13.0	11.0	10.5	10.3	11.1	11.7	10.8	11.3	12.3	11.4	10.8	13.6
	10	13.0	11.2	9.7	8.3	8.4	9.1	9.2	8.4	9.8	10.2	9.7	9.7	NA
	11	12.0	11.2	9.4	8.2	8.3	9.1	9.5	8.2	9.7	10.1	9.4	9.4	NA
Conductivity (μmho/cm)	9	90	180	220	253	350	452	460	490	500	470	460	520	420
	10	70	92	130	153	180	190	210	225	230	225	200	220	NA
	11	70	92	130	153	180	188	195	225	192	215	200	215	NA
Temperature (°C)	9	0.5	5.0	9.3	9.0	10.8	7.5	7.0	7.0	7.5	5.5	5.0	6.0	1.0
	10	1.5	7.0	12.3	14.7	15.0	11.5	10.5	12.5	9.5	8.0	5.2	6.8	NA
	11	1.5	7.5	12.8	15.0	15.5	11.5	10.1	11.5	9.2	7.8	5.0	6.5	NA

NA - no analysis.

* pH determination by Fisher Accumet 150 pH meter.

Table 4. Summary of Analysis of Variance and Comparison of Location Means for Water Chemistry Analyses, Creek Mile 426.5, 1976.

Parameter	Analysis of Variance Effect of Location: F Value (df)	Analysis of Variance Effect of Location: Significant Effect	Location 9 to 10: t Value (df)	Location 9 to 10: Significant Difference	Locations 9 & 10 to 11: t Value (df)	Locations 9 & 10 to 11: Significant Difference
Suspended N	1.28 (2, 16)	No	1.60 (16)	No	0.06 (16)	No
Total Dissolved N	13.55 (2, 18)	Yes	4.52 (18)	Yes	2.58 (18)	Yes
Suspended P	2.85 (2, 18)	No	2.05 (18)	No	1.22 (18)	No
Total Dissolved P	0.61 (2, 18)	No	0.91 (18)	No	0.62 (18)	No
Suspended C	2.44 (2, 18)	No	1.91 (18)	No	1.11 (18)	No
Si	40.18 (2, 18)	Yes	7.71 (18)	Yes	4.57 (18)	Yes
Cl	22.08 (2, 18)	Yes	5.74 (18)	Yes	3.35 (18)	Yes
SO_4	25.30 (2, 18)	Yes	6.13 (18)	Yes	3.61 (18)	Yes
Total Suspended Solids	3.11 (2, 18)	No	2.14 (18)	Yes	1.28 (18)	No
Total Dissolved Solids	34.80 (2, 18)	Yes	6.88 (18)	Yes	4.72 (18)	Yes
Na	25.20 (2, 18)	Yes	6.12 (18)	Yes	3.59 (18)	Yes
K	38.69 (2, 18)	Yes	7.58 (18)	Yes	4.45 (18)	Yes
Ca	31.14 (2, 18)	Yes	6.82 (18)	Yes	3.98 (18)	Yes
Mg	33.94 (2, 18)	Yes	7.01 (18)	Yes	4.34 (18)	Yes

Table 5. Field Water Chemistry Data for Smith Creek, 1976.

Analysis	Location	Date												
		April 28	May 12	May 31	June 9	June 23	July 7	July 21	Aug. 3	Aug. 18	Aug. 31	Sept. 15	Sept. 28	Oct. 10
pH	5	7.5	8.0	8.0	8.5	8.5	7.5	8.5	8.5	8.5	8.0	NA	NA	NA
	6	7.5	8.0	8.0	8.5	8.5	7.5	8.5	8.0	8.5	8.5	NA	NA	NA
	7	7.5	8.0	8.0	8.0	8.5	7.7	8.0	8.0	8.5	8.5	NA	NA	NA
	8	7.5	8.0	8.0	8.0	8.0	7.5	8.0	8.0	8.5	8.5	NA	NA	NA
O_2 (mg/L)	5	13.0	13.0	11.5	9.6	9.4	9.5	10.2	8.6	10.4	10.7	10.4	10.7	13.3
	6	14.0	13.2	11.0	9.6	9.6	9.4	10.2	8.0	10.4	10.6	10.4	10.6	12.9
	7	14.0	12.9	11.9	9.5	8.4	9.3	11.1	8.2	10.0	10.2	10.2	10.4	12.4
	8	13.0	12.8	11.3	9.7	8.6	9.1	9.4	7.6	9.2	10.0	10.0	10.2	12.7
	*Spring	NA	NA	NA	NA	8.3	NA	NA	NA	NA	NA	NA	NA	NA
Conductivity (μmho/cm)	5	71	180	178	325	580	680	850	1100	870	900	950	690	780
	6	71	180	180	325	550	680	850	1100	840	900	920	980	750
	7	61	170	175	310	550	650	810	1100	810	870	890	900	700
	8	61	145	165	263	500	590	710	860	690	640	720	760	610
	*Spring	NA	NA	NA	NA	800	3420	3200	NA	3610	3150	3320	3300	2375
Temperature (°C)	5	1.0	4.5	8.0	10.3	14.5	13.0	12.5	16.0	13.4	11.7	10.5	10.5	2.0
	6	1.0	4.2	8.5	10.5	14.0	12.8	11.5	16.0	13.0	11.9	10.4	10.5	2.0
	7	1.0	4.0	8.5	10.5	16.5	13.0	9.9	15.5	12.8	11.5	9.5	10.0	2.0
	8	1.0	4.0	8.0	10.6	16.5	13.0	11.5	15.0	12.5	11.2	9.0	9.0	2.0
	*Spring	NA	NA	NA	NA	16.5	NA	NA	NA	14.0	15.0	15.0	14.5	7.5

*Spring - Groundwater inflow between Loc. 7 and Loc. 8.

NA - no analysis.

**pH determination by Fisher Accumet pH meter.

Table 6. Summary of Analysis of Variance and Comparison of Location Means For Water Chemistry Analyses, Smith Creek, 1976.

	Analysis of Variance Effect of Location		Comparison of Location Means Locations Compared					
			Location 5 to 6		Location 7 to 8		Locations 5 & 6 to 7 & 8	
Parameter	F Value (df)	Significant Effect	t Value (df)	Significant Difference	t Value (df)	Significant Difference	t Value (df)	Significant Difference
Suspended N	3.41 (3,30)	Yes	0.23 (30)	No	1.24 (30)	No	2.94 (30)	Yes
Total Dissolved N	0.45 (3,30)	No	0.25 (30)	No	0.55 (30)	No	0.99 (30)	No
Suspended P	3.14 (3,30)	Yes	0.62 (30)	No	1.13 (30)	No	2.96 (30)	Yes
Total Dissolved P	0.62 (3,30)	No	0.82 (30)	No	0.41 (30)	No	1.01 (30)	No
Suspended C	2.11 (3,30)	No	0.11 (30)	No	0.98 (30)	No	2.31 (30)	Yes
Si	33.08 (3,27)	Yes	0.95 (27)	No	7.34 (27)	Yes	6.71 (27)	Yes
Cl	25.89 (3,30)	Yes	0.20 (30)	No	5.46 (30)	Yes	6.92 (30)	Yes
SO_4	19.76 (3,30)	Yes	1.11 (30)	No	4.88 (30)	Yes	5.85 (30)	Yes
Total Suspended Solids	2.79 (3,27)	No	0.08 (27)	No	0.92 (27)	No	2.74 (27)	Yes
Total Dissolved Solids	22.49 (3,27)	Yes	0.51 (27)	No	5.33 (27)	Yes	6.27 (27)	Yes
Na	26.07 (3,30)	Yes	0.22 (30)	No	5.26 (30)	Yes	7.10 (30)	Yes
K	19.05 (3,30)	Yes	0.38 (30)	No	3.76 (30)	Yes	6.53 (30)	Yes
Ca	5.89 (3,30)	Yes	0.10 (30)	No	3.07 (30)	Yes	2.87 (30)	Yes
Mg	11.29 (3,30)	Yes	0.48 (30)	No	4.37 (30)	Yes	3.81 (30)	Yes

Table 7. Summary of Analysis of Variance and Comparison of Location Means for Benthic Invertebrates, Creek Mile 422.7 1976.

Benthic Group		Analysis of Variance Source of Variation (df) Location (3.80)	Date (3,80)	Interaction (9,80)		Comparison of Location Means Locations Compared (df) Location 1-2(80)	Location 3-4(80)	Location 1&2 and 3&4(80)
Chironomidae	F. Value	8.29	1.99	0.99	t Value	0.49	0.36	4.95
	Sig. Effect?	Yes	No	No	Sig. Difference?	No	No	Yes
Copepoda	F. Value	10.30	3.88	2.25	t Value	5.08	0.77	2.08
	Sig. Effect?	Yes	Yes	Yes	Sig. Difference?	Yes	No	No
Simuliidae	F. Value	1.65	0.87	0.98	t Value	2.07	0.81	0.12
	Sig. Effect?	No	No	No	Sig. Difference?	Yes	No	No
Other Diptera	F. Value	7.64	1.93	0.29	t Value	1.12	2.98	3.76
	Sig. Effect?	Yes	No	No	Sig. Difference?	No	Yes	Yes
Ephemeroptera	F. Value	1.19	10.79	2.12	t Value	0.26	1.79	0.54
	Sig. Effect?	No	Yes	Yes	Sig. Difference?	No	No	No
Acarina	F. Value	2.46	5.17	2.61	t Value	0.24	1.85	1.98
	Sig. Effect?	No	Yes	Yes	Sig. Difference?	No	No	No
Ostracoda	F. Value	1.08	4.27	1.83	t Value	1.78	0.29	0
	Sig. Effect?	No	Yes	No	Sig. Difference?	No	No	No
Plecoptera	F. Value	9.74	23.74	5.79	t Value	1.13	3.08	4.19
	Sig. Effect?	Yes	Yes	Yes	Sig. Difference?	No	Yes	Yes
Trichoptera	F. Value	10.26	2.35	1.32	t Value	0.51	2.32	5.01
	Sig. Effect?	Yes	No	No	Sig. Difference?	No	Yes	Yes
Other	F. Value	1.10	8.17	0.88	t Value	0.12	0.70	1.67
	Sig. Effect?	No	Yes	No	Sig. Difference?	No	No	No
Total	F. Value	8.92	13.05	2.17	t Value	0.44	0.78	5.10
	Sig. Effect?	Yes	Yes	Yes	Sig. Difference?	No	No	Yes

*Sig. Effect and Sig. Difference calculated at 95% confidence level.

Table 8 . Summary of length-weight data for slimy sculpin from Creek Mile 422.7, 1976.

Total Length Interval	N	Total Length (mm) Mean	S.D.	S.E.	Weight (g) Mean	S.D.	S.E.
0 - 9.9	7	9.3*	-	-	-	-	-
10 - 19.9	6	10.7	0.52	0.21	0.02	0.02	0.01
20 - 29.9	9	25.8	3.67	1.22	0.23	0.11	0.04
30 - 39.9	17	32.9	2.59	0.63	0.38	0.12	0.03
40 - 49.9	13	43.3	2.69	0.75	0.90	0.24	0.07
50 - 59.9	16	53.9	2.59	0.65	1.83	0.33	0.08
60 - 69.9	6	63.8	2.48	1.01	3.11	0.44	0.18
70 - 79.9	10	73.3	3.34	1.05	5.01	0.96	0.30
80 - 89.9	5	81.4	1.67	0.75	6.78	1.26	0.56
90 - 99.9	1	98.0	-	-	9.20	-	-

* Total fork length of 7 individuals measured together = 65 mm

Table 9 . Summary of length and weight by age for slimy sculpin from Creek Mile 422.7, 1976.

Otolith Age	N	Total Length (mm) Mean	S.D.	Range	Weight (g) Mean	S.D.	Range
0	6	10.7	0.52	10 - 11	0.02	0.02	.01 - .06
1	7	29.3	2.29	27 - 33	0.34	0.10	0.2 - 0.5
2	5	41.0	1.87	38 - 43	0.82	0.19	0.6 - 1.1
3	11	54.5	3.78	49 - 62	1.87	0.45	1.3 - 2.7
4	8	69.3	3.62	64 - 74	4.21	0.77	3.0 - 5.2
5	5	79.4	4.98	71 - 82	6.62	1.41	5.3 - 8.8
6	2	77.5	2.12	76 - 79	6.20	0.14	6.1 - 6.3

Table 10. Food items as percent by number, of diet in slimy sculpin from Creek Mile 422.7, 1976.

Fork Length Range (mm)	0 - 25	26 - 50	51 - 75	76 - 100
Number of stomachs analysed	3	38	28	8
Number of empty stomachs	1	7	4	1
Mean number of organisms/stomach	1.7	2.9	9.8	1.8
Food Item % of Diet				
Arachnida				
Araneida	0	0	0	7.1
Acarina	0	0.1	0	0
Insecta				
Diptera				
Larvae				
Chironomidae	0	18.0	18.9	14.3
Simuliidae	0	3.6	5.4	0
Other	20.0	18.9	9.5	7.1
Plecoptera	20.0	5.4	13.5	14.3
Ephemeroptera	40.0	34.2	21.6	14.3
Trichoptera	0	4.5	17.6	7.1
Collembola	0	0.1	0	0
Crustacea				
Ostracoda	20.0	11.7	0	0
Nematoda	0	0.1	5.4	0
Fish Remains	0	0.1	8.1	35.7

Table 11. Summary of length-weight data for lake chub from Creek Mile 422.7, 1976.

Fork Length Interval	N	Fork Length (mm)			Weight (g)		
		Mean	S.D.	S.E.	Mean	S.D.	S.E.
20 - 29.9	12	27.4	1.08	0.31	0.28	0.06	0.02
30 - 39.9	3	32.0	1.73	1.00	0.40	0.10	0.06
40 - 49.9	2	48.0	1.41	1.00	1.00	0.14	0.10
50 - 59.9	1	50.0	-	-	1.20	-	-

Table 12. Summary of length and weight by age for lake chub from Creek Mile 422.7, 1976.

Otolith Age	N	Fork Length (mm)			Weight (g)		
		Mean	S.D.	Range	Mean	S.D.	Range
0	10	27.7	1.34	27 - 30	0.29	0.06	0.2 - 0.4
1	2	48.0	1.41	47 - 49	1.00	0.14	0.9 - 1.1

Table 13. Compendium of fork length, weight and age data for arctic grayling captured from Creek Mile 422.7, 1976.

Age	Fork Length (mm)	Weight (g)	Sex and Maturity
2	150	43.2	-
2	166	-	maturing male
2	168	-	maturing female
3	212	100.0	ripe male
4	222	119.3	maturing male

Table 14. Summary of length-weight data for lake chub from Creek Mile 426.5, 1976.

Fork Length Interval	N	Fork Length (mm)			Weight (g)		
		Mean	S.D.	S.E.	Mean	S.D.	S.E.
20 - 29.9	1	27.0	-	-	0.30	-	-
30 - 39.9	2	37.0	1.41	1.00	0.55	0.21	0.15
40 - 49.9	3	45.7	1.53	0.88	1.20	0.10	0.06
50 - 59.9	3	54.3	2.89	1.67	2.20	0.36	0.21
60 - 69.9	3	63.0	1.73	1.00	3.10	0.10	0.06
70 - 79.9	2	74.0	2.83	2.00	4.95	0.07	0.05
80 - 89.9	2	84.0	5.66	4.00	6.50	1.27	0.90
90 - 99.9	1	97.0	-	-	8.70	-	-
100 - 109.9	1	102.0	-	-	10.60	-	-

Table 15. Summary of length and weight by age for lake chub from Creek Mile 426.5, 1976.

Otolith Age	N	Fork Length (mm)			Weight (g)		
		Mean	S.D.	Range	Mean	S.D.	Range
1	2	51.0	7.07	46 - 56	1.60	0.71	1.1 - 2.1
2	6	58.3	8.96	47 - 72	2.80	1.24	1.3 - 4.9
3	2	78.0	2.83	76 - 80	5.30	0.42	5.0 - 5.6
4	1	102.0	-	-	10.60	-	-

Table 16. Food items as percent by number, of diet in lake chub from Creek Mile 426.5, 1976.

Fork Length Range (mm)	26-50	51-75	76-100	100+
Number of stomachs analysed	6	7	4	1
Number of empty stomachs	1	2	1	1
Mean number of organisms/stomach	2.3	0.9	1.0	0
Food Item % of Diet				
Insecta				
Diptera				
Adult	14.3	12.5	0	
Larvae				
Simuliidae	42.9	12.5	0	
Other	0	12.5	0	
Plecoptera			25.0	
Ephemeroptera	7.1	25.0		
Trichoptera	7.1	37.5	50.0	
Coleoptera	7.1	0	25.0	
Crustacea				
Ostracoda	14.3		0	
Nematoda	7.1		0	

Table 17. Summary of length-weight data for longnose sucker from Creek Mile 426.5, 1976.

Fork Length Interval	N	Fork Length (mm)			Weight (g)		
		Mean	S.D.	S.E.	Mean	S.D.	S.E.
30 - 39.9	2	38.5	0.71	0.50	0.70	0.00	0.00
40 - 49.9	1	46.0	-	-	1.20	-	-
50 - 59.9	3	54.3	4.04	2.33	1.87	0.59	0.34
60 - 69.9	1	65.0	-	-	3.90	-	-
70 - 79.9	2	72.5	0.71	0.50	4.25	0.21	0.15

Table 18. Compendium of age, fork length, and weight data for slimy sculpin, northern redbelly dace and burbot captured from Creek Mile 426.5, 1976.

	Otolith Age	Fork Length (mm)	Weight (g)
Slimy Sculpin	1	41	0.7
	3	56	2.0
	4	65	3.2
	4	74	5.1
Northern Redbelly Dace	1	33	0.5
	2	48	1.4
	2	62	3.3
	N.D.	38	0.9
Burbot	1	119	11.0
	2	122	11.6
	N.D.	134	17.3

N.D. - Not determined.

Table 19. Summary of Analysis of Variance and Comparison of Location Means for Benthic Invertebrates, Smith Creek 1976.

		Analysis of Variance Source of Variation (df)				Comparison of Location Means Locations Compared (df)		
Benthic Group		Location (3,80)	Date (3,80)	Interaction (9,80)		Location 5-6(80)	Location 7-8(80)	Location 5&6-7&8(80)
Chironomidae	F. Value	19.12	56.69	7.87	t Value	1.99	2.54	7.13
	Sig. Effect?	Yes	Yes	Yes	Sig. Difference?	No	Yes	Yes
Copepoda	F. Value	1.58	1.52	0.90	t Value	0.08	1.65	1.42
	Sig. Effect?	No	No	No	Sig. Difference?	No	No	No
Simuliidae	F. Value	1.27	10.10	1.04	t Value	1.93	0.27	0.10
	Sig. Effect?	No	Yes	No	Sig. Difference?	No	No	No
Other Diptera	F. Value	1.46	27.09	1.14	t Value	1.40	0.15	2.04
	Sig. Effect?	No	Yes	No	Sig. Difference?	No	No	Yes
Ephemeroptera	F. Value	5.48	4.74	2.35	t Value	1.06	2.17	2.30
	Sig. Effect?	Yes	Yes	Yes	Sig. Difference?	No	Yes	Yes
Acarina	F. Value	25.22	61.66	19.03	t Value	1.18	5.13	6.93
	Sig. Effect?	Yes	Yes	Yes	Sig. Difference?	No	Yes	Yes
Nematoda	F. Value	15.11	33.17	11.31	t Value	0.38	3.60	5.69
	Sig. Effect?	Yes	Yes	Yes	Sig. Difference?	No	Yes	Yes
Oligochaeta	F. Value	4.24	6.52	2.50	t Value	0.06	0.83	3.47
	Sig. Effect?	Yes	Yes	Yes	Sig. Difference?	No	No	Yes
Plecoptera	F. Value	3.75	15.38	2.47	t Value	1.38	1.90	2.21
	Sig. Effect?	Yes	Yes	Yes	Sig. Difference?	No	No	Yes
Trichoptera	F. Value	18.29	10.07	2.51	t Value	1.42	4.03	6.06
	Sig. Effect?	Yes	Yes	Yes	Sig. Differnce?	No	Yes	Yes
Other	F. Value	4.19	6.81	1.72	t Value	0.05	0.64	3.49
	Sig. Effect?	Yes	Yes	No	Sig. Difference?	No	No	Yes
Total	F. Value	27.32	56.60	10.87	t Value	0.08	3.69	8.21
	Sig. Effect?	Yes	Yes	Yes	Sig. Difference?	No	Yes	Yes

*Sig. Effect and Sig. Difference Calculated at 95% confidence level.

Table 20. Summary of length and weight for migrant Arctic grayling from Smith Creek, 1976.

		Upstream									Downstream							
		Fork Length (mm)				Weight (g)					Fork Length (mm)				Weight (g)			
Age	N	Range	Mean	S.D.	S.E.	Range	Mean	S.D.	S.E.	N	Range	Mean	S.D.	S.E.	Range	Mean	S.D.	S.E.
Male																		
2	0									2	186 - 194	190.0	5.7	4.0	50 - 100	75.0	35.4	25.0
3	10	198 - 238	220.0	13.2	4.2	100 - 150	120.0	25.8	8.2	7	185 - 231	210.4	15.7	5.9	50 - 125	100.0	25.0	9.4
4	2	274 - 276	275.0	1.4	1.0	150 - 250	200.0	70.7	50.0	4	223 - 291	248.5	29.7	14.9	100 - 250	165.0	62.5	31.2
5	3	258 - 336	296.7	39.0	22.5	155 - 300	251.7	83.7	48.3	0								
6	3	315 - 344	326.3	15.6	8.9	350 - 400	366.7	28.9	16.7	0								
Female																		
2	1	-	170.0	-	-	-	50.0	-	-	2	172 - 180	176.0	5.7	4.0	50 - 90	70.0	28.3	20.0
3	9	189 - 265	211.4	22.5	7.5	50 - 150	91.7	30.6	10.2	5	184 - 226	206.4	18.2	8.2	50 - 100	90.0	22.4	10.0
4	2	261 - 272	266.5	7.8	5.5	-	200.0	0.0	0.0	1	-	282.0	-	-	-	220.0	-	-
5	4	239 - 281	266.8	19.6	9.8	150 - 250	212.5	47.9	23.9	2	208 - 323	265.5	81.3	57.5	100 - 400	250.0	212.1	150.0
6	3	278 - 294	285.0	8.2	4.7		250.0	0.0	0.0	0								
7	1	-	340.0	-	-	-	650.0	-	-	0								
8	1	-	305.0	-	-	-	300.0	-	-	0								
Total																		
2	6	170 - 222	189.3	19.1	7.8	50 - 150	80.8	40.1	16.4	15	172 - 226	189.3	13.4	3.5	50 - 150	77.7	27.7	7.2
3	74	184 - 280	218.1	19.7	2.3	50 - 210	114.5	33.2	3.9	62	180 - 284	226.8	22.7	2.9	30 - 250	126.4	44.7	5.7
4	31	188 - 290	242.7	24.6	4.4	95 - 300	154.1	52.3	9.4	20	196 - 327	256.3	28.2	6.3	50 - 330	189.8	64.4	14.4
5	15	236 - 336	273.9	24.7	6.4	150 - 300	207.0	55.0	14.2	13	208 - 336	286.2	37.2	10.3	100 - 400	256.2	87.8	24.3
6	7	278 - 344	303.1	24.0	9.1	250 - 400	300.0	64.5	24.4	2	-	292.0	0.0	0.0	225 - 275	250.0	35.4	25.0
7	2	340 - 349	344.5	6.4	4.5	450 - 650	550.0	141.4	100.0	0								
8	1	-	305.0	-	-	-	300.0	-	-	2	303 - 307	305.0	2.8	2.0	250 - 300	275.0	35.4	25.0

Table 21. Food items as percent by number, of diet in migrant Arctic grayling from Smith Creek, 1976.

Fork Length Range (mm)	171-255	256-340	171-340
Number of stomachs analysed	32	12	44
Number of empty stomachs	0	0	0
Mean number of organisms/ stomach	32.6	62.1	40.6
Food Item % of Diet			
Arachnida			
Araneida	0.3	0.5	0.4
Insecta			
Hymenoptera			
Formicidae	2.2	10.1	5.5
Other	0.1	1.9	0.8
Diptera			
Adult	0	0.8	0.3
Larvae			
Chironomidae	0.4	0	0.2
Other	0.5	0.5	0.5
Hemiptera			
Corixidae	3.4	0.5	2.2
Other	0.1	0.9	0.5
Plecoptera	0.8	3.8	2.0
Ephemeroptera	1.6	0.8	1.3
Trichoptera	13.1	23.6	17.5
Coleoptera	13.4	6.9	3.6
Odonata	0.2	0.8	0.5
Crustacea			
Amphipoda	75.8	50.6	65.3
Nematoda	0.2	0.3	0.2
Nematomorpha	0	0.3	0.1
Fish Remains	0.1	0.1	0.1

Table 22. Summary of length-weight data for juvenile Arctic grayling from Smith Creek, 1976.

Fork Length Interval	N	Fork Length Mean	Fork Length S.D.	Fork Length S.E.	Weight Mean	Weight S.D.	Weight S.E.
20 - 29.9	9	27.2	1.64	0.55	0.19	0.03	0.01
30 - 39.9	11	35.5	2.58	0.78	0.58	0.16	0.05
40 - 49.9	7	44.6	2.94	1.11	1.14	0.24	0.09
50 - 59.9	5	54.0	3.24	1.45	2.02	0.35	0.16
60 - 69.9	4	67.0	1.41	0.71	4.00	0.22	0.11
70 - 79.9	5	73.4	2.07	0.93	5.04	0.70	0.31
80 - 89.9	1	82.0	-	-	5.50	-	-
90 - 99.9	2	94.5	2.12	1.50	10.35	0.07	0.05

Table 23. Summary of length and weight by age for juvenile Arctic grayling from Smith Creek, 1976.

Age	N	Fork Length Mean	Fork Length S.D.	Fork Length Range	Weight Mean	Weight S.D.	Weight Range
0	39	43.8	15.34	24 - 75	1.5	1.60	0.1 - 6.2
1	2	71.5	2.12	70 - 73	4.7	0.50	4.3 - 5.0
2	2	94.5	2.12	93 - 96	10.4	0.07	10.3 - 10.4

Table 24. Summary of young-of-the year Arctic grayling from Smith Creek, 1976.

Date	N	Fork Length			Weight		
		Mean	S.D.	Range	Mean	S.D.	Range
June 29	3	25.3	1.15	24 - 26	0.2	0.00	-
July 4	5	28.8	0.84	28 - 30	0.2	0.04	0.1 - 0.2
July 6	4	33.8	8.30	27 - 45	0.5	0.42	0.2 - 1.1
July 11	2	48.0	0.00	-	1.4	0.00	-
July 12	5	39.4	7.86	33 - 52	1.0	0.70	0.5 - 2.2
July 14	7	37.7	1.98	35 - 41	0.7	0.11	0.5 - 0.8
Aug. 17	11	59.5	11.11	42 - 75	3.0	1.68	0.9 - 6.2
Sept. 28	1	75.0	-	-	4.8	-	-
Dec. 9	1	68.0	-	-	4.3	-	-

Table 25. Food items as percent by number, of diet in Arctic grayling collected from sampling locations on Smith Creek, 1976.

Fork Length Range (mm)	0-25	26-50	51-75	76-100	0-100	158-263
Number of stomachs analysed	1	28	12	3	44	4
Number of empty stomachs	0	0	0	0	0	0
Mean number of organisms/stomach	12.0	15.1	12.4	15.0	14.3	49.8
Food Item % of Diet						
Arachnida						
Araneida	0	0.2	1.3	0	0.5	0
Acarina	0	5.2	0	0	3.5	1.0
Insecta						
Hymenoptera						
Formicidae	0	0	0	0	0	19.1
Other	0	0.7	2.0	0	1.0	7.5
Diptera						
Adult	0	10.9	37.6	0	16.2	1.5
Larvae						
Chironomidae	50.0	29.8	16.8	0	25.0	1.0
Simuliidae	41.7	7.3	0	0	5.7	1.5
Other	0	7.6	0.7	0	5.2	0
Hemiptera	0	0.7	6.7	0	2.1	7.5
Colembola	0	0.7	0.7	0	0.6	0
Plecoptera	0	0.7	4.7	8.9	2.2	0
Ephemeroptera	8.3	19.9	6.7	42.2	18.1	39.7
Trichoptera	0	15.1	19.5	20.0	16.2	13.6
Coleoptera	0	0.2	0.7	0	0.3	6.0
Crustacea						
Amphipoda	0	0.5	1.3	26.7	2.5	1.5
Nematoda	0	0.5	1.3	2.2	0.8	0

Table 26. Summary of length and weight for migrant northern pike from Smith Creek, 1976.

		Upstream									Downstream							
		Length (mm)				Weight (g)					Length (mm)				Weight (g)			
Age	N	Range	Mean	S.D.	S.E.	Range	Mean	S.D.	S.E.	N	Range	Mean	S.D.	S.E.	Range	Mean	S.D.	S.E.
Male																		
2	3	322 - 371	239.7	27.2	15.7	250 - 350	283.3	57.7	33.3									
3	29	326 - 491	414.6	38.7	7.2	250 - 800	482.5	142.5	26.5	11	407 - 505	442.0	31.7	9.5	390 - 950	600.0	190.4	57.4
4	12	385 - 513	439.8	37.9	10.9	325 - 1000	598.8	180.4	52.1	7	438 - 531	469.0	37.9	14.3	610 - 960	750.7	140.8	53.2
5	5	415 - 553	487.0	53.1	23.7	450 - 1250	816.0	306.6	137.1	3	464 - 537	506.7	38.0	21.9	725 - 1000	841.7	142.2	82.1
6	1	-	430.0	-	-	-	550.0	-	-	1	-	436.0	-	-	-	650.0	-	-
Female																		
2	1	-	332.0	-	-	-	250.0	-	-									
3	14	361 - 507	441.3	49.0	13.1	200 - 850	590.4	184.3	49.2	5	470 - 508	487.6	14.4	6.4	575 - 775	685.0	84.0	37.6
4	7	475 - 600	523.8	44.9	18.3	700 - 1350	992.7	212.9	86.9	3	490 - 531	507.0	21.4	12.3	700 - 910	840.0	121.2	70.0
5	3	513 - 628	575.7	58.2	33.6	1000 - 1900	1500.0	458.3	264.6									
Total																		
2	5	322 - 371	339.6	19.9	8.9	250 - 350	270.0	44.7	20.0	1	-	428.0	-	-	-	400.0	-	-
3	50	326 - 572	425.5	47.1	6.7	200 - 960	520.5	171.6	24.3	23	403 - 516	452.3	35.9	7.5	300 - 950	619.6	169.5	35.3
4	23	385 - 600	468.8	55.6	11.6	325 - 1400	748.7	279.5	58.3	15	436 - 570	489.0	43.3	11.2	610 - 1240	831.7	191.8	49.5
5	8	415 - 628	520.3	68.4	24.2	450 - 1900	1072.5	488.9	172.9	3	464 - 537	506.7	38.0	22.0	725 - 1000	841.7	142.2	82.1
6	1	-	430.0	-	-	-	550.0	-	-	1	-	436.0	-	-	-	650.0	-	-

Table 27. Summary of growth in length and weight for migrant longnose sucker from Smith Creek, 1976.

Fork Length Interval	Upstream							Downstream						
		Fork Length (mm)			Weight (g)				Fork Length (mm)			Weight (g)		
	N	Mean	S.D.	S.E.	Mean	S.D.	S.E.	N	Mean	S.D.	S.E.	Mean	S.D.	S.E.
Male														
250 - 274.9	2	259.5	4.9	3.5	199.0	1.4	1.0	2	271.0	4.2	3.0	275.0	35.4	25.0
275 - 299.9	4	285.5	7.3	3.7	262.5	47.9	23.9	5	280.0	4.2	1.9	265.0	48.7	21.8
300 - 324.9	1	315.0	-	-	380.0	-	-	2	315.0	7.1	5.0	337.5	17.7	12.5
325 - 349.9	1	326.0	-	-	400.0	-	-	2	328.5	3.5	2.5	425.0	35.4	25.0
350 - 374.9														
375 - 399.9														
Female														
250 - 274.9	1	271.0	-	-	250.0	-	-							
275 - 299.9														
300 - 324.9	4	308.8	9.1	4.5	375.0	28.9	14.4	4	316.8	3.9	1.9	412.5	25.0	12.5
325 - 349.9	3	341.0	5.3	3.1	466.7	76.4	44.1	2	342.5	3.5	2.5	525.0	35.4	25.0
350 - 374.9	1	350.0	-	-	500.0	-	-							
375 - 399.9														
Total														
250 - 274.9	5	262.4	6.1	2.7	223.6	25.6	11.4	2	271.0	4.2	3.0	275.0	35.4	25.0
275 - 299.9	4	285.5	7.3	3.7	262.5	47.9	23.9	8	282.3	5.0	1.8	263.1	56.2	19.9
300 - 324.9	6	310.8	7.7	3.2	388.3	37.6	15.4	10	316.3	4.9	1.5	369.0	51.4	16.2
325 - 349.9	5	337.8	7.6	3.4	460.0	65.2	29.2	5	334.4	7.8	3.5	460.0	65.2	29.2
350 - 374.9	1	350.0	-	-	500.0	-	-							
375 - 399.9														

Table 28. Summary of length-weight data for juvenile longnose suckers from Smith Creek, 1976.

Fork Length Interval	N	Fork Length (mm) Mean	S.D.	S.E.	Weight (g) Mean	S.D.	S.E.
May - June							
10 - 19.9	0						
20 - 29.9	0						
30 - 39.9	1	34.0	-	-	0.5	-	-
40 - 49.9	6	47.0	1.4	0.6	1.13	0.23	0.10
50 - 59.9	7	52.6	2.5	0.9	1.64	0.34	0.13
60 - 69.9	0						
70 - 79.9	1	72.0	-	-	4.2	-	-
July - August							
10 - 19.9	18	16.2*			0.08*		
20 - 29.9	2	26.5	2.1	1.5	0.20	0.00	0.00
30 - 39.9	5	37.0	3.5	1.5	0.72	0.27	0.12
40 - 49.9	13	44.9	3.3	0.9	1.27	0.41	0.11
50 - 59.9	16	53.4	3.0	0.8	2.05	0.47	0.12
60 - 69.9	9	65.3	2.7	0.9	3.57	0.57	0.19
70 - 79.9	0						
September - October							
10 - 19.9							
20 - 29.9	1	22.0	-	-	0.10	-	-
30 - 39.9	1	38.0	-	-	0.70	-	-
40 - 49.9	4	43.8	1.9	0.1	1.10	0.00	0.00
50 - 59.9	0						
60 - 69.9	2	63.0	0.0	0.0	3.30	0.00	0.00
70 - 79.9	1	76.0	-	-	5.70	-	-
Overall							
10 - 19.9	18	16.2*			0.08*		
20 - 29.9	3	25.0	3.0	1.7	0.17	0.06	0.03
30 - 39.9	7	36.7	3.1	1.2	0.69	0.23	0.09
40 - 49.9	23	45.3	2.9	0.6	1.20	0.33	0.07
50 - 59.9	23	53.1	2.8	0.6	1.93	0.47	0.10
60 - 69.9	11	64.9	2.6	0.8	3.52	0.53	0.16
70 - 79.9	2	74.0	2.8	2.0	5.00	1.06	0.75

* derived from total length and weight of 18 individuals measured together.

Table 29. Food items as percent by number, of diet in juvenile longnose sucker from Smith Creek, 1976.

Fork Length Range (mm)	0-25	26-50	51-75	76-100
Number of stomachs analysed	2	36	32	1
Number of stomachs with unidentifiable contents	2	10	9	0
Number of empty stomachs	0	4	3	0
Mean number of organisms/ stomach	N/A	18.5	44.8	22.0
Food Item % of Diet				
Arachnida				
Acarina	0	0	0.2	0
Insecta				
Diptera				
Adult	0	0.2	0	0
Larvae				
Chironomidae	0	94.6	96.7	90.9
Simuliidae	0	3.5	0.2	0
Other	0	0	0	0
Plecoptera	0	0	0	9.1
Ephemeroptera	0	0.2	0.6	0
Trichoptera	0	0.8	1.8	0
Coleoptera	0	0	0.2	0
Crustacea				
Ostracoda	0	0.2	0.2	0
Copepoda	0	0	0.1	0
Nematoda	0	0.2	0.1	0

N/A - not applicable.

Table 30. Compendium of fork length, weight and age data for burbot captured from Smith Creek, 1976.

Age	Fork Length (mm)	Weight (g)
2	131	17.8
3	106	7.5
3	134	18.8
4	160	21.6
4	198	39.9
5	237	100.7
-	69	2.1
-	171	36.3

Table 31. Summary of length-weight data for slimy sculpin from Smith Creek, 1976.

Fork Length Interval	N	Total Fork Length (mm) Mean	S.D.	S.E.	Weight (g) Mean	S.D.	S.E.
10 - 19.9	4	18.3	1.50	0.75	0.10	0.00	0.00
20 - 29.9	13	25.2	2.95	0.82	0.18	0.08	0.02
30 - 39.9	6	34.7	2.58	1.05	0.50	0.15	0.06
40 - 49.9	6	45.8	3.37	1.38	1.27	0.42	0.17
50 - 59.9	2	53.5	2.12	1.50	1.85	0.49	0.35
60 - 69.9	3	65.0	2.00	1.15	3.17	0.06	0.03
70 - 79.9	1	72.0	-	-	5.20	-	-

Table 32. Summary of length and weight by age for slimy sculpin from Smith Creek, 1976.

Age	N	Total Fork Length (mm) Mean	S.D.	Range	Weight (g) Mean	S.D.	Range
0	13	22.5	3.82	16 - 29	0.16	0.08	0.1 - 0.3
1	9	38.3	6.50	29 - 48	0.74	0.33	0.3 - 1.3
2	3	52.0	3.00	49 - 55	1.80	0.36	1.5 - 2.2
4	4	66.8	3.86	63 - 72	3.68	1.02	3.1 - 5.2

Table 33. Food items as percent by number, of diet in slimy sculpin from Smith Creek, 1976.

Fork Length Range (mm)	0-25	26-50	51-76
Number of stomachs analysed	12	17	6
Number of empty stomachs	7	1	0
Mean number of organisms/ stomach	3.9	13.5	10.2
Food Item % of Diet			
Insecta			
Diptera			
Larvae			
Chironomidae	93.6	88.3	34.4
Simuliidae	0	0.9	26.2
Plecoptera	0	0	4.9
Ephemeroptera	0	7.0	29.5
Trichoptera	2.1	2.6	4.9
Crustacea			
Amphipoda	4.3	0.9	0
Nematoda	0	0.4	0

Table 34. Summary of length and weight data for lake whitefish from Smith Creek, 1976.

Fork Length Interval	N	Fork Length (mm)			Weight (g)		
		Mean	S.D.	S.E.	Mean	S.D.	S.E.
30 - 39.9	8	35.4	1.77	0.63	0.54	0.13	0.05
40 - 49.9	12	43.9	2.57	0.74	1.02	0.25	0.07
50 - 59.9	3	50.3	0.58	0.33	1.53	0.06	0.03
60 - 69.9	3	65.3	3.51	2.03	3.27	0.71	0.41
70 - 79.9	5	73.8	2.77	1.24	4.78	0.71	0.32
130 - 139.9	1	138.0	-	-	31.6	-	-

Table 35. Summary of length and weight by age for lake whitefish from Smith Creek, 1976.

Age	N	Fork Length (mm)			Weight (g)		
		Mean	S.D.	Range	Mean	S.D.	Range
0	31	49.2	13.93	33 - 76	1.77	1.58	0.3 - 5.9
2	1	138.0	-	-	31.60	-	-

Table 36. Food items as percent by number, of diet in lake whitefish from Smith Creek, 1976.

Fork Length Range (mm)	26-50	51-75	76-100	101+
Number of stomachs analysed	22	7	2	1
Number of empty stomachs	3	3	0	1
Mean number of organisms/ stomach	8.4	3.6	4.5	0
Food Item % of Diet				
Arachnida				
Acarina	12.5	0	0	0
Insecta				
Hymenoptera	0	12.0	0	0
Diptera				
Adult	1.1	0	0	0
Larvae				
Chironomidae	22.8	8.0	88.9	0
Simuliidae	49.5	0	0	0
Other	6.0	0	0	0
Plecoptera	0.5	0	0	0
Ephemeroptera	4.3	16.0	0	0
Trichoptera	2.7	8.0	11.1	0
Coleoptera	0.5	0	0	0

Table 37. Summary of length-weight data for lake chub from Smith Creek, 1976.

Fork Length Interval	N	Fork Length (mm) Mean	S.D.	S.E.	Weight (g) Mean	S.D.	S.E.
30 - 39.9	9	36.4	2.65	0.88	0.68	0.18	0.06
40 - 49.9	12	45.0	2.83	0.82	1.28	0.24	0.07
50 - 59.9	8	53.4	3.46	1.22	2.35	0.54	0.19
60 - 69.9	2	66.5	3.54	2.50	4.40	0.42	0.30
70 - 79.9	1	71.0	-	-	5.30	-	-
80 - 89.9	1	89.0	-	-	9.20	-	-
90 - 99.9	1	97.0	-	-	13.4	-	-

Table 38. Summary of length and weight by age for lake chub from Smith Creek, 1976.

Age	N	Fork Length (mm) Mean	S.D.	Range	Weight (g) Mean	S.D.	Range
1	27	43.7	6.39	32 - 56	1.26	0.58	0.4 - 2.6
2	3	74.7	12.90	64 - 89	6.20	2.67	4.1 - 9.2
3	1	69.0	-	-	4.70	-	-

Table 39. Food items as percent by number, of diet in lake chub from Smith Creek, 1976.

Fork Length Range (mm)	26-50	51-75	76-100
Number of stomachs analysed	23	9	2
Number of empty stomachs	4	2	0
Mean number of organisms/stomach	23.9	11.1	2.5
Food Item % of Diet			
Arachnida			
Acarina	0.4	0	0
Insecta			
Hymenoptera	1.5	1.0	0
Diptera			
Larvae			
Chironomidae	3.3	2.0	0
Simuliidae	91.8	86.0	0
Other	1.3	0	0
Ephemeroptera	0.4	2.0	0
Trichoptera	1.3	7.0	100.0
Coleoptera	0.2	0	0
Nematoda	0	2.0	0

Table 40. Compendium of length and weight data for longnose dace from Smith Creek, 1976.

Fork Length (mm)	Weight (g)
22	0.1
24	0.1
24	0.2
25	0.2
26	0.2
27	0.3
101	14.6
117	18.3

Appendix 1. Bed Material Analysis - Creek Mile 422.7, Location 1.

VISUAL DESCRIPTION AND SAMPLING PROCEDURE

Visually described as a cobble and coarse gravel section. Approximately 50% of the area is occupied by large cobbles. Six (6) large cobbles were measured in situ along the long, short and intermediate axes (Table 1-1). The other 50% of bed was comprised of smaller stones and gravel. A total of 3772 g (dry wt) of the surface material was collected and analysed for size (Table 1-2, Figure 1-1).

Table 1-1 Large Cobbles

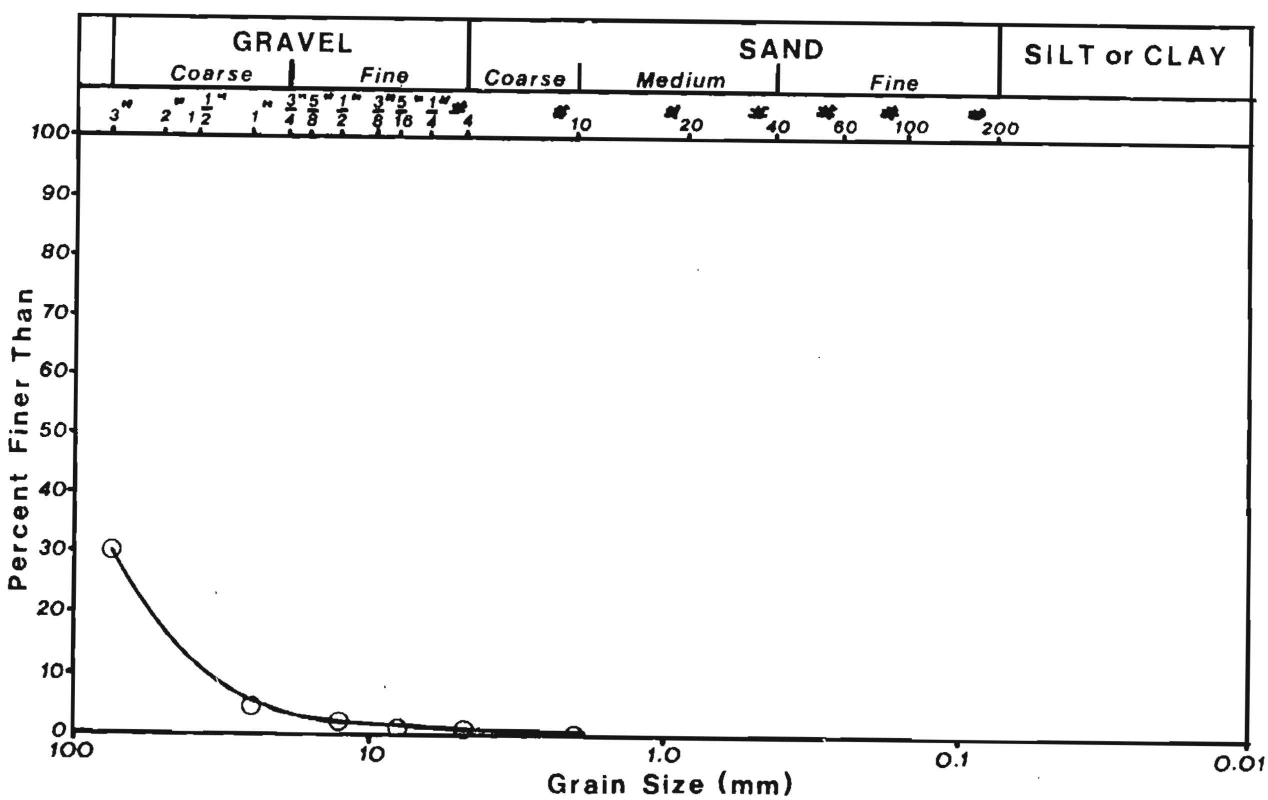
AXIS (cm)	N	$\overline{X}$	SD	SE
Long	6	24.1	7.32	2.99
Short	6	12.3	1.88	0.77
Intermediate	6	17.4	4.39	1.79

Table 1-2 Small Cobbles

Wt Cobbles + Tare 2791.0 g   Wt Tare 154.0 g   Wt Cobbles 2637.0 g

AXIS (cm)	N	$\overline{X}$	SD	SE
Long	10	7.8	1.68	0.53
Short	10	3.2	0.92	0.29
Intermediate	10	5.5	0.85	0.27

Figure 1-1. Grain Size Distribution   Sample Wt = 1135 g



Appendix 2. Bed Material Analysis - Creek Mile 422.7, Location 2.

VISUAL DESCRIPTION AND SAMPLING PROCEDURE

Visually described as a cobble riffle. Approximately 85% of the bed area was composed of cobbles and 14% of coarse gravel. A composite sample of this material was taken. Results of analyses are presented in Table 2-1 and Table 2-2. Approximately 1% of the bed area was composed of sand. A sample of this material was analyzed for grain size distribution (Figure 2-1).

Table 2-1. Cobbles

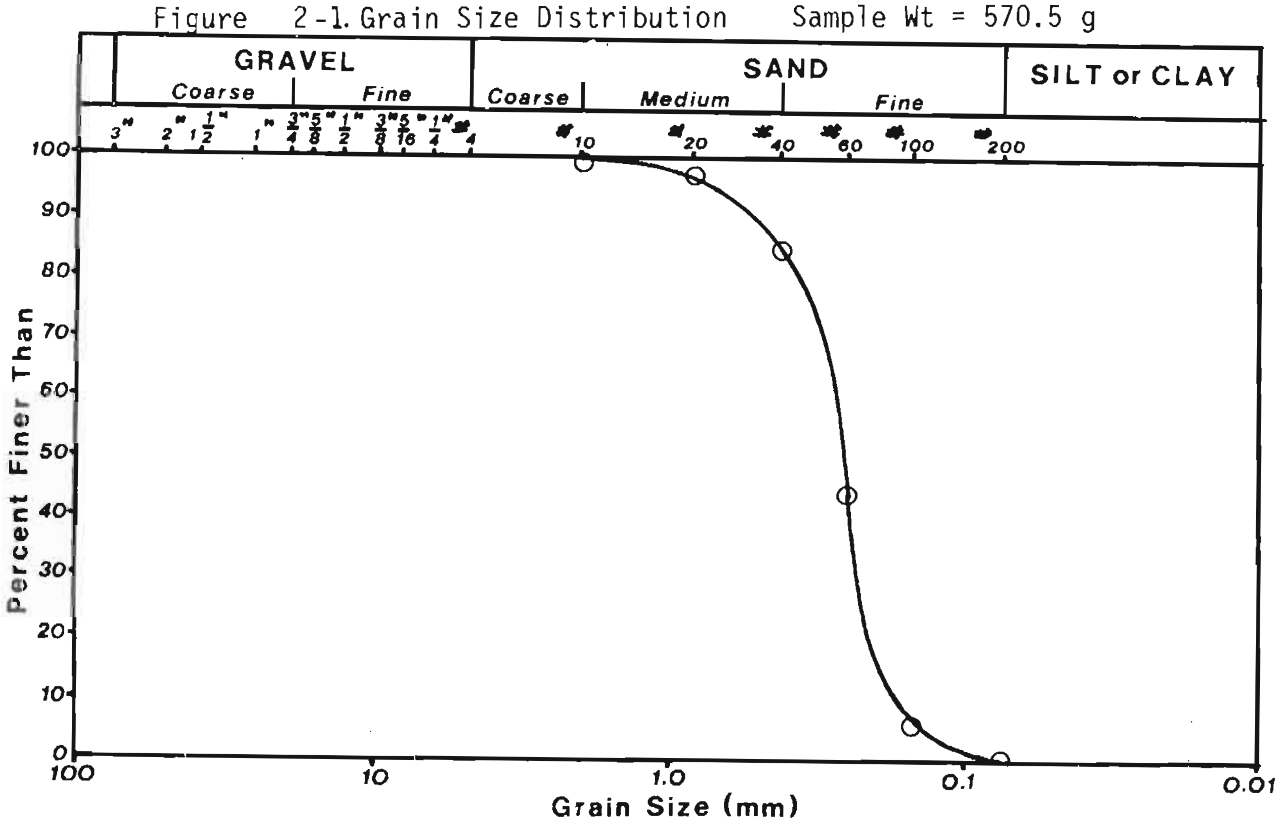
Wt Cobbles and Tare 5024.0 g   Wt Tare 200.0 g   Wt Cobbles 4824.0 g

AXIS (cm)	N	$\bar{X}$	SD	SE
Long	9	9.8	2.44	0.81
Short	9	4.3	1.50	0.50
Intermediate	9	7.0	1.41	0.47

Table 2-2. Coarse Gravel

Wt Gravel and Tare 1435.0 g   Wt Tare 584.0 g   Wt Gravel 851.0 g

Figure 2-1. Grain Size Distribution   Sample Wt = 570.5 g



Appendix 3. Bed Material Analysis - Creek Mile 422.7, Location 3.

VISUAL DESCRIPTION AND SAMPLING PROCEDURE

Visually described as a boulder-cobble riffle. Approximately 40% of the stream bed consisted of boulders. A sample of these (n=7) were measured in situ along 3 axes (Table 3-1). A sample of the material making up the other 60% of bed was taken. This sample was made up entirely of small cobbles. Their dimensions are given in Table 3-2).

Table 3-1. Boulders

AXIS (cm)	N	$\bar{X}$	SD	SE
Long	7	30.5	7.75	2.93
Short	7	20.3	7.02	2.65
Intermediate	7	23.2	6.95	2.63

Table 3-2. Small Cobbles

AXIS (cm)	N	$\bar{X}$	SD	SE
Long	16	6.9	1.85	0.46
Short	16	3.0	1.10	0.27
Intermediate	16	5.1	1.48	0.37

Appendix 4. Bed Material Analysis - Creek Mile 422.7, Location 4.

VISUAL DESCRIPTION AND SAMPLING PROCEDURE

Visually described as boulders and cobbles between sand banks. Sand is visible between the rocks on the stream bed. Approximately 50% of the bed was covered by boulders. Six (6) of these were measured in situ along 3 axés (Table 4-1). Approximately 40% of the bed area was comprised of cobbles. A sample of these was obtained and measured (Table 4-2). Approximately 10% of the bed area was composed of sand. A sample of this material was collected and analyzed for grain size distribution (Figure 4-1).

Table 4-1. Boulders

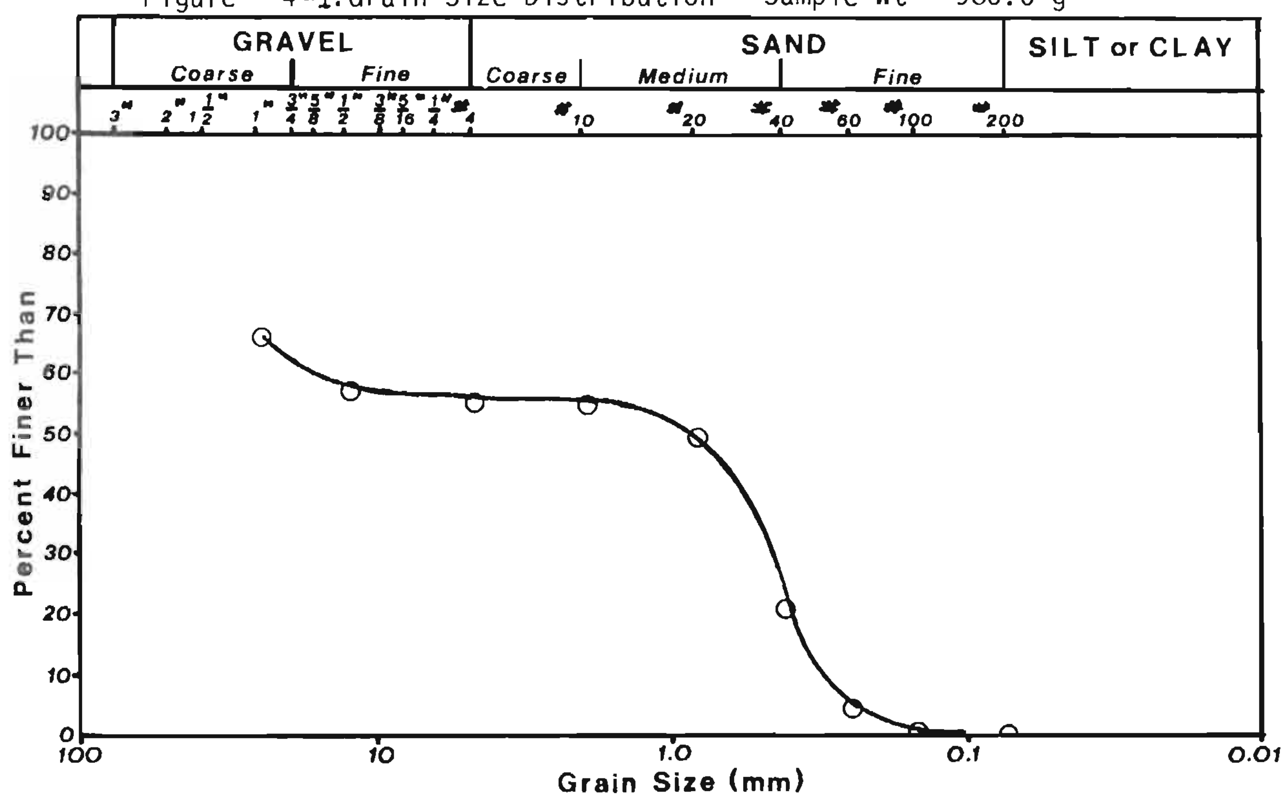
AXIS (cm)	N	$\bar{X}$	SD	SE
Long	6	27.0	7.70	3.14
Short	6	20.3	6.41	2.62
Intermediate	6	16.1	4.45	1.82

Table 4-2. Cobbles

Wt Cobbles and Tare 5570.0 g   Wt Tare 200.0 g   Wt Cobbles 5370.0 g

AXIS (cm)	N	$\bar{X}$	SD	SE
Long	9	9.9	2.71	0.90
Short	9	5.2	1.39	0.46
Intermediate	9	7.1	1.05	0.35

Figure 4-1. Grain Size Distribution   Sample Wt = 980.0 g



Appendix 5. Flow Summary Table - Creek Mile 422.7, Location 1.

Date	Stage (m) Datum Elevation	Stage (m) Above Zero Datum	Discharge (m^3 sec) Meas.	Discharge (m^3 sec) Calc.	Area (m^2) Meas.	Velocity (m/mc) Meas.	Velocity (m/mc) Calc.	Hyd. Radius (m) Meas.	Hyd. Radius (m) Calc.	Slope %	Comments
May 15	141.730	.38	0.18	0.24	0.92	0.20		0.17			Discharge Station 36.5m U/S from Staff Gauge
May 21	141.686	.336	0.12	0.15	0.55	0.22	0.24	0.17	0.20		Discharge Station 45.7m D/S from Staff Gauge
May 28	141.682	.332	0.14	0.14	0.62	0.22	0.23	0.18	0.19		Discharge Station 45.7m D/S from Staff Gauge
May 29	141.710	.36	0.27	0.19	0.87	0.31	0.28	0.24	0.22		Discharge Station 45.7m D/S from Staff Gauge
June 4	141.670	.32	0.16	0.12	0.68	0.24	0.21	0.20	0.18		Discharge Station 45.7m D/S from Staff Gauge
June 10	141.631	.281	0.07	0.07	0.52	0.13	0.15	0.16	0.15	1.44	SLOPE-June 11, 15.24m U/S and D/S from Discharge Station
June 17	141.606	.256	0.06	0.05	0.39	0.15	0.12	0.13	0.13		Discharge Station 45.7m D/S from Staff Gauge
June 24	141.604	.254	0.04	0.05	0.37	0.11	0.12	0.12	0.12	1.92	Discharge Station 45.7m D/S from Staff Gauge
June 24	141.604	.254	0.05	0.05	0.33	0.15		0.06		3.12	Discharge Station 8.8m U/S from Staff Gauge

Equations:

1) $\log_{10}Q = 1.0163 + 3.8983\ (\log_{10}S)$ CI = 2.6603 - 5.1364
r = .942

2) $\log_{10}\overline{V} = 0.5580 + 2.4848\ (\log_{10}S)$ CI = 1.3660 - 3.6037
r = .931

3) $\log_{10}R = 0.0792 + 1.6557\ (\log_{10}S)$ CI = 0.9841 - 2.3273
r = .943

where Q = discharge
S = stage
$\overline{V}$ = Mean cross-sectional velocity
R = hydraulic radius
CI = 95% confidence interval of b
r = correlation

Appendix 6. Flow Summary Table - Creek Mile 422.7, Location 2.

Date	Stage (m) Datum Elevation	Stage (m) Above Zero Datum	Discharge (m^3/sec) Meas.	Discharge (m^3/sec) Calc.	(Area) (m^2) Meas.	Velocity (m/mc) Meas.	Velocity (m/mc) Calc.	Hyd. Radius (m) Meas.	Hyd. Radius (m) Calc.	Slope %	Comments
April 29			2.84		2.37	1.20		0.20			Flow on ice
May 1			1.94		1.96	0.99		0.26			Flow on ice
May 21	168.027	.287	0.10	0.16	0.39	0.26	0.33	0.14	0.17		Permanent discharge station 30.5m D/S of staff gauge
May 28	168.014	.274	0.15	0.14	0.46	0.33	0.31	0.16	0.16		
May 29	168.040	.300	0.20	0.18	0.55	0.36	0.36	0.19	0.18		
June 4	167.984	.244	0.15	0.10	0.46	0.32	0.26	0.16	0.14		
June 10	167.934	.194	0.06	0.05	0.32	0.19	0.18	0.12	0.12	1.72	SLOPE June 11 - 15.24m U/S and D/S from Discharge Station
June 17	167.924	.184	0.05	0.05	0.28	0.18	0.16	0.11	0.11		
June 24	167.911	.171	0.03	0.04	0.25	0.12	0.15	0.10	0.10	1.77	SLOPE June 25 - 15.24M U/S and D/S from Discharge Station

Equations:

1) $\log_{10}Q = 0.6958 + 2.7532\ (\log_{10}S)$ CI = 1.3809 - 4.1254
r = .918

2) $\log_{10}\overline{V} = 0.3823 + 1.5868\ (\log_{10}S)$ CI = 0.7635 - 2.4102
r = .912

3) $\log_{10}R = 0.2629 + .9408\ (\log_{10}S)$ CI = 0.4288 - 1.4528
r = .904

where Q = Discharge
$\underline{S}$ = stage
$\overline{V}$ = Mean cross-sectional velocity
R = hydraulic radius
CI = 95% confidence interval of b
r = correlation

Appendix 7. Flow Summary Table - Creek Mile 422.7, Location 3.

Date	Stage (m) Datum Elevation	Stage (m) Above Zero Datum	Discharge (m^3/sec) Meas.	Discharge (m^3/sec) Calc.	(Area) (m^2) Meas.	Velocity (m/mc) Meas.	Velocity (m/mc) Calc.	Hyd. Radius (m) Meas.	Hyd. Radius (m) Calc.	Slope %	Comments
May 15	171.110	.420	0.19	0.24	0.64	0.30	0.32	0.21	0.23		
May 21	171.062	.372	0.12	0.15	0.60	0.20	0.24	0.21	0.20		
May 28	171.062	.372	0.14	0.15	0.62	0.23	0.24	0.19	0.20		
May 29	171.111	.421	0.27	0.24	0.80	0.34	0.32	0.23	0.23		
June 4	171.064	.374	0.20	0.15	0.68	0.29	0.24	0.23	0.20		
June 10	171.002	.312	0.10	0.07	0.53	0.19	0.16	0.20	0.17	1.41	SLOPE - June 11 - 15.24m U/S and D/S from Discharge Station
June 17	170.973	.283	0.05	0.05	0.38	0.13	0.13	0.15	0.15		
June 24	170.968	.278	0.04	0.05	0.35	0.11	0.12	0.13	0.15	1.56	SLOPE - June 25 - 15.24m U/S and D/S from Discharge Station

Equations:

1) $\log_{10}Q = 0.8302 + 3.8658\ (\log_{10}S)$ CI = 2.6003 - 5.1312
r = .950

2) $\log_{10}\overline{V} = 0.3747 + 2.3104\ (\log_{10}S)$ CI = 1.5344 - 3.0863
r = .948

3) $\log_{10}R = 0.2496 + 1.0383\ (\log_{10}S)$ CI = 0.3792 - 1.6974
r = .844

where Q = Discharge
S = stage
$\overline{V}$ = Mean cross-sectional velocity
R = hydraulic radius
CI = 95% confidence interval of b
r = correlation

Appendix E. Flow Summary Table - Creek Mile 422.7, Location 4.

Date	Stage (m) Datum Elevation	Stage (m) Above Zero Datum	Discharge (m^3/sec) Meas.	Discharge (m^3/sec) Calc.	(Area) (m^2) Meas.	Velocity (m/mc) Meas.	Velocity (m/mc) Calc.	Hyd. Radius (m) Meas.	Hyd. Radius (m) Calc.	Slope %	Comments
April 29			2.21		2.94	0.75		0.13			Flow over ice
May 6	173.53	.50	0.71	0.51	1.08	0.66	0.66	0.26	0.23		
May 15	173.41	.38	0.23	0.33	0.58	0.40	0.48	0.20	0.21		
May 21	173.30	.27	0.11	0.20	0.46	0.24	0.32	0.19	0.20		
May 28	173.25	.22	0.13	0.14	0.45	0.29	0.26	0.18	0.19		
May 29	173.29	.26	0.23	0.18	0.62	0.37	0.31	0.20	0.20		
June 4	173.20	.17	0.18	0.09	0.62	0.29	0.19	0.20	0.18		
June 10	173.14	.11	0.06	0.05	0.47	0.14	0.11	0.18	0.17	2.32	SLOPE - June 11 - 15.24m U/S and D/S from Discharge Station
June 17	173.12	.09	0.03	0.04	0.42	0.07	0.09	0.17	0.16		
June 24	173.124	.094	0.03	0.04	0.40	0.08	0.10	0.16	0.16	2.17	SLOPE - June 25 - 15.24m U/S and D/S from Discharge Station

Equations:

1) $\log_{10}Q = 0.1788 + 1.5618\,(\log_{10}S)$ CI = 1.0051 - 2.1185
r = .929

2) $\log_{10}\overline{V} = 0.1692 + 1.1579\,(\log_{10}S)$ CI = 0.7969 - 1.5190
r = .944

3) $\log_{10}R = 0.5861 + 0.1953\,(\log_{10}S)$ CI = 0.0633 - 0.3272
r = .798

where Q = discharge
S = stage
$\overline{V}$ = Mean cross-sectional velocity
R = hydraulic radius
CI = 95% confidence interval of b
r = correlation

Appendix 9. Water Chemistry Data For Creek Mile 422.7, 1976.

Analysis	Location	Date: April 28	May 12	May 31	June 9	July 6	July 20	Aug. 3	Aug. 18	Aug. 31	Sept. 15	Sept. 28	Oct. 14
Suspended N µg/L	1	142	50	47	3	20	84	87	18	N/S	<1	N/S	15
	2	149	83	43	15	63	22	1	11	73	<1	<1	16
	3	151	156	37	4	<1	17	30	3	9	8	26	47
	4	99	85	53	19	6	41	7	4	11	<1	17	36
Total Dissolved N µg/L	1	670	420	460	320	310	370	260	340	N/S	290	350	350
	2	660	420	460	330	330	360	300	320	270	280	320	340
	3	670	390	480	330	360	410	280	320	270	300	280	290
	4	670	410	460	340	350	430	290	320	260	290	280	320
Suspended P µg/L	1	44	13	2	1	1	4	1	<1	N/S	1	<1	1
	2	32	1	2	1	1	<1	2	<1	2	1	<1	1
	3	29	1	2	2	1	<1	2	<1	<1	<1	<1	1
	4	20	<1	3	1	<1	<1	2	<1	1	<1	<1	1
Total Dissolved P µg/L	1	18	10	5	4	7	5	4	4	N/S	4	8	13
	2	17	10	5	4	8	3	3	2	3	3	7	14
	3	15	10	5	4	11	2	3	2	2	3	7	9
	4	14	10	6	4	5	3	3	3	2	3	7	10
Suspended C µg/L	1	2350	910	310	220	340	400	270	200	N/S	100	N/S	220
	2	2910	530	260	240	290	190	450	130	250	140	170	330
	3	2240	490	380	420	370	80	510	170	480	130	250	160
	4	1600	460	340	240	190	130	230	190	230	150	300	530

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Appendix 9. Continued

Analysis	Location	April 28	May 12	May 31	June 9	July 6	July 20	Aug. 3	Aug. 18	Aug. 31	Sept. 15	Sept. 28	Oct. 14
		Date											
Si mg/L	1	1.47	1.77	1.96	2.12	2.56	2.70	2.80	2.82	N/S	2.71	2.71	2.75
	2	1.48	1.76	1.93	2.12	2.60	2.68	2.80	2.83	2.77	2.70	2.68	2.74
	3	1.48	1.75	1.93	2.14	2.62	2.67	2.77	2.84	2.71	2.68	2.70	2.74
	4	1.47	1.75	1.92	2.12	2.59	2.68	2.76	2.83	2.70	2.67	2.68	2.78
Cl mg/L	1	1.0	1.0	1.2	1.6	1.0	1.8	0.8	1.8	N/S	1.2	1.2	1.0
	2	1.0	0.8	0.8	1.2	1.0	1.6	0.8	1.4	1.4	1.0	1.0	0.6
	3	1.0	0.8	0.8	1.8	0.6	1.6	1.2	1.4	1.2	1.0	1.2	0.8
	4	1.2	1.2	1.0	0.8	0.4	1.6	1.0	1.4	1.0	1.2	1.2	0.6
SO_4 mg/L	1	5.4	4.6	5.4	5.6	5.2	5.6	3.8	4.6	N/S	5.6	5.6	6.8
	2	5.4	4.2	5.6	5.4	4.0	3.8	3.8	3.4	4.4	4.2	4.4	5.2
	3	5.4	4.2	5.8	4.0	4.0	3.0	3.8	3.4	4.4	4.2	4.4	5.0
	4	5.6	4.2	5.6	4.8	4.0	3.4	3.8	3.4	4.4	4.0	4.4	5.0
Total Suspended Solids mg/L	1	51	40	5	2	2	<1	1	<1	N/S	<1	1	15
	2	43	11	5	1	<1	1	4	<1	4	1	1	12
	3	42	5	6	5	<1	<1	4	<1	7	1	<1	4
	4	22	6	8	1	1	<1	1	<1	1	1	<1	10
Total Dissolved Solids mg/L	1	120	160	160	210	240	300	290	290	N/S	250	250	240
	2	120	160	160	210	520	300	260	250	260	260	290	260
	3	130	160	160	210	240	260	280	250	250	260	250	230
	4	130	160	170	210	240	280	260	240	260	260	260	270

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Appendix 9. Continued

Analysis	Location	Date											
		April 28	May 12	May 31	June 9	July 6	July 20	Aug. 3	Aug. 18	Aug. 31	Sept. 15	Sept. 28	Oct. 14
Na mg/L	1	0.27	0.75	1.01	1.03	1.25	1.52	1.50	1.62	N/S	2.25	1.51	1.58
	2	0.27	0.70	0.94	1.26	1.06	1.31	1.22	1.34	1.52	1.95	1.17	1.20
	3	0.27	0.64	0.98	1.21	1.01	1.25	1.19	1.21	1.48	1.93	1.20	1.28
	4	0.30	0.61	1.01	0.82	1.00	1.20	1.16	1.37	1.37	1.98	1.16	1.19
K mg/L	1	0.86	0.67	0.36	0.44	0.53	0.67	0.77	0.65	N/S	0.64	0.73	0.73
	2	0.83	0.61	0.30	0.48	0.43	0.60	0.74	0.60	0.74	0.61	0.62	0.66
	3	0.84	0.66	0.30	0.50	0.41	0.60	0.67	0.58	0.65	0.62	0.62	0.66
	4	0.82	0.64	0.30	0.40	0.43	0.54	0.67	0.51	0.65	0.61	0.64	0.64
Ca mg/L	1	17.4	32.6	37.4	48.9	69.8	62.0	47.8	63.4	N/S	58.2	65.5	65.5
	2	17.7	33.3	36.1	46.0	64.4	63.2	62.6	64.6	64.6	61.2	66.5	65.5
	3	17.8	32.3	35.8	47.6	65.0	62.6	64.5	64.0	61.4	59.0	65.5	65.5
	4	18.1	32.5	36.6	46.5	62.6	63.2	61.3	60.8	62.1	56.7	66.0	66.0
Mg mg/L	1	4.06	7.40	9.64	11.6	15.9	15.5	9.77	17.4	N/S	16.7	15.0	15.4
	2	4.06	7.36	10.5	10.6	14.2	14.9	15.2	28.1	17.5	16.1	14.9	15.4
	3	4.16	7.45	9.17	11.2	14.0	14.8	15.2	27.6	17.4	15.3	14.2	15.3
	4	3.92	7.31	7.86	10.7	14.2	14.5	15.1	26.8	17.7	15.8	15.0	14.7

N/S = No Sample

Appendix 10. Bed Material Analysis - Creek Mile 426.5, Location 9.

VISUAL DESCRIPTION AND SAMPLING PROCEDURE

Visually described as a boulder-cobble riffle section between steep clay-organic banks. Approximately 75% bed area was comprised of boulders of which 7 were measured in situ along 3 axes (Table 10-1). The other 25% of bed area was made up mainly of cobbles and gravel. A sample of this material was taken and analyzed. That portion of the sample retained by a 7.62 cm (3") mesh was measured individually along 3 axes (Table 10-2). The grain size distribution for the entire sample is presented in Figure 10-1.

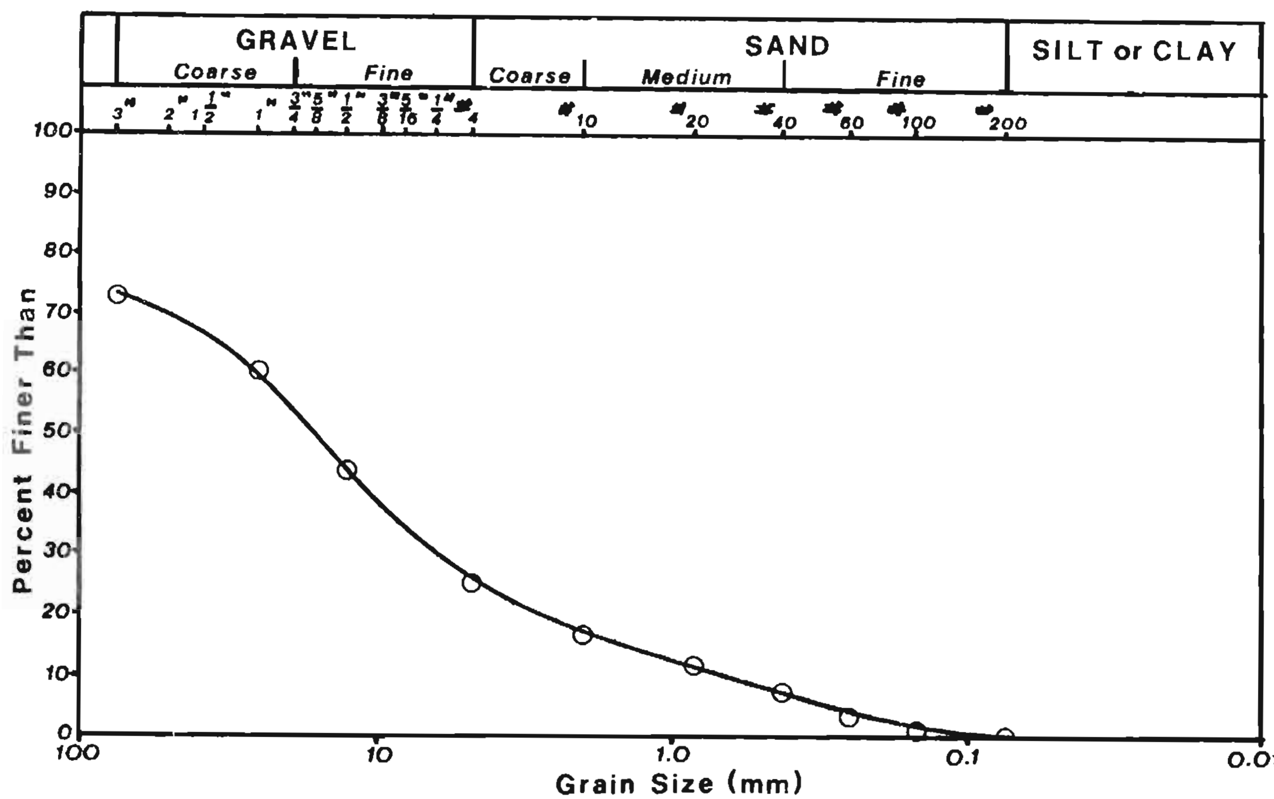
Table 10-1. Boulders

AXIS (cm)	N	$\bar{X}$	SD	SE
Long	7	26.7	10.24	3.87
Short	7	13.8	8.53	3.23
Intermediate	7	19.9	7.69	2.91

Table 10-2. Cobbles

AXIS (cm)	N	$\bar{X}$	SD	SE
Long	2	8.5	2.12	1.50
Short	2	4.0	0.00	0.00
Intermediate	2	5.5	0.71	0.50

Figure 10-1. Grain Size Distribution Sample Wt = 3579.5 g



Appendix 11. Bed Material Analysis - Creek Mile 426.5, Location 10.

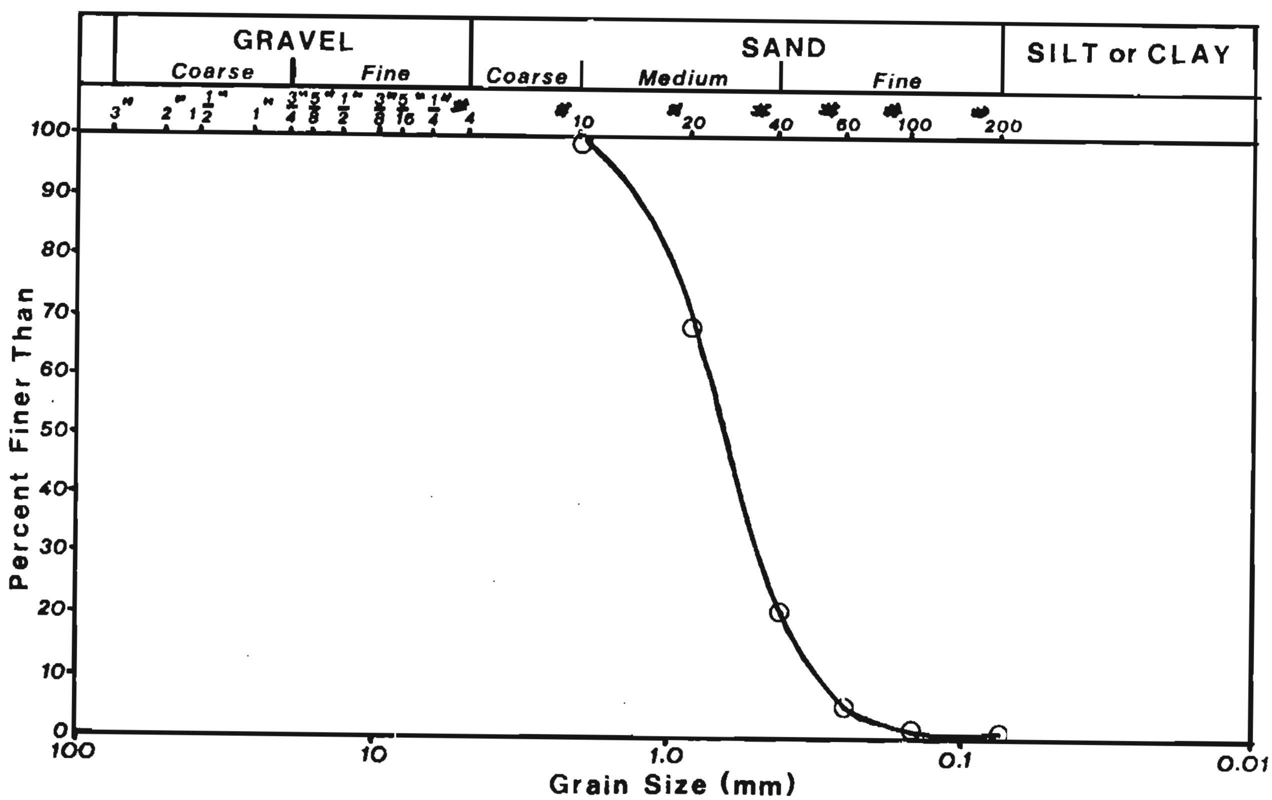
VISUAL DESCRIPTION AND SAMPLING PROCEDURE

Visually described as a boulder riffle with a small amount of sand between boulders. Well rounded boulders made up approximately 95% of bed area. Five (5) of these were measured in situ along 3 axes (Table 11-1). A sample of sand which comprised approximately 5% of bed area was collected. The grain size distribution for this sample is presented in Figure 11-1).

Table 11-1. Boulders

AXIS (cm)	N	$\overline{X}$	SD	SE
Long	5	45.7	21.85	9.77
Short	5	33.5	15.49	6.93
Intermediate	5	37.6	15.07	6.74

Figure 11-1. Grain Size Distribution Sample Wt = 832.5 g



Appendix 12 . Bed Material Analysis - Creek Mile 426.5, Location 11.

VISUAL DESCRIPTION AND SAMPLING PROCEDURE

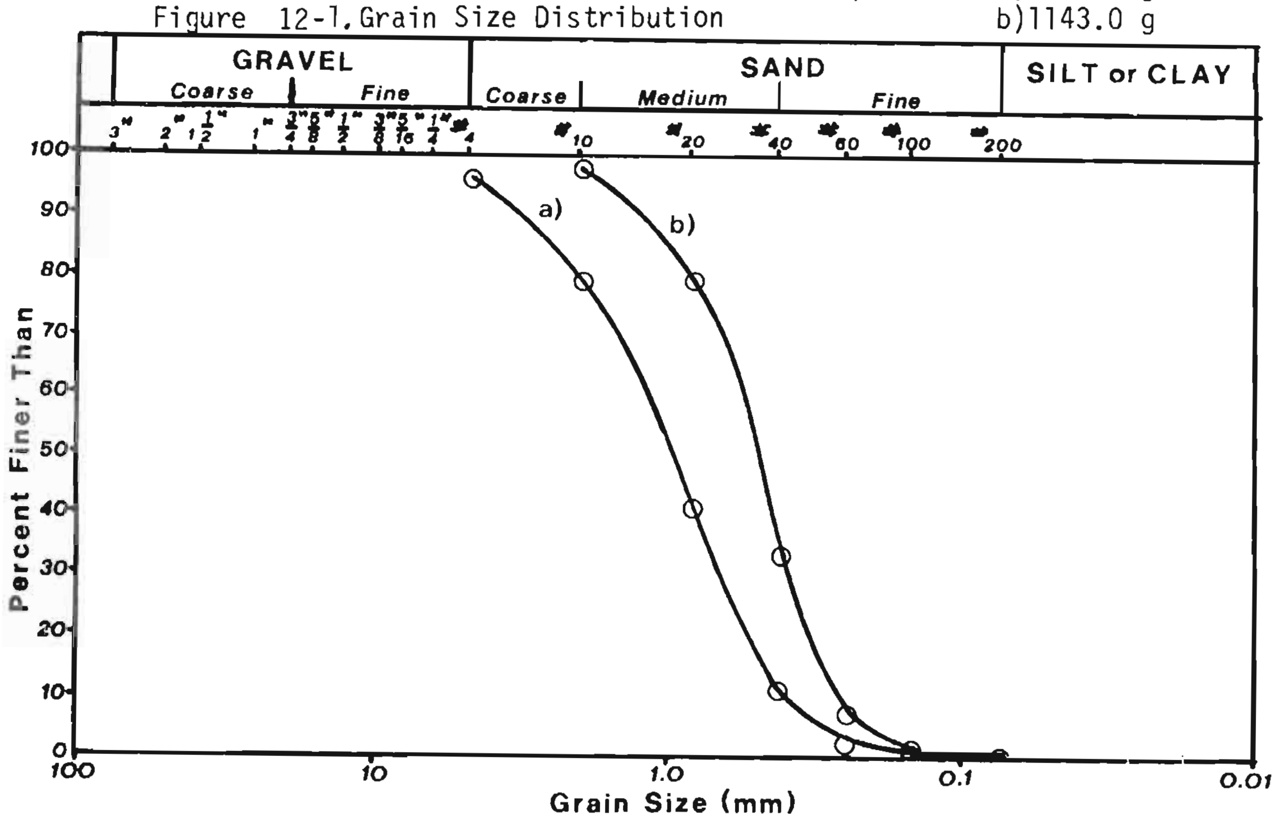
Visually described as a boulder riffle with sand interspersed. Boulders comprised approximately 80% of bed area. Six (6) of these were measured in situ along 3 axes. (Table 12-1). Sand made up the other approximate 20% of bed area. A sample was taken of coarse sand in mid channel (Figure 12-1a) and another sample was taken of finer sand near the north shore (Figure 12-1b).

Table 12-1. Boulders

AXIS (cm)	N	$\bar{X}$	SD	SE
Long	6	26.3	11.22	4.58
Short	6	19.1	9.18	3.75
Intermediate	6	22.4	10.47	4.27

Sample Wt = a) 529.5 g
b) 1143.0 g

Figure 12-1. Grain Size Distribution



Appendix 13. Flow Summary Table - Creek Mile 426.5, Location 9.

Date	Stage (m) Datum Elevation	Stage (m) Above Zero Datum	Discharge (m^3/sec) Meas.	Discharge (m^3/sec) Calc.	Area (m^2) Meas.	Velocity (m/mc) Meas.	Velocity (m/mc) Calc.	Hyd. Radius (m) Meas.	Hyd. Radius (m) Calc.	Slope %	Comments
May 19	73.48	0.29	0.24	0.25	0.64	0.38	0.38	0.17	0.17		
May 26	73.46	0.27	0.19	0.21	0.59	0.32	0.33	0.15	0.16		
June 2	73.50	0.31	0.32	0.29	0.67	0.48	0.42	0.18	0.18		
June 9	73.49	0.30	0.26	0.27	0.72	0.36	0.40	0.19	0.17	3.29	SLOPE June 10-9.14m U/S and D/S from Discharge Section
June 22	73.338	0.198	0.10	0.10	0.51	0.20	0.20	0.13	0.13	3.29	SLOPE 9.14m U/S and D/S from Discharge Section
June 30	73.495	0.305	0.07		0.44	0.16					Mackenzie Back Up

Equations:

1) $\log_{10}Q = 0.7005 + 2.4370\ (\log_{10}S)$ CI = 1.7311 - 3.1429
r = .988

2) $\log_{10}\overline{V} = 0.5025 + 1.7208\ (\log_{10}S)$ CI = 0.8548 - 2.5868
r = .965

3) $\log_{10}R = 0.4004 + 0.6854\ (\log_{10}S)$ CI = 0.1829 - 1.1878
r = .93

where Q = discharge
S = stage
$\overline{V}$ = mean cross sectional velocity
R = hydraulic radius
CI = 95% confidence interval of b
r = correlation

Appendix 14. Flow Summary Table - Creek Mile 426.5, Location 10.

Date	Stage (m) Datum Elevation	Stage (m) Above Zero Datum	Discharge (m^3/sec) Meas.	Discharge (m^3/sec) Calc.	Area (m^2) Meas.	Velocity (m/mc) Meas.	Velocity (m/mc) Calc.	Hyd. Radius (m) Meas.	Hyd. Radius (m) Calc.	Slope %	Comments
May 5	183.60	0.68	0.84	1.18	1.20	0.70	0.79	0.24	0.32		
May 13	183.37	0.45	0.28	0.26	0.65	0.43	0.38	0.27	0.24		
May 20	183.30	0.38	0.15	0.14	0.47	0.32	0.28	0.22	0.21		
May 27	183.28	0.36	0.15	0.11	0.48	0.31	0.25	0.24	0.20		
June 3	183.32	0.40	0.17	0.17	0.62	0.28	0.31	0.28	0.22		
June 9	183.26	0.34	0.10	0.09	0.47	0.21	0.23	0.23	0.20	4.97	SLOPE-June 11-15.24m U/S and D/S from Discharge section
June 17	183.18	0.26	0.02	0.03	0.17	0.12	0.14	0.11	0.16	5.12	SLOPE-June 25-15.24m U/S and D/S from Discharge Section

Equations:

1) $\log_{10}Q = 0.6651 + 3.6668\ (\log_{10}S)$ CI = 2.6297 - 4.7038
r = .971

2) $\log_{10}\overline{V} = 0.1984 + 1.7859\ (\log_{10}S)$ CI = 1.2293 - 2.3425
r = .965

3) $\log_{10}R = 0.3833 + 0.6894\ (\log_{10}S)$ CI = 0 - 1.6322
r = .644

where Q = discharge
S = stage
$\overline{V}$ = mean cross sectional velocity
R = hydraulic radius
CI = 95% confidence interval of b
r = correlation

Appendix 15. Flow Summary Table - Creek Mile 426.5, Location 11.

Date	Stage (m) Datum Elevation	Stage (m) Above Zero Datum	Discharge (m^3/sec) Meas.	Discharge (m^3/sec) Calc.	Area (m^2) Meas.	Velocity (m/mc) Meas.	Velocity (m/mc) Calc.	Hyd. Radius (m) Meas.	Hyd. Radius (m) Calc.	Slope %	Comments
May 5	188.58	0.66	0.64	0.74	0.65	0.98	0.92	0.29	0.33		
May 13	188.34	0.42	0.18	0.21	0.31	0.59	0.55	0.16	0.18		
May 20	188.27	0.35	0.14	0.12	0.25	0.56	0.44	0.14	0.16		
May 27	188.23	0.31	0.10	0.09	0.33	0.31	0.39	0.17	0.12		
June 3	188.26	0.34	0.15	0.11	0.33	0.45	0.43	0.17	0.14		
June 9	188.21	0.29	0.09	0.07	0.25	0.35	0.36	0.13	0.11		
June 17	188.12	0.20	0.01	0.02	0.08	0.12	0.23	0.05	0.07	3.82	SLOPE June 11-15.24m U/S and D/S from Discharge Section
July 1	188.05	0.13	0.01	0.01	0.05	0.22	0.14	-	0.04	3.89	SLOPE June 25-15.24m U/S and D/S from Discharge Section

Equations:

1) $\log_{10}Q = 0.3965 + 2.8701\ (\log_{10}S)$ CI = 2.1521 - 3.5882
r = .970

2) $\log_{10}\overline{V} = 0.1743 + 1.1575\ (\log_{10}S)$ CI = 0.4918 - 1.8231
r = .867

3) $\log_{10}R = 0.2439 + 1.3000\ (\log_{10}S)$ CI = 0.6748 - 1.9251
r = .923

where Q = discharge
S = stage
$\overline{V}$ = mean cross sectional velocity
R = hydraulic radius
CI = 95% confidence interval of b
r = correlation

Appendix 16. Water Chemistry Data For Creek Mile 426.5, 1976.

Analysis	Location	April 28	May 12	May 31	June 9	July 6	July 20	Aug. 3	Aug. 18	Aug. 31	Sept. 15	Sept. 28	Oct. 14
Suspended N	9	368	N/S	95	191	67	17	N/S	7	51	<1	6	27
μg/L	10	76	N/S	43	36	<1	55	234	22	57	4	46	N/S
	11	106	61	181	24	14	51	40	53	118	4	35	N/S
Total	9	700	410	460	560	230	220	N/S	210	150	130	170	140
Dissolved N	10	660	410	550	530	550	630	590	500	390	410	480	N/S
μg/L	11	670	420	600	530	560	530	540	500	400	410	480	N/S
Suspended P	9	283	38	39	95	15	4	N/S	3	3	1	2	1
μg/L	10	10	5	2	3	2	3	6	1	2	1	2	N/S
	11	9	1	2	2	1	1	3	2	3	3	1	N/S
Total	9	17	11	12	9	6	2	N/S	3	3	3	8	5
Dissolved P	10	16	9	6	13	13	4	4	4	4	3	8	N/S
μg/L	11	14	9	7	5	12	4	7	4	4	5	9	N/S
Suspended C	9	10740	1170	1760	4290	810	260	N/S	290	340	190	380	70
μg/L	10	1200	130	310	400	380	800	1630	240	510	290	580	N/S
	11	1020	630	310	380	310	320	380	250	690	480	380	N/S
Si	9	2.03	1.70	2.00	2.42	4.07	4.61	N/S	4.61	4.59	4.48	4.59	4.55
mg/L	10	1.97	1.08	0.866	1.01	1.84	2.06	2.06	2.40	2.32	2.38	2.53	N/S
	11	1.97	1.08	0.862	1.02	1.79	1.96	1.97	2.37	2.32	2.36	2.51	N/S
Cl	9	5.8	9.4	17.2	23.8	62.0	81.0	N/S	95.0	76	90.5	84.5	69.0
mg/L	10	1.2	0.8	0.8	1.0	0.6	2.2	0.6	2.2	2.4	3.2	1.4	N/S
	11	1.2	1.2	0.8	0.6	0.6	1.8	0.4	1.8	1.4	2.2	1.2	N/S

.../cont'd

Appendix 16. Continued

Analysis	Location	April 28	May 12	May 31	June 9	July 6	July 20	Aug. 3	Aug. 18	Aug. 31	Sept. 15	Sept. 28	Oct. 14
SO_4	9	9.4	17.4	23.2	23.8	57.0	60.0	N/S	26.5	74.0	61.0	55.8	73.0
mg/L	10	5.2	3.8	4.4	6.4	4.2	4.0	3.6	4.0	6.4	6.4	6.6	N/S
	11	5.0	3.6	4.4	5.4	4.2	3.6	5.6	4.4	5.6	5.6	6.0	N/S
Total	9	460	81	66	149	28	9	N/S	7	4	1	6	11
Suspended	10	6	6	3	5	3	4	8	1	2	1	3	N/S
Solids mg/L	11	5	4	1	1	2	1	1	1	4	2	1	N/S
Total	9	160	230	230	280	440	470	N/S	450	470	490	450	520
Dissolved	10	140	130	160	180	210	220	240	220	240	240	230	N/S
Solids mg/L	11	140	140	140	150	210	130	220	220	240	210	230	N/S
Na	9	3.64	9.40	14.3	17.2	46.0	59.1	N/S	56.1	59.9	57.1	54.4	56.1
mg/L	10	0.49	0.82	0.92	0.76	0.76	1.44	2.46	1.54	1.79	2.36	1.52	N/S
	11	0.47	0.60	0.87	0.74	0.69	0.92	0.89	1.07	1.25	1.73	1.00	N/S
K	9	1.13	0.80	0.70	0.81	1.53	1.68	N/S	1.90	1.99	1.80	1.98	1.85
mg/L	10	1.02	0.44	0.18	0.24	0.31	0.44	0.60	0.56	0.62	0.57	0.62	N/S
	11	0.99	0.41	0.16	0.20	0.31	0.47	0.58	0.54	0.65	0.57	0.62	N/S
Ca	9	24.8	32.2	41.4	46.0	77.1	80.4	N/S	69.1	76.8	80.7	80.0	84.1
mg/L	10	24.1	24.8	29.9	33.4	47.6	46.6	55.9	55.0	56.3	54.1	59.1	N/S
	11	23.6	24.6	29.1	33.5	52.4	49.7	54.0	51.8	56.3	51.5	57.5	N/S
Mg	9	5.68	7.83	11.4	13.2	22.2	25.3	N/S	37.3	30.1	22.8	25.3	27.0
mg/L	10	4.87	4.91	5.69	6.33	9.50	11.7	11.5	24.2	14.1	13.2	12.1	N/S
	11	4.78	4.78	5.35	6.61	9.29	11.0	11.1	23.7	13.5	12.5	11.7	N/S

N/S = No Sample

Appendix 17. Bed Material Analysis - Smith Creek, Location 5.

VISUAL DESCRIPTION AND SAMPLING PROCEDURE

Visually described as having a substrate of coarse gravel with occasional cobbles. Approximately 95% of the bed area was cobble size or smaller. A surface sample of $1 m^2$ of bed was collected. The cobbles in this sample (i.e. retained on 7.62 cm (3") mesh) were separated and measured (Table 17-1). The grain size distribution for the entire sample is presented in Figure 17-1a. A composite subsurface sample under $1 m^2$ of bed was taken and analyzed for grain size distribution (Figure 17-1b). A surface sample of the transitional zone between cobbles in the channel and the vegetated higher bank was also taken and analyzed (Figure 17-1c).

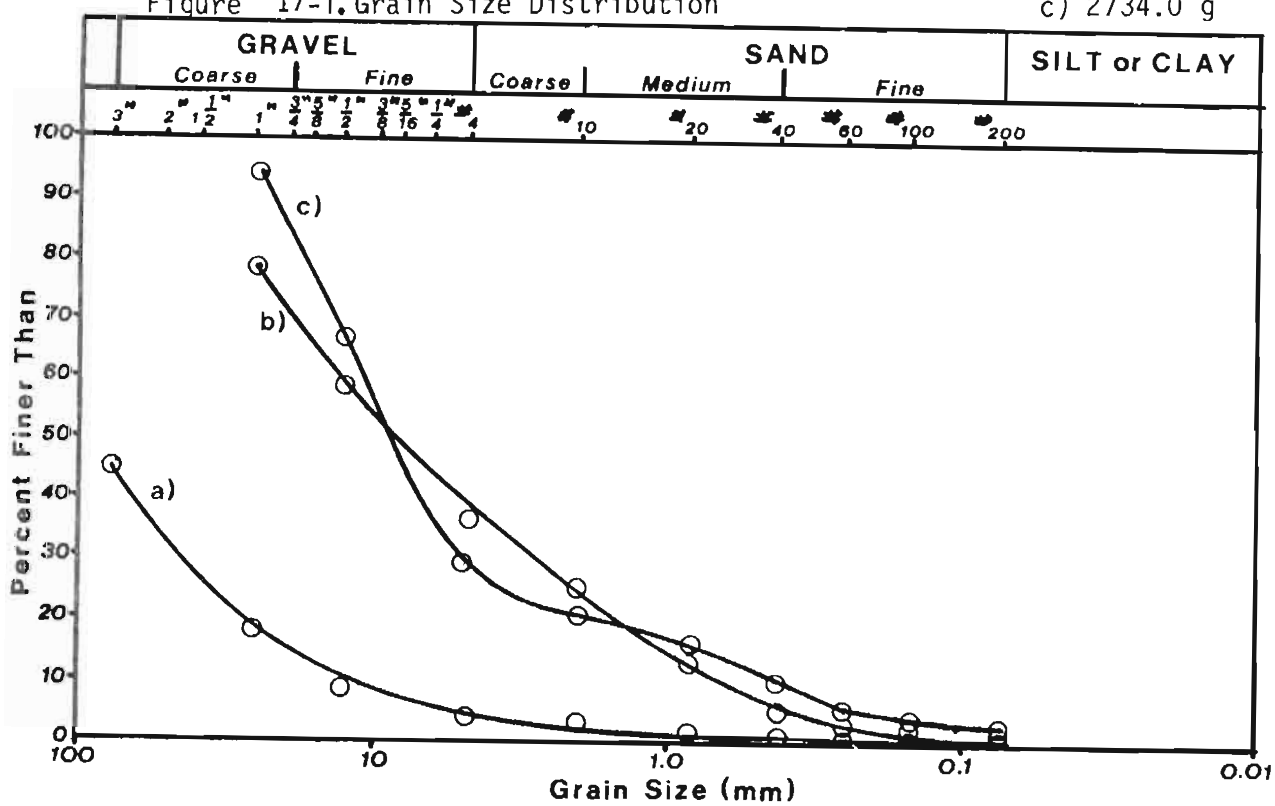
Table 17-1. Cobbles

Wt Cobbles and Tare 2524.0 g Wt Tare 200.0 g Wt Cobbles 2324.0 g

AXIS (cm)	N	$\bar{X}$	SD	SE
Long	5	9.8	1.30	0.58
Short	5	5.0	0.71	0.32
Intermediate	5	6.8	1.79	0.80

Sample Wt = a) 4175.4 g
b) 2066.5 g
c) 2734.0 g

Figure 17-1. Grain Size Distribution



Appendix 18. Bed Material Analysis - Smith Creek, Location 6.

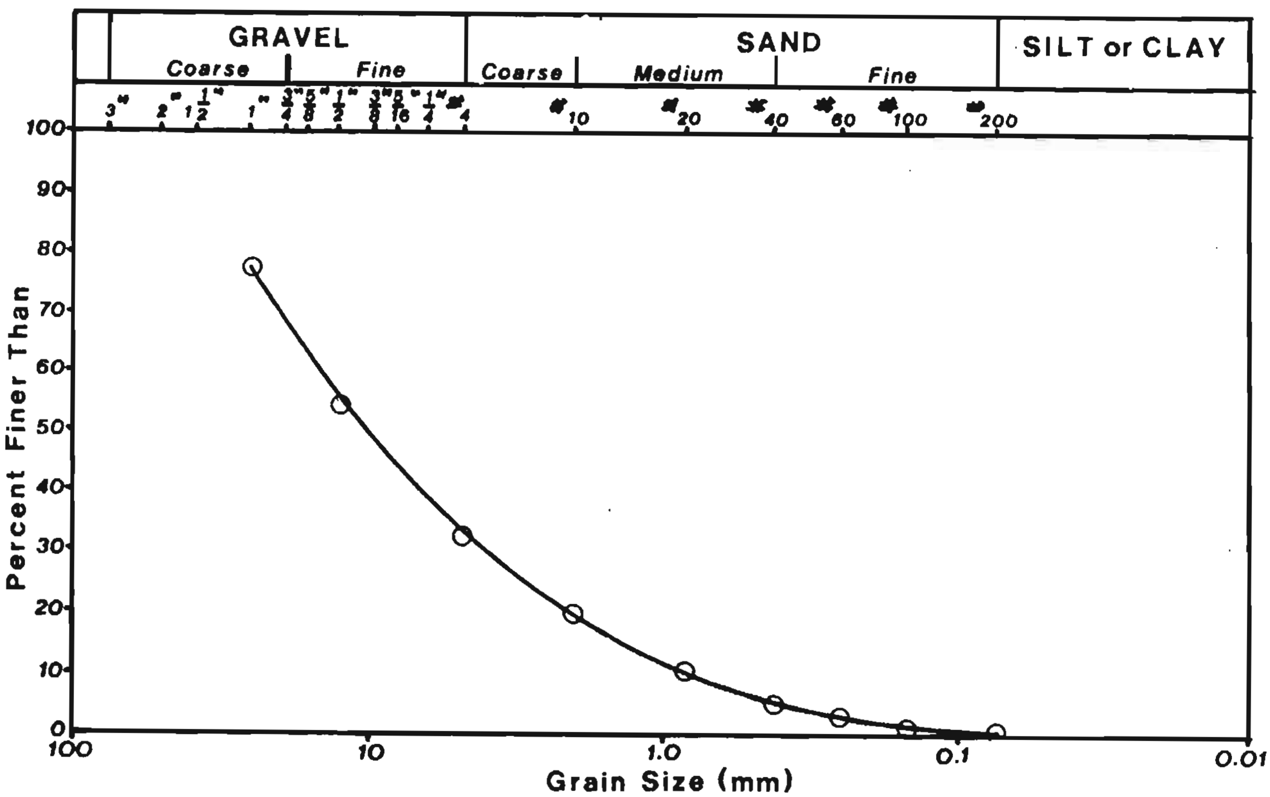
VISUAL DESCRIPTION AND SAMPLING PROCEDURE

Visually described as a cobble and gravel area. Approximately 75% of the bed area was covered by large cobbles. Seven (7) of these were measured in situ along 3 axes and the results are presented in Table 18-1. Approximately 25% of the bed area was made up of gravel. A sample of this material was collected and results of grain size determination are presented in Figure 18-1. Fines from the sample may have been lost when it was collected from the stream bottom.

Table 18-1. Cobbles

AXIS (cm)	N	$\overline{X}$	SD	SE
Long	7	30.1	11.50	4.35
Short	7	14.9	8.61	3.25
Intermediate	7	21.50	5.81	2.20

Figure 18-1. Grain Size Distribution　　Sample Wt = 3148.5 g



Appendix 19, Bed Material Analysis - Smith Creek, Location 7.

VISUAL DESCRIPTION AND SAMPLING PROCEDURE

The south side of this section is visually described as consisting of large boulders with cobbles and coarse gravel interspersed. Six (6) boulders on the south side of the section were measured in situ along three axes (Table 19-1). A sample of the cobbles and coarse gravel between the boulders was taken and analyzed (Table 19-2). This sample consisted of 82.4% cobbles, 17.3% gravel larger than a 2.54 cm (3") mesh and 0.3% smaller gravel. The weight of gravel in the sample totaled 1210.5 g. A composite sample of the stream bed near the north side of the section was also taken (Table 19-4, Figure 19-1). This sample is representative of the main channel material. Some fines may have been lost in acquiring the samples but the loss is not considered significant here.

Table 19-1. Boulders

AXIS (cm)	N	$\overline{X}$	SD	SE
Long	6	51.6	32.87	13.42
Short	6	27.1	9.46	3.86
Intermediate	6	41.5	24.13	9.85

Table 19-2. Cobbles**

Long	12	10.0	2.45	0.71
Short	12	3.8	1.54	0.45
Intermediate	12	6.1	1.24	0.36

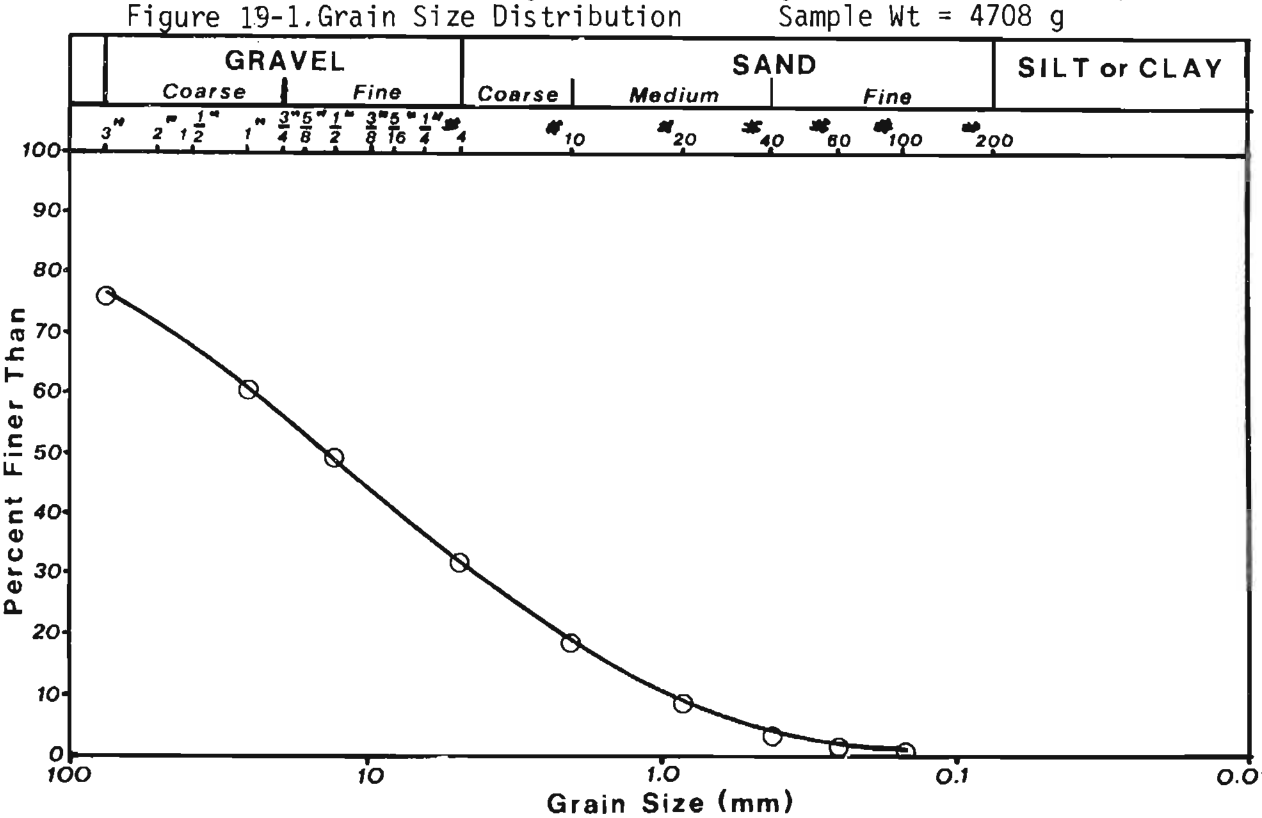
Table 19-3. Cobbles***

Long	4	7.5	1.29	0.65
Short	4	3.5	0.58	0.29
Intermediate	4	6.5	1.29	0.65

**Wt Cobbles and Tare 58.50 g Wt Tare 202.5 g Wt Cobbles 5648.0 g

***Wt Cobbles and Tare 1348.0 g Wt Tare 153.0 g Wt Cobbles 1195.0 g

Figure 19-1. Grain Size Distribution   Sample Wt = 4708 g



Appendix 20. Bed Material Analysis - Smith Creek, Location 8.

VISUAL DESCRIPTION AND SAMPLING PROCEDURE

Visually described as a cobble and coarse gravel substrate. Approximately 5-10% of the bed area was covered by boulders. A surface sample of cobble material was collected. That portion of the sample retained by the 7.62 cm (3") mesh was measured individually along three (3) axes. This data is presented in Table 20-1. The grain size distribution for the entire sample is presented in Figure 20-1a. A composite subsurface sample was also taken and the grain size distribution is presented in Figure 20-1b.

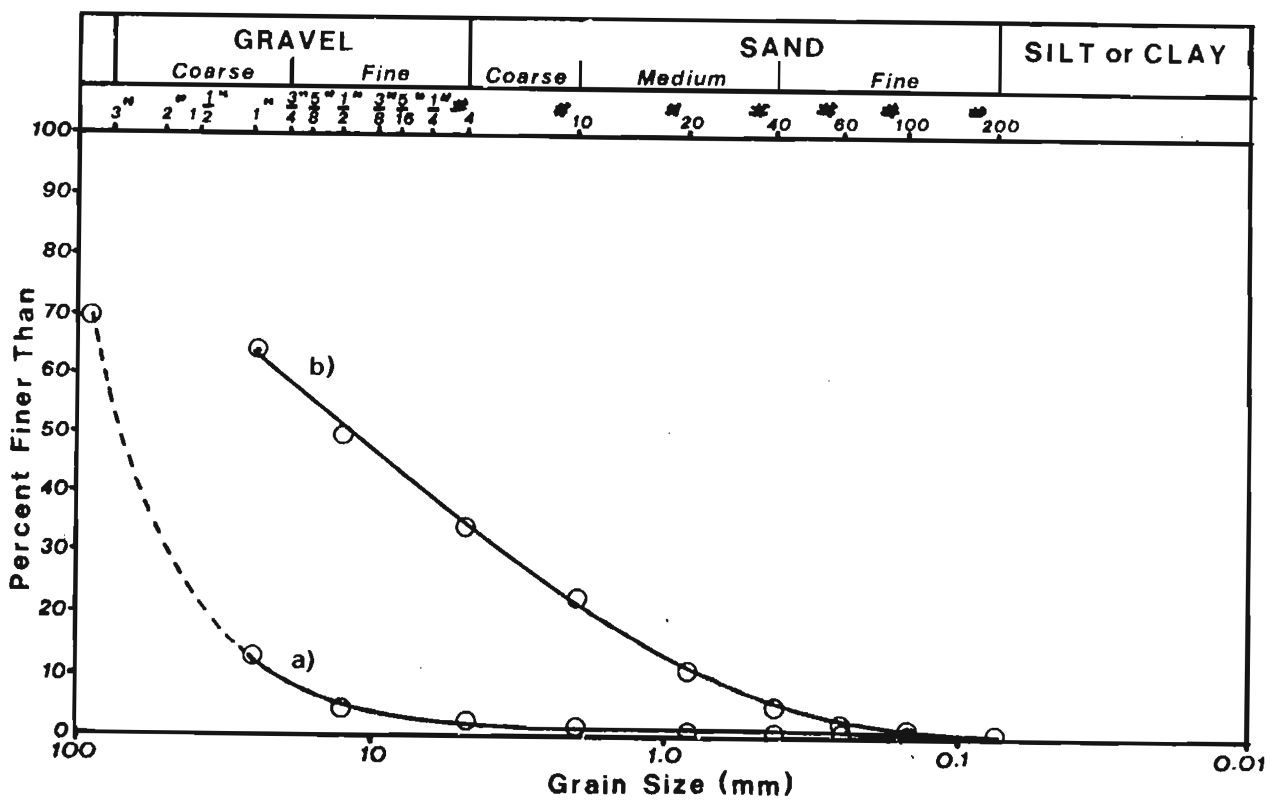
Table 20-1. Cobbles

Wt Tare and Cobbles 3846.1 g Wt Tare 155.0 g Wt Cobbles 3691.1 g

AXIS (cm)	N	$\bar{X}$	SD	SE
Long	5	12.4	3.44	1.54
Short	5	3.6	1.14	0.51
Intermediate	5	8.6	1.52	0.68

Sample Wt = a) 5304.1 g
b) 3365.9 g

Figure 20-1. Grain Size Distribution



Appendix 21. Flow Summary Table - Smith Creek, Location 5.

Date	Stage (m) Datum Elevation	Stage (m) Above Zero Datum	Discharge (m^3/sec) Meas.	Discharge (m^3/sec) Calc.	Area (m^2) Meas.	Velocity (m/mc) Meas.	Velocity (m/mc) Calc.	Hyd. Radius (m) Meas.	Hyd. Radius (m) Calc.	Slope %	Comments
May 5	76.43	0.42	3.39	3.21	4.76	0.72	0.73	0.45	0.44		
May 10	76.28	0.27	1.86	1.84	3.67	0.51	0.51	0.42	0.40		
May 17	76.19	0.18	1.01	1.10	2.95	0.34	0.36	0.39	0.37		
May 24	76.15	0.14	0.71	0.80	2.47	0.29	0.29	0.34	0.35		
May 31	76.33	0.32	2.83	2.28	4.30	0.66	0.58	0.41	0.42		
June 7	76.135	0.125	0.69	0.70	2.40	0.29	0.27	0.34	0.35	0.11	SLOPE-June 6 - 15.2m U/S and D/S from Discharge Station
June 14	76.103	0.093	0.41	0.48	2.17	0.19	0.21	0.32	0.33	0.19	SLOPE-June 13-15.2m U/S and D/S from Discharge Station
June 21	76.103	0.093	0.39	0.48	2.12	0.18	0.21	0.31	0.33		
June 28	76.06	0.05	0.24	0.22	1.80	0.13	0.12	0.30	0.29		
Oct 12	76.045	0.035	0.17	0.14	1.67	0.10	0.09	0.29	0.27		

Equations:

1) $\log_{10}Q = 0.9825 + 1.2628 (\log_{10}S)$ CI = 1.1150 - 1.4105
r = .990

2) $\log_{10}\overline{V} = 0.1796 + 0.8340 (\log_{10}S)$ CI = 0.7470 - 0.9210
r = .992

3) $\log_{10}R = 0.2850 + 0.1927 (\log_{10}S)$ CI = 0.1521 - 0.2332
r = .968

where Q = discharge
S = stage
$\overline{V}$ = Mean Cross-sectional velocity
R = hydraulic radius
CI = 95% confidence interval of b
r = correlation

Appendix 22. Flow Summary Table - Smith Creek, Location 6.

Date	Stage (m) Datum Elevation	Stage (m) Above Zero Datum	Discharge (m^3/sec) Meas.	Discharge (m^3/sec) Calc.	Area (m^2) Meas.	Velocity (m/mc) Meas.	Velocity (m/mc) Calc.	Hyd. Radius (m) Meas.	Hyd. Radius (m) Calc.	Slope %	Comments
April 22	78.81	0.14	1.07	0.75	2.40	0.45	0.39	0.37	0.30		
April 24	79.02	0.35	2.47	2.65	3.45	0.72	0.75	0.49	0.49		
April 25	79.09	0.42	3.61	3.40	4.04	0.89	0.86	0.57	0.55		
April 26	79.25	0.58	5.08	5.32	4.82	1.05	1.09	0.64	0.65		
May 2	79.25	0.58	5.66	5.32	5.26	1.08	1.09	0.66	0.65		
May 10	78.95	0.28	1.92	1.94	3.17	0.61	0.64	0.47	0.44		
May 17	78.85	0.18	1.01	1.06	2.14	0.47	0.47	0.32	0.34		
May 24	78.81	0.14	0.78	0.75	1.88	0.42	0.39	0.29	0.30		
May 31	79.06	0.39	2.77	3.07	3.33	0.83	0.82	0.47	0.52		
June 7	78.80	0.13	0.65	0.67	1.72	0.38	0.37	0.26	0.28	0.66	SLOPE-June6-15.2m U/S and D/S from discharge section
June 14	78.77	0.10	0.44	0.47	1.52	0.29	0.30	0.25	0.24	0.48	SLOPE-June 13'15.2m U/S and D/S from discharge section
June 21	78.77	0.10	0.42	0.47	1.50	0.28	0.30	0.24	0.24		
June 28	78.73	0.06	0.22	0.23	1.10	0.20	0.21	0.17	0.18		

Equations:

1) $\log_{10}Q = 1.0529 + 1.3826\ (\log_{10}S)$ CI = 1.2727 - 1.4925
r = .993

2) $\log_{10}\overline{V} = 0.2082 + 0.7252\ (\log_{10}S)$ CI = 0.6682 - 0.7822
r = .993

3) $\log_{10}R = 0.0526 + 0.5588\ (\log_{10}S)$ CI = 0.4865 - 0.6310
r = .982

where Q = discharge
S = stage
$\overline{V}$ = Mean cross sectional velocity
R = hydraulic radius
CI = 95% confidence interval of b
r = correlation

Appendix 23. Flow Summary Table - Smith Creek, Location 7.

Date	Stage (m) Datum Elevation	Stage (m) Above Zero Datum	Discharge (m^3/sec) Meas.	Discharge (m^3/sec) Calc.	Area (m^2) Meas.	Velocity (m/mc) Meas.	Velocity (m/mc) Calc.	Hyd. Radius (m) Meas.	Hyd. Radius (m) Calc.	Slope %	Comments
April 22	87.79	0.24	1.23	1.25	1.89	0.65	0.61	0.33	0.28		
April 27	88.49	0.92	*	7.31	*	*	1.33	-	0.52		*Incomplete
May 2	88.35	0.80	5.98	6.08	5.74	1.04	1.23	0.57	0.49		
May 10	87.93	0.38	1.95	2.28	2.52	0.77	0.80	0.29	0.35		
May 17	87.76	0.21	0.95	1.04	1.63	0.58	0.57	0.21	0.26		
May 24	87.71	0.16	0.74	0.73	1.34	0.55	0.49	0.19	0.23		
May 31	87.95	0.40	3.00	2.44	3.21	0.93	0.82	0.36	0.35		
June 7	87.70	0.15	0.68	0.67	1.43	0.47	0.47	0.25	0.22	1.39	SLOPE June 6 -15.2m U/S and D/S from Discharge Section
June 14	87.66	0.11	0.44	0.45	1.16	0.38	0.39	0.20	0.19	1.81	SLOPE June 13-15.2m U/S and D/S from Discharge Section
June 21	87.65	0.10	0.44	0.39	1.09	0.40	0.37	0.19	0.19		
June 28	87.61	0.06	0.19	0.20	0.84	0.23	0.28	0.16	0.15		

Equations:

1) $\log_{10}Q = 0.9116 + 1.3171 (\log_{10}S)$ CI = 1.2089 - 1.4253
r = .995

2) $\log_{10}\overline{V} = 0.1441 + 0.5756 (\log_{10}S)$ CI = 0.4616 - 0.6895
r = .972

3) $\log_{10}R = 0.2665 + 0.4648 (\log_{10}S)$ CI = 0.3182 - 0.6114
r = .933

where Q = discharge
$\underline{S}$ = stage
$\overline{V}$ = Mean cross sectional area
R = hydraulic radius
CI = 95% confidence interval of b
r = correlation

Appendix 24. Flow Summary Table - Smith Creek, Location 8.

Date	Stage (m) Datum Elevation	Stage (m) Above Zero Datum	Discharge (m^3sec) Meas.	Discharge (m^3sec) Calc.	Area (m^2) Meas.	Velocity (m/mc) Meas.	Velocity (m/mc) Calc.	Hyd. Radius (m) Meas.	Hyd. Radius (m) Calc.	Slope %	Comments
April 22	89.98	0.23	1.03	1.50	2.96	0.35	0.41	0.32	0.37		
April 26	90.25	0.50	5.34	4.86	6.06	0.88	0.88	0.50	0.45		
May 2	90.24	0.49	6.15	4.72	6.16	0.93	0.86	0.53	0.45		
May 10	90.01	0.26	2.01	1.81	3.84	0.52	0.47	0.37	0.38		
May 17	89.93	0.18	1.04	1.04	3.06	0.34	0.33	0.33	0.35		
May 24	89.90	0.15	0.71	0.79	2.70	0.26	0.27	0.32	0.33		
May 31	90.07	0.32	2.59	2.48	4.37	0.59	0.57	0.37	0.40		
June 7	89.87	0.12	0.59	0.56	2.52	0.23	0.22	0.30	0.31	0.26	SLOPE June 6-15.2m U/S and D/S from Discharge Section
June 14	89.86	0.11	0.39	0.49	2.17	0.18	0.20	0.30	0.21	0.32	SLOPE June 13-15.2m U/S and D/S from Discharge Section
June 21	89.86	0.11	0.37	0.49	2.23	0.17	0.20	0.31	0.31		
June 28	89.81	0.06	0.23	0.20	1.81	0.13	0.11	0.26	0.26		
Oct 12	89.79	0.04	0.14	0.11	1.70	0.08	0.08	0.27	0.24		

Equations:

1) $\log_{10}Q = 1.1426 + 1.5135\ (\log_{10}S)$ CI = 1.3237 - 1.7033
r = .985

2) $\log_{10}\overline{V} = 0.2347 + 0.9686\ (\log_{10}S)$ CI = 0.8735 - 1.0638
r = .990

3) $\log_{10}R = 0.2694 + 0.2539\ (\log_{10}S)$ CI = 0.1692 - 0.3386
r = .904

where Q = discharge
S = stage
$\overline{V}$ = mean cross-sectional velocity
R = hydraulic radius
CI = 95% confidence interval of b
r = correlation

Appendix 25. Water Chemistry Data For Smith Creek, 1976.

Analysis	Location	Date												
		April 28	May 12	May 31	June 9	July 7	July 21	Aug. 3	Aug. 18	Aug. 31	Sept. 15	Sept. 28	Oct. 14	Dec. 10
Suspended N µg/L	5	123	160	125	9	20	27	21	35	84	18	10	20	<1
	6	126	78	92	39	29	24	47	14	66	14	30	39	N/S
	7	109	104	119	37	24	25	<1	12	22	21	8	21	<1
	8	78	42	N/S	20	22	<1	20	14	23	12	5	35	<1
Total Dissolved N µg/L	5	690	480	620	440	330	510	230	240	180	210	220	220	220
	6	780	460	590	500	330	360	220	230	260	210	220	230	N/S
	7	720	470	660	540	480	330	230	250	250	200	230	270	220
	8	670	440	N/S	500	370	370	260	300	240	220	250	240	260
Suspended P µg/L	5	47	23	41	12	2	5	3	3	2	1	1	3	10
	6	40	13	34	12	4	1	3	4	3	2	2	7	N/S
	7	24	13	28	13	2	3	1	2	1	2	1	2	15
	8	26	9	N/S	5	2	1	4	<1	2	1	1	3	4
Total Dissolved P µg/L	5	17	12	19	7	7	17	5	3	3	3	8	6	5
	6	17	13	10	8	8	5	4	3	4	4	9	5	N/S
	7	16	12	11	9	8	4	3	3	5	3	7	5	5
	8	17	12	N/S	6	11	5	4	4	4	3	8	5	5
Suspended C µg/L	5	2750	2110	3260	800	380	430	330	320	340	310	310	260	610
	6	3320	1230	2800	840	520	230	300	360	390	250	370	650	N/S
	7	2300	1280	2750	970	330	540	250	290	430	260	280	240	900
	8	2280	910	N/S	480	280	170	290	220	480	180	290	530	320

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Appendix 25. Continued.

		Date												
Analysis	Location	April 28	May 12	May 31	June 9	July 7	July 21	Aug. 3	Aug. 18	Aug. 31	Sept. 15	Sept. 28	Oct. 14	Dec. 10
Si	5	1.47	N/S	2.00	2.15	2.94	3.68	4.01	3.88	3.71	3.73	3.75	3.84	5.15
mg/L	6	1.46	1.66	1.99	2.15	2.99	3.68	4.08	3.91	3.75	3.78	3.77	3.82	N/S
	7	1.43	1.64	1.97	2.10	2.92	3.70	4.10	3.85	3.71	3.73	3.76	3.72	5.21
	8	1.42	1.60	N/S	2.03	2.74	3.44	3.97	3.67	3.49	3.41	3.45	3.63	5.10
Cl	5	4.4	17.4	8.4	32.8	84.0	149	186	162	159	194	191	155	408
mg/L	6	4.4	17.0	9.4	32.2	85.5	153	185	162	165	198	195	148	N/S
	7	4.0	16.6	8.6	29.2	77.5	143	175	150	148	181	176	128	440
	8	2.6	5.2	N/S	21.6	55.0	114	158	94.0	105	140	132	119	390
SO_4	5	10.4	28.5	24.0	57.5	134	204	231	114	214	236	246	241	544
mg/L	6	10.6	26.5	23.2	57.8	134	196	215	114	209	236	243	220	N/S
	7	10.2	24.8	22.6	54.1	128	194	215	108	202	236	233	201	584
	8	8.4	22.4	N/S	46.5	98.0	164	205	87.5	156	187	190	202	592
Total	5	58	N/S	72	20	9	13	4	8	3	3	5	11	17
Suspended	6	54	26	68	21	8	2	5	6	3	4	5	28	N/S
Solids mg/L	7	32	29	65	21	4	16	5	5	2	3	4	6	25
	8	35	21	N/S	8	4	3	4	3	3	1	2	12	5
Total	5	160	N/S	210	340	600	810	880	740	790	900	920	860	1650
Dissolved	6	150	210	210	360	610	790	920	750	790	910	910	890	N/S
Solids mg/L	7	150	210	160	330	590	780	890	710	740	980	890	820	1730
	8	140	190	N/S	320	460	680	860	580	630	710	740	820	1640

..../cont'd

Appendix 25. Continued

Analysis	Location	April 28	May 12	May 31	June 9	July 7	July 21	Aug. 3	Aug. 15	Aug. 31	Sept. 15	Sept. 28	Oct. 14	Dec. 10
		Date												
Na	5	2.41	10.7	6.78	22.4	60.1	9.70	112	91.8	99.5	113	108	105	246
mg/L	6	2.34	10.9	7.14	22.0	59.7	95.3	112	91.8	103	109	109	99.6	N/S
	7	2.09	9.4	5.30	19.1	51.2	89.0	106	76.5	95.6	108	97.9	84.5	246
	8	1.23	5.23	N/S	14.5	34.4	70.4	96.0	57.4	66.3	72.8	67.8	79.5	224
K	5	0.94	0.99	0.46	0.87	1.74	2.35	3.19	2.54	2.77	2.84	2.92	2.94	5.06
mg/L	6	0.96	0.97	0.48	0.89	1.68	2.48	3.05	2.59	2.72	2.78	2,94	2.85	N/S
	7	0.94	0.86	0.46	0.87	1.51	2.21	3.09	2.45	2.63	2.78	2.78	2.58	6.42
	8	1.01	0.82	N/S	0.78	1.29	2.18	2.98	2.16	2.32	2.38	2.40	2.60	6.18
Ca	5	21.4	43.1	38.0	54.4	95.7	107	115	102	97.9	124	128	219	38.8
mg/L	6	21.2	38.7	38.1	53.9	96.9	107	121	102	110	122	124	119	N/S
	7	21.0	38.4	38.4	54.6	93.9	108	111	97.9	105	132	126	120	39.5
	8	20.5	35.4	N/S	50.7	83.7	103	117	94.7	102	115	113	118	37.6
Mg	5	4.68	10.1	10.3	14.6	25.4	32.3	34.6	44.4	36.4	34.3	35.6	39.5	60.1
mg/L	6	4.73	9.60	10.3	15.1	25.8	33.0	36.1	44.8	37.8	33.8	37.0	36.7	N/S
	7	4.63	9.31	10.1	13.9	24.7	32.3	35.5	45.1	37.1	34.8	36.4	36.7	58.3
	8	4.49	8.54	N/S	13.3	22.9	30.6	36.1	41.1	33.2	30.7	30.2	36.1	55.9

N/S = No Sample