AN ABSTRACT OF THE THESIS OF

NILES ALLEN BINNS for the M.S. in FISHERIES
(Name) (Degree) (Major)

Date thesis is presented June 17, 1965

Title EFFECTS OF ROTENONE TREATMENT ON THE FAUNA OF THE GREEN RIVER, WYOMING

Redacted for Privacy

Abstract approved
(Major professor)

From July, 1962 to October, 1964, samples were taken of the invertebrates and fishes of the Green River in southwestern Wyoming to determine the effects of rotenone treatment on the river fauna. The river was treated in September, 1962, with emulsified rotenone, and concentrations applied to the river ranged from 2.5 ppm to nearly 10 ppm of a five percent rotenone product. The reaction of the fauna to the toxicant was investigated at the time of treatment, and post-treatment population levels of the fauna were followed closely to establish the time needed for recovery to pre-treatment levels.

Fish as well as adult beetles, leeches, snails, stonefly nymphs, and other invertebrates were observed dying during the treatment; their bodies were often conspicuous in quiet eddies of the river. Many of the fishes fled downstream ahead of the rotenone

during the treatment, but were eventually trapped at the next rotenone introduction station. Reactions of intoxicated fish are described.

The invertebrate populations in the Green River were drastically reduced by the rotenone treatment, but began to re-appear in the upper 30 miles of the treated area within one month. The lower treated area was almost barren of invertebrate organisms until the spring of 1963. By September, 1963, invertebrate numbers thoughout the treated area were equal to or greater than those found prior to treatment, but changes in the composition of the invertebrate fauna were noticeable. A succession of invertebrate groups occurred during the post-treatment recovery period. Two years after treatment, the patterns of dominant invertebrate groups in the river were still dissimilar to pre-treatment patterns. Tendipedidae were usually the predominant organism.

Two mayfly genera, Pentagenia and Hexagenia, did not reappear after treatment, but several other mayfly genera, including Leptophlebia and Isonychia, apparently immigrated into the area.

The 24 and 48 hour median tolerance limits of the mayfly Siphlonurus sp. to rotenone were found by bioassays to be 0.024 ppm and 0.09 ppm of five percent rotenone preparation.

Intensive sampling with dynamite and gill nets immediately after the treatment produced no fish in the mainstream below the upper ten miles of the treated area. A few untreated sloughs were probably the source from which the river was later re-populated by flannelmouth suckers (Catostomus latipinnis Baird and Girard), Pantosteus suckers, redside shiners [Richardsonius balteatus (Richardson)], speckled dace [Rhinichthys osculus (Girard)], fathead minnows (Pimephales promelas Rafinesque), and carp (Cyprinus carpio Linnaeus). These species, except for carp, had their pre-treatment distribution at the close of study. Carp were found only in scattered areas. Whitefish [Prosopium williamsoni (Girard)], and brown trout (Salmo trutta Linnaeus) required nearly two years to regain their pre-treatment distribution pattern. This apparently was due to a slow downstream migration from untreated areas. Forage fish were abundant two years after treatment, but coarse fish population numbers were still below pre-treatment levels. Squawfish (Ptychocheilus lucius Girard), humpback suckers [Xyrauchen texanus (Abbott)], channel catfish [Ictalurus punctatus (Rafinesque)], and black bullheads [Ictalurus melas (Rafinesque)] did not re-appear after treatment apparently because the only source of recruitment was below Flaming Gorge Dam. Small bony-tail chubs [Gila robusta (Baird and Girard)] re-appeared in parts of the treated area in the second summer, probably from parts of the drainage above the treated area.

Large numbers of rainbow trout (Salmo gairdneri Richardson) were planted in the treated area six months after treatment and are now supporting a successful trout fishery.

Rotenone concentrations were determined during the treatment using bioassay techniques and a colorimetric method. Bioassays appeared to give the most accurate results.

EFFECTS OF ROTENONE TREATMENT ON THE FAUNA OF THE GREEN RIVER, WYOMING

by

NILES ALLEN BINNS

A THESIS

submitted to

OREGON STATE UNIVERSITY

in partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE

June, 1966

APPROVED:

Redacted for Privacy

Associate Professor of Fisheries
In Charge of Major

Redacted for Privacy

Head of Department of Fisheries and Wildlife

Redacted for Privacy

Dean of Graduate School

Date thesis is presented June 17, 1965

Typed by Luanne Bayless

ACKNOWLEDGMENTS

Special appreciation is extended to Mr. F. W. (Bob) Jackson, District Fisheries Biologist, who contributed much to the success of this investigation.

Mr. Fred Eiserman, Fisheries Management Coordinator, also contributed measurably to the project, as did Mr. Dick Baldes, Project Assistant in 1963 and 1964, and the members of Fish Management Crew Number 4. Mr. Cliff Bosley aided the study by making available his unpublished fish length data from earlier studies of the lower river. The author is indebted to the innumerable other personnel of the Wyoming Game and Fish Department who helped at various times.

Thanks are due to the various U.S. Fish and Wildlife Service personnel who assisted in gathering data during the treatment.

Gratitude is expressed to Mr. E. L. Heinschel of the Intermountain Chemical Company for providing access to the company water chemistry records.

Dr. Charles E. Warren, Oregon State University, provided guidance in the initial organization of the study and offered helpful criticism in its later stages. Dr. Carl E. Bond, Dr. Donald W. Chapman, and others of the faculty of Oregon State University also made many helpful suggestions.

Appreciation is extended to Mr. George Chadwick of the Pacific Cooperative Water Pollution and Fisheries Research Laboratories, Oregon State University, and the Oregon Game Commission for assistance in developing the field bioassay method.

Special consideration and thanks is extended to the many landowners along the river, who, without exception, permitted the project personnel to trespass on their lands during the study.

I am indebted to Dr. George Baxter, University of Wyoming, for the time he spent in confirming the invertebrate identifications.

Thanks are also due to Mr. L. D. Becker, U. S. Geological Survey, for providing in advance 1964 water-flow records for the Green and New Fork Rivers.

Appreciation is extended to Mrs. F. W. Jackson and Mrs. Niles T. Binns for donating their talents as seamstresses in the construction and maintenance of the drift net.

This investigation was financed through Dingel-Johnson Federal Aid to Fish Restoration funds administered by the Wyoming Game and Fish Department under projects: D. J. F-25-R-2 and D. J. F-25-R-4.

TABLE OF CONTENTS

LIST OF FIGURES

List of Figures (continued)

LIST OF TABLES

LIST OF APPENDICES

List of Appendices (continued)

EFFECTS OF ROTENONE TREATMENT ON THE FAUNA OF THE GREEN RIVER, WYOMING

INTRODUCTION

The 1962 rotenone treatment of the Green River in Wyoming offered an excellent opportunity to study the effects of the treatment on the fauna, both at the time of treatment and during the post-treatment recovery period. The efficiency of the treatment, its effects on fish food organisms, and the post-treatment re-entry of fish species into the treated area all merited study. Accordingly, studies were conducted before and after treatment to evaluate the treatment and its effects on the river fauna, especially the fish food organisms. Sampling activity was initiated in July, 1962, two months prior to treatment, and continued until September, 1964. Although some work was done on other sections of the treated area, the primary emphasis of the study was on the Green River and its principal tributary, the New Fork River, from a point shortly above the treated area to the Flaming Gorge Dam, about 117 miles downstream. Only selected macro-invertebrates and the fishes of the river were sampled during the study. The results of the study are presented in this dissertation.

The rotenone treatment of the Green River followed congressional authorization of the two main-stream dams, Flaming Gorge and Fontenelle, of the Colorado River Storage Project. Construction of these two dams presented the Wyoming and Utah Game and Fish Departments with a choice of either (1) trying to establish a trout fishery, after impoundment, in the presence of a rapidly expanding coarse fish population, or (2) depressing the coarse fish population sufficiently, before impoundment, to permit introduced game fish to become established in the new reservoirs. Since the entire area involved had an excellent potential as a future trout fishery, the decision was made to treat the river before impoundment. Cost of treatment after dam closure would have been prohibitive. Thus, about 445 miles of the Green River and its tributaries upstream from the Flaming Gorge Dam were treated in early September, 1962 with Chem-Fish Regular, an emulsified rotenone product.[1] The treatment operation is described in detail in a joint report by both departments (Binns, *et al.*, 1963); however, a brief description of the treatment procedures will be presented later in this report.

[1] Manufactured by Chemical Insecticide Corporation, Metuchen, New Jersey. Guaranteed Analysis:

Active ingredients		70 percent
Methylated Naphthalene	55	
Other Cube extractives	10	
Rotenone	5	
Inert ingredients		30
Total		100

The limnology of the Green River, below LaBarge, has been described in detail by Bosley (1960) and by McDonald and Dotson (1960); both publications suggest depressing the coarse fish population with rotenone. In addition, investigations have been made of the aquatic biota of the Green River in Dinosaur National Monument, situated about 50 miles downstream from the Flaming Gorge Dam site (Utah University, 1963).

Rotenone ($C_{23}H_{22}O_6$), a principle constituent of Derris sp. and Lonchocarpus sp., has long been noted for its piscicidal and insecticidal properties; use of the compound to control rough fish populations has established it as an excellent fisheries management tool. A concentration of 0.5 ppm of five percent rotenone is generally believed to be the minimum effective level for fish control work in lakes; however, some fish species, such as the bullhead (Ictalurus sp.), are notoriously resistant to rotenone and may require as much as 2.0 ppm of five percent rotenone for satisfactory kills (Leonard, 1938 and Krumholz, 1948). The concentration of rotenone needed for effective eradication of undesirable fish is considerably higher in streams than in lakes because of water movement and the resultant dilution and detoxification. Thus, Berry and Larkin (1954) recommended usage of a concentration greater than 5.0 ppm of five percent rotenone when rehabilitating streams, especially when such rotenone resistant fish as large carp and suckers are present.

In spite of widespread use, surprisingly little is known about the effects of rotenone on stream fish food organisms. Observations made during various treatment projects in the past 30 years appear to conflict regarding the influence of rotenone on fish food organisms. M'Gonigle and Smith (1938), Leonard (1938), Smith (1940 and 1941), Brown and Ball (1943), Ball and Hayne (1952), Pintler and Johnson (1958), Zilliox and Pfeiffer (1960), and Prevost (1960) all reported that treatment with various preparations containing five percent rotenone did not significantly affect fish food organisms. A few of these investigators did note, however, that some of the organisms suffered adverse effects. Smith (1941), using 0.5 ppm derris (five percent rotenone), found some mortality among *Chaoborus* larvae and that snails and leeches were eliminated from the population. Smith (1940) noted that planktonic crustaceans and amphipods were killed when exposed to 0.5 ppm of five percent derris powder, and that caddis fly larvae of the family Phryganeidae were killed by prolonged exposure to the chemical. Brown and Ball (1943) said that dragonflies, leeches, and a mosquito, *Corethra* sp., were seriously affected when exposed to a 0.5 ppm concentration of five percent derris powder. Dragonflies were again present in high numbers within three months. Ball and Hayne (1952) reported that only Aeschnidae (dragonflies) and Hirudinea (leeches) died when the fish population of a lake was removed with derris containing five percent rotenone.

Conversely, numerous workers have noted rotenone to be highly toxic to aquatic invertebrates. Davidson (1930), Ginsburg (1933), Fellton (1940), Cutkomp (1943), Zischkale (1952), Rudd and Genelly (1956), and Das and McIntosh (1961) all documented the high toxicity of rotenone and rotenone preparations to invertebrates. Scheuring and Heuschman (1935), referred to in Lindgren (1960), observed high mortality among _Sialis_ sp. (Megaloptera), Corixidae (Hemiptera), and _Chironomus_ _plumosus_ (Diptera) when these organisms were exposed to rotenone.

Hooper (1948) reported that only cladocercans and copepods were adversely affected by an application of 0.5 ppm of five percent derris to a small Minnesota lake. Amphipoda, Diptera, Nematoda, Mollusca, and Trichoptera, among others, showed a decrease in numbers after the treatment, but this was attributed to other influencing factors; the Oligochaeta increased after treatment. Treatment of a San Diego water supply reservoir with emulsified rotenone caused a decrease in all organisms (Hoffman and Payette, 1956).

The effects of 1.0 ppm of five percent derris powder upon the bottom fauna of two Colorado reservoirs were studied by Cushing and Olive (1957). They reported a decline of the

Tendipedidae (midge) population, which later recovered. Oligochaete worms were not affected by the toxicant and their numbers increased for a period after treatment.

Berzins (1958), referred to in Ahlmquist (1959), found that almost all the fish and invertebrates in two lakes were killed by 0.5 ppm of emulsified rotenone.

One of the most detailed studies of recent years was that carried out by Ahlmquist (1959) in Sweden. She concluded that treatment with emulsified rotenone concentrations strong enough to kill fish (0.5 ppm of five percent rotenone) will also kill much of the benthic and epiphytic fauna.

Another Swedish worker, Lindgren (1960, p. 182), concluded from his laboratory and field experiments that:

> The invertebrates of the bottom exhibit sensitivity to rotenone at 0.5 ppm (of five percent rotenone preparation). The use of higher concentrations thus implies great risk for the partial or complete disappearance of this invertebrate population. The invertebrates are, however, less sensitive to rotenone than are the fishes which suffer from the poison in a physiologically different way. The invertebrates have, on the whole, better chances of escaping the poison in one way or another than the fishes. On this account, we have good reasons to assume that even after complete extermination of the stock of fishes and a fairly considerable reduction of the invertebrate population, a sufficient number of the latter will survive in order to guarantee their continued existence in the treated lake.

Kiser, Donaldson, and Olson (1963) reported that the zooplankton in a lake was killed when exposed to 0.5 ppm of five percent rotenone powder. Wollitz (1962) also noted the disappearance of the zooplankton after treatment with 5.5 percent emulsified rotenone; dragonflies, caddisflies, and other insects also were reduced or eliminated by the treatment. Populations of the families Tendipedidae and Tubificidae were adversely affected, but recovered to twice their original level within one month.

One of the characteristics of rotenone as an insecticide is its apparent specificity of action. This fact accounts in part for the conflict of results found in the literature. Roark (1933) and Shepard (1951) both commented on the fact that rotenone is a highly effective insecticide against some insects, but is ineffective against others.

Rotenone isusually used as a contact poison (applied to body surface with entry gained through the cuticle and tracheae), but it is also effective as a stomach poison (application to the food and entry through the mid-gut) (Brown, 1951; Shepard, 1951; and Tischler, 1935). Brown (1951), Shepard (1951), and Roark (1933) mention that rotenone is a characteristically slow acting insecticide; Tischler (1935) and Brown (1951) report that rotenone affected insects show a decrease in oxygen consumption, indicating that the ability of the insects to utilize oxygen has been influenced.

Early investigators concluded that the rotenone acted on the gills of fish. The respiratory function of the gill filaments was considered to be destroyed by a breakdown and withering away of the gill epithelium (Daneel, 1933), referred to in Leonard (1939). Later work presented evidence to show that the histolysis of the gill epithelium was a secondary effect of the poison (Hamilton, 1941 and Krumholz, 1948). Vaso-constriction of the gill capillaries, preventing passage of red blood cells through the gills with resultant suffocation, was believed to be the cause of death in rotenone affected fish.

Recent work done by Lindahl and Oberg (1961) and Oberg (1962) in Europe has indicated that both the histolysis and vaso-constriction mentioned above are secondary changes resulting from a very advanced stage of toxication. Normal circulation and no histolysis was noted when careful examination was made of fish poisoned to the point of equilibrium loss. The primary action of rotenone was shown to lie in blockage of important biochemical pathways of cell metabolism.

DESCRIPTION OF STUDY AREA

The Green River is located in southwest Wyoming on the west slope of the continental divide (Figure 1). Parts of three national forests are included in the drainage area, which covers a wide variety of geological types in its 10,000 square miles above Green River City (U. S. Geological Survey, 1964). The river originates in the rugged Wind River Mountains, the crest of which forms part of the continental divide. This formerly glaciated area is characterized by hard, granitic mountains. Much of the area is above timber line; the lower slopes are covered with a typical coniferous and aspen forest.

The western side of the drainage is bounded by the Wyoming Range, which is characterized by softer, more easily eroded, rock types. The basin between the two mountain ranges is typified by hills and flatlands covered with sagebrush. The southward basin gradually develops into the Little Colorado Desert, a typical northern scrub desert covered with sagebrush, rabbitbrush, and greasewood. Near the Utah-Wyoming state line, the Green River is fed by streams originating on the forested north slope of the Unita Mountains, which extend from east to west. These tributaries originate in Utah, flow north into the Wyoming desert area and swing eastward to the Green River. Below the state line, the

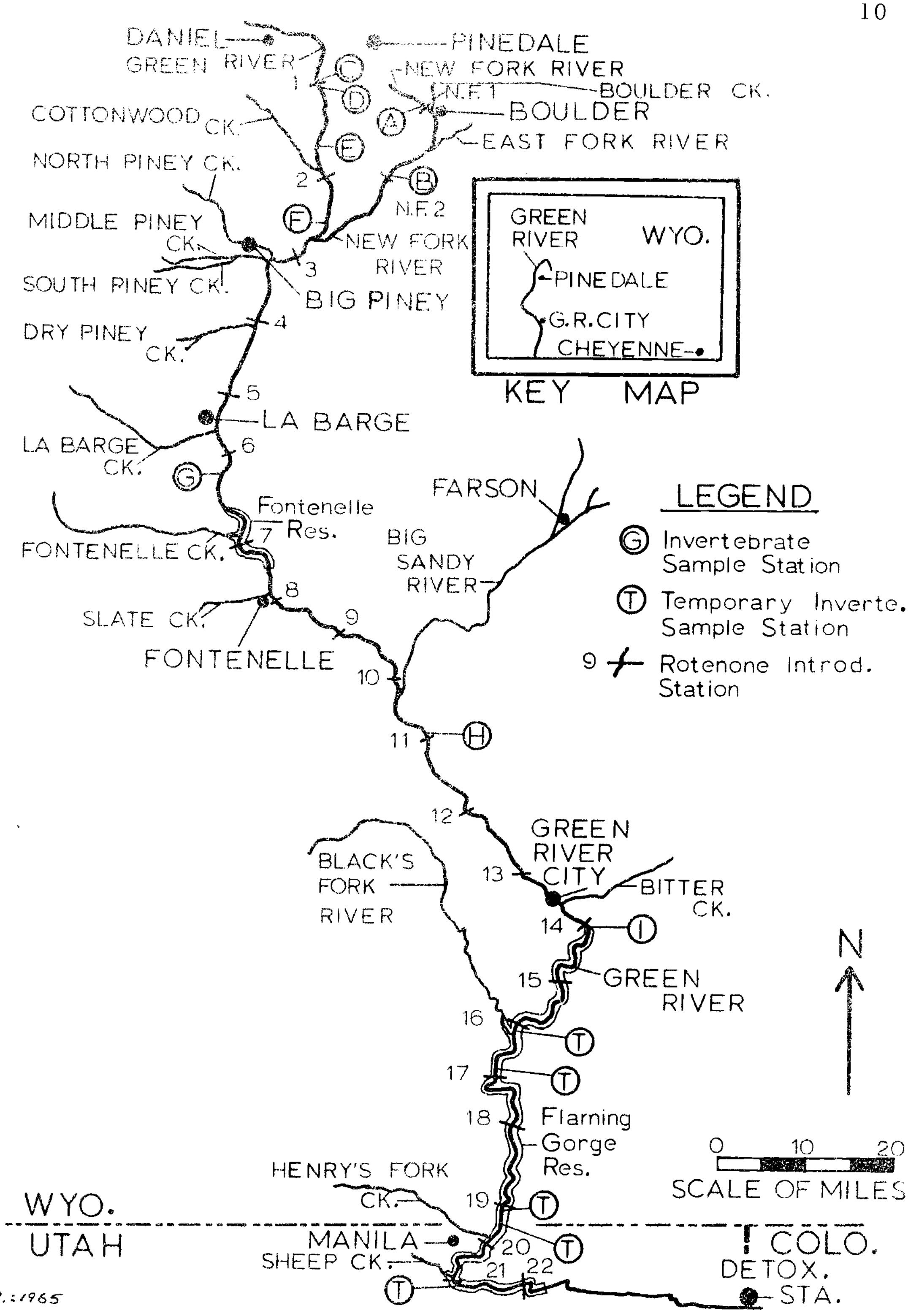


Figure 1. Map of the Green River study area showing tributaries, invertebrate sampling stations, rotenone introduction stations, and other features. Insert map shows the location of the Green River in Wyoming.

Green River has eroded deep, highly scenic, canyons in its passage through the Unita Mountains. The Flaming Gorge Dam is located in one of these canyons; its reservoir when filled will extend upstream some 91 miles, to within five miles of Green River City.

The climate of the Green River drainage is often severe, with sudden fluctuations. Temperatures in the study area range from -50°F. to $+100^{\circ}$F.; annual precipitation in the head water areas is about 18 inches, but the desert area receives only about eight inches a year.

Because of the variety of geological formations in the watershed, water of very different qualities is found in the various tributaries. In general, the waters coming from the Wind River Mountains are low in dissolved minerals and carry little silt. The streams coming from the more westernly Wyoming Range are richer in dissolved minerals and contribute occasional heavy silt loads. The Green River picks up considerable silt and alkaline water from tributaries in the desert area and from tributaries flowing across the desert from the Unita Mountains.

A considerable sheep and cattle ranching industry is located within the drainage. Summer irrigation, associated with livestock and agricultural activities in the upper basin, often causes sudden fluctuations in the chemistry of the river water.

Considerable domestic and oil-field pollution was reported in the lower Green River as recently as 1959 (Bosley, 1960). In recent years, however, strict water pollution laws have helped reduce pollution drastically. The towns of Green River and Rock Springs have installed sewage treatment plants, and there has been a substantial decrease in pollutants from the railroad yards at Green River City. Some wastes still enter the river from the small towns and oil fields; and an examination of the river bed, during low-water reveals the occasional presence of oil-covered bottom areas, residual from past oil pollution. The gradual disappearance of fish species, such as the Colorado River squawfish (Ptychocheilus lucius Girard), once relatively common near Green River City (Jordan and Evermann, 1908) may be attributed to historical pollution conditions.

The longitudinal gradient of the Green River in the study area is shown in Figure 2. While flowing through the study area, the river moves from an elevation of 7,000 feet above sea level to one of 5,600 feet. The New Fork River gradient profile is not shown in Figure 2, but it changes in elevation by only 200 feet in the 26 miles included in the study area.

For the purposes of the present study, the Green River was divided into four sections: (I) The New Fork River, (II) the Upper Green River, (III) the Middle Green River, and (IV) the Lower Green River (Figure 3). Section I includes the New Fork River

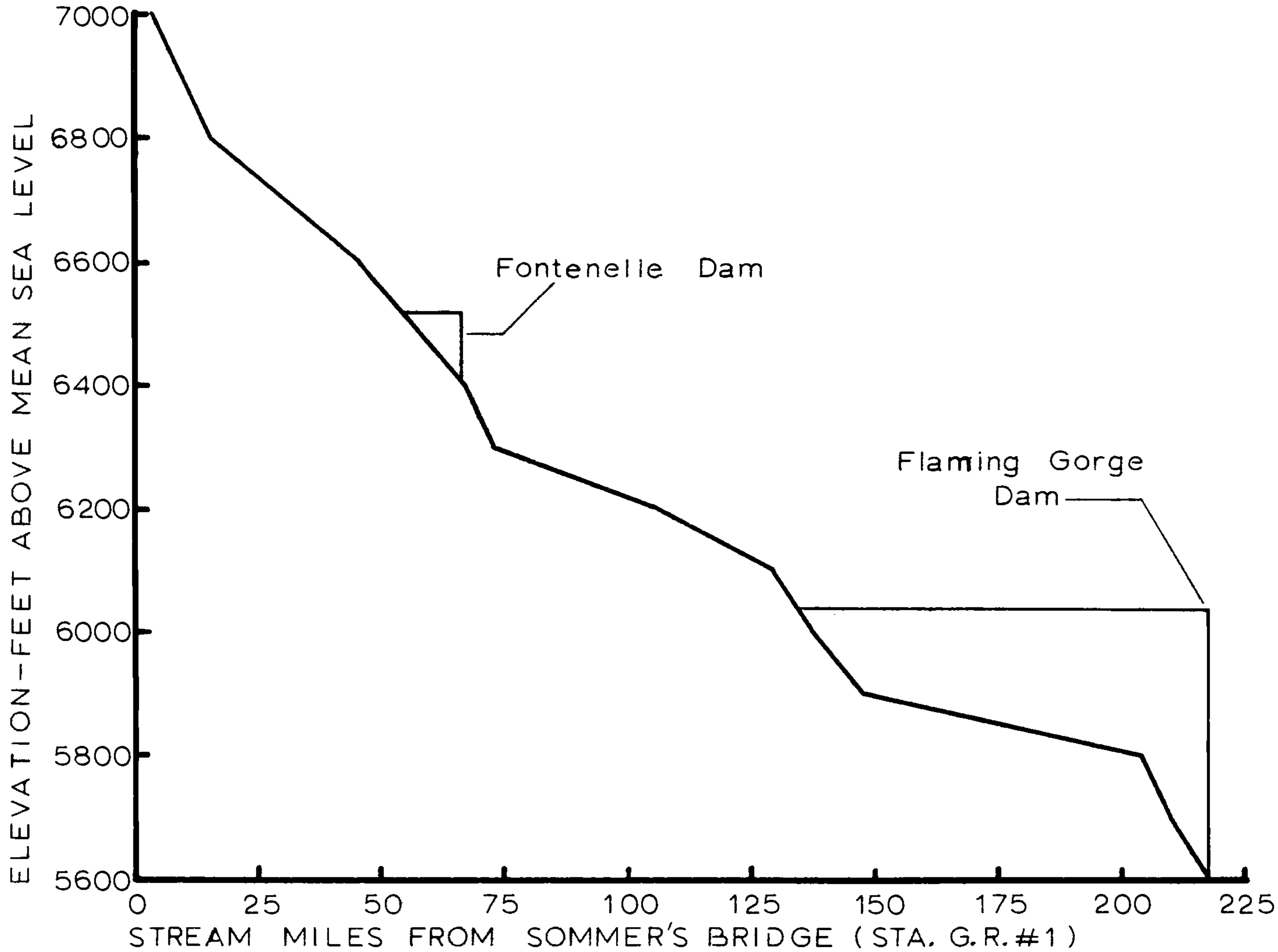


Figure 2. Longitudinal gradient profile of the Green River, Wyoming (data from U.S.G.S. topographical maps.

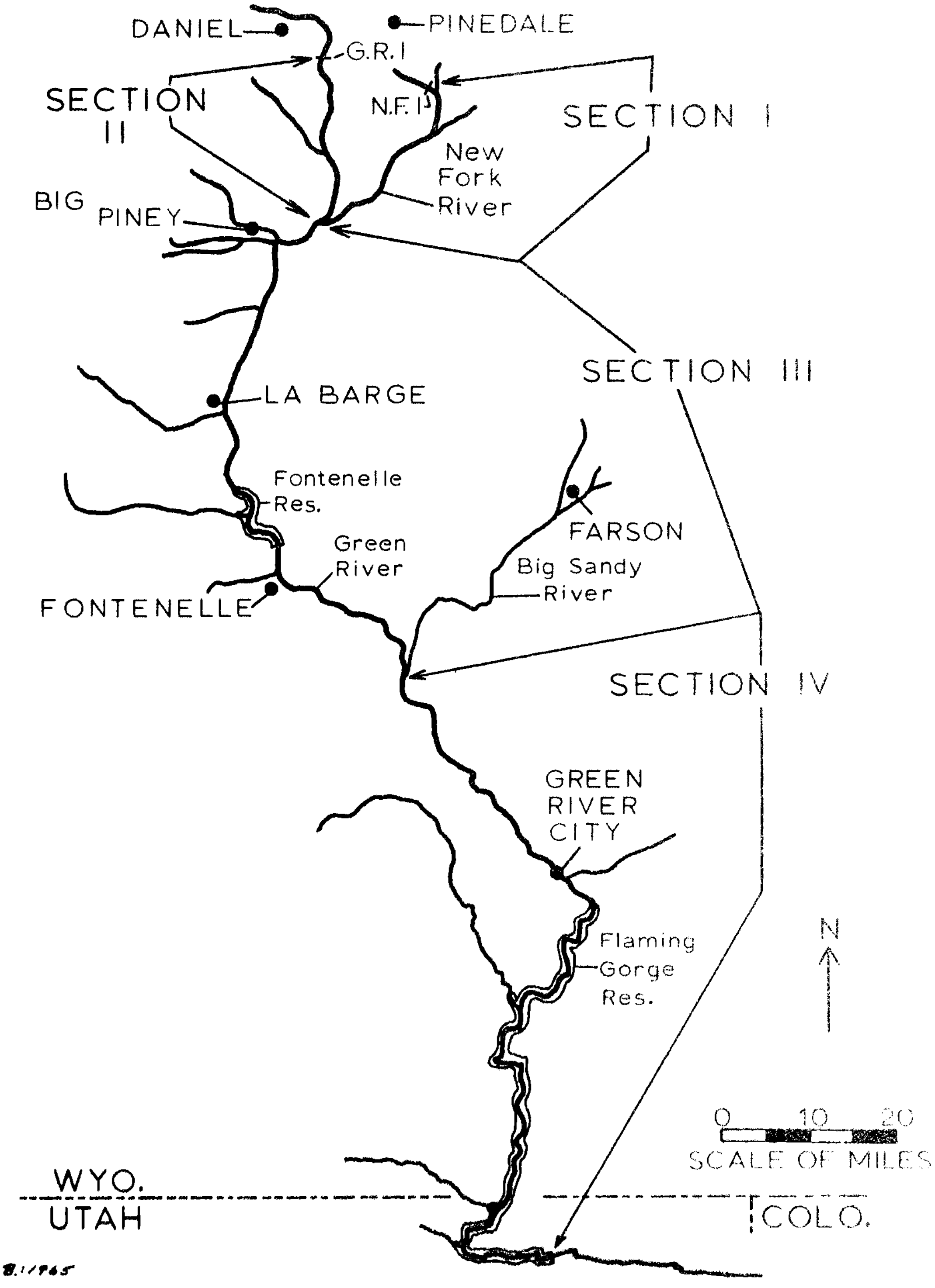


Figure 3. The four sections of the Green River study area.

from the bridge near Boulder (upper end of treated area) to its confluence with the Green River 26 miles downstream. Water-flow data are recorded by the U. S. Geological Survey at two places in this section. Figures 4 and 5 graphically show the water-flow for the study period. The stream flow ranged from a low of 30 cubic feet per second (cfs) during the winter near the upper study limit to nearly 5,000 cfs near its mouth during the runoff in June. The methyl-orange alkalinity and hydrogen ion (pH) values recorded during the study at stations A and B are presented in Figures 6 and 7; standard methods were used to determine the water chemistry. At station A, the alkalinity ranged from a low of 64 ppm $CaCO_3$ to a high of 158 ppm; the range at station B was from 64 ppm to 131 ppm. The higher values were usually encountered during the fall, when water flows were low. The pH values of the New Fork River varied from a low of 7.25 at station B to a high of 8.8 at station A. The New Fork in this section is characterized by long riffles between the pools and only a few deep holes. The bottom is made up of medium-sized, rounded rubble and coarse gravel. There are numerous back-waters and sloughs formed by old meanders of the river. Tributaries entering this section include Boulder Creek and the East Fork River.

Section II, of the upper Green River, covers about 16 miles from Sommers Bridge near Pinedale to the confluence of the New

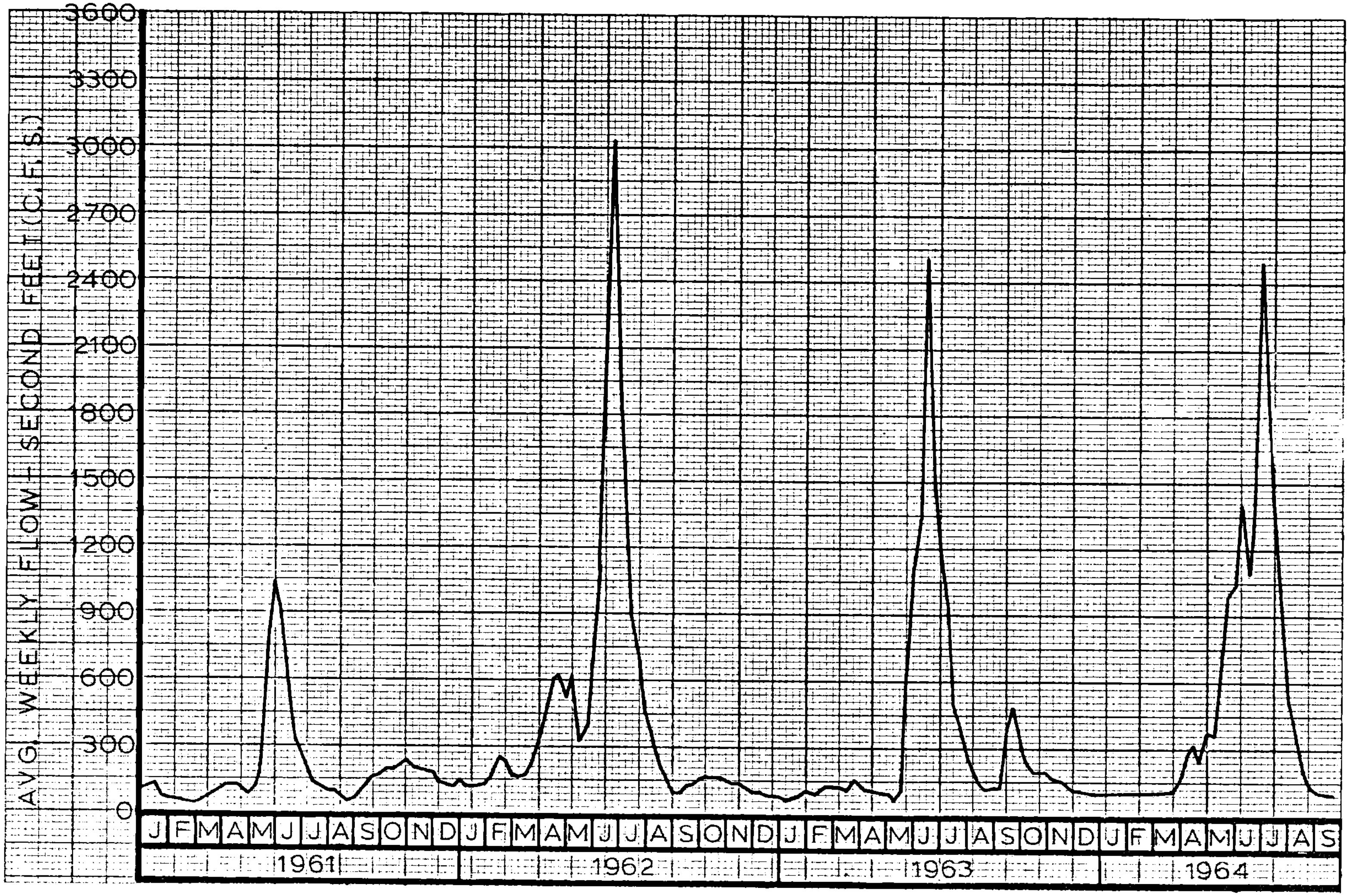


Figure 4. Discharge of the New Fork River near Boulder, Wyoming from January 1, 1961 to October 1, 1964 (data from U.S.G.S. gaging station records).

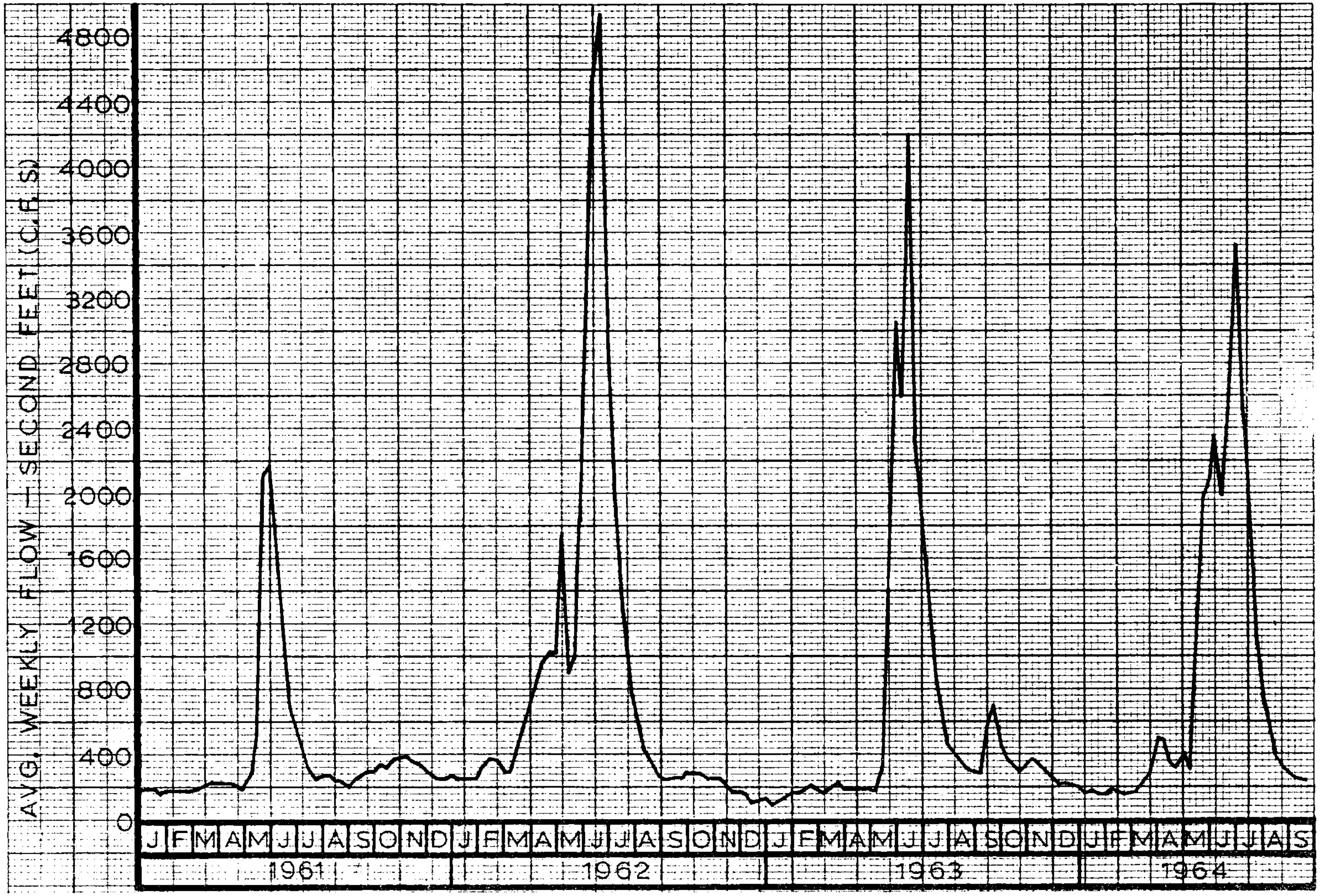


Figure 5. Discharge of the New Fork River near Big Piney, Wyoming from January 1, 1961 to October 1, 1964 (data from U.S.G.S. gaging station records).

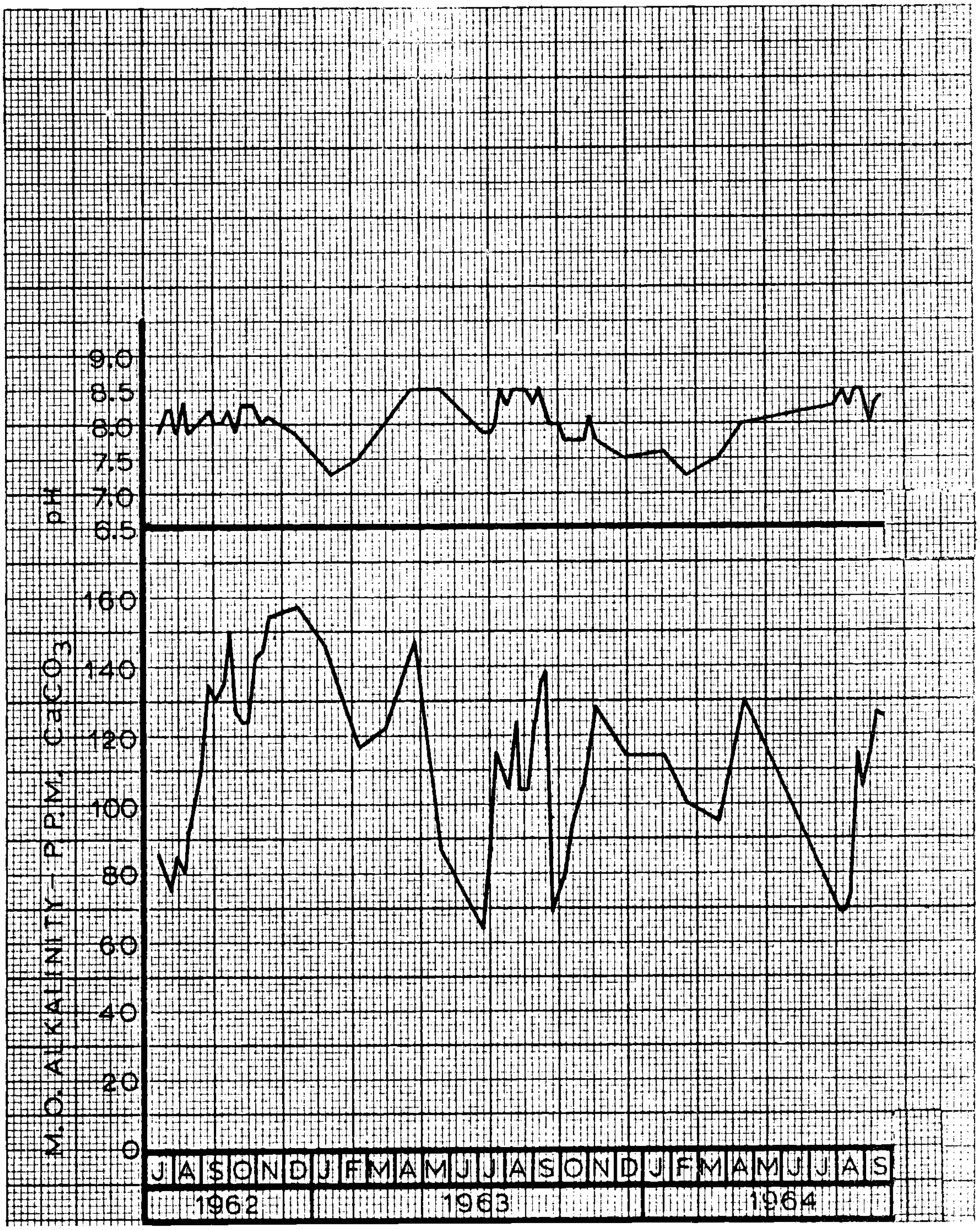


Figure 6. Water chemistry of the New Fork River at station A from July 16, 1962 to September 21, 1964.

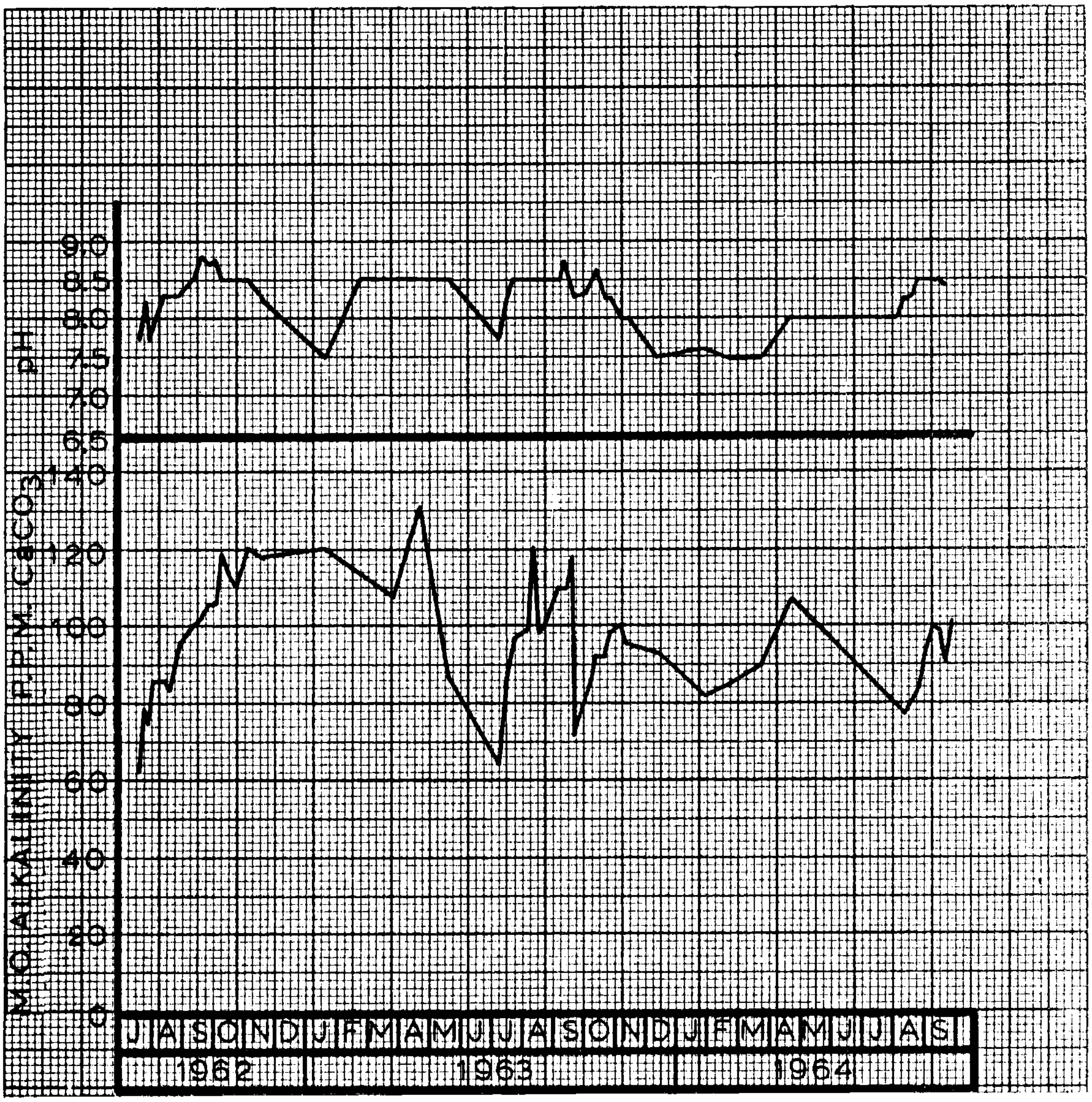


Figure 7. Water chemistry of the New Fork River at station B from July 21, 1962 to September 21, 1964.

Fork River. The nearest water gaging station is about 30 miles upstream. The stream flow ranges from 70 cfs to about 3,100 cfs (Figure 8). The pH and the methyl-orange alkalinities, during the period of the study, are shown in Figures 9 and 10. The alkalinity ranged from 74 to 200 ppm $CaCO_3$ and the pH range was from 7.5 to 8.8. These chemical conditions were often subject to sudden fluctuations in the summer. The average daily water temperature records for the summer and fall of 1964, from the recording thermometers at stations E and #6, are presented in Figure 11. Little difference is evident in the values from the two recorders. The maximum water temperatures at stations E and #6 were 74°F. and 72°F., respectively. The minimum values were 44°F. and 46°F., respectively. Other temperature records were taken (at all stations) with a pocket thermometer of certified accuracy and the minimum water temperature recorded at any location during the study was 31°F., a common winter temperature at all stations. Many riffles and pools are to be found in section II; the bottom type ranges from coarse rubble, in the upper part of the section to medium rubble and coarse gravel near the confluence of the New Fork River.

Sizeable areas of sloughs and backwaters can be found in this section, particularly at the peak of summer irrigation. The principal tributary in this section is Cottonwood Creek.

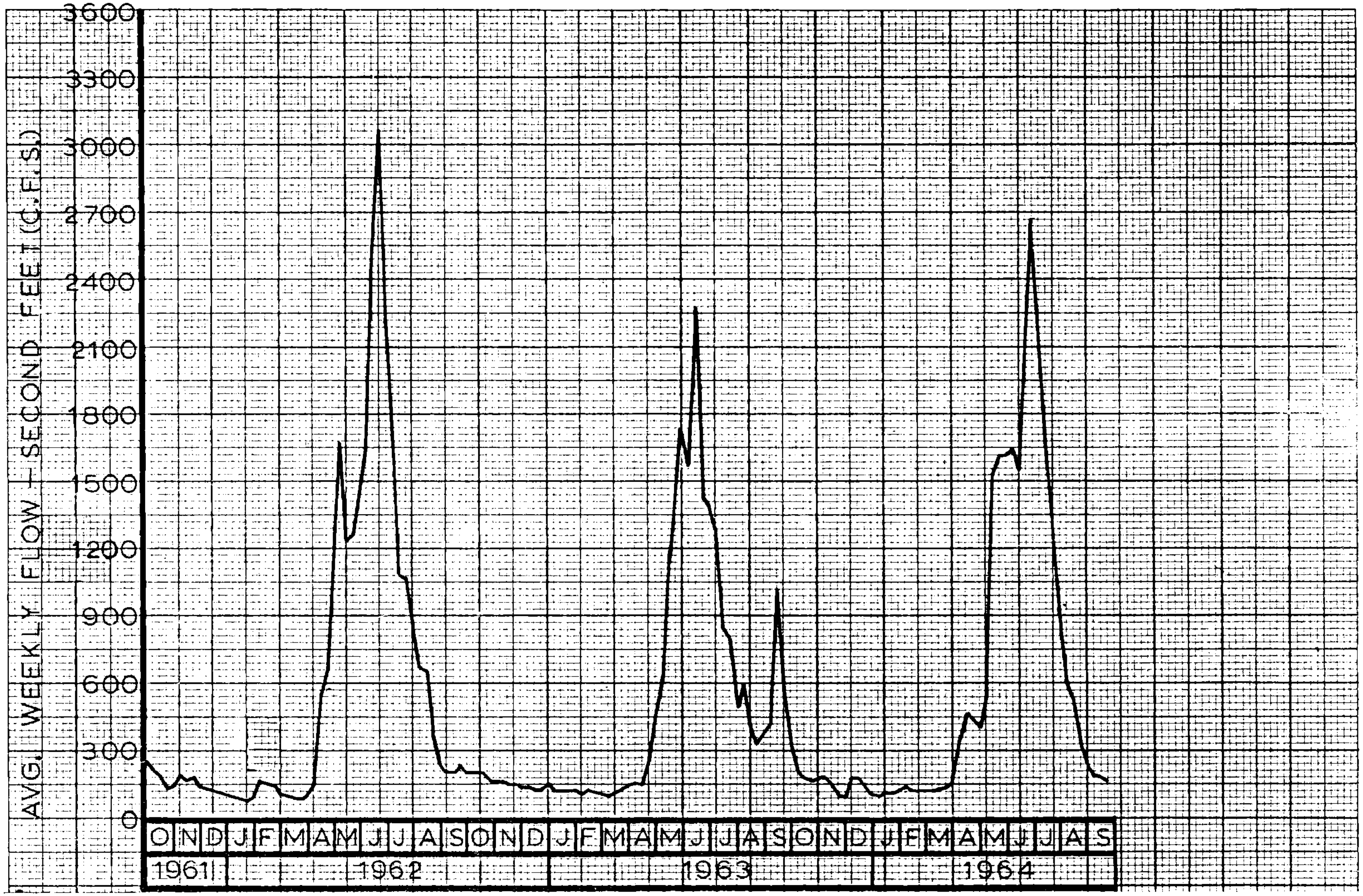


Figure 8. Discharge of the Green River at Warren Bridge near Daniel, Wyo. from October 1, 1961 to October 1, 1964 (data from U.S.G.S. gaging station records).

Figure 9. Water chemistry of the Green River at Sommers Bridge from July 17, 1962 to September 22, 1964.

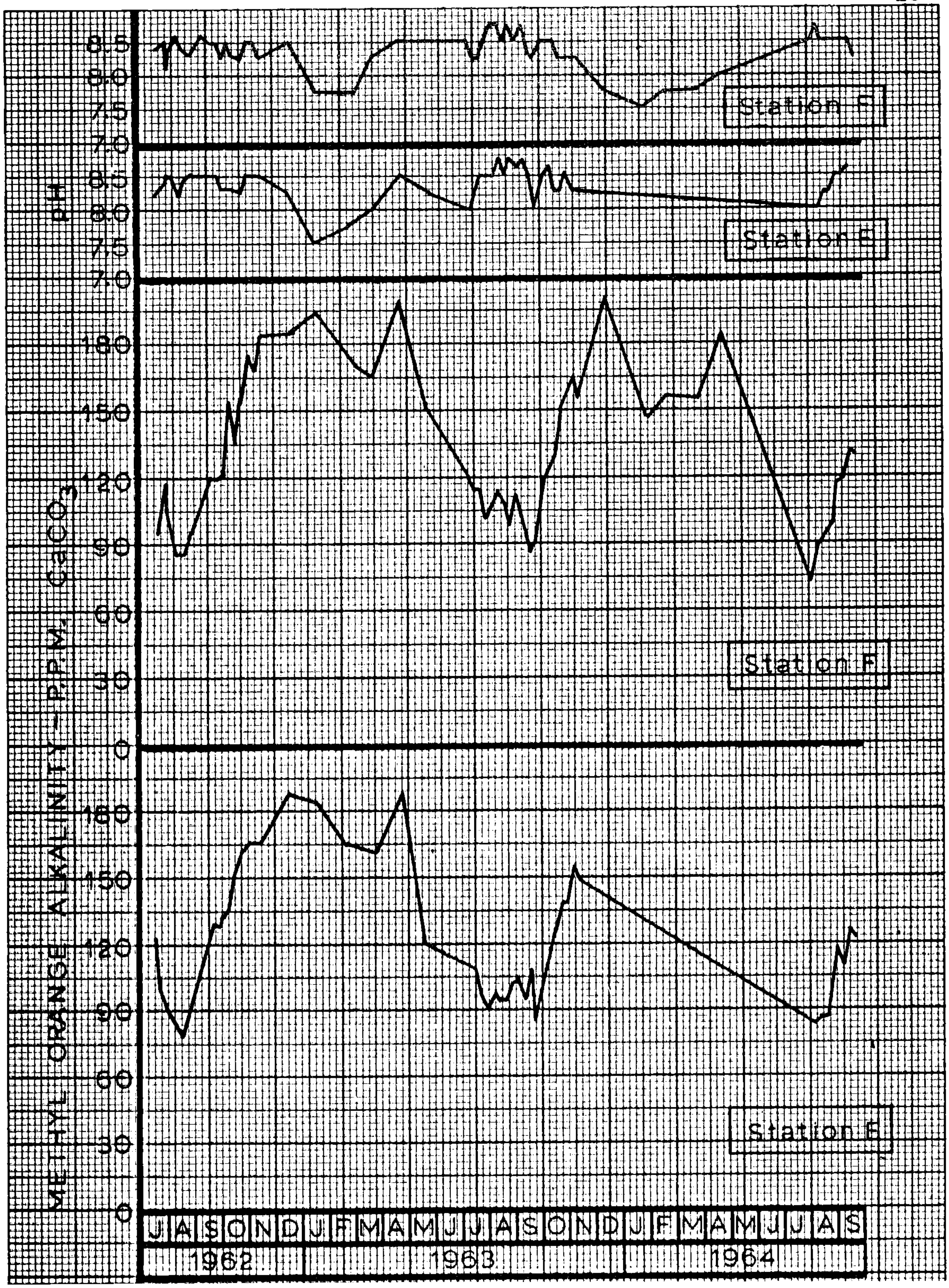


Figure 10. Water chemistry of the Green River at stations E and F from July, 1962 to September, 1964.

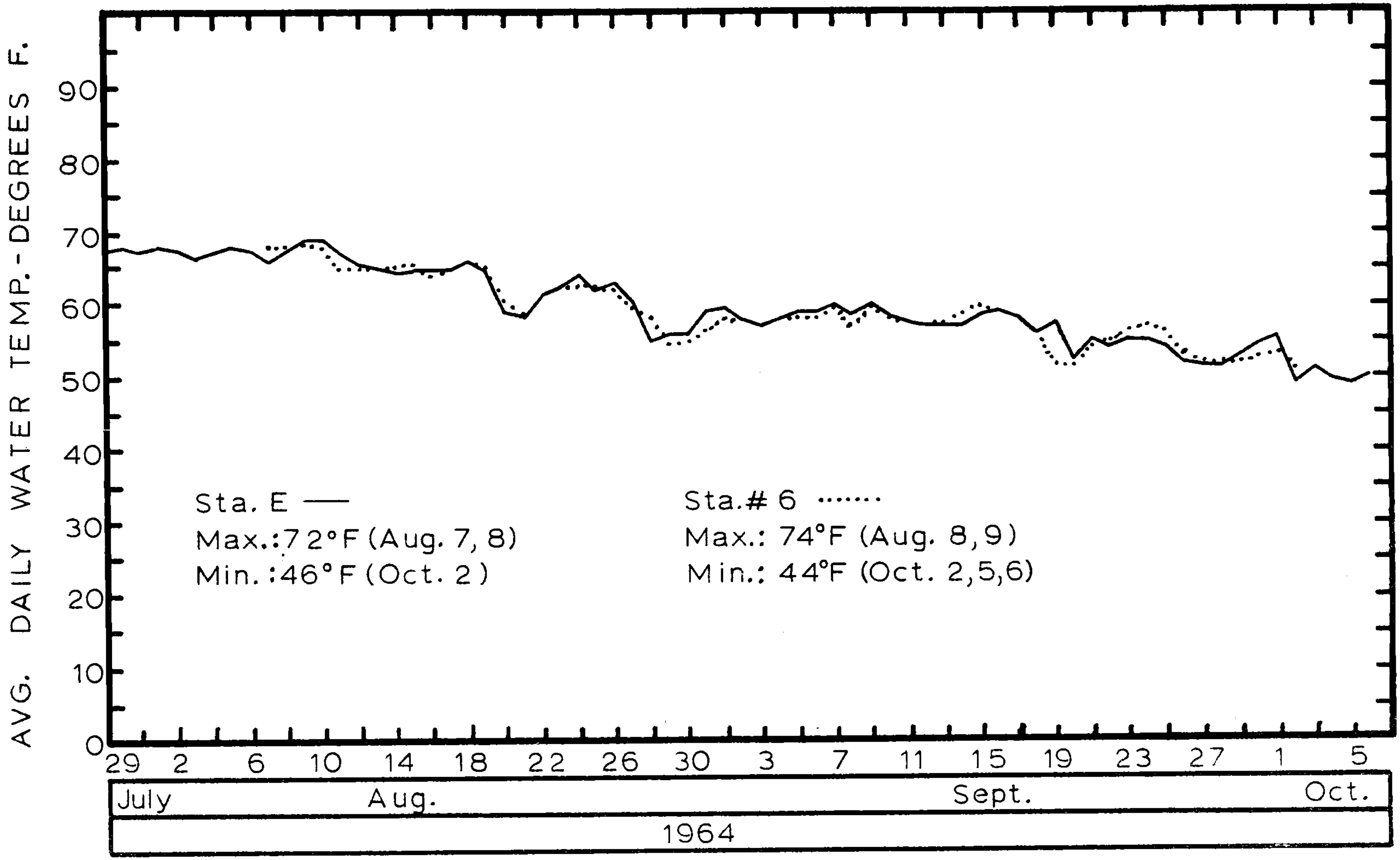


Figure 11. Average daily water temperatures as recorded by thermographs at stations E and #6 during the summer and fall of 1964.

Section III includes the river area from the New Fork-Green River confluence to the mouth of the Big Sandy River. Figure 12 shows the river flow data from the U. S. Geological Survey gage near Fontenelle. The minimum flow is about 200 cfs and the maximum flow 7,900 cfs. The water chemistry data, collected at Names Hill (station G), is shown in Figure 13. Alkalinity extremes were 100 to 187 ppm $CaCO_3$, while pH ranged from 7.5 to 8.75. Turbidity concentrations tend to increase below Fontenelle because of the more erosive character of the watershed.

The river in section III has fewer riffles and pools than in section II, but the pools tend to be longer. The composition of the bottom changes from medium rubble, in the upper end of the section to small rubble and sand at the lower end. Many tributaries enter the Green River in this section. The main ones are North Piney, Middle Piney, South Piney, LaBarge Creek, Fontenelle Creek, Slate Creek, and the Big Sandy River. All of the tributaries but the last flow from the Wyoming Range. Fontenelle Dam is located in this section and started to influence water conditions in late 1963.

Section IV extends from the Big Sandy River confluence to the Flaming Gorge Dam. Stream discharge records from the gages at Green River City and Linwood, Utah are contained in Figures 14 and 15. Extremes are 200 and 9,300 cfs.

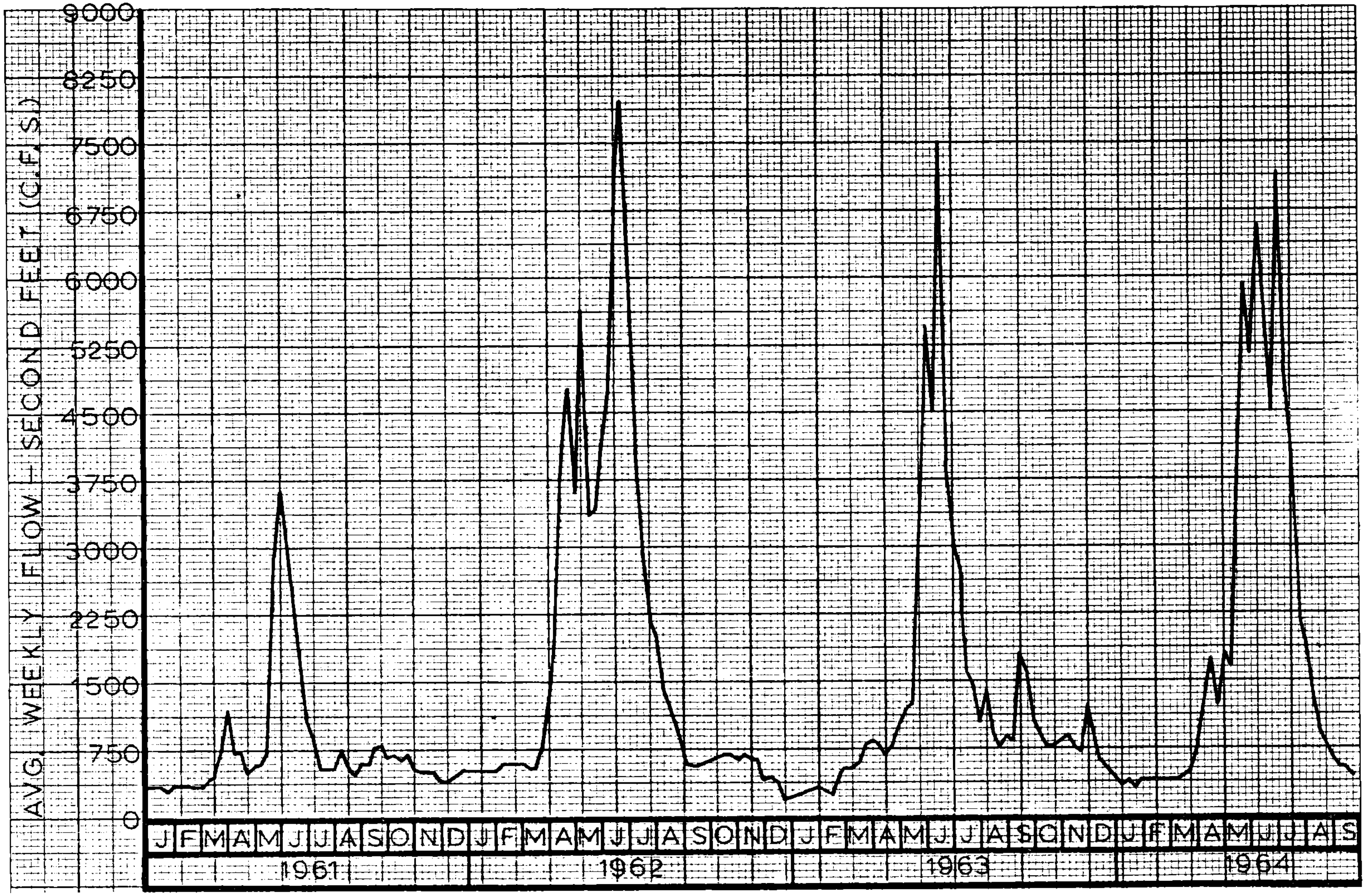


Figure 12. Discharge of the Green River near Fontenelle from January 1, 1961 to October 1, 1964 (data from U.S.G.S. gaging station records).

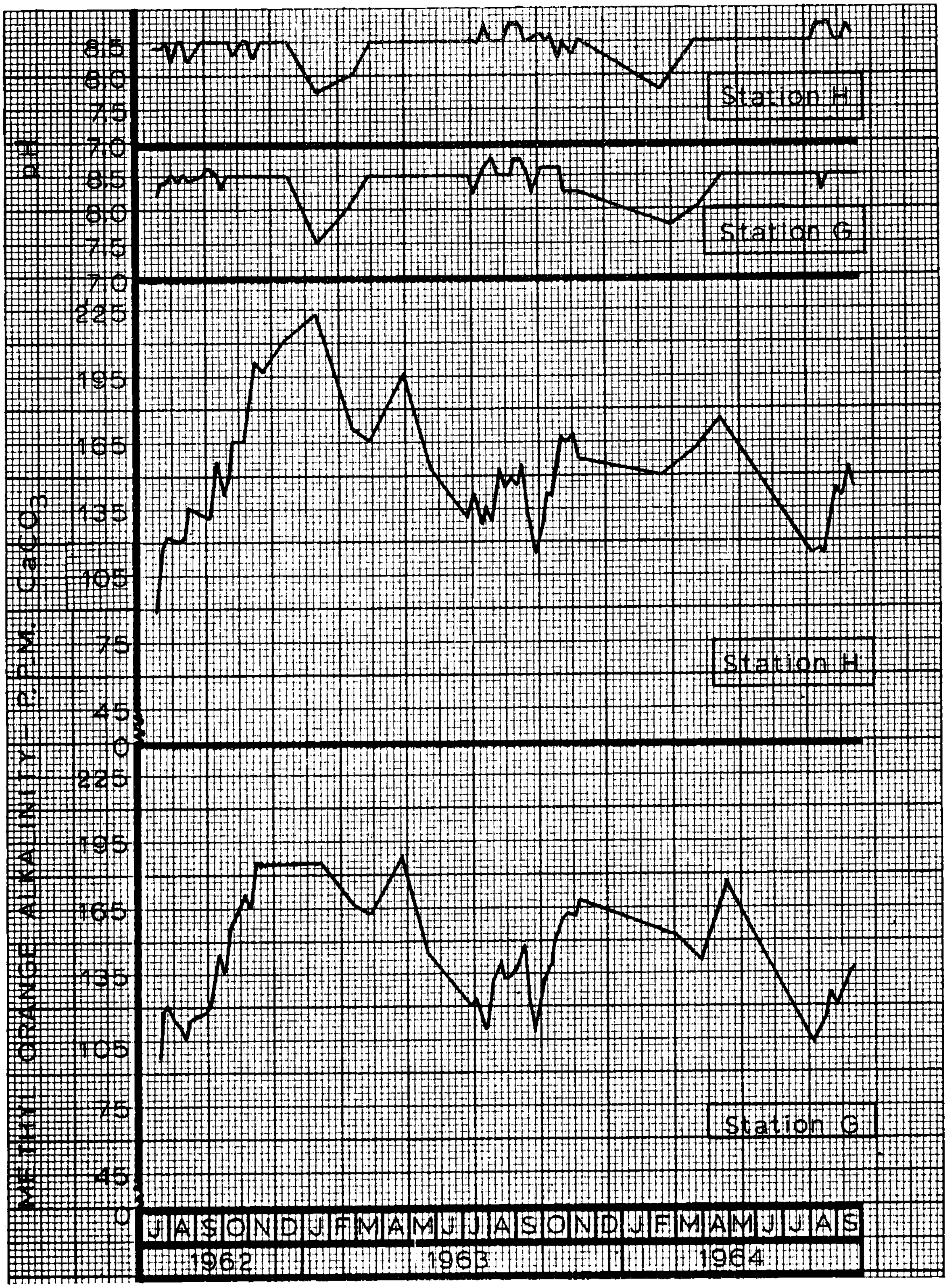


Figure 13. Water chemistry of the Green River at stations G and H from July, 1962 to September, 1964.

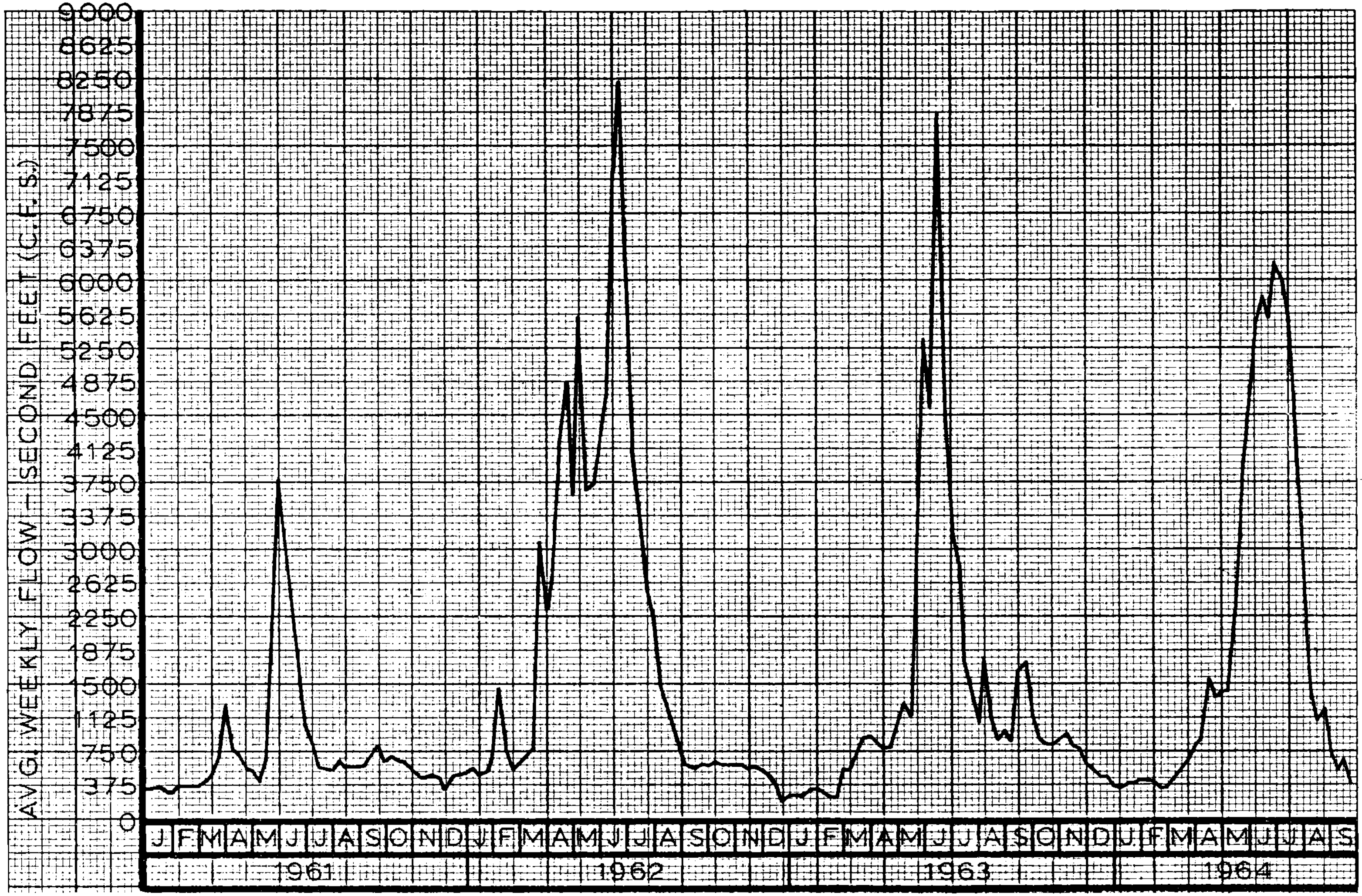


Figure 14. Discharge of the Green River near Green River City from January 1, 1961 to October 1, 1964 (data from U.S.G.S. gaging station records).

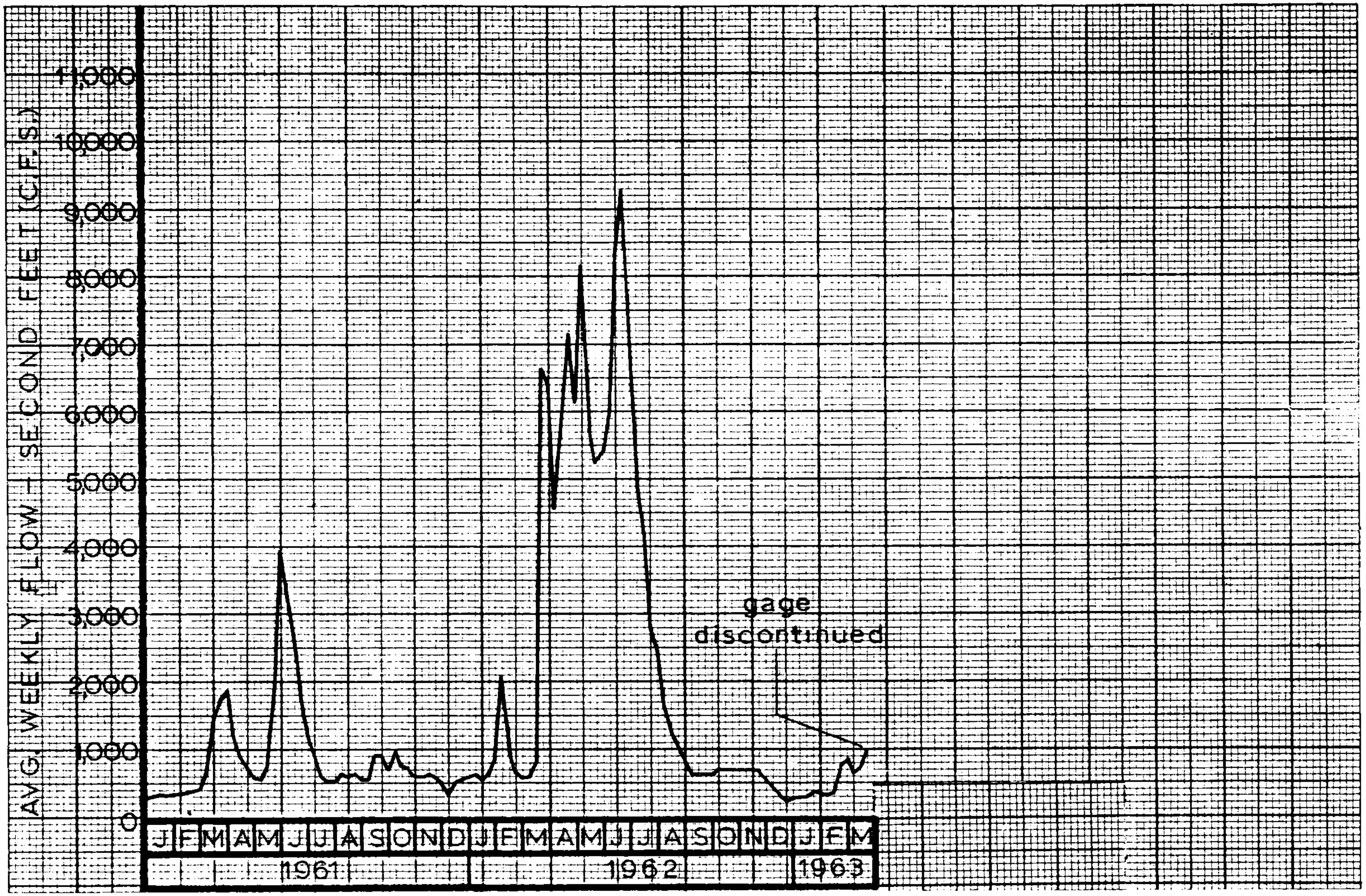


Figure 15. Discharge of the Green River near Linwood, Utah from January 1, 1961 to March 31, 1963 (data from U.S.G.S. gaging station records).

Water chemistry data, recorded by the Intermountain Chemical Company sodium carbonate plant, are presented in Figure 16. The company removes 1,000,000 gallons of water a day from the river to a holding tank which serves as a reservoir for the company power plant 20 miles west of the river. The values shown in the graphs are weekly averages and vary somewhat from the river values because of the time the water is held in the tank. However, the data reflect trends in water chemistry of this section of the river. Alkalinity and pH values recorded at stations H and I during the study are shown in Figures 13 and 17. The ranges in this section of the river are: pH 7.5 to 8.75; alkalinity 89 to 228 ppm $CaCO_3$. The bottom types in this section range from small rubble, mud, and sand to coarse rubble near the Flaming Gorge Dam. The former are common in the area above the state line. Pools and riffles are recognizable as such only in the upper part of the section. Most of the remainder is similar to an irrigation canal with steep banks and gradually sloping bottom.

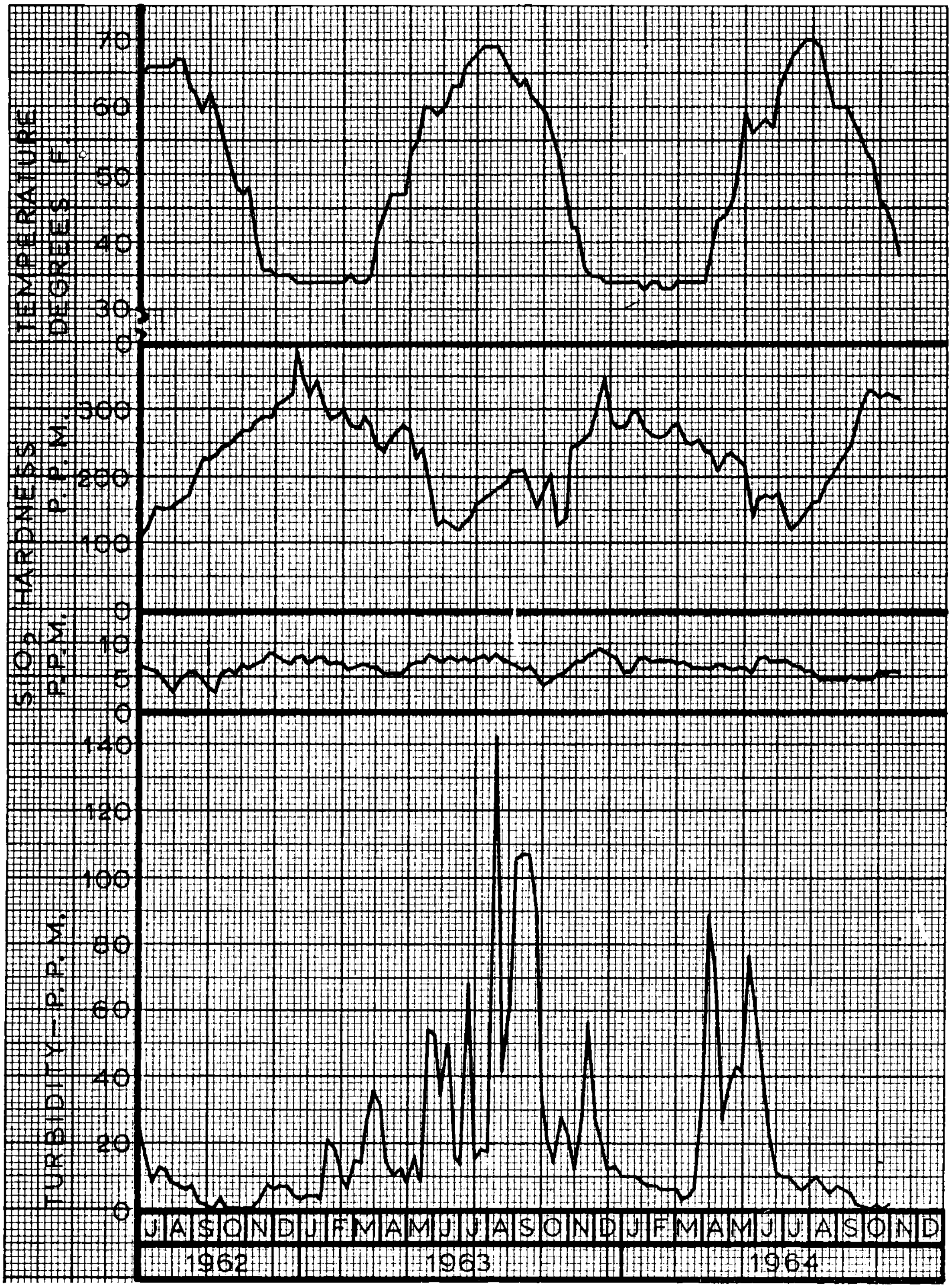


Figure 16. Average weekly water chemistry recordings at the Intermountain Chemical Company powerplant from July 1, 1962 to November 1, 1964.

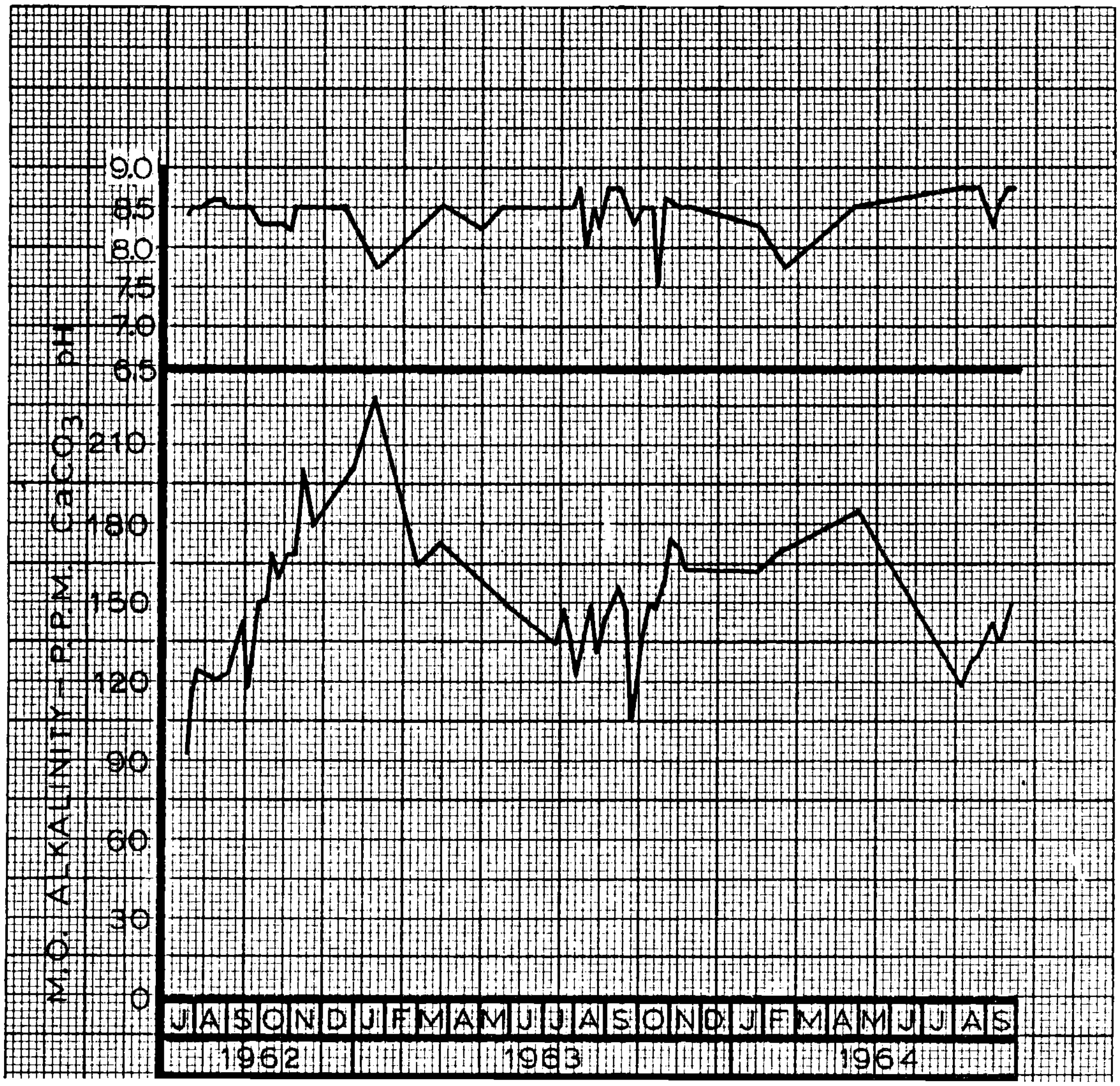


Figure 17. Water chemistry of the Green River at station I from July 23, 1962 to September 25, 1964.

METHODS

Treatment Mechanics

The rotenone[2] was introduced into the Green River from a series of rotenone introduction stations located every ten miles on the mainstream and as necessary on each tributary (Figure 1). Each station was located on a high bank of the river and consisted of two 55 gallon barrels, each with its own valve and short length of one inch hose, which in turn was connected to a yoke comprised of two gate valves and a gas valve. The yoke was connected to lengths of one inch industrial hose coupled together to span the river. The valves at the barrels and at the yoke junction, especially the gas valve, provided the necessary control of the rotenone flow. The toxicant was pumped from a stockpile into two barrels where the liquid was allowed to flow out into the hose, there to be dispersed into the stream by several additional valves, which were pre-set to dispense approximately the same amount of rotenone.

Discharge of rotenone at each station, main-stream or tributary, was started at a pre-determined time. At main-stream stations discharges of rotenone were started, in sequence three

[2] In the remainder of this report, unless otherwise specified, the word rotenone will be used to indicate rotenone preparations containing five percent rotenone.

hours apart, and were continued for seven hours. The tributary stations were operated so that rotenone discharged into the tributaries reached the main stream when rotenone was present there. The tributary stations were operated from three to six hours, depending upon requirements.

The numerous small off-channel sloughs and backwaters located along the river were treated by personnel equipped with backpack spray units. The larger off-channel waters were sprayed from a helicopter.

River flow data was collected immediately prior to the treatment and used to calculate the discharge of rotenone from each station needed to produce a concentration of 5.0 ppm of five percent rotenone in the river. The concentration developed at the last six stations was scheduled to be gradually reduced from 5.0 ppm to 2.0 ppm to assist in the detoxification operation. The latter operation took place from a bridge 31 miles downstream from Flaming Gorge Dam and utilized potassium permanganate to neutralize the rotenone.

Unfortunately, a sudden drop in the river flow, which was undetected until the latter stages of the treatment, resulted in the introduction of more rotenone than needed to produce a 5.0 ppm concentration. The actual concentrations, based upon corrected flow data and discharges of rotenone, ranged from 9.4 ppm at station #1 to 2.5 ppm at station #22.

Fish Sampling

Samples of the fish population were taken with gill nets, dynamite, minnow seines and traps, electro-fishing gear, and rotenone. Because of the diversity of habitats present in the river, no one sampling method was applicable to all situations.

The experimental gill nets were used wherever deep and slow moving water could be found. Shallow water and floating debris, including drifting algae, limited the use of nets in much of the stream. The nets often became clogged with algae in the few areas where they could be used effectively. All net-sets were made for over-night periods or longer. Some attempts were made to catch fish by floating gill-nets through deep holes, but were not successful because of snags and other obstructions.

Dynamite was probably the most successful and widely used fish sampling tool. Unfortunately, this method of sampling was not adopted until the fall of 1962, when floating ice made gill-netting ineffective. Both 50 percent straight nitroglycerine and 47 percent nitroglycerine-ammonia dynamite were used. The explosive was set off with a standard safety fuse and blasting cap combination; the fuse was lit on shore and the charge thrown into position. This type of fish sampling produced quick results with a minimum of manpower. The dynamite was usually used in selected deep holes at seasonal intervals. The fish were either retrieved at the riffle below the hole or a boat was used. Charges were also set off in weed beds near shore or in sloughs and backwaters. At one hole on the New Fork River (about 50 feet wide by 100 feet long by 15 feet deep) the killing radius of one stick of the 50 percent straight nitroglycerine dynamite was observed to be about 30 feet. Between 600 and 700 whitefish and trout were killed by the blast.

A short minnow seine was used during the latter part of the study. Shortage of manpower, the roughness of the river bottom, and the numerous submerged snags precluded extensive use of larger seines.

Numerous minnow traps were placed in backwaters and near weed beds throughout the study area in 1963 and 1964. The baits used were dog food in cans with the can ends removed and oatmeal balls wrapped in cheesecloth. Some sets caught many fish, but others caught only a few fish or none at all.

Electro-fishing gear was used on occasion, but this method was largely ineffective due to the size of the river and the high conductivity of the water, especially in the lower river.

Rotenone was used to collect fishes during and shortly after the treatment program. Post-treatment use of this method was limited to sloughs and backwaters in order to avoid any possible influence on main-stream invertebrate populations.

Invertebrate Sampling

Station locations are shown in Figure 1, and a list of station locations is included in Appendix 39. Sampling stations were lettered to distinguish them from the rotenone introduction stations which were numbered; the latter could then be used as landmarks because of their ten mile intervals. Samples of the invertebrate population were made with drift and bottom samplers at nine permanent sampling stations and several temporary stations. A number of emergence traps were used in 1963 and 1964 to sample the adult segment of the insect population.

The Surber square-foot bottom sampler was chosen over other bottom samplers because of its portability. From one to three bottom samples were taken at each station once a week during the summer and fall and once a month in the winter and spring, when possible. Successive samples were always taken in an undisturbed area slightly upstream from previous samples. Where more than one sample was taken, samples were taken at different water depths, proceeding from shallow to deep water. Leonard (1939) noted that dependable results can be obtained from a single, carefully handled sample. Needham and Usinger (1956) found from a statistical analysis of 100 square-foot samples that two or three samples would be needed to insure finding all of the common genera.

The drift sampler was made of iron rod welded into a one-foot square frame. The frame was fitted with a modified Surber Sampler net. Steel rings welded to the sampler made it possible to hang it between two steel fence posts driven into the stream bed (Figure 18). The water velocity determinations, made in connection with the drift samples, were taken with a Gurley current meter according to the instructions given by Corbett (1962). One drift sample was collected at each station whenever bottom samples were taken. The length of time the net was set varied from 30 seconds to 40 minutes, depending upon the amount of debris floating downstream. The usual length of set was about five minutes.

A test was made of the efficiency of the drift net in recovering floating objects at different velocities. Small cork pieces were released at different velocities and the average number caught in a series of trials at each velocity was recorded. The results are given in Appendix 40. Three of the velocities had recovery rates of at least 60 percent; recovery rates at the other velocities were 14 and 47 percent.

Both the drift and bottom sample collections were sorted as they were taken and then were preserved in a 70 percent alcohol-glycerine mixture, for later laboratory identification and enumeration. A few collections were preserved in entirety and later sorted

Figure 18. The drift net in operation.

in the laboratory.

A sugar floatation method, described by Anderson (1959), was used on 1964 collections to speed initial sorting operations. An efficiency test was made at each station to determine the degree to which the sugar floatation increased the number of organisms recovered from the samples. In this efficiency test, all organisms possible were picked without sugar; then with the aid of sugar floatation as many remaining organisms as possible were removed. The total of the results obtained by both methods was used as the total number of organisms present in the sample. Appendix 41 presents the results of the test.

Organisms captured in drift and bottom samples were identified using the keys in Ward and Whipple (1959), Pennak (1953), Usinger (1956), Baxter (n.d.), and Ross (1956). Most of the invertebrates were identified as far as family; the mayflies were identified to genus. Volumes of the organisms were obtained by hand centrifuging in a graduated centrifuge tube. The numbers of organisms present in each sample were determined by direct count under a microscope; only in a few instances, such as at station D, were other methods employed. The 1964 samples at station D contained, in the late summer, so many organisms that the laboratory enumeration was seriously slowed. To alleviate the problem, a method of estimating the smaller numbers of invertebrates, which were often very small, was adopted. All of the larger organisms were removed as in direct enumeration and also many of the smaller ones. The remaining specimens were transferred to a 30 ml vial, the vial filled with alcohol, capped, gently mixed, and a 1 ml sample removed with a graduated eye dropper for enumeration. This sub-sampling procedure was repeated at least five times, (organisms were returned to the sampling vial after each 1 ml enumeration) and the average number of organisms per 1 ml was calculated; multiplication by 30 gave an estimate of the total number of organisms. This figure was added to the figure obtained by direct enumeration to get the total invertebrates in the sample.

To simplify sample comparison, drift sample collections were converted to a standard unit of numbers per minute per cubic foot per second (no./min./cfs). The method of calculation is given in Appendix 42.

Winter invertebrate sampling was complicated by two to three feet of ice cover on the river. An ice "spud" and a chain saw with an ice-cutting blade were used to cut sampling holes. In some instances, small patches of open water were located near enough to the sample stations to be used as sampling holes. Considerable sampling difficulty was experienced at many of the stations because of water depth, lack of current, or unique freezing patterns. In some cases, no samples could be obtained.

Emergence traps similar to the one used by Coche (1964) were used in 1963 only on the upper reservoir areas. This early model, utilizing an inner tube float, worked well, but the float material did not withstand the harsh climatic conditions and the trap soon sank. An improved trap was made of plastic screen and pipe and used on the river in 1964 with excellent results (Figure 19). Care was taken to anchor the traps away from areas used by the public, but, nevertheless, one trap was stolen (station B) and another damaged by vandalism (station F). The traps were set out at stations B, E, F, #6, and H.

Determination of Rotenone Concentrations

During the treatment project, the downstream movement of rotenone was determined by the use of live carp in basket containers placed above each rotenone introduction station. Observation of rotenone movement was also made by noting the first appearance of distressed fish. The concentrations of rotenone in the river during treatment were measured by colorimetric tests and field and laboratory bioassays.

The colorimetric test used was developed by Post (1955). The field and laboratory bioassays employed the method described by the American Public Health Association (1960) and Cohen, *et al.* (1960). The laboratory bioassays were conducted by U. S. Public

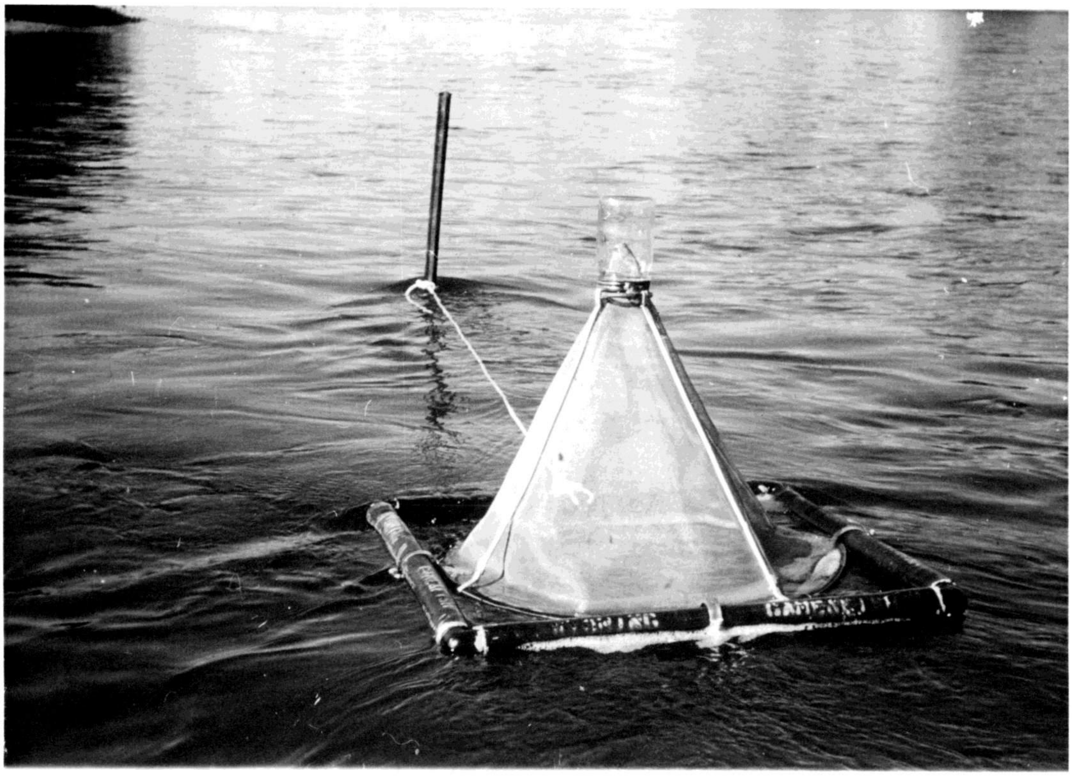


Figure 19. The insect emergence trap in operation on the river. Emerging insects are funneled up into the jar where they are trapped.

Health Service personnel, and the results have been reported by Henderson (1963).

The field bioassays were conducted about one-half mile below station #1 on the first day of the treatment. Unfortunately, a shortage of test fish limited planned bioassay activities to this one set of determinations. Water used for dilution purposes was removed from the stream immediately prior to treatment and stored in milk cans. The test fish were small young-of-the-year carp acclimated to the river water for 24 hours prior to treatment. Test containers were 4 quart polyethylene buckets, placed in the river to minimize water temperature fluctuations. The temperature was $60^{\circ} \pm 1^{\circ}$F. during the test.

Five fish were used for each test concentration, including the control solution of plain river water. No mortality was noted among the controls. The time needed for all five fish in a container to lose equilibrium was used as a measure of toxicity.

A logarithmic series of rotenone solutions of known concentrations were prepared and used under the same conditions used for the river water solutions of unknown concentration. The two sets of determinations were made simultaneously. When the data from the series of known concentrations was plotted on log-log graph paper, a standard curve was obtained (Figure 20). Reference to this standard curve and the time duration for loss of equilibrium

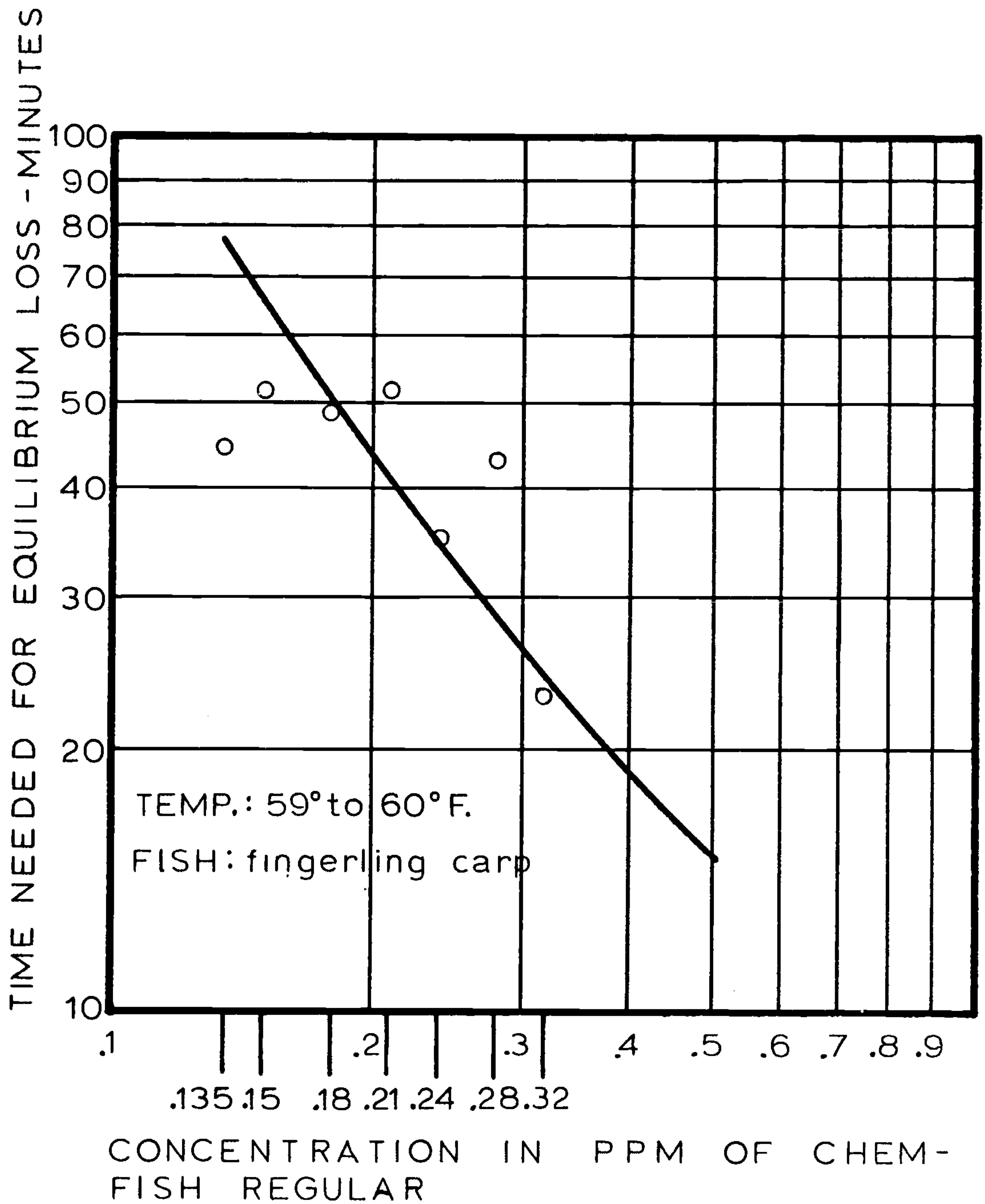


Figure 20. Standard curve for field bioassay determinations of rotenone concentration 1/2 mile below Green River station #1 on September 4, 1962.

in the river water solutions of unknown rotenone concentration, provided the rotenone concentrations in the river water solutions.

Rotenone TL_m of Mayflies

A laboratory bioassay was set up to determine the 24 hour median tolerance limit (TL_m) of a common mayfly, Siphlonurus sp. This species was chosen because it was very common in the river at the time of the bioassay and also because of its large size. The specimens used were nearly mature numphs. The method used was the standard method described in American Public Health Association (1960). Ten specimens were placed in each solution, including the control; containers were 1 gallon glass jars. Each solution was gently aerated by air from a small pump and airstone. River water, from the areas where the insects were collected, was used for dilutions. Water temperatures were maintained at $68^{\circ} \pm 1^{\circ}$F. by a running water bath. A thin substrate of washed aquarium gravel was provided to make the insects less restless.

RESULTS

Fish

The results of the fish sampling are summarized by period and river section in Table 1. The unpublished fish length data collected by Bosley during his study of the lower river (Bosley, 1960) is included in the pretreatment figures for sections III and IV. His figures were from gill net catches only. The results of fish sampling will be presented in chronological order.

Pretreatment

The pretreatment fish populations of the New Fork River (section I) and the upper Green River (section II) were typical populations with all size and age groups represented. The larger, mature members of the various species were very noticeable. The Rocky Mountain whitefish [*Prosopium williamsoni* (Girard)] was the dominant species, followed by the flannelmouth sucker (*Catostomus latipinnis* Baird and Girard). The speckled dace [*Rhinichthys osculus* (Girard)], the redside shiner [*Richardsonius balteatus* (Richardson)], and the sculpin (*Cottus bairdi* Girard) were numerous. Also present, in reduced numbers, were the fathead minnow (*Pimephales promelas* Rafinesque), the Utah sucker (*Catostomus ardens* Jordan and Gilbert), the brown trout (*Salmo trutta* Linnaeus), and the rainbow trout (*Salmo gairdneri*

TABLE 1. SYNOPSIS OF GREEN RIVER PRETREATMENT AND POST-TREATMENT FISH SAMPLING RESULTS BY TIME PERIOD AND RIVER SECTION.

-KEY-

Species:

Su	= unidentified sucker	F	= fathead minnow
Cl	= flannelmouth sucker	R	= redside shiner
Ca	= Utah sucker	Sq	= squawfish
P	= _Pantosteus_ sp. sucker	BT	= bonytail chub
WF	= whitefish	HBT	= humpback bonytail
Brn	= brown trout	Sc	= sculpin
Rbw	= rainbow trout	Im	= black bullhead
Trt	= unspecified trout	Ip	= channel catfish
C	= carp	Xt	= humpback sucker
D	= speckled dace	Ga	= Utah chub

Location:
1 = mainstream
2 = backwater connected with river
3 = offchannel slough not connected with river

Abundance: A = abundant C = common O = occasional R = rare

SECTION I (NEW FORK RIVER)

Period	Species	Location	Abundance	Length in inches Mean	Min	Max	Remarks
Pre-treatment	Su	2	A				fry
	Cl	1	C	19.7	19.25	20.00	
	Ca	1	O	14.7	13.25	15.25	
	P	1	C	18.4	17.25	19.00	
	WF	1	A	12.1	6.75	12.75	
	Brn	1	C	15.2	12.00	19.50	
	Rbw	1	O	11.1	10.50	11.75	
	C	2,3	C				fry
	D	1,2,3	A				all sizes
	R	1,2,3	A				all sizes
	F	1,2,3	C				all sizes
Fall, 1962	Su	2	C				newly hatched fry
	WF	1	R	12.8			upper third only
	Brn	1	R	6.0			upper third only
	C	3	C				fingerlings
	D	3	O				all sizes
	F	3	O				all sizes
	R	3	O				all sizes
Spring, 1963	Su	1	R				fingerlings
	P	3	O				fingerlings
	WF	1	R	14.9	13.00	16.25	upper half only
	Brn	1	R	5.1	4.75	5.50	upper half only
	C	3	C				all sizes
	D	3	C				all sizes
	F	3	O				all sizes
	R	3	C				all sizes
	Sc	3	O				all sizes

TABLE 1 (CONTINUED). SYNOPSIS OF FISH SAMPLING.

Period	Species	Location	Abundance	Length in inches			Remarks
				Mean	Min	Max	
Summer and Fall, 1963	Su	3	O				fingerlings
	Cl	1	O	9.1	7.00	11.75	
	P	1	O	12.8	6.75	16.00	
	WF	1	O	12.0	10.00	14.00	
	WF	3	O				fingerlings
	Brn	1	R	9.0	5.00	9.75	
	Brn	3	R				fingerlings
	D	1,2,3	O				all sizes
	F	1,2,3	O				all sizes
	R	1,2,3	O				all sizes
Spring, 1964	Cl	1	O	20.0			
	P	2	O				
	WF	1	C	12.2	5.50	16.75	
	Brn	1	C	15.1	14.20	16.50	
	D	2	O				all sizes
	F	2	O				all sizes
	R	2	O	2.0	1.75	2.50	
Summer and fall, 1964	Su	2	C				fry
	Cl	1	C	8.8	7.75	9.75	
	Ca	2	R	12.5			one only
	P	2	C	7.0			
	WF	1	A	8.4	7.25	15.75	
	WF	2,3	O				fingerlings
	Brn	1,2	C	10.2	8.50	14.75	
	C	2,3	C				fry, fingerlings
	D	1,2,3	C				all sizes
	F	1,2,3	C				all sizes
	R	1,2,3	A				all sizes
		SECTION II (UPPER GREEN RIVER)					
Pre-treatment	Cl	1	C	18.3	16.25	19.25	
	P	1,2	O	14.5			
	WF	1	A	9.9	6.50	12.00	
	Brn	1	C	13.8	11.50	16.00	
	Rbw	1	C	10.4	9.50	11.25	
	D	1,2,3	C				all sizes
	R	1,2,3	C				all sizes
	Sc	1	C				all sizes
Fall, 1962	Su	2	A				newly hatched fry
	WF	1	C	11.0			scattered schools
	D	2,3	O				immature
	R	2	O				all sizes

TABLE 1 (CONTINUED). SYNOPSIS OF FISH SAMPLING.

Period	Species	Location	Abundance	Length in inches			Remarks
				Mean	Min	Max	
Spring, 1963	Su	2	C				fry
	Cl	1	O	17.0			many seen at Sommer's Bridge
	WF	1	C	13.4	11.25	12.00	
	Brn	1	O	11.0			
	D	2	O				fry sometimes common
	R	2	O				fry sometimes common
Summer and fall, 1963	Su	2	O				fingerling
	Cl	1	O				all sizes
	WF	1	C				all sizes
	P	1	O				fingerlings
	Brn	1	O				fingerlings
	D	1,2	O				all sizes
	R	1,2	O				all sizes
Spring, 1964	no samples taken						
Summer and Fall, 1964	Cl	1	C	19.6	19.50	19.75	
	P	1,2	O				
	WF	1	C	8.8			
	Brn	1	C	8.1			
	D	1,2	C				all sizes
	F	1,2	O				lower section only
	R	1,2	C				all sizes
	Sc	1,2	C				all sizes
		SECTION III (MIDDLE GREEN RIVER)					
Pre-treatment	Cl	1,2	A	13.90	7.0	20.50	
	Ca	1	C	12.25	10.25	17.00	
	P	1,2	C				all sizes
	WF	1	A	11.60	7.50	18.50	
	Brn	1,2	C	15.10	4.00	22.00	
	Rbw	1	C	15.00			
	C	1,2,3	C	12.40	1.0	26.75	
	D	1,2,3	C				all sizes
	F	1,2,3	C				all sizes
	R	1,2,3	C				all sizes
	Sc	1,2,3	C				all sizes
	BT	1	C	14.6	7.0	16.5	

TABLE 1 (CONTINUED). SYNOPSIS OF FISH SAMPLING.

Period	Species	Location	Abundance	Length in inches: Mean	Min	Max	Remarks
Fall, 1962	Brn	3	R	10.0			
	C	3	C				fingerlings, retreated
	D	3	C				all sizes, retreated
	F	3	O				all sizes, retreated
	Sc	3	O				all sizes, retreated
							note: no fish were found in mainstream
Spring, 1963	WF	1	O	13.0	12.00	14.00	upper end of section only
	Brn	1	R	10.0			upper end of section only
Summer and Fall, 1963	Su	2	C				fry and fingerlings
	Cl	1,2	C	10.0	2.00	21.00	
	WF	1	O	14.0			above LaBarge only
	Brn	1	O				above LaBarge only
	C	1,2,3	O	10.3	7.50	13.00	no fry found
	D	1,2,3	O				fry common
	F	1,2,3	O				fry common
	R	1,2,3	C	2.5	2.00	3.00	fry common
Spring, 1964	Cl	1,2	C				
	WF	1	O	10.0	5.00	15.00	above Fontenelle town only
	Brn	1	O				above LaBarge only
	C	1,2,3	O				
	D	1,2,3	O				
	F	1,2,3	O				
	R	1,2,3	C				
Summer and Fall, 1964	Cl	1,2	C	10.8	6.00	21.00	
	P	2	O	9.3			
	WF	1	C	9.4	5.25	16.00	
	Brn	1	R	8.5			
	C	1,2,3	O				all sizes
	D	1,2,3	C				all sizes
	F	1,2,3	A				all sizes
	R	1,2,3	A				all sizes
	BT	1,2	O				fry and fingerlings
	Sc	1	C				
	Ga	1,2	R				reported by Miller*
			SECTION IV (LOWER GREEN RIVER)				
Pre-treatment	Cl	1,2	A	11.4	7.00	20.25	
	P	1,2	O	7.0	6.00	8.00	
	WF	1	C	10.1			

* Personal communication, July 26, 1964.

TABLE 1 (CONTINUED). SYNOPSIS OF FISH SAMPLING.

Period	Species	Location	Abundance	Length in inches Mean	Min	Max	Remarks
Pre-treatment (continued)	Brn	1	R	16.0			
	Trt	1	O	12.0	8.00	16.00	
	C	1,2,3	C	15.3	10.00	26.75	
	D	1,2,3	C				all sizes
	F	1,2,3	O				all sizes
	R	1,2,3	A				all sizes
	Ip	1	O	12.4	12.30	12.50	lower part of section (Bosley's data)*
	Im	?	O				reported by Bosley (1960) and McDonald and Dotson (1960)
	Sq	1	O	20.9	16.40	24.00	from Bosley's data*
	BT	1	C	12.8	6.00	16.75	from Bosley's data*
	HBT	1	O	14.3	13.0	17.00	from Bosley's data*
	Sc	1	O	4.8			from Bosley's data*
	Xt	1	R				reported by Bosley (1960) and McDonald and Dotson (1960)
	Ga	1,2	R				reported by Miller**
Fall, 1962							no fish found in mainstream; carp and other coarse fish reported near Linwood in sloughs
Spring, 1963							no fish found
Summer and Fall, 1963	Cl	1,2	O	12.7	2.75	19.50	in river above reservoir
	Cl		O	6.0	4.00	7.25	near head of reservoir
	WF	1	R	5.0			upper end of section
Spring, 1964	Cl	1	O				various sizes
	Cl		C	8.9	6.00	12.00	head of reservoir
	WF	1	R				upper end of section
	C	1	O				less than 10 inches
	C		C	8.7	5.25	12.00	head of reservoir
Summer and Fall, 1964	Cl	1,2	C	11.1	4.50	21.25	
	P	1,2	O	6.5	4.00	8.50	
	WF	1	O	8.5	5.00	11.50	
	C	1,2,3	O	11.4	3.50	15.50	figures for river only
	D	1,2,3	C				all sizes
	F	1,2,3	A				all sizes
	R	1,2,3	A				all sizes
	BT	1	R	4.5			

*unpublished; used with his permission.
**personal communication, July 26, 1964.

Richardson). The brown trout was probably the most common trout. The redside shiner and the fathead minnow are both recently introduced exotics which have spread and become very common in the river. The Utah sucker was found occasionally only in sections I and III and was not found below station #9 in section III.

The carp was present in section I, as far upstream as mile 10 of the treated area. This species apparently migrated up the New Fork River, from the Green River, each year during high water. The adult carp spawned in the sloughs and backwaters of the New Fork River while those areas were connected with the mainstream. Following the subsidence of the runoff, the adults retreated to the main stream and the warmer, deeper areas down river. The young fry remained in the natural brood ponds until the following year. The upstream spawning migrations allowed the carp to gradually extend its range until the excellent trout fishery of the upper New Fork and Green Rivers was threatened. This danger was a primary reason for the 1962 rotenone treatment of the Green River.

Sections III and IV of the Green River had a fish population somewhat similar to the upper areas. However, because of the warmer, more turbid water, the coarse fish populations dominated the habitat. Whitefish, although common, surrendered their dominance to flannelmouth suckers and decreased in number downstream. The bonytail chub [Gila robusta (Girard)] was a common inhabitant of the lower river, as were other species of minnows. The squawfish (Ptychocheilus lucius Girard) and the humpback sucker [Xyrauchen texanus (Abbott)] were present in limited numbers. These species have declined in recent years because of pollution, especially during the war years. The black bullhead [Ictalurus melas (Rafinesque)] and the channel catfish [Ictalurus punctatus (Rafinesque)] were recorded by both Bosley (1960) and McDonald and Dotson (1960). No squawfish, humpback suckers, or catfish were taken during the fish sampling in 1962. The lengths reported in Table 1 for squawfish, humpback suckers, and catfish are taken from Bosley's unpublished data. The squawfish appears to have been present only near the Dutch John town site. Trout were found only occasionally below the LaBarge area because of poor habitat and strong competition from the coarse fish.

The fish population in the Green River below Middle Firehole Creek (section IV) was strongly depressed by a trial treatment made in 1961 to test rotenone dispensing systems. During this trial treatment, trout, humpback suckers, and channel catfish were found to be very rare, and no squawfish were reported. The following species, reported by previous investigators (Bosley, 1960; and McDonald and Dotson, 1960), were not found during the 1962 pretreatment gill netting in the lower river: yellow perch [Perca flavescens (Mitchill)], brook trout [Salvelinus fontinalis (Mitchill)] brown trout, channel catfish, black bullhead, and sculpin. The lower river was difficult to sample, especially since dynamite was not used at that time, and this may account for the failure to pick up some of the above species. However, brown trout, channel catfish, and sculpins were found during the treatment. The Utah chub [Gila atraria (Girard)] and the Utah sucker were the only fish species not reported by either Bosley (1960) or McDonald and Dotson (1960). Neither species was believed to be common prior to treatment; however, Miller reported that he had found the Utah chub prior to treatment.[3] The humpback chub (Gila cypha Miller) has been reported from this section of the river, but its existence in the river at the time of treatment is not certain at the present time.

---

[3]Oral communication with Dr. Robert R. Miller on July 26, 1964.

<u>Green River treatment observations</u>

During the treatment project, investigational activities were concentrated on making population estimates, following the rotenone movement, determining rotenone concentrations, and observing the reactions of the fauna to the toxicant.

Attempts to make fish population estimates were abandoned after the first day, when the activities of crowds of people made unbiased counts of fish along the banks impossible. Salvage by the public greatly decreased the wastage of fish. At no time was there any serious nuisance problem resulting from dead fish. Some information was obtained by midstream drift counts made as the rotenone moved past different points on the river. Observations were also made at a few isolated locations which had not been disturbed by the public. The results of these counts are presented in Table 2. This table shows that <u>Cottus bairdi</u> was more common in section II than was previously suspected. A brief, premature, release of rotenone from station #1 was made on the evening prior to the scheduled start. Because of this release, many trout were killed before the main treatment and were removed by the public before the count was made near the field bioassay site, thus interferring with the estimation of the trout population. Observations revealed marked dominance of whitefish in the fish population of

TABLE 2. NUMBER OF FISH RECORDED IN DRIFT AND BANK COUNTS MADE DURING OR SHORTLY AFTER THE SEPTEMBER, 1962 ROTENONE TREATMENT OF THE GREEN RIVER.

-SPECIES KEY-

Su	= unspecified sucker	C	= carp
Cl	= flannelmouth sucker	D	= speckled dace
P	= *Pantosteus* sp. sucker	R	= redside shiner
WF	= whitefish	BT	= bonytail chub
Brn	= brown trout	Sc	= sculpin
Rbw	= rainbow trout	Ip	= channel catfish
HT	= hybrid trout (rainbow trout x cutthroat trout)		

Location	Date (Sept.)	Species	Number	Remarks
3/4 mile below G.R. Sta. #1	4	WF	33	Bank to bank count in 100 feet of a side channel. Area undisturbed except for trout. Sculpins hard to spot because many were lodged under rocks.
		Brn	1	
		P	17	
		D	19	
		R	5	
		Sc	82	
TOTAL			157	
200 yards above N.F. Sta. #2	11	WF	179	Bank count; 100 yards; area undisturbed except for trout.
		Brn	9	
		Rbw	3	
		Su	109	
		C	1	
TOTAL			301	
1 mile above G.R. Sta. #11	5	Brn	1	
		WF	50	Drift count: 1 hour, 15 minutes.
		Rbw	1	
		Cl	50	
		P	2	
		BT	5	
		D	1	
		R	3	
TOTAL			113	
1-1/4 mile below G.R. Sta. #11	5	WF	127	Drift count: 25 minutes.
		P	98	
		BT	14	
		D	57	
		R	72	
		Sc	61	
		C	3	
TOTAL			432	

TABLE 2 (CONTINUED). NUMBER OF FISH RECORDED IN DRIFT AND BANK COUNTS

Location	Date (Sept.)	Species	Number	Remarks
1/2 mile below G.R. Sta. #12	5	WF	82	Drift count: 30 minutes.
		P	23	
		BT	14	
		D	19	
		C	3	
TOTAL			141	
200 yards below G.R. Sta. #14	9	WF	13	Sandbar count in middle of river, 150 yards. Area undisturbed.
		Su	214	
		BT	16	
TOTAL			243	
1 mile below G.R. Sta. #18	6	BT	5	Drift count: 50 minutes. Very few fish over 5 inches seen.
		Su	69	
		D	48	
TOTAL			167	
1 mile below G.R. Sta. #18	6	Su	269	Bank count made 2 hours after drift count. All fish under 6 inches, except for 1-11 inch sucker.
		BT	4	
		D	53	
		R	3	
		Sc	1	
TOTAL			310	
1 mile below G.R. Sta. #19	6	WF	1	Drift count: 30 minutes. Numerous dace and shiners seen, but no accurate count obtained.
		Cl	17	
		BT	1	
		C	1	
		HT	2	
TOTAL			22	
3 miles above G.R. Sta. #21	7	WF	1	Bank count, 1/2 mile. Sucker and shiner fingerlings numerous, but no accurate count obtained.
		HT	3	
		Cl	100	
		P	20	
TOTAL			133	
1 mile above Jarvie Ranch, Browns Park	7	Cl	28	Bank count (all fish coming to shore in 2 hours after arrival of rotenone).
		P	3	
		Ip	28	
		C	9	
		BT	1	
TOTAL			69	

section I.

A drift count, made above station #11, indicated that the numbers of whitefish and suckers were nearly equal in this area; a count below station #11 showed whitefish to predominate, with no evidence of flannelmouth suckers. The disparity of these two counts points up the probably variation in species composition in adjacent sections of the river.

The effectiveness of the reduction of the fish population below station #14 by the 1961 test operation was very evident from the drift counts. The population was made up largely of small suckers and speckled dace. Only a few adult fish were found. Both species were either survivors from the test operation or immigrants into the area. A few hybrid trout were taken near stations #19, #20, and #21. These were probably migrants from nearby tributaries. Gill netting at station #21, prior to treatment, had showed trout to be present. The trout numbers seemed to be greatest near Sheep Creek and declined up the river.

The only channel catfish observed during the 1962 treatment were found in Brown's Park near the detoxification station. All fish in this area were surprisingly scarce. Only five squawfish and no humpback chubs were reported during the treatment despite intensive searching by various groups of observers. The squawfish were found only below the Flaming Gorge Dam site.

Observations were made during the treatment on the reaction of fish to rotenone. A high bank on the river's west shore, about two miles above station #9, provided an excellent vantage point for such observations. Prior to rotenone infusion, a school of large carp was noticed moving slowly about the deep pool at the base of the high bank. When the rotenone arrived, as evidenced by the appearance of distressed fish in the main current, the carp became restless and suddenly headed downstream. Immediately prior to, and for a short time after, arrival of the rotenone, numerous schools of large fish were seen moving swiftly downstream. Most of these fish were large suckers and carp from upstream areas.

The arrival of the rotenone was marked by the sudden appearance, at the water's surface, of scattered whitefish which thrashed about in great distress. The sequence of appearance of each species after exposure to the rotenone is given in Table 3. Various size groups of different species seemed to pass by in bunches possibly indicating differences in the sensitivity of different size and age groups to the toxicant.

Different species reacted to the rotenone in different ways. As mentioned before, many fish tried to escape downstream; others moved into uncontaminated backwaters and springs. When exposed to the rotenone, some fish, especially whitefish, reacted violently by surfacing and splashing around. Others reacted by swimming

TABLE 3. APPROXIMATE TIME REQUIRED FOR EACH SPECIES OF FISH TO APPEAR AFTER EXPOSURE TO ROTENONE.

Time in minutes												
0	10	20	30	40	50	60	70	80	90	100	110	120
	Prosopium williamsoni											
			Richardsonius balteatus									
			Ictalurus punctatus									
				Catostomus latipinnis								
				Rhinichthys osculus								
				Salmo gairdneri 1/								
				Salmo trutta 1/								
					Gila robusta							
					assorted cyprinids 2/							
										Cottus bairdi		
										Cyprinus carpio 3/		
											Pantosteus sp.	

1/ Time varied from 30 to 65 minutes.

2/ In weed beds near shore.

3/ Time varied from 15 minutes to 5 hours.

in circles, at the same time making convulsive, shivering body movements. This reaction was followed by vigorous diving and surfacing as the fish moved downstream. Prolonged exposure to the toxicant resulted in many fish moving toward shore, a common response of the suckers (Figure 21). Other fish ceased struggling and began to drift downstream with the current as though stunned. This was a characteristic reaction of carp which drifted slowly downstream, apparently dazed, but still responsive to sight stimuli.

As the duration of toxicant exposure increased, greater numbers of fish were observed dead or dying along the bank or drifting downstream with the current. Great numbers of dead fish rolled and tumbled along with the stream current. After about three hours of exposure to the toxicant, carp in the quiet waters were unresponsive to stimulation and had often lost their equilibrium. By this time, only dead fish were to be seen in the main stream flow. Large numbers of dead fish often accumulated just above each rotenone introduction station. These fish were evidently escapees trapped between the rotenone moving downstream and the rotenone newly introduced.

Table 4 presents the predicted and observed arrival time of the rotenone at some of the stations. Observations on fish held in "live cages" are also given. The predicted arrival time was calculated from an estimated stream velocity of one mile per hour

Figure 21. A rotenone-affected sucker struggling in shallow water along the river bank during the treatment. Note the cloud of silt in the water near the sucker's caudal fin as the dying fish attempts to move into still shallower water, possibly in search of oxygen.

TABLE 4. ARRIVAL TIMES OF ROTENONE AND RESULTS OF LIVE CAR CHECKS AT VARIOUS LOCATIONS ON THE GREEN RIVER.

Location	Date (Sept.)	Predicted arrival time of rotenone 1/	Observed arrival time of rotenone	Time of live car check	Remarks
Sta. #3	4	2100	2015	2115	Test fish in good condition.
Sta. #3	5			1145	All test fish dead.
Sta. #7	5	0900	0930		
Sta. #8	5	1200		1100	Test fish in early stages of toxication.
Sta. #9	5	1500	1530	1700	Test fish dead.
Sta. #10	5	1800	1415	1500	Test fish still alive.
Sta. #11	5	2100	1730	2030	Test fish in early stages of toxication.
Sta. #13	6	0300	0130	0300	All test fish dead or in distress.
Sta. #16	6	1200	1000	1100	Test fish dead or dying.
Sta. #17	6	1500	1330	1200	Test fish still alive.
Sta. #18	6	1800	1600	1700	Test fish very weak, river fish dying.
Sta. #19	6	2100		2000	Test fish alive, but beginning to show signs of toxicant.
Sta. #20	6	2400	2125	2230	Test fish near death.
Detox. Station	8	0630	0615		

1/ Based on river flow of 1 mph.

and river mileages obtained from aerial photographs and topographic map measurements.

The one mile per hour velocity figure used in the predictions was obtained during the 1961 trial treatment. Though some departures from this velocity were expected, especially on the upper river, it was believed to be fairly representative of the overall velocity. Rotenone arrived at the various stations from 30 minutes to nearly four hours earlier than predicted, indicating that the water velocity was greater in some sections than had been anticipated.

Arrival of the rotenone from an upstream station at the next downstream station before its operation was terminated usually insured that fish escaping ahead of the rotenone were trapped and killed. The converse of this situation occurred on the New Fork River when the rotenone from station #1 did not reach station #2 before rotenone discharge had been discontinued for several hours. Thus, there was a possibility of a zone of untreated water in the New Fork. However, as there was still rotenone present in the Green River when it received untreated water from the New Fork River, any fish moving down the New Fork in this water should have been trapped at the confluence of the two rivers. Retreatment of the New Fork River several days later revealed that the only fish in the mainstream were restricted to the upper five miles.

These are believed to have been downstream migrants (Peterson, 1963).

The survival time of the small carp in the live cages varied from one to four hours after initial rotenone contact. The test carp at station #11 did not begin to lose their equilibrium for nearly three hours after initial exposure. After four hours, the young carp were so weak that they were pressed together at the downstream end of the cage; death followed shortly. Differences in survival duration probably were primarily due to the fish being exposed to different concentrations of rotenone. Variations in the natural toxic resistance of test fish may also account for some of the differences. Adult carp in the river near station #9 were first observed in distress 105 minutes after exposure.

After the closure of each rotenone introduction station, the river below remained contaminated until all the rotenone from upstream stations had either decomposed or dispersed downstream. Accumulations of rotenone downstream subjected the lower sections of the river to very extended periods of contamination. For example, at Green River City, rotenone was first present on September 6 at 0100 hours; Henderson (1963) reported finding at least 0.1 ppm of rotenone at about 1200 hours on September 11. Rotenone was thus present for at least 131 hours (5-1/2 days). Assuming a river flow of one mile per hour, the rotenone from

Green River station #1 should have taken about 125 hours to travel the distance to Green River City.

An original objective of this study was to determine the distance the rotenone remained effective downstream from the last rotenone introduction station. The decision to establish a detoxification station at Brown's Park eliminated all possibility of realizing this objective.

Post-treatment fish investigations

During the fall and early winter of 1962, an intensive fish sampling program was undertaken to determine the extent of fish population reduction in the treated area. Special attention was given to the deep holes in the mainstream and the side channel sloughs and backwaters where fish were known to over-winter prior to treatment. Overnight gill-netting and multiple dynamite explosions were the principal collection methods used in the mainstream; rotenone was used for checkingoff-channel areas. Figures 22 and 23 show the longitudinal distribution of flannelmouth suckers, carp, brown trout, and whitefish düring the study. Mainstream fish populations consisted of whitefish, brown trout, and various cyprinids, mostly redside minnows. These populations were found only in the upper sections of the treated area. Whitefish were found 15 miles down the treated Green River and in the upper five

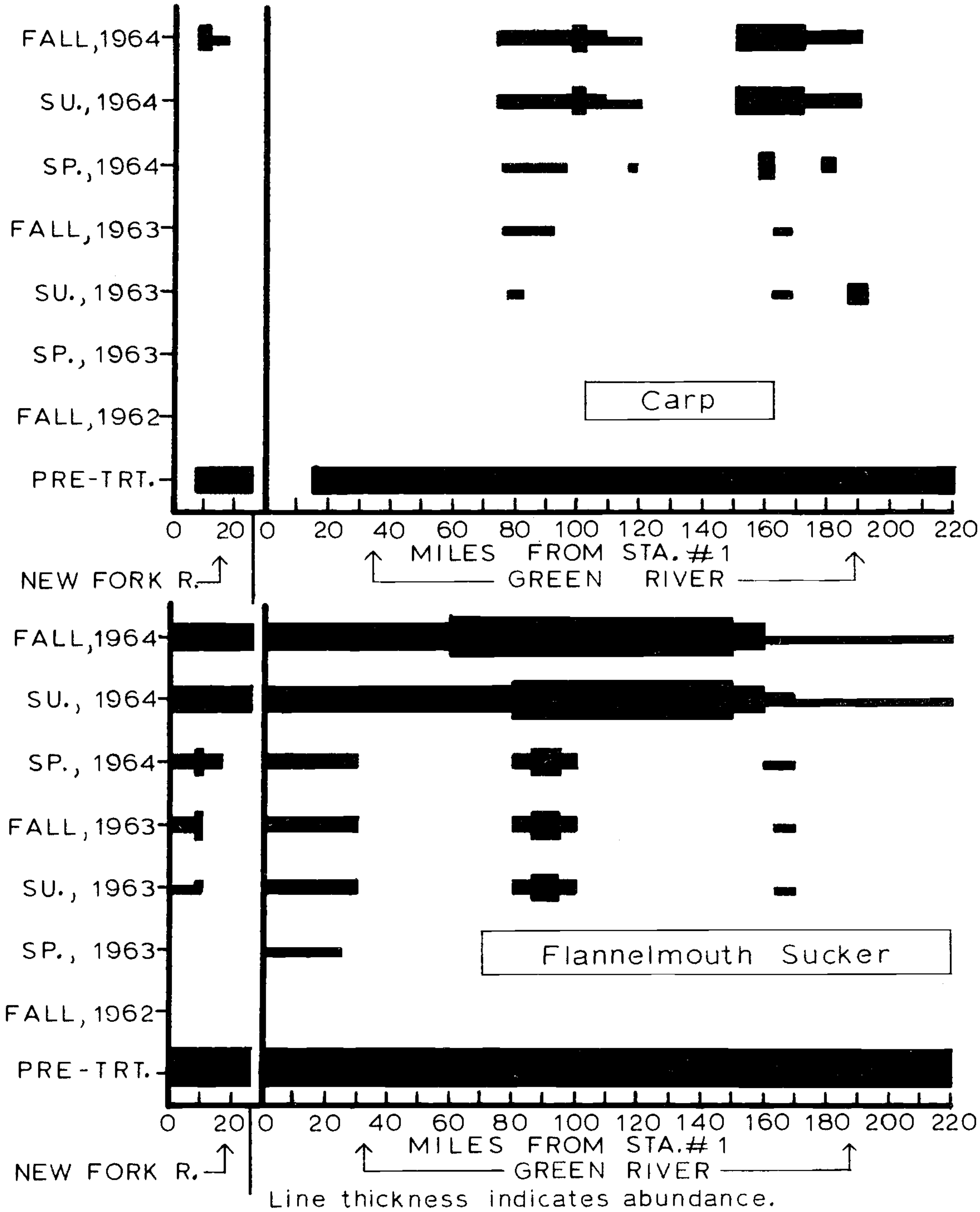


Figure 22. Longitudinal distribution of carp and flannelmouth suckers in the Green and New Fork Rivers.

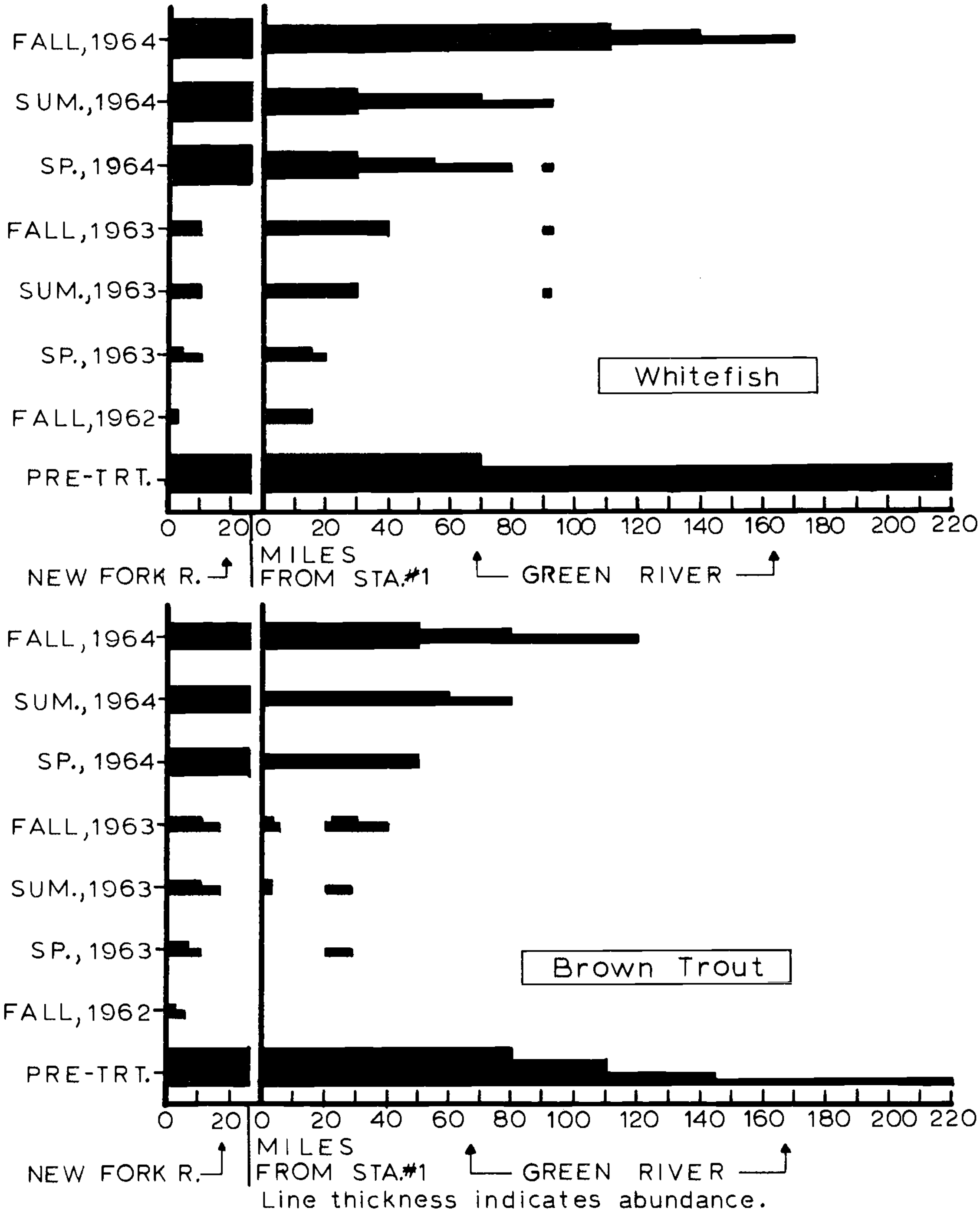


Figure 23. Longitudinal distribution of brown trout and whitefish in the Green and New Fork Rivers.

miles of the New Fork River. The rapid re-entry of this species was expected as whitefish were found to have moved about 1-1/2 miles downstream into treated areas from untreated waters about a week after the 1961 test project. No carp were found in the mainstream.

A pair of redside shiners was captured with a hand net in a spring-fed backwater near station F. Other unidentified, small fish were occasionally seen near stations D and E when the invertebrate samples were being taken. Only one brown trout was found in the treated area, and it was taken from a small check dam about five miles downstream from New Fork station #1.

Sampling of a few of the numerous sloughs and backwaters, upstream from Big Piney, on the Green and New Fork Rivers revealed that numerous fish of all species, including trout and carp, were present in many areas. The smaller sloughs and backwaters were re-treated immediately when residue fish populations were found. Water temperatures near 40°F. and the onset of winter conditions precluded any attempt to re-treat the larger off-channel areas.

By December of 1962, enough sampling had been completed to indicate that the treatment had considerably reduced all mainstream fish populations. No fish were found except those mentioned above. Even the sloughs and backwaters on the lower river appeared to be barren of fish life.

Realizing that the sloughs and backwaters on the upper river were a potential source of re-infestation, plans were made to re-treat those areas in which winter conditions were not severe enough to kill the fish. Dissolved oxygen determinations made in February, 1963, on water samples collected from beneath the ice indicated that the chances for fish mortality were great, as oxygen concentrations ranged from 0 to 1.5 ppm.

Following the break-up of ice in the spring of 1963, fish sampling activities were resumed. The only slough area found to contain fish during this period was an extensive series of long, deep ponds in an old "ox-bow" of the New Fork River. This area was apparently missed by the original treatment, since the 1963 retreatment yielded carp of all sizes up to 9-1/2 pounds, brown trout, and various suckers and cyprinids.

Sampling on the mainstream with dynamite prior to the 1963 runoff in June, showed that young brown trout, sucker fry, adult redside shiners, and adult whitefish had penetrated about ten miles into the treated area of the New Fork River. Only scattered white-fish were found in section II. No fish were found below station #3, but reports were received of several large brown trout being caught near Big Piney. These fish were probably spawners that entered the Piney drainages prior to treatment and thus survived.

Restocking of the treated area with rainbow trout was initiated during this period. Most of the fish planted were fry, but numbers of larger rainbows were planted in the upper reaches. These fish appeared in the fish sampling collections during the remainder of the study.

An attempt was made in the summer and fall of 1963 to gill-net at all locations sampled the previous year and in all other suitable areas. In addition, extensive fish sampling activities were conducted with dynamite. Flannelmouth suckers were found at widely scattered locations in the river and in the Flaming Gorge Reservoir, near its upper end. Most of these were of small size. Analysis of scale samples indicated that these fish were of the 1962 year class. This indicates either that they were young from late spawning fish and survived the treatment as eggs, or that they were residents of scattered untreated sloughs and backwaters. Newly-hatched sucker fry were found in some areas in late September and early October of 1962, so the first explanation is possible, especially in view of the fact that Smith (1940) found fish eggs to be resistant to rotenone.

Carp up to 13 inches long were found near station #9. An attempt to re-treat an adjacent backwater in which carp were present was not successful due to flash floods in August, 1963. Examination of scales from the smaller 6-7 inch carp indicated that they were members of the 1962 year class. These fish apparently survived in some untreated slough near station #9. The backwater in which they were found had been heavily treated with rotenone when it was checked immediately after the treatment. No fish were found at that time.

Carp of the 1962 year class were also found in the Flaming Gorge Reservoir near the entry point of the Green River.

Redside shiners were found in limited numbers throughout the river during the summer of 1963. Those in the lower reaches were believed to be treatment survivors, rather than downstream migrants. A few adult fathead minnows and numerous fathead and dace fry were found in sections I and III. The status of the sculpin population was uncertain, as they are a difficult species to sample.

Pantosteus suckers were occasionally found in sections I and II. Whitefish were found in the upper ten miles of section I, were common in all of section II, and were present in section III, above LaBarge, and at the mouth of the Big Sandy River. Fish at the latter site may have come down the Big Sandy from its upper reaches. A few small brown trout were found in section I, as far downstream as station #2. Their presence in the Green River proper was limited to the upper two or three miles of section II and to the vicinity of the Piney tributaries in section III.

No bonytail chubs, Utah suckers, or carp of the 1963 year class were found. No carp of any kind were found above the Fontenelle Reservoir site.

By the spring of 1964, one-to-two-pound brown trout occurred along all of section I, and large schools of whitefish were also present. Large flannelmouth suckers were found in various localities. Sampling, at this time, was limited by rising, murky water.

Sampling during the 1964 summer-fall period showed that flannelmouth suckers were common to abundant in all sections of the river. As a rule, this fish was found in the deep holes, especially in section IV. Three distinct size groups were noticeable by this time. The few larger (20 inches) specimens were probably fish that were present in untreated areas or were downstream migrants. The next size group was made up of the 1962 year class and was composed of individuals about 14-15 inches long. The 1963 year class fish were about 8-9 inches long and formed the bulk of the sucker population.

Carp were present in limited numbers in scattered parts of the treated area. Carp of the 1964 year class were found near stations #9 and #11 and in a few backwaters on the New Fork River. Larger carp were not found above Fontenelle Dam, but, because of evident reproduction, were obviously present in sections I and III. Judging from the large numbers of carp fry found in one area on the New Fork River, large increases in the carp population in this section can be expected within the next two years. However, extensive predation by the brown trout already well established in this section may provide some degree of biological control.

Whitefish were found all through the treated area and in the upper end of Flaming Gorge Reservoir. The population was sparse below Green River City at the close of the study, but was slowly increasing, largely from an accumulation of downstream migrants.

Brown trout were found as far downstream as Green River City at the close of the study. This fish greatly extended its range during the 1964 summer, but apparently is still rare in the lower part of section III and in the upper part of section IV.

Bonytail chub were occasionally found in 1964 in sections III and IV for the first time since the treatment. No specimens were longer than five inches and most were smaller.

Redside shiners and fathead minnows were found all through sections that were treated and were very numerous in sections III and IV. The rapid re-population of the river by these species is indicative of the explosive reproductive potential of a fish species subject to little competition or predation. The fathead minnow is probably more widespread and numerous than it was prior to treatment.

The speckled dace is also present in all sections, but is not nearly as common as the above two species. One adult specimen of the Utah sucker was taken from the New Fork River in August, 1964, and may have been a downstream migrant from untreated sections. Sculpins were captured occasionally in minnow traps near LaBarge and were taken with electro-fishing gear below Fontenelle Dam. The present status of this fish is obscure, but, like the other species, it has probably re-entered much of its pre-treatment habitat.

Several specimens of a small cyprinid, tentatively identified as Utah chubs, were reported by Dr. Robert R. Miller in collections made in July, 1964, at the mouth of the Big Sandy River; in addition, several Utah chubs were taken in gill-nets near the head of the Flaming Gorge Reservoir in 1964. No specimens of channel catfish, squawfish, humpback sucker, humpback bonytail chub, or the so-called humpback chub have been collected in the treated area during post-treatment investigations.

Invertebrates

The results of the invertebrate sampling program are tabulated in the Appendices. Results from each station will be reviewed separately because of the diverse habitats represented. It should be noted here that field observations on the reactions of the river invertebrates, in situ, to treatment were substituted for original plans calling for observations of the invertebrates in pans placed in the river at the time of treatment. Lack of time and obvious difficulties in holding live insects under artificial conditions necessitated the substitution .

Station A

This station was located on the New Fork River above the treated area to provide information on the normal population trends of invertebrates not exposed to rotenone. Samples were taken from a riffle situated about 200 yards upstream from the New Fork River Bridge at Boulder.

Figure 24 shows the fluctuations in numbers and volumes exhibited by the benthic and drift biota at station A. The three dominant organisms present in selected bottom samples from station A are illustrated by Figure 25; the samples shown were selected to show the fauna immediately before and after the treatment and at

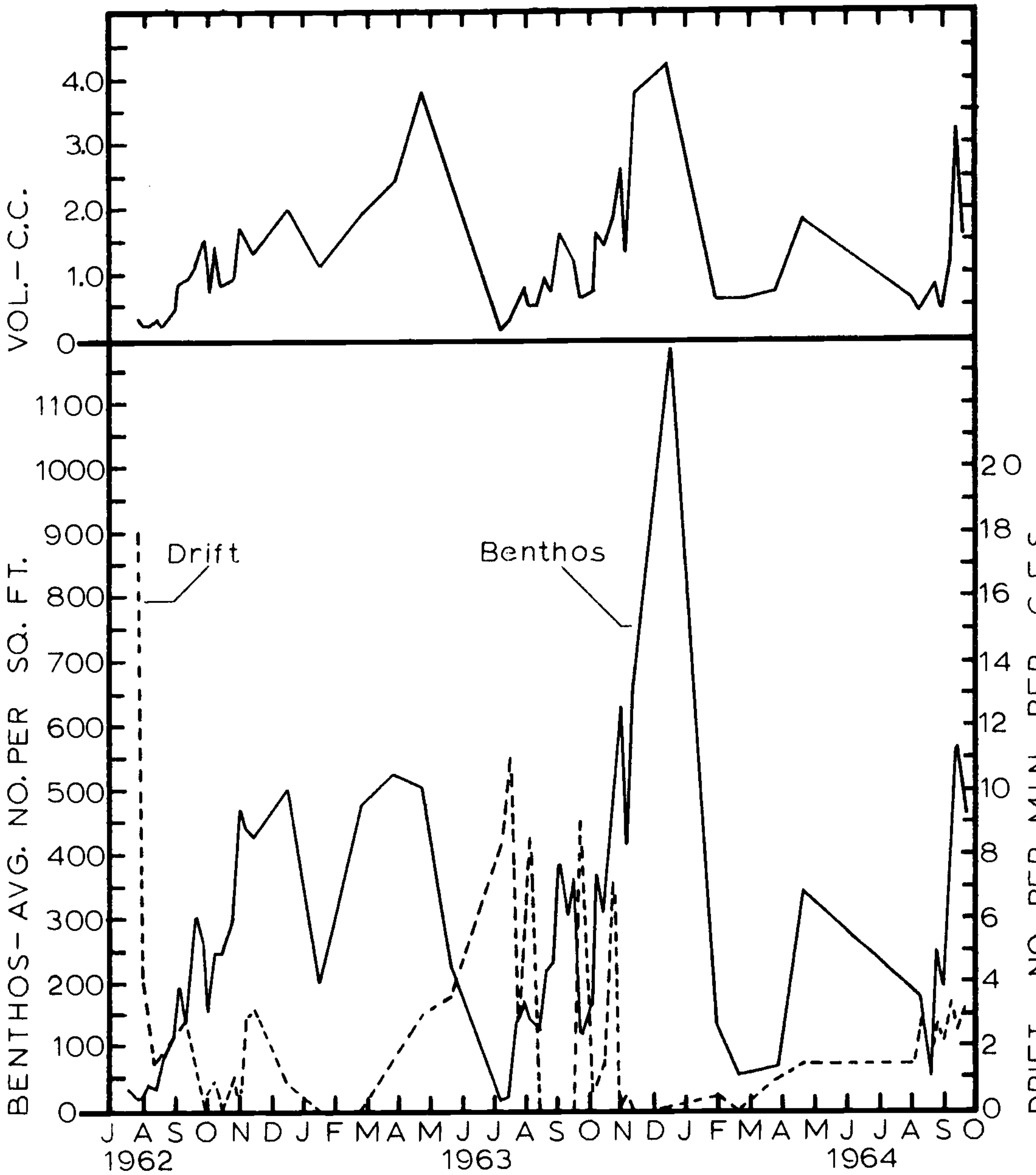


Figure 24. Numbers and centrifuged volumes (benthos only) of bottom and drift samples at invertebrate station A from July 16, 1962 to September 21, 1964. The fauna at this station was not exposed to rotenone.

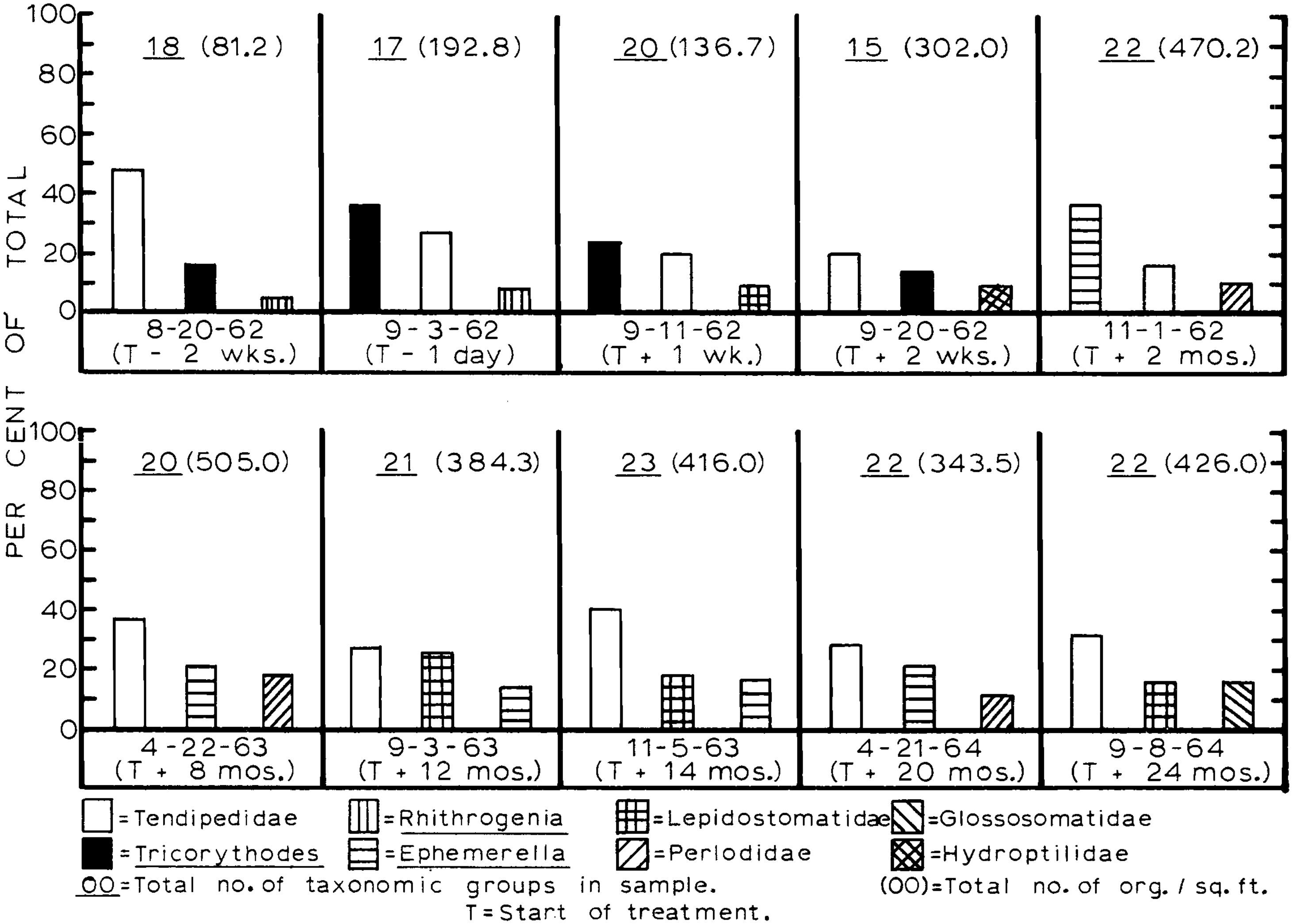


Figure 25. Composition of selected bottom samples at station A. The fauna at this station was not exposed to rotenone.

seasonal intervals thereafter. These two figures show that the benthos reaches peaks during the late fall-early winter period and in the spring, after the ice break-up. The runoff in June severely reduces the number of benthic organisms present. Drift abundance is maximum in June and again for periods in the summer and fall, reflecting heavy summer hatches of adult insects. The benthic population is dominated by larvae of aquatic midges (Tendipedidae) during much of the year. Occasionally immature mayflies, of the genera *Tricorythodes* and *Ephemerella*, are common. Stoneflies of the family Perlodidae and various caddisflies (Lepidostomatidae, Hydroptilidae, and Glossosomatidae) are often prominent in the fall and spring. The number of taxonomic groups present remains fairly constant the year around.

Station B

This station was located on a riffle area just upstream from New Fork Station #2 (the old New Fork Bridge). Heavy growths of water crowfoot (*Ranunculus*), aquatic moss, and algae (usually *Cladophora*) were located in the deeper, swifter water in the middle of the stream. The samples were taken in shallow water, near shore, where there was very little vegetation except for an occasional fall bloom of *Cladophora*. Fresh-water sponges were present here. Prior to treatment, handfuls of plants pulled from the heavily vegetated area of station B teemed with various invertebrate organisms. Though populations in the sample area were not large, they appeared to be approaching a fall peak similar to that at the control station upstream.

The total numbers of the benthic organisms (Figure 26) dropped sharply after treatment, but soon returned to relatively high levels.

Figure 27 shows the difference in the composition of the invertebrate fauna at station B. Dominance patterns after treatment were very different. Prior to treatment, the stonefly family Perlodidae had progressively increased in abundance through the summer. This trend would be expected since stonefly numbers in a normal population are usually greatest in the fall, winter, and early spring. Immediately after rotenone treatment, the dominant benthic organisms were water beetles. A few midge larvae, cranefly larvae, biting midges, and mayflies survived the toxicant application. Handfuls of the vegetation from the deeper water contained numerous dead snail and cranefly carcasses. Only one live invertebrate was noticed--a cased caddis fly (Brachycentridae). An analysis of the population composition and recovery rate will be presented later in this report.

Drift catches increased for a brief period after the treatment (Figure 26). Many of the organisms caught at that time were

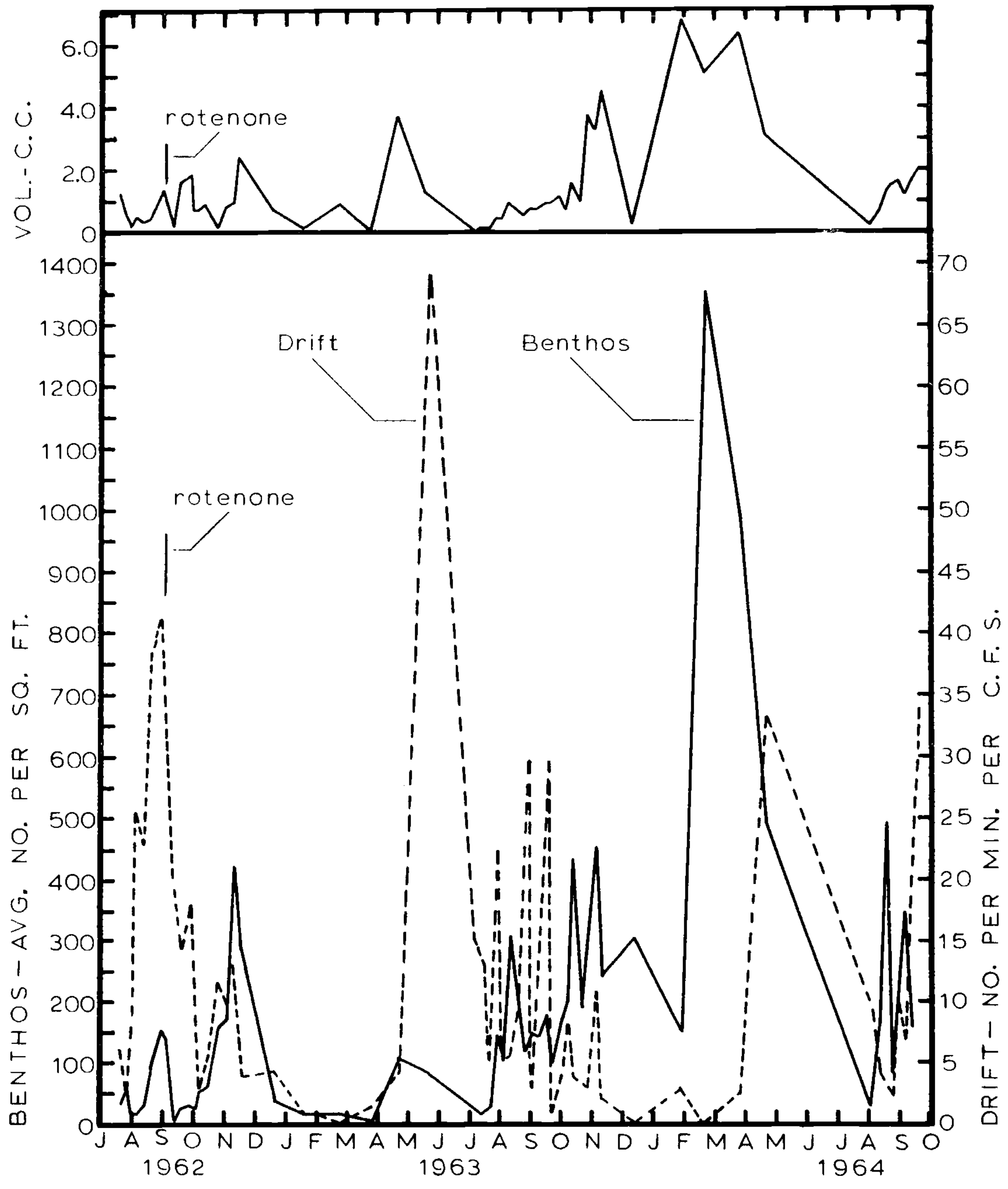


Figure 26. Numbers and centrifuged volumes (benthos only) of bottom and drift samples at invertebrate sample station B from July 21, 1962 to September 21, 1964.

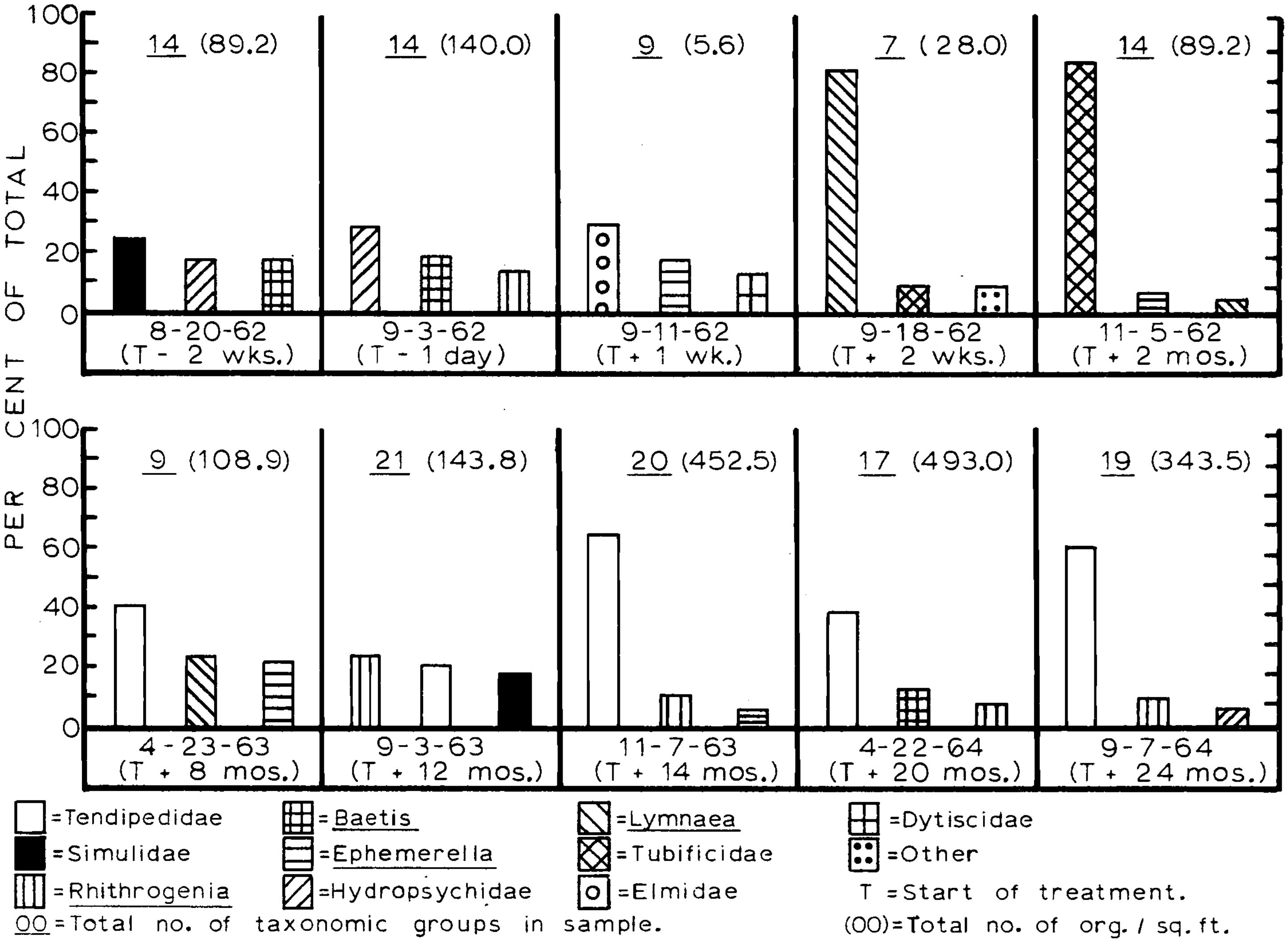


Figure 27. Composition of selected bottom samples at station B over a period from 2 weeks before rotenone exposure to 2 years after.

apparently dead (no movement, even when placed in alcohol). Aquatic beetles were the predominant organism taken.

Table 5 shows the groups missing from the fauna for successive intervals after the treatment. No groups were missing at the close of study.

Station C

This station was located above the treated area on the Green River and served as a control station. Samples were taken from the fast water riffle immediately above rotenone introduction station #1. Scattered algae clumps and fresh water sponges were present at times.

The invertebrate population trend was similar to that noted at station A. The population developed peaks in the fall and spring months; marked reductions occurred during the June runoff (Figure 28). No winter samples were obtained because of the unique pattern of ice formation found during the first winter. The water was found to be moving downstream in a channel formed between the surface ice and a layer of anchor ice which covered the stream bottom. The area was also observed to be scoured heavily prior to freeze-up by chunks of floating ice. No samples were obtained during the winter months because of this, and the fact that in 1963-64, the landowner requested that no holes be cut in the ice for the

TABLE 5. INVERTEBRATE TAXONOMIC GROUPS LISTED AS ABSENT OR OF SPORADIC (S) OCCURANCE AT THE END OF EACH TIME INTERVAL IN THE POST-ROTENONE EXPOSURE PERIOD. ONLY THOSE GROUPS PRESENT BEFORE TREATMENT ARE LISTED. DATA IS FOR STATION B.

Time in months						
3	8	12	15	18	20	24
Oligochaeta 1/	Oligochaeta 1/	Oligochaeta 1/	Empididae	Empididae	Empididae	none
Tipulidae (S)	Tipulidae	Empididae	Hydropsychidae	Hydropsychidae (S)		
Empididae	Empididae	Hydropsychidae (S)	Brachycentridae	Brachycentridae		
Baetis (S)	*Tricorythodes* (S)	Brachycentridae				
Tricorythodes (S)	*Heptagenia*					
Heptagenia	Pteronarcidae					
Pteronarcidae	Perlidae					
Perlidae	Hydropsychidae					
Hydropsychidae	Brachycentridae					
Brachycentridae	Hydroptilidae					
Hydroptilidae	Lepidostomatidae					
Lepidostomatidae						

1/ Excluding Tubificidae.

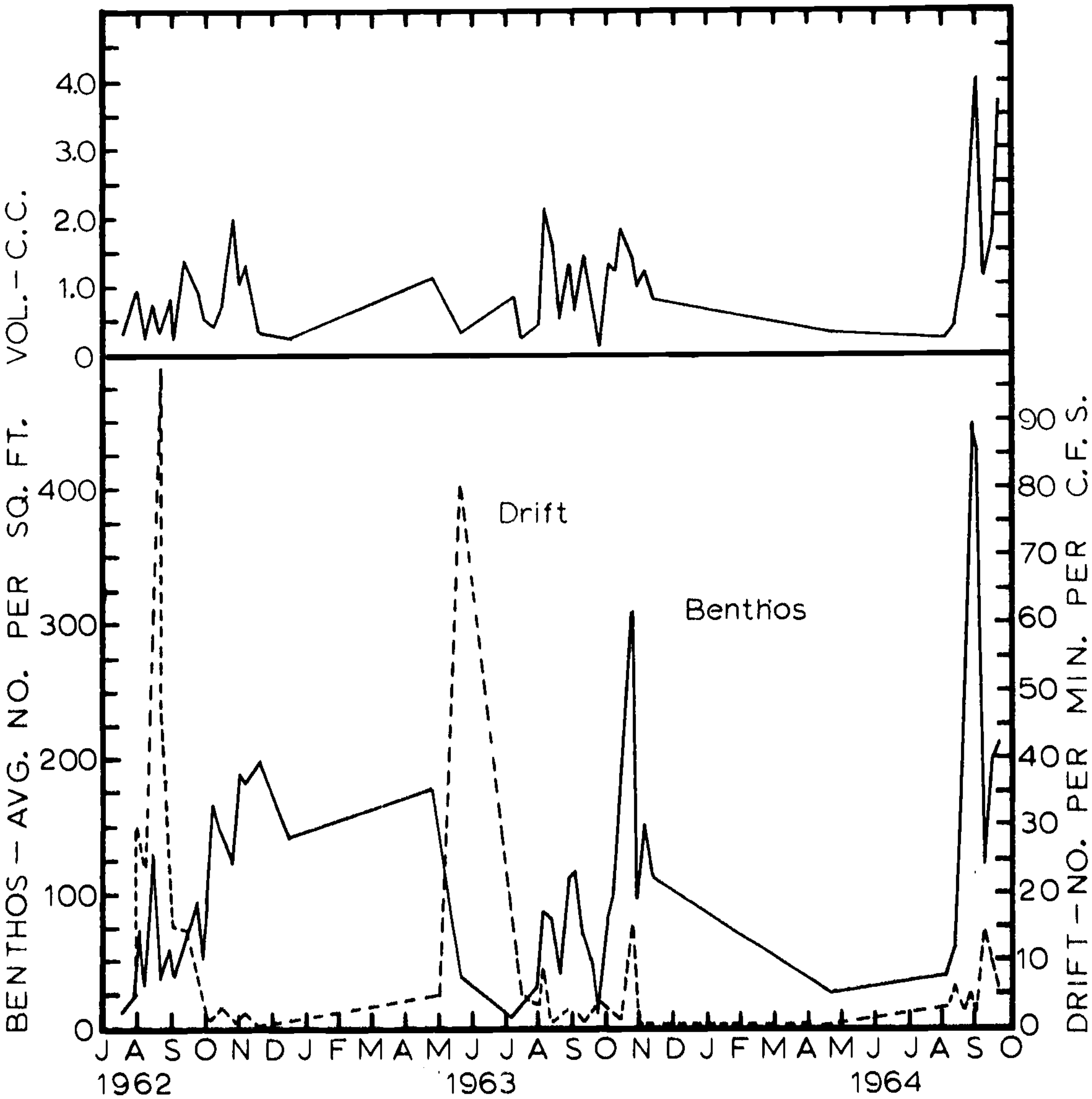


Figure 28. Numbers and centrifuged volumes (benthos only) of bottom and drift samples at invertebrate sample station C from July 17, 1962 to September 22, 1964. The fauna at this station was not exposed to rotenone.

safety of prize bulls in adjacent pastures.

Drift organisms (Figure 28) were most abundant during the late summer hatches, the June runoff, and just prior to freeze-up. Tendipedidae, various Baetidae, and adult Dytiscidae were commonly found in the drift samples.

The benthic community was composed mostly of those species adapted to swift water (Figure 29). The mayflies _Baetis_ and _Rhithrogenia_ dominated the population at various times. The midges (Tendipedidae) and caddisflies, especially the net-spinning Hydropsychidae, were also common. The midges were found mostly in the small scattered patches of vegetation present in the area.

Station D

Station D was located in the treated area below rotenone introduction station #1. The samples were taken from the edge of a long, deep glide. No riffles could be located in the area near the station.

The stream bottom in this area was covered with a mat of moss and _Ranunculus_, especially during the warm summer months. This station had a larger invertebrate population than any other sampling station. The abundance of invertebrates appeared to be correlated with the abundance of aquatic vegetation.

Because of the range in population numbers, semi-logarithmic

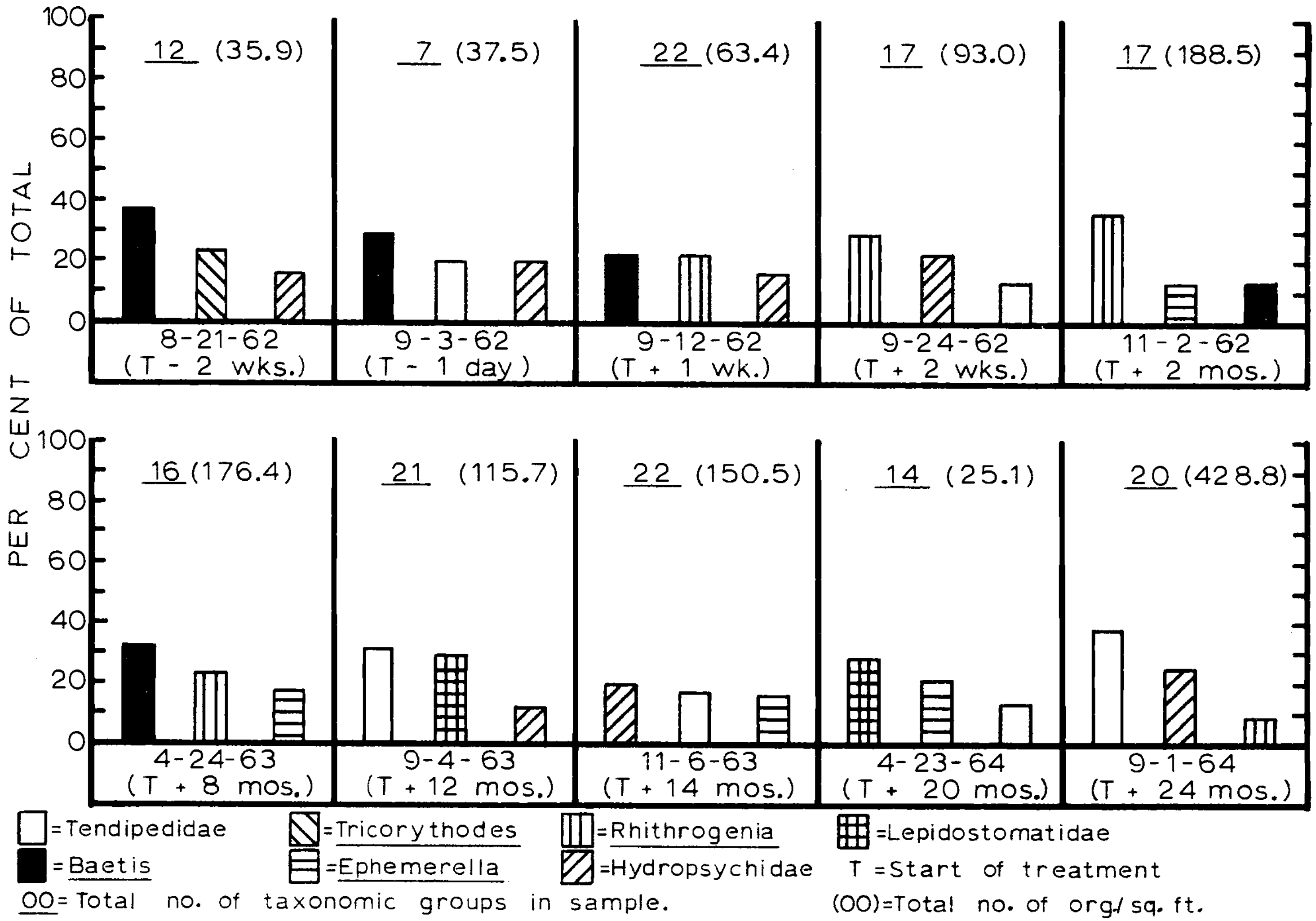


Figure 29. Composition of selected bottom samples at station C from August 21, 1962 to September 1, 1964. The fauna at this station was not exposed to rotenone.

graph paper was used in Figures 30 and 31. The dominant benthic invertebrates at this station during the study are shown in Figure 32.

The toxicant sharply reduced the invertebrate fauna at this station. Only one snipfly larvae (Rhagionidae), a stonefly nymph (Perlodidae), and several dragonfly naiads (Gomphidae) were found in three one-square-foot samples taken one week after treatment. Adult aquatic beetles were the chief component of the drift fauna.

Almost complete annihilation of the insect fauna was to be expected in view of observations made in this area during treatment. At that time, various small water beetles were killed in great numbers and were washed onto the shore in dense windrows. Mayflies, stoneflies, and dragonflies were noticed crawling about in apparent distress on the stream bottom. Other stoneflies and dragonflies were seen floating downstream. Leeches, in numbers previously unsuspected, were found dead and dying in the bottom moss.

Several weeks after treatment, a small, spring-fed backwater was retreated to eliminate some sucker fry. This operation provided some of the best observations on the reactions of various invertebrates to the toxicant which were obtained during the project.

Immediately after the toxicant was introduced, beetles of all sizes came to the surface and thrashed about; most soon died and

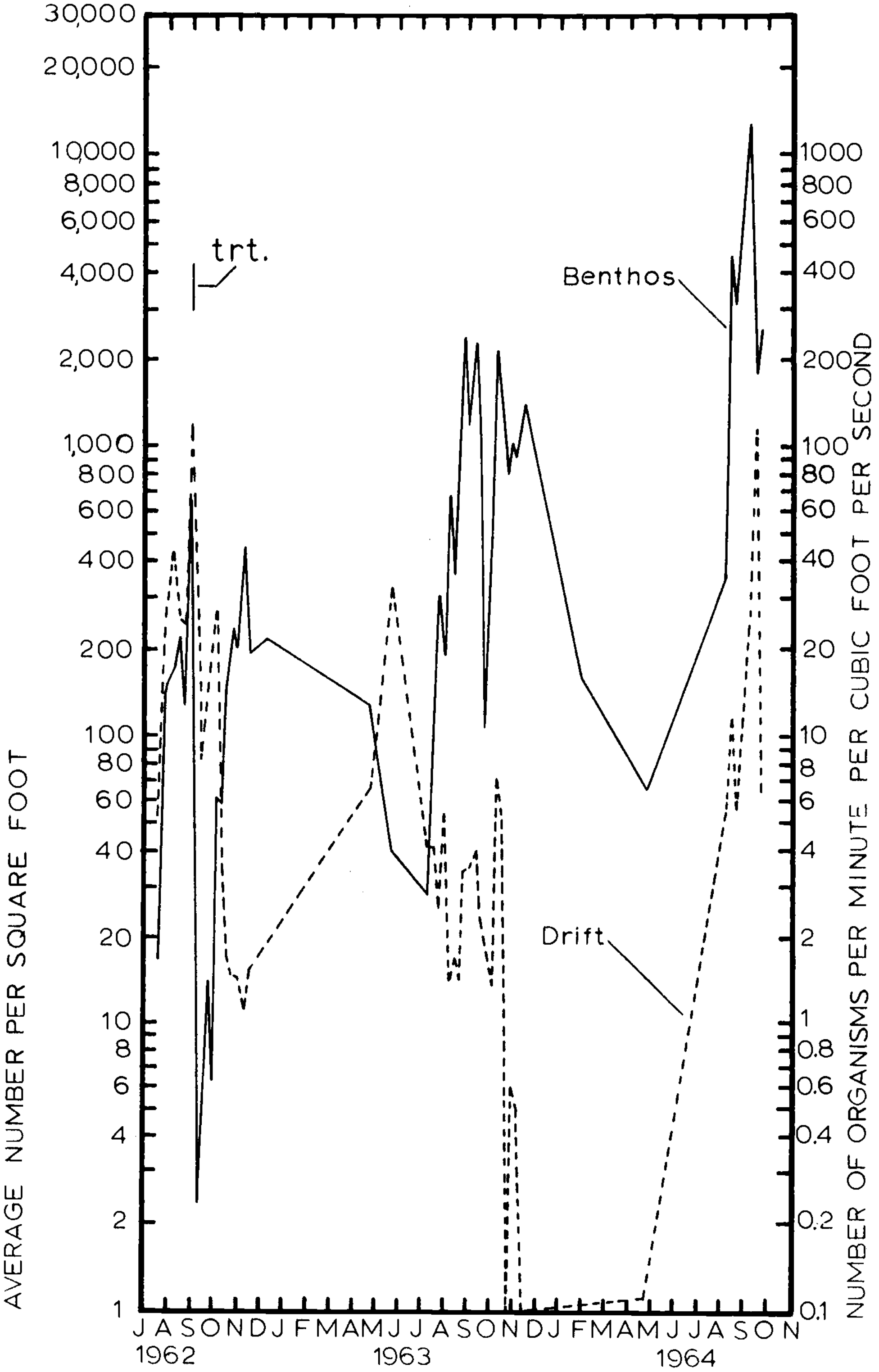


Figure 30. Numbers of invertebrates in bottom and drift samples at station D from July 17, 1962 to September 22, 1964.

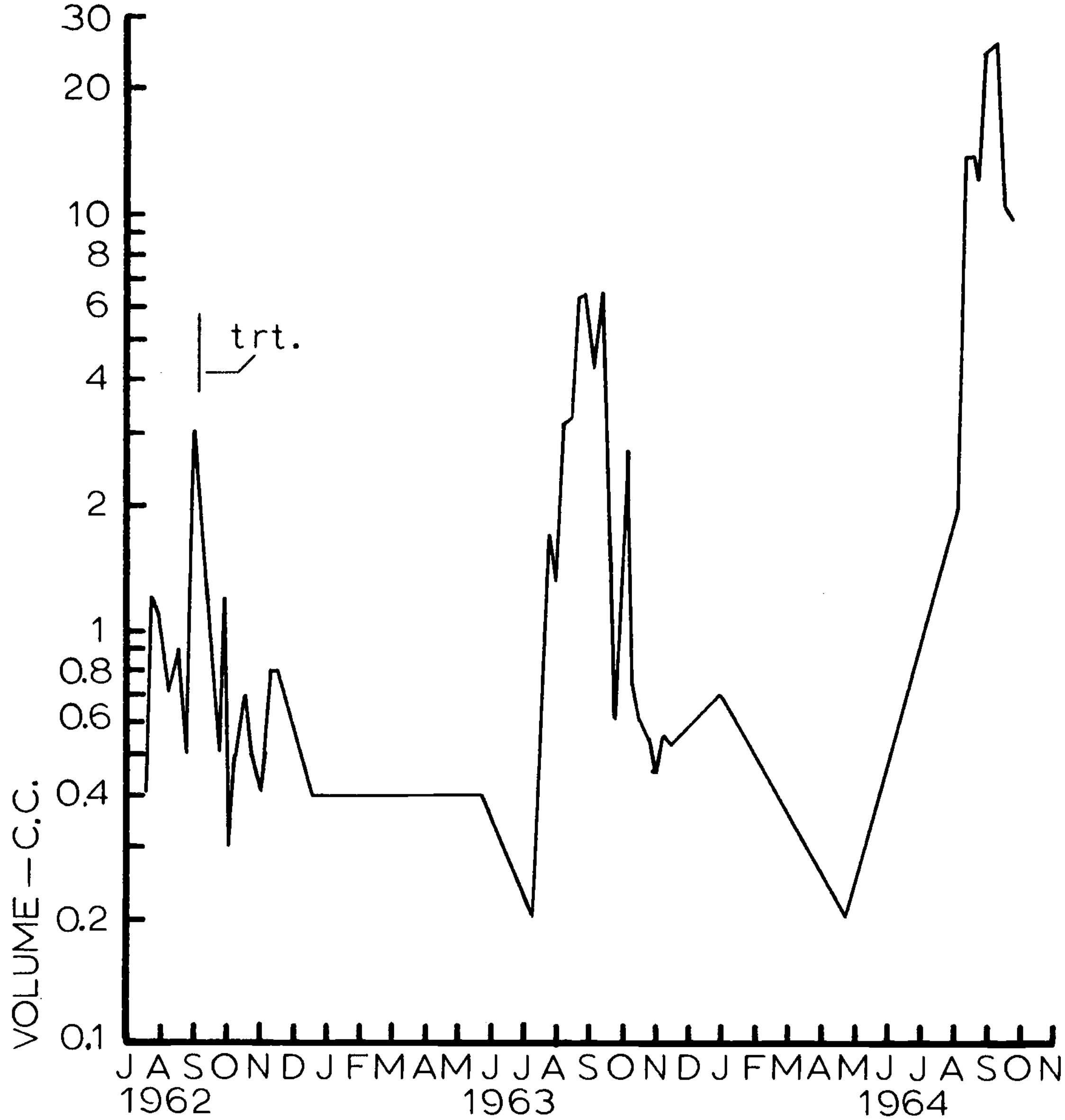


Figure 31. Volumes of benthic invertebrates taken in bottom samples at station D from July 17, 1962 to September 22, 1964.

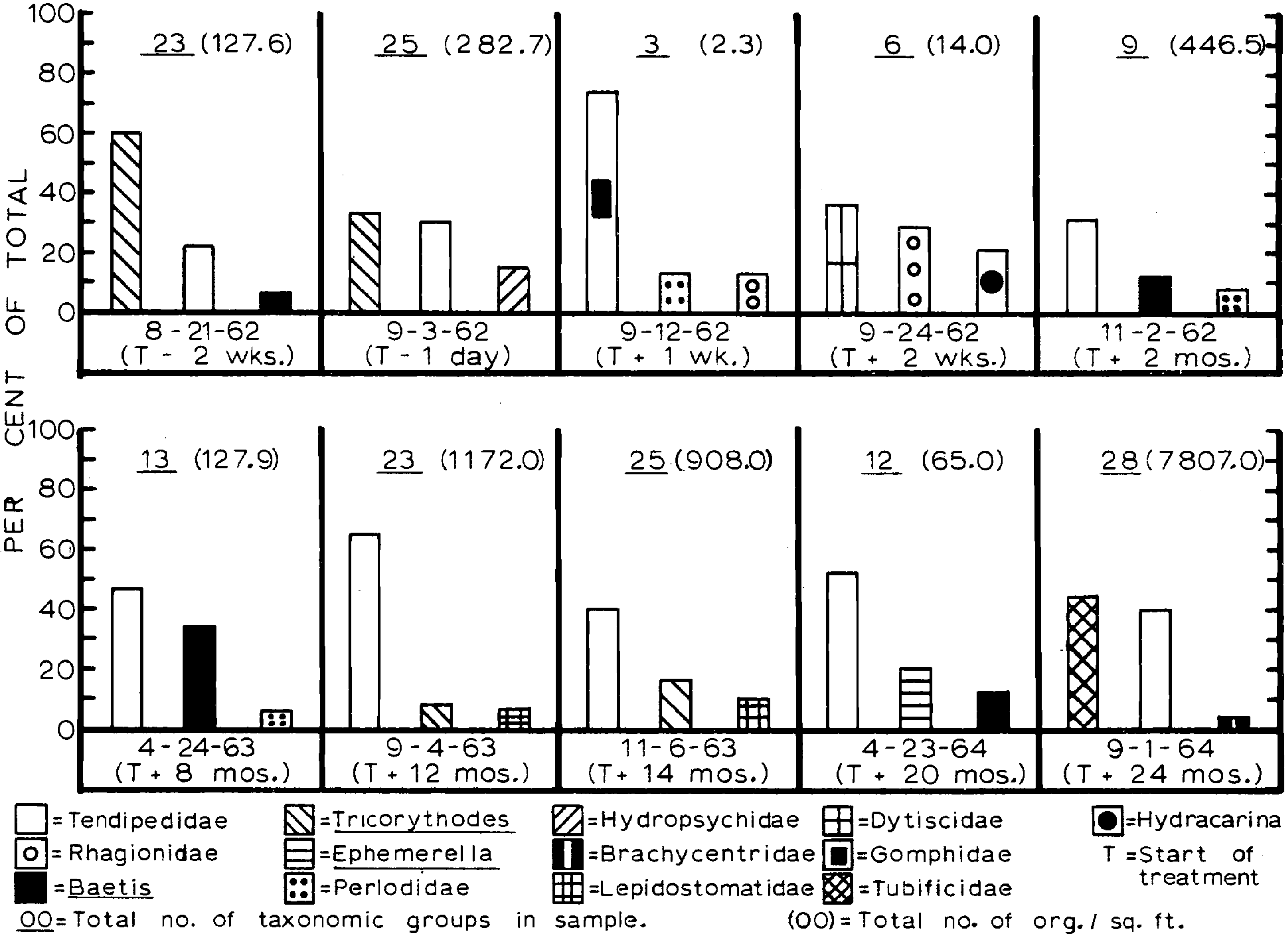


Figure 32. Composition of selected bottom samples at station D over a period from 2 weeks before rotenone exposure to 2 years after.

drifted into windrows along the shore. The leeches reacted to the rotenone very quickly and many fled downstream. Those that did not soon succumbed to the poison. Insects of many species were noted in distress. Some of the larger water beetles attempted to escape by climbing out on the exposed rocks in the pool. These crawled about with difficulty, fell back into the water, and died. The snails dropped to the bottom from their locations on submerged rocks and lay still. A visual check was made of this area one week later. A nearby untreated backwater provided a comparison. Snails and other invertebrates were common in the untreated pool, but the treated area exhibited little life. Many snail and leech carcasses still littered the bottom.

The fauna at station D remained impoverished for only a short time after treatment. Total numbers of organisms and the number of taxonomic groups began to increase almost immediately. Tendipedidae soon became the dominant benthic group and remained so for a long period. Baetis and Perlodidae were sub-dominants during the first eight months following treatment.

After an initial increase, the abundance of organisms in the drift remained low throughout the first fall and winter, but began to increase in the spring as the water flow increased. Midges (Tendipedidae) and mayflies (Baetidae) dominated the biota present in the drift.

In the summer following treatment, the number of invertebrates surpassed pre-treatment levels. Midges were by far the dominant group, but mayflies were more common in the drift catches. The community appeared to be rapidly approaching its former composition, with nearly as many groups present as before treatment.

The total population decreased during the second winter, but in the summer of 1964 it increased to a high of 12,746 invertebrates in one square-foot sample. Midges and Oligochaeta were the most numerous organisms present. Many of the midges were very small, which complicated processing of the samples. All of the other groups were also present in increased numbers. Part of the increase in numbers of invertebrates taken from the samples in 1964 may have been due to the use of the sugar floatation technique; however, the test of field sorting efficiency (Appendix 41) indicates that about 57 percent of the number of organisms recovered at station D with sugar would have been taken without use of the sugar solution. Thus, the population level still shows an increase over levels present in previous years.

Midges and mayflies continued to dominate the drift fauna in 1964.

The rapid recovery of the invertebrate fauna at station D was probably due to its proximity to the untreated section of the river.

An excellent habitat in the form of moss, algae, and Ranunculus beds may also have helped in the re-establishment of the fauna.

Station E

This station was located slightly over five miles downstream from rotenone introduction station #1 near a bridge on the Phil Marincic, Jr. ranch. Bottom samples were taken from the second riffle downstream from the bridge. The drift samples were taken near the head of the first riffle. Vegetation in the bottom sampling area consisted largely of scattered clumps of algae and Potomogeton pectinatis. In late summer as the high water subsided, the areas near shore were covered with dense growths of algae and fresh water sponge. The invertebrate population in this vegetated area was high. However, by the time this abnormal situation had begun to influence the bottom samples, receding water had usually made it necessary to take the bottom samples in deeper, less vegetated areas of the river. In general, the sampling area was ecologically quite similar to that at station C.

Introduction of the rotenone into this area of the river resulted in a sharp decrease in invertebrate numbers. The population appeared to be on the increase immediately prior to treatment. One week after treatment, the population consisted mostly of snipe-fly larvae (Rhagionidae) and numbered only about 18 organisms per square-foot sample, as against about 144 a week earlier (Figures 33 and 34). A drift sample at this time showed a slight increase in the numbers of insects drifting downstream.

The fauna at station E proved to be even more resilient than that of station D. Two weeks after treatment, total numbers were higher and the composition of the fauna nearly the same as that found the day prior to treatment. However, the number of families was not the same. The mayfly Tricorythodes was the dominant organism, both before and after treatment. This mayfly has a series of generations each summer and always seems to be present in the river. For this reason, the area was probably re-populated by eggs layed prior to treatment, or possibly by downstream drift of eggs and immature individuals.

A superficial examination of the data from this station would suggest that the fauna had recovered fully from the effects of the rotenone by the time the river froze over in 1962. However, a careful comparison with the data from the two control stations indicates that the fauna at station E did not have a normal composition during the first eight months after treatment. The bulk of the population at station E consisted of midge larvae (Tendipedidae), and only seven familes were present in February at the peak of abundance. The population at station A had a greater diversity of species and 16 families. Furthermore, the dominance was spread rather

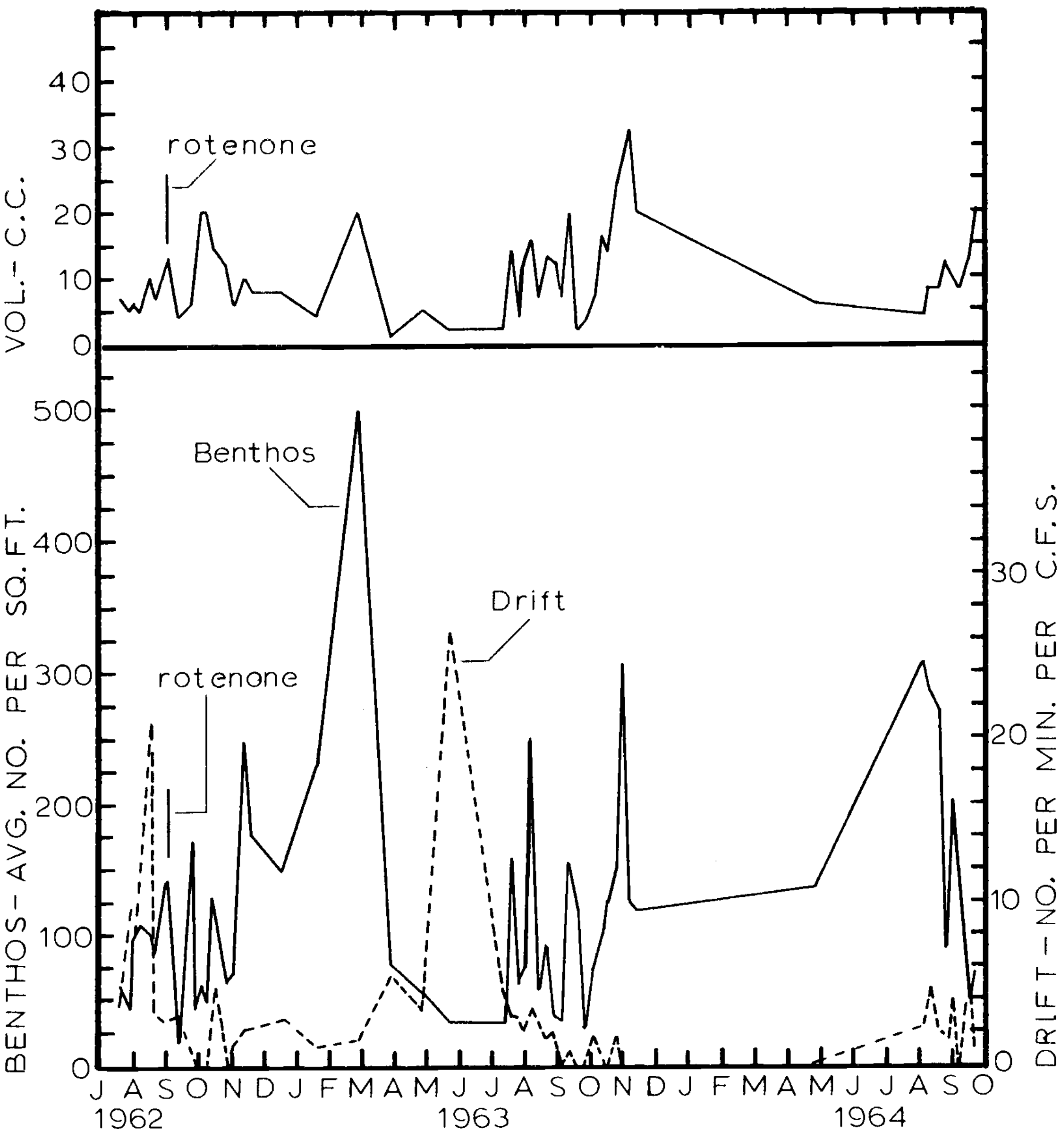


Figure 33. Numbers and centrifuged volumes (benthos only) of bottom and drift samples at invertebrate sample station E from July 18, 1962 to September 23, 1964.

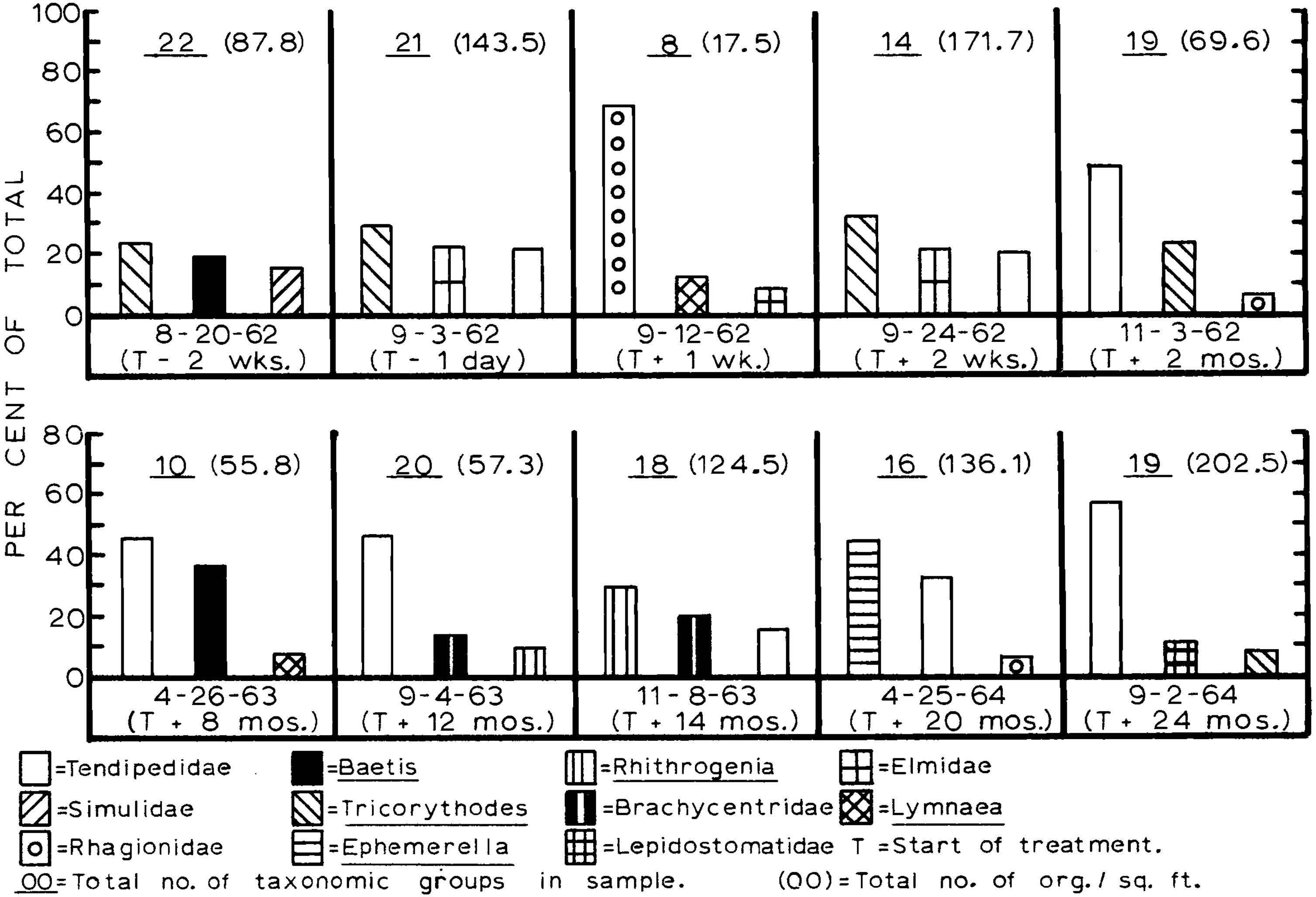


Figure 34. Composition of selected bottom samples at station E over a period from 2 weeks before rotenone exposure to 2 years after.

evenly over three groups (Tendipedidae, Baetidae, and Perlodidae) at station A; whereas, at station E, the tendipedids alone were dominant.

Following the 1963 spring runoff, the population numbers were again found to be reduced. After this time, the numerical fluctuations of the fauna shown in Figure 33 were similar to those at the two control stations. Figure 34 reveals that the composition was different from that present prior to treatment.

The population present two years after treatment was numerically greater than that found prior to rotenone treatment, but the composition was strikingly different in that the Tendipedidae had achieved dominance over the remainder of the fauna. Prior to treatment, the fauna was dominated by three groups, the least numerous being the Tendipedidae. It is interesting that an emergence trap set during August and September, 1964, captured adults of Simulidae, Tendipedidae, and Baetidae in almost equal numbers. However, since the trap often served as an attraction, both for larval attachment and as a place for emerging insects to crawl from the water, the numerical data obtained should be used with caution. The chief value of the emergence traps in 1964 was to show what insects were present.

Station F

This sampling location was about 15 miles downstream from rotenone introduction station #1, but was above the confluence of the New Fork River. Samples were taken on the second riffle downstream from the Big Piney Cutoff bridge. Vegetation consisted mainly of a few scattered patches of a mixed growth of Ranunculus, aquatic moss, and Potomogeton pectinatus. An unidentified algae covered the rocks, especially in the deeper water, during the late summer and early fall, sometimes giving the bottom a light green color. The riffle provided a habitat that was ecologically similar to that at station C.

The bottom fauna population, adversely affected by the rotenone, decreased in number to a low level at which it remained until the following spring (Figure 35). It is of interest that the population level at this location was low during October and November. In contrast, the control stations had population peaks during the fall months. Immediately after treatment, a large number of stoneflies (Pteronarcidae) were found dead near this station in the quiet pools where eddies had deposited them. After the main treatment, a small backwater at station F was re-treated to eliminate a school of sucker fry. The water beetles and water boatmen (Corixidae) showed distress very soon after contact with the toxicant.

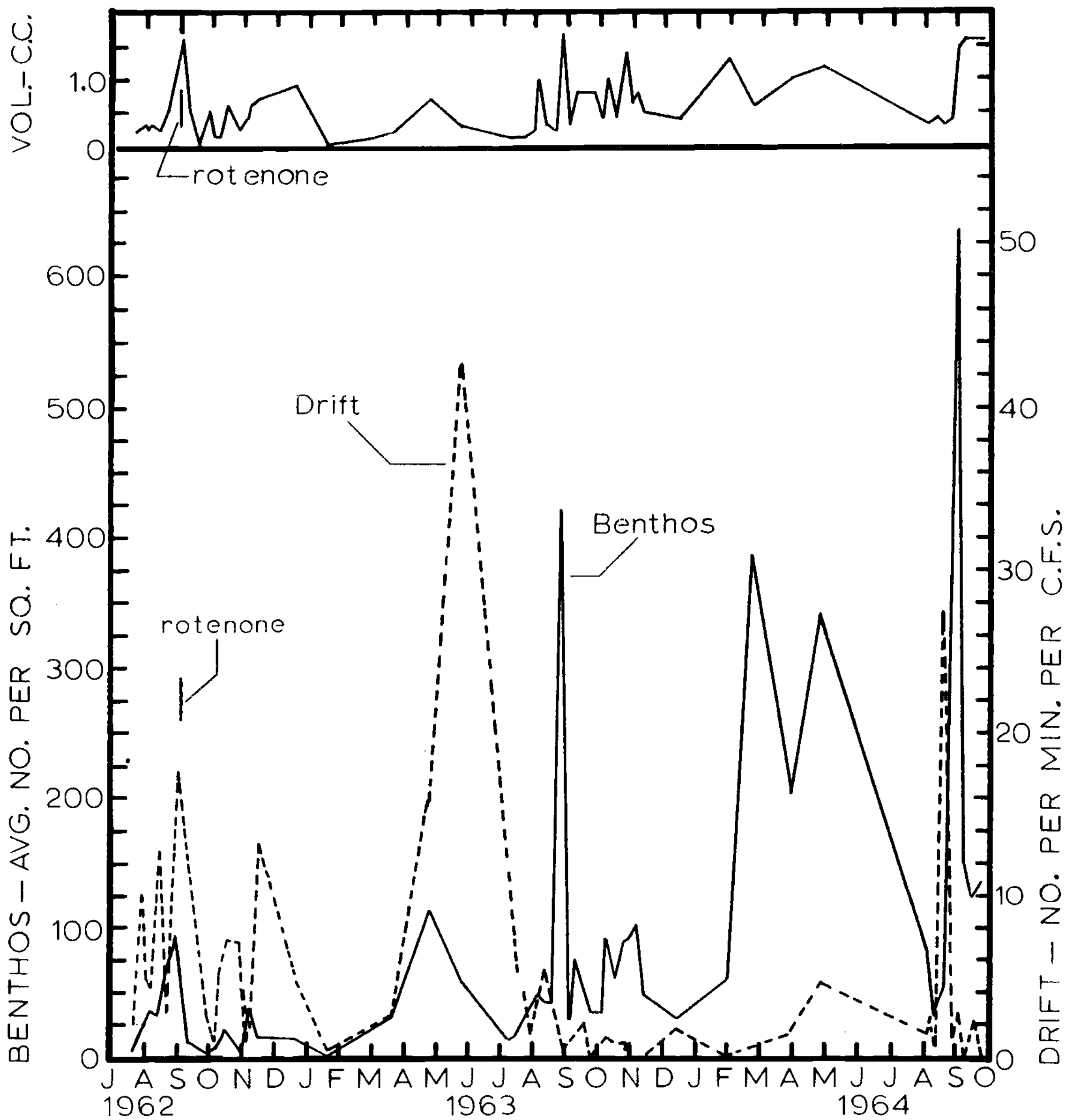


Figure 35. Numbers and centrifuged volumes (benthos only) of bottom and drift samples at invertebrate sample station F from July 20, 1962 to September 24, 1964.

The numerical decrease of invertebrates at station F would have been greater if exotic amphipods had been ignored, as only four other families were present in limited numbers. Amphipods are rarely found in the mainstream in large numbers. The animals may have been involved in a fall migration. Pennak (1953) reported that some amphipods migrate upstream in the spring and downstream in the fall. In the Green River, amphipods usually occurred only in bottom samples taken at times considered to be late spring and early fall at this elevation. The benthos in the autumn of 1962 (Figure 36) was dominated by a series of groups. No one family or genera remained dominant for very long. Some of the dominant groups normally would have formed a small part of the fauna were the fauna more varied. Caddisflies of the families Hydroptilidae and Lepidostomatidae were not among the most abundant three families prior to treatment at station F or at either of the control stations. Two weeks after treatment these two families numerically dominated the fauna, even though they may have been no more numerous than usual.

The abundance of drift organisms remained relatively constant during the summer and fall of 1962. A sharp increase in numbers occurred just before the river froze over in November (Figure 35). A similar increase in numbers also occurred at station A in mid-November.

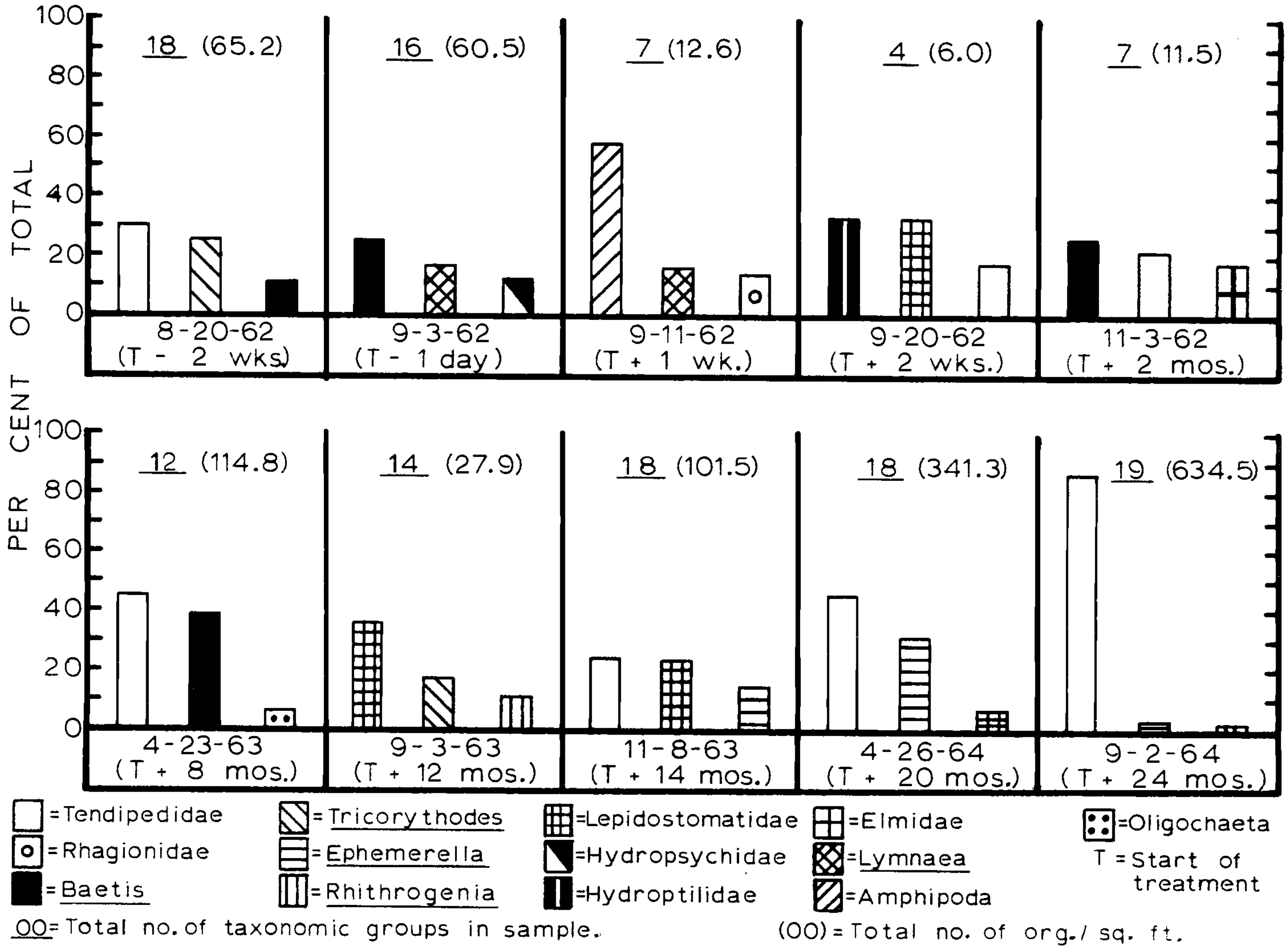


Figure 36. Composition of selected bottom samples at station F over a period from 2 weeks before rotenone exposure to 2 years after.

Catches of drift organisms were greatest in May of 1963. The original sample records indicate that the majority of the organisms were very small, newly hatched Baetis. Unfortunately, no samples were taken in May, 1964 because of high water, so it is not known if the same fluctuation repeated itself in 1964.

In 1963, the benthic invertebrates at station F attained and remained at numerical levels comparable with those found before the treatment. A sharp peak occurred in late August when small Tendipedidae were numerous for a week or so and then disappeared. This probably represented a hatch. The benthic fauna present in 1963 attained more normal composition as the year progressed. The number of families increased from a low of four in September, 1962, to 18 in November, 1963, the latter number being equal to the maximum number found before treatment.

The composition of the benthic fauna at station F, in 1963, (Figure 36) continued to exhibit the succession of changes in dominant groups which began in the fall of 1962. The abundance of bottom fauna increased greatly in the spring of 1964 in spite of a cold, wet, prolonged spring that resulted in cold, high, murky water conditions in the river. The increase was due mostly to the Tendipedidae and a mayfly (Ephemerella). The caddisfly family Lepidostomatidae, which was dominant, dropped to third in level of abundance.

After a reduction during the peak of the June runoff, benthic organisms again increased in number. The greatest increase was made by the midges (Tendipedidae), which comprised 86 percent of the fauna in September. Midges comprised the bulk of the adult insects caught by the emergence trap. Figure 36 shows the decline of Lepidostomatidae and the increase of Tendipedidae to a position of dominance. At the control stations also, the Tendipedidae were dominant in September. However, at the control stations, several groups were present and no single group dominated. The composition of the invertebrate fauna at station F in 1964 was obviously not similar to the pre-treatment composition.

Table 6 gives a list of the groups missing from the benthos at the end of selected time intervals during the recovery period. All except Hydropsychidae, Empididae, and Corixidae were present after 12 months, and the family Corixidae (water boatmen) was the only group missing at the end of the study.

Station G

Station G was located at the same sampling site used by Bosley (1960). It was near the roadside campground approximately one-half mile downstream from Names Hill about 57 river miles downstream from rotenone introduction station #1. The vegetation in the sample area usually consisted of scattered patches of aquatic

TABLE 6. INVERTEBRATE TAXONOMIC GROUPS LISTED AS ABSENT OR OF SPORADIC (S) OCCURANCE AT THE END OF EACH TIME INTERVAL IN THE POST-ROTENONE EXPOSURE PERIOD AT STATION F. ONLY THOSE GROUPS PRESENT BEFORE TREATMENT ARE LISTED.

Time in months						
3	8	12	15	18	20	24
Oligochaeta[1/]	Empididae	Empididae	Empididae	Empididae	Corixidae	Corixidae
Empididae	*Tricorythodes* (S)	Hydropsychidae	Hydropsychidae	Hydropsychidae		
Tricorythodes (S)	*Ephemerella* (S)	Corixidae	Corixidae	Corixidae		
Ephemerella	*Choroterpes*					
Choroterpes	*Rhithrogenia*					
Rhithrogenia (S)	*Heptagenia*					
Heptagenia	Pteronarcidae					
Pteronarcidae	Perlidae					
Perlidae	Perlodidae (S)					
Perlodidae	Hydropsychidae (S)					
Hydropsychidae (S)	Brachycentridae					
Brachycentridae (S)	Hydroptilidae					
Hydroptilidae (S)	Lepidostomatidae					
Lepidostomatidae(S)	Corixidae					
Corixidae						

1/ Excluding Tubificidae.

moss, Potomogeton pectinatus, and algae. Bosley (1960) reported that Cladophora and Spirogyra were the predominant algae genera present. The plant growth usually increased in density during the late summer.

The pre-treatment invertebrate fauna at this station was well-developed with numbers tending to increase. The toxicant caused a drastic reduction of the fauna (Figure 37), which remained at numerically low levels until the following summer. Two adult aquatic beetles were the only invertebrates found one week after the treatment. The number of groups found in the benthic samples decreased from 16 to two in the space of one week and remained below three until the following summer (Figure 38).

The fauna in the first eight months after treatment was dominated by a series of invertebrate groups: the snail Lymnaea, the annilid worm family Tubificidae, and the midges, Tendipedidae.

The samples of drift organisms showed several numerical peaks during the fall of 1962. Adult beetles and terrestrial insects made up the bulk of the catches during this period. Organisms in the drift were not abundant until the 1963 runoff in May.

In the summer of 1963, the fauna was dominated by an errup-tion of buffalo gnat larvae (Simulidae) which almost seemed to cover the stream bed. Representatives of this family were many times more numerous than in the previous summer. Numbers

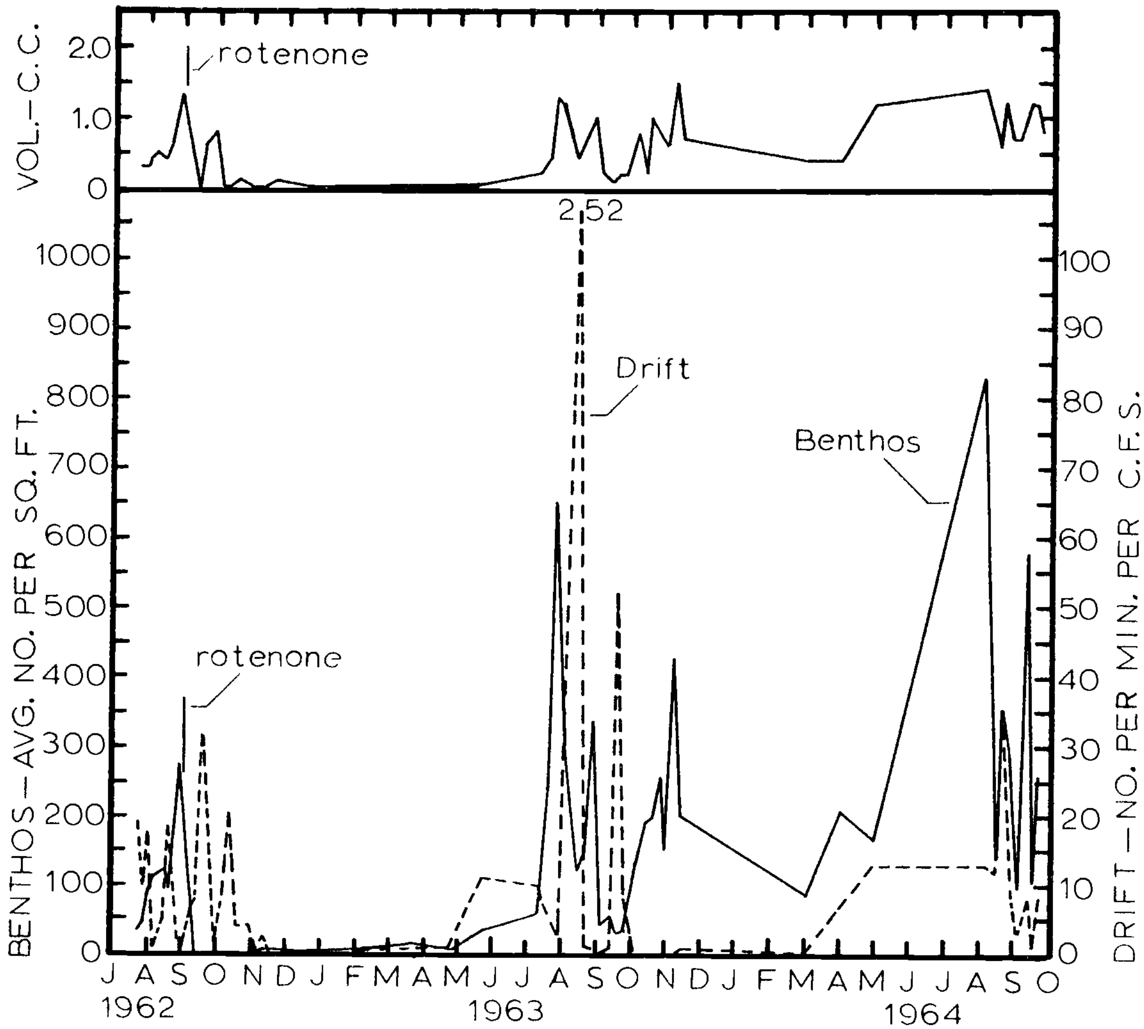


Figure 37. Numbers and centrifuged volumes (benthos only) of bottom and drift samples at invertebrate sample station G from July 23, 1962 to September 24, 1964.

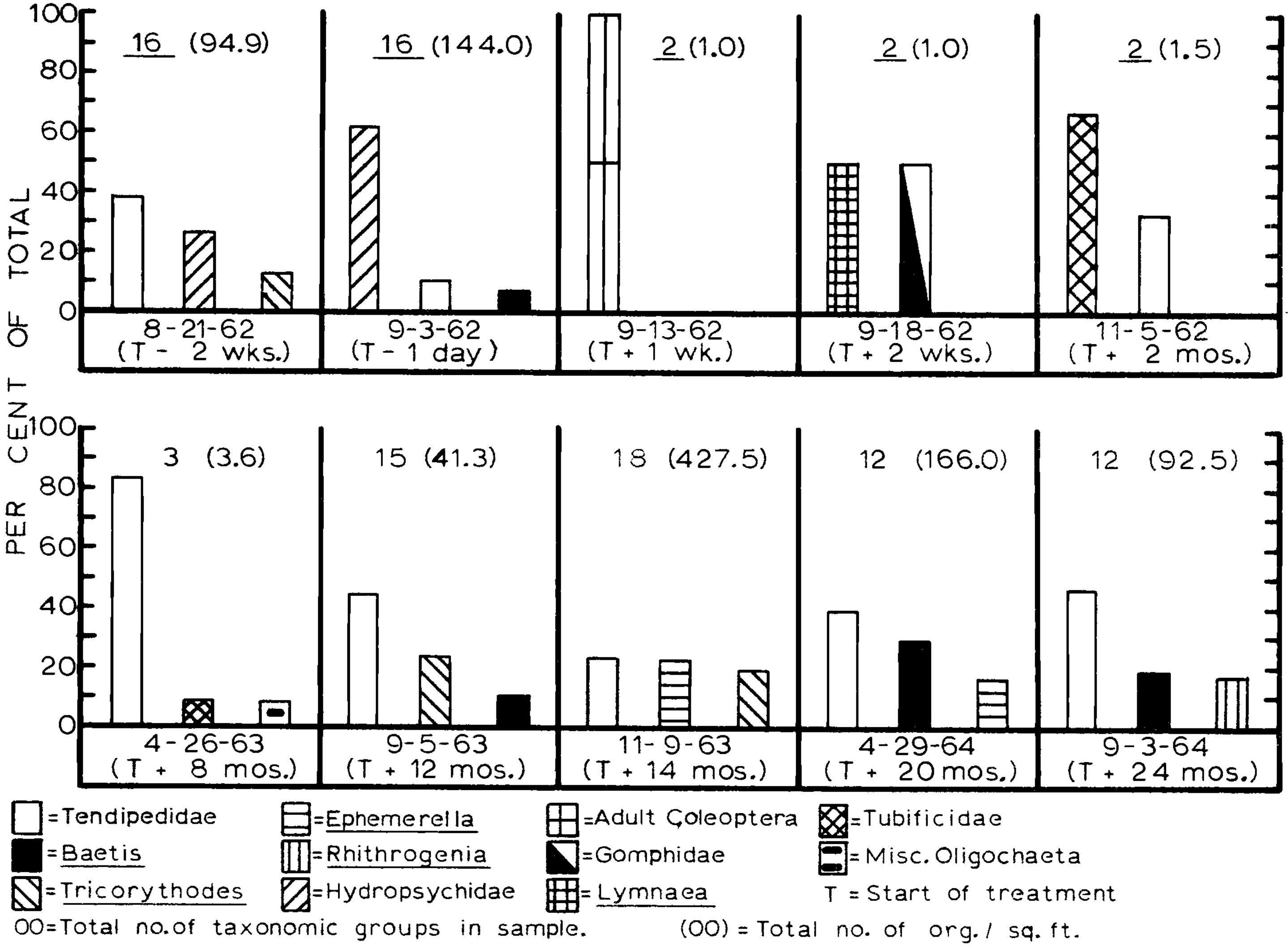


Figure 38. Composition of selected bottom samples at station G over a period from 2 weeks before rotenone exposure to 2 years after.

decreased in August when flash floods resulting from rains swept the lower river areas. Between floods, the mayflies, especially Tricorythodes, attained a numerical peak. The drift catches during August and September (Figure 37) periodically exhibited sharp increases resulting from the scouring effects of the flash floods. The drift was mainly composed of mayflies. This group and the midges again became abundant in the fall after flooding ceased.

The benthic invertebrates reached a high level of abundance in the second summer after treatment. A sharp peak in abundance of Simulidae was noted, but this family was not as prevalent as in 1963. Tendipedidae, along with the mayflies, Baetis, Ephemerella, and Rhithrogenia dominated the fauna at this station in the summer of 1964. An emergence trap captured mostly Tendipedidae and Baetidae adults. The only groups that had not regained their pre-treatment abundance level were the net-spinning caddisflies (Hydropsychidae) and the craneflies (Tipulidae) (Table 7). A small population of Hydropsychidae was present at the close of the study, but this group had not regained its former numerical level. The Tipulidae were sporadically present in 1963 and 1964.

Two years after treatment the composition of the benthic fauna differed from the pre-treatment composition. The number of taxonomic groups was less; Tendipedidae had replaced Hydropsychidae as the dominant group; the mayfly Rhithrogenia

TABLE 7. INVERTEBRATE TAXONOMIC GROUPS LISTED AS ABSENT OR OF SPORADIC (S) OCCURANCE AT THE END OF EACH TIME INTERVAL IN THE POST-ROTENONE EXPOSURE PERIOD AT STATION G. ONLY THOSE GROUPS PRESENT BEFORE TREATMENT ARE LISTED.

Time in months						
3	8	12	15	18	20	24
Hydracarina (S)	Hydracarina	*Lymnaea* (S)	Tipulidae (S)	Tipulidae	Tipulidae	Tipulidae
Oligochaeta[1/]	Oligochaeta[1/]	Tipulidae	Hydropsychidae	Hydropsychidae	Hydropsychidae	
Hirudinea	Hirudinea	Hydropsychidae (S)				
Lymnaea (S)	*Lymnaea*					
Nematoda	Nematoda					
Tendipedidae (S)	Simulidae (S)					
Simulidae	Tipulidae					
Tipulidae	*Baetis* (S)					
Baetis	*Tricorythodes*					
Tricorythodes	*Ephemerella*					
Ephemerella	*Choroterpes*					
Choroterpes	*Rhithrogenia*					
Rhithrogenia (S)	*Heptagenia*					
Heptagenia	Pteronarcidae					
Pteronarcidae	Perlidae					
Perlidae	Perlodidae					
Perlodidae (S)	Hydropsychidae					
Hydropsychidae	Brachycentridae					
Brachycentridae	Hydroptilidae					
Hydroptilidae	Leptocercidae					
Leptocercidae	Glossosomatidae					
Glossosomatidae						

1/ Excluding Tubificidae.

was one of the dominant organisms; and the total number of organisms was less.

Station H

Samples at station H were taken from a riffle area on the east side of the river about one-fourth mile above Big Island Bridge. This site was slightly upstream and across the river from the sampling location used by Bosley (1960).

Patches of Chara, an unidentified aquatic moss, Potomogeton pectinatus, and algae were present at the sampling site. The density of aquatic vegetation was greatest in the late summer. A thin layer of diatoms and silt in the river bottom was normal in the area. Bosley (1960) listed Cladophora as the principal algae present in this area, and he indicated that it was abundant in the summer.

The pre-treatment invertebrate fauna was strongly dominated by the mayflies Tricorythodes and Choroterpes (Figure 39). Various caddisflies, especially Hydropsychidae, were also present. Midges were present, but not in great numbers. Bosley (1960) reported finding the caddisfly family Phryganeidae in this section of the river, but no specimens of this group were found during the present study.

Aquatic invertebrates at station H were exposed to rotenone on September 5, 1962. As previously noted, the toxicant was

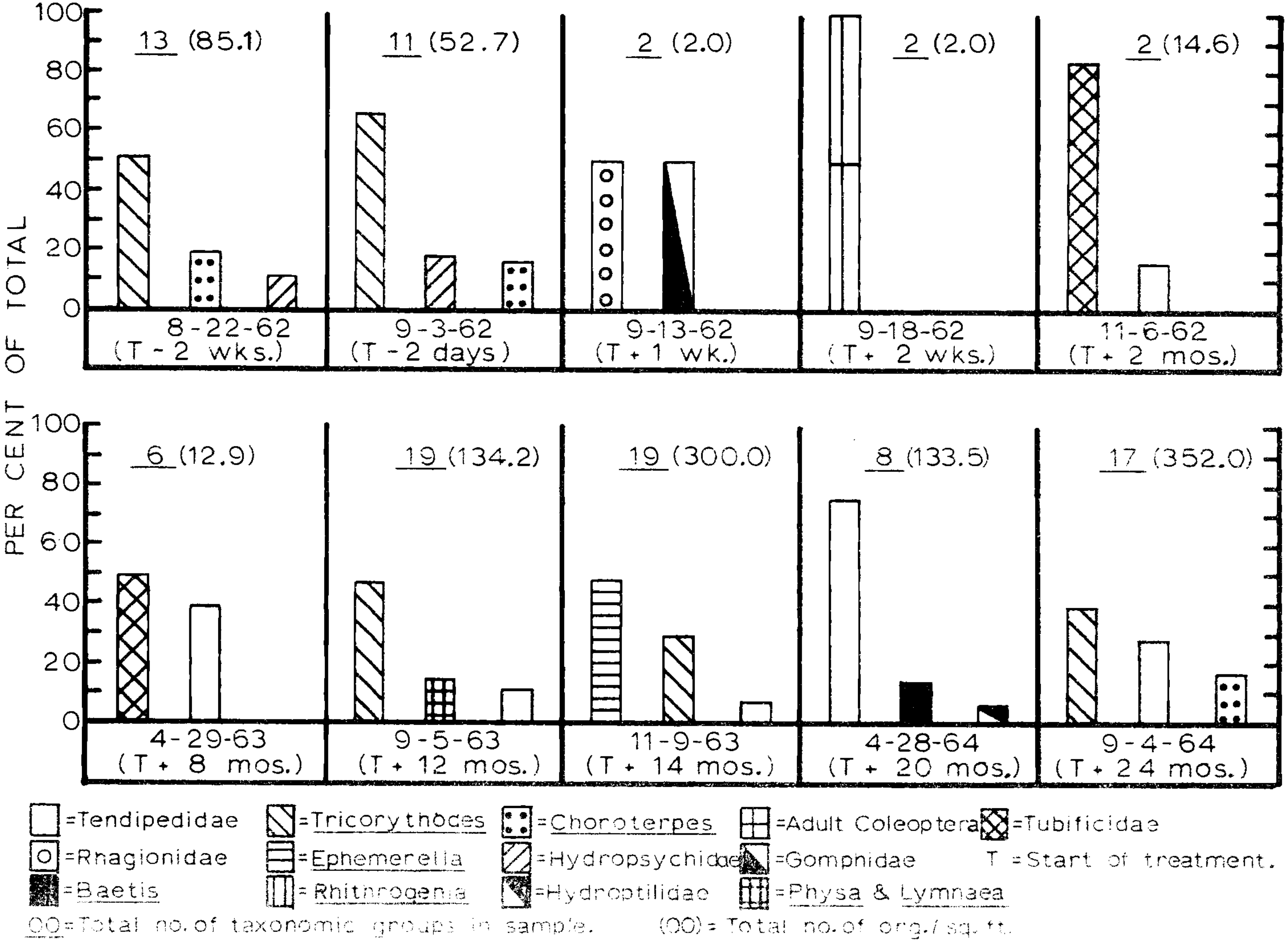


Figure 39. Composition of selected bottom samples at station H over a period from 2 weeks before [illegible] exposure to 2 years after.

present for several days thereafter. Near this station, numerous dead, winged insects of various kinds, adult beetles, and stonefly nymphs were observed floating downstream during the treatment. A drift sample taken at station H four days after initial rotenone exposure contained only three live insects: a caddisfly larvae, an adult beetle, and an adult midge. When the contents of several bottom samples were placed in pans, the contrast to pre-treatment samples was very noticeable. Those insects that were still alive were very sluggish and reacted reluctantly to touch stimuli. There was none of the usual rapid activity. Caddisfly larvae (Hydropsychidae) that were normally a green color had a pale, washed-out appearance and were very near death. Several carcasses of Hydropsychidae, Baetidae, and Corixidae were found in the benthic samples.

One week after treatment, a set of samples was taken and the bottom fauna was found to be much reduced. Only occasional snipefly larvae (Rhagionidae) and dragonfly nymphs (Gomphidae) were found. Later in the fall, tubifex worms (Tubificidae) and midge larvae (Tendipedidae) appeared. The former were dominant. The benthic population remained at a low level until the following summer when a sharp numerical increase was noted (Figure 40). Mayflies, especially Tricorythodes, were dominant. The snails Physa and Lymnaea were common, as were the midges (Figure 39).

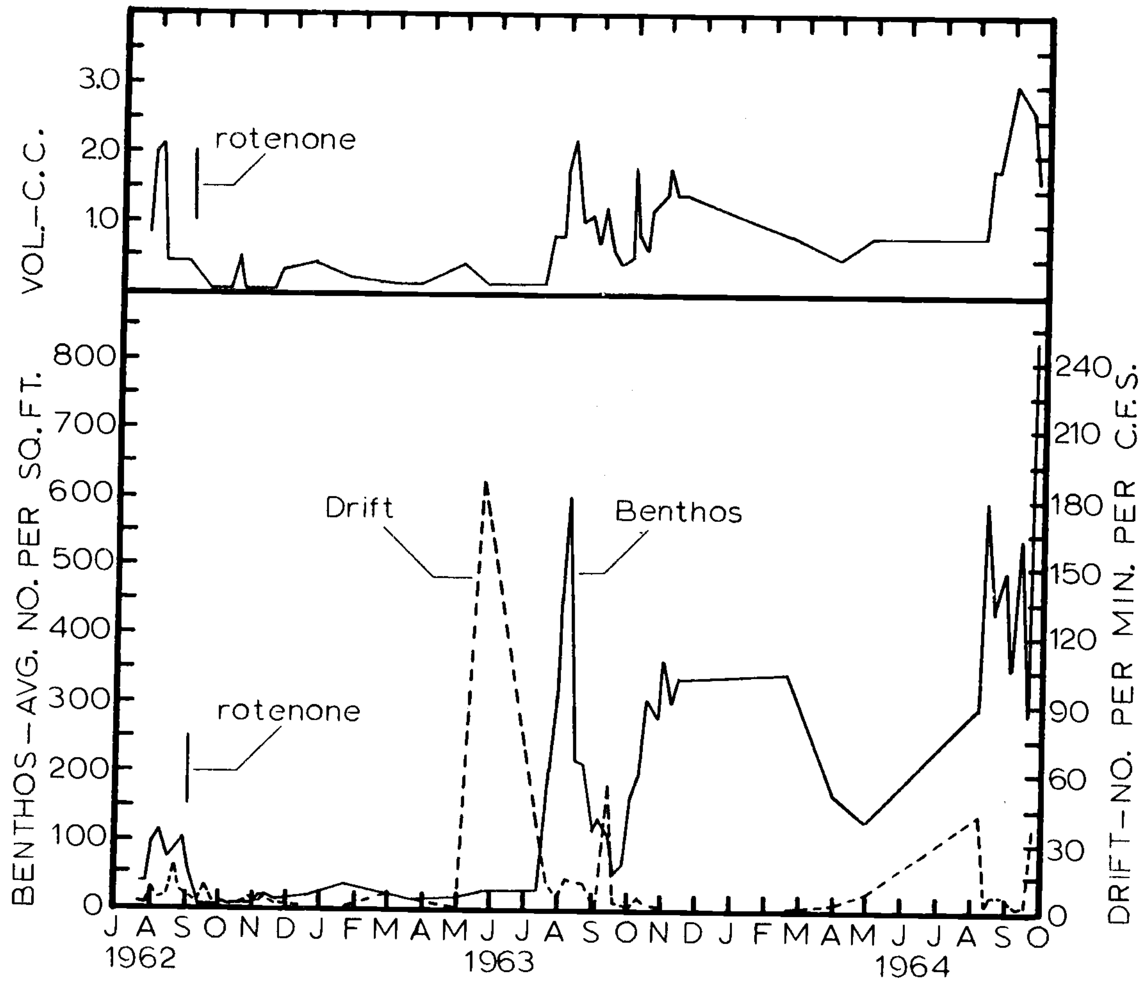


Figure 40. Numbers and centrifuged volumes (benthos only) of bottom and drift samples at invertebrate sample station H from July 23, 1962 to September 25, 1964.

Except for a brief period when numbers increased shortly after the treatment, the abundance of organisms in the drift dropped to a low level and remained there until the runoff in June, 1963 when drift-net catches increased. Midges predominated in the samples.

The invertebrate fauna at station H was adversely affected by the 1963 flash floods in August and September. During this period, numbers of benthic organisms decreased and the drift-net catches increased. A period in which population levels were high and stable followed; this condition persisted until the following spring. The numbers of benthic organisms declined in the spring and rose again in the summer of 1964. Midges and mayflies were prevalent in the samples. An emergence trap at station H caught mostly midges and mayflies; however, buffalo gnats (Simulidae) were common for a period in samples collected by all methods.

Table 8 gives those groups that were missing from the benthos at the end of successive sampling periods after treatment. The caddisflies and mayflies of the family Ephemeridae were the principal missing groups after a 12-month recovery period. All of the caddisflies, except Glossosomatidae (rare before treatment) were found after 24 months. The net-spinning caddisflies (Hydropsychidae) were present, but had not regained their former level of abundance. Of the mayflies, *Ephemera* and *Pentagenia* had not returned after

TABLE 8. INVERTEBRATE TAXONOMIC GROUPS LISTED AS ABSENT OR OF SPORADIC (S) OCCURANCE AT THE END OF EACH TIME INTERVAL IN THE POST-ROTENONE EXPOSURE PERIOD AT STATION H. ONLY THOSE GROUPS PRESENT BEFORE TREATMENT ARE LISTED.

Time in months						
3	8	12	15	18	20	24
Baetis	*Baetis*	*Ephemera*	*Ephoron*	*Ephoron*	*Ephemera*	*Ephemera*
Tricorythodes (S)	*Tricorythodes*	*Pentagenia*	*Pentagenia*	*Pentagenia*	*Pentagenia*	*Pentagenia*
Ephemerella	*Ephemerella*	*Ephoron* (S)	*Ephemera*	*Ephemera* (S)	Glossosomatidae	Glossosomatidae
Choroterpes	*Choroterpes*	Perlidae (S)	Hydropsychidae	Hydropsychidae		
Brachycercus	*Brachycercus*	Hydropsychidae	Hydroptilidae	Hydroptilidae		
Rhithrogenia	*Rhithrogenia*	Hydroptilidae	Glossosomatidae	Glossosomatidae		
Heptagenia	*Heptagenia* (S)	Leptocercidae				
Ephoron	*Ephoron*	Glossosomatidae				
Ephemera	*Ephemera*					
Pentagenia	*Pentagenia*					
Perlidae	Perlidae					
Perlodidae	Perlodidae					
Hydropsychidae	Hydropsychidae					
Hydroptilidae	Hydroptilidae					
Leptocercidae	Leptocercidae					
Glossosomatidae	Glossosomatidae					

24 months. Ephemera, present in 1962 prior to treatment, was found occasionally in the fall of 1963, but not in 1964. Pentagenia was rare before treatment and, as of the termination of this study, had not been found following the treatment. Five mayfly genera not found before treatment (Leptophlebia, Paraleptophlebia, Traverella, Iron, and Isonychia) appeared sporadically at intervals during the recovery period.

Two years after treatment, near the end of the study, the benthic fauna was similar to that found before treatment (Figure 40) except that the family Hydropsychidae had not regained its former position among the dominant organisms. Its place had been taken by the midges (Tendipedidae). The numerical level of the fauna at this time was higher than before rotenone treatment, partly because of the greater numbers of midge larvae. The volume also was at a higher level.

Station I

This station was located near the old Kinkaid Ranch, which lies about five miles below Green River City and is within the maximum impoundment area of Flaming Gorge Dam. The samples were taken from a shoal area near shore. Rotenone introduction station #14, at mile 130 from Green River station #1, was located about 100 yards upstream.

Vegetation in this area was limited to widely scattered clumps of the algae *Cladophora*, which often formed long strands in the late summer and early fall. Bosley (1960) reported that a reduced diatom growth was present and that the algae *Spirogyra* was to be found in early summer.

The pre-treatment invertebrate fauna at station I was dominated by mayflies, mostly those of the genera *Ephoron* and *Tricorythodes* (Figure 41). Oligochaeta and Tendipedidae closely followed the mayflies in order of abundance. Bosley (1960) found that Tendipedidae and annelid worms were prevalent. He stated that the fauna then present was characteristic of polluted water. Apparently the fauna had changed significantly in the few years following abatement of pollution. Groups more representative of clean water, e.g., Odonata, Trichoptera, aquatic Coleoptera, and Plecoptera, were present in the summer of 1962. Bosley did not find any of these groups.

At the time of rotenone treatment, the benthic fauna was decreasing in abundance, particularly the benthic mayfly population as the nymphs matured and left the ecosystem. The drift net catches (Figure 42) increased at this time, indicating that hatches were occurring.

The rotenone devastated the invertebrate fauna of the river at station I. Samples taken four days after initial rotenone

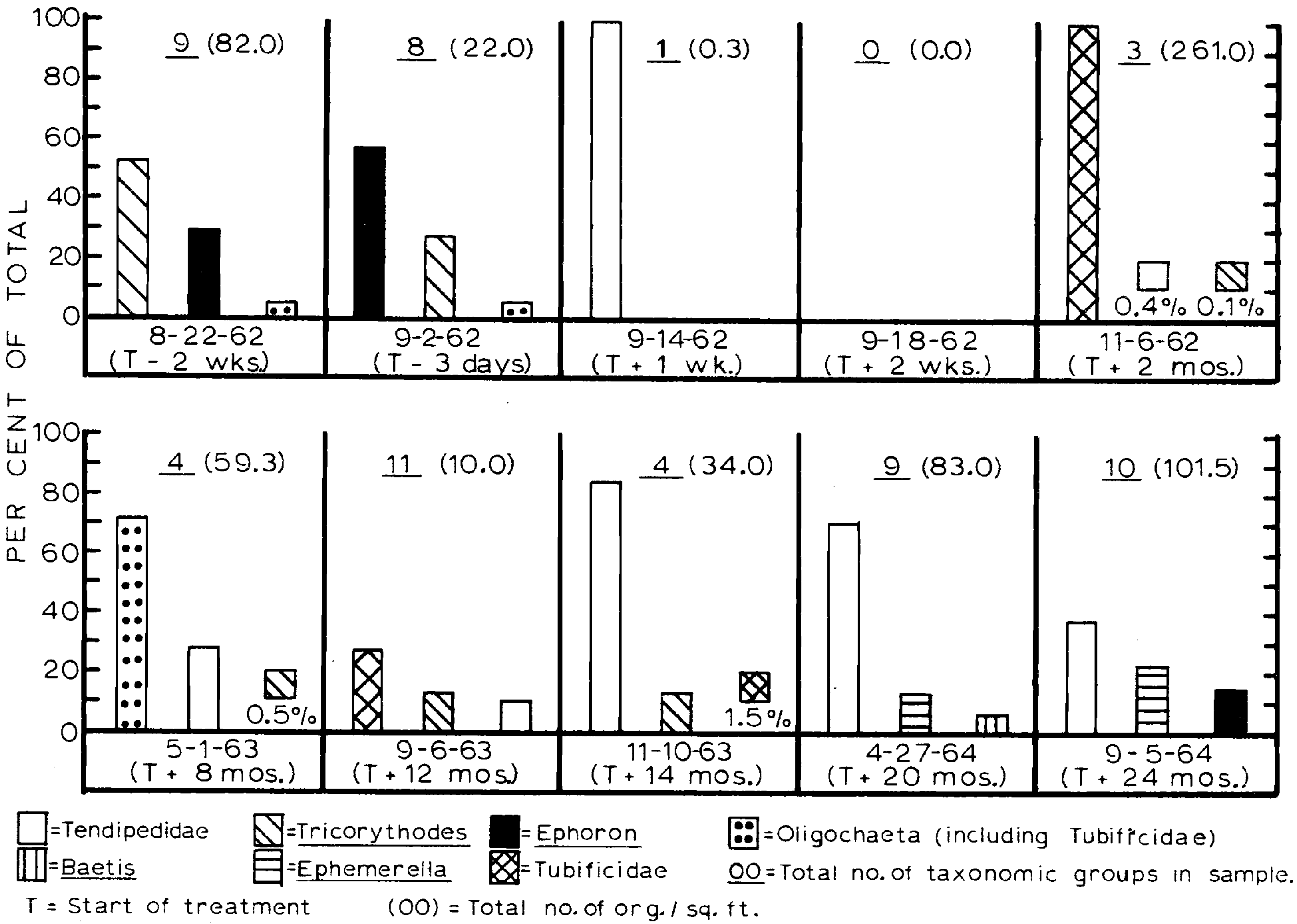


Figure 41. Composition of selected bottom samples at station I over a period from 2 weeks before rotenone exposure to 2 years after.

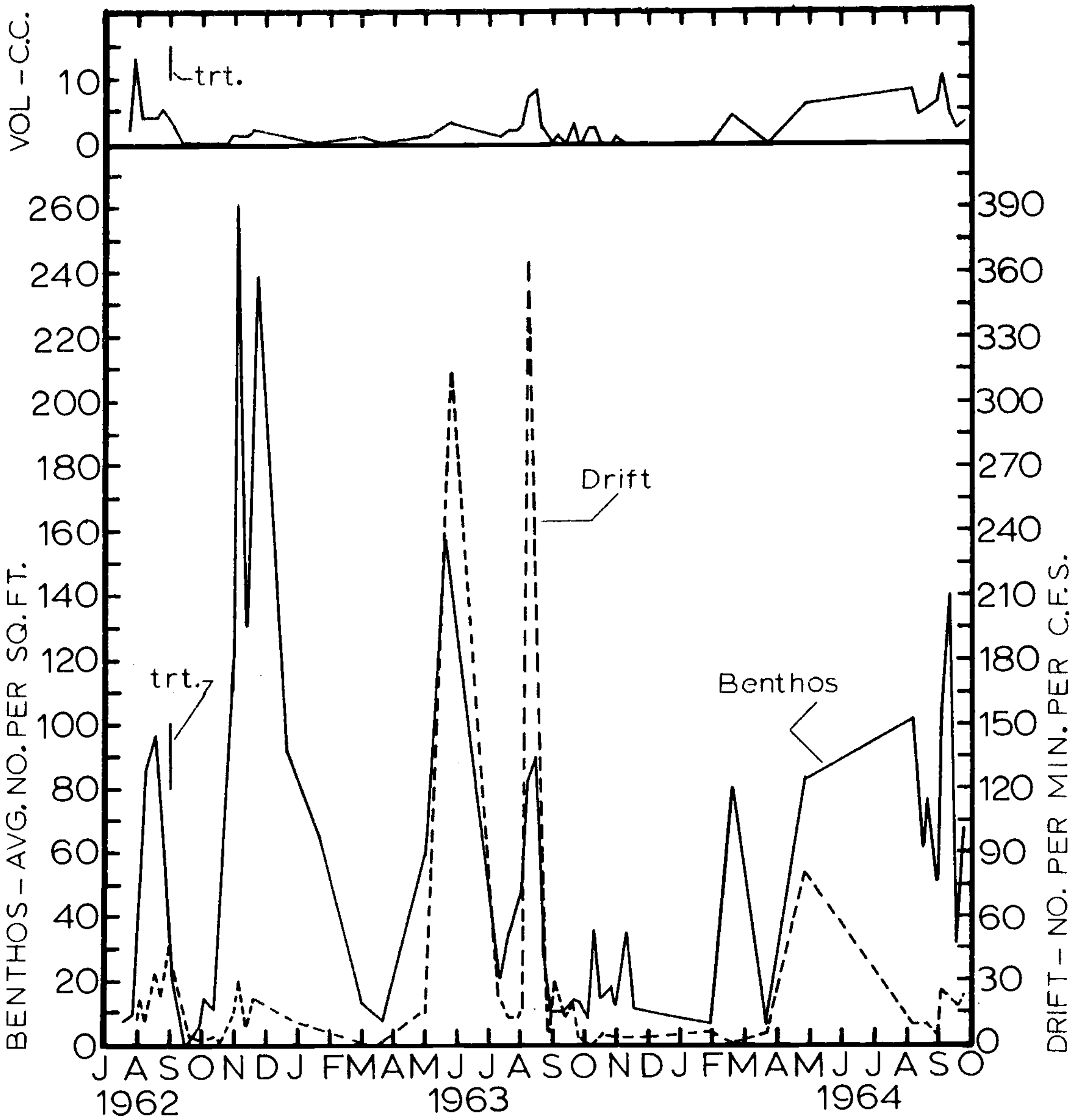


Figure 42. Numbers and centrifuged volumes (benthos only) of bottom and drift invertebrate samples at station I from July 23, 1962 to September 25, 1964.

exposure, while the river was still toxic, contained only a few living invertebrates. These appeared to be drugged. The remains of dead aquatic organisms were common in the bottom samples. No live insects were taken in the drift sample. Only one midge larvae was found in three one-square-foot bottom samples taken one week after the rotenone treatment; no organisms were found two weeks after treatment.

In the eight months following the treatment, annelid worms, especially Tubificidae, became very abundant (Figure 41). Samples thus contained large numbers of organisms having a small total volume (Figure 42). The Tubificidae are known to inhabit polluted waters where the fauna may be periodically affected by toxic materials. At station I, reduction of other species may have permitted the annelid worms to increase. Cushing and Olive (1957) reported that Oligochaetes were not affected by rotenone; the Oligochaete populations in the lakes included in their studies also increased after treatment.

During the first eight months following treatment, increases in the drift net catches were largely due to great numbers of Tubificidae (Figure 42). A large hatch of midges occurred in May, 1963.

Following the 1963 runoff, the mayflies dominated the fauna, and midges and annelid worms became relatively less abundant.

The most abundant mayfly in this period was *Tricorythodes*.

The 1963 flash floods reduced the invertebrate population to a remnant of its pre-flood size, and the tubificids again became dominant. The drift net catch numbers increased sharply (Figure 42) perhaps being indicative of the fate of many of the bottom organisms.

The benthic fauna continued at a low level until the following spring, when the level increased as an unidentified species of a large, black midge (Tendipedidae) made its annual appearance.

Tendipedidae became the prevalent group early in 1964 and remained as such until the completion of the study. The emergence trap at station I in the summer of 1964 caught mostly adult midges. The drift also contained large numbers of Tendipedidae, but the mayfly family Baetidae became more common in September.

Two years after the treatment, benthic organisms were apparently numerically more abundant in this section of the river than prior to treatment. However, the composition of the fauna was somewhat different. In September, 1964, Tendipedidae was dominant followed by *Ephemerella* and *Ephoron*; at the same time in 1962, *Tricorythodes*, *Ephoron*, and Oligochaeta were numerically the most abundant three organisms.

Table 9 lists *Hexagenia* and Tipulidae as missing from the fauna at the close of study. Both were rare before the treatment.

TABLE 9. INVERTEBRATE TAXONOMIC GROUPS LISTED AS ABSENT OR OF SPORADIC (S) OCCURANCE AT THE END OF EACH TIME INTERVAL IN THE POST-ROTENONE EXPOSURE PERIOD AT STATION I. ONLY THOSE GROUPS PRESENT BEFORE TREATMENT ARE LISTED.

Time in months						
3	8	12	15	18	20	24
Baetis	*Baetis* (S)	*Choroterpes* (S)	*Choroterpes* (S)	*Choroterpes*	*Hexagenia*	*Hexagenia*
Tricorythodes (S)	*Tricorythodes*	*Ephemerella* (S)	*Hexagenia*	*Hexagenia*	Tipulidae	Tipulidae
Ephemerella	*Ephemerella*	*Hexagenia*	Tipulidae	Tipulidae		
Choroterpes	*Choroterpes*	*Ephemera*				
Brachycercus	*Brachycercus*	Tipulidae				
Rhithrogenia	*Rhithrogenia*	Leptocercidae				
Heptagenia	*Heptagenia*					
Ephoron	*Ephoron*					
Ephemera	*Ephemera*					
Hexagenia	*Hexagenia*					
Tipulidae	Tipulidae					
Perlodidae	Perlodidae					
Hydropsychidae	Hydropsychidae					
Leptocercidae	Leptocercidae					

The mayflies *Traverella* and *Isonychia* were *not* found prior to rotenone treatment, but appeared during the recovery period. *Traverella* appeared in July, 1963, and was common in 1964; *Isonychia* made a brief appearance in August, 1964. Damselflies (Coenagrionidae), the Lepidopteran family Pyralididae, saddlecase caddisflies (Glossosomatidae), the micro-caddisflies (Hydroptilidae), the fly family Anthomyiidae, snipeflies (Rhagionidae), buffalo gnats (Simulidae), beetles of the family Elmidae, nematodes, and the snails *Lymnaea* and *Physa* were found in the post-treatment recovery period. None were found before treatment; however, Bosley (1960) reported finding a few Rhagionidae, Hydroptilidae, and *Lymnaea* in this area.

Lower river

No pre-treatment samples were taken below station I, but in the spring of 1963, a series of temporary stations were established along the lower river. Samples were obtained at each station through 1963 and 1964 until each was covered by the rising water in Flaming Gorge Reservoir. Sampling stations were established near treatment stations #21, #20, #19, #17, and #16. The latter, because of rising water, could not be sampled after April, 1964. Bosley (1960) provided a good description of the aquatic flora and fauna as far down as the state line (near station #20). He reported the bottom fauna as consisting mainly of Tendipedidae and Baetidae. The aquatic flora was reported as poor, consisting mostly of small amounts of Cladophora and diatoms.

During rotenone treatment, a great number of dead and dying adult mayflies were noticed floating downstream; this may have been a normal hatch or it may have been triggered by the insects being contacted by the rotenone. The sub-imago state that developed was soon overcome by the toxicant.

During the latter part of the treatment, it was possible to compare before and after treatment the aquatic fauna present near the Jarvie Ranch about 15 miles upstream from the detoxification station. Immediately before the rotenone arrived in the area, a rough evaluation of the fauna was made by lifting rocks near shore. The following morning, after the rotenone had been present for about 16 hours, the same area was similarly checked.

Before the rotenone arrived, numerous mayflies, caddisflies (Brachycentridae), and midge larvae (Tendipedidae) were found. All were active, either scurrying to escape or withdrawing into vegetative cover. After the treatment, the mayflies appeared languid and made no attempt to escape. The caddisfly cases were still attached, but some of the occupants were noted hanging from the cases and apparently dead. No midge larvae could be found.

Because of the encroaching waters of the reservoir, the main collecting activity after the 1963 runoff was concentrated at station #17, and later, at station #16. Changes of the fauna at both of these sites are shown in Figures 43 and 44. The benthos at station #17 reached a high level of abundance soon after the runoff subsided. The great bulk of the fauna was composed of mayflies, several genera being abundant at different times. The mayflies and other organisms were sharply reduced by the August and September flash floods. Drift net catches greatly increased at the time of the first flood, but catches increased very little after this, probably because most of the fauna had been swept away. The drift sample was taken when the first flood was near its peak, and a large number of organisms and amount of debris was seen moving downstream with the roily flood water.

Sampling activity was switched to station #16 early in September, when the reservoir covered the sample site at station #17. Population levels here were low as a result of the floods. Mayflies were the prevalent group, but midges became the dominant group before the river froze over in the winter. Tendipedidae remained the dominant group until sampling activity was terminated in April, 1964. Ten familes were present at the conclusion of sampling as compared to the four reported by Bosley (1960) for this section of the river.

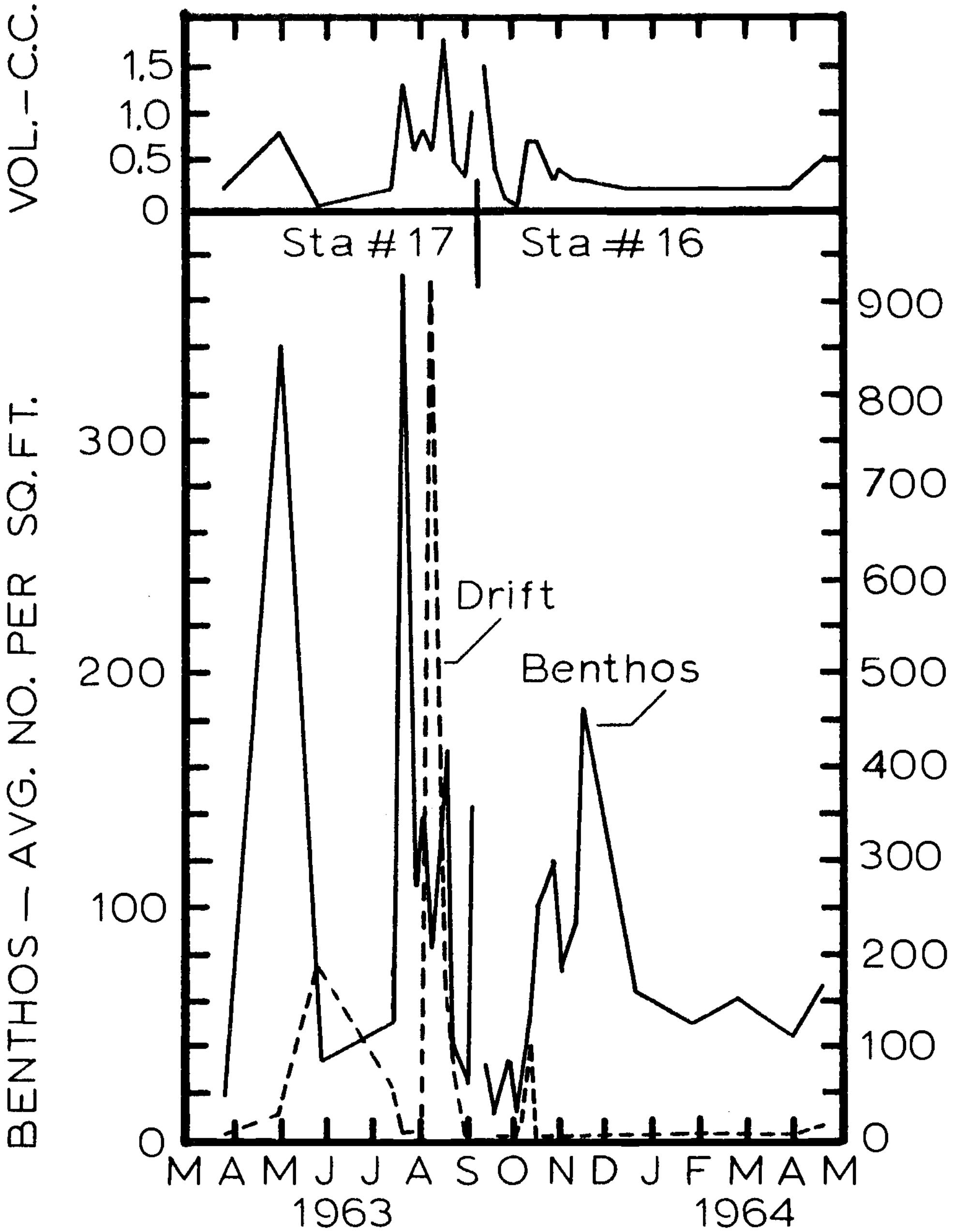


Figure 43. Numbers and centrifuged volumes (benthos only) of bottom and drift samples at stations #16 and #17 from March 24, 1963 to April 19, 1964.

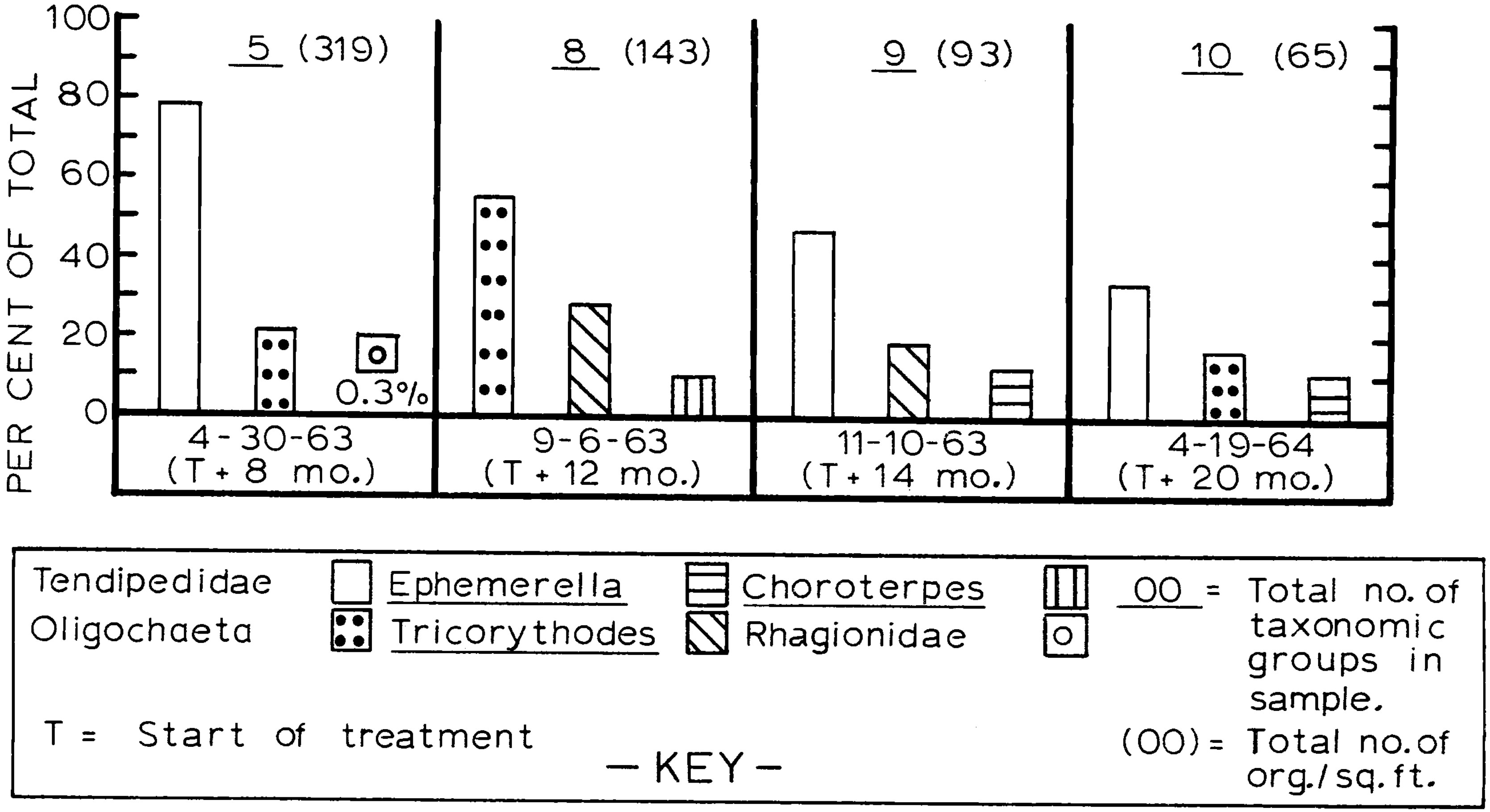


Figure 44. Composition of selected bottom samples at stations #16 and #17 from April, 1963 to April, 1964.

Determination of Rotenone Concentrations

A synopsis of the rotenone concentrations present in the river during and after the treatment is given in Table 10. Henderson (1963) presents comprehensively the laboratory bioassay results. The data shown are values selected from his report; some were from measurements made on water samples collected by state personnel. The rotenone concentrations calculated from stream flow data and amounts of rotenone used at each station are also given.

Field bioassay

The results of rotenone concentration determinations by field bioassay, one-half of a mile below Green River station #1, are presented in Table 11. The concentration of toxicant fluctuated throughout the day. A low of 3.9 ppm was recorded 2-1/2 hours after rotenone introduction at station #1. The highest reading of 8.8 ppm was recorded 5-1/2 hours after initiation of treatment. Calculated concentration of toxicant introduced from Green River #1 (Table 10) was 6.4 ppm. Much of the fluctuation in concentration was believed to be due to erratic rotenone introduction at the station upstream. Periodic changes in the river water color from green to a milky color sustantiated this explanation. The higher concentrations were determined on samples of water with

TABLE 10. ROTENONE CONCENTRATIONS DEVELOPED IN THE GREEN RIVER DURING ITS TREATMENT AS MEASURED BY DIFFERENT METHODS.

Location	Rotenone concentration (ppm)1/			Time in hours from initial rotenone introduction at nearest upstream station
	As calculated from stream flow data and gallonage of rotenone used	As determined by Post colorimetric method	As determined by bioassay method2/	
NF #1	9.4			
NF #2	7.8			
GR #1	6.4			
mile 0.5			3.9*	2.5
mile 0.5			7.3*	5.5
mile 5			5.6	5.5
mile 8			5.6	6.5
GR #2	6.4			
GR #3	7.1			
GR #4	7.3			
GR #5	7.0			
mile 42			5.6	19.5
GR #6	7.1			
mile 52			0.3	59.5
mile 52			0.07	84.5
GR #7	7.3			
GR #8	7.3			
mile 69.8			5.6	7.0
mile 70.5			1.0	54.0
GR #9	6.8			
GR #10	6.8			
GR #11	7.2			
GR #11			1.8	46.0
mile 105			3.0	28.0
mile 105			1.8	49.0
mile 105		2.0		49.0
GR #12	7.5			
GR #13	6.7			

1/ Expressed as ppm of Chem-fish Regular.

2/ Except for field bioassays, all determinations were made by C. Henderson.

* Denotes field bioassays, all others were laboratory bioassays.

TABLE 10 (CONTINUED). GREEN RIVER ROTENONE CONCENTRATIONS.

Location	Rotenone concentration (ppm)1/			Time in hours from initial rotenone introduction at nearest upstream station
	As calculated from stream flow data and gallonage of rotenone used	As determined by Post colorimetric method	As determined by bioassay method2/	
mile 125			3.0	1.5
mile 125			1.8	49.0
mile 126			3.0	23.5
GR #14	6.3			
GR #15	6.7			
GR #16	6.7			
mile 159.8			3.4	7.0
mile 159.8		3.5		7.0
GR #17	6.0			
mile 169.8			3.2	5.0
mile 169.8		3.0		5.0
GR #18	4.8			
GR #19	5.3			
GR #20	5.8			
mile 199			0.7	13.0
mile 199		1.0		13.0
GR #21	5.8			
mile 200			2.8	14.0
mile 200		3.0		14.0
mile 210			4.2	17.5
mile 210		4.0		17.5
GR #22				
Flaming Gorge Dam			5.6	15.0
Flaming Gorge Dam			0.5	85.0

1/, 2/ see preceding page.

TABLE 11. GREEN RIVER ROTENONE CONCENTRATIONS 1/2 MILE BELOW STATION #1 AS DETERMINED BY FIELD BIOASSAY ON SEPTEMBER 4, 1962.

Sample number	Channel	Time	Time needed for test fish to lose equilibrium (minutes)	Toxicant concentration (ppm)1/
1	west	1035	45	3.9
2	west	1100	40	4.3
3	west	1215	20	7.4
4	east	1245	30	5.4
5	east	1328	22	6.8
6	west	1328	17	8.8
7	west	1426	39	4.4
8	east	1435	22	6.8

1/ Expressed in ppm of Chem-fish Regular.

a milky color.

Incomplete mixing apparently occurred in the short distance traversed from the drip station to the bioassay point. Most of the higher determinations were made from samples from the west side of the river. However, the concentration present in all samples from the east channel of the river was apparently sufficient to destroy the fish present. Observation of the river above the bioassay site revealed that the water along the west bank was a milky-white color. The flow of water in this section of the river was predominantly along the west bank because of channel curves.

Post colorimetric method

Erratic results were obtained with the Post colorimetric rotenone test. Some of the determinations made with this method compared very closely with the results of laboratory bioassays of the same water samples (Table 10). Other tests were hard to read, and a considerable amount of guess-work was necessary to determine the concentrations. Many of the determinations made during the first two days were discarded as unreliable, especially after a talk with George Post, the originator of the method, revealed that the determinations were not made properly. He said that the hydrochloric acid-nitric acid mixture for the test should be made up at least one to two days before using, otherwise color development would be slow. Furthermore, the sample should be placed in darkness to allow color development.

Median Tolerance Limit of *Siphlonurus* sp.

The results of the rotenone bioassay with the mayfly, *Siphlonurus* sp., are given in Figure 45. Cannibalism among control specimens and in the weaker rotenone concentrations destroyed the validity of some of the bioassay data obtained. However, the data presented here meet the requirement of at least 90 percent survival in the control solution (American Public Health Association, 1960). The 24-hour median tolerance limit (TL_m) was 0.012 ppm pure rotenone and the 48-hour TL_m was 0.0045 ppm (Figure 45). Observations made during the test revealed that as the rotenone became effective, insect movement decreased. Gill movements became sporadic and jerky, until finally the gills moved only rarely and movement appeared labored. Loss of equilibrium, the next symptom of intoxication, was followed shortly by death.

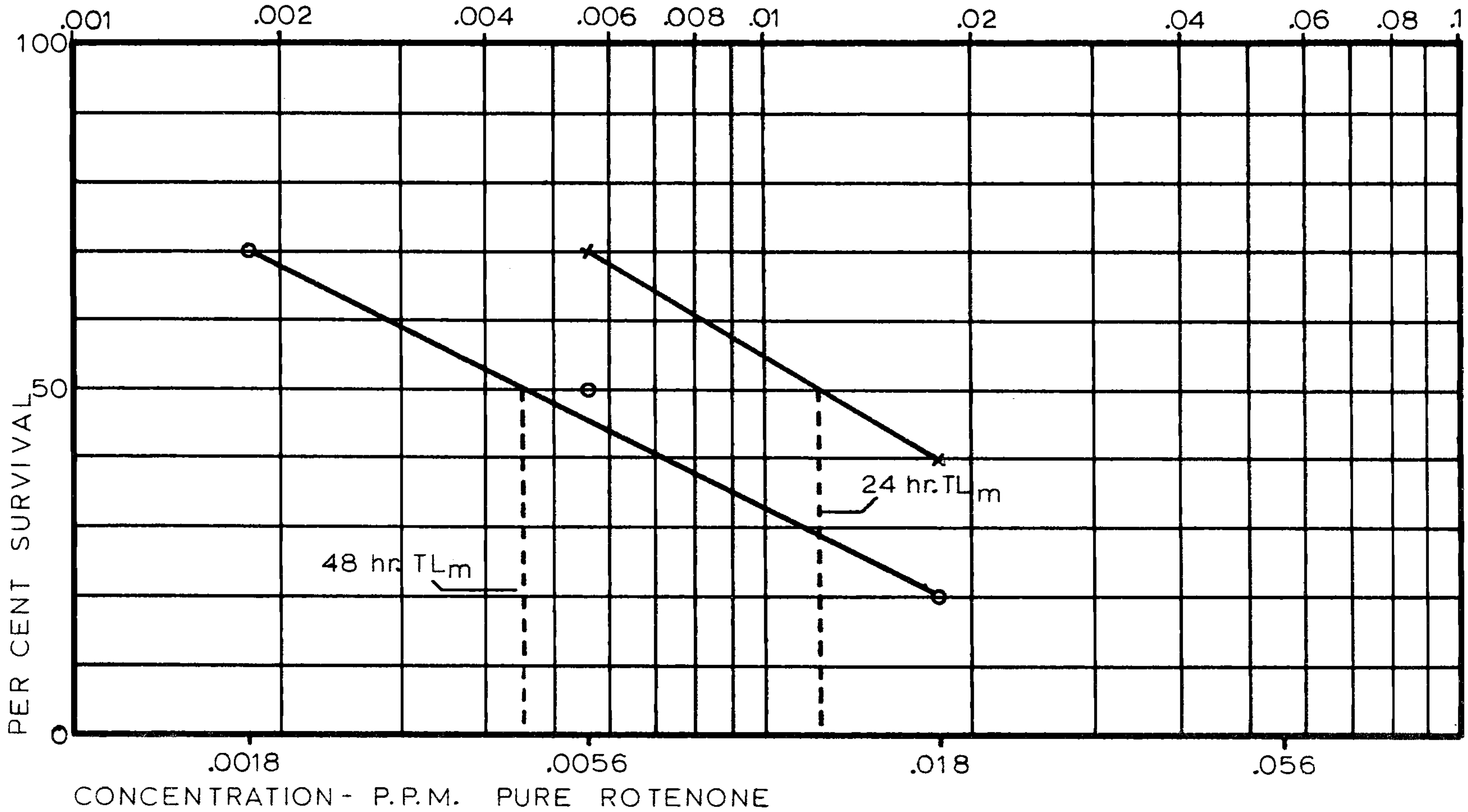


Figure 45. Toxicity of pure rotenone to the mayfly **Siphlonurus** sp. as determined by bioassays.

DISCUSSION

The foregoing data show that the river fauna was drastically reduced by the rotenone treatment. Except for fish in the slough and backwater areas, the fish populations were virtually exterminated in the treated area.

As would be expected from the insecticidal properties of rotenone and the concentrations used, the invertebrates present in the treated area were very adversely affected by the treatment. The data reveal that most of the few survivors were species like the dragonflies (Gomphidae) and snipeflies (Rhagionidae) that normally are found burrowing in the mud and aquatic vegetation of the stream bottom. Both groups were prominent in the fauna immediately after the treatment.

Rotenone appears to decompose at a fairly rapid rate, especially in warm, alkaline, turbid waters (Prevost, 1960). Several writers have indicated that the rate of rotenone decomposition is increased by reaction with the substrate. Berry and Larkin (1954) have suggested that rotenone is absorbed and detoxified at a high rate by the large surface area covered by masses of aquatic vegetation. The numerous aquatic animals normally present in such vegetation were believed to play an important role in detoxifying the water. These workers also pointed out that bottom sediments of fine silt and organic debris would contribute to detoxification of rotenone. Kiser, Donaldson, and Olson (1963) attributed incomplete kills of zooplankton in weed beds to the speed with which the rotenone was detoxified by the large amount of organic matter present and also to the fact that it was difficult to obtain an even distribution of rotenone in the weed beds. The latter point may account for some of the poor fish kills that occurred in the sloughs and backwaters of the Green River. Lindgren (1960) and Ahlmquist (1959) believed that the bottom mud would protect the benthic animals which burrow into the substrate.

Detoxification processes may be partially offset by the fact that some of the decomposition products may also be toxic. Shepard (1951) stated that one of the decomposition products of rotenone, dehydrorotenone, has insecticidal properties under certain conditions. The Merck Index (1960) lists both dehydrorotenone and rotenonone as toxic to insects.

After the original depression of the fauna by rotenone, a recovery period followed in which the fauna of the treated area began to return to pre-treatment status. Larimore, Childers, and Hechrotte (1959) believed that the rate at which a stream was reinvaded after population depletion was dependent upon: (1) the extent of depleted area; (2) the sources of new organisms along with the associated problems of species motility, barrier factors, species abundance at the source, and distances involved; (3) the extent of damage to habitat; (4) the water levels; and (5) the season of year. They reported a rapid repopulation of a drought-stricken stream by fish and invertebrates. Kanally (1964) found that a population of brown trout returned to pre-drought levels within three years after population destruction. Krumholz and Minckley (1964) reported that fish were quick to re-populate an area previously uninhabitable due to pollution.

The Green River might be re-populated through: (1) migration of organisms from unaffected areas such as tributaries, untreated upstream waters, and sloughs and backwaters; (2) passive transport of an organism, or its quiescent stage, e.g., egg or pupae, by water, wind, or other organisms; (3) a surviving population in the treated waters; (4) presence at time of treatment of a physiologically inactive organismic stage which was unaffected by the rotenone. In the last case for example, the egg may sometimes be the most resistant stage of the life cycle of many organisms. Smith (1941) reported that fish eggs were unaffected by exposure to 0.5 ppm of five percent rotenone.

All of the above factors might be expected to contribute to the re-establishment of fish populations. Probably the most important factor influencing fish populations was active movement from untreated areas. The longitudinal distribution patterns of whitefish, brown trout, carp, and flannelmouth suckers during the period of study are shown in Figures 22 and 23. Whitefish, especially young individuals, re-appeared in the treated area mostly as a result of slow, continual dispersal downstream. The single exception, as shown on Figure 23, was at the mouth of the Big Sandy River. This small, isolated population may well have migrated down the Big Sandy River from its untreated, upper reaches. Re-introduction of rotenone into the area treated in 1961 showed that whitefish had moved about 1-1/2 miles downstream in one week (Stone, 1961 and Eiserman, 1961). Thoreson (1958) reported that whitefish had moved about 35 miles downstream one year after treatment of the Marias River in Montana.

Brown trout re-populated the treated area by downstream migration and dispersal from the untreated mainstream and the tributaries in the vicinity of Big Piney. The brown trout found near Big Piney were large fish and were probably emmigrants returning to the mainstream after spawning runs into untreated tributary waters. Usually, the sequence of re-population by brown trout appeared to follow a regular pattern. A few fingerling-sized fish, apparently from upstream spawning areas, first appeared in the treated habitat. These were followed later by large, mature fish.

Re-appearance of flannelmouth suckers also depended in part upon downstream dispersal, but immigration from untreated sloughs and backwaters was also important. The small centers of sucker populations (Figure 22) undoubtedly came from areas missed or incompletely treated. Scattered small populations of young, newly hatched sucker fry were found about one month after the treatment in backwaters connected to the main river. This would indicate that some eggs from late spawners were present at the time of treatment and were unaffected by the rotenone.

Carp re-appeared only in scattered sections of the river (Figure 22) and are believed to have survived treatment in poorly treated off-channel areas. Scale aging and size indicate that many of the carp were members of the 1962 year class. These fish would normally be present in off-channel brood-ponds at the time of the treatment. Poorly treated areas are also believed to be the primary source of the redside shiners and fathead minnows that had re-appeared in the lower river in great numbers by the fall of 1964.

The squawfish, which reached its limit of upstream penetration in the mid-treatment area, and which was much reduced by past conditions of pollution, did not re-appear after treatment. Flaming Gorge Dam prevented recruitment of this species from the only apparent source. In contrast, the bonytail chub was present in lakes above the affected area and young immigrants began to appear in the depopulated area two years after treatment.

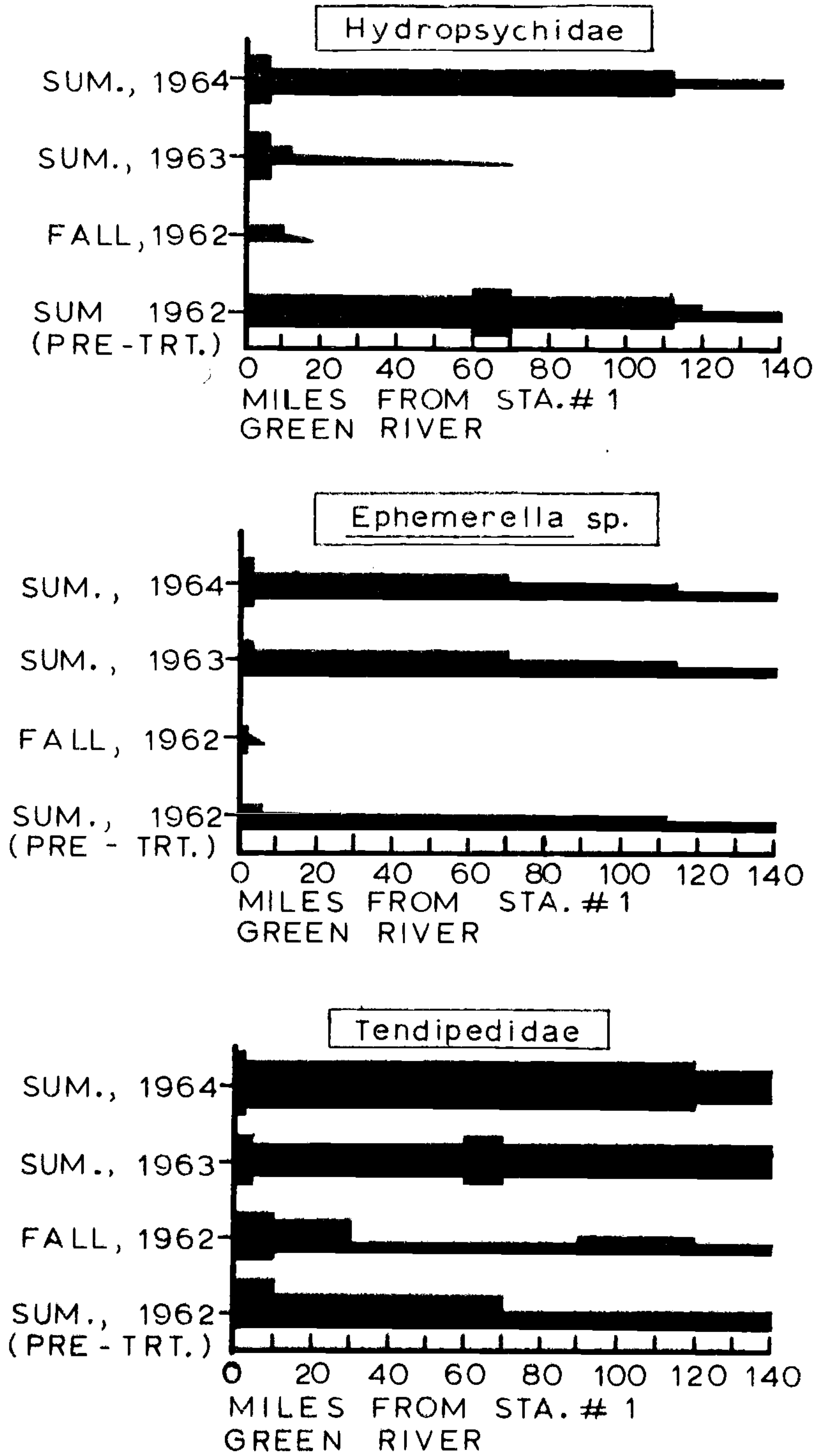
The re-establishment of the aquatic invertebrate fauna probably involved all of the described means of re-population. The method by which each invertebrate species became re-established in the treated area reflected its mode of life. For example, snails would be restricted to passive transportation, while strong swimmers with a flying adult stage, like Baetis, could readily move about and colonize new unoccupied habitat. Recolonization of the treated area by snails, especially Physa, resulted in part from the snails rising in the water and being transported by currents to a new location.

The survival of eggs laid in the treated area prior to treatment or subsequently carried in by stream currents was probably an important factor in re-establishing many of the invertebrate groups, especially those with an annual cycle of appearance. For example, the mayfly Ephoron was not found above the mouth of the Big Sandy River, so its eggs could not have been re-introduced from untreated upstream waters. Yet, this animal appeared the summer following treatment in its previous habitat and was distributed uniformly enough to preclude immigration by adults. Much of the invertebrate fauna fluctuation observed in the summer of 1963 may have been due to the annual cyclic appearance of certain species. Lack of competition (for space, food, etc) from species normally present in the fauna, but not present in 1963 may have permitted a few groups, such as Simulidae, to periodically become unusually abundant. Maturation, with subsequent disappearance from the fauna, of one of the abundant groups resulted in a low population level perhaps because no other species were present to take advantage of the void thus created.

Figure 46 shows the longitudinal distribution of three common insect groups: the net-spinning caddisflies (Hydropsychidae), the midges (Tendipedidae) and the mayfly (Ephemerella). Tendipedidae re-appeared in the depopulated area very soon after treatment; Ephemerella returned to pre-treatment the following summer. This would perhaps indicate the re-appearance of these groups resulted from eggs laid in treated areas prior to treatment. Hydropsychidae was one of the last groups to return to the fauna. Downstream movement apparently was the principal means of re-population by Hydropsychidae, since the population build-up (Figure 46) moved from the untreated upstream area successively to the lower river reaches and the larvae arrived only sporadically at first and not in large numbers.

Ecological Aspects

From an ecological standpoint, the introduction of rotenone into the complex ecosystem of the river was catastrophic. The



Line thickness indicates abundance.

Figure 46. Longitudinal distribution in the Green River of three insect groups showing (from top) slow, medium, and rapid recovery rates after exposure to rotenone.

complete destruction of some species and the reduction of others, at all trophic levels, undoubtedly influenced the entire ecosystem. Even though measurements could not be made on all forms of the river flora and fauna, some relationships appeared obvious.

One of the initial results of treatment was an increase in the clarity of the river water. This was also noticeable after the 1961 test project and seems to have been a direct result of the elimination of bottom-feeding fish from the habitat. Reduction of turbidity resulted in increased availability of light for the aquatic flora, which was apparently not adversely affected by the rotenone. Light increase, along with the fertilizing effect of decaying animals and the elimination of animal grazing activities, apparently resulted in increased plant abundance. A thick, jelly-like diatom bloom developed on the stream bottom throughout much of the river below Big Piney in the fall of 1962. The attached algae Cladophora also became abundant in some areas of the river, notably on the New Fork River. Henderson (1963) reported finding heavy growths of the stalked diatom Gomphonema and the algae Cladophora on the river bottom two weeks after treatment. He said that phytoplankton showed no significant changes and that zooplankton, except for the protozoans, was reduced or absent.

Ricker and Gottschalk (1941), describing carp population removal by seining, reported that the water cleared and the aquatic vegetation increased. Bonn and Holbert (1961) reported a plankton increase following rotenone treatment and believed it to be caused by a reduction in the numbers of bottom feeding fish. Schoenecker and Peckham (1963) noted the river water cleared sufficiently for observers to see the bottom after treatment with rotenone to eliminate bottom feeding fish in the Snake River, Nebraska.

One of the most noticeable after-effects of the rotenone treatment was an apparent succession of invertebrate species during the recovery period. This was evident at almost all stations, but was most apparent at station B on the New Fork River, where the situation appeared to resemble the characteristic succession of dominant plant groups following fire destruction of a forested area. Hynes (1960, p. 130) stated that "invertebrates tend to recolonize formerly polluted reaches in succession." He believed that mobility was an important factor in determining when a given species would re-appear.

Figure 47 presents the recovery trends shown by four groups of invertebrates, at station B, during the study. Prior to treatment, the fauna was characterized by short term dominance by various groups. After population depression by rotenone, the annelid worms, Tubificidae, were strongly dominant and remained so until the ice thawed the following spring. A midge-mayfly (Tendipedidae-Baetidae) group slowly started to recover in the fall

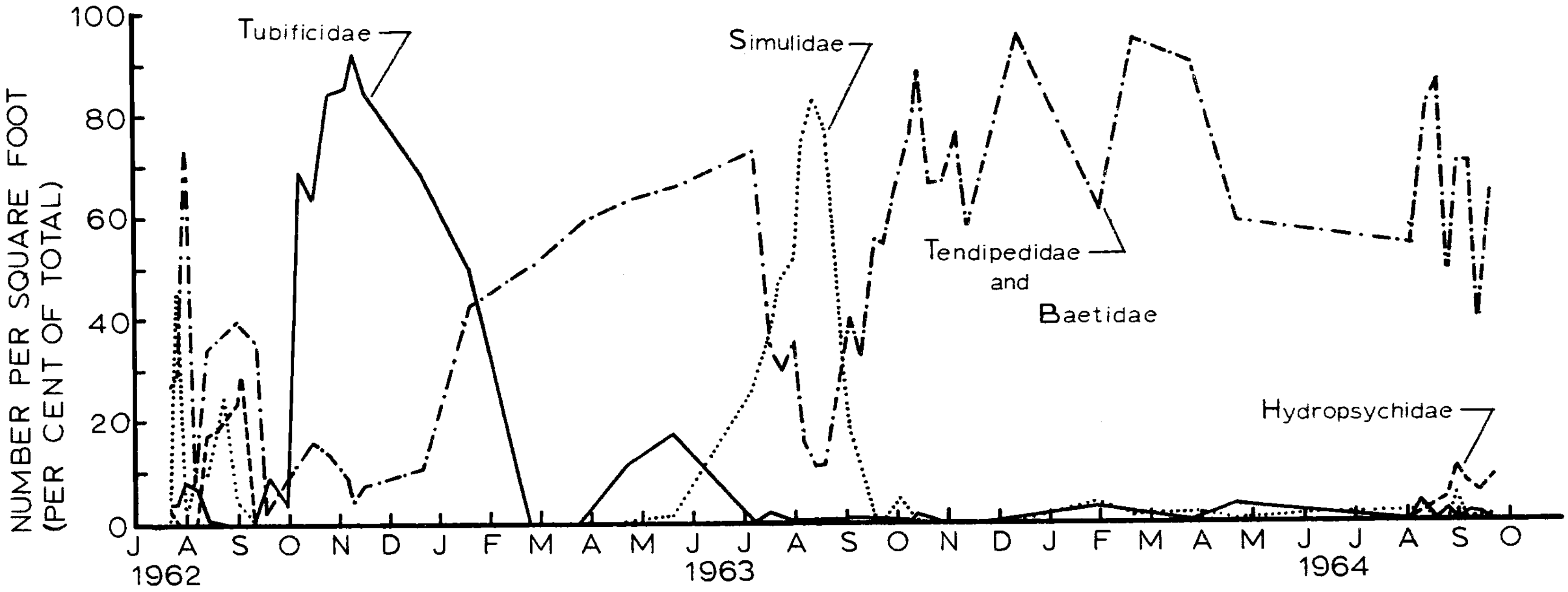


Figure 47. Succession of dominant benthic invertebrates at station B, New Fork River, from July, 1962 to September, 1964.

and achieved dominance some four months after treatment. This group remained dominant for several months in the spring and early summer. In the meantime, another group, Simulidae, had started to increase and rose to dominance in the summer of 1963. Contemporarily, the midge-mayfly group decreased sharply.

The net-spinning caddisflies (Hydropsychidae), common before treatment, did not re-appear at station B until the summer of 1964. A slight reduction occurred in the dominant midge-mayfly group when the caddisflies appeared. Figure 47 shows very clearly that the fauna at station B had not returned to its pre-treatment composition.

Reduction of the fish population, especially the large adult coarse fish, strongly influenced the recovery of the fish fauna. The few adults present in portions of the treated area obviously produced large numbers of young fish in the 1963 spawnings. Growth rates of the 1963 year-class and of the few 1962 year-class survivors were high. Flannelmouth suckers attained a 7-8 inch size in their first year and were 14-16 inches long at two years of age. One-year-old carp were about seven inches, as compared to a usual pre-treatment length of five inches, and averaged about 10 to 11 inches in two years. Successful spawnings of other species also occurred in 1964. By the end of that year, three distinct age groups of flannelmouth suckers were evident in the population.

A noticeable feature of the post-treatment fish population was the absence of efficient predator-prey relationships. Large numbers of rainbow trout, including some up to five pounds in size, were stocked in the treated area beginning in the spring of 1963 and continuing through 1964. Over 8,000,000 rainbow trout were placed in Flaming Gorge Reservoir alone. Random examination of stomachs from the larger rainbow trout checked during the study indicated that they were not feeding on other fish species to any great extent, but mostly on snails. The large numbers of cyprinid fish, other than carp, also indicated a lack of predation.

The rainbow trout was selected for restocking the river largely because of its availability in the requisite large numbers. Furthermore, the marked reduction of competitive fish species in the lower river offered an opportunity to try to establish a good rainbow trout fishery below Fontenelle Dam.

By the summer of 1964, it was obvious that the rainbow fishery of the river could not be maintained in the face of the developing heavy fishing pressure, except with unfeasible, continued heavy stocking. Since brown trout had started to invade the lower river (Figure 19), which is a suitable habitat, a decision was made in late 1964 to stock 720,000 fingerling brown trout in the river between Green River City and Fontenelle Dam. Though a more difficult species for the average fisherman to catch, the brown trout can maintain itself in the face of heavy fishing pressure, provide a challenge to the better fishermen, and exert very efficient predatory pressure on other fish species. Large brown trout are normally piscivorous, and a single individual will often consume a large number of small fish. It is expected that this species will provide a valuable biological control on coarse fish populations in the lower Green River system.

Final Status of the Fauna

A list of fish present in the Green River as of November 1, 1964, is given in Appendix 37. A comparison with pre-treatment data (Binns, et al., 1963; Bosley, 1960; McDonald and Dotson, 1960) shows that several changes have occurred. Channel catfish, Colorado River squawfish, humpback suckers, black bullheads, and yellow perch had not been found at the close of study. New species include the lake trout [Salvelinus namaycush (Walbaum)] and kokanee salmon [Oncorhynchus nerka (Walbaum)] (introduced).

Appendix 38 is a list of the invertebrates present in the Green River as of October 1, 1964. New groups recorded in the lower river are Sialidae and Leptophlebia, Traverella, Iron, and Paraleptophlebia, Isonychia. Pentagenia and Hexagenia have not been found since the treatment.

Evaluation of Rotenone Determination Methods

The experience gained from determing rotenone concentration during the treatment suggests that laboratory bioassay analysis, in spite of its occasional inconvenience and time consumption, is still the best method presently available for determining rotenone concentrations in water. Field bioassays are believed to give fairly accurate results, but experimental conditions are somewhat difficult to control. The Post colorimentric rotenone determination method proved erratic. Results were insufficiently consistent to allow any assurance of accuracy. Other workers have reported conflicting opinions of the Post method. Richard (1964) reported erratic results; Bonn and Holbert (1961) reported poor results; but, Hoffman and Payette (1956) reported good results when the method was used under laboratory conditions. An evident need exists for a simple, accurate field method for determing rotenone concentration under all natural water conditions.

Evaluation of Treatment

The 1962 rotenone treatment of the Green River had as its stated objectives: (1) the depression of the coarse fish populations, particularly carp, in the impoundment areas of the Flaming Gorge and Fontenelle Reservoirs and associated river sections; and

(2) the establishment of a sportfishery in the treated waters to meet the anticipated demand.

An evaluation can best be made by considering the development of the treated area in the two years since treatment. Fisherman use of the Flaming Gorge Reservoir and the Green River upstream has far exceeded the most optimistic pre-impoundment estimates. Fishing has been excellent and planted trout have shown good growth rates. Coarse fish populations have become re-established in the treated area, but, to date, have remained relatively unimportant factors in interspecific competition.

All investigations to date, indicate that the Green River Rehabilitation Project, from a fishery management standpoint, has been successful in attaining its basic objectives. However, coarse fish populations in the lower treated area appear to be increasing and may again reach problem status at some time in the future. Possible coarse fish populations in a few years, combined with an anticipated increase in the already intense trout fishery, may result in a reduction of the present high level of fishing success. Without continued heavy stocking of rainbow trout, brown trout will probably become the dominant trout in the river above Flaming Gorge Dam because the habitat appears to be better suited to brown trout.

Although the rehabilitation of the Green River was successful in creating a rainbow trout fishery, I feel that this tool of the fishery manager should not be used indiscriminately. Future stream rehabilitation projects should be carefully scrutinized before implementation to assure that each project is really needed.

BIBLIOGRAPHY

1. Almquist, Elisabeth. Observations on the effect of rotenone emulsives on fish food organisms. Fisheries Board of Sweden, Report of the Institute for Freshwater Research, Drottningholm 40: 146-160. 1959.

2. American Public Health Association. Standard methods for the examination of water and wastewater. 11th ed. New York, 1960. 626 p.

3. Anderson, Robert O. A modified floatation technique for sorting bottom fauna samples. Limnology and Oceanography 4: 223-239. 1959.

4. Ball, Robert, and Donald W. Hayne. Effects of the removal of the fish population on the fish food organisms of a lake. Ecology 33: 41-48. 1952.

5. Baxter, George. A key to the common organisms occurring in Telephone Creek, Nash Fork Creek, North Fork Creek, and the Little Laramie River, Wyoming. Laramie, University of Wyoming, n. d. 6 numb. leaves. (Mimeographed)

6. Berry, G., and P. A. Larkin. Field trials with "Fish-Tox" in streams. Canadian Fish Culturist 15: 10-15. 1954.

7. Berzins, B. Om fiskevard med rotenon. Södra Sveriges Fiskerforening, Arsskrift 1957: 41-53.

8. Binns, Allen et al. The planning, operation, and analysis of the Green River fish control project. Cheyenne and Salt Lake City, Wyoming Game and Fish Department and Utah State Department of Fish and Game, 1963. 83 p.

9. Bonn, Edward W., and Leon R. Holbert. Some effects of rotenone products on municipal water supplies. Transactions of the American Fisheries Society 90: 287-297. 1961.

10. Bosley, Clifford E. Pre-impoundment study of the Flaming Gorge Reservoir. Cheyenne, 1960. 81 p. (Wyoming. Game and Fish Commission. Fisheries Technical Report no. 9)

11. Brown, A. W. A. Insect control by chemicals. New York, Wiley, 1951. 817 p.

12. Brown, C. J. D., and Robert C. Ball. An experiment in the use of derris root (rotenone) on the fish and fish food organisms of Third Sister Lake. Transactions of the American Fisheries Society 72:267-284. 1943.

13. Coche, Andre Georges. Net production of juvenile Steelhead, Salmo gairdneri Richardson, in a freshwater impoundment. Ph. D thesis. Corvallis, Oregon State University, 1964. 272 numb. leaves.

14. Cohen, Jesse M. et al. Effect of fish poisons on water supplies. Part 1: Removal of toxic materials. Journal of the American Water Works Association 52:1551-1566. 1960.

15. Corbett, Don M. et al. Stream gaging procedure. Washington, 1962. 245 p. (U. S. Geological Survey. Water Supply Paper no. 888)

16. Cushing, Colbert E., Jr., and John R. Olive. Effects of toxaphene and rotenone upon the macroscopic bottom fauna of two nothern Colorado reservoirs. Transactions of the American Fisheries Society 86:294-301. 1957.

17. Cutkomp, L. K. Toxicity of rotenone to animals. Soap and Sanitary Chemistry 19:107-115, 123. 1943.

18. Daneel, Rolf. Die Giftwirkung des Rotenons and seiner Derivate auf Fische (II, Der Angriffspunkt der Gifte). Zeitschrift für vergleichende Physiologie 18:524-535. 1933.

19. Das, M., and A. H. McIntosh. Effect of time and temperature on toxicity of insecticides to insects. III. Tests of seven poisons in the range 10-28 °C. Annals of Applied Biology 49:267-289. 1961.

20. Davidson, W. M. Rotenone as a contact insecticide. Journal of Economic Entomology 23:868-874. 1930.

21. Eiserman, Fred. Green River coarse fish test run from Middle Firehole Canyon Creek to the Buckboard Ranch, August, 1961. Cheyenne, Wyoming Game and Fish Department, 1961. 9 numb. leaves. (Mimeographed)

22. Fellton, Herman L. Control of aquatic midges with notes on the biology of certain species. Journal of Economic Entomology 33:252-264. 1940.

23. Ginsburg, Joseph M. Rotenone: its insecticidal value. 1933. 2 p. (New Jersey. Agricultural Experiment Station. Circular no. 273)

24. Hamilton, Howard Laverne. The biological action of rotenone on fresh-water animals. Proceedings of the Iowa Academy of Science 48:467-469. 1941.

25. Henderson, Croswell. Protection of domestic water supplies and studies of pollutional parameters during the Green River fish control project. Denver, U. S. Public Health Service, 1963. 62 p.

26. Hoffman, Donald A., and Robert C. Payette. Operation carp on a San Diego reservoir. Water and Sewage Works, July, 1956, p. 281-287.

27. Hooper, Frank F. The effect of derris root (rotenone) upon plankton and bottom fauna organisms of a small Minnesota lake. Proceedings of the Minnesota Academy of Science 16:29-32. 1948.

28. Hynes, H. B. N. The biology of polluted waters. Liverpool, Liverpool University Press, 1960. 202 p.

29. Kanally, Jack. The recovery of a depleted trout population in North Sybelle Creek, Albany County, Wyoming. Cheyenne, Wyoming Game and Fish Department, 1964. 5 numb. leaves. (Administration Progress Report: Project no. 260-5-8) (Mimeographed)

30. Kiser, R. W., John R. Donaldson, and Paul R. Olson. The effect of rotenone on zooplankton populations in freshwater lakes. Transactions of the American Fisheries Society 92:17-24. 1963.

31. Krumholz, Louis A. The use of rotenone in fisheries research. Journal of Wildlife Management 12:305-317. 1948.

32. Krumholz, Louis A., and W. L. Minckley. Changes in the fish population in the upper Ohio River following temporary pollution abatement. Transactions of the American Fisheries Society 93:1-5. 1964.

33. Leonard, Justin W. Notes on the use of derris as a fish poison. Transactions of the American Fisheries Society 68:269-279. 1938.

34. ___________. Comments on the adequacy of accepted stream bottom sampling technique In: Transactions of the Fourth North American Wildlife Conference, 1939. Washington, D. C., American Wildlife Institute, p. 288-295.

35. Lindahl. P. E., and K. E. Oberg. The effect of rotenone on respiration and its point of attack. Experimental Cell Research 23:228-237. 1961.

36. Lindgren, Per Erik. About the effect of rotenone upon benthonic animals in lakes. Fisheries Board of Sweden, Report of the Institute for Freshwater Research, Drottningholm 41: 172-184. 1960.

37. McDonald, Donald B., and Phil A. Dotson. Pre-impoundment investigations of the Green River and Colorado River developments. Salt Lake City, 1960. 70 p. (Utah. State Department of Fish and Game. Informational Bulletin no. 60-3)

38. Merck index of chemicals and drugs, 7th ed., N. J. Merck & Co., 1960. 1641 p.

39. M'Gonigle, R. H., and M. W. Smith. Cobequid hatchery-fish production in the Second River, and a new method of disease control. Progressive Fish Culturist no. 38:5-11. 1938.

40. Needham, Paul R., and C. L. Usinger. Variability in the macrofauna of a single riffle in Prosser Creek, California, as indicated by the Surber sampler. Hilgardia 24:383-409. 1956.

41. Oberg, K. E. The site of action of rotenone in the respiratory chain. Experimental Cell Research 24:163-164. 1962.

42. Pennak, Robert W. Freshwater invertebrates of the United States. New York, Ronald Press, 1953. 769 p.

43. Peterson, Laurence. The retreatment of the New Fork River concerned with the Green River Rehabilitation Project. Cheyenne, Wyoming Game and Fish Department, March, 1963. 1 p. (Mimeographed)

44. Pintler, Herbert E., and William C. Johnson. Chemical control of rough fish in the Russian River drainage, California. California Fish and Game 44:91-124. 1958.

45. Post, George. A simple color test for rotenone in water. Progressive Fish Culturist 17:190-191. 1955.

46. Prevost, Gustave. Use of fish toxicants in the Province of Quebec. Canadian Fish Culturist 28:13-36. 1960.

47. Richard, James B. The detoxification of water containing rotenone with chlorine in Echo Creek, El Dorado County. Sacramento, California Department of Fish and Game, 1964. 13 numb. leaves. (Inland Fisheries Administrative Report no. 64-16) (Mimeographed)

48. Ricker, William E., and John Gottschalk. An experiment in removing coarse fish from a lake. Transactions of the American Fisheries Society 70:382-390. 1941.

49. Roark, R. C. Rotenone. Industrial and Engineering Chemistry 25:639-642. 1933.

50. Ross, Herbert H. A textbook of entomology. 2d ed. New York, Wiley, 1956. 519 p.

51. Rudd, Robert L., and Richard E. Genelly. Pesticides: their use and toxicity in relation to wildlife. Davis, 1956. 209 p. (California. State Department of Fish and Game. Game Bulletin no. 7)

52. Scheuring, L., and O. Heuschmann. Uber die Giftwirkung von Derrispräparaten auf Fische. Allgemeine Fischereizeitung 60:370-378. 1935.

53. Schoenecker, William and Richard Peckham. Snake River renovation report - 1963. Lincoln, Nebraska. Game, Forestation, and Parks Commission, 1963. 30 p.

54. Shepard, Harold H. The chemistry and action of insecticides. New York, McGraw-Hill, 1951. 504 p.

55. Simon, James R. Wyoming fishes. Rev. ed. Cheyenne, 1951. 129 p. (Wyoming. Game and Fish Department. Bulletin no. 4)

56. Smith, M. W. Copper sulphate and rotenone as fish poisons. Transactions of the American Fisheries Society 69:141-157. 1940.

57. ________________. Treatment of Potter's Lake, New Brunswick, with rotenone. Transactions of the American Fisheries Society 70:347-355. 1941.

58. Stone, Rod. Resume of the Green River experimental coarse fish control, August, 1961. Salt Lake City, Utah State Department of Fish and Game, 1961. 7 numb. leaves.

59. Thoreson, Nels A. Marias River fishing restoration. Helena, Montana State Department of Fish and Game, 1958. 3 numb. leaves. (Federal Aid Job Completion Report: Project F-15-D-4). (Mimeographed)

60. Tischler, Nanthaniel. Studies on how derris kills insects. Journal of Economic Entomology 28:215-220. 1935.

61. U.S. Geological Survey. Quality of surface waters of the United States, 1962. Parts 9-14. Washington, D.C., U.S. Government Printing Office, 1964. 691 p. (U.S. Geological Survey Water Supply Paper no. 1945)

62. Usinger, Robert L. (ed.) Aquatic insects of California. Berkeley, University of California Press, 1956. 508 p.

63. Utah. University. Division of Biological Sciences. Studies of biota in Dinosaur National Monument, Utah and Colorado. Salt Lake City, 1963. 77 p. (Miscellaneous Papers, no. 1)

64. Ward, Henry Baldwin, and George Chandler Whipple. Freshwater biology. 2d ed. New York, Wiley, 1959. 1248 p.

65. Welch, Paul S. Limnological methods. New York, McGraw-Hill, 1948. 381 p.

66. Zilliox, R. G., and M. Pfeiffer. The use of rotenone for management of New York trout waters. Canadian Fish Culturist 28:3-10. 1960.

67. Zischkale, Max. Effects of rotenone and some common herbicides on fish-food organisms. Field and Lab 20:18-24. 1952.

68. Wollitz, Robert E. Effects of certain commercial fish toxicants on the limnology of three cold-water ponds, Montana. Proceedings of the Montana Academy of Sciences 22:54-81. 1962.

APPENDICES

APPENDIX 1. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION A FROM JULY 16, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-16	7-26	7-30	8-6	8-13	8-20	8-29	9-3	9-11	9-20	9-27	10-2	10-8	10-15
NO. OF SAMPLES	3	3	3	3	3	3	3	2	3	1	3	3	3	3
Hydracarina	0.7	0.3	0.3	1.7	1.6	2.9	3.7	4.5	3.6	12.0	3.0	4.0	1.6	2.3
Tubificidae														
other Oligochaeta													0.3	
Lymnaea														
Nematoda					0.3				0.3				0.3	
Amphipoda														
Tendipedidae	11.7	4.0	2.3	11.7	10.7	36.3	26.0	52.0	27.3	61.0	36.7	32.7	72.0	63.3
Simulidae	8.0	0.3		0.7					0.3					
Tipulidae		0.3	0.7	2.0		1.3	7.3	8.0	7.0	8.0	3.0	4.0	2.0	2.3
Heleidae	0.3					0.3	0.7	0.5	2.0	1.0	1.3	1.3	0.3	1.3
Rhagionidae														
Empididae			0.3								0.3		0.3	0.3
Psychodidae														0.3
Baetis	1.7	4.7	4.0	7.0	5.7	7.3	7.0	10.5	5.7	2.0	4.3	1.3	0.7	0.3
Tricorythodes		0.3		0.3	2.7	13.0	36.7	69.0	32.3	43.0	10.0	20.0	10.7	17.3
Ephemerella	5.0	4.3	3.3	5.3	4.0	2.0	1.3	6.0	5.3	7.0	100.7	13.3	64.7	62.3
Paraleptophlebia				0.3	1.7	2.3	3.3	3.0	7.7	5.0	8.7	11.0	6.7	6.7
Rhithrogenia			2.0	1.0		4.0		14.5	10.0	19.0	25.0	9.7	39.0	11.0
Heptagenia			0.7	3.0	1.7	0.3		2.0	2.3			0.3	0.7	0.3
Iron														
Pteronarcidae	0.7				0.3	1.0					0.3			
Perlidae		0.3	0.7		0.3				0.3	1.0	1.0		0.7	0.3
Perlodidae	0.7	0.3	0.7	0.3	0.7	3.7	7.7	7.0	9.3	23.0	22.7	6.7	20.3	12.0
Nemouridae														
Hydropsychidae	0.3					0.3		0.3	0.3	1.0	3.0	0.3	1.0	0.3
Brachycentridae	0.3	0.3			0.3									
Hydroptilidae				0.3		0.7	1.0	1.5	1.3	27.0	2.0	13.0	5.3	20.0
Lepidostomatidae						2.7	11.0	3.5	12.0	70.0	20.3	25.0	15.0	29.7
Leptocercidae											0.7			
Psychomyiidae														
Glossosomatidae														
Elmidae	2.3	1.0	1.0	2.3	1.3	2.7	3.7	9.5	8.7	22.0	19.0	8.7	7.3	13.0
Dytiscidae		0.7	0.7	0.3	1.0	0.3	0.7							
other Coleoptera												0.3		
Gomphidae														
Corixidae	0.3	0.3	0.3				8.0	1.0	0.3					
Pyralidae														
TOTAL NUMBER	32.0	17.1	17.1	36.6	36.6	32.2	81.2	118.1	192.8	136.7	302.0	262.0	152.5	248.8
AVG. VOL. (CC)		0.3	0.2	0.2	0.3	0.2	0.4	0.8	0.9	1.1	1.5	0.7	1.4	0.8

APPENDIX 1 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION A FROM JULY 16, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-25	11-1	11-8	11-15	12-16	1-17	2-25	3-25	4-22	5-20	7-8	7-15	7-23	7-29
NO. OF SAMPLES	2	3	3	3	2	1	2	3	3	3	3	3	3	3
Hydracarina	3.5	2.0	1.0	1.3	1.5			0.3				0.3		2.9
Tubificidae										0.3	0.3			
other Oligochaeta		0.3	1.4	0.3										
Lymnaea														0.3
Nematoda		0.7	1.0	0.3		1.0	1.0	0.3	0.5					
Amphipoda														
Tendipedidae	76.5	78.0	53.7	62.0	81.5	67.0	142.0	214.3	187.3	2.3	8.3	3.0	73.7	27.0
Simulidae		0.3			1.5		12.0	7.7	0.5			1.3	13.3	2.3
Tipulidae	3.0	2.0	1.7	0.7	1.5	2.0	0.5	1.7	2.0	4.0		0.3	1.3	1.3
Heleidae	1.5	0.3	0.3	0.3			2.0		1.7	0.7				
Rhagionidae					0.5	1.0				0.7				
Empididae		1.0	0.3	1.7	0.5		1.5		0.5					
Psychodidae	0.5	0.3	0.3	0.3										
Baetis	4.5	2.7	2.7	2.0	28.0	1.0	44.0	29.3	42.7	12.0	1.0	7.3	10.7	25.3
Tricorythodes	40.5	35.3	19.0	28.0	16.0	2.0	5.5	3.7	5.0	1.0			3.0	4.3
Ephemerella	70.0	176.0	179.0	164.0	168.0	49.0	151.5	115.3	106.0	15.7	0.7	1.0	8.0	68.7
Paraleptophlebia	9.5	27.3	21.3	27.3	37.5	5.0	1.5	1.7	13.3	14.0			0.7	2.0
Rhithrogenia	17.0	34.7	51.3	41.0	68.0	18.0	44.5	37.0	46.3	45.0	0.3	1.7		0.3
Heptagenia		1.3	0.7	1.7					0.3	2.0		1.0	0.3	5.3
Iron												0.3	1.3	0.3
Pteronarcidae							0.5	0.3					1.0	3.3
Perlidae		0.3	0.7	0.7			1.0	0.3	1.0				1.0	2.0
Perlodidae	10.5	50.0	38.0	32.3	44.0	25.0	48.5	63.0	98.7	51.7	1.0	1.0	4.0	10.0
Nemouridae								1.3	0.5					
Hydropsychidae		5.7	6.3	6.0	5.5		5.0	8.7	0.3	6.7			0.3	
Brachycentridae												0.3	0.3	0.3
Hydroptilidae	8.5	8.7	15.0	16.0	3.0	2.0	1.5	2.0	0.5	0.7			0.3	1.3
Lepidostomatidae	45.0	34.0	34.3	27.7	37.5	30.0	7.0	30.0	27.7	35.7				
Leptocercidae					0.5				1.0					
Psychomyiidae														
Glossosomatidae							0.5	0.3						
Elmidae	8.5	9.3	10.3	12.7	6.0		9.0	8.3	3.0	30.7	0.7	1.3	3.3	7.3
Dytiscidae										0.3				
other Coleoptera		0.3								0.3				
Gomphidae								0.3						
Corixidae											0.3			
Pyralidae														
TOTAL NUMBERS	245.1	299.0	438.3	420.3	501.0	203.0	478.0	524.8	505.0	223.4	12.6	18.8	123.2	166.3
AVG. VOL. (CC)	0.9	1.7	1.5	1.3	2.0	1.1	1.9	2.4	3.8	2.4	0.1	0.2	0.5	0.8

APPENDIX 1 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION A FROM JULY 16, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-5	8-12	8-19	8-26	9-3	9-10	9-16	9-23	10-2	10-7	10-13	10-23	10-28	11-5
NO. OF SAMPLES	3	3	3	3	3	3	3	3	3	3	2	2	2	2
Hydracarina	1.6	1.0	2.3	4.7	5.0	7.9	5.3	1.0	1.9	2.3	2.0	2.0	3.0	4.0
Tubificidae		0.3	1.7	0.3	0.3	0.7	0.7	0.3	1.3	0.7	1.5	1.0	6.0	0.5
other Oligochaeta					0.3								0.5	0.5
<u>Lymnaea</u>						0.3			2.3	0.3				1.5
Nematoda				0.3			0.7		0.7		0.5		1.0	0.5
Amphipoda														
Tendipedidae	39.7	29.0	54.0	57.3	104.0	72.7	98.0	27.0	28.3	40.3	73.5	194.5	279.0	165.5
Simulidae	3.0		0.7		2.3			0.3		3.3		2.0	1.5	5.5
Tipulidae	2.7	3.7	4.3	4.0	9.3	6.7	4.3	1.3	1.3	1.3	1.0	0.5	1.0	2.0
Heleidae				0.3	0.7	1.3	4.7				0.5		2.5	
Rhagionidae			0.7	0.3	2.7		0.3	0.3		1.3	0.5	1.0	2.5	0.5
Empididae														
Psychodidae														
<u>Baetis</u>	19.7	13.3	12.0	21.3	16.7	5.7	6.3	1.7	1.0	4.7	3.5	13.0	2.5	6.0
<u>Tricorythodes</u>	3.7	19.3	40.3	26.7	31.3	19.3	23.3	4.3	7.0	10.7	23.5	10.5	26.5	9.0
<u>Ephemerella</u>	33.7	33.0	18.7	15.0	48.0	30.7	45.3	12.3	27.3	143.3	86.0	120.0	134.5	68.5
<u>Paraleptophlebia</u>	4.0	9.7	14.3	9.7	15.0	16.7	16.0	1.0	3.0	20.0	18.0	28.5	18.0	19.0
<u>Rhithrogenia</u>			4.0	3.7	7.0	4.0	10.7	4.7	4.3	7.0	9.5	20.5	14.5	21.5
<u>Heptagenia</u>	2.7	4.0	2.0	1.7	0.3	2.7	0.3		0.3	0.3	1.5	2.0		
<u>Iron</u>	0.3													
Pteronarcidae	4.0	0.3	3.7	2.7	0.7	0.3	0.7	0.3					0.5	
Perlidae	1.0		2.3	4.3	4.0	3.7	2.7		0.3	5.7	3.0	2.5	2.0	1.0
Perlodidae	2.7	1.7	3.0	4.0	8.0	8.7	13.7	2.7	5.7	14.7	23.0	13.5	40.0	25.5
Nemouridae														
Hydropsychidae	0.3	0.3	10.3	4.3	5.7	4.7	2.7	0.3	3.0	26.0	6.5	11.5	13.5	3.5
Brachycentridae														
Hydroptilidae	0.7	0.7	4.3	0.7	3.3	2.7	8.3	6.0	6.7	12.0	7.5	21.0	16.5	2.5
Lepidostomatidae		3.3	22.3	45.0	96.7	99.0	102.7	43.7	69.3	41.7	41.0	49.0	59.9	74.0
Leptocercidae							0.7	1.0	1.3	13.3			2.0	0.5
Psychomyiidae			0.3											
Glossosomatidae				0.3						0.3		1.0		1.0
Elmidae	19.0	5.3	17.7	19.7	23.0	15.0	13.3	5.7	8.7	15.0	5.5	8.5	3.5	4.0
Dytiscidae														0.5
other Coleoptera	0.3									1.3		0.5	0.5	
Gomphidae				0.3		0.7	0.3							
Corixidae														
Pyralidae										0.3				
TOTAL NUMBER	139.5	124.9	214.9	230.1	384.3	303.4	361.1	113.9	164.8	365.8	308.0	503.0	630.0	416.0
AVG. VOL. (CC)	0.5	0.5	0.9	0.7	1.6	[illegible]	1.2	0.6	0.7	1.6	1.4	1.8	2.6	1.3

APPENDIX 1 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION A FROM JULY 16, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	43	44	45	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-11	12-11	1-28	2-21	3-25	4-21	8-3	8-10	8-17	8-24	8-31	9-8	9-14	9-21
NO. OF SAMPLES	2	2	2	2	3	2	2	2	2	2	2	2	2	2
Hydracarina	4.0	9.5	0.5			0.5	4.5	0.5		0.5	2.0	1.5	4.5	0.5
Tubificidae	3.0											1.0	17.0	
other Oligochaeta	2.5	0.5	0.5			0.5							0.5	
<u>Lymnaea</u>													0.5	
Nematoda	1.0													
Amphipoda							0.5							
Tendipedidae	258.0	553.0	54.5	35.5	8.7	94.5	108.5	92.5	11.5	90.5	57.0	134.0	190.5	84.5
Simulidae	1.0	12.0	0.5	0.5	13.7	21.5	5.5	10.0			0.5			
Tipulidae	2.5	2.0			0.4	4.0	2.0	0.5	3.0	0.5	0.5	8.0	1.0	1.0
Heleidae	9.0	0.5				0.5					0.5	1.0	1.0	
Rhagionidae	2.0	1.5			0.5		1.0			0.5			2.0	1.0
Empididae			0.5	0.5		1.0					1.5	1.0	3.5	1.5
Psychodidae														
<u>Baetis</u>	4.5	53.5	1.0	1.0	4.7	19.0	14.5	20.0	9.5	20.5	5.0	29.0	22.0	18.0
<u>Tricorythodes</u>	26.0	17.0	2.5	0.5	0.3	5.0	6.0	1.0	4.0	21.0	20.5	21.0	5.5	4.5
<u>Ephemerella</u>	113.0	157.5	39.0	4.5	3.0	71.5	16.0	15.5	5.5	13.0	10.5	17.5	43.5	22.0
<u>Paraleptobhlebia</u>	12.5	85.0	4.5		0.7	3.5	0.5		4.0	1.5	4.5	10.5	3.0	0.5
<u>Rhithrogenia</u>	10.5	81.5	3.5	3.0	23.3	34.5		13.5	2.0	9.5	15.5	40.0	34.0	62.5
<u>Heptagenia</u>		3.5				0.5		2.0	1.5	7.5	13.0	3.0		0.5
<u>Iron</u>										0.5				
Pteronarcidae		0.5	0.5	0.5		0.5	1.5	1.5		1.5	0.5		2.0	1.0
Perlidae	7.5	9.0	2.5	1.0	2.3	4.5	1.0	2.0		1.5		2.5	18.0	6.5
Perlodidae	26.5	72.0	5.0	3.5	11.3	38.0	1.5	0.5	1.5	2.5	3.5	11.0	16.5	31.5
Nemouridae					0.5									
Hydropsychidae	18.5	16.5	3.0	1.0		6.5			1.0	34.0	5.0	25.5	103.0	83.5
Brachycentridae							0.5							
Hydroptilidae	12.0	3.5					3.5	9.0	0.5	9.0	0.5	5.0	10.5	20.0
Lepidostomatidae	117.5	73.5	13.0	0.5	0.3	31.0			0.5	3.5	35.5	67.0	33.5	59.0
Leptocercidae	0.5						1.0					0.5		
Psychomyiidae														
Glossosomatidae	3.0	1.0					2.5	1.0	0.5	21.0	4.0	68.0	21.0	42.0
Elmidae	13.5	17.0	2.0	1.5	1.5	5.0	12.0	5.5	4.5	8.0	7.5	10.5	29.5	22.5
Dytiscidae									1.0					
other Coleoptera	1.0					1.0	0.5	1.0		0.5		4.0	1.0	
Gomphidae												0.5	0.5	
Corixidae														
Pyralidae	2.0			0.5		0.5								
TOTAL NUMBER	651.5	1180.0	133.0	54.0	65.5	343.5	184.5	176.0	50.5	247.0	187.5	426.0	563.5	462.5
AVG. VOL. (CC)	3.8	4.2	0.6	0.6	0.7	2.8	0.6	0.4	0.6	0.8	0.4	1.1	3.2	1.6

APPENDIX 2. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION B FROM JULY 21, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-21	7-26	7-30	8-6	8-13	8-20	8-29	9-3	9-11	9-18	9-27	10-2	10-8	10-15
NO. OF SAMPLES	3	3	3	3	3	3	3	2	3	2	2	3	3	3
Hydracarina	1.3	0.3	0.3			0.9	0.6	1.0	0.3	0.5	0.5	1.3	0.3	0.7
Tubificidae		2.3	0.7	1.3	2.3	0.7				2.5	1.0	7.0	35.0	38.3
other Oligochaeta					0.3									
Hirudinea														
<u>Lymnaea</u>	15.3	6.0	1.3	3.3			1.7	8.0		23.0	25.5	11.3	9.0	11.3
<u>Physa</u>														
Planorbidae	1.0													
Pelecypoda		0.3												
Nematoda	1.7		0.3		0.3									
Amphipoda														
Tendipedidae	3.0	13.3	8.7	0.3	4.3	16.0	16.7	18.0	0.3		0.5	1.0	1.7	2.7
Simulidae	0.3	27.0	0.3	1.7	3.3	22.0	8.0	5.0						
Tipulidae		3.3	1.3	1.3	1.7	3.3	4.0	2.5	0.3					
Heleidae	0.3					0.3	0.7		0.3	0.5				
Rhagionidae													0.3	
Empididae								1.0						
<u>Baetis</u>	2.7	3.3	2.7	0.7	5.0	13.7	38.0	26.0						
<u>Tricorythodes</u>					0.7	1.0	3.0	6.0	0.7	0.3				0.3
<u>Ephemerella</u>	3.0	1.0	1.7	0.3	2.0	1.3	2.7	2.0	1.0		0.7	5.3	4.3	6.7
<u>Choroterpes</u>														
<u>Paraleptophlebia</u>											0.3			0.3
<u>Brachycercus</u>														
<u>Rhithrogenia</u>				4.3	1.0	8.0	29.0	20.0			0.7			0.3
<u>Heptagenia</u>					2.7									
<u>Iron</u>														
Pteronarcidae								0.5						
Perlidae		1.0					1.3	0.5						
Perlodidae	0.3					0.7	3.7	1.5		0.5		0.3		
Nemouridae														
Hydropsychidae	0.7				5.7	16.3	35.7	40.5						
Brachycentridae					0.3			0.5						
Hydroptilidae				0.3	0.7	1.3		1.0						
Lepidostomatidae							0.3							
Leptocercidae														
Glossosomatidae														
Elmidae	0.7	0.3	0.3	0.7	0.7	3.7	5.3	5.5	1.7			1.0	0.3	
Dytiscidae		0.7	0.3	1.3	2.0		1.3	0.5	0.7	0.5		0.7		0.3
Gomphidae														
Corixidae	1.0	0.7		0.3	0.7				0.3					
TOTAL NUMBER	31.3	59.5	17.8	15.8	33.3	89.2	152.0	140.0	5.6	28.0	30.0	27.9	50.9	60.3
AVG. VOL. (CC)	1.2	0.6	0.3	0.4	0.3	0.4	1.1	1.4	0.2	1.6	1.8	0.7	0.7	0.9

APPENDIX 2 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION B FROM JULY 21, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-25	11-5	11-10	11-17	12-21	1-19	2-25	3-26	4-23	5-20	7-8	7-15	7-23	7-29
NO. OF SAMPLES	1	3	2	2	3	1	3	3	3	3	3	3	3	3
Hydracarina	1.0	0.7	5.0	0.5					0.6	5.4				0.3
Tubificidae	132.0	145.0	389.5	241.0	26.3	7.0			12.3	14.3		0.3	0.3	1.3
other Oligochaeta														
Hirudinea														
Lymnaea	1.0	8.3	7.0	22.5	7.3	1.0	9.0	0.7	25.7	6.0			0.3	1.3
Physa					0.7									
Planorbidae									0.7					
Pelecypoda														
Nematoda	1.0		0.5											
Amphipoda														
Tendipedidae	9.0	3.3	4.0	11.0	0.7	2.0	4.0	0.7	44.7	25.7	13.7	0.7	4.0	26.3
Simulidae									0.3	1.0	6.0	8.3	11.3	74.0
Tipulidae														
Heleidae	1.0		1.0							0.3				
Rhagionidae														
Empididae														
Baetis	1.0									18.0	3.0	3.7	1.0	5.3
Tricorythodes													0.3	1.3
Ephemerella	11.0	12.0	14.0	20.5	3.3	4.0	5.0	0.3	24.0	10.7	0.3	1.3	1.3	17.3
Choroterpes														
Paraleptophlebia										0.3				0.7
Brachycercus													0.3	
Rhithrogenia										0.7		0.7	1.0	2.0
Heptagenia											0.3	0.7	2.0	5.3
Iron													0.3	0.7
Pteronarcidae														
Perlidae														
Perlodidae		0.3												0.7
Nemouridae														
Hydropsychidae														
Brachycentridae														
Hydroptilidae													1.0	6.3
Lepidostomatidae														
Leptocercidae														
Glossosomatidae														
Elmidae		0.3	0.5	1.0	0.3				0.3	0.7				
Dytiscidae										0.3		0.3	0.3	
Gomphidae				0.5										
Corixidae				0.5					0.3					
TOTAL NUMBER	157.0	169.9	421.0	286.5	38.6	14.0	18.0	1.7	108.9	83.4	23.3	15.9	23.8	143.2
AVG. VOL. (CC)	0.2	0.8	0.9	2.4	0.7	0.1	0.9	<0.1	3.7	1.2	<0.1	0.1	0.1	0.4

APPENDIX 2 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION B FROM JULY 21, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-5	8-12	8-19	8-26	9-3	9-10	9-18	9-23	10-2	10-9	10-13	10-23	10-28	11-7
NO. OF SAMPLES	3	3	3	3	3	3	3	3	3	3	3	3	2	2
Hydracarina			0.3		1.7	1.9	7.4	2.0	4.6	2.7	0.3	0.3	1.0	0.5
Tubificidae	0.3	0.7	0.3	0.3	1.0	1.0	1.0	0.7	0.7		6.3	0.3	1.0	
other Oligochaeta		0.3		0.7	0.6	1.3		2.0		0.3	1.0		2.0	
Hirudinea											0.3			
<u>Lymnaea</u>		1.0	1.0	0.3	0.3	1.7	3.3	1.0	0.7	1.0	2.7	1.3	3.5	4.5
<u>Physa</u>		0.3			0.3	0.7	1.3	1.0	0.3	0.7	0.7	0.7	0.5	1.0
Planorbidae				0.3	0.3	0.7	0.3	1.3	3.0	2.0	1.0	1.0	0.5	1.0
Pelecypoda														
Nematoda					0.3	0.3		0.3			0.3	0.5	0.5	0.5
Amphipoda							0.3		0.3		0.7	1.0	0.5	0.5
Tendipedidae	6.0	13.3	9.0	7.7	20.0	20.0	84.0	47.7	96.7	123.3	326.3	109.0	172.0	295.5
Simulidae	73.0	251.7	156.0	57.3	26.0	17.7			3.7		0.7		0.5	
Tipulidae		0.3			0.3	0.3	0.3	10.0	4.0	4.3		0.3	3.5	3.0
Heleidae							0.7	0.3		1.0				1.5
Rhagionidae						0.7			0.3	0.3	0.3			
Empididae														
<u>Baetis</u>	3.0	8.7	9.3	15.3	17.7	8.3	5.7	0.7		3.3	26.0	13.5	23.5	11.0
<u>Tricorythodes</u>	4.3	2.7	1.0	1.0	4.3	2.3	0.3	1.0	2.7	2.3	4.5	2.5	2.5	6.5
<u>Ephemerella</u>	2.7	7.7	4.0	5.3	5.0	4.7	4.7	2.7	3.3	14.7	38.5	17.5	26.0	28.5
<u>Choroterpes</u>	0.7				0.3									
<u>Paraleptophlebia</u>				0.3	0.3	0.3	2.7	0.7	1.3	6.3	8.0	6.0	4.0	3.5
<u>Brachycercus</u>														
<u>Rhithrogenia</u>	4.7	7.0	14.0	20.3	24.7	43.7	31.7	8.7	9.0	10.0	10.0	40.0	48.5	49.5
<u>Heptagenia</u>	5.3	5.3	0.7	1.0			0.3			0.3				0.5
<u>Iron</u>		0.3												
Pteronarcidae		0.7		0.3		2.0	0.3				0.7	0.3	2.5	0.5
Perlidae		2.3	2.0	3.7	1.7	4.3	5.0	1.7	3.3	2.7	10.7	2.0	8.0	5.0
Perlodidae	0.7	1.0	1.3	0.3	3.3	3.7	7.0	3.0	2.3	11.7	8.3	8.7	18.5	13.5
Nemouridae														
Hydropsychidae		0.3	1.0			1.0	0.3		0.3	0.3	0.7			
Brachycentridae														
Hydroptilidae		0.7	0.7		0.3		0.3		1.0	1.0	0.3	0.3	3.0	
Lepidostomatidae			0.3	1.0	14.3	11.7	11.3	8.0	10.3	7.0	4.3	8.0	15.5	24.5
Leptocercidae						0.3	6.0	3.3	3.3	1.3	1.0	1.0	1.5	1.5
Glossosomatidae														
Elmidae		0.3	1.0	1.3	1.0	1.0	0.3		0.3	0.3	1.0			
Dytiscidae	0.7		0.7											
Gomphidae														
Corixidae								0.3						
TOTAL NUMBER	101.4	304.6	202.6	116.9	143.8	139.7	174.4	96.3	151.4	196.9	432.3	187.7	339.0	452.5
AVG. VOL. (CC)	0.4	0.9	0.7	0.5	0.7	0.7	0.9	0.9	1.1	0.7	1.5	0.9	3.7	3.3

APPENDIX 2 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION B FROM JULY 21, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	43	44	45	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-12	12-12	1-28	2-22	3-26	4-22	8-8	8-11	8-19	8-24	8-31	9-7	9-14	9-21
NO. OF SAMPLES	2	2	2	1	2	2	2	2	2	2	2	2	2	2
Hydracarina	0.5			1.0	7.5	0.5		0.5				0.5	0.5	3.0
Tubificidae		2.0	4.5	28.0		19.0		6.0		2.0		6.5	2.0	
other Oligochaeta	1.0	0.7	0.5											
Hirudinea	0.5													
Lymnaea	0.5	0.3	1.5		1.5	5.5	1.0	1.0	4.5	9.5	6.5	1.0	5.5	9.0
Physa	1.5				0.5									
Planorbidae	1.5	0.3	0.5											
Pelecypoda														
Nematoda	0.5	0.5	1.0						0.5					
Amphipoda	0.5													
Tendipedidae	111.5	248.0	33.0	1051.0	391.0	190.0	6.5	101.5	386.0	26.5	146.5	210.5	46.5	259.5
Simulidae			5.5	14.0	16.5	1.0	0.5	0.5	2.0		12.5		0.5	3.0
Tipulidae	3.5		4.0	2.0	2.0	1.0		0.5		1.0		1.0	1.0	3.0
Heleidae	1.0	1.7		3.0	4.0	0.5								
Rhagionidae			5.0	1.0					1.0		0.5	0.5		0.5
Empididae												0.5		0.5
Baetis	6.0	10.7	12.5	120.0	340.5	66.0	3.0	5.0	14.0	7.5	13.0	12.5	8.5	18.0
Tricorythodes	2.0	3.7		2.0	65.0	1.5	0.5	8.5	17.5	6.0	5.0	5.0	2.5	2.5
Ephemerella	18.0	26.7	46.0	108.0	92.5	25.5	3.0	12.5	8.0	2.5	4.0	13.5	6.0	55.0
Choroterpes								1.5	2.0					
Paraleptophlebia	2.0	0.3	0.5	2.0	0.3	0.5					0.5	1.5	0.5	1.5
Brachycercus														
Rhithrogenia	45.0	0.7	13.0	2.0	20.0	41.0		5.0	28.5	17.0	17.5	33.0	41.0	70.0
Heptagenia						1.5	8.0	7.5	1.5				1.0	2.5
Iron					0.5									
Pteronarcidae	0.5		3.5	2.0	5.0				1.0			0.5		
Perlidae	7.0	0.3	6.0	2.0	11.0	4.0		2.0	4.5	1.0	2.0	9.0	4.5	8.0
Perlodidae	18.0	3.7	6.0	6.0	14.0	115.0		0.5	1.5		0.5	1.0	1.5	10.0
Nemouridae					1.0									
Hydropsychidae		0.3			0.5			3.0	17.5	3.5	24.0	25.0	9.0	43.0
Brachycentridae											5.0	1.5	0.5	3.5
Hydroptilidae	0.5	0.3					0.5	0.5	1.0		0.5			3.0
Lepidostomatidae	17.5	1.3	6.0	7.0	10.0	8.0		0.5	0.5	0.5	0.5	17.0	24.5	19.0
Leptocercidae	0.5		1.0	1.0	1.5	3.5								
Glossosomatidae							0.5			0.5	0.5			0.5
Elmidae		0.3		1.0	0.5		0.5		2.0	2.0	0.5	3.5	2.0	2.5
Dytiscidae									0.5					0.5
Gomphidae													0.5	
Corixidae														
TOTAL NUMBER	239.5	301.7	150.0	1353.0	989.5	493.0	24.0	156.5	494.0	79.5	239.5	343.5	158.0	518.0
AVG. VOL. (CC)	4.4	0.1	6.7	5.0	6.3	3.0	0.1	0.5	1.2	1.4	1.5	1.1	1.5	1.9

APPENDIX 3. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION C FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-17	7-29	7-31	8-7	8-15	8-21	8-30	9-3	9-12	9-24	9-28	10-3	10-9	10-16
NO. OF SAMPLES	3	3	3	3	3	3	3	2	3	1	3	3	3	3
Hydracarina	1.0	1.4	0.6	0.3					0.3		1.3	1.0	0.3	1.6
Tubificidae		0.3		0.3			0.3		0.7	1.0	0.3			
other Oligochaeta		0.3	0.3		0.3	0.3			0.3					
Hirudinea	2.0													
<u>Lymnaea</u>	1.0	4.7	4.0	0.3	2.3	1.7	1.3		1.7	2.0	1.0	1.7	0.7	2.0
<u>Physa</u>														
Nematoda	0.3								0.3					0.3
Tendipedidae	1.3	3.7	8.3	4.0	9.0	3.0	10.3	7.5	9.0	12.0	10.7	10.0	88.7	27.0
Simulidae	1.0	0.3	21.3	2.3	38.7	0.7	0.7	0.5	0.7	1.0	0.3	0.7		0.7
Tipulidae			0.3	0.7	0.7	0.3	1.0		1.3	5.0	1.7	0.7	1.0	0.7
Heleidae	0.3				0.3								0.3	
Rhagionidae												0.3		0.3
Empididae		0.3	0.3											
<u>Baetis</u>		13.0	33.0	16.7	59.3	13.3	22.7	11.0	14.0	6.0	1.7	8.3	6.3	6.7
<u>Tricorythodes</u>	1.3		1.3	1.7	8.3	8.3	5.7	8.0	4.0	4.0	2.3	2.0	3.3	2.0
<u>Ephemerella</u>	2.0	1.0	0.3	0.7	2.3	1.7	1.7		0.7	2.0	5.7	9.7	20.7	22.0
<u>Paraleptophlebia</u>		0.3							0.7			1.3	1.3	1.3
<u>Rhithrogenia</u>						0.3	2.7	2.5	13.7	27.0	12.0	18.3	19.3	50.7
<u>Heptagenia</u>									1.3					
Pteronarcidae														
Perlidae		0.3					0.3		0.3	1.0	0.3	1.0	0.3	0.3
Perlodidae			0.3		0.3				2.0	3.0	1.0	1.3	2.3	2.0
Hydropsychidae					4.7	5.7	7.3	7.5	10.0	20.0	7.0	30.0	9.3	16.3
Brachycentridae		0.3	0.3		0.3		1.3		1.7	1.0	0.3	0.7	0.7	
Hydroptilidae					0.3						0.3			0.3
Lepidostomatidae						0.3			1.0	4.0	1.3	4.7	6.0	9.7
Leptocercidae											0.3		0.3	
Glossosomatidae														
Helicopsychidae									0.7	1.0	0.3	0.3	0.3	
Elmidae					1.0		1.3	0.5	1.7	2.0	2.0	1.3	2.7	2.7
Dytiscidae		0.3		1.0	2.3	0.3			0.7					
other Coleoptera	0.3									1.0		1.0		
Gomphidae							0.3							
Corixidae	0.3		0.3											
Mesoveliidae													0.3	
TOTAL NUMBER	10.8	26.2	70.7	27.9	130.2	35.9	56.8	37.5	63.4	93.0	50.5	94.0	164.5	146.6
AVG. VOL. (CC)	0.3	0.9	0.8	0.2	0.7	0.3	0.8	0.2	1.4	0.9	0.5	0.7	0.4	0.7

APPENDIX 3 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION C FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-26	11-2	11-9	11-20	12-17	1	2	3	4-24	5-21	7-9	7-16	7-24	7-30
NO. OF SAMPLES	3	3	3	3	2	0	0	0	3	3	3	3	3	3
Hydracarina	1.7	1.0	1.6	2.4	1.0	NO SAMPLES TAKEN	NO SAMPLES TAKEN	NO SAMPLES TAKEN	0.7					
Tubificidae														
other Oligochaeta	0.6		0.3											
Hirudinea														
Lymnaea	0.3	3.0	4.7						3.7	0.3	0.3		0.7	0.7
Physa														
Nematoda	0.7													
Tendipedidae	9.3	9.7	6.7	41.7	10.0				12.7	0.7	0.7	2.7	2.7	3.7
Simulidae	0.7	0.7	0.3	1.0	0.5				1.3	0.3	0.3	1.0	0.3	0.3
Tipulidae	1.7	1.0	1.7	1.0					2.3			0.3		0.7
Heleidae	1.0													
Rhagionidae	1.0	0.5												
Empididae				2.0					0.3					
Baetis	13.0	24.0	26.0	25.0	37.5				57.0	23.3	2.7	4.7	6.7	3.7
Tricorythodes		3.3	5.0	12.3					1.7					0.7
Ephemerella	10.0	24.7	29.0	52.3	13.5				30.3	2.0	0.7	2.0	3.3	5.3
Paraleptophlebia	1.0	2.0	9.3	1.3	4.0				3.0	0.3				
Rhithrogenia	46.0	68.0	48.7	26.7	57.5				40.7	8.0	0.7	0.7		
Heptagenia			1.3		0.5								1.7	
Pteronarcidae	1.0													
Perlidae			1.7									0.3		
Perlodidae	5.0	8.7	10.0	8.7	6.5				9.7	1.3		0.3		
Hydropsychidae	13.3	8.0	8.7	8.0	5.0				2.3			1.7	1.3	0.7
Brachycentridae			0.3	0.3							1.3	1.0	8.3	13.3
Hydroptilidae			0.7								0.3	0.3		
Lepidostomatidae	5.3	6.7	14.7	9.3	5.0				8.7	0.3				
Leptocercidae	1.0		0.7											
Glossosomatidae									0.3					0.3
Helicopsychidae	0.7	1.3	0.3	0.3	1.0									
Elmidae	0.7	0.5	1.0	4.7					1.7	1.0		0.3		
Dytiscidae			0.3											
other Coleoptera														
Gomphidae		0.5												
Corixidae														
Mesoveliidae														
TOTAL NUMBER	123.0	188.5	183.1	196.7	142.0				176.4	37.6	6.9	15.3	25.0	29.4
AVG. VOL. (CC)	2.0	1.0	1.3	0.3	0.2				1.1	0.3	0.8	0.2	0.3	0.4

APPENDIX 3 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION C FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-6	8-13	8-20	8-27	9-4	9-11	9-17	9-24	10-3	10-8	10-14	10-24	10-29	11-6
NO. OF SAMPLES	3	3	3	3	3	2	3	3	3	3	2	2	2	2
Hydracarina				1.7	0.7		0.3		0.3					
Tubificidae	0.3	0.3		0.3	0.7	0.5				0.3	2.0	36.5		3.0
other Oligochaeta												0.5		
Hirudinea														
Lymnaea		1.7		0.7	2.7	2.5	1.0	0.3	5.0	2.0	3.5	2.0	0.5	2.0
Physa				0.3	5.3		1.3	0.3	0.3	0.3				
Nematoda							0.7						0.3	
Tendipedidae	12.0	20.3	7.7	39.0	36.3	18.5	11.0	0.3	9.0	21.0	41.5	118.5	22.0	25.0
Simulidae	3.7		0.3	0.3	0.3						0.5			1.0
Tipulidae	0.7			0.7	0.7		0.7		1.0	1.7			0.5	3.5
Heleidae														
Rhagionidae		2.7	0.3	1.3	2.0	5.5	0.7	0.3	1.0	4.7	5.5	9.0	2.0	10.5
Empididae														
Baetis	7.0	4.0	1.3	6.7	5.0		0.7		1.3	2.7	2.0	10.0	3.0	5.5
Tricorythodes	1.0	3.3	0.7	1.0	0.7	0.5		0.3	0.3	3.3	3.5	5.0	0.5	4.5
Ephemerella	1.7	1.7	0.3	0.3	1.0	0.5	0.7		3.3	6.3	19.5	52.5	18.0	24.0
Paraleptophlebia		0.3	0.3						0.7	0.7	1.0	3.0	2.0	1.0
Rhithrogenia			1.3	2.0	0.7	1.5	0.7	1.3	12.0	8.3	14.0	12.0	12.5	8.5
Heptagenia	0.7	1.3	0.7		1.0	0.5			0.3				0.5	
Pteronarcidae	0.3			0.3	0.3			0.3				1.0		
Perlidae	0.3						0.3	0.3			1.5			0.5
Perlodidae	0.3	0.7	0.3		0.3	0.5	0.3			0.7	0.5	6.0	4.5	4.5
Hydropsychidae	10.7	4.7	6.3	7.3	13.3	5.5	3.0	0.3	12.0	18.3	49.0	27.5	15.0	29.0
Brachycentridae	40.3	39.0	9.7	31.3	7.7	13.0	6.0	0.3	7.0	8.7	12.0	9.0	3.5	5.0
Hydroptilidae	4.0	0.7	0.3	2.3	2.0					1.3	2.5			
Lepidostomatidae		2.0	8.0	11.0	33.7	14.5	24.3	4.0	20.0	14.0	14.0	9.5	6.5	15.0
Leptocercidae									0.7	0.3	0.3			
Glossosomatidae				1.0	0.3	1.0			3.0	1.7	7.0	4.0	3.0	2.0
Helicopsychidae			0.3	1.0		2.5				0.3				1.0
Elmidae			0.3	1.3	1.0		0.3		0.3	1.0	0.5	2.5	1.0	3.5
Dytiscidae		0.7					0.3							
other Coleoptera						0.5				0.3		0.5		1.0
Gomphidae														0.5
Corixidae														
Mesoveliidae														
TOTAL NUMBER	85.7	81.0	39.2	110.8	115.7	67.5	52.2	8.0	77.6	97.9	180.3	309.0	95.3	150.5
AVG. VOL. (CC)	2.1	1.6	0.5	1.3	0.6	1.4	0.8	0.1	1.3	1.2	1.8	1.4	1.0	1.2

APPENDIX 3 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION C FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	43	44	45	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-13	12	1	2	3	4-23	8-5	8-12	8-18	8-25	9-1	9-9	9-16	9-22
NO. OF SAMPLES	2	0	0	0	0	3	2	2	2	2	2	2	2	2
Hydracarina														
Tubificidae									0.5		2.5			0.5
other Oligochaeta														
Hirudinea														
Lymnaea	2.0							0.5		0.5			0.5	0.5
Physa														
Nematoda											0.3			
Tendipedidae	28.0					3.3	23.5	18.0	86.5	276.5	162.0	33.5	52.5	45.5
Simulidae						1.0	1.5	3.0	2.5	2.0	7.0		1.0	
Tipulidae	1.0							0.5	1.0	2.0	1.0	2.5		1.5
Heleidae														
Rhagionidae	6.5							0.5	1.5	1.0	1.0	1.5	0.5	
Empididae						0.3		0.5	1.0	1.0			0.5	
Baetis	2.0					2.0	4.5	13.5	30.0	32.5	23.5	9.5	7.5	6.5
Tricorythodes	3.0					2.7	1.0	1.0	3.0	11.0	1.0	0.5	5.5	1.5
Ephemerella	23.0					5.3	0.5	0.5		0.5	2.0	1.5	12.0	4.5
Paraleptophlebia	0.5					0.3				1.0			1.0	1.0
Rhithrogenia	19.0					.	0.5	4.0	10.5	13.5	37.0	19.0	28.5	38.0
Heptagenia								1.0	1.0			0.5	2.5	
Pteronarcidae		NO SAMPLES TAKEN	NO SAMPLES TAKEN	NO SAMPLES TAKEN	NO SAMPLES TAKEN		0.5		1.0	1.0	2.5	1.0		
Perlidae	0.5							0.5			0.5		1.0	2.5
Perlodidae	2.5					1.7				1.0	1.0	1.0	2.0	2.5
Hydropsychidae	11.0					0.3	0.5	6.5	20.0	27.5	106.5	23.0	21.5	26.5
Brachycentridae	3.0					0.3	5.0	2.5	11.5	30.0	35.5	10.0	16.0	26.5
Hydroptilidae							0.5	1.5	14.0	2.5	11.5	5.5	1.5	
Lepidostomatidae	7.0					7.0				4.0	4.0	0.5	18.0	30.5
Leptocercidae														
Glossosomatidae	0.5							3.0	4.5	35.0	28.0	6.5	21.5	19.5
Helicopsychidae														
Elmidae	1.5					0.3			2.0	3.5	1.5	1.0	2.5	1.0
Dytiscidae						0.3						0.5	0.5	
other Coleoptera	0.5										0.5	1.0		0.5
Gomphidae	0.5					0.3								
Corixidae														
Mesoveliidae														
TOTAL NUMBER	112.0					25.1	38.0	58.0	192.0	448.5	428.8	119.5	199.0	209.5
AVG. VOL. (CC)	0.8					0.3	0.2	0.4	1.2	2.5	4.0	1.1	1.8	3.7

APPENDIX 4. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION D FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-17	7-29	7-31	8-7	8-15	8-21	8-30	9-3	9-12	9-24	9-28	10-3	10-9	10-16
NO. OF SAMPLES	3	3	3	3	3	3	3	2	3	1	3	3	3	3
Hydracarina	0.7	4.0	2.7	0.3	2.7	0.3	30.9	5.0		3.0		2.0	1.6	2.3
Tubificidae	0.7	0.3		3.0		0.7	3.3	2.5						
other Oligochaeta	0.3	2.7	10.3	1.0	1.0	0.3	0.3	0.5			0.3		0.3	2.0
Hirudinea		0.3												
Lymnaea	0.3	0.3		0.3			3.7	4.5						
Physa														
Planorbidae							0.3	0.5						
Nematoda		0.7				0.7								
Tendipedidae	4.3	17.7	23.0	39.0	76.7	27.7	353.0	83.0			3.0	44.3	43.0	113.0
Simulidae		0.7	1.3	1.3	0.7		2.0	0.5						
Tipulidae			0.3			0.3								
Heleidae	0.3													
Rhagionidae				0.3	0.3	0.3	7.0	5.5	0.3	4.0	0.7	1.7	1.3	2.7
Empididae						0.3								
Baetis		11.3	7.0	38.3	23.0	7.3	20.0	14.0				3.0	8.3	23.0
Tricorythodes	5.3	83.0	90.3	75.7	110.3	76.3	188.0	93.0		1.0		1.7		3.5
Ephemerella	3.7	8.7	7.7	7.7	4.3	5.3	7.0	2.5			0.3	4.3	1.0	3.5
Paraleptophlebia		0.3	0.3	0.3	1.7	1.6	2.3				0.3	0.7		1.5
Brachycercus					0.3		0.3							
Rhithrogenia						0.8		0.5				0.3		
Heptagenia						0.8	1.7	2.5						
Pteronarcidae							1.3	4.0			0.3			0.7
Perlidae							0.7	1.0						
Perlodidae	0.3					0.3	6.0	3.0	0.3			2.0	1.0	1.0
Nemouridae														
Hydropsychidae				0.3	1.3	0.3	10.0	39.5						0.3
Brachycentridae		6.0	5.0		4.0	1.0	5.7	8.5						
Hydroptilidae		1.0	1.0	4.0	3.0	0.3	2.3	0.5						
Lepidostomatidae	0.3						1.7	3.0						
Leptocercidae							1.3	1.5						
Psychomyiidae													0.3	
Glossosomatidae			0.3											
Helicopsychidae							0.3	0.5						
Elmidae	0.3	0.7	0.7	0.7		0.3	6.0	4.5			0.7		0.3	0.3
Dytiscidae		0.3			0.7	1.7	0.7			5.0	0.3	0.3		
other Coleoptera				0.3										
Gomphidae							2.7	1.5	1.7		0.3		0.7	
Corixidae	0.3		0.7	1.0	1.3	0.7		0.7		1.0		0.3		
Pyralidae		0.3												
TOTAL NUMBER	16.8	138.3	151.3	173.5	220.4	127.6	658.6	282.7	2.3	14.0	6.3	60.6	57.8	143.3
AVG. VOL. (CC)	0.4	1.2	1.1	0.7	0.9	0.5	3.0	2.6	1.2	0.5	1.2	0.3	0.5	0.7

APPENDIX 4 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION D FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	15	16	17	18	19*	23	24	25	26	27	28	29	30
YEAR	1962					1963							
MONTH & DAY	10-26	11-2	11-9	11-16	12-17	4-24	5-21	7-9	7-16	7-24	7-30	8-6	8-13
NO. OF SAMPLES	2	2	2	2	2	3	3	3	3	3	3	3	3
Hydracarina			2.5	1.5	0.5				1.0	2.7	1.0	16.6	30.0
Tubificidae				1.0				0.3			0.3	2.7	0.7
other Oligochaeta								0.3		0.3	1.6	0.3	
Hirudinea													
Lymnaea				0.5		0.3			0.3	2.7	3.7	12.7	9.0
Physa											0.3		
Planorbidae												1.0	
Nematoda			0.5									1.0	0.3
Tendipedidae	177.5	137.5	225.5	121.0	43.5	60.3	1.3	1.3	22.7	126.5	54.7	362.0	827.0
Simulidae	2.0	0.5	1.5	2.0	3.5	5.0			0.3		0.7	1.0	0.7
Tipulidae			0.5	0.5						0.3		0.7	
Heleidae													
Rhagionidae	2.5	0.5	2.0	3.5						0.7	1.0	10.0	15.0
Empididae													0.3
Baetis	43.5	52.0	181.5	46.0	136.0	43.3	22.3	13.3	11.3	24.3	12.0	16.0	11.7
Tricorythodes			0.5	0.5	0.5	1.0	0.3	0.7	7.3	17.7	22.0	52.3	78.3
Ephemerella	6.5	4.0	13.5	10.0	18.5	5.7	2.7	2.7	15.7	26.7	15.7	37.3	27.0
Paraleptophlebia	1.0	4.0	5.5		6.5	1.3	2.3	0.7		4.3	4.3	5.3	8.3
Brachycercus													
Rhithrogenia		0.5			1.0	2.7	2.3	2.0	0.3				
Heptagenia							0.3		1.7	2.3	3.3	3.3	2.3
Pteronarcidae				0.5						11.3	7.7	41.3	52.7
Perlidae									2.0			0.7	6.0
Perlodidae	3.0	1.0	3.5	3.0	6.5	6.0	8.0	0.3	1.0	1.7	0.3	6.7	4.0
Nemouridae						0.7							
Hydropsychidae									1.0	3.7	5.3	14.7	7.3
Brachycentridae				0.5				6.0	37.7	75.7	56.0	90.7	58.7
Hydroptilidae										0.7	0.3	11.3	2.0
Lepidostomatidae									0.3			2.7	15.0
Leptoceridae										0.3		0.3	0.7
Psychomyiidae													
Glossosomatidae													
Helicopsychidae													
Elmidae	0.5	0.5		1.0	1.0	0.3				1.0	0.3	1.7	0.3
Dytiscidae			0.5		1.0	1.0					0.3	0.7	3.0
other Coleoptera	0.5				1.0	0.3	0.3			0.3			0.3
Gomphidae												0.7	0.7
Corixidae													
Pyralidae													
TOTAL NUMBER	237.0	200.5	446.5	191.5	219.5	127.9	40.0	27.5	102.6	303.2	190.5	690.4	1,161.3
AVG. VOL. (CC)	0.5	0.4	0.8	0.8	0.4	0.4	0.4	0.2	0.6	1.7	1.3	3.2	3.5

* No samples taken in January, February, March, 1963 (Series Number 20, 21, and 22).

APPENDIX 4 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION D FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	31	32	33	34	35	36	37	38	39	40
YEAR	1963									
MONTH & DAY	8-20	8-27	9-4	9-11	9-17	9-24	10-3	10-14	10-24	10-29
NO. OF SAMPLES	3	2	2	1	3	3	2	1	1	2
Hydracarina	26.3	71.0	28.5	78.0	12.6		4.0	16.0	4.0	4.3
Tubificidae	1.0	12.0	5.0	28.0	5.0	1.3	2.0		8.0	3.0
other Oligochaeta	0.3	2.5	3.5	3.0	0.3	1.0	0.5	5.0	1.0	1.0
Hirudinea	0.3	0.5								
Lymnaea	9.7	18.0	20.0	28.0	4.3	5.7	20.0	2.0	22.0	12.0
Physa	1.0	0.5	0.5	1.0	1.7	0.3				0.5
Planorbidae		1.0		1.0			2.0	5.0		0.5
Nematoda	1.3	1.0	5.0	0.3			2.0			
Tendipedidae	929.7	1,731.5	755.5	1,691.0	771.3	20.0	271.0	1,595.0	999.0	605.5
Simulidae	0.3	1.5					0.5			
Tipulidae						0.3				0.5
Heleidae									1.0	
Rhagionidae	22.3	38.0	25.0	47.0	13.7	1.0	10.5	33.0	18.0	9.5
Empididae										
Baetis	20.7	17.5	7.0	3.0	1.0	0.3	1.0	5.0	11.0	9.0
Tricorythodes	52.7	77.5	74.5	79.0	48.7	17.0	51.5	156.0	67.0	120.5
Ephemerella	15.0	30.0	20.0	23.0	24.3	2.0	3.5	94.0	59.0	155.5
Paraleptophlebia	7.0	9.5	8.5	4.0	9.0	1.7	4.0	17.0	10.0	11.5
Brachycercus										
Rhithrogenia	3.0	4.0	5.0	1.0	5.3	1.3	2.5	1.0	25.0	4.5
Heptagenia	4.0	2.5	4.0	4.0	2.3	1.3	3.0	1.0	18.0	10.5
Pteronarcidae	32.0	47.0	17.5	51.0	9.3	1.7	3.5	26.0	10.0	12.0
Perlidae	3.0	14.5	6.5	27.0	2.0	0.3	0.5	10.0	6.0	5.3
Perlodidae	8.7	10.5	14.0	7.0	8.3	4.7	3.5	36.0	15.0	39.5
Nemouridae										
Hydropsychidae	49.0	123.0	10.5	9.0	5.0		7.5	22.0	47.0	82.5
Brachycentridae	92.0	106.0	51.0	60.0	7.7	0.7	10.5	34.0	33.0	51.5
Hydroptilidae	5.0	4.5	2.5	1.0				1.0		1.0
Lepidostomatidae	50.7	97.0	97.5	140.0	70.7	46.3	49.0	79.0	71.0	87.0
Leptocercidae			6.0	4.0	1.0		0.5	4.0	2.0	5.0
Psychomyiidae										
Glossosomatidae										1.5
Helicopsychidae	2.7	1.0	7.0	1.0	1.3		20.0	5.0	6.0	1.5
Elmidae	2.7	2.5	2.5	2.0	1.7	0.7	0.5	2.0		1.0
Dytiscidae	1.0									
other Coleoptera	0.3	0.5		1.0				1.0		0.5
Gomphidae	1.3	1.0						1.0	1.0	0.5
Corixidae										
Pyralidae										
TOTAL NUMBER	1,161.3	1,342.9	2,426.0	1,172.0	2,299.0	1,006.9	107.7	471.5	2,158.0	1,434.0
AVG. VOL. (CC)	3.5	6.4	6.5	4.2	6.5	1.6	0.6	2.7	7.5	6.0

APPENDIX 4 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION D FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	41	42	43*	45	48	49	50	51	52	53
YEAR	1963			1964						
MONTH & DAY	10-29	11-6	11-13	1-31	4-23	8-5	8-12	8-18	8-25	9-1
NO. OF SAMPLES	2	1	2	1	2	1	1	1	1	1
Hydracarina	1.0	7.0	6.0	1.0		1.0	26.0	18.0	19.0	35.0
Tubificidae	6.0	4.0	1.5				715.0	419.0	595.0	3,450.0
other Oligochaeta	2.5	2.0	1.0				4.0			
Hirudinea										
Lymnaea	9.5	31.0	9.5				7.0	6.0	32.0	6.0
Physa			1.5						1.0	2.0
Planorbidae										
Nematoda							6.0	6.0		10.0
Tendipedidae	508.0	365.0	754.0	12.0	34.0	159.0	2,406.0	1,819.0	2,823.0	3,086.0
Simulidae					2.0	4.0	7.0			1.0
Tipulidae	1.0	1.0	1.0				1.0			2.0
Heleidae										
Rhagionidae	12.0	32.0	22.0	12.0		15.0	635.0	298.0	789.0	229.0
Empididae							2.0		6.0	1.0
Baetis	14.5	12.0	10.0	16.0	8.0	10.0	44.0	30.0	31.0	45.0
Tricorythodes	103.5	147.0	89.0	52.0	1.0	79.0	306.0	117.0	150.0	98.0
Ephemerella	129.5	79.0	160.5	48.0	13.0	7.0	47.0	26.0	32.0	101.0
Paraleptophlebia	14.5	20.0	25.5	4.0	3.0		28.0	3.0	1.0	5.0
Brachycercus										
Rhithrogenia	10.5	15.0	3.5	1.0				3.0	14.0	17.0
Heptagenia	5.0	16.0	10.0	4.0			6.0	1.0	5.0	4.0
Pteronarcidae	10.0	12.0	16.5				37.0	14.0	6.0	23.0
Perlidae	3.0	4.0	2.5	2.0			11.0		3.0	24.0
Perlodidae	27.5	29.0	117.0	1.0	1.0		13.0	5.0	5.0	7.0
Nemouridae										
Hydropsychidae	71.5	12.0	67.0	2.0	1.0	6.0	22.0	96.0	119.0	246.0
Brachycentridae	25.5	16.0	18.5	2.0		82.0	258.0	215.0	158.0	273.0
Hydroptilidae	0.5	1.0	1.0				22.0	24.0	15.0	22.0
Lepidostomatidae	52.5	90.0	64.5	3.0	0.5		5.0	1.0	7.0	20.0
Leptocercidae	1.0	6.0	1.0					2.0	1.0	4.0
Psychomyiidae										
Glossosomatidae		1.0	1.0		0.5		2.0	8.0	27.0	15.0
Helicopsychidae	4.0	4.0	4.5	1.0						
Elmidae			2.5		0.5	4.0	17.0	18.0	54.0	78.0
Dytiscidae			1.5						1.0	
other Coleoptera	1.0	1.0	1.0		0.5					1.0
Gomphidae	1.0	1.0	0.5			1.0	2.0			1.0
Corixidae										
Pyralidae										
TOTAL NUMBER	1,015.0	908.0	1,394.0	161.0	65.0	368.0	4,629.0	3,129.0	4,894.0	7,807.0
AVG. VOL. (CC)	4.5	5.5	5.2	0.7	0.2	2.0	13.9	13.9	12.0	23.8

* No samples taken in December, 1963 or in February and March, 1964 (Series Number 44, 46, and 47).

APPENDIX 4 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION D FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	54	55	56
YEAR	1964		
MONTH & DAY	9-9	9-16	9-22
NO. OF SAMPLES	1	1	1
Hydracarina	80.0	18.0	25.0
Tubificidae	8,132.0	332.0	202.0
other Oligochaeta			
Hirudinea			
<u>Lymnaea</u>	5.0	3.0	8.0
<u>Physa</u>	1.0		1.0
Planorbidae			
Nematoda	17.0	1.0	11.0
Tendipedidae	3,161.0	945.0	1,771.0
Simulidae			
Tipulidae	1.0	1.0	
Heleidae			1.0
Rhagionidae	247.0	97.0	70.0
Empididae	6.0		3.0
<u>Baetis</u>	27.0	2.0	4.0
<u>Tricorythodes</u>	121.0	63.0	73.0
<u>Ephemerella</u>	162.0	36.0	144.0
<u>Paraleptophlebia</u>	13.0	3.0	10.0
<u>Brachycercus</u>			
<u>Rhithrogenia</u>	35.0	12.0	25.0
<u>Heptagenia</u>	4.0	11.0	4.0
Pteronarcidae	32.0	5.0	7.0
Perlidae	21.0	2.0	1.0
Perlodidae	24.0	10.0	6.0
Nemouridae			
Hydropsychidae	295.0	13.0	34.0
Brachycentridae	212.0	100.0	67.0
Hydroptilidae	40.0	2.0	1.0
Lepidostomatidae	32.0	88.0	45.0
Leptocercidae	3.0	8.0	2.0
Psychomyiidae			
Glossosomatidae			
Helicopsychidae	6.0	12.0	17.0
Elmidae	63.0	69.0	23.0
Dytiscidae	1.0	1.0	
other Coleoptera	1.0	2.0	
Gomphidae	4.0		1.0
Corixidae			
Pyralidae			
TOTAL NUMBER	12,746.0	1,836.0	2,572.0
AVG. VOL. (CC)	25.4	10.3	9.7

APPENDIX 5. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION E FROM JULY 18, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-18	7-29	7-31	8-7	8-16	8-20	8-29	9-3	9-12	9-24	9-28	10-3	10-8	10-16
NO. OF SAMPLES	3	3	3	3	3	3	2	2	3	1	3	3	3	3
Hydracarina	0.3	0.3	0.3	2.6		0.6	1.5	0.5		3.0		0.3		
Tubificidae		0.3				1.0	1.5	6.5			2.3	2.3	1.0	2.7
other Oligochaeta		0.7	0.3	1.0	1.3	0.3	1.5			2.0	1.3	1.0	0.3	0.3
Hirudinea								0.5						
Lymnaea	0.3	1.0	0.7		0.7	0.3	7.0	5.0	2.0	25.0	5.0	2.0	4.3	4.0
Physa														
Planorbidae								0.5						
Nematoda														
Tendipedidae	24.0	11.7	16.0	17.0	14.3	9.3	15.5	29.5		34.0	10.0	37.0	31.3	101.7
Simulidae	4.0	2.0	2.7	1.0	4.7	13.3	4.0							
Tipulidae	0.3		0.3			0.7	1.5	0.5	1.0	1.0	1.7	1.7	1.7	
Heleidae				0.3						1.0		1.3	0.7	1.3
Rhagionidae	2.0		0.3	0.3	1.7	6.0	10.5	1.0	12.0	2.7	3.7	1.3	1.3	3.3
Empididae														
Tabanidae	0.7													
Culicidae												0.3		
Baetis	0.7	14.7	27.0	35.7	14.7	16.3	12.0	3.5					0.5	
Tricorythodes	18.3	7.0	37.0	34.3	43.3	23.0	46.0	42.0	0.3	55.0	11.3	5.0	3.5	12.0
Ephemerella	4.7	3.3	4.3	6.0	4.7	4.7	3.5	4.5		1.0		0.3		1.0
Choroterpes			1.3	4.3	1.7	1.0	4.0	1.0			0.3			
Paraleptophlebia					0.3	0.7								0.5
Siphlonurus														
Rhithrogenia						0.3	2.5	1.0						
Heptagenia						0.3	5.0	2.5						
Pteronarcidae						0.3	0.5	0.5		6.0	0.3	0.7	1.7	1.0
Perlidae														
Perlodidae							3.0	3.5						0.7
Nemouridae														
Hydropsychidae	0.7	0.3			1.3	4.0	8.5	5.0	0.3				0.3	0.3
Brachycentridae	3.0	0.7	0.7		7.7	0.3	2.5	1.0	0.3	2.0	1.7	4.7	0.3	2.0
Hydroptilidae	0.7	0.7	0.3	1.7	1.0	1.0								
Lepidostomatidae				0.3				3.5		2.0	1.0	1.0		
Leptocercidae							1.5	0.5		1.0		0.3	0.3	
Glossosomatidae														
Helicopsychidae														
Elmidae	0.3	1.0	0.7	1.3	1.7	3.3	7.0	31.0	1.3	36.0	2.3	2.3	1.0	1.3
Dytiscidae	0.3			0.7	1.0	0.3	0.5		0.3		0.3	0.3		0.3
other Coleoptera	0.3										0.3		0.3	
Gomphidae	0.3			0.3	0.3	0.7	0.5				0.7	1.0		
Corixidae	0.3			0.3										
TOTAL NUMBER	62.2	43.7	92.0	107.1	100.4	87.8	140.5	143.5	17.5	171.7	42.3	62.5	47.6	127.9
AVG. VOL. (CC)	0.7	0.5	0.6	0.5	1.0	0.7	1.1	1.3	0.4	6.0	1.5	2.0	2.0	1.4

APPENDIX 5 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION E FROM JULY 18, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-27	11-3	11-14	11-19	12-18	1-18	2-27	3-27	4-26	5-22	7-10	7-18	7-25	7-30
NO. OF SAMPLES	3	3	3	2	3	1	1	3	3	3	3	3	3	3
Hydracarina							1.0				0.3		0.3	
Tubificidae	0.7	1.0	3.3	5.0	0.7	3.0	1.0				1.0	0.7	0.3	1.0
other Oligochaeta		1.7	1.0									0.7	0.3	
Hirudinea													0.3	
Lymnaea	2.0	1.0	2.7	1.5	0.3				4.0			1.7		1.0
Physa				0.5										
Planorbidae									0.3					
Nematoda					0.3									
Tendipedidae	38.7	34.0	208.3	132.5	126.7	184.0	447.0	75.3	20.3	3.7	7.0	35.7	11.3	8.0
Simulidae		0.3	1.7	1.5	2.0				0.3			1.0	0.7	22.7
Tipulidae	1.3	1.0	0.7	0.5	0.7									
Heleidae	0.7	1.0	0.7	1.0			4.0							
Rhagionidae	3.0	4.0	6.0	3.3	1.0	7.0					0.7	2.0	1.3	0.7
Empididae														
Tabanidae														
Culicidae														
Baetis	1.3	3.7	3.0	3.0	5.0	12.0	23.0	0.3	25.0	23.7	8.0	20.3	5.7	8.0
Tricorythodes	7.3	16.0	13.3	16.5	7.0	18.0	14.0		4.0	3.0	1.7	10.0	14.3	3.0
Ephemerella	0.3	0.3	1.3	3.5	0.7		2.0			1.7	3.7	13.7	3.7	5.7
Choroterpes														
Paraleptophlebia	0.3	0.3	0.7	0.5	0.3		2.0				0.3	0.3	4.3	1.0
Siphlonurus														
Rhithrogenia				0.5					0.3			0.3		
Heptagenia											2.0	2.3	1.7	3.0
Pteronarcidae	0.3		0.3			1.0					0.7	6.7	1.3	
Perlidae														
Perlodidae	2.0	0.3		0.5	0.3	1.0								
Nemouridae									0.3					
Hydropsychidae	0.3	0.7	0.3		0.3	1.0						1.7	0.7	0.7
Brachycentridae	1.3	1.3	1.0	2.5	1.3	1.0	8.0				5.7	59.0	13.3	17.0
Hydroptilidae														
Lepidostomatidae		0.7	0.7	1.5	0.7	1.0								
Leptocercidae		0.3												
Glossosomatidae														
Helicopsychidae			0.3											
Elmidae	2.0	1.0	3.7	1.0	1.0	1.0		0.3	1.0	1.0		0.7		0.3
Dytiscidae		1.0			0.7		1.0					1.7	1.0	0.3
other Coleoptera									0.3					
Gomphidae														0.3
Corixidae														
TOTAL NUMBER	61.6	69.6	249.3	175.3	149.0	230.0	503.0	75.9	55.8	33.4	31.1	158.6	60.5	73.0
AVG. VOL. (CC)	1.2	0.6	1.0	0.8	0.7	0.4	2.0	0.1	0.5	0.2	0.2	1.4	0.4	1.1

APPENDIX 5 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION E FROM JULY 18, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-7	8-13	8-21	8-27	9-4	9-11	9-18	9-25	10-5	10-12	10-15	10-25	10-29	11-8
NO. OF SAMPLES	3	3	3	3	3	2	3	3	2	3	2	2	2	2
Hydracarina	0.3				0.3	2.5							2.0	
Tubificidae	4.0	0.3	1.3	0.7	0.7	2.0	2.7		1.0	0.7	1.5			1.0
other Oligochaeta	0.3						0.3		1.5	0.3	0.5		0.5	
Hirudinea														
Lymnaea	5.0	0.7	0.3	0.7	1.3	7.0	2.0	4.3	1.5		4.5	6.5	7.0	6.5
Physa								0.3				0.5		
Planorbidae														
Nematoda	0.3					0.5								
Tendipedidae	115.0	12.0	25.0	5.7	26.3	77.0	87.7	8.3	24.0	50.0	49.0	64.0	148.0	18.5
Simuliidae	7.7	13.0	10.3	0.7			0.7					0.5	1.0	0.5
Tipulidae				0.3	0.7			0.7	0.5	1.3	1.0		1.0	1.5
Heleidae												0.5		
Rhagionidae	11.7	1.3	4.7	1.3	3.7	13.0	1.3	0.3	5.0	2.7	3.0	1.5	10.0	4.0
Empididae														
Tabanidae														
Culicidae														
Baetis	17.7	8.7	12.7	4.0	4.0	0.5			0.5	0.3	3.0	4.0	14.5	4.0
Tricorythodes	26.0	1.7	2.0		0.3	5.5	4.7	0.7	9.5	10.3	3.5	3.5	22.5	2.5
Ephemerella	20.7	2.0	2.3	0.7	1.0	2.5	3.0	0.7	1.5	5.0	13.0	8.0	24.5	8.0
Choroterpes														
Paraleptophlebia	3.3	0.7	1.0		0.3	2.5	1.7		2.0	0.7	2.0	2.5	0.5	2.0
Siphlonurus														
Rhithrogenia	2.0	1.3	2.7	4.3	5.0	1.0	0.7	4.7	8.5	8.7	14.5	18.5	21.5	36.0
Heptagenia	0.7	1.0	4.3		0.7	1.0	2.3	1.0	2.5	4.0	2.5	3.5	1.0	2.0
Pteronarcidae	16.3	1.0	0.3		1.0	12.5	1.0		0.5	0.3	1.5	0.5	1.0	1.5
Perlidae	4.3	0.3	0.7	0.7	0.7	4.5	0.7	0.7	1.0	0.7	2.0	1.5	3.0	2.5
Perlodidae	1.7				0.3	3.0			1.0	0.7	1.0	4.0	3.0	2.0
Nemouridae					1.3	0.5			1.5	1.0	1.0	2.5	3.5	6.5
Hydropsychidae	3.0	1.3	0.7	1.3	7.3	7.0	1.0	1.0	6.0	12.3	15.0	16.0	37.0	23.5
Brachycentridae	14.0	10.7	14.7	6.7										
Hydroptilidae	0.7	0.7		0.3	1.3	9.0	7.3	3.0	5.0	4.7	4.5	8.5	3.5	2.0
Lepidostomatidae		0.7	2.0	4.7	0.3	1.0							0.5	
Leptocercidae														
Glossosomatidae														
Elmidae	3.3		1.0	0.3	0.7	0.5	0.3		0.5		1.5	1.0	1.0	
Helicopsychidae										0.3				
Dytiscidae	0.7	0.3						0.3						
other Coleoptera											0.5	0.5		
Gomphidae				0.7		0.5					0.5			
Corixidae														
TOTAL NUMBER	252.0	57.6	86.0	35.3	57.3	154.5	117.3	25.9	73.5	104.0	125.5	148.5	306.5	124.5
AVG. VOL. (CC)	1.5	0.7	1.3	1.2	0.7	2.0	0.2	0.3	0.7	1.6	1.4	2.4	5.0	3.2

APPENDIX 5 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION E FROM JULY 18, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	43*	48	49	50	51	52	53	54	55	56
YEAR	1963	1964								
MONTH & DAY	11-13	4-25	8-6	8-12	8-19	8-26	9-2	9-8	9-16	9-23
NO. OF SAMPLES	2	3	2	2	2	2	2	2	2	2
Hydracarina		0.3	2.0	1.0	0.5					
Tubificidae				0.5	2.0	1.5		0.5	0.5	
other Oligochaeta	4.0			0.5		0.5			0.5	
Hirudinea										
<u>Lymnaea</u>	9.0	1.0		0.5	2.0	1.0	1.5		2.0	
<u>Physa</u>										
Planorbidae										
Nematoda										
Tendipedidae	39.0	43.3	226.5	206.5	184.0	127.5	115.5	51.0	12.0	6.0
Simulidae			10.0	19.0	2.5	1.0				1.0
Tipulidae	0.5		0.5		0.5		0.5	1.0		
Heleidae										
Rhagionidae	7.0	7.3	4.5	3.5	1.0	1.0	2.5	1.5	2.5	
Empididae			0.5	0.5	0.5		0.5	0.5	1.0	
Tabanidae										
Culicidae										
<u>Baetis</u>	4.0	6.0	16.0	20.0	17.5	10.0	12.5	9.0	1.5	2.5
<u>Tricorythodes</u>	6.5	6.7	31.0	8.5	24.0	10.5	17.0	3.0	2.5	1.0
<u>Ephemerella</u>	9.0	59.3	5.0	3.5	1.5	1.0	5.0	1.0	0.5	1.5
<u>Choroterpes</u>					0.5					
<u>Paraleptophlebia</u>	1.0	2.3	0.5	0.5			1.0	1.5		
<u>Siphlonurus</u>		0.3								
<u>Rhithrogenia</u>	11.5	0.3	1.0	2.5	10.0	11.5	10.5	48.0	22.0	28.5
<u>Heptagenia</u>	4.0		0.5	0.5	4.0	3.5	3.0	4.5	4.5	4.0
Pteronarcidae	0.5		0.5	2.0		0.5	0.5			1.0
Perlidae	2.0				1.0	2.0	2.0	3.5	1.0	2.0
Perlodidae	1.5	4.0		0.5			1.0	1.5		
Nemouridae										
Hydropsychidae	4.5	0.3	1.5	2.0	9.0	5.0	4.5	3.5		3.0
Brachycentridae	4.5	2.0	0.5	6.0	3.0	4.5	0.5	1.5	1.5	4.0
Hydroptilidae			4.0	1.0	3.0	1.0				
Lepidostomatidae	9.0	1.3			1.5	1.0	22.5	12.5	4.5	13.0
Leptocercidae										
Glossosomatidae							1.0	0.5		1.5
Helicopsychidae										0.5
Elmidae	0.5	1.3	3.0	1.0	2.5	1.5	1.0	1.5		0.5
Dytiscidae		0.3	0.5	0.5		4.5				
other Coleoptera				0.5						
Gomphidae	0.5							0.5		
Corixidae										
TOTAL NUMBER	118.5	136.1	308.5	280.5	270.5	89.0	202.5	146.5	56.0	70.5
AVG. VOL. (CC)	2.0	0.6	0.4	0.8	0.8	1.2	1.0	0.8	1.2	2.0

* No samples were taken in December, 1963 and in January, February, and March, 1964 (Series Number 44, 45,46, and 47).

APPENDIX 6. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION F FROM JULY 20, 1962 TO SEPTEMBER 24, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-20	7-29	8-1	8-6	8-13	8-20	8-30	9-3	9-11	9-20	9-27	10-4	10-9	10-15
NO. OF SAMPLES	3	3	3	3	3	3	3	2	3	1	3	3	3	3
Hydracarina	0.3	0.3		1.3	1.4	2.3	0.6		0.3					
Tubificidae		0.3		0.3		1.0	1.3	1.0					0.3	1.0
other Oligochaeta			0.3	1.3		0.3	0.3							
Hirudinea			0.3	0.3										
<u>Lymnaea</u>	0.7	1.3		0.3			2.7	10.0	2.0		2.3	0.3	0.7	2.0
<u>Physa</u>														
Planorbidae														
Nematoda	0.7	2.0				0.3								
Amphipoda									7.3					
Tendipedidae	1.3	2.3	1.3	9.0	2.0	19.3	12.3	2.5		1.0	0.3	4.0	3.3	14.3
Simulidae	0.3	0.3	2.0	1.7	2.3	0.7	3.0							
Tipulidae	0.7	0.7		0.3	0.3	5.0	1.3	3.0					0.3	0.7
Heleidae							0.3						0.3	
Rhagionidae	0.3			0.3		0.3	1.3	0.5	1.7		1.0	0.7		0.7
Empididae						0.3								
<u>Baetis</u>	0.3	12.3	17.3	16.3	21.0	7.0	29.7	15.0					0.3	1.0
<u>Tricorythodes</u>		0.7	1.3	0.7	0.7	16.0	7.7	8.0	0.3					0.3
<u>Ephemerella</u>	0.3	0.3	1.3	1.0	1.3	5.7	0.7	0.5						
<u>Choroterpes</u>					0.3	2.0	0.7							
<u>Paraleptophlebia</u>														
<u>Brachycercus</u>														
<u>Rhithrogenia</u>							5.0	3.0		1.0				
<u>Heptagenia</u>							0.3	0.5						
Pteronarcidae							0.3							
Perlidae					0.3			1.5						
Perlodidae						0.3	1.0	0.5						
Hydropsychidae			0.3	1.7	0.3		7.3	7.5	0.7			0.3		
Brachycentridae		0.3				1.7	9.7	2.0						1.3
Hydroptilidae						0.7				2.0				
Lepidostomatidae							2.7	0.5		2.0				
Leptocercidae														
Glossosomatidae														
Helicopsychidae							0.3						0.3	
Elmidae		0.3	0.7		0.7	1.0	3.7	4.5	0.3				0.3	2.0
Dytiscidae						1.3	0.7					0.3		
other Coleoptera													0.3	
Gomphidae														
Corixidae			0.3											
TOTAL NUMBER	4.6	21.1	25.2	34.5	30.6	65.2	92.8	60.5	12.6	6.0	3.6	5.6	6.1	23.3
AVG. VOL. (CC)	0.2	0.3	0.2	0.3	0.2	0.5	1.2	1.6	0.5	<0.1	0.5	0.1	0.2	0.6

APPENDIX 6 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION F FROM JULY 20, 1962 TO SEPTEMBER 24, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-27	11-3	11-8	11-15	12-18	1-19	3-2	3-21	4-23	5-22	7-9	7-15	7-23	7-31
NO. OF SAMPLES	3	2	3	3	3	2	3	3	3	3	3	3	3	3
Hydracarina										1.0				0.3
Tubificidae			3.0	3.0					1.0	5.0	0.7	0.3	2.3	1.0
other Oligochaeta									6.7	8.7	0.3		0.3	
Hirudinea														
Lymnaea	1.3	2.0	4.3	3.0	4.3		0.3		1.3	1.3	0.3	1.0		0.7
Physa			1.0					0.3						
Planorbidae									0.3					
Nematoda	0.7													0.3
Amphipoda														0.7
Tendipedidae	1.7	2.5	22.0	6.0	5.3	1.0	17.3	23.0	51.7	18.3	1.7	0.7	3.0	5.3
Simulidae		0.5	0.7	1.0	1.0			1.0	5.7	0.3	1.3	1.7	5.7	4.0
Tipulidae												0.3		0.7
Heleidae														
Rhagionidae	0.7	1.0	0.7	3.3	2.3				0.7					
Empididae														
Baetis	1.0	3.0	6.3				2.7	7.0	44.7	19.0	5.3	10.0	9.7	16.3
Tricorythodes			0.3						0.3			0.3	1.0	8.0
Ephemerella									1.0	3.0	1.0	0.7	0.7	2.7
Choroterpes														
Paraleptophlebia										0.3				1.0
Brachycercus											0.3			
Rhithrogenia												0.7	2.0	1.0
Heptagenia											0.3		0.7	0.7
Pteronarcidae											0.3	0.3		
Perlidae														
Perlodidae										0.3	0.3		1.0	0.3
Hydropsychidae										0.3				
Brachycentridae											0.3			0.3
Hydroptilidae											0.7	0.3	0.7	
Lepidostomatidae														
Leptocercidae														
Glossosomatidae														
Helicopsychidae														
Elmidae	0.3	2.0			1.0		0.3		0.7	0.7				0.3
Dytiscidae	0.3	0.5	0.7		0.3	0.5			0.7					
other Coleoptera														
Gomphidae														
Corixidae														
TOTAL NUMBER	6.0	11.5	39.1	16.3	14.2	1.5	20.6	31.6	114.8	58.2	12.9	16.3	27.0	43.6
AVG. VOL. (CC)	0.2	0.4	0.6	0.7	0.9	0.1	0.1	0.2	0.7	0.3	0.1	0.1	0.1	0.2

APPENDIX 6 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION F FROM JULY 20, 1962 TO SEPTEMBER 24, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-5	8-12	8-21	8-26	9-3	9-10	9-19	9-25	10-5	10-9	10-15	10-25	10-30	11-8
NO. OF SAMPLES	3	3	3	3	3	2	3	3	2	3	2	2	2	2
Hydracarina	1.0	1.3	0.6	2.0		1.0	1.6			1.0		0.5	1.0	0.5
Tubificidae	0.3	0.3	0.3	4.0				0.3		0.7			1.0	0.5
other Oligochaeta		0.3										0.5		0.5
Hirudinea														
Lymnaea	1.3	0.7	0.7	2.7	1.0	3.5	3.7	3.7	1.5	3.3	2.0	5.5	2.5	4.5
Physa	0.3			0.3		1.0	2.0	1.3		1.7	0.5		1.0	0.5
Planorbidae							0.3	0.3		0.3	1.0			0.5
Nematoda				0.7	0.3								0.5	
Amphipoda							0.3	0.3						
Tendipedidae	8.7	4.0	5.3	215.3	2.0	31.5	11.3	9.3	4.0	45.3	25.0	17.5	28.0	24.0
Simulidae	5.3	1.7	5.0	94.7										
Tipulidae	1.3	2.0		1.0	1.7			1.0	1.0	0.3	0.3	3.5	0.5	2.5
Heleidae					0.3	1.0	0.7			0.7		0.5	1.5	2.0
Rhagionidae	0.3	0.3	0.7	1.3		0.5	1.0		1.5	1.0	3.0	0.5	1.0	2.5
Empididae														
Baetis	11.7	11.0	10.3	29.0	3.0	1.0				0.3		1.0	2.5	2.0
Tricorythodes	11.0	14.7	8.7	12.3	4.7	3.5	2.7	3.7	8.0	4.7	8.0	8.0	10.5	8.0
Ephemerella	5.0	1.7	1.7	3.3	0.3	1.0			0.5	2.3	4.5	3.5	7.5	14.0
Choroterpes		0.7	0.3		0.3									
Paraleptophlebia				0.3		0.5	0.3			1.0				
Brachycercus														
Rhithrogenia	0.7	1.7	3.0	7.0	3.0	3.0	1.0	3.3	2.5	9.0	3.0	5.5	9.5	9.5
Heptagenia	0.3	0.7	0.3	0.3					0.5					
Pteronarcidae	0.3			18.3			0.3	1.0	0.5	0.3		0.5		
Perlidae	0.3		0.7	5.3	0.7	1.0	0.3	1.3	0.5	1.7	0.5	3.5	3.0	2.0
Perlodidae	0.3		0.3	9.7		2.5	13.7	1.0	2.5	3.7	1.0	6.5	3.0	3.5
Hydropsychidae														
Brachycentridae	0.7	0.7		6.3		4.5	0.7	1.7		3.3	1.0	4.0	0.5	
Hydroptilidae		0.3		1.3	0.3				0.5					
Lepidostomatidae	0.3		2.3	5.0	10.0	17.5	10.3	5.3	9.0	11.0	11.0	25.5	18.5	23.5
Leptocercidae				0.3			0.7		0.5	0.3		0.5		
Glossosomatidae												0.5		
Helicopsychidae				0.3	0.3									
Elmidae		0.3	0.3				0.3					0.5		
Dytiscidae														
other Coleoptera				0.3		1.0		0.3						
Gomphidae						0.5				0.3				1.0
Corixidae														
TOTAL NUMBER	49.1	42.6	40.5	421.1	27.9	74.5	51.2	33.8	33.0	92.2	60.8	88.0	92.0	101.5
AVG. VOL. (CC)	1.0	0.3	0.2	1.7	0.3	0.8	0.8	0.8	0.4	1.0	0.4	1.4	0.6	0.8

APPENDIX 6 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION F FROM JULY 20, 1962 TO SEPTEMBER 24, 1964.

SERIES NUMBER	43	44	45	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-12	12-12	1-31	2-23	3-27	4-26	8-4	8-11	8-19	8-26	9-2	9-8	9-17	9-24
NO. OF SAMPLES	2	2	1	1	1	3	2	2	2	2	2	2	2	2
Hydracarina						0.3	0.5	1.0		0.5	2.0			
Tubificidae											2.5			
other Oligochaeta						0.3								
Hirudinea														
<u>Lymnaea</u>	4.0	1.5			1.0	1.7		0.5	0.5	4.5	6.5	13.0	3.0	7.0
<u>Physa</u>						0.3								
Planorbidae	0.5													
Nematoda					0.5									
Amphipoda														
Tendipedidae	9.5	6.5	4.0	223.0	56.0	153.0	56.0	8.5	22.5	8.5	548.0	62.5	32.0	18.0
Simulidae		1.0	1.0	49.0		1.0		0.5	1.5	3.5	5.0			
Tipulidae	2.0	0.5							1.0		1.0			1.0
Heleidae						0.3								
Rhagionidae	0.5	2.0		1.0	5.0		5.0	3.0	3.0	1.5	1.0	3.5	3.5	1.5
Empididae							0.5				0.5	3.0	1.0	2.0
<u>Baetis</u>	2.0		7.0	21.0	11.0	21.0	6.5	6.0	7.5	4.5	9.5	12.0	5.0	2.5
<u>Tricorythodes</u>	1.5	0.5	1.0	4.0	8.0	4.7	6.0	5.0	7.5	1.5	3.5	1.0	3.0	
<u>Ephemerella</u>	7.5	11.5	23.0	71.0	98.0	106.0	0.5	3.5	2.5	0.5	17.5	3.0	0.5	0.5
<u>Choroterpes</u>									1.0					
<u>Paraleptophlebia</u>						0.3								0.5
<u>Brachycercus</u>														
<u>Rhithrogenia</u>	10.0	4.0	11.0	15.0	14.0	16.7	3.0		4.0	3.0	13.5	30.0	43.5	89.5
<u>Heptagenia</u>						1.0	0.5			0.5		4.0	0.5	2.0
Pteronarcidae			2.0		2.0	1.3					1.0	0.5		
Perlidae	2.0	2.0	6.0		2.0		0.5		0.5		8.0	1.0	2.0	3.5
Perlodidae	2.5		2.0	1.0	2.0	10.7								0.5
Hydropsychidae									2.0	0.5	9.5	1.5	4.5	4.0
Brachycentridae	0.5		3.0		2.0		2.0	2.5		1.5	1.5	1.5	13.0	1.0
Hydroptilidae							1.5				1.5			
Lepidostomatidae	5.5			3.0	2.0	21.7					1.0	13.0	11.0	1.5
Glossosomatidae													0.5	
Leptocercidae						0.3			0.5	1.0				
Helicopsychidae														
Elmidae							0.5	0.5		0.5	1.5	1.0	0.5	1.5
Dytiscidae						0.7								
other Coleoptera														
Gomphidae													0.5	
Corixidae														
TOTAL NUMBER	48.0	29.5	60.0	388.0	203.5	341.3	83.0	31.0	54.0	320.0	634.5	150.5	124.0	136.5
AVG. VOL. (CC)	0.5	0.4	1.3	0.6	1.0	1.2	0.3	0.4	0.3	0.4	1.5	1.6	1.6	1.6

APPENDIX 7. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION G FROM JULY 24, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-24	7-27	8-1	8-8	8-16	8-21	8-28	9-3	9-13	9-18	9-29	10-5	10-11	10-17
NO. OF SAMPLES	3	3	3	3	3	3	3	2	2	2	2	1	2	2
Hydracarina			0.3	0.3	0.3	0.3	1.4					1.0		
Tubificidae	19.3	23.3	47.3	21.7	0.3	0.7	2.3	1.5						
other Oligochaeta		2.0	1.7	2.3	1.0		2.3							
Hirudinea							0.3							
Lymnaea	0.3		0.3	1.0	0.7	1.0	1.0	0.5		0.5				
Physa														
Nematoda				0.3										
Amphipoda														
Tendipedidae	0.3	3.3	6.3	11.0	50.0	36.3	127.3	14.5					0.5	
Simulidae		1.0	5.7	41.7	5.0	3.7	13.3	1.0						
Tipulidae							0.7	1.5						
Heleidae														
Rhagionidae					0.3		1.7	0.5					0.5	0.5
Culicidae														
Baetis	9.7	11.7	19.7	20.0	10.3	10.3	15.7	10.0						
Tricorythodes	2.0	0.3	0.7	1.3	12.3	11.7	9.0	9.5						
Ephemerella		0.3	0.7	1.0	4.4	0.7	1.0	1.5						
Choroterpes				0.7	3.7	2.3	0.3							
Paraleptophlebia														
Caenis														
Rhithrogenia				1.3	0.3	0.3	0.3	2.0						
Heptagenia						0.7	2.0	2.0						
Pteronarcidae							1.3							
Perlidae						0.3		2.0						
Perlodidae		0.3		1.3	2.0	1.0	5.7	5.5						
Hydropsychidae	1.0	1.7	1.3	4.0	29.0	25.0	89.7	89.0						
Brachycentridae				0.3		0.3	0.7							
Hydroptilidae				2.0	0.3			0.5						
Lepidostomatidae														
Leptocercidae					0.3									
Glossosomatidae	0.3													
Elmidae					1.0	0.3	2.0	2.5						
Dytiscidae	0.3		0.3	1.0	0.7				0.5		0.5			
other Coleoptera									0.5					
Gomphidae					1.0					0.5	1.0			
Corixidae							0.3				1.0			0.5
TOTAL NUMBER	33.2	43.9	84.2	111.2	123.2	94.9	278.3	144.0	1.0	1.0	2.5	1.0	1.0	1.0
AVG. VOL. (CC)	0.3	0.3	0.4	0.5	0.4	0.6	1.3	1.0	<0.1	0.6	0.8	<0.1	<0.1	0.1

APPENDIX 7 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION G FROM JULY 24, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	15	16	17	18	19	20	21*	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-29	11-5	11-12	11-20	12-19	1-23	2	3-21	4-26	5-23	7-10	7-18	7-25	7-31
NO. OF SAMPLES	1	2	3	3	3	1	0	2	3	3	3	3	2	3
Hydracarina			0.3								0.7	0.3		1.0
Tubificidae	1.0	1.0	5.3	3.0	0.3				0.3	18.7	2.7	0.3		2.0
other Oligochaeta									0.3		0.3			2.0
Hirudinea														
Lymnaea				0.3										0.3
Physa														
Nematoda														
Amphipoda													0.5	0.7
Tendipedidae		0.5		0.3	0.3	3.0		8.0	3.0	15.0	1.3	71.0	48.0	36.7
Simulidae										0.3	41.3	125.3	558.5	203.7
Tipulidae														
Heleidae														
Rhagionidae					0.7									
Culicidae										0.7				
Baetis										1.0	9.0	10.0	13.5	14.3
Tricorythodes											0.7	7.3	9.5	137.0
Ephemerella												0.3	2.5	12.0
Choroterpes												1.0	1.0	8.3
Paraleptophlebia														
Caenis														
Rhithrogenia				0.7							0.3	0.3	2.0	0.3
Heptagenia												1.0		2.0
Pteronarcidae												0.7	1.0	1.0
Perlidae														0.3
Perlodidae				0.3									0.5	1.7
Hydropsychidae														
Brachycentridae													1.0	1.3
Hydroptilidae											2.7	20.7	12.5	6.7
Lepidostomatidae														
Leptocercidae														
Glossosomatidae														
Elmidae				0.3		1.0								
Dytiscidae														0.3
other Coleoptera														
Gomphidae														
Corixidae				0.3										
TOTAL NUMBER	1.0	1.5	5.6	5.2	1.3	4.0		8.0	3.6	35.7	59.0	237.9	650.5	432.0
AVG. VOL. (CC)	<0.1	<0.1	<0.1	0.1	<0.1	<0.1		<0.1	<0.1	0.1	0.2	0.4	1.3	1.3

* No samples taken during February, 1963.

APPENDIX 7 (CONTINUED). **AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION G FROM JULY 24, 1962 TO SEPTEMBER 23, 1964.**

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-7	8-14	8-21	8-28	9-5	9-12	9-19	9-25	10-6	10-12	10-15	10-27	10-30	11-9
NO. OF SAMPLES	3	3	3	3	3	2	3	3	2	1	2	2	2	2
Hydracarina	1.3	0.3	0.7	2.6	0.9	0.5				2.0				
Tubificidae	0.3	0.7	0.3	0.7	0.3	1.5	0.7	1.0			1.5	1.7	37.0	70.5
other Oligochaeta			0.3	0.7		3.0	0.7	0.7			3.0	3.0	11.0	17.0
Hirudinea				0.3										
<u>Lymnaea</u>								0.3	0.5		1.5		0.5	
<u>Physa</u>											0.5			1.0
Nematoda				0.3										
Amphipoda		0.7	0.7	0.3				0.7	1.5	2.0	1.5			2.5
Tendipedidae	28.3	8.3	60.0	255.0	18.0	19.5	4.7	5.3	46.0	107.0	62.5	95.5	34.0	96.5
Simulidae	95.3	1.7	1.0		0.3	0.5	0.3	0.3	0.5		0.5	0.5		0.5
Tipulidae					0.3									
Heleidae										1.0				
Rhagionidae					1.0	0.5	0.3			1.0	3.5	0.3	0.5	2.5
Culicidae														
<u>Baetis</u>	6.7	2.3	9.7	13.0	4.3	1.5				13.0	5.5	8.0	5.0	8.5
<u>Tricorythodes</u>	93.0	88.7	54.3	31.7	9.3	17.0	12.7	16.7	38.0	21.0	32.5	17.0	7.5	80.0
<u>Ephemerella</u>	7.0	1.3	5.0	9.0	2.3	5.0	3.7	5.3	25.5	41.0	64.0	111.0	48.0	96.0
<u>Choroterpes</u>	1.7	2.3	2.7	0.7			0.3							
<u>Paraleptophlebia</u>							0.3				0.5	0.5		6.0
<u>Caenis</u>														
<u>Rhithrogenia</u>	0.7	2.0	2.0	1.7	1.0	1.0		1.0				1.0		
<u>Heptagenia</u>			1.7	0.3	0.3		0.3	0.3	1.5		1.5			2.5
Pteronarcidae	0.7	0.7	1.3	2.0				1.0	0.3			0.5		0.5
Perlidae	2.3	3.3	4.0	16.7	2.3	0.5	1.7	1.7	2.0	2.0	5.0	1.5	1.0	7.0
Perlodidae		1.3	0.3	0.3	0.3	3.5	1.7	0.7	4.5		12.5	16.5	4.0	30.0
Hydropsychidae		0.7	1.0		0.3		0.3		1.5		0.5	1.0		
Brachycentridae				0.3								1.0		
Hydroptilidae	1.7	0.3	1.0						0.5		0.5			0.5
Lepidostomatidae		0.3	0.3	0.3					0.5					
Leptocercidae		0.3		0.3	0.3	0.5								
Glossosomatidae														
Elmidae			0.7	1.0								0.5		0.5
Dytiscidae														
other Coleoptera														
Gomphidae	0.7		1.0	1.3			0.7		0.5					0.5
Corixidae														
TOTAL NUMBER	239.6	115.3	148.0	338.4	41.3	54.5	29.4	34.3	133.0	190.0	198.0	258.5	149.0	427.5
AVG. VOL. (CC)	0.7	0.4	0.7	1.0	0.2	0.1	0:2	0.2	0.8	0.2	1.0	0.6	0.6	1.5

APPENDIX 7 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION G FROM JULY 24, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	43	44*	45*	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-14	12	1	3-3	3-30	4-29	8-6	8-15	8-20	8-27	9-3	9-13	9-17	9-23
NO. OF SAMPLES	2	0	0	1	1	2	2	2	2	2	2	2	2	2
Hydracarina							0.5		0.5	1.0		1.0	0.5	
Tubificidae	11.0			4.0	2.0	2.5				1.0		3.0		
other Oligochaeta	3.5					1.5			0.5					
Hirudinea							0.5							
<u>Lymnaea</u>	0.5													
<u>Physa</u>														
Nematoda	0.5						0.5							
Amphipoda	1.0													
Tendipedidae	52.5			9.0	162.0	64.5	232.0	79.5	260.5	195.5	43.0	411.0	35.5	155.5
Simulidae				2.0	1.0	12.0	520.0	5.5	12.0	10.5	1.5	6.5		0.5
Tipulidae							0.5							
Heleidae					1.0									
Rhagionidae	1.0						1.0		2.0	4.5		2.0	2.0	3.0
Culicidae														
<u>Baetis</u>	3.0			24.0	15.0	48.5	15.0	4.0	16.5	17.5	17.5	47.5	12.5	10.5
<u>Tricorythodes</u>	25.0			8.0	2.0	4.0	19.5	27.0	30.0	15.5	5.0	10.0	5.5	8.5
<u>Ephemerella</u>	88.5			42.0	19.0	27.0	4.0	1.0	1.0	1.5	2.0	12.5	9.0	17.0
<u>Choroterpes</u>							14.0	1.5	9.0	3.0	1.0	4.0		0.5
<u>Paraleptophlebia</u>	1.0													2.0
<u>Caenis</u>														0.5
<u>Rhithrogenia</u>	1.0					0.5	5.0	5.0	4.5	7.0	15.5	26.0	16.5	19.5
<u>Heptagenia</u>	0.5						2.0	2.5	3.0	2.5	3.5	23.0	12.0	7.5
Pteronarcidae	0.5													
Perlidae	3.0				4.0	1.0	2.5	0.5	1.5		2.0	18.5	2.5	12.5
Perlodidae	8.5					3.0				1.0	0.5		1.5	
Hydropsychidae							10.5	9.5	10.5	13.5	0.5	12.0	4.0	17.5
Brachycentridae										1.0		0.5	0.5	
Hydroptilidae							1.5		1.0	2.0		1.0	0.5	1.0
Lepidostomatidae	0.5													2.5
Leptocercidae					1.0					0.5		1.0	0.5	
Glossosomatidae										0.5				
Elmidae	0.5					0.5		0.5	0.5				0.5	
Dytiscidae								0.5						
other Coleoptera							0.5							
Gomphidae	2.0							0.5	0.5	1.0	0.5	1.0	1.0	
Corixidae														
TOTAL NUMBER	203.5			89.0	207.0	166.0	829.5	137.5	353.5	279.0	92.5	580.5	104.5	258.5
AVG. VOL. (CC)	0.7			0.4	0.4	1.2	1.4	0.6	1.2	0.7	0.7	1.2	1.2	0.8

* No samples taken during December, 1963 and January, 1964.

APPENDIX 8. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION H FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-23	7-28	8-2	8-9	8-16	8-22	8-28	9-3	9-13	9-18	9-29	10-5	10-12	10-17
NO. OF SAMPLES	3	3	3	3	3	3	3	2	1	1	3	3	3	3
Hydracarina	1.0				0.7	0.3								
Tubificidae							1.0					1.3		0.3
other Oligochaeta			0.7		2.7							0.3	0.7	
Hirudinea														
Lymnaea	0.7							2.5					0.3	
Physa														
Planorbidae														
Pelecypoda														
Nematoda														
Amphipoda														
Tendipedidae	3.0	2.7	0.7	2.7	1.5	9.3	10.3	4.5			0.7	2.7	0.3	0.3
Simulidae	0.3	0.3	0.3	1.3	0.3	1.0	0.7							0.3
Tipulidae														
Heleidae											0.3			
Rhagionidae						0.3			1.0				0.3	0.3
Baetis	7.3	2.3	3.7	3.7	1.3	1.7	9.7	5.5						
Tricorythodes	16.7	23.3	69.0	94.3	53.0	43.3	41.0	35.0					0.7	1.0
Ephemerella	0.3	0.3	0.3	0.7			1.0	0.5						
Choroterpes	3.0	5.0	12.0	7.0	7.3	16.0	5.7	8.5						
Paraleptophlebia														
Leptophlebia														
Traverella														
Brachycercus		0.3												
Isonychia														
Rhithrogenia								0.5						
Heptagenia						1.3	5.7	6.5						
Iron														
Ephoron			1.0		0.7	0.7	1.0							
Ephemera		0.7	1.0		0.3	0.7		1.0						
Pentagenia				0.3										
Perlidae		0.3				0.3	0.3							
Perlodidae	1.3					1.0	0.3	0.5						
Hydropsychidae	1.7	0.7	1.0	2.7	2.3	9.3	23.3	14.0						
Brachycentridae														
Hydroptilidae	2.3	0.7	0.3	0.7	0.7									
Lepidostomatidae														
Leptocercidae					0.3		0.3							
Glossosomatidae	0.3													
Elmidae			0.3	0.3				0.5						
Dytiscidae										1.0				
other Coleoptera										1.0				
Gomphidae		0.3							1.0				0.3	
Coenagrionidae														
Corixidae							1.0							
Pyralidae														
Sialidae														
TOTAL NUMBER	37.9	37.0	90.3	113.7	71.4	85.1	101.2	79.0	2.0	2.0	1.0	4.3	2.3	1.9
AVG. VOL. (CC)	0.8	2.0	2.1	0.4	0.4	0.4	0.4	0.3	1.0	<0.1	<0.1	<0.1	0.5	<0.1

APPENDIX 8 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION H FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-29	11-6	11-13	11-22	12-19	1-22	2-28	3-22	4-29	5-23	7-11	7-20	7-27	8-1
NO. OF SAMPLES	3	3	3	3	3	1	3	3	3	3	3	3	3	3
Hydracarina												0.7	0.3	
Tubificidae	2.0	12.3	11.3	4.7	0.3				5.0	4.0		0.7	83.7	1.0
other Oligochaeta			0.3		0.7					0.3	0.6	4.3	0.3	2.7
Hirudinea														
Lymnaea	0.3			0.7							0.3	1.3	2.0	12.3
Physa				0.7	0.3				0.3				2.0	8.0
Planorbidae														
Pelecypoda			0.3						0.3	1.0				
Nematoda														
Amphipoda														
Tendipedidae	3.3	2.3	6.0	2.7	14.3	33.0	18.0	11.0	6.3	12.7		18.7	29.0	7.7
Simuliidae			0.7			1.0					7.3	6.7	0.7	0.3
Tipulidae														
Heleidae				0.3										
Rhagionidae	0.3				1.0									
Baetis											10.3	5.0	8.7	7.7
Tricorythodes	0.3		0.3								1.7	121.7	164.3	334.3
Ephemerella													0.7	0.7
Choroterpes											2.3	21.7	30.7	64.7
Paraleptophlebia														
Leptophlebia									0.7	1.3				
Traverella														
Brachycercus														2.3
Isonychia												1.0		0.3
Rhithrogenia											0.3			
Heptagenia										2.0	1.0	1.7	1.0	1.3
Iron														0.3
Ephoron												0.3		3.0
Ephemera														
Pentagenia														
Perlidae														
Perlodidae											0.3	0.3	0.7	
Hydropsychidae														
Brachycentridae														
Hydroptilidae												13.0	2.7	2.3
Lepidostomatidae														
Leptocercidae														
Glossosomatidae														
Elmidae														0.3
Dytiscidae														
other Coleoptera									0.3	1.0				
Gomphidae											1.0	0.7	0.3	1.0
Coenagrionidae														
Corixidae			0.3											0.3
Pyralidae														
Sialidae														
TOTAL NUMBER	6.2	14.6	19.2	9.1	16.6	34.0	18.0	11.0	12.9	22.3	25.1	197.7	327.0	450.3
AVG. VOL. (CC)	<0.1	<0.1	<0.1	0.3	0.4	0.2	0.1	0.1	0.4	0.1	0.1	0.8	0.8	1.7

APPENDIX 8 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION H FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-8	8-14	8-22	8-29	9-5	9-12	9-19	9-27	10-4	10-10	10-15	10-26	10-30	11-9
NO. OF SAMPLES	3	3	3	3	3	2	3	3	3	3	2	2	2	2
Hydracarina	0.7	0.3	0.3		1.3	0.5			1.0			2.5		
Tubificidae	13.7	50.0	1.7	2.7	2.0		0.7			0.3	0.5	0.5	14.5	1.5
other Oligochaeta	5.0	11.7	2.7	5.0	2.0	1.0		0.3	1.0		1.0		3.0	1.0
Hirudinea		0.3			0.3									
Lymnaea	35.0	5.3	14.7	5.3	9.7	12.5	1.0	5.7	6.7	3.0	5.0	3.0	10.0	11.5
Physa	9.3	9.7	5.3	2.3	9.0	8.5	0.7	6.3	11.3	2.3	5.0	4.5	1.5	5.5
Planorbidae				0.3		0.5		0.3						0.5
Pelecypoda		0.3												
Nematoda				0.3									0.5	
Amphipoda					0.7		0.3	2.7	2.3	0.7	0.5	1.0	0.5	1.0
Tendipedidae	17.0	5.0	3.0	22.3	15.3	11.5	1.3	2.3	19.7	14.7	32.0	50.5	37.0	22.0
Simulidae	1.7	0.3	6.3	0.7	3.3	4.5		0.7	1.0	0.7	1.0			
Tipulidae														
Heleidae			0.3	0.3					1.0		0.5	1.0		2.0
Rhagionidae														
Baetis	18.7	3.0	8.3	2.0	2.0	2.5	0.3	0.7	0.7	1.0		4.5	5.5	4.5
Tricorythodes	433.3	86.3	104.3	54.3	62.7	47.0	33.3	33.3	68.7	84.0	132.0	96.0	130.5	86.5
Ephemerella		0.3	5.3	6.0	6.0	11.0	3.7	3.7	35.0	84.0	117.0	106.5	243.5	146.5
Choroterpes	54.7	30.3	44.7	10.0	12.3	6.5	3.0		0.7					
Paraleptophlebia									4.0	1.3	1.5	4.5	2.5	2.5
Leptophlebia														
Traverella														
Brachycercus	3.7	8.3	0.3	1.7	1.0	1.5		1.7						
Isonychia			0.3											
Rhithrogenia								1.7						
Heptagenia	0.7	1.7	6.0	0.3	1.3	3.0	0.3	0.3	3.0	0.3	1.5	1.0	7.0	5.0
Iron														
Ephoron	0.3		0.3											
Ephemera										0.3	0.3			0.5
Pentagenia														
Perlidae		0.3			0.7	0.5	0.3			0.3	1.5	0.5	1.0	0.5
Perlodidae	0.3		0.7		0.3	0.5	0.3	0.3	0.3	0.3	1.0	1.5	2.5	3.5
Hydropsychidae														
Brachycentridae													1.0	
Hydroptilidae	6.3	0.7	6.0	1.0							1.0			
Lepidostomatidae				0.7						0.3	1.0			
Leptocercidae	1.3	2.0	0.3		2.0	1.0	2.0	4.0	6.0	3.3	1.0		2.0	3.5
Glossosomatidae														
Elmidae		0.3		1.0				0.3	0.3	0.3		0.5	0.5	1.0
Dytiscidae													0.5	
other Coleoptera														
Gomphidae	1.3	0.7		1.7	2.3	1.0	0.7	1.0		0.3	1.5	2.0	1.0	1.0
Coenagrionidae							0.3							
Corixidae		0.7	0.3											
Pyralidae														
Sialidae									0.3					
TOTAL INSECTS	602.5	217.6	210.9	117.2	134.2	112.5	47.9	65.2	162.9	197.4	305.0	281.0	364.5	300.0
AVG. VOL. (CC)	2.2	1.0	1.1	0.7	1.2	0.6	0.4	0.5	0.8	0.6	1.2	1.4	1.8	1.4

APPENDIX 8 (CONTINUED). **AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION H FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.**

SERIES NUMBER	43	44*	45*	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-15	12	1	2-19	3-29	4-28	8-7	8-14	8-21	8-28	9-4	9-13	9-18	9-25
NO. OF SAMPLES	2	0	0	1	1	2	2	2	2	2	2	2	2	2
Hydracarina								0.5			0.5	0.5	1.5	1.0
Tubificidae	6.5			4.0					0.5		0.5			7.0
other Oligochaeta	5.0								0.5					
Hirudinea														
<u>Lymnaea</u>	18.0						2.0	1.5		1.0		0.5	2.0	0.5
<u>Physa</u>	4.5						1.5	0.5	1.5	0.5		1.5	1.5	
Planorbidae	0.5													
Pelecypoda														
Nematoda														
Amphipoda	1.5													
Tendipedidae	11.0			67.0	122.0	99.5	20.0	195.5	147.0	84.0	99.5	230.0	105.0	508.0
Simulidae	3.0						7.0	16.0	16.0	50.5	5.0	9.5	1.0	0.5
Tipulidae														
Heleidae														
Rhagionidae														
<u>Baetis</u>	1.5			21.0	13.0	17.5	10.0	10.5	17.5	18.0	22.0	12.0	15.0	9.0
<u>Tricorythodes</u>	98.0			84.0	19.0	1.5	190.5	281.5	235.5	172.5	136.0	209.0	100.5	179.0
<u>Ephemerella</u>	177.0			171.0	13.0	1.5			2.0		2.5	8.5	5.0	88.5
<u>Choroterpes</u>							51.0	66.5	90.5	62.5	59.5	34.0	35.0	8.5
<u>Paraleptophlebia</u>	4.0													
<u>Leptophlebia</u>					3.0	2.0								
<u>Traverella</u>								1.5						
<u>Brachycercus</u>							0.5							
<u>Isonychia</u>							0.5							
<u>Rhithrogenia</u>						0.5								
<u>Heptagenia</u>	2.0					5.5	3.0	2.0	2.5	2.0	2.0	2.5	5.0	4.0
<u>Iron</u>														
<u>Ephoron</u>							0.5	0.5	1.0		2.5	0.5		
<u>Ephemera</u>														
<u>Pentagenia</u>														
Perlidae								2.0		2.0	1.0	1.0	1.5	4.0
Perlodidae	1.0			1.0				0.5	2.0		1.0			
Hydropsychidae								2.5	5.5	6.5	5.5	5.5	1.0	1.5
Brachycentridae														
Hydroptilidae							8.5	14.5	2.0	2.0		1.5		
Lepidostomatidae														1.5
Leptocercidae	1.5					5.5			1.5	1.5	10.0	17.5	9.0	14.0
Glossosomatidae														
Elmidae	0.5								1.0		0.5	0.5		
Dytiscidae											0.5			
other Coleoptera														
Gomphidae	0.5				1.0			1.0	2.0	2.5	3.5	7.0	3.0	2.5
Coenagrionidae														
Corixidae														
Pyralidae												0.5		
Sialidae														
TOTAL NUMBER	336.0			348.0	171.0	133.5	295.0	597.0	436.0	498.0	352.0	541.5	286.5	829.5
AVG. VOL. (CC)	1.4			0.8	0.5	0.8	0.8	1.8	1.8	2.4	3.0	2.8	2.6	1.6

* No samples taken during December, 1963 and January, 1964.

APPENDIX 9. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION I FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-23	7-28	8-3	8-9	8-17	8-22	8-28	9-2	9-14	9-18	9-29	10-5	10-12	10-17
NO. OF SAMPLES	3	3	3	3	3	3	3	2	3	3	3	3	3	3
Hydracarina	0.3				0.3									
Tubificidae	0.7		1.0	0.7	2.7		0.3	0.5			4.0	10.0	10.3	48.3
other Oligochaeta		1.3	0.7	2.3	3.3	3.0	0.3	0.5			0.7	3.3		
Lymnaea														
Physa														
Nematoda												0.3		
Tendipedidae	0.7		2.0	2.3	5.7	2.7	2.7	0.5	0.3		0.3	0.3	0.3	0.7
Simulidae														
Tipulidae					0.3		0.3							
Heleidae														
Rhagionidae														
Anthomyiidae														
Baetis	2.0	1.7	1.7	3.3	2.0	3.0	2.7	1.0						
Tricorythodes	1.3	2.7	29.7	56.3	59.7	42.3	11.7	6.0						0.3
Ephemerella	0.3		0.3											
Choroterpes	0.7	1.0	2.7	1.3	5.3	4.3	0.7	0.5						
Traverella														
Brachycercus	0.3		0.3	0.3		0.7	0.3	0.5						
Isonychia														
Rhithrogenia				0.3										
Heptagenia					0.7	1.7	0.3							
Ephoron		2.3	18.7	17.7	15.0	24.0	17.0	12.5						
Ephemera						0.3	0.7							
Hexagenia	0.3													
Perlodidae			0.3											
Hydropsychidae				0.7	1.0									
Hydroptilidae														
Leptocercidae					1.0									
Glossosomatidae														
Elmidae														
other Coleoptera			0.3											
Gomphidae							0.3							
Coenagrionidae														
Pyralidae														
TOTAL NUMBER	6.7	8.9	57.7	85.3	97.0	82.0	37.2	22.0	0.3	0	5.0	13.9	10.6	49.3
AVG. VOL. (CC)	0.2	1.3	0.4	0.4	0.4	0.5	0.4	0.3	<0.1	0	<0.1	<0.1	<0.1	<0.1

APPENDIX 9 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION I FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-30	11-6	11-13	11-21	12-30	1-22	3-1	3-22	5-1	5-24	7-11	7-20	7-27	8-2
NO. OF SAMPLES	3	3	3	3	3	1	1	3	3	3	3	3	3	3
Hydracarina	0.3												0.3	0.3
Tubificidae	120.3	259.7	129.0	236.3	93.3	64.0	12.0	1.7	36.3	65.3	1.0	2.7		0.3
other Oligochaeta									6.0	6.0	0.7	7.7		0.3
Lymnaea													0.3	
Physa														1.0
Nematoda														
Tendipedidae	0.7	1.0	1.7	2.3			1.0	5.0	16.7	85.0		0.3	0.7	0.3
Simulidae											1.7	0.3	0.3	0.3
Tipulidae														
Heleidae														
Rhagionidae														
Anthomyiidae														
Baetis								0.3	0.3	1.0	9.7	5.3	2.0	2.7
Tricorythodes		0.3		0.3							1.0	1.3	4.3	12.0
Ephemerella											0.3			
Choroterpes											1.7	5.3	16.7	17.7
Traverella													0.7	1.0
Brachycercus														2.0
Isonychia														
Rhithrogenia											1.3	7.7	2.0	1.0
Heptagenia											1.7	2.7	2.7	4.0
Ephoron											1.0	1.7	9.7	5.7
Ephemera														
Hexagenia														
Perlodidae														
Hydropsychidae														
Hydroptilidae														
Leptocercidae														
Glossosomatidae														
Elmidae														
other Coleoptera														
Gomphidae				0.3			0.3						0.7	0.7
Coenagrionidae														
Pyralidae														
TOTAL NUMBER	121.3	261.0	130.7	239.2	93.3	64.0	13.3	7.0	59.3	157.3	20.1	35.0	43.0	48.6
AVG. VOL. (CC)	0.1	0.1	0.1	0.2	0.1	<0.1	0.1	<0.1	0.1	0.3	0.1	0.2	0.2	0.2

APPENDIX 9 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION I FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-9	8-15	8-23	8-29	9-6	9-13	9-20	9-26	10-4	10-10	10-16	10-26	10-31	11-10
NO. OF SAMPLES	1	3	3	3	3	2	3	3	3	3	2	2	2	2
Hydracarina					0.3									
Tubificidae		1.3	0.3		2.7	1.5	0.3	1.7		0.3		1.0		0.5
other Oligochaeta		1.0	0.3				0.3	2.0						
Lymnaea				0.3						0.3				
Physa				0.3			2.3		0.3	0.7			0.5	
Nematoda					0.3									
Tendipedidae	22.0	0.3	0.7		1.0	1.0		1.3	1.0	3.7	4.0	4.5	7.5	28.5
Simulidae		0.3												
Tipulidae														
Heleidae											0.5			
Rhagionidae														
Anthomyiidae	1.0													
Baetis	9.0	4.7	2.3				1.3	0.7	0.3		1.0			
Tricorythodes	21.0	49.0	9.3	4.3	1.3	3.3	5.3	4.3	3.7	35.5	7.0	6.5	3.5	4.5
Ephemerella							0.7		0.3	1.0	0.5	5.0	1.0	
Choroterpes	7.0	19.3	9.7	2.7	0.7		0.7							
Traverella		2.0												
Brachycercus	1.0	2.0		0.3									0.5	
Isonychia														
Rhithrogenia	3.0	1.7	0.3		0.7	0.3		1.7						
Heptagenia		0.3	1.7	1.3	1.0	0.7	1.3		0.7	7.0	1.0	0.5	2.5	0.5
Ephoron	19.0	4.0	0.7	0.7	0.7				0.3					
Ephemera										0.5				
Hexagenia														
Perlodidae		0.7			1.0	0.5			0.3				0.5	
Hydropsychidae														
Hydroptilidae	1.0	1.7	1.0											
Leptocercidae		0.3				1.0	0.3							
Glossosomatidae														
Elmidae			0.3											
other Coleoptera							0.3							
Gomphidae		0.3		0.3	0.3		1.0	1.0	1.0	0.7				
Coenagrionidae							0.3							
Pyralidae							0.3							
TOTAL NUMBER	82.0	88.9	26.6	10.2	10.0	10.5	14.4	12.7	7.9	35.0	14.0	17.5	16.0	34.0
AVG. VOL. (CC)	0.7	0.8	0.2	0.1	0.1	0.1	0.3	0.1	0.2	0.2	0.1	0.1	0.1	0.1

APPENDIX 9 (CONTINUED). AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION I FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	43	44*	45	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-15	12	1-27	2-18	3-23	4-27	8-7	8-15	8-21	8-29	9-5	9-12	9-18	9-25
NO. OF SAMPLES	2	0	3	2	1	2	2	2	2	2	2	2	2	2
Hydracarina												0.5		
Tubificidae	0.5		0.3	0.5		2.5						0.5		
other Oligochaeta						1.5						0.5		
Lymnaea														
Physa														
Nematoda														
Tendipedidae	6.0		3.0	59.5	5.0	58.5	3.5	9.5	21.5	20.0	38.0	107.5	17.0	52.5
Simulidae													0.5	
Tipulidae														
Heleidae														
Rhagionidae				1.0		0.5								
Anthomyiidae														
Baetis	0.5			10.5		5.0	3.0	5.0	4.5	3.0	2.0			1.5
Tricorythodes	2.0					1.5	31.0	15.0	15.5	8.5	16.0	3.5	3.0	2.5
Ephemerella	1.0		0.7	1.5		10.5						1.0		
Choroterpes							24.5	14.0	14.5	9.5	23.0	11.5	2.5	2.5
Traverella							18.0	5.0	6.0	1.5	1.5			
Brachycercus							1.5				0.5	1.5		
Isonychia							1.0	0.5						
Rhithrogenia			2.0	7.0			1.5	1.5	1.5			0.5		2.0
Heptagenia	1.0					2.5	8.5	1.0	5.5	2.5	3.5	1.0	3.0	2.5
Ephoron							13.5	9.0	4.5	2.0	15.5	8.0	2.5	4.0
Ephemera														
Hexagenia														
Perlodidae						0.5						1.0		1.0
Hydropsychidae							0.5		1.5	1.0			2.5	0.5
Hydroptilidae							0.5	0.5	0.5	1.5				
Leptocercidae							0.5				0.5	1.5		
Glossosomatidae												0.5		
Elmidae														
other Coleoptera												0.5		
Gomphidae				0.5			1.0			1.0	1.0			
Coenagrionidae														
Pyralidae														
TOTAL NUMBER	11.0		6.0	80.0	5.0	83.0	108.5	61.0	75.5	50.5	101.5	139.5	31.0	67.0
AVG. VOL. (CC)	<0.1		<0.1	0.4	<0.1	0.6	0.8	0.4	0.5	0.6	1.0	0.4	0.2	0.3

* No samples taken during December, 1963.

APPENDIX 10. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION #16 FROM SEPTEMBER 13, 1963 TO APRIL 19, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
YEAR	1963											1964			
MONTH & DAY	9-13	9-20	9-27	10-4	10-11	10-16	10-27	10-31	11-10	11-15	12-17	1-26	2-27	3-31	4-19
NO. OF SAMPLES	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2
Hydracarina					1.0										
Tubificidae							1.0		2.0	2.0	36.0				9.0
other Oligochaeta										1.0					2.0
Physa	1.0						2.0								
Tendipedidae	2.0	1.0	3.0		3.0	8.0	23.0	31.0	44.0	92.0	10.0	26.0	39.0	16.0	22.0
Heleidae			1.0												
Baetis	4.0	2.0	2.0	1.0	4.0	2.5	5.0				2.0	2.0	1.0	2.0	2.0
Tricorythodes	10.0	2.0	16.0	4.0	26.0	9.5	36.0	9.0	18.0	44.0		2.0	13.0	3.0	2.5
Ephemerella		1.0	4.0		2.0	23.0	28.0	6.0	15.0	27.0	1.0	4.0	5.0	7.0	7.0
Choroterpes	4.0	1.0													
Traverella	2.0						2.0					1.0	3.0		
Rhithrogenia	8.0		5.0	3.0	1.0	1.5	11.0	17.0	4.0	11.0	13.0	10.0		13.0	2.0
Heptagenia			1.0	1.0	11.0	8.0	10.0	5.0	7.0	5.0	2.0	3.0		3.0	1.5
Perlidae							1.0								
Perlodidae		1.0				2.0	1.0	2.0	1.0			2.0			1.0
Hydropsychidae			1.0					1.0							
Leptocercidae			1.0						1.0						
Gomphidae	1.0	1.0			1.0				1.0						1.0
TOTAL NUMBER	32.0	9.0	34.0	9.0	49.0	99.0	119.0	72.0	93.0	182.0	64.0	50.0	61.0	44.0	65.0
AVG. VOL. (CC)	1.5	0.4	0.1	<0.1	0.7	0.7	0.3	0.4	0.3	0.3	0.2	0.3	0.2	0.2	0.5

APPENDIX 11. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATION #17 FROM MARCH 24, 1963 TO SEPTEMBER 6, 1963.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12
YEAR	1963											
MONTH & DAY	3-24	4-30	5-25	7-11	7-20	7-27	8-2	8-9	8-15	8-23	8-30	9-6
NO. OF SAMPLES	1	1	1	1	1	1	1	1	1	1	1	1
Tubificidae	1.0	45.0	17.0	1.0	2.0			5.0	8.0	2.0		69.0
other Oligochaeta		21.0					3.0	8.0	4.0	2.0	3.0	9.0
Physa								1.0	8.0	2.0		1.0
Tendipedidae	16.0	249.0	17.0			1.0	1.0	1.0	5.0	1.0	3.0	
Simulidae				5.0	4.0	1.0			2.0		1.0	
Rhagionidae		1.0										
Baetis	1.0	3.0		23.0	14.0	9.0	5.0	3.0	8.0	1.0		
Tricorythodes	1.0				2.0	9.0	50.0	4.0	47.0	14.0	5.0	40.0
Ephemerella												1.0
Choroterpes							7.0	34.0	17.0	8.0	6.0	14.0
Traverella				11.0	292.0	47.0	29.0	3.0	8.0			
Brachycercus									31.0	5.0	2.0	
Isonychia					14.0				1.0			
Rhithrogenia				5.0	12.0				5.0			
Heptagenia					1.0	3.0	3.0		3.0	1.0	2.0	2.0
Ephoron				6.0	22.0	36.0	39.0	18.0	8.0	5.0		
Perlodidae					2.0	1.0	1.0				1.0	
Brachycentridae									1.0			
Hydroptilidae						2.0						
Elmidae									1.0			
Gomphidae						1.0		1.0	7.0	1.0	2.0	7.0
Corixidae								4.0	3.0			
TOTAL NUMBER	19.0	319.0	34.0	51.0	370.0	110.0	138.0	82.0	167.0	42.0	25.0	143.0
AVG. VOL. (CC)	0.2	0.8	<0.1	0.2	1.3	0.6	0.8	0.6	1.8	0.5	0.3	1.0

APPENDIX 12. AVERAGE NUMBER OF ORGANISMS PER SQUARE FOOT TAKEN IN BOTTOM SAMPLES AT STATIONS ON THE LOWER RIVER IN MARCH, APRIL, AND MAY, 1963.

Station #19

NO. OF SAMPLES	1
DATE	5-25
Tubificidae	3.0
Tendipedidae	16.0
TOTAL NUMBER	19.0
AVERAGE VOLUME (CC)	<0.1

Station #20

NO. OF SAMPLES	1	2
DATE	3-24	4-30
Tubificidae		1.0
Tendipedidae	50.0	5.0
Simulidae	3.0	
Heleidae	1.0	
<u>Baetis</u>	2.0	1.0
TOTAL NUMBER	56.0	7.0
AVERAGE VOLUME (CC)	0.4	<0.1

Station #21

NO. OF SAMPLES	1
DATE	3-23
Tendipedidae	5.0
TOTAL NUMBER	5.0
AVERAGE VOLUME (CC)	0.2

APPENDIX 13. NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION A FROM JULY 16, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8*	9	10*	11	12	13	14
YEAR	1962													
MONTH & DAY	7-16	7-26	7-30	8-6	8-13	8-20	8-29	9-3	9-11	9-20	9-27	10-2	10-8	10-15
Hydracarina		1	1											
Lymnaea			1											
Tendipedidae	10		3		1		1					2	1	
Simulidae														
Heleidae														
Tabanidae	1													
Baetidae	1		1	2		1			1					
Heptagenidae														
Perlodidae														
Nemouridae														
Hydropsychidae	1													
Hydroptilidae														
Lepidostomatidae														
Leptocercidae														
Glossosomatidae														
Elmidae				1										
Dytiscidae														
other Coleoptera														
Corixidae	4		1											
Proctotrupoidea														
other Hymenoptera														
Entomobryidae														
non-aquatic		1												
TOTAL INVERTEBRATES	17	2	7	3	1	1	1		1		0	2	1	0
AVERAGE WATER VELOCITY (CFS)		0.34	0.38	0.25	0.22	0.18	0.14		0.12		0.12	0.29	0.33	0.33
LENGTH OF SET (MIN)		5	5	5	5	5	5	0	5	0	10	15	5	5
AVERAGE VOLUME (CC)	0.8	1.0	2.0	<0.1	<0.1	<0.1	<0.1		<0.1		0	<0.1	<0.1	0
NUMBER OF ORGANISMS PER MINUTE PER CFS		18.1	5.6	3.5	1.4	1.6	2.2		2.8		0	0.6	9.4	0

* No samples taken.

APPENDIX 13 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION A FROM JULY 16, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-26	11-1	11-8	11-15	12-16	1-17	2-25	3-25	4-22	5-20	7-8	7-15	7-23	7-29
Hydracarina														
Lymnaea													1	1
Tendipedidae								7	5		3	5		1
Simulidae											1	2	1	
Heleidae											1	3		
Tabanidae														
Baetidae	1		1	1	1			8	1	2	10	5		1
Heptagenidae								5		1		1		
Perlodidae								1						1
Nemouridae								1						
Hydropsychidae														
Hydroptilidae														
Lepidostomatidae														
Leptocercidae														
Glossosomatidae														
Elmidae			1										1	1
Dytiscidae											1			
other Coleoptera				1										
Corixidae			1											
Proctotrupoidea														
other Hymenoptera												1		
Entomobryidae				1										
non-aquatic												6		
TOTAL INVERTEBRATES	1	0	3	3	1	0	0	22	6	3	16	23	3	4
AVERAGE WATER VELOCITY (CFS)	0.31	0.31	0.33	0.29	0.37	0.25	0.74	0.64	0.62	0.27	0.58	0.62	0.37	0.29
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	<0.1	0	<0.1	<0.1	<0.1	0	0	1.5	0.1	<0.1	0.3	0.3	<0.1	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	1.0	0	2.8	3.1	0.8	0	0	10.6	2.9	3.5	8.3	11.0	2.5	4.2

APPENDIX 13 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION A FROM JULY 16, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-5	8-12	8-19	8-25	9-3	9-10	9-16	9-23	10-2	10-7	10-13	10-23	10-28	11-5
Hydracarina										1				
Lymnaea														
Tendipedidae	1							3			1			
Simulidae														
Heleidae														
Tabanidae														
Baetidae	2							3		1		1		
Heptagenidae								2						1
Perlodidae								2						
Nemouridae														
Hydropsychidae														
Hydroptilidae	1													
Lepidostomatidae								5			1			
Leptocercidae								3						
Glossosomatidae														
Elmidae	1													
Dytiscidae														
other Coleoptera														
Corixidae														
Proctotrupoidea														
other Hymenoptera														
Entomobryidae														
non-aquatic	1										1			
TOTAL INVERTEBRATES	6	0	0	0	0	0	0	18	0	2	3	1	0	1
AVERAGE WATER VELOCITY (CFS)	0.22	0.37	0.33	0.29	0.29	0.29	0.33	0.60	0.55	0.40	0.37	0.37	0.37	0.37
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	5	10	10	10	6	12	10
AVERAGE VOLUME (CC)	<0.1	0	0	0	0	0	0	<0.1	0	<0.1	<0.1	<0.1	0	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	8.5	0	0	0	0	0	0	9.0	0	0.8	1.3	7.1	0	0.4

APPENDIX 13 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION A FROM JULY 16, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	43	44	45	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-11	12-11	1-38	2-21	3-25	4-21	8-3	8-10	8-17	8-24	8-31	9-8	9-14	9-21
Hydracarina							1	1						
Lymnaea														
Tendipedidae			1		1	1			1			1	1	3
Simulidae										2				
Heleidae														
Tabanidae														
Baetidae					1	2	1	4		1	1	1		
Heptagenidae														
Perlodidae														
Nemouridae														
Hydropsychidae														
Hydroptilidae													1	
Lepidostomatidae														
Leptocercidae														
Glossosomatidae												1		
Elmidae									1					
Dytiscidae														
other Coleoptera														
Corixidae							1							
Proctotrupoidea											1			
other Hymenoptera														
Entomobryidae														
non-aquatic														
TOTAL INVERTEBRATES	0	0	1	0	2	3	3	5	2	3	2	3	2	3
AVERAGE WATER VELOCITY (CFS)	0.37	0.37	0.62	0.77	0.71	0.65	0.66	0.53	0.40	0.33	0.29	0.27	0.25	0.29
LENGTH OF SET (MIN)	12	5	5	5	5	5	5	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	0	0	<0.1	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	0	0	0.5	0	0.9	1.4	1.4	2.8	1.5	2.7	2.1	3.4	2.5	3.1

APPENDIX 14. NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION B FROM JULY 21, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8*	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-21	7-26	7-30	8-6	8-13	8-20	8-29	9-3	9-11	9-18	9-27	10-2	10-8	10-15
Hydracarina	2	1	4		2	1	1			1				
Tubificidae							1			1		6	1	
<u>Lymnaea</u>	1													
<u>Physa</u>														
Tendipedidae	6	2	5	24	22	31	28		4	3	10	12		1
Simulidae	1			7	5	5	2		4			1		
Tipulidae									3					
Heleidae				2			1		1		3	8		
Empididae				1					1			1		
Dolichopodidae										2				
Muscidae												2		
Sarcophagidae													1	
Scopeumatidae										1			1	
Sciomyzidae		1							2		1			
Phoridae											1			
Baetidae	7	3	8	6	6	31	30		5	1				3
Heptagenidae														
Perlodidae	1						1		1					
Hydropsychidae		1	1											
Hydroptilidae		1		4	1	2	3							
Leptocercidae			1						1					
Odontocercidae				1										
Elmidae									3	3		2		3
Dytiscidae	1		1	1	1				9	4	3		1	
other Coleoptera	2			1							2	1		
Corixidae	3	1	4	5	2				2		1	3		2
Proctotrupoidea														
Chalcidoidea				3										
Ichneumonidae													1	
Braconidae							1				1	1		
other Hymenoptera									1		2	2		
non-aquatic	6			3	3	3	3		1	2	7	9	1	1
TOTAL INVERTEBRATES	30	9	25	58	44	73	71		37	19	31	48	6	10
AVERAGE WATER VELOCITY (CFS)	1.5	0.92	0.92	0.68	0.58	0.58	0.52		0.55	0.40	0.52	0.55	0.58	0.52
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	0	5	5	5	10	5	5
AVERAGE VOLUME (CC)	1.5	0.6	0.2	0.4	0.3	0.4	0.4		0.3	0.2	0.2	0.3	0.1	0.2
NUMBER OF ORGANISMS PER MINUTE PER CFS	6.0	2.9	8.0	25.5	22.9	38.0	41.2		20.7	14.4	18.0	13.4	3.0	5.6

* No samples taken.

APPENDIX 14 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION B FROM JULY 21, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-25	11-5	11-10	11-17	12-21	1-19	2-25	3-26	4-23	5-20	7-8	7-15	7-23	7-29
Hydracarina										2	1		2	1
Tubificidae	1	4	13	1	5				2	52				
Lymnaea														
Physa														
Tendipedidae		2	1		1	1		2	12	61	2	1	6	7
Simulidae											6	1	2	12
Tipulidae														
Heleidae										2		1		
Empididae														
Dolichopodidae														
Muscidae														
Sarcophagidae														
Scopeumatidae														
Sciomyzidae														
Phoridae														
Baetidae					2					32	31	9	4	25
Heptagenidae														
Perlodidae														
Hydropsychidae														
Hydroptilidae														
Leptocercidae														
Odontocercidae														
Elmidae		2	2	1	1									
Dytiscidae	1	1	1						1	2				
other Coleoptera		1			1					3	1			
Corixidae	2	1		4				1			1			
Proctotrupoidea														
Chalcidoidea														
Ichneumonidae														
Braconidae														
other Hymenoptera	2									3				1
non-aquatic	10										2	1	1	4
TOTAL INVERTEBRATES	16	11	17	5	10	2	0	3	15	157	44	13	15	50
AVERAGE WATER VELOCITY (CFS)	0.42	0.33	0.40	0.40	0.71	0.62	0.62	0.65	1.05	0.68	0.89	0.76	0.77	0.62
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	5	5	5	5	2	5.5	5
AVERAGE VOLUME (CC)	0.2	0.2	0.1	0.2	0.1	<0.1	0	0.1	0.2	0.4	0.3	<0.1	0.1	0.3
NUMBER OF ORGANISMS PER MINUTE PER CFS	11.5	9.9	12.9	3.8	4.4	1.0	0	1.4	4.2	69.1	15.0	13.0	5.1	22.4

APPENDIX 14 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION B FROM JULY 21, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-5	8-12	8-19	8-26	9-3	9-10	9-18	9-23	10-2	10-9	10-13	10-23	10-28	11-7
Hydracarina							1							
Tubificidae		1				3								
Lymnaea									1					
Physa							1							
Tendipedidae		2	4	7	1	8	4		4	11	7	19	3	2
Simulidae	2	3	3	5		3	3		1					
Tipulidae														
Heleidae		1								1			1	1
Empididae														
Dolichopodidae														
Muscidae														
Sarcophagidae														
Scopeumatidae														
Sciomyzidae														
Phoridae														
Baetidae	2	3	12	43	5	11	24		1	5		8	2	4
Heptagenidae				1							1		1	
Perlodidae											1			
Hydropsychidae														
Hydroptilidae						1								
Leptocercidae								1						
Odontocercidae														
Elmidae														
Dytiscidae		1												
other Coleoptera														
Corixidae	1													
Proctotrupoidea														
Chalcidoidea														
Ichneumonidae														
Braconidae														
other Hymenoptera														
non-aquatic	2		1	1		2			3	3				
TOTAL INVERTEBRATES	7	11	20	57	6	28	33	1	10	20	9	27	7	7
AVERAGE WATER VELOCITY (CFS)	0.70	0.62	0.65	0.58	0.64	0.65	0.33	0.76	0.76	0.74	0.70	0.70	0.70	0.20
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	2.5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	0.1	0.1	0.2	0.5	0.2	0.2	0.2	<0.1	0.1	0.1	0.1	0.1	<0.1	0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	5.0	5.3	9.2	29.6	2.9	12.9	29.7	0.8	4.0	8.0	3.8	11.3	2.9	10.8

APPENDIX 14 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION B FROM JULY 21, 1962 TO SEPTEMBER 21, 1964.

SERIES NUMBER	43	44	45	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-12	12-12	1-28	2-22	3-26	4-22	8-4	8-11	8-19	8-24	8-31	9-7	9-14	9-21
Hydracarina														
Tubificidae														
Lymnaea														
Physa														
Tendipedidae	4		1			127	7	3	1	2	9	5	3	30
Simulidae							4		1					
Tipulidae														1
Heleidae							1							
Empididae														
Dolichopodidae														
Muscidae						1			1					
Sarcophagidae														
Scopeumatidae														
Sciomyzidae														
Phoridae														
Baetidae	1		4		2	4	5	4	3	1	4	4	4	29
Heptagenidae						2	1							1
Perlodidae														
Hydropsychidae														
Hydroptilidae							1							2
Leptocercidae						12								
Odontocercidae														
Elmidae														
Dytiscidae						6	1					1	1	
other Coleoptera														
Corixidae							1				1			
Proctotrupoidea							1							
Chalcidoidea														
Ichneumonidae														
Braconidae														
other Hymenoptera														
non-aquatic	1						1	1		1	4	2	6	2
TOTAL INVERTEBRATES	6	0	5	0	2	152	23	8	6	4	18	12	14	65
AVERAGE WATER VELOCITY (CFS)	0.72	0.58	0.55	0.55	0.22	0.68	0.74	0.67	0.60	0.56	0.55	0.55	0.54	0.58
LENGTH OF SET (MIN)	6	5	5	5	5	6	5	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	<0.1	0	<0.1	0	<0.1	0.8	0.2	<0.1	0.2	<0.1	0.1	0.1	0.3	0.5
NUMBER OF ORGANISMS PER MINUTE PER CFS	2.0	0	2.8	0	2.1	33.4	9.2	3.9	3.0	2.2	10.1	6.7	7.8	33.8

APPENDIX 15. NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION C FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	1*	2	3	4	5	6	7	8*	9	10*	11	12	13	14
YEAR	1962													
MONTH & DAY	7-17	7-29	7-31	8-7	8-15	8-21	8-30	9-3	9-12	9-24	9-28	10-3	10-9	10-16
Hydracarina			2	2		1								
Oligochaeta			1											
Tendipedidae		2	10	15	17	3	10		4		2	2		
Simulidae		2	1	1	4	1								
Heleidae				1	3									
Culicidae		1		1										
Dolichopodidae				1										
Muscidae														
Sciomyzidae														
Baetidae		7	62	17	513	77	4		11		3	2	1	3
Heptagenidae						1								
Perlodidae														
Hydropsychidae		1												
Brachycentridae														
Hydroptilidae					1		1							
Lepidostomatidae														
Psychomyiidae														
Glossosomatidae														
Pteronarcidae														
Elmidae				1										
Dytiscidae				9	1	1	3							
other Coleoptera														
Corixidae			1		1									
Proctotrupoidea														
Braconidae														
non-aquatic			1	2		1	1		1					
TOTAL INVERTEBRATES		13	78	50	540	85	19		16		5	4	1	3
AVERAGE WATER VELOCITY (CFS)		0.75	0.74	0.62	0.54	0.54	0.38		0.33		0.29	0.29	0.29	0.29
LENGTH OF SET (MIN)	0	5	5	5	5	5	5	0	5	0	6	15	5	5
AVERAGE VOLUME (CC)		0.3	1.0	0.3	2.5	0.5	0.2		0.1		<0.1	<0.1	<0.1	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS		5.2	31.2	24.0	302.0	47.6	15.2		14.4		4.3	1.6	1.0	3.1

* No samples taken.

APPENDIX 15 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION C FROM JULY 17, 1962 TO SEPTEMBER 27, 1964.

SERIES NUMBER	15	16	17	18*	19*	20*	21*	22*	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-26	11-2	11-9	11-20	12-17	1-16	2-19	3-25	4-24	5-21	7-9	7-16	7-24	7-30
Hydracarina											1	1	1	1
Oligochaeta														
Tendipedidae		1								2	5		2	
Simulidae														
Heleidae													1	
Culicidae														
Dolichopodidae														
Muscidae														
Sciomyzidae														
Baetidae	1								5	83	20	4	2	5
Heptagenidae											3			
Perlodidae										1				
Hydropsychidae										1			1	
Brachycentridae											5	2		
Hydroptilidae										1				
Lepidostomatidae										6				
Psychomyiidae														
Glossosomatidae										2				
Pteronarcidae														
Elmidae														
Dytiscidae			3						7	3				
other Coleoptera										1				
Corixidae														
Proctotrupoidea														
Braconidae														
non-aquatic														2
TOTAL INVERTEBRATES	1	1	3						12	100	34	5	9	8
AVERAGE WATER VELOCITY (CFS)	0.25	0.25	0.46						0.76	0.92	0.71	0.77	0.77	0.74
LENGTH OF SET (MIN)	5	5	5	0	0	0	0	0	5	5	5	5	5	5
AVERAGE VOLUME (CC)	<0.1	<0.1	<0.1						0.1	0.9	0.5	<0.1	0.2	0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	1.2	1.2	2.0						4.8	80.0	14.3	5.0	3.6	3.2

* No samples taken.

APPENDIX 15 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION C FROM JULY 17, 1962 TO SEPTEMBER 27, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-6	8-13	8-20	8-27	9-4	9-11	9-17	9-24	10-3	10-8	10-14	10-24	10-29	11-6
Hydracarina														
Oligochaeta														
Tendipedidae	5		1	2	4			1	3	1	1			
Simulidae	1				1									
Heleidae												1		
Culicidae														
Dolichopodidae														
Muscidae								1					1	
Sciomyzidae														
Baetidae	5	2	1	1		2	4	1	1	2				
Heptagenidae												1		
Perlodidae														
Hydropsychidae												1		
Brachycentridae			2				1							
Hydroptilidae														
Lepidostomatidae									3		1			
Psychomyiidae	1													
Glossosomatidae														
Pteronarcidae				2										
Elmidae														
Dytiscidae	2			1	2									
other Coleoptera														
Corixidae														
Proctotrupoidea														
Braconidae										1				
non-aquatic	5						2	5			1	1		
TOTAL INVERTEBRATES	19	2	4	6	7	2	7	8	7	4	3	4	1	0
AVERAGE WATER VELOCITY (CFS)	0.65	0.76	0.65	0.72	0.83	0.77	0.92	0.65	0.77	0.71	0.66	0.65	0.65	0.66
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	5	5	5	6	6	5	5
AVERAGE VOLUME (CC)	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0
NUMBER OF ORGANISMS PER MINUTE PER CFS	8.7	0.8	1.8	2.5	2.5	0.8	2.2	3.7	2.8	1.7	1.2	15.2	0.5	0

APPENDIX 15 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION C FROM JULY 17, 1962 TO SEPTEMBER 27, 1964.

SERIES NUMBER	43	44*	45*	46*	47*	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-13	12	1	2	3	4-23	8-5	8-12	8-18	8-25	9-1	9-9	9-16	9-22
Hydracarina														
Oligochaeta														
Tendipedidae							3	6	5	1	2	10	9	2
Simulidae														
Heleidae														
Culicidae														
Dolichopodidae											1			2
Muscidae							1							
Sciomyzidae							1							
Baetidae	1					1	2	1	1	5	2			
Heptagenidae										1				
Perlodidae														
Hydropsychidae														
Brachycentridae							1							
Hydroptilidae														
Lepidostomatidae														
Psychomyiidae														
Glossosomatidae														
Pteronarcidae														
Elmidae														
Dytiscidae								8		1		13	1	2
other Coleoptera														
Corixidae												1		
Proctotrupoidea										1				
Braconidae														
non-aquatic								1		1		1	2	2
TOTAL INVERTEBRATES	1					1	8	16	6	10	5	25	12	8
AVERAGE WATER VELOCITY (CFS)	0.70					0.74	0.90	0.82	0.72	0.62	0.58	0.55	0.40	0.40
LENGTH OF SET (MIN)	10					5	5	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	<0.1					<0.1	0.1	0.2	0.1	0.2	<0.1	0.2	<0.1	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	0.2					0.4	2.7	5.8	2.5	4.8	2.6	14.0	9.1	6.1

* No samples taken.

APPENDIX 16. NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION D FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8*	9	10*	11	12	13	14
YEAR	1962													
MONTH & DAY	7-17	7-29	7-30	8-7	8-15	8-21	8-30	9-3	9-12	9-24	9-28	10-3	10-9	10-16
Hydracarina							1							
Oligochaeta														
Tendipedidae		26	27	32	8	8	46				5	12		12
Simulidae		2	1	2	10	1	1				2			
Tipulidae		1	1											
Heleidae	1		3	2			1							
Empididae				1										
Culicidae	3				1									
Dolichopodidae			2											
Muscidae	1		1			1								
Scopeumatidae														
Sciomyzidae		1												
Phoridae											1			
Baetidae		25	18	20	9	14	38		1		19	16		3
Heptagenidae						1								
Perlodidae			1	1										
Pteronarcidae														
Nemouridae														
Brachycentridae														
Hydroptilidae			1	2		3	2							
Lepidostomatidae														
Helicopsychidae							1						1	
Phryganeidae			1											
Psychomyiidae	2													
Glossosomatidae														
Elmidae			1		1									
Dytiscidae		1	1	6	2	1	3		7			1	1	2
other Coleoptera	1	1		1	1									
Corixidae	1	1		1										
Gerridae		1												
Mesoveliidae														2
Saldidae		1	1											
Proctotrupoidea														
Chalcidoidea			1											
Ichneumonidae														
Braconidae														
other Hymenoptera											1			
non-aquatic	2			3	1	2	4					1		1
TOTAL INVERTEBRATES	11	59	61	74	33	31	97		8		28	30	4	19
AVERAGE WATER VELOCITY (CFS)		0.62	0.62	0.52	0.38	0.40	0.24		0.29		0.33	0.33	0.33	0.33
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	0	5	0	5	5	5	5
AVERAGE VOLUME (CC)	0.2	1.1	4.4	0.5	0.3	0.4	0.5		0.1		0.2	0.4	0.1	0.2
NUMBER OF ORGANISMS PER MINUTE PER CFS	5.3	28.3	29.3	42.9	26.4	23.6	120.3		8.3		25.2	27.0	3.6	17.1

* No samples taken.

APPENDIX 16 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION D FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	15	16	17	18	19*	20*	21*	22*	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-26	11-2	11-9	11-16	12-17	1-16	2	3	4-24	5-21	7-9	7-16	7-24	7-30
Hydracarina	1		2							1	1			
Oligochaeta											1			
Tendipedidae	3	7	17						4	4	1		4	1
Simulidae		1												2
Tipulidae														
Heleidae														
Empididae														
Culicidae														
Dolichopodidae														
Muscidae														
Scopeumatidae	3	1												
Sciomyzidae														
Phoridae		1												
Baetidae	3	1	3	1					1	13	1	2	1	4
Heptagenidae														
Perlodidae			1											
Pteronarcidae														
Nemouridae									1					
Brachycentridae										1	2			2
Hydroptilidae														1
Lepidostomatidae														
Helicopsychidae														
Phryganeidae														
Psychomyiidae														
Glossosomatidae										4	1			
Elmidae														
Dytiscidae	1		1	2					4					
other Coleoptera		2												
Corixidae														
Gerridae														
Mesoveliidae														
Saldidae														
Proctotrupoidea														
Chalcidoidea														
Ichneumonidae		1												
Braconidae										1				
other Hymenoptera	1													
non-aquatic	3	2								2	1	1		
TOTAL INVERTEBRATES	14	16	23	3					10	26	8	3	5	10
AVERAGE WATER VELOCITY (CFS)	0.29	0.33	0.62	0.60					0.46	0.60	0.56	0.55	0.60	0.56
LENGTH OF SET (MIN)	5	5	5	5	0	0	0	0	5	2	5	2	5	5
AVERAGE VOLUME (CC)	0.1	0.2	0.2	<0.1					0.1	0.8	<0.1	<0.1	<0.1	0.2
NUMBER OF ORGANISMS PER MINUTE PER CFS	14.6	14.4	11.0	1.5					6.6	32.5	4.3	4.2	2.5	5.4

* No samples taken.

APPENDIX 16 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN BOTTOM SAMPLES AT STATION D FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-6	8-13	8-20	8-27	9-4	9-11	9-17	9-24	10-3	10-8	10-14	10-24	10-29	11-6
Hydracarina								1						
Oligochaeta														
Tendipedidae				2		4	1	3	9	3	1			
Simulidae								1						
Tipulidae														
Heleidae								6						1
Empididae														
Culicidae														
Dolichopodidae														
Muscidae								1						
Scopeumatidae														
Sciomyzidae								4						
Phoridae														
Baetidae	3	2	3	1	8	4	3	9		11	1		1	
Heptagenidae									1					
Perlodidae														
Pteronarcidae							1							
Nemouridae														
Brachycentridae				3			1							
Hydroptilidae														
Lepidostomatidae										1				
Helicopsychidae									3					
Phryganeidae														
Psychomyiidae														
Glossosomatidae														
Elmidae														
Dytiscidae		2						3						
other Coleoptera									1					
Corixidae														
Gerridae														
Mesoveliidae														
Saldidae														
Proctotrupoidea														
Chalcidoidea														
Ichneumonidae														
Braconidae								1						
other Hymenoptera														
non-aquatic				1			1	8	2		8			
TOTAL INVERTEBRATES	3	4	3	7	8	9	6	37	16	15	10	0	1	1
AVERAGE WATER VELOCITY (CFS)	0.64	0.71	0.65	0.62	0.68	0.68	0.70	0.60	0.35	0.62	0.58	0.56	0.52	0.56
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	<0.1	<0.1	<0.1	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0	<0.1	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	1.4	1.7	1.4	3.4	3.5	4.0	2.5	18.5	13.8	7.2	5.2	0	0.6	0.5

APPENDIX 16 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION D FROM JULY 17, 1962 TO SEPTEMBER 22, 1964.

SERIES NUMBER	43	44*	45	46*	47*	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-13	12	1-31	2	3	4-23	8-5	8-12	8-18	8-25	9-1	9-9	9-16	9-22
Hydracarina														2
Oligochaeta														
Tendipedidae							4	9	2	2	2	39	34	3
Simulidae														
Tipulidae														
Heleidae								1						
Empididae														
Culicidae														
Dolichopodidae														
Muscidae														
Scopeumatidae														1
Sciomyzidae														
Phoridae														
Baetidae						1	3	2	1	2	3	3	124	
Heptagenidae														
Perlodidae														
Pteronarcidae														
Nemouridae														
Brachycentridae										1				
Hydroptilidae														
Lepidostomatidae														
Helicopsychidae														
Phryganeidae														
Psychomyiidae														
Glossosomatidae														
Elmidae														
Dytiscidae							1	4						1
other Coleoptera							1							
Corixidae														
Gerridae														
Mesoveliidae														
Saldidae													1	
Proctotrupoidea													1	1
Chalcidoidea														
Ichneumonidae														
Braconidae														
other Hymenoptera														
non-aquatic							3		1		1		1	
TOTAL INVERTEBRATES	0		0			1	12	16	4	5	6	42	161	8
AVERAGE WATER VELOCITY (CFS)	0.58		0.25			0.38	0.68	0.43	0.18	0.15	0.12	0.40	0.42	0.38
LENGTH OF SET (MIN)	5	0	40	0	0	5	5	5	5	6	5	5	5	5
AVERAGE VOLUME (CC)	0		0			<0.1	0.2	0.1	<0.1	0.1	<0.1	0.1	0.2	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	0		0			0.1	5.3	11.5	5.8	10.0	15.0	31.9	115.9	6.4

* No samples taken.

APPENDIX 17. NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION E FROM JULY 18, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8*	9	10*	11	12	13	14
YEAR	1962													
MONTH & DAY	7-18	7-29	7-30	8-7	8-16	8-20	8-29	9-3	9-12	9-24	9-28	10-3	10-8	10-16
Hydracarina		6	3	8	3	1								
Oligochaeta														
Tendipedidae	1	4	2	7	6	2	2							1
Simulidae														
Tipulidae														
Heleidae	6	2												
Tabanidae	1													
Culicidae	1													
Baetidae	2	7	4	5	24	2	1		2					
Perlodidae														
Hydropsychidae					1									
Brachycentridae	2													
Hydroptilidae			1	1	2									
Lepidostomatidae														
Leptocercidae														
Helicopsychidae												1		
Dytiscidae					1				1			1		3
other Coleoptera														
Corixidae		4		2										
Chalcidoidea			1											
non-aquatic	1	1	1			1								
TOTAL INVERTEBRATES	14	24	12	23	37	6	3		3		0	2	0	4
AVERAGE WATER VELOCITY (CFS)	0.74	0.74	0.62	0.62	0.52	0.55	0.35		0.29		0.27	0.24	0.27	0.25
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	0	5	0	5	15	5	5
AVERAGE VOLUME (CC)	0.4	1.2	<0.1	<0.1	0.4	0.1	<0.1		<0.1		0	<0.1	0	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	3.6	9.6	5.8	11.0	21.5	3.4	2.6		3.1		0	0.7	0	4.7

* No samples taken.

APPENDIX 17 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION E FROM JULY 18, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	15	16	17	18*	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-27	11-3	11-14	11-19	12-18	1-18	2-27	3-27	4-26	5-22	7-10	7-18	7-25	7-30
Hydracarina											1		1	1
Oligochaeta										1				
Tendipedidae		1	1		2	1		5	30	3	1		1	
Simulidae														
Tipulidae							1				1			
Heleidae											1			
Tabanidae												1		
Culicidae														
Baetidae					1	1			4	41	3	1	1	2
Perlodidae											1			
Hydropsychidae														
Brachycentridae											1			
Hydroptilidae													1	
Lepidostomatidae										1				
Leptocercidae										1				
Helicopsychidae														
Dytiscidae			1		1			1	6				1	
other Coleoptera														
Corixidae														
Chalcidoidea														
non-aquatic					1						2	1		
TOTAL INVERTEBRATES	0	1	2		5	2	1	6	40	47	11	3	5	3
AVERAGE WATER VELOCITY (CFS)	0.24	0.24	0.27		0.55	0.55	0.18	0.33	0.37	0.55	0.65	0.54	0.55	0.46
LENGTH OF SET (MIN)	5	5	5	0	5	5	5	5	5	5	5	3	5	5
AVERAGE VOLUME (CC)	0	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	0.3	0.3	0.2	0.2	<0.1	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	0	1.2	2.2		2.8	1.1	1.7	5.4	3.4	26.3	5.1	2.9	2.8	2.0

* No sample taken.

APPENDIX 17 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION E FROM JULY 18, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-7	8-13	8-21	8-27	9-4	9-11	9-18	9-25	10-5	10-12	10-15	10-25	10-29	11-8
Hydracarina	1													
Oligochaeta														
Tendipedidae			1									1		
Simulidae									1					
Tipulidae														
Heleidae														
Tabanidae														
Culicidae														
Baetidae	1	3	1									1		
Perlodidae														
Hydropsychidae														
Brachycentridae				1										
Hydroptilidae														
Lepidostomatidae														
Leptocercidae									1					
Helicopsychidae														
Dytiscidae	1	1												
other Coleoptera						1						1		
Corixidae														
Chalcidoidea														
non-aquatic	1			1										
TOTAL INVERTEBRATES	4	4	2	2	0	1	0	0	2	0	0	3	0	0
AVERAGE WATER VELOCITY (CFS)	0.37	0.46	0.37	0.31	0.37	0.37	0.55	0.58	0.33	0.27	0.24	0.24	0.22	0.24
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	5	5	5	10	10	10	10
AVERAGE VOLUME (CC)	<0.1	<0.1	<0.1	<0.1	0	<0.1	0	0	<0.1	0	0	<0.1	0	0
NUMBER OF ORGANISMS PER MINUTE PER CFS	3.4	2.6	1.7	2.0	0	0.8	0	0	1.8	0	0	1.9	0	0

APPENDIX 17 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION E FROM JULY 18, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	43	44*	45*	46*	47*	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-13	12	1	2	3	4-25	8-6	8-12	8-19	8-26	9-2	9-8	9-16	9-23
Hydracarina														
Oligochaeta														
Tendipedidae							2	3	1		1		3	
Simulidae														
Tipulidae														
Heleidae														
Tabanidae														
Culicidae														
Baetidae							2	5	2		4		2	
Perlodidae														
Hydropsychidae									1					
Brachycentridae														
Hydroptilidae														
Lepidostomatidae														
Leptocercidae														
Helicopsychidae														
Dytiscidae								1		2				1
other Coleoptera														
Corixidae														
Chalcidoidea														
non-aquatic							1						1	
TOTAL INVERTEBRATES	0					0	5	9	4	2	5	0	6	1
AVERAGE WATER VELOCITY (CFS)	0.25					0.62	0.65	0.60	0.55	0.40	0.38	0.35	0.33	0.31
LENGTH OF SET (MIN)	12					5	5	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	0					0	<0.1	<0.1	<0.1	<0.1	<0.1	0	<0.1	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	0					0	2.3	4.5	2.2	1.5	4.0	0	5.4	1.0

* No samples taken.

APPENDIX 18. NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION F FROM JULY 20, 1962 TO SEPTEMBER 24, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8*	9	10*	11	12	13	14
YEAR	1962													
MONTH & DAY	7-20	7-29	8-1	8-6	8-13	8-20	8-30	9-3	9-11	9-20	9-27	10-4	10-9	10-15
Hydracarina	1	4		1	1									
Tubificidae														
other Oligochaeta									1					
Lymnaea														
Amphipoda		1							2					
Tendipedidae	1	7	7	4	13		6		1		1	1		5
Simulidae		1												
Heleidae		1	2				4						1	
Rhagionidae						1								
Culicidae		1												
Phoridae														
Baetidae		5	2	4	3	3	9		3					
Perlodidae		1												
Hydropsychidae									5					
Brachycentridae														
Hydroptilidae									2					
Lepidostomatidae														
Leptocercidae														
Glossosomatidae														
Elmidae		1				1								
Dytiscidae	1	1					1				1			2
other Coleoptera											1		1	
Corixidae	1	3	1											
Hymenoptera													1	
non-aquatic	1						3						3	1
TOTAL INVERTEBRATES	5	26	12	9	17	5	23		14		3	1	6	8
AVERAGE WATER VELOCITY (CFS)	0.77	0.77	0.73	0.65	0.56	0.56	0.40		0.40		0.40	0.37	0.37	0.33
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	0	5	0	5	5	5	5
AVERAGE VOLUME (CC)	0.2	0.4	0.1	<0.1	<0.1	0.1	0.3		0.3		<0.1	<0.1	<0.1	0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	2.0	10.2	5.0	5.2	12.6	2.7	17.5		10.7		2.3	0.8	5.0	7.2

* No samples taken.

APPENDIX 18 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION F FROM JULY 20, 1962 TO SEPTEMBER 24, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-27	11-3	11-8	11-15	12-13	1-19	3-2	3-21	4-23	5-22	7-9	7-15	7-23	7-31
Hydracarina											2			
Tubificidae												1		
other Oligochaeta										1				
<u>Lymnaea</u>														
Amphipoda														
Tendipedidae	5	1		9	8	1	4	4	29	2	1	2	3	1
Simulidae														
Heleidae														
Rhagionidae														
Culicidae	1													
Phoridae														
Baetidae									1	44	20	2	5	2
Perlodidae														
Hydropsychidae														
Brachycentridae														
Hydroptilidae											4			
Lepidostomatidae														
Leptocercidae														
Glossosomatidae													1	
Elmidae				1										
Dytiscidae	1		1	2	1									
other Coleoptera														
Corixidae			1								2			
Hymenoptera														
non-aquatic	1												1	
TOTAL INVERTEBRATES	8	1	2	12	9	1	4	4	30	47	29	5	10	3
AVERAGE WATER VELOCITY (CFS)	0.35	0.37	0.33	0.27	0.54	0.77	0.62	0.46	0.58	0.83	0.77	0.71	0.66	0.58
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	5	5	2	5	2	5	5
AVERAGE VOLUME (CC)	0.1	<0.1	0.1	0.6	<0.1	<0.1	<0.1	<0.1	0.3	0.4	0.1	<0.1	0.2	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	6.9	0.8	1.8	13.2	5.2	0.4	1.9	2.6	15.6	42.3	11.6	5.2	4.4	1.6

APPENDIX 18 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION F FROM JULY 20, 1962 TO SEPTEMBER 24, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-5	8-12	8-21	8-26	9-3	9-10	9-19	9-25	10-5	10-9	10-15	10-25	10-30	11-8
Hydracarina	2	1												
Tubificidae														
other Oligochaeta														
<u>Lymnaea</u>				1										
Amphipoda														
Tendipedidae			2	1		2					1			
Simulidae		1												
Heleidae														
Rhagionidae														
Culicidae														
Phoridae														
Baetidae	2	3	4				2				1			
Perlodidae														
Hydropsychidae														
Brachycentridae							1							
Hydroptilidae														
Lepidostomatidae														
Leptocercidae														
Glossosomatidae														
Elmidae					1					1				
Dytiscidae														
other Coleoptera														
Hymenoptera														
non-aquatic									1	1				
TOTAL INVERTEBRATES	4	5	6	2	1	2	5	0	1	2	2	1	0	0
AVERAGE WATER VELOCITY (CFS)	0.46	0.68	0.52	0.46	0.55	0.54	0.72	0.74	0.52	0.46	0.40	0.40	0.40	0.46
LENGTH OF SET (MIN)	5	2	5	5	5	5	5	5	5	5	12	5	5	5
AVERAGE VOLUME (CC)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0	<0.1	<0.1	<0.1	<0.1	0	0
NUMBER OF ORGANISMS PER MINUTE PER CFS	2.6	5.5	3.5	1.3	0.6	1.2	2.1	0	0.6	1.3	0.8	0.8	0	0

APPENDIX 18 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION F FROM JULY 20, 1962 TO SEPTEMBER 24, 1964.

SERIES NUMBER	43	44	45	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-12	12-12	1-31	2-23	3-27	4-26	8-4	8-11	8-19	8-26	9-2	9-8	9-17	9-24
Hydracarina														
Tubificidae														
other Oligochaeta														
<u>Lymnaea</u>														
Amphipoda														
Tendipedidae					1	1	1		34		3			
Simulidae														
Heleidae														
Rhagionidae														
Culicidae														
Phoridae														
Baetidae				1			2		1				1	
Perlodidae		2												
Hydropsychidae														
Brachycentridae		1				8			1					
Hydroptilidae														
Lepidostomatidae						2								
Leptocercidae														
Glossosomatidae														
Elmidae														
Dytiscidae														
other Coleoptera														
Corixidae														
Hymenoptera														
non-aquatic								1					1	
TOTAL INVERTEBRATES	0	3	0	1	1	11	3	1	36	0	3	0	2	0
AVERAGE WATER VELOCITY (CFS)	0.46	0.58	0.83	0.62	0.22	0.71	0.65	0.52	0.40	0.37	0.33	0.29	0.27	0.27
LENGTH OF SET (MIN)	5	5	5	5	5	5	55	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	0	0.2	0	<0.1	<0.1	0.2	<0.1	<0.1	0.1	0	<0.1	0	<0.1	0
NUMBER OF ORGANISMS PER MINUTE PER CFS	0	1.6	0	0.5	1.4	4.6	1.4	0.6	27.4	0	2.7	0	2.2	0

APPENDIX 19. NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION G FROM JULY 24, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8*	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-24	7-27	8-1	8-8	8-16	8-21	8-28	9-3	9-13	9-18	9-29	10-5	10-11	10-17
Hydracarina														
Tubificidae														
other Oligochaeta														
Physa														
Tendipedidae	19	11	9	1	1	3			4	14		5		
Simulidae														
Heleidae			1											
Empididae														
Empididae														
Culicidae														
Dolichopodidae										2				
Muscidae									2					
Scopeumatidae										1				
Sciomyzidae													1	
Baetidae	2		2	1	3	4				1	1			
Heptagenidae														
Perlodidae													1	
Brachycentridae	1													
Hydroptilidae										2				
Leptocercidae														
Elmidae													1	1
Dytiscidae			10						4	1		1	3	
other Coleoptera										2			4	
Corixidae											1			1
Proctotrupoidea														
Chalcidoidea														
Ichneumonidae	1	1												
Braconidae													3	
other Hymenoptera													2	
non-aquatic										13	1	5	20	5
TOTAL INVERTEBRATES	23	12	22	2	4	7	0		10	37	3	11	35	7
AVERAGE WATER VELOCITY (CFS)	0.37	0.37	0.38	0.31	0.22	0.20	0.18		0.37	0.37	0.37	0.52	0.52	0.52
LENGTH OF SET (MIN)	5	5	5	5	6	5	5	0	5	5	5	5.5	5	5
AVERAGE VOLUME (CC)	0.2	0.1	0.2	<0.1	<0.1	0.1	0		0.2	0.3	0.1	0.1	0.2	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	19.0	10.1	17.6	2.0	5.0	10.8	0		8.4	31.1	2.5	5.8	20.3	4.1

* No sample taken.

APPENDIX 19 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION G FROM JULY 24, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27*	28
YEAR	1962					1963								
MONTH & DAY	10-29	11-5	11-12	11-20	12-19	1-23	2-28	3-21	4-26	5-23	7-10	7-18	7-25	7-31
Hydracarina												1		
Tubificidae			1							12	2			
other Oligochaeta										1				
Physa														
Tendipedidae			2				1	1	3	11		1		
Simulidae														1
Heleidae														
Empididae	1													
Culicidae										4				
Dolichopodidae														
Muscidae														
Scopeumatidae														
Sciomyzidae														
Baetidae											6	1		1
Heptagenidae														
Perlodidae														
Brachycentridae														
Hydroptilidae											1	1		1
Leptocercidae														
Elmidae			1											
Dytiscidae	2	1												
other Coleoptera														
Corixidae												1		
Proctotrupoidea														1
Chalcidoidea														
Ichneumonidae														
Braconidae														
other Hymenoptera														
non-aquatic	3										1			
TOTAL INVERTEBRATES	6	1	4	0	0	0	1	1	3	28	10	5		4
AVERAGE WATER VELOCITY (CFS)	0.46	0.40	0.52	0.35	0.14	0.62	0.37	0.65	0.77	0.77	0.76	0.67		0.56
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	5	5	5	2	2	0	5
AVERAGE VOLUME (CC)	0.1	<0.1	<0.1	0	0	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	4.0	0.8	2.3	0	0	0	0.8	0.5	1.2	11.2	10.0	5.8		2.2

* No sample taken.

APPENDIX 19 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION G FROM JULY 24, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-7	8-14	8-21	8-28	9-5	9-12	9-19	9-25	10-6	10-12	10-15	10-27	10-30	11-9
Hydracarina														
Tubificidae							1							
other Oligochaeta														
Physa	1													
Tendipedidae	15	3					1	3						
Simulidae	1	2												
Heleidae								1						
Empididae														
Culicidae		1												
Dolichopodidae														
Muscidae		1												
Scopeumatidae														
Sciomyzidae														
Baetidae	94	91	2	1		1	16							
Heptagenidae														
Perlodidae														
Brachycentridae														
Hydroptilidae	1	1												
Leptocercidae		1						3						
Elmidae														
Dytiscidae														
other Coleoptera		1												
Corixidae	1													
Proctotrupoidea														
Chalcidoidea	1													
Ichneumonidae														
Braconidae														
other Hymenoptera							1							
non-aquatic							1							
TOTAL INVERTEBRATES	114	101	2	1	0	1	20	7	0	0	0	0	0	0
AVERAGE WATER VELOCITY (CFS)	0.52	0.60	0.46	0.46	0.40	0.40	0.58	0.65	0.46	0.40	0.40	0.46	0.46	0.40
LENGTH OF SET (MIN)	5	1	5	5	5	5	1	2	5	5	5	6	5	5
AVERAGE VOLUME (CC)	0.3	0.3	<0.1	<0.1	0	<0.1	0.2	<0.1	0	0	0	0	0	0
NUMBER OF ORGANISMS PER MINUTE PER CFS	66.1	252.5	1.3	0.7	0	0.8	52.0	8.1	0	0	0	0	0	0

APPENDIX 19 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION G FROM JULY 24, 1962 TO SEPTEMBER 23, 1964.

SERIES NUMBER	43	44*	45*	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-14	12	1	3-3	3-30	4-29	8-6	8-15	8-20	8-27	9-3	9-13	9-17	9-23
Hydracarina														
Tubificidae														
other Oligochaeta														
<u>Physa</u>														
Tendipedidae	1				11	11	5	6	5		1	5	1	6
Simulidae									1					
Heleidae														
Empididae														
Culicidae														
Dolichopodidae												1		
Muscidae														
Scopeumatidae														
Sciomyzidae								1						
Baetidae					1	14	15	14	59	7	2	3		1
Heptagenidae								1						1
Perlodidae														
Brachycentridae														
Hydroptilidae														
Leptocercidae						1								
Dytiscidae					1		4	1				1		
Elmidae						1								
other Coleoptera						1								
Corixidae														
Proctotrupoidea														
Chalcidoidea						1								1
Ichneumonidae														
Braconidae						1								
other Hymenoptera														
non-aquatic						2	3			1				
TOTAL INVERTEBRATES	1			0	15	32	27	23	65	7	4	10	1	9
AVERAGE WATER VELOCITY (CFS)	0.40			0.55	0.68	0.74	0.62	0.58	0.55	0.40	0.40	0.38	0.37	0.37
LENGTH OF SET (MIN)	5	0	0	5	5	5	5	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	<0.1			0	0.2	0.4	<0.1	0.3	0.4	0.1	<0.1	0.1	<0.1	0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	0.8			0	6.6	12.8	13.0	12.0	36.4	9.1	3.0	8.0	0.8	7.6

* No samples taken.

APPENDIX 20. NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION H FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8*	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-23	7-28	8-2	8-9	8-16	8-22	8-28	9-3	9-13	9-18	9-29	10-5	10-12	10-17
Hydracarina														
Tubificidae														
Tendipedidae	1		1	3		4	1			1		1		2
Simulidae														
Heleidae														1
Muscidae										2				
Sciomyzidae					1									
Baetidae	2	2	22	5	6	22	5							
Heptagenidae					1									
Hydropsychidae	1													
Hydroptilidae			1			3	1		2	2				
Leptocercidae					1	1								
Elmidae		1												
Coenagrionidae														
Corixidae							1							
Proctotrupoidea														
Chalcidoidea														
Ichneumonidae										1				
Braconidae										1				
non-aquatic	1						1			2	1	2	1	
TOTAL INVERTEBRATES	5	3	24	8	9	30	9		2	9	1	3	1	3
AVERAGE WATER VELOCITY (CFS)	0.74	0.74	0.67	0.66	0.54	0.52	0.40		0.29	0.29	0.52	0.54	0.55	0.55
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	0	5	5	5	5.5	5	5
AVERAGE VOLUME (CC)	0.2	<0.1	0.4	<0.1	0.2	0.4	0.2		<0.1	0.2	<0.1	<0.1	<0.1	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	2.0	1.2	11.0	3.7	5.0	17.4	6.8		2.1	9.5	0.6	1.5	0.6	1.7

* No sample taken.

APPENDIX 20 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION H FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	15	16	17	18	19	20	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-29	11-6	11-13	11-22	12-19	1-22	2-28	3-22	4-29	5-23	7-11	7-20	7-27	8-1
Hydracarina										1	1		1	
Tubificidae	1	3	3	2						1				
Tendipedidae	2		5	1			7	3		246	7	2		
Simulidae											10	1		1
Heleidae														
Muscidae														
Sciomyzidae														
Baetidae				1				1		1	5	4	6	4
Heptagenidae														
Hydropsychidae														
Hydroptilidae														
Leptocercidae														
Elmidae														
Coenagrionidae														
Corixidae												1		1
Proctotrupoidea														
Chalcidoidea														
Ichneumonidae														
Braconidae											2			
non-aquatic	5	2	2								3	1		1
TOTAL INVERTEBRATES	8	5	10	4	0	0	7	4	0	249	28	9	7	7
AVERAGE WATER VELOCITY (CFS)	0.54	0.54	0.56	0.60	0.40	0.37	0.33	0.40	0.40	0.40	0.60	0.52	0.40	0.40
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	5	5	5	2	2	5	5
AVERAGE VOLUME (CC)	0.1	<0.1	0.2	<0.1	0	0	0.2	<0.1	0	0.6	0.2	<0.1	0.2	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	4.5	2.8	5.4	2.0	0	0	6.3	3.0	0	189.2	35.0	13.1	5.3	5.3

APPENDIX 20 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION H FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-8	8-14	8-22	8-29	9-5	9-12	9-19	9-27	10-4	10-10	10-15	10-26	10-30	11-9
Hydracarina														
Tubificidae														
Tendipedidae	1							1		4	2			
Simulidae		1												
Heleidae												1		
Muscidae														1
Sciomyzidae														
Baetidae	5	46	5	38	1	13	2	2		1	1			
Heptagenidae		1												
Hydropsychidae														
Hydroptilidae		1		3	1									
Leptocercidae							1							
Elmidae														
Coenagrionidae							1							
Corixidae	1													
Proctotrupoidea														
Chalcidoidea														
Ichneumonidae														
Braconidae														
non-aquatic		1	1					1		1		1		
TOTAL INVERTEBRATES	7	50	6	41	2	13	4	4	0	6	3	2	0	1
AVERAGE WATER VELOCITY (CFS)	0.40	0.46	0.40	0.37	0.40	0.37	0.52	0.55	0.40	0.3	0.37	0.37	0.37	0.38
LENGTH OF SET (MIN)	2	2	2	5	5	1	5	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	<0.1	0.3	<0.1	0.3	<0.1	0.2	<0.1	<0.1	0	0.1	<0.1	<0.1	0	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	13.3	82.5	11.4	34.4	1.5	54.6	2.3	2.2	0	5.2	2.5	1.7	0	0.8

APPENDIX 20 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION H FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	43	44*	45*	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-15	12	1	2-19	3-29	4-28	8-7	8-14	8-21	8-28	9-4	9-13	9-18	9-25
Hydracarina														
Tubificidae														
Tendipedidae					3	5	7	1	2	3	2	1	1	3
Simulidae							1			1				1
Heleidae														
Muscidae														1
Sciomyzidae														
Baetidae					1	2	64	3	4		1		1	16
Heptagenidae							1		1					
Hydropsychidae														
Hydroptilidae								1	1	1	1			
Leptocercidae						1								
Elmidae														
Coenagrionidae														
Corixidae														
Proctotrupoidea									1					
Chalcidoidea														1
Ichneumonidae														1
Braconidae														1
non-aquatic							5			2	1			1
TOTAL INVERTEBRATES	0			0	4	8	78	5	9	7	5	1	3	25
AVERAGE WATER VELOCITY (CFS)	0.40			0.15	0.22	0.40	0.56	0.58	0.38	0.33	0.33	0.26	0.38	0.22
LENGTH OF SET (MIN)	6	0	0	10	20	5	5	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	0			0	0.1	0.2	0.6	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.2
NUMBER OF ORGANISMS PER MINUTE PER CFS	0			0	1.4	6.1	42.1	2.6	7.2	6.3	4.5	1.2	2.4	35.5

* No samples taken.

APPENDIX 21. NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION I FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8*	9	10	11	12	13	14
YEAR	1962													
MONTH & DAY	7-23	7-28	8-3	8-9	8-17	8-22	8-28	9-2	9-14	9-18	9-29	10-5	10-12	10-17
Hydracarina	1					1								
Tubificidae				2		1	1							
other Oligochaeta					4	2								
Nematoda													1	
Tendipedidae	1	2	8	6	11	8	4			1	1	1	1	
Simulidae			1		1									
Heleidae			2											
Sciomyzidae			1			1								
Ephydridae										1				
Baetidae	1		9	7	19	11	49							
Heptagenidae				1	7		1							
Ephemeridae	1													
Perlodidae														
Hydroptilidae					1	1	1			1				
Dytiscidae														
other Coleoptera											1			
Corixidae														
Proctotrupoidea														
Chalcidoidea														
Braconidae			1	1			1							
non-aquatic			16	4		4			2			1	1	
TOTAL INVERTEBRATES	4	2	38	21	43	29	57		2	3	2	2	3	0
AVERAGE WATER VELOCITY (CFS)	0.68	0.68	0.68	0.62	0.40	0.40	0.38		0.25	0.22	0.27	0.25	0.29	0.26
LENGTH OF SET (MIN)	5	5	5	5	5	5	5	0	5	5	10	5	5	5
AVERAGE VOLUME (CC)	0.2	<0.1	0.3	0.2	0.4	0.2	<0.1		<0.1	0.1	<0.1	<0.1	<0.1	0
NUMBER OF ORGANISMS PER MINUTE PER CFS	2.1	1.0	19.8	10.1	32.7	22.0	45.6		2.5	4.3	1.1	2.5	3.2	0

* No sample taken.

APPENDIX 21 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION I FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	15	16	17	18	19	20*	21	22	23	24	25	26	27	28
YEAR	1962					1963								
MONTH & DAY	10-30	11-6	11-13	11-21	12-20	1-22	3-1	3-22	5-1	5-24	7-11	7-20	7-27	8-2
Hydracarina														
Tubificidae	6	26	7	20	5				10	9				
other Oligochaeta										1				
Nematoda														
Tendipedidae	1		1						5	150	2	1	1	2
Simulidae											3		1	
Heleidae														
Sciomyzidae														
Ephydridae														
Baetidae								1			41	20	10	17
Heptagenidae													4	
Ephemeridae														
Perlodidae														
Hydroptilidae												1		2
Dytiscidae														
other Coleoptera													1	
Corixidae														
Proctotrupoidea														
Chalcidoidea														
Braconidae										1				
non-aquatic													1	
TOTAL INVERTEBRATES	7	26	8	20	5		0	1	15	161	46	22	18	21
AVERAGE WATER VELOCITY (CFS)	0.25	0.25	0.29	0.29	0.12		0.40	0.38	0.31	0.38	0.62	0.55	0.48	0.39
LENGTH OF SET (MIN)	5	5	5	5	5	0	5	5	5	2	2	2	5	5
AVERAGE VOLUME (CC)	<0.1	<0.1	<0.1	<0.1	<0.1		0	<0.1	0.2	0.4	0.2	<0.1	0.4	0.2
NUMBER OF ORGANISMS PER MINUTE PER CFS	13.4	29.1	8.5	21.2	12.5		0	0.8	15.0	322.0	22.1	12.3	11.5	16.0

* No sample taken.

APPENDIX 21 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION I FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	29	30	31	32	33	34	35	36	37	38	39	40	41	42
YEAR	1963													
MONTH & DAY	8-9	8-15	8-23	8-29	9-6	9-13	9-20	9-26	10-4	10-10	10-16	10-26	10-31	11-10
Hydracarina														
Tubificidae							1							
other Oligochaeta														
Nematoda														
Tendipedidae	11	3	1				1		1		2			2
Simulidae														
Heleidae												1		
Sciomyzidae														
Ephydridae														
Baetidae	13	16	7	5	37	1	1	1		1	1			
Heptagenidae	1	1			1	1				1			1	
Ephemeridae	53													
Perlodidae		1												
Hydroptilidae		1												
Dytiscidae		1												
other Coleoptera														
Corixidae	1				1									
Proctotrupoidea														
Chalcidoidea												1		
Braconidae														
non-aquatic				1				1				1	1	
TOTAL INVERTEBRATES	79	23	8	6	39	2	3	2	1	2	3	3	2	2
AVERAGE WATER VELOCITY (CFS)	0.65	0.40	0.40	0.27	0.33	0.24	0.46	0.52	0.33	0.31	0.29	0.29	0.25	0.24
LENGTH OF SET (MIN)	0.5	0.5	0.5	5	6	1	0.5	2	5	5	5	5	5	5
AVERAGE VOLUME (CC)	0.7	1.0	<0.1	0.1	0.7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	363.4	174.8	60.8	6.7	29.2	12.6	19.8	2.9	0.9	0.2	3.2	3.2	2.5	2.5

APPENDIX 21 (CONTINUED). NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION I FROM JULY 23, 1962 TO SEPTEMBER 25, 1964.

SERIES NUMBER	43	44*	45	46	47	48	49	50	51	52	53	54	55	56
YEAR	1963		1964											
MONTH & DAY	11-15	12	1-27	2-18	3-23	4-27	8-7	8-15	8-21	8-29	9-5	9-12	9-18	9-25
Hydracarina										1				
Tubificidae														
other Oligochaeta														
Nematoda														
Tendipedidae	2		2		3	109	6		7		10	7	11	4
Simulidae								1						
Heleidae														
Sciomyzidae														
Ephydridae														
Baetidae			1		1		6	8	5	2	9	4	120	1
Heptagenidae			1				2	1				1		5
Ephemeridae												1		
Perlodidae														
Hydroptilidae							1						2	1
Dytiscidae														
other Coleoptera														
Corixidae														
Proctotrupoidea							1							
Chalcidoidea														
Braconidae														
non-aquatic							2	1			1		3	
TOTAL INVERTEBRATES	2		4	0	4	109	18	11	12	3	20	13	136	11
AVERAGE WATER VELOCITY (CFS)	0.29		0.22	0.29	0.25	0.40	0.55	0.38	0.37	0.26	0.25	0.22	0.25	0.15
LENGTH OF SET (MIN)	5	0	5	5	5	5	5	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	<0.1		<0.1	0	<0.1	0.9	0.1	0.1	<0.1	<0.1	0.2	0.2	1.5	0.2
NUMBER OF ORGANISMS PER MINUTE PER CFS	2.1		5.7	0	5.0	82.8	10.1	8.8	9.8	3.5	25.2	19.9	17.0	22.0

* No sample taken.

APPENDIX 22. NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION #16 FROM SEPTEMBER 13, 1963 TO APRIL 19, 1964.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
YEAR	1963											1964			
MONTH & DAY	9-13	9-20	9-27	10-4	10-11	10-16	10-27	10-31	11-10	11-15	12-17	1-26	2-17	3-31	4-19
Tubificidae		1													1
Tendipedidae		1			5			1			1	4		2	20
Heleidae					1		1								
Sciomyzidae						1									
Baetidae		3			1			1	1				2		2
Heptagenidae				1							2	1			2
Chalcidoidea					1										
non-aquatic			1		122	2									
TOTAL INVERTEBRATES	0	5	1	1	130	3	1	2	1	0	3	5	2	2	25
AVERAGE WATER VELOCITY (CFS)	0.25	0.62	0.65	0.52	0.37	0.33	0.33	0.29	0.40	0.37	0.58	0.33	0.25	0.37	0.62
LENGTH OF SET (MIN)	5	5	2	5	5	5	5	5	5	5	5	5	5	5	5
AVERAGE VOLUME (CC)	0	0.1	0.1	0.1	0.8	0.1	0.1	0.1	0.1	0	0.1	0.1	0.1	0.1	0.2
NUMBER OF ORGANISMS PER MINUTE PER CFS	0	2.4	1.2	0.6	109.2	2.7	0.9	2.1	9.8	0	1.6	4.5	2.5	1.7	12.0

APPENDIX 23. NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION #17 FROM MARCH 24, 1963 TO SEPTEMBER 11, 1963.

SERIES NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13
YEAR	1963												
MONTH & DAY	3-24	4-30	5-25	7-11	7-20	7-27	8-2	8-9	8-15	8-23	8-30	9-6	9-11
Tubificidae	1	2	6										
Tendipedidae	4	44	50			1		2	1				
Simulidae		1											
Empididae		1											
Baetidae				31	1	8		298	15	21	1		
Heptagenidae								54	5				
Ephemeridae								163	1	1			
Perlodidae								1					
Chrysomelidae		1											
Gomphidae								4					
Vespidae			1										
non-aquatic		2			1		2						
TOTAL INVERTEBRATES	5	51	57	31	2	9	2	522	22	22	1	0	0
AVERAGE WATER VELOCITY (CFS)	0.62	0.55	0.46	0.42	0.37	0.37	0.25	0.18	0.33	0.40	0.24	0.27	0.56
LENGTH OF SET (MIN)	5	5	1	2	2	5	5	5	0.5	1	5	5	1
AVERAGE VOLUME (CC)	<0.1	0.4	0.2	0.2	<0.1	0.1	<0.1	2.8	0.2	0.8	<0.1	0	0
NUMBER OF ORGANISMS PER MINUTE PER CFS	2.4	28.6	188.1	57.4	4.2	7.6	2.5	918.7	198.0	83.6	1.3	0	0

APPENDIX 24. AVERAGE NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION #19 ON MAY 25, 1963.

Tubificidae	1
Tendipedidae	70
Muscidae	1
Corixidae	1
TOTAL INVERTEBRATES	73
AVERAGE WATER VELOCITY (CFS)	0.52
LENGTH OF SET (MIN)	1
AVERAGE VOLUME (CC)	0.1
NUMBER OF ORGANISMS PER MINUTE PER CFS	211.7

APPENDIX 25. AVERAGE NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION #20 IN MARCH AND APRIL, 1963

SAMPLE NUMBER	1	2
DATE	3-24	4-30
Oligochaeta		2
Tendipedidae	1	15
Simulidae		1
Baetidae		2
Hydroptilidae		1
Proctotrupoidea		1
Pompilidae		1
non-aquatic		5
TOTAL INVERTEBRATES	1	28
AVERAGE WATER VELOCITY (CFS)	0.33	0.55
LENGTH OF SET (MIN)	5	5
AVERAGE VOLUME (CC)	<0.1	0.4
NUMBER OF ORGANISMS PER MINUTE PER CFS	0.9	15.7

APPENDIX 26. AVERAGE NUMBER OF ORGANISMS TAKEN IN DRIFT SAMPLES AT STATION #21 ON MARCH 23, 1963.

Tendipedidae	48
Dolichopodidae	1
TOTAL INVERTEBRATES	49
AVERAGE WATER VELOCITY (CFS)	-
LENGTH OF SET (MIN)	5
AVERAGE VOLUME (CC)	0.4
NUMBER OF ORGANISMS PER MINUTE PER CFS	-

APPENDIX 27. NUMBER OF ADULT INSECTS CAPTURED EACH WEEK BY EMERGENCE TRAP #1, LOCATED ON FLAMING GORGE RESERVOIR ABOUT 2 MILES UPSTREAM FROM THE OLD BRINEGAR RANCH, DURING AUGUST, 1963

		DATE			
ORDER	FAMILY	8-2	8-9	8-15	8-22
Diptera					
	Tendipedidae	834	270	242	395
	Simulidae	1			
	Muscidae	4	3	1	5
	Empididae			1	
	Helomyzidae			1	
	Ephydridae				1
Ephemeroptera					
	Baetidae			3	5
Trichoptera					
	Hydroptilidae	1			
Lepidoptera					
	Pyralidae				1
	TOTAL INSECTS	844	243	255	407

APPENDIX 28. NUMBER OF ADULT INSECTS CAPTURED EACH WEEK BY EMERGENCE TRAP #2, LOCATED ON FLAMING GORGE RESERVOIR NEAR UPPER MARSH CREEK, DURING AUGUST, 1963

		DATE		
ORDER	FAMILY	8-2	8-9	8-15
Diptera				
	Tendipedidae	794	660	260
	Simulidae	2		
	Muscidae		12	2
	Sciomyzidae	2		
	Helomyzidae		4	
	Tephritidae			1
Ephemeroptera				
	Baetidae		3	11
	Heptagenidae	2		
Trichoptera				
	Hydroptilidae		1	
Hemiptera				
	Lygaeidae	1		
	TOTAL INSECTS	801	680	275

APPENDIX 29. NUMBER OF ADULT INSECTS CAPTURED EACH WEEK BY EMERGENCE TRAP #3, LOCATED ON FLAMING GORGE RESERVOIR NEAR MIDDLE MARCH CREEK, DURING AUGUST AND SEPTEMBER, 1963.

ORDER	FAMILY	DATE 8-2	8-9	8-15	8-22	8-29	9-7	9-12
Diptera								
	Tendipedidae	586	913	848	256	82	92	58
	Muscidae		6	7	1	5	2	1
	Helomyzidae		9	4		1		
	Simulidae		1					
	Ephydridae			1	1			
	Empididae				1			
	Heleidae				1			
Ephemeroptera								
	Baetidae	1	3	10		5	16	17
	Heptagenidae	1						
Hemiptera								
	Saldidae		1					
	TOTAL INSECTS	588	933	870	260	93	110	76

APPENDIX 30. NUMBER OF ADULT INSECTS CAPTURED EACH WEEK DURING JULY AND AUGUST, 1964, BY AN EMERGENCE TRAP LOCATED ON FLAMING GORGE RESERVOIR NEAR THE MOUTH BLACK'S FORK RIVER.

		DATE			
ORDER	FAMILY	7-7	7-17	8-1	8-7
Diptera					
	Tendipedidae	17	456	521	434
	Simulidae	3	5	7	
	Muscidae				3
	Sciomyzidae			5	1
	Empididae			1	
	Scopeumatidae			2	
Ephemeroptera					
	Baetidae		2	1	2
	Heptagenidae	1	1		2
Plecoptera					
	Perlodidae	14	6		
	Perlidae			2	
Trichoptera					
	Hydroptilidae			1	1
Coleoptera					
	Chrysomelidae			1	
	Carabidae			1	
	Meloidae			1	
	Gyrinidae		3		
Hemiptera					
	Cicadellidae			3	3
	Lygaeidae			2	
	Saldidae				1
	Tingidae	1			
Hymenoptera					
	Braconidae			1	
	Ichneumonidae			1	
	Chalcidoidea				1
	Formicidae			1	
	TOTAL INSECTS	36	473	552	448

APPENDIX 31. NUMBER OF ADULT INSECTS CAPTURED WEEKLY DURING AUGUST, 1964, BY AN EMERGENCE TRAP LOCATED AT STATION B, NEW FORK RIVER.

		DATE		
ORDER	FAMILY	8-4	8-11	8-19
Diptera				
	Tendipedidae	85	30	34
	Simulidae	7	3	
	Heleidae	1		
	Sciomyzidae	5	2	
	Empididae	17	31	10
	Dolichopodidae		1	
	Dixidae		1	
Plecoptera				
	Perlodidae	44	15	7
Trichoptera				
	Hydropsychidae	2	3	
	Hydroptilidae	4	2	
	Helicopsychidae		1	1
Coleoptera				
	Chrysomelidae	1	1	2
	Coccinellidae	2		2
Hemiptera				
	Cicadellidae	11	13	
	Lygaeidae	2		1
	Membracidae	1		
	Saldidae	1		
	Miridae		1	1
	Tingidae			1
Hymenoptera				
	Formicidae		1	4
Lepidoptera				1
	TOTAL INSECTS	183	105	66

APPENDIX 32. NUMBER OF ADULT INSECTS CAPTURED WEEKLY DURING AUGUST AND SEPTEMBER, 1964, BY AN EMERGENCE TRAP LOCATED ON THE GREEN RIVER AT STATION E.

		DATE							
ORDER	FAMILY	8-5	8-12	8-18	8-26	9-2	9-8	9-16	9-23
Diptera									
	Tendipedidae	6	4	20	19	12	23	31	22
	Simulidae	4	16	52	36	30	6	6	4
	Tipulidae		2						
	Empididae	4							
	Dolichopodidae					3	1	1	1
	Muscidae	4						1	
	Sciomyzidae								1
	Culicidae	1							
Ephemeroptera									
	Baetidae	7	2	5	22	16			
Plecoptera									
	Perlodidae	2							
Trichoptera									
	Hydroptilidae		3				1	5	6
	Hydropsychidae	3	4						
	Psychomyiidae	9							
Hemiptera									
	Lygaeidae				1				
Lepidoptera		3							
TOTAL INSECTS		42	31	78	78	61	31	44	34

APPENDIX 33. NUMBER OF ADULT INSECTS CAPTURED WEEKLY DURING AUGUST AND SEPTEMBER, 1964, BY AN EMERGENCE TRAP LOCATED ON THE GREEN RIVER AT STATION F.

		DATE				
ORDER	FAMILY	8-26	9-2	9-8	9-17	9-24
Diptera						
	Tendipedidae	61		37	50	31
	Dolichopodidae	1				
	Simulidae			1		2
	Sciomyzidae				3	
	Tephritidae			1		
Ephemeroptera						
	Baetidae			1		
Plecoptera						
	Perlidae	2	2			
Trichoptera						
	Hydroptilidae	1		2	2	
Hemiptera						
	Cicadellidae			2		
	Aphididae			1	1	
	Tingidae				1	
Hymenoptera						
	Proctotrupoidea	1				
	Chalcidoidea			2	2	
Lepidoptera				1		
	TOTAL INSECTS	66	2	48	59	33

APPENDIX 34. NUMBER OF ADULT INSECTS CAPTURED WEEKLY DURING AUGUST AND SEPTEMBER, 1964, BY AN EMERGENCE TRAP LOCATED ON THE GREEN RIVER AT STATION #6.

		DATE					
ORDER	FAMILY	8-20	8-26	9-3	9-13	9-17	9-23
Diptera							
	Tendipedidae	79	93	137	77	36	61
	Simulidae		7	6	3	1	2
	Muscidae	1					
	Dolichopodidae	1	1				
	Scopeumatidae	1					
	Empididae			1			
	Sciomyzidae						1
Ephemeroptera							
	Baetidae	7	2	11	2	4	7
	Heptagenidae		1				
Hemiptera							
	Cicadellidae	4	2		3		3
	Aphididae						1
	Saldidae				1		
	Lygaeidae		1				
	Tingidae		1				
	Coreidae		1				
Hymenoptera							
	Formicidae				2		
	Braconidae					1	
Coleoptera							
	Chrysomelidae	1					
	TOTAL INSECTS	94	109	155	90	49	75

APPENDIX 35. NUMBER OF ADULT INSECTS CAPTURED WEEKLY DURING AUGUST AND SEPTEMBER, 1964, BY AN EMERGENCE TRAP LOCATED ON THE GREEN RIVER AT STATION H.

		DATE						
ORDER	FAMILY	8-14	8-21	8-28	9-4	9-13	9-18	9-25
Diptera								
	Tendipedidae		68	61	13	27	9	13
	Simulidae	2	18	14	32	35	13	5
	Muscidae			2	4			1
	Empididae			1				
	Dolichopodidae						1	
	Anthomyiidae			1	4			
	Helomyzidae					1	1	
	Heleidae							1
	Scopeumatidae							1
Ephemeroptera								
	Baetidae	1	20	6		18	5	3
	Heptagenidae		1				5	3
Plecoptera								
	Perlodidae	2	1					
Trichoptera								
	Hydropsychidae		1		3	2		
	Hydroptilidae		8	13	1	3	2	1
Hemiptera								
	Lygaeidae		4		2			3
	Miridae				1			
	Cicadellidae				1			
	Saldidae							1
Hymenoptera								
	Proctotrupoidea	1			1			
Coleoptera								
	Chrysomelidae				1	1		1
Orthoptera								
	Locustidae					1		
TOTAL INSECTS		6	130	98	63	88	36	33

APPENDIX 36. NUMBER OF ADULT INSECTS CAPTURED WEEKLY DURING AUGUST AND SEPTEMBER, 1964, BY AN EMERGENCE TRAP LOCATED ON THE GREEN RIVER AT STATION I.

ORDER	FAMILY	DATE 8-7	8-15	8-21	8-29	9-5	9-12	9-18	9-25
Diptera									
	Tendipedidae	7	15	45	76	135	121	288	120
	Simulidae			1					
	Muscidae	2			1				
	Sciomyzidae			1	2		3		
	Cecidomyiidae		1						
	Anthomyiidae								1
Ephemeroptera									
	Baetidae		2		2			2	2
	Heptagenidae			39	2	1			
Plecoptera									
	Perlodidae		1						
Trichoptera									
	Hydropsychidae		1	1					
	Hydroptilidae			1	2	7	4		
Coleoptera									
	Chrysomelidae	1	1	2					
	Coccinellidae			1			1		
	Carabidae	1							
Hemiptera									
	Cicadellidae	3	2	2	3	1	1		
	Miridae	3	2			1			
	Membracidae	4	27	2					
	Aphididae				1				
	Tingidae		1						
Hymenoptera									
	Formicidae		1						
Lepidoptera		2							
TOTAL INSECTS		23	54	95	89	145	129	290	123

APPENDIX 37. A LIST OF THE FISHES PRESENT IN THE GREEN AND NEW FORK RIVERS TWO YEARS AFTER POPULATION DEPRESSION WITH ROTENONE. SPECIES ARE LISTED IN ORDER OF APPARENT ABUNDANCE.

Redside shiner	Richardsonius balteatus (Richardson)
Fathead minnow	Pimephales promelas Rafinesque
Rainbow trout	Salmo gairnderi Richardson
Flannelmouth sucker	Catostomus latipinnis Baird and Girard
Mountain whitefish	Prosopium williamsoni (Girard)
Speckled dace	Rhinichthys osculus (Girard)
Bluehead sucker	Pantosteus delphinus (Cope)
Mottled sculpin	Cottus bairdi Girard
Mountain sucker	Pantosteus platyrhychus (Cope)
Brown trout	Salmo trutta Linnaeus
Carp	Cyprinus carpio Linnaeus
Bonytail chub	Gila robusta Baird and Girard
Utah chub	Gila atraria (Girard)
Utah sucker	Catostomus ardens Jordan and Gilbert
Kokanee salmon*	Oncorhynchus nerka (Walbaum)
Lake trout**	Salvelinus namaycush (Walbaum)

* Status uncertain since planted in reservoir; scattered specimens have been reported by fishermen.

** Reservoir only; very rare.

APPENDIX 38. A LIST OF THE AQUATIC INVERTEBRATES PRESENT IN THE GREEN AND NEW FORK RIVERS TWO YEARS AFTER ROTENONE TREATMENT.

Hydracarina

Annelida

Tubificidae

other Oligochaeta

Hirudinea

Gastropoda

Physidae

Physa

Lymnaeidae

Lymnaea

Planorbidae

Nematoda

Amphipoda

Diptera

Tendipedidae

Simulidae

Rhagionidae

Atherix variegata

Tipulidae

Heleidae (Ceratopogonidae)

Empididae

Culicidae

Psychodidae

Ephemeroptera

Baetidae

Baetis

Ephemerella

Tricorythodes

Appendix 38 (continued)

<u>Paraleptophlebia</u>

<u>Leptophlebia</u>

<u>Choroterpes</u>

<u>Brachycercus</u>

<u>Siphlonurus</u>

<u>Caenis</u>

<u>Isonychia</u>

<u>Traverella</u>

Heptagenidae

<u>Heptagenia</u>

<u>Rhithrogenia</u>

<u>Iron</u>

Ephemeridae

<u>Ephemera</u>

<u>Ephoron</u>

Plecoptera

Perlidae

Pteronarcidae

Perlodidae

Nemouridae

Trichoptera

Hydropsychidae

Brachycentridae

Hydroptilidae

Lepidostomatidae

Leptocercidae

Glossosomatidae

Psychomyiidae

Helicopsychidae

Appendix 38 (continued)

Coleoptera

- Elmidae
- Dytiscidae
- Hydraenidae
- Hydrophilidae
- Dryopidae
- Haliplidae
- Heterocercidae
- Chrysomelidae
- Histeridae
- Curculionidae

Odonata

- Gomphidae
- Coenagrionidae

Lepidoptera

- Pyralidae

Hemiptera

- Corixidae

Megaloptera

- Sialidae

APPENDIX 39. LOCATION OF INVERTEBRATE SAMPLE STATIONS.

STATION	LOCATION
A	South side of New Fork River about 200 yards upstream from the bridge at Boulder (NF#1).
B	North side of New Fork River about 100 yards upstream from the old New Fork Bridge (NF#2).
C	West side of Green River on first riffle above Sommer's Bridge (GR#1).
D	West side of Green River about 200 yards downstream from Sommer's Bridge.
E	West side of Green River on second riffle downstream from the bridge at the Phil Marincic Jr. ranch.
F	East side of Green River about 400 yards downstream from the Big Piney Cutoff Bridge.
G	West side of Green River at the Names Hill Campground.
H	East side of Green River about 300 yards above Big Island Bridge (GR#11).
I	West side of Green River near the old KinKaid Ranch; station located about 100 yards downstream from GR#14.
Temp. 21	West side of Green River about 4 miles downstream from the mouth of Sheep Creek.
Temp. #20	East side of Green River about two miles upstream from the old Linwood Bridge.
Temp. #19	West side of Green River about one mile downstream from GR#19.
Temp. #17	West side of Green River at site of old Buckboard Ranch.
Temp. #16	West side of Green River about one-half mile upstream from the mouth of Black's Fork.

APPENDIX 40. DRIFT NET EFFICIENCY TEST.

Procedure: Five trials were made at each water velocity using 20 small cork pieces (chips) per trial. The chips were released seperately three feet upstream from the net on a collision heading. The average number of chips caught in the net was then calculated and is presented below.

Velocity (cfs)	Average number of chips caught	Percent caught	Variation in number caught	Remarks
0.95	13.2	66	10-16	Large, prominent "bow-wave" was present in front of the net, but water velocity was great enough to force the chips into the net.
0.71	2.8	14	1-4	Medium sized "bow-wave" was present; many of the chips were pushed to the side of the net by the wave and did not enter the net at all.
0.58	12.2	61	8-15	"Bow-wave was much reduced and most of the chips entered the net; most of those not caught floated back out after entering the net.
0.40	13.0	65	9-18	Same as under 0.58 cfs.
0.25	9.3	46	7-17	Very little "bow-wave", but water currents just inside the net mouth were such that many chips floated back out after entering the net.

APPENDIX 41. EFFICIENCY OF BOTTOM SAMPLE SORTING TECHNIQUE.

Procedure: Immediately after being taken, the sample was placed in a pan containing river water where, with the aid of forceps and an eyedropper, it was picked over until no more bottom animals could be found. The river water was then removed through a fine screen, the sample placed in the sugar solution, and the remaining organisms removed as they floated to the surface. Where much vegetation was present, the sample was returned to fresh water to allow the organisms to regain their original specific gravity; afterwhich, they were again covered by sugar solution. This procedure insured finding a high percentage of the organisms. The sum of the original fresh water pick and the pick made with sugar solution was used as the total number of organisms present in the sample.

Station	Total number of organisms found in sample	Percent of total found without sugar	Percent of total that was found after sugar was used	Remarks
A	424	89	11	Little vegetation present.
B	272	89	11	Little vegetation present.
C	31	85	15	Little vegetation present.
D	37	57	43	Much vegetation present; many small midges missed on first pick.
E	145	83	17	Little vegetation present.
F	84	93	7	No vegetation present.
G	115	67	33	Small amount of vegetation present.
H	106	57	43	Moderate amount of vegetation present; many small midges missed on first pick.
I	104	60	40	Little vegetation present.

APPENDIX 42. METHOD OF CONVERSION OF ACTUAL DRIFT SAMPLE CATCHES TO STANDARD UNITS OF CATCH.

The samples of the stream drift fauna taken during the study were obtained with a drift sampler which was designed to hang between two steel fence posts driven into the river bottom. When in use, the sampler was set so that a column of water 10 inches by 12 inches was filtered. Each time a drift sample was taken, the average water velocity, in cubic feet per second (cfs), between the two posts was determined with a current meter. After the samples had been enumerated in the laboratory, the actual number of organisms captured was converted to a standard unit of catch to allow for comparison between samples obtained at different stations and water velocities. This standard unit was computed as follows: (1) the rate of water flow between the fence posts was determined using the formula given by Welch (1948) for calculating the discharge of a stream; (2) the number of organisms taken per minute was determined. Steps 1 and 2 allowed the catch to be expressed as number of organisms per minute at the rate of flow from which the sample was taken; (3) the above number was converted to the standard unit. The calculation method is illustrated by the following examples.

Example #1:

Actual number of organisms taken	= 17
Water velocity between the posts	= 0.60 cfs
Length of time that the net was set	= 5 minutes

water flow = R = Width x Depth x Velocity x bottom constant
= 1 ft. x 10 inches x 0.60 cfs x 0.8
= 1 ft. x 0.83 ft. x 0.60 cfs x 0.8
= 0.66 x 0.60
= 0.39 cfs

thus, 17 organisms per 5 minutes per 0.39 cfs
or 3.4 org./ min./0.39 cfs (multiply by 1/0.39 = 2.56)
or 8.7 org./ min./ 1 cfs

Appendix 42 (continued)

Example #2:

Actual number of organisms taken	= 1
Water velocity between the posts	= 0.76
Length of time that the net was set	= 2.5 minutes

water flow = R = WDVc
= 1 x 0.83 x 0.76 x 0.8
= 0.66 x 0.76
= 0.50 cfs

thus, 1 org./ 2.5 min./ 0.5 cfs
or 0.4 org./min./0.5 cfs
or 0.8 org./min./1 cfs