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Selected Biological Studies of the Thompson River System

by
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SELECTED BIOLOGICAL STUDIES OF
THE THOMPSON RIVER SYSTEM

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I INTRODUCTION

Beginning in 1970 and increasing through 1972-1973, a large number of complaints from the public were received by federal and provincial agencies emphasizing the deterioration of water quality in Kamloops Lake and the Thompson River. Most complaints described changes in water colour, excessive benthic algal growth, the presence of foam and the tainting of fish downstream of Kamloops Lake. Many reports described a change in the apparent water colour from a "traditional dark green" to a dark brown colour, a change in the colour of benthic algae from green to brown, and the presence of heavy algal growths which obscured bottom rocks and gravel downstream of Kamloops Lake.

Because of the growing public concern and the great commercial and recreational value of the fishery and other resources in this system, an interim low water sampling program was conducted by federal and provincial agencies in April, 1973. One recommendation of this program helped establish a joint federal-provincial monitoring and data collection program to define the cause of undesirable algal growth, foaming, colour, and fish tainting in the Thompson River system (Pollution Control Branch and Environment Canada, 1973). This program began in the fall of 1973.

Fisheries Operations contribution to this program was a study of selected aspects of river biology. Benthic invertebrate populations were sampled at four river stations. Visual observations of algal growth were noted and benthic algal production was quantified on a monthly basis at several river stations by measuring periphyton standing crop on artificial substrates. The effect of Weyerhaeuser pulp mill effluent on the palatability of fish flesh was also investigated using tainting experiments.

General river conditions including water colour were noted throughout the study. Water quality data for the overall Thompson River investigation were collected by other Task Force members and are not included in this report.

This report presents and discusses the results of the above studies and includes a review of the salmon resources of the Thompson River system. Also included in appendix form are the raw periphyton and benthic invertebrate data. These data have been presented as baseline information which could be of use in any future monitoring programmes in the Thompson River system.

II STUDY AREAS

(1) North Thompson River System

The North Thompson River system is comprised of streams from the Clearwater and North Thompson River basins. The mean annual flow of the North Thompson River as measured at McLure is approximately 16,000 cubic feet per second (cfs) and the mean annual low flow, based on annual seven day average low flows up to 1972, is 2,550 cfs (Environment Canada, 1974). The Clearwater basin includes the main stem Clearwater River, several lakes, and associated tributaries. In addition to the Clearwater River, the North Thompson River receives two major tributaries, the Raft and Barriere Rivers, and many minor tributaries from its headwaters in the Cariboo Mountains to the confluence with the South Thompson River in Kamloops. The drainage area of the system, approximately 8,000 square miles, is largely forested but includes small towns and some farmland.

(2) Thompson and South Thompson River System

The South Thompson River, which originates in the Shuswap Lake system, has a mean annual flow of 10,000 cfs and a mean annual low flow of 2,630 cfs as measured at Chase (Environment Canada, 1974). The South Thompson River drainage area is approximately 6,500 square miles in area and is characterized by large lakes, forests, farmland, and small municipalities. Major tributaries of the South Thompson River include the Shuswap and Adams Rivers. The Thompson River begins at Kamloops with the confluence of the North and South Thompson Rivers and flows west into Kamloops Lake. The river flows from Kamloops Lake in a south-westerly direction (mean annual flow of 27,000 cfs at Spences Bridge; mean annual low flow of 5,900 cfs near Savona) to its confluence with the Fraser River at Lytton. Flows as low as 4,300 cfs have been recorded at Savona. The

drainage area of the Thompson River below Kamloops is approximately 7,000 sq. miles. The main tributaries to the Thompson River below Kamloops Lake include the Deadman, Bonaparte and Nicola Rivers.

III SALMON RESOURCES OF THE THOMPSON RIVER SYSTEM

Annual numbers of salmon spawners in the various streams of the Thompson River system for the 1960 to 1974 period are presented in Tables 1 to 4.

(1) North Thompson

Populations of coho, chinook, and sockeye salmon spawn and rear in the North Thompson River and associated tributaries. The main coho spawning grounds are located in the Clearwater and Barriere Rivers and in Lion, Louis, and Lemieux Creeks. Runs of 2,000, 1,500, 7,500, 3,500, and 3,500 spawners have been recorded in these respective streams. Smaller runs are found in other tributary streams (Table 1). Coho spawn in the late fall (October and November) and the progeny rear for one year in the river prior to migrating to sea.

Chinook salmon spawn primarily in the mainstream of the North Thompson and in the Clearwater River. Up to 3,500 chinook have spawned per year in each of these rivers. Smaller chinook runs occur in other tributaries. Spawning takes place in September to October and the juveniles rear in the system for a period of a few months to a year before migrating to sea.

The only major sockeye stream in the North Thompson system is the Raft River which supports up to 15,000 spawning fish annually. Minor runs have also been recorded in the mainstream North Thompson, Barriere, and Clearwater Rivers (Table 3). Spawning peaks in September to October and the newly hatched fry migrate downstream to North Barriere and Kamloops Lakes where they rear for approximately one year prior to migrating to the sea.

(2) Thompson and South Thompson

The Thompson and South Thompson Rivers support runs of coho, chinook, sockeye and pink salmon. The main coho spawning grounds are located in the Upper Adams, Bessette and Eagle Rivers. Runs of 3,500 spawners have been recorded in each of these streams. Several other smaller streams have runs of up to 1,500 spawners (Table 1).

Chinook spawn throughout the Thompson - South Thompson system with major runs occurring in the Lower Shuswap, South Thompson, Adams and Nicola Rivers. Runs of 15,000, 7,500, 5,000 and 4,500 spawners have been recorded respectively in these streams. Smaller runs are supported in the tributaries of the Thompson and South Thompson Rivers (Table 2).

The largest runs of sockeye occur in the Adams and Shuswap Lakes systems (Table 3) with the major spawning areas located in the Adams, Little, Seymour and Lower Shuswap Rivers. Runs of greater than 1,000,000 spawners have been recorded in the Adams River, up to 220,000 in the Little River and 75,000 in both the Seymour and Lower Shuswap Rivers.

Pink salmon spawn extensively in the Thompson River from Kamloops Lake to Spences Bridge where runs greater than 250,000 spawners have been recorded. Runs up to 3,500 and 1,500 spawners have been recorded in the Bonaparte and Nicola Rivers respectively. Table 4 presents annual pink salmon escapements for all streams in the Thompson - South Thompson system.

IV SAMPLING LOCATIONS

(1) Benthic Invertebrates

Benthic invertebrate sampling stations were established at four locations: Little Fort on the North Thompson River, Chase on the South Thompson River, and Savona and Walachin¹ on the Thompson River (Figure 1). Sampling was conducted in April of 1973, 1974, and 1975 and the same sampling locations were used at each station each year. The Chase and Savona sampling sites were located in major salmon spawning areas. Salmon spawn in the immediate vicinity of the Walachin and Little Fort sampling sites.

The Little Fort station was situated in the main stem of the North Thompson River approximately 300 m upstream of Lemieux Creek at the head of a large gravel bar. The river bottom consisted of gravel ranging in size from 1 to 10 cm in diameter with the majority being about 6 or 7 cm in diameter. At Chase, benthic invertebrates were sampled approximately 150 m downstream of the Chase Bridge. The bottom gravel averaged about 5 cm in diameter with a range of approximately 1 to 7 cm. The Savona site was located about 150 m downstream from the highway bridge. The river bottom consisted of small mobile gravel with a mean diameter of about 4 cm. At Walachin the sampling site was located immediately adjacent to the village of Walachin. Bottom material was comprised of cobble-like stones with a mean diameter of from 10 to 12 cm and ranging up to 15 cm in diameter. The mean water depth and water velocity at each sampling station are listed in Table 5. Velocities were determined with a Gurley² pygmy current meter.

1 also spelled Walhachin

2 Gurley Engineering Instruments, Troy, N.Y., U.S.A.

(2) Periphyton

In 1973-74 artificial substrate stations were located on the North Thompson River at McLure, on the South Thompson River at Chase, and on the Thompson River at Savona and Walachin (Figure 1). In addition the B.C. Fish and Wildlife Branch established eight artificial substrate stations on the Thompson River at Kamloops. Three of these latter stations were located upstream from the Weyerhaeuser pulpmill effluent diffusers, two between the mill and city sewage lagoons and three downstream from the sewage lagoons (Figure 2). In 1974-75 the stations at McLure, Chase, Savona and Walachin were utilized and the eight Fish and Wildlife stations in the vicinity of the pulpmill and sewage lagoons were deleted and replaced by three new stations (Figure 2).

The water depth and velocity regimes at McLure, Chase, Savona, and Walachin in 1973-74 are documented in Table 6. The river bottom at three locations was similar to that at the benthic invertebrate sampling sites except for Savona where the river bottom was comprised of sediments interspersed with larger rocks which ranged from 10 to 17 cm in diameter.

The eight artificial substrate stations established by the Fish and Wildlife Branch were selected in areas which had similar bottom characteristics, water depth, and velocity regimes. Velocities at these stations were not measured but appeared lower than those at the other river stations. The water depth at each station was approximately 0.5 m with the river bottom at most stations consisting primarily of sand and small pebbles. The two upstream stations were situated on either side of the upstream end of Rabbit Island. The river bottom in this area was comprised of gravel varying in size from 1 to 9 cm in diameter. The two Rabbit Island sites and a third site located about 100 m upstream of the pulpmill diffuser

were not influenced by either the pulpmill discharge or the city sewage effluent. Two stations were established below the mill diffuser but above the sewage lagoons, one on the south shore and one in mid channel. The remaining three sites were situated downstream of the sewage lagoon as shown in Figure 2.

In 1974-75 artificial substrate stations were located in three new areas; adjacent the city sewage lagoons on the south shore, immediately downstream from the mill diffuser, and a control site upstream from the mill diffuser (Figure 2). The substrates were placed at a depth of approximately 0.5 m at each location. When river levels dropped the substrates were moved to deeper water in an attempt to maintain similar depth and velocity conditions. The mean current velocity and range of values for each station as measured in November 1974 are listed in Table 6.

V SAMPLING TECHNIQUES AND SAMPLE ANALYSIS

(1) Benthic Invertebrates

(a) Sampling Techniques

Benthic invertebrate samples were collected at each of the previously described sites using a sampler described by Mundie (1971). The sampler, which enclosed a sampling area of approximately 0.18 m^2 , was placed on the river bottom at depths of 0.30 to 0.45 m. All larger rocks in the sample were carefully scraped of attached algae and invertebrates, then removed. The smaller gravel, sand, sediment and all associated invertebrates, algae, and detritus were collected to a depth of approximately 6 to 8 cm. A 200 μ mesh net was used on the sampler so most fine organic and inorganic material associated with the substrate was collected. Six samples were obtained from each station and preserved in a 5% formalin solution until analyzed.

(b) Sample Analysis

Samples were separated into organic and inorganic fractions using a flotation column. The sample was first placed in the column then water was forced into the bottom of the column and allowed to exit through overflow holes. By regulating water flow, material of different densities could be separated. Heavier sand and inorganic material remained on the bottom of the separation column, while the displaced organic material was retained on 0.3 mm mesh bolting cloth.

The organic material which consisted primarily of invertebrates, algae and wood debris was stained with Rose Bengal ($200 \text{ mg l}^{-1} \text{ H}_2\text{O}$) and counterstained with Chlorazol Black E ($1 \text{ gm } 100 \text{ ml}^{-1} \text{ H}_2\text{O}$). The counterstain stained the detrital and algal material black while the invertebrates remained pink which facilitated their separation, enumeration, and sub-

sequent identification. Once stained the organic material was placed in a plankton splitter and divided into fractions of a more manageable size. Little variation between fractions of the same sample was evident. The invertebrates were sorted, identified, enumerated, dried, and weighed. The dry weight of the algae and detritus fraction was also determined. Keys used for the invertebrate identification were those of Pennak (1953), Ward and Whipple (1959), Usinger (1973), and Mounce (1973).

The inorganic material which consisted of smaller rocks, pebbles, sand, and silts was dried and sorted according to size class with a U.S. standard sieve series. Sieve sizes ranged from an opening of 0.074 mm to 9.5 mm. The fraction of material retained on each sieve less than 2.38 mm was then weighed.

(2) Periphyton

(a) Artificial Substrate Sampling and Periphyton Analysis

Artificial substrates measuring 18 cm x 7.3 cm were cut from 3 mm thick polished plexiglass sheets. The surface of each substrate used in 1973-74 (October, 1973 to April, 1974) was divided into four quadrats, each approximately 22 cm², which served as periphyton colonization surfaces. The ends of each substrate were used for handling, labelling, and attaching the substrates to concrete blocks. The substrates used in the 1974-75 sampling period (November, 1974 to March, 1975) were identical to those used previously except that they were divided into two instead of four quadrats, each measuring approximately 44 cm².

Concrete blocks measuring 5 cm x 23 cm x 30 cm with a piece of 0.5" (1.27 cm) thick plywood bolted to the top surface were used to anchor the substrates to the river bottom. Two substrates, each elevated from the

block by two, 2 cm long pieces of polyvinyl chloride tubing, were attached horizontally to each plywood base with brass screws (Figure 3). Six blocks, each containing two substrates, were then attached together with rope and placed at each station. Only eight replicate substrates were used per station in the 1974-75 sampling period. In 1974-75, the substrates at the three Kamloops stations were attached vertically to the cement blocks in an attempt to reduce problems of sedimentation (Figure 4).

The artificial substrates were exposed for periods of 30 ± 2 days for the colonization and growth of periphyton communities. The first exposure period commenced October 1, 1973. After exposure, the substrates were removed and a new set substituted. The periphyton from one quadrat of each of the 1973-74 substrates was scraped, on site, into a vial of Lugol's solution for subsequent taxonomic identification. The substrates were then frozen until laboratory analysis. In the laboratory, chlorophyll a, b, c, and phaeopigment determinations were made on the periphyton from another quadrat and the biomass on the remaining two quadrats was determined. A complete description of the laboratory method is presented in Appendix 1. Because of monetary constraints only the algae from the February 1974 substrates were identified and enumerated. Only the numerically dominant periphyton species were identified so a large category containing unidentified forms remained. In 1974-75 the substrates were frozen on site. In the laboratory, one quadrat was analyzed for pigments and the other for biomass determinations.

(b) Periphyton on Natural versus Artificial Substrates

In an attempt to ascertain the extent to which the artificial plexiglass substrates resembled natural rock substrates, a short term study

was initiated in December, 1974. At each of four stations, McLure, Chase, Savona, and Walachin, four flat surfaced rocks, each approximately 20 cm in diameter, were selected from the river bank to serve as natural substrates. The rock surfaces were scraped thoroughly with a wire brush and labelled with paint. The four rocks and the artificial substrates were left together in the river for one month. In January 1975 the artificial substrates and rocks were removed. The artificial substrates were immediately frozen and a periphyton sample was taken from each of the four rocks on site with a periphyton sampler constructed from a piece of plexiglass tubing 10 cm in length and with an inside diameter of 50 mm. A piece of 0.25 inch (0.63 cm) neoprene rubber was attached to one end of the sampler to form a seal when placed against a rock surface. The sampler was held firm against the rock surface, a small quantity of water was added, and the rock surface enclosed by the sampler was thoroughly scraped with a small brush (Figure 4). The periphyton-water mixture was then removed from the sampler with a pipette and transferred to a polyethelene bottle. The procedure was repeated until all periphyton in the sample had been collected. The bottles containing the periphyton were then frozen along with the artificial substrates. The periphyton samples from both the rock and artificial substrates were analyzed for chlorophyll a, b, c, and phaeopigment content.

(c) Effect of River Velocity on Periphyton Standing Crop

In February, 1975 an experiment was initiated to determine the effect of varying river velocities on algal standing crop. Five sites were selected at Chase with velocities ranging from 0.09 to 0.43 m sec⁻¹. Two plexiglass substrates were placed at each of the five sites and left for one month, after which chlorophyll a and ash-free dry weight determinations

were made on the attached algae.

(3) Fish Tainting Experiments

(a) Laboratory

In October 1973 a fish tainting study was carried out at the abandoned Lloyd Creek fish hatchery near Kamloops. Rainbow trout (Salmo gairdneri)¹, approximately 21 cm in fork length (range 17.5 to 24.5 cm) and weighing 94 g (range 43.9 to 146.4 g) were subjected to various concentrations of Weyerhaeuser pulp mill effluent under static conditions. Samples were collected from the effluent pipeline which leads to the effluent diffuser. These samples were diluted to concentrations of 0.5%, 2%, and 4% by volume. Dilution water and control treatment water (0% effluent) were taken from Lloyd Creek. These effluent concentrations represented concentrations which could occur in the receiving waters. Fish were exposed to these effluent concentrations for periods of 8 hours, 2 days and 6 days. Under the assumption that tainting would occur, a group of fish exposed to a 2% concentration of effluent were placed in fresh water after each exposure period to determine if detainting would occur.

Duplicate tanks (245 cm x 25 cm x 18 cm) were lined with 10 gauge sheet plastic and set up with 24 fish per tank. The fish were gently transferred to a fresh mixture of effluent in alternate tanks each morning. The effluent solutions were continuously aerated throughout the experiment. After each exposure period, six animals were removed from each tank, killed, weighed, and measured for length. Each fish was then wrapped individually in aluminum foil, placed in plastic bags and frozen with dry ice. The fish placed in fresh water to determine if detainting occurred were removed after exposure periods of 2 and 10 days and prepared for analysis in the above manner.

1 Trout obtained from the Sun Valley Trout Farms, Mission, B.C.

Cross contamination of fish samples was prevented by storing fish from specific exposure periods and effluent concentrations in separate plastic bags. Taste and odour analysis were performed at the Fisheries Service Vancouver Laboratory using an organoleptic technique. A complete description of the technique is given in Appendix 2.

(b) In Situ

An in situ tainting experiment using rainbow trout from Sun Valley Trout Farms was conducted in March 1975 to determine if tainting occurred in the natural environment and to complement the laboratory experiments. Trout averaging 16.1 cm in fork length (range 14.5 to 17.2 cm) were exposed to North and South Thompson and Thompson River waters over various time periods. Thirty trout were placed in an expanded aluminum mesh cage (60 cm x 60 cm x 122 cm) at each of six sites. One site was located in each of the North and South Thompson Rivers; another immediately downstream from the Weyerhaeuser pulp mill diffuser; two adjacent to the sewage lagoons and one below Kamloops Lake in the Thompson River at Savona (Figures 1 and 2). The cages were anchored with metal stakes at depths varying from 0.3 to 1.0 m of water (Table 7). Six fish were removed from each cage after 3, 7 or 8, and 13, 14, or 15 days exposure (Table 7). The pulp mill shut down on April 1, 1975. Because of the pulp mill shut down the fish downstream from the diffuser were left in place for extended time periods (see Table 7). Wave action caused by high winds, and human interference caused the loss of some fish at some of the stations after three days exposure. These fish were replaced with fish from other stations (Table 7). At the end of the experiment the fish were gutted, wrapped in aluminum foil, and frozen. Taste analysis was performed in July, 1975.

(4) River Water Colour

Apparent water colour was documented at various stations on the river system by means of visual description from the shore, snorkeling and photographing water samples under identical light conditions. In April 1975 a surface water sample was taken from each of the six in situ fish tainting sites (Figures 1 and 2). An equal volume of water from each site was placed in a separate 10 gallon (37.8 l) clear glass aquarium. The aquaria were placed against a common (snow) background, visually described, and photographed.

VI RESULTS

(1) Benthic Invertebrates

Analysis of the benthic invertebrate data revealed distinct patterns in the types of animal taxa, numbers of organisms and faunal diversity between sampling sites downstream of Kamloops Lake and those sites on the North and South Thompson Rivers. Four major insect groups (orders), the Ephemeroptera, Plecoptera, Trichoptera, and Diptera, represented a large portion of the faunal community at each station. Crustaceans, primarily copepods, and oligochaetes, nematodes and acarines comprised most of the remaining benthic faunal assemblage. The types and numbers of organisms collected are tabulated in Appendix 3.

Few crustaceans were found at the Little Fort station in each of the three sampling years compared to the other three stations. For example, in 1974 a total of 11 crustaceans were collected at Little Fort compared with 1242 at Walachin, the station with the next fewest crustacea. This difference in crustacean abundance can be explained by the fact that each station except Little Fort is immediately downstream from a large lake. Many of the crustaceans collected probably existed as zooplankton in the lakes and their presence in downstream benthic locations could be the result of drift from their natural lake habitat.

The mean number of oligochaetes m^{-2} found at each station for each year sampled are indicated in Figure 5. This figure illustrates the large numbers of oligochaetes found at Walachin for three successive years and at Savona in 1975. Between station differences in the number of oligochaetes was tested for significance by a one-way analysis of variance. As documented in Tables 8 to 10 significant differences were found each year in the numbers of oligochaetes between stations ($p. < 0.001$, 1973; $p. < 0.005$,

1974; $p < 0.001$, 1975). Individual degree of freedom comparisons revealed which stations were significantly different from others (Tables 8 to 10). In 1973 and 1974 numbers at Walachin were significantly greater than at any other station ($p < 0.05$) and no significant differences existed between the remaining three stations. In 1975 oligochaete abundance at Savona was significantly greater than at any other station although the mean number at Walachin remained considerably high. As an example of the large variation between stations, in 1973 a total of 16,708 individual oligochaetes were collected from Walachin compared with 412 individuals from Savona, 112 from Chase and 79 from Little Fort.

In an attempt to determine if differences in benthic invertebrate community structure existed between stations, faunal diversity was quantitatively analyzed for each station. The specific index utilized to measure diversity is based on information theory (Shannon, 1948) and is commonly used in pollution studies (Cole 1973, Harger et al. 1973, Dills and Rogers 1974, Nuttall & Purves 1974). The index, (H'), takes into account the number of distinct faunal groups in an assemblage of organisms and the number of individuals within each group and is computed as follows:

$$H' = -\sum_{i=1}^s p_i \log p_i$$

where s = total number of taxa (taxonomic groupings)

p_i = proportion of individual organisms represented by the i^{th} taxa (taxonomic grouping)

The diversity of the fauna at each station was computed by using all the taxa present in each sample (total diversity) and the insect families only (insect diversity). Insect diversity was computed separately because of the intrinsic role insects play in salmonid food chains (Mundie

1974) and because changes in the abundance of specific insects is reflected in insect diversity and can be related to variations in water quality. Some caution must be exercised in the interpretation of the diversity values obtained in this study because diversity, as calculated, does not represent generic or species differences within each animal group. The diversity indices, especially insect diversity, can be used to assess benthic community structure and can, in turn, be discussed in terms of water quality at specific locations.

The variation in total diversity at each station in the three sampling years is illustrated in Figure 6. No consistent pattern in total diversity is evident between stations from year to year. Analysis of variance comparisons of total diversity between stations were computed for each year to determine if significant differences in total diversity existed (Tables 11 to 13). The hypothesis of equal diversity existing between stations was rejected for each sampling year ($p < 0.001$, 1973; $p < 0.05$, 1974; $p < 0.001$, 1975).

Analysis of insect diversity revealed a consistent pattern between stations over the three year period (Figure 7). Generally, insect diversity was greater at Little Fort and Chase than at Savona and Walachin. Analysis of variance comparisons of insect diversity each year indicated that significant differences existed between stations each year ($p < 0.001$, 1973; $p < 0.05$, 1974; $p < 0.001$, 1975; Tables 11 to 13). Individual degree of freedom comparisons were employed to determine which stations were significantly different from each other and in particular, to determine if insect diversity at Walachin, the station with the lowest insect diversity, was significantly lower than each of the other 3 stations. The individual

degree of freedom comparisons for each year indicate that insect diversity at Walachin is significantly lower than all other stations in each sampling year (Tables 11 to 13).

The mean number of individuals m^{-2} within each of the four major insect orders collected at each station are shown in Figures 8 to 11. Some specific characteristics in insect abundance are apparent, in particular the consistently low numbers of Ephemeroptera and Plecoptera recovered from Walachin compared with the other three stations. For example the mean number of Ephemeroptera m^{-2} collected from Walachin in 1973 was 90 compared with 1042 from Chase, 1376 from Little Fort and 1497 from Savona. Similarly over the three sampling years the mean plecopteran abundance m^{-2} at Walachin ranged from 0 in 1974 to 6 in 1975. Plecopteran abundance at other stations was considerably higher as shown in Figure 8. A noticeable trend of decreasing plecopteran abundance from 1973 to 1975 was apparent at Little Fort. The reason for this population decline is unknown but is probably related to natural temporal fluctuations in population abundance. Of interest also is the variation in mean population abundance between years at each station which was minimal at Walachin compared with other stations (see Figure 8). Such results suggest that natural fluctuations in the abundance of these populations at Walachin are dampened by the stresses imposed by decreased water quality. Significant patterns in the abundance of Trichoptera and Diptera did not exist over the three sampling years.

Examination of invertebrate biomass showed no significant differences between stations although invertebrate biomass was generally lower at Savona and Walachin than at Chase and McLure especially in 1974 and 1975 (Table 14). In the examination of the sediments collected in the invertebrate samples attention was directed at the inorganic fractions smaller

than 2.38 mm in diameter. The amount of sediment of this size class, especially the finer material, would be important in controlling the presence and abundance of certain benthic invertebrates. The dry weight of material in this size class was noticeably low at Walachin compared with the other three stations, e.g. a mean of 467 g m^{-2} compared with 4431 g m^{-2} at Savona, 5554 g m^{-2} at Chase and 7336 g m^{-2} at Little Fort (Table 15). For most stations the greatest proportion of the total inorganic weight was comprised of material which passed the 1.19 mm sieve and was retained on the 0.297 mm sieve (Table 16).

The biomass (dry weight) of the organic material collected in the Mundie samples varied considerably between sampling years. Analysis of variance comparisons between stations were computed for each sampling year. In 1973 biomass was significantly greater at Savona than at any other station. The lowest level was found at Little Fort (Table 17). In 1974 and 1975 biomass at Walachin was greater than at any other station (Tables 18 and 19). Particularly low organic levels were obtained from Savona in 1974. The organic material from Savona and Walachin was comprised almost entirely of benthic algae while at Chase, and in particular at Little Fort, many samples contained an assortment of wood chips, twigs, and leaves which would contribute to an overestimate of organic biomass at these stations.

(2) Periphyton

(a) 1973-74 Sampling Period

In this report estimates of periphyton standing crop are reported and discussed in terms of chlorophyll a and ash-free dry weight (volatile solids). At McLure, Chase, Savona, and Walachin distinct monthly fluctuations occurred in the mean levels of these two variables. Standing crop estimates

at Savona and Walachin greatly exceeded those at McLure and Chase especially during months of peak production such as March 1974 (Figures 12 and 13). Chlorophyll a at Savona and Walachin in March 1974 averaged 1.35 and 2.68 $\mu\text{g cm}^{-2}$ respectively compared with a mean of 0.25 $\mu\text{g cm}^{-2}$ at Chase and McLure. A similar pattern is apparent with ash-free dry weight where values at Savona and Walachin are clearly greater than McLure and Chase. In March 1974 the mean ash-free dry weight for Walachin and Savona was 0.57 and 0.65 mg cm^{-2} compared with a mean of 0.23 and 0.12 mg cm^{-2} at McLure and Chase. The data from most of the stations near the pulp mill and sewage lagoons are not as extensive as those from the four other stations and specific trends are not apparent although peaks in chlorophyll a and ash-free dry weight generally occurred in February and March 1974. The mean monthly levels of chlorophyll a and ash-free dry weight for the three stations immediately downstream of the sewage lagoons have been plotted for comparative purposes (Figures 14 and 15). Although chlorophyll a and ash-free dry weight values were higher at certain Kamloops stations than at the four upstream and downstream stations, no direct comparisons should be made. River velocities were much lower at the Kamloops stations and sample collections from these stations in this area were inadequate. Also heavy silt deposits probably affected the growth and development of the periphyton community at the stations in Kamloops. All data from the analysis of periphyton from all stations in both years are listed in Appendix 4.

Analysis of variance techniques were applied to the periphyton data to determine if significant differences in chlorophyll a and ash-free dry weight levels existed between the stations of McLure, Chase, Savona and Walachin and between sampling months. As shown in Table 20, significant differences were present between stations and between months for both

chlorophyll a and ash-free dry weight. Duncan's multiple range test (Li, 1964) revealed that chlorophyll a in March 1974 was significantly greater than in any other month ($p < 0.05$). No significant differences in chlorophyll a levels existed between the remaining six sampling months (i.e., these six months formed an homogenous subset). Duncan's test of station differences showed that chlorophyll a levels at Savona and Walachin were significantly greater than at Chase and McLure ($p < 0.05$). Ash-free dry weight levels were also significantly greater in March than any other month. Duncan's test of station differences in ash-free dry weight resulted in two homogenous subsets of months ($p < 0.05$): (1) Chase, McLure and Walachin (2) Walachin and Savona (Table 20). The levels at Walachin and Savona were greater than at McLure and Chase.

Chlorophyll a and ash-free dry weight determinations for the three stations immediately downstream of the sewage lagoons were also compared using analysis of variance to determine if any significant differences existed in the immediate area of sewage exfiltration from the sewage lagoons. As shown in Table 21 no significant difference in either chlorophyll a or ash-free dry weight existed between the three stations. Chlorophyll a levels in March were greater than in any other month (Table 21). No significant differences in ash-free dry weight existed between months.

The identification of attached algae from the February 1974 artificial substrates yielded no significant trends in species abundance. These results are tabulated in Appendix 5. A large category of unidentified species precluded statistical comparisons between stations and the application of diversity measures. The number of dominant species per station varied between 2 and 7 with McLure and Chase each having 6 dominant species compared with 2 at Savona and 3 at Walachin. At Savona, Fragilaria

vaucheriae accounted for 37% of the total cells present (based on a mean number of cells from two cm^2 samples) and Gomphonema olivaceum, 22% of the total. G. olivaceum and F. vaucheriae were also the dominant species at Walachin with each comprising 55% and 9% respectively of the total cells identified. Hannaea arcus, the third identified alga at Walachin comprised 6% of the remaining identified cells. In the North Thompson River at McLure, G. olivaceum and Synedra ulna accounted for 35% and 32% of the total cells with Achnanthes minutissima, Cymbella ventricosa and H. arcus comprising the remaining identified species. In the South Thompson River at Chase, Tabellaria fenestrata dominated the community with 48% of the total cells while F. vaucheriae, H. arcus and S. ulna formed the remaining identified portion. Total cell counts also varied considerably between stations with the numbers at Savona and Walachin being greater than those at Chase and McLure. The mean number of cells cm^{-2} at Walachin was 18,628; at Savona, 7,760; at Chase, 5,457; and at McLure, 1,074.

There was no consistent pattern in the number of algal species between the stations in the vicinity of the pulp mill and sewage lagoons. The total number of cells at these stations also varied tremendously as shown in Appendix 5. The lack of specific patterns of cell abundance and species dominance is probably related to the varied circulation patterns established by the confluence of the North and South Thompson Rivers and the problem of silt accumulation on the substrates.

(b) 1974-75 Sampling Period

Distinct monthly fluctuations in benthic algal standing crop occurred from November 1974 to March 1975 (Figures 16 to 19). An initial peak in the levels of chlorophyll a and ash-free dry weight occurred in December 1974 at most stations. This biomass peak was followed by a decline

to a minimum level in January 1975 where mean chlorophyll a levels at all stations except the sewage lagoon station were below $0.2 \mu\text{g cm}^{-2}$. The values at the sewage lagoon station deviated somewhat from this pattern by being higher in January 1975 than in December 1974 and reaching a minimum in February 1975. This difference at the sewage lagoon may be related to a different type of periphyton community which develops near the sewage lagoons and is discussed later. Chlorophyll a levels, except at the sewage lagoon, tended to increase through February and March 1975. As illustrated in Figure 16, chlorophyll a levels were higher at the downstream stations of Walachin and Savona than at McLure and Chase. In December 1974 chlorophyll a levels at Savona and Walachin were 1.33 and $0.38 \mu\text{g cm}^{-2}$ compared with $0.25 \mu\text{g cm}^{-2}$ at McLure. In March 1975 when the second peak in chlorophyll a production occurred, Walachin and Savona had levels of 1.25 and $0.73 \mu\text{g cm}^{-2}$ while at Chase the mean level was $0.16 \mu\text{g cm}^{-2}$. Chlorophyll a was not determined from the McLure periphyton in March because all the algae was utilized in the determination of ash-free dry weight. The mean chlorophyll a level at the sewage lagoon station was also high in March ($1.48 \mu\text{g cm}^{-2}$). Figure 20 illustrates the difference in algal abundance on natural substrates between stations. Visual estimates of algal standing crop usually agreed with the quantitative substrate determinations. Algal abundance always appeared much greater downstream from Kamloops Lake (Savona and Walachin) than at upstream stations (McLure and Chase).

One anomaly does exist in these data and concerns the high levels of chlorophyll a found at Chase in November and December 1974. These unusually high levels probably resulted from a change in river velocity in late November and December whereby the substrates were left in a back eddy characterized by no measurable flow. Under these conditions benthic algae proliferated and because export from this area was minimal, levels of

standing crop were abnormally high. The substrates at Chase were moved to an area of higher velocities in January 1975. Because of this anomaly at Chase, the November and December 1974 values have not been incorporated in the statistical analyses of periphyton standing crop and have been ignored when interpreting differences between stations.

As illustrated in Figures 17 and 19, extreme monthly variations in the levels of ash-free dry weight occurred at most stations. High levels of ash-free dry weight were found at Savona and the Sewage Lagoon in November and December 1974, and February and March 1975. In November, the mean ash-free dry weight at Savona and the Sewage Lagoon was 4.47 and 2.79 mg cm^{-2} respectively, while the level at McLure was 0.06 mg cm^{-2} . In March 1975, Savona, Walachin, and the Sewage Lagoon had mean ash-free dry weight levels of 4.74, 2.44, and 2.43 mg cm^{-2} respectively, compared with levels at Chase and McLure of 0.52 and 0.03 mg cm^{-2} . Two factors must be considered when interpreting the periphyton data and comparing results between stations. First, the substrates at McLure and the three Kamloops stations were covered by ice throughout most of January and February 1975. This would undoubtedly serve to limit algal production and therefore reduce algal standing crop. Second, comparisons between the three Kamloops stations and the other four stations cannot be made directly because the artificial substrates at Kamloops were attached vertically and the processes of colonization, succession and development of the periphytic organisms may differ between vertical and horizontal substrates.

Two-way analysis of variance comparisons were utilized to determine if the differences between months and stations were significant in 1974-75. Significant differences in chlorophyll a levels existed between months and stations (Table 22). Duncan's test resulted in two homogenous

subsets of months with some overlap ($p < 0.05$). The two homogenous subsets were (January 1975 - February 1975) and (February 1975 - November 1974 - December 1974 - March 1975) with the mean chlorophyll a level lowest in January and highest in March. The mean chlorophyll a level at Savona was significantly greater than at McLure, Chase or Walachin. No significant difference in chlorophyll a existed between the latter three stations although the mean level at Walachin was greater than at Chase or McLure.

Ash-free dry weight values did not vary significantly between months but significant differences were apparent between stations. The mean level at Savona was significantly greater than the mean levels within the homogenous subset of McLure, Chase and Walachin. Although not significantly greater, the mean ash-free dry weight level at Walachin was approximately twice that of either McLure or Chase.

Chlorophyll a and ash-free dry weight levels were significantly greater at the sewage lagoon than at the control or diffuser sites in the Thompson River (Table 23). No significant monthly differences in ash-free dry weight existed but differences in chlorophyll a were apparent. Three homogenous subsets of months were stratified from Duncan's test ($p < 0.05$). In increasing order they are (1) February 1975 (2) December 1974, January 1975, and November 1974, and (3) November 1974 and March 1975.

A three-way analysis of variance comparison was utilized to test year, month and station differences in chlorophyll a and ash-free dry weight for the four stations of McLure, Chase, Savona and Walachin. As shown in Table 24 no significant differences existed in chlorophyll a between 1973-74 and 1974-75. Significant differences did exist for months and stations. The mean chlorophyll a level in March was significantly

greater than in any other month and the stations of Walachin and Savona formed a homogenous subset where mean chlorophyll a levels were significantly greater than at Chase and McLure. Significant differences in ash-free dry weight were realized between years and stations but not between months. The mean ash-free dry weight obtained in 1974-75 was significantly greater than in 1973-74 and the level at Savona was significantly greater than within the homogenous subset of Chase, McLure, and Walachin (Table 24).

(c) Artificial versus Natural Substrates

The chlorophyll a values obtained from the periphyton on natural rock substrates and from the artificial substrates in December are illustrated in Figure 21. The chlorophyll a values from rock surfaces tended to fall within the range of values obtained from the artificial substrates at Chase and McLure, however, the values for the rock substrates at Savona and Walachin were greater than those from artificial substrates. The values obtained on rock and artificial substrates were compared by analysis of variance (Table 25). There were no significant differences in standing crop between the two substrate types at McLure and Chase. At Savona and Walachin the rock substrates had significantly greater levels of chlorophyll a than the artificial substrates.

(d) Effect of Velocity on Periphyton Standing Crop

The algal standing crop estimates from the substrates exposed to various river velocity regimes at Chase are documented in Table 26. Standing crop estimates tended to be higher at low velocities but much variation existed over small velocity intervals. For example, at velocities from 0.09 to 0.12 m sec⁻¹, chlorophyll a values varied from 2.897 to 0.294 µg cm⁻² respectively. Also, at the highest velocity, 0.43 m sec⁻¹, the mean ash-free dry weight was as much as eight times greater than the value obtained at a velocity of 0.11 m sec⁻¹. Levels of chlorophyll a and ash-free dry

weight of replicate substrates (i.e. at assumed identical velocities) were consistently similar. The reasons for the large variations in standing crop over small velocity differences are unknown but are probably related, in part, to unmeasurable differences in micro-currents which developed around each substrate.

(3) Fish Tainting Experiments

(a) Laboratory

A summary of the results from the organoleptic analysis of the trout used in this experiment is represented in Table 27. After the eight hour exposure period the odour scores of fish from each treatment were high except those from the 4% effluent concentration which showed a slight reduction in odour quality compared with control fish. No deterioration in flavour was apparent after eight hours at any effluent concentration. Noticeable reductions in mean odour scores were evident after two days in fish from all treatments except the control and a slight deterioration in flavour noted in the fish from concentrations of 0.5 and 2%. No flavour deterioration was observed after two days at the 4% concentration. An interruption of the normal effluent exchange sequence in the experiment occurred on the sixth day when the mill was shut down and effluent discharge into the river ceased. On this day samples of effluent for the experiment were collected directly from the biological treatment pond adjacent the effluent discharge point instead of from the effluent pipeline as in previous samples. After five hours exposure to this effluent all fish in the 2% tank were visibly stressed and some fish died in the 4% exposure tank. All fish had died after 14 hours in the 4% tank and after 24 hours in the 2% tank. Odour ratings of these fish and the fish exposed to the 0.5% effluent were so low and objectionable that taste analysis was

not performed. Odour and taste scores of control fish remained high after seven days. The effluent which killed fish at 2% and 4% concentrations contained "collapsed foam" which was suspected to contain the toxic compounds. Analysis of the undiluted effluent for resin acid soaps indicated resin acid levels that could be responsible for the fish mortality (i.e. 10 mg l^{-1}).

(b) In Situ

The evaluation of fish from the in situ fish tainting experiment was performed, under contract, by the Department of Food Sciences, University of B.C.. The final report which contains the procedures used in the analysis, statistical analyses, and the results is presented in Appendix 6. The following is a short summary of the results from that report.

Fish which were kept in water obtained from the trout farm were considered control fish by the taste panel. Taste and odour scores from these fish were used in comparisons with fish from the various stations (treatments). Control samples of trout were rated consistently and significantly superior to those from all experimental sites on both odour and taste. Samples of fish located adjacent to the pulp mill diffuser and the upstream sewage lagoon were noticeably and significantly poorer in odour and taste quality than those from other stations and particularly poor in comparison with control samples. Off flavours detected from fish at the sewage lagoon station and the diffuser station were characterised as stale, rancid, earthy, sour and strongly fish. A summary table has been constructed to show relationships between time and treatment combinations (Table 28). Correlations did not exist between taste and exposure time for fish from the stations on the North Thompson, the South Thompson, and the Thompson River at Savona, but after 13 days exposure, all fish from

stations downstream from the pulp mill had flavour ratings which were lower than those obtained after 3 or 7 days exposure. At the diffuser and the two sewage lagoon stations there was a negative correlation between taste quality and exposure time. At the diffuser site the mean taste score dropped from 3.26 after 3 days exposure (6.0 was the highest rating, indicating excellent taste and odour) to a low of 2.18 after 13 days exposure. The control sample was rated at 4.85. Similar trends were not apparent with fish odour although the lowest odour scores (2.96 and 3.26) were recorded at the diffuser and the upstream sewage lagoon station respectively after 13 days.

(4) River Water Colour

Water in the South Thompson River during November to April can be described as a dark, clear colour. The water in the North Thompson River is clear but with a definite greenish colouration. Water immediately below the pulp mill diffuser is a dark brown colour and at the entrance to Kamloops Lake, Thompson River water is an amber-brown colour. Downstream of Kamloops Lake from Savona to Spences Bridge the river water is a light amber colour. The photograph in Figure 3 illustrates differences in apparent water colour from six river stations. Stream bank observations of river colour agree with this photographic representation.

VII DISCUSSION

(1) Benthic Invertebrates

Aquatic invertebrates differ in terms of their water quality requirements and have been classified into groups according to their tolerance to organic pollution. For example, members of the Plecoptera, Ephemeroptera, and Trichoptera have been categorized as forms sensitive to environmental change (Keup, Ingram and MacKenthun, 1966). Some members of the Simuliidae, Tendipedidae and Amphipoda have been classified as of intermediate tolerance to organic pollution while the Oligochaeta, particularly, the Tubificidae, can tolerate heavier organic pollution. The assemblage of benthic invertebrates which develop in a given area is indicative of a combination of recurring short term critical water conditions, long-time environmental factors, (Gaufin and Tarzwell, 1952), and biological interactions. Because benthic organisms are affected by such varied conditions and generally do not migrate over large distances they serve as valuable indicators of past as well as present river conditions. Patterson and Nursall (1975) suggested that a consideration of only physical and chemical data might not indicate possible changes in benthic river fauna. They suggested that marked changes in benthic invertebrate community structure in the North Saskatchewan River downstream from combined effluent discharges from the city of Edmonton may be associated with factors which are not readily apparent from water analyses such as increases in nutrient levels, substrate modification, increases in the levels of chemical compounds which initiate organism avoidance patterns or the ephemeral combination of factors to lethal levels that directly excludes a species in a sensitive phase of its life cycle.

The abundance of Oligochaeta in the bottom of lakes has been used

as a means of classifying degrees of organic pollution (Wright, 1955). Three separate classifications were proposed as follows: (1) Heavy pollution, more than 5,000 oligochaetes m^{-2} , (2) Moderate pollution, 1000-5000 m^{-2} and (3) Light pollution, 100-999 m^{-2} . Notwithstanding the inherent problems in using such a rigid classification scheme and relating it to the lotic environment, it does provide a guideline which is useful for comparative purposes. Based on this lake classification system, Walachin would be considered to have suffered from extremely heavy pollution in 1973 (more than 20,000 worms m^{-2} in some samples) and moderate pollution in 1974 and 1975. Watt et al. (1973) suggested that oligochaete worms were sensitive biological indicators of long and short term organic enrichment. They described correlations between oligochaete population densities and water pollution conditions in the St. John River. Oligochaete abundance is often directly related to the amount of organic enrichment hence the deposition of organics from allochthonous sources such as the pulp mill and sewage system or autochthonous sources such as accumulated periphyton and periphyton decomposition products could account for the large numbers of oligochaetes downstream of Kamloops Lake.

Several authors have reviewed the environmental requirements of certain major groups of insects, e.g. Plecoptera (Gaufin, 1962); Ephemeroptera (Leonard, 1962); Trichoptera (Roback, 1962). Based on such requirements, insects have been commonly used to indicate varying degrees of pollution. Accordingly, the benthic invertebrate results indicate that river conditions downstream of Kamloops Lake are probably responsible for a lower number of insect families, especially the pollution sensitive Ephemeroptera and Plecoptera, and also lower insect diversity as expressed by (H') than at upstream stations. Holmes (1975) noted a similar reduction in the

numbers of Ephemeroptera and Plecoptera downstream of a sewage outfall on the Coldwater River at Merritt. The impact of lower water quality on the benthic insect community is maximal at Walachin where insect diversity was significantly lower than any other station. Servizi and Burkhalter (1970) found macroinvertebrate communities consisting of pollution sensitive, facultative and tolerant species in a sampling program carried out at Walachin between 1962 and 1966. The authors used artificial trays to measure invertebrate abundance and found large and varied populations of macroinvertebrates at Walachin consisting of Ephemeroptera, Trichoptera, Tendipedidae, and Oligochaeta. The alterations of insect communities in the Thompson River may have serious adverse impacts on the food chain dynamics of salmonids and other fish which rear downstream of Kamloops Lake. Food chain dynamics were not investigated but herbivorous and omnivorous members of some families of Ephemeroptera such as the Baetidae, Heptageniidae, Ephemerellidae, and also chironomid larvae, are known to be major components in the diet of juvenile salmon (Mundie, 1974). The scarcity of these forms, except for the chironomids, at Savona and Walachin may seriously impair salmon feeding habits.

The heavy growth of benthic algae at Walachin may account for a major part of the reduced insect diversity. Heavy algal growth may reduce attachment sites for certain insects and algal decomposition could cause a reduction of dissolved oxygen in the micro habitats of the interstitial gravel environment. The algae may also affect insect mobility and restrict respiratory functions. The fact that insect diversity at Savona was not significantly lower than at upstream stations and that there was no noticeable reduction in the abundance of pollution sensitive forms at Savona is probably related to the absence of substrate gravel suitable for benthic

algae. The gravel at the Savona invertebrate sampling site was too small and mobile to allow for extensive periphyton development yet it provided a suitable substrate for some benthic invertebrates. With the absence of extensive periphyton accumulations on small gravel at Savona, benthic invertebrates were not adversely affected. Patterson and Nursall (1975) noted the destruction of the habitat occupied by stoneflies, mayflies and caddisflies in the North Saskatchewan River and suggested that their exclusion from this habitat could be related to a loss of a clean clinging surface, the covering of respiratory surfaces, or the formation of a de-oxygenated microzone within the gravel substrate interstices. Mundie (1974) emphasized that gross production of filamentous algal forms is not desirable because such growths obliterate various benthic invertebrates, reduce flows through gravel and affect fish directly by restricting their movements. Such filamentous forms were most prevalent at Walachin.

The possible effect of pulp mill effluent on invertebrate communities should not be overlooked. Stone, Griffing, and Knight (1972) reviewed the possible effects pulp mill effluent may have on aquatic organisms. These effects included a reduction in water transparency which could reduce the predatory activity of animals which hunt by sight; direct toxic effects by chemicals in the discharged effluent; dissolved oxygen reduction by bacterial decomposition, and a range of sublethal effects on both plants and animals. A study conducted to determine the distribution and abundance of benthic invertebrates prior to and following the discharge of effluent from the Crestbrook pulp mill on the Kootenay River is described by Langford (1974). Prior to mill start-up the major orders of insects were equally represented above and below the mill site. Following the mill start-up Ephemeroptera and Plecoptera were absent downstream from

the mill outfall. The study also included an investigation of the volume and dry weight of aquatic insects above and below the mill outfall. A significant reduction in both volume and dry weight was documented below the mill outfall. The nature of the results in the Crestbrook study are similar to those found in this study, that is, consistently low numbers of "pollution-sensitive" Plecoptera and Ephemeroptera at Walachin.

The use of aquatic invertebrates as indicators of changes in water quality has been criticized because of the considerable expertise required to identify organisms, especially to the species level (Wilhm and Dorris, 1966). Furthermore, Cairns (1974) suggests little data exists which supports the indicator species assessment of water quality and the results are difficult to quantify and require much information about the responses of organisms to various types of pollution stresses that have not been adequately studied. Also, environmental conditions affect species distribution and must be accounted for when grouping organisms into specific classes based on their supposed tolerance to pollution. The application of diversity measurements require that different taxa be recognized but not necessarily identified, hence a major drawback of the indicator species concept is eliminated. It is our contention that because of the controversy which exists over the relative value of indicator species versus analysis of community structure, maximum interpretive value could be obtained from the available data by a consideration of both insect abundance in conjunction with the indicator concept as well as the formal diversity and community structure concept. Accordingly, in this study we have interpreted the data by utilizing the concept of indicator species and analyzing faunal diversity.

(2) Periphyton

The quantitative sampling results and the qualitative appraisals of benthic algal abundance in the Thompson River system indicate a reduction in water quality downstream of Kamloops Lake compared with stations on the North and South Thompson Rivers. During the low flow periods of 1973-74 and 1974-75 the levels of chlorophyll a and ash-free dry weight were considerably higher at Savona and Walachin than at McLure and Chase suggesting greater nutrient levels downstream of Kamloops Lake. The causal factors accounting for this proliferation of benthic algae downstream of Kamloops Lake are unknown but we believe that the increased growths are related to nutrients from unnatural sources such as sewage discharges and pulp mill effluent.

Cairns, Lanza, and Parker (1972) discussed changes in algal communities under the influence of increases in nitrogen and phosphorous which are related to the basic nutrient requirements of algal species, differences between algal species in their ability to concentrate nutrients, and competitive interactions between various forms. Tilley and Haushild (1975) found that periphyton net productivity varied directly with increases in selected nutrients, e.g. phosphates, nitrates, nitrites and ammonia. Increased growths of algae may also be related to changes in the resident herbivorous community. Herbivores which would normally limit extensive algal growth could be eliminated directly by toxic components of effluent resulting in a great reduction in algal grazing. A change in the algal species composition of a periphyton community may also result in forms which cannot be consumed by aquatic herbivores thereby reducing overall consumer efficiency. A reduction of grazing pressure on some species could favour those species once limited by grazing thereby allowing them to become

dominant components of the periphyton community.

An increase in benthic algal production in streams under the influence of organic pollution is well documented (Butcher 1947, Blum 1956, Hawkes 1963, Cairns et al. 1972). The effects of high levels of organic inputs to streams are often manifested in a reduction of algal species diversity with a corresponding increase in abundance of a few dominant species. Hynes (1969) states that whenever streams are enriched, particularly by sewage, certain types of macrophytes and periphyton algae tend to occur in great abundance. The response of attached diatom populations to changes in water quality depend on the amount as well as the kind of pollutant discharged to a stream (Patrick & Strawbridge, 1963). Low levels of pollutants or relatively non-toxic pollutants results in a few species increasing greatly in abundance and dominating the diatom community. Very severe toxic effluents will reduce both the number of species and the number of individuals per species. Unfortunately the taxonomic analysis of the periphyton in this study is very limited and few conclusions about species diversity can be drawn from the data.

Visual estimates of algal abundance at Savona and Walachin may be more indicative of the extent of algal accumulation than the artificial substrate sampling study revealed. As was concluded in the comparison of artificial versus natural rock substrates, algal standing crop was significantly lower on artificial substrates at Walachin and Savona than at McLure and Chase. One reason for this difference may be the result of a high export rate of benthic algae from the artificial substrates leading to an underestimate of algal standing crop. In laboratory experiments it has been shown that as algal biomass accumulated on a substrate, current action eventually dislodged large portions of benthic growth and transported them

out of the immediate area (McIntire, 1968). The filamentous and "mat-like" nature of the periphyton at Savona and Walachin would suggest that the export of large fractions of algal biomass occurs frequently. Because of the relatively smooth surfaces of the artificial substrates, algal loss from artificial substrates could be greater than from rock substrates. It was noticed that large portions of the filamentous algal mat would slough off the substrates at Savona and Walachin when the substrates were disturbed (e.g. during removal). The periphyton community at Chase and McLure is predominately non-filamentous and does not lend itself to the export of extensive algal fractions. A second hypothetical reason for a possible underestimate of algal standing crop at Savona and Walachin may be related to the physical dislodgement of periphyton or the prevention of recruitment on the artificial substrates by a "whiplash" effect from the filamentous algae. The long filamentous forms which develop along the edge of the substrates would constantly scour the surface of the plates thereby preventing further colonization of the substrates. This possibility is substantiated by the fact that the growth on the substrates at the Savona and Walachin stations was patchy. Although river velocities varied between stations it is apparent from the results of the velocity experiment that large differences in algal standing crop between stations cannot be explained on the basis of differing velocities. Stockner and Shortreed (1975) classified sampling stations on two Vancouver Island creeks into three categories based on velocity. The velocities measured in this study fall within two of these categories, i.e. pools ($0-0.20 \text{ m sec}^{-1}$) and runs ($0.2-0.46 \text{ m sec}^{-1}$). Mean chlorophyll a and ash-free dry weight levels at stations classified as runs were equal to or greater than the levels at pool stations (Stockner and Shortreed, 1975). Such evidence corroborates our conclusion that the range of velocities in this study were not important in controlling benthic

algal standing crop. In light of the above considerations it must be emphasized that algal abundance downstream of Kamloops Lake is significantly greater than the upstream stations of McLure and Chase and that the quantitative artificial substrate estimates of algal standing crop at Savona and Walachin may actually be underestimates of "actual" algal standing crop.

In a study of Kootenay River periphyton above and below the Crestbrook pulp mill, differences were found in the levels of chlorophyll a carotenoids, and algal dry weight. Downstream of the mill there was an "approximately 30 fold increase in chlorophyll a and a 10 fold increase in carotenoids and dry weight" (Langford, 1974). In this study chlorophyll a values at Walachin and Savona were up to 10 times greater than at McLure and Chase. Chlorophyll a values of up to $0.05 \mu\text{g cm}^{-2}$ were reported upstream of the Crestbrook pulp mill which are of the same order of magnitude as those measured at Chase and McLure.

The extremely high ash-free dry weight levels at the Sewage Lagoon station and at Savona in 1974-75 suggests that the organisms comprising the periphyton community at these sites were, in part, non-photosynthetic and were probably heterotrophic bacterial and fungal forms. We have no taxonomic data to support this hypothesis but further support of this theory may be found through examination of chlorophyll a and ash-free dry weight values obtained at the sewage lagoon station in 1974-75. As is illustrated in Figure 18 the levels of chlorophyll a fluctuated throughout the sampling period. Ash-free dry weight levels, however, remained relatively constant each month at the sewage lagoon station unlike the control and diffuser stations which suggests a portion of the periphyton community responded asynchronously with the autotrophic forms. That portion, as suggested, was probably comprised of heterotrophic forms.

An increase in ash-free dry weight in 1974-75 compared with 1973-74 at Savona could be the result of a major establishment of non-photosynthetic forms downstream of Kamloops Lake. Also, changes in the autotrophic species composition may account for ash-free dry weight differences. A community of diatoms would contain more ash than a community of filamentous greens and blue-greens. Such a change in species composition would be reflected in ash-free weight differences. These speculations require further studies to test their validity.

(3) Fish Tainting

The results from our in situ and laboratory fish tainting experiments strongly indicate that effluent from the Weyerhaeuser pulp mill is having a detrimental effect on the palatability of fish downstream from the pulp mill diffuser. Sewage effluent may also pose a fish tainting problem in the Thompson River especially in the area adjacent to the sewage lagoon where exfiltration from the lagoons is extensive and also in the river downstream from the sewage effluent discharge site.

In a Fisheries Service fish tainting study at Kitimat, B.C., the site of a Eurocan pulp and paper mill, pulp mill effluent concentrations of 1.3% were found to impair sockeye salmon flavour after one week exposure. After a three week exposure period all fish in effluent concentrations of 1.3, 1.8, 2.2 and 4.0% were found to be extremely objectionable in flavour (bitter and acrid) and distinct "off" odours were reported. Control fish held in open tanks at the pulp mill became tainted apparently by contamination by aerial emissions. Controls well removed from the pulp mill were not tainted (Geiger, 1972).

A significant reduction in taste and odour quality was documented

in a study of fish tainting associated with discharges from the Crestbrook pulp mill on the Kootenay River. Significantly lower flavour scores were recorded for both cutthroat trout and Rocky Mountain whitefish caught below the outfall compared with fish caught above the outfall (Langford, 1972). The severe fish tainting problems which have persisted since 1966 has resulted in decreasing angler use of the Kootenay River.

The tainting results obtained in this study do not correspond with results from certain other tainting experiments. For example, Shumway and Palensky (1973) demonstrated that biologically stabilized kraft mill effluent produced very high "off" flavours in fish at concentrations of 50% by volume and above after 48 hours exposure. At concentrations of 16 to 50% effluent by volume, flavour indices were moderately depressed. At lower concentrations of 1.0 to 8.1% by volume no flavour impairment was noted. Such discrepancies between study results may be explained by differences in effluent characteristics between mills. Because a high degree of variation in effluent toxicity exists between kraft pulp mills (Howard and Walden, 1969) there could exist a similar degree of variation in the amount and potency of fish tainting compounds between mills. The effect of the fish mortalities in the laboratory experiments on odour and taste are unknown although Cook et al. (1973) found that those fractions of total kraft pulp mill effluent which were most toxic to fish were the same as those causing fish tainting in effluent discharged into the St. Lawrence River.

The components of pulp mill effluent and sewage effluent which cause fish tainting are unknown and further research is required to isolate and identify such compounds.

(4) Colour

The effect of colour on river biology was not investigated. The increase in apparent water colour downstream from the Weyerhaeuser pulp mill diffuser which persists downstream from Kamloops Lake could interfere with predatory activity and limit or preclude the growth of certain algal species.

VIII CONCLUSIONS

- (1) The abundance of the "pollution-sensitive" Ephemeroptera and Plecoptera was considerably lower at Walachin than at any other benthic invertebrate sampling station.
- (2) The number of Oligochaeta was significantly greater at Walachin than at Little Fort, Chase, or Savona in 1973 and 1974. In 1975 oligochaete abundance at Savona exceeded that of other stations with the number at Walachin remaining considerably higher than at Little Fort or Chase. These trends indicate a high degree of organic enrichment of the Thompson River downstream from Kamloops Lake.
- (3) Insect family diversity was significantly lower at Walachin than any other station in 1973, 1974 and 1975. Generally, insect diversity was greater at Little Fort and Chase than at Savona and Walachin.
- (4) The above mentioned gross difference in benthic invertebrate community structure at Walachin and Savona as compared with Chase and Little Fort could have serious consequences on the food chain dynamics of salmonids and other fish which rear downstream from Kamloops Lake.
- (5) Periphyton standing crop on artificial substrates, expressed in terms of chlorophyll a and ash-free dry weight, was significantly greater at Savona and Walachin than at McLure and Chase during the low flow sampling period of 1973-74. In 1974-75 the standing crop of periphyton was significantly greater at Savona than at any other station and the level at Walachin was considerably greater than at McLure or Chase.
- (6) The quantitative estimates of benthic algal standing crop at Savona and Walachin may be underestimates of actual algal production.

Extensive algal accumulations at Savona and Walachin probably lead to the export of significant amounts of algae from these areas.

- (7) Photographic and visual observations corroborate the quantitative conclusions reached in this study, i.e. periphyton abundance at McLure and Chase was noticeably lower than at Savona and Walachin.
- (8) Pulp mill and possibly sewage effluent seriously reduced salmonid palatability.
- (9) Apparent water colour below the Weyerhaeuser pulp mill diffuser is drastically altered by the mill effluent. This discolouration persists, to a lesser degree, in the Thompson River downstream of Kamloops Lake.

IX RECOMMENDATIONS

- (1) The results from this study must be integrated with the data from water quality studies if more definitive conclusions are to be drawn from the available biological data.
- (2) Nutrient releases from land use activities and effluent discharges that are likely responsible for excessive algal growth in the Thompson River must be greatly reduced at their sources.
- (3) Positive action must be taken immediately to identify and control the factors that account for the alteration of benthic invertebrate community structure downstream from Kamloops Lake.
- (4) Every attempt must be made to identify and remove fish tainting agents from the Weyerhaeuser pulp mill effluent.
- (5) Colour removal from the Weyerhaeuser pulp mill effluent is desirable from an aesthetic point of view.
- (6) Further studies of the Thompson River system should be undertaken to augment the investigations described in this report. We suggest that the following studies be included:
 - (a) A detailed quantitative, taxonomic study of attached algae from stations below Kamloops Lake, in the vicinity of the sewage lagoon and pulp mill diffuser, and on the North Thompson and South Thompson Rivers should be conducted to determine species composition, species abundance and species diversity.
 - (b) Many algae possess the ability to store phosphate in excess during periods when excess phosphate is available in aquatic ecosystems and may draw on such phosphate reserves during times

of phosphate scarcity. An examination of the phosphate content of algae from selected stations downstream and upstream of Kamloops Lake may provide clues to the amount of phosphate in the aquatic medium and take into account shock loads of phosphate or minor temporal changes in phosphate input to the system which would normally be overlooked with conventional sampling techniques.

- (c) The identification and analysis of the total pool of biologically active phosphate and other limiting nutrients at sites below Kamloops Lake and at sites on the North and South Thompson Rivers would provide a more reliable index of such nutrient levels. For example this pool should include not only total phosphorous in the water itself but also the phosphorous associated with plankton, macrophytes, biological films, periphyton and bottom sediments. Such an index might be more closely associated with periphyton growths.
- (d) A detailed taxonomic study of benthic invertebrates at stations above and below the effluent discharge points should be performed with the organisms identified to the species level. The invertebrates could then be more closely partitioned into groups according to their pollution sensitivity and more meaningful diversity measures could be obtained.
- (e) Laboratory experiments should be conducted to evaluate the role of treated municipal sewage effluent in the tainting of fish flesh.
- (f) The effect of colour in Weyerhaeuser pulp mill effluent on functional and structural aspects of river biology should be investigated.

- (g) The relationship between altered benthic invertebrate community structure and the feeding ecology of salmonids and other fish should be examined.

- (h) All future biological studies should incorporate detailed chemical and physical analyses of water and sediments.

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Table 1
Estimates of annual coho salmon escapements¹

Name of Stream	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Adams River	1500	200	750	750	400	750	400	200	400	750	400	300	200	300	150
Upper Adams River	750	3500	500	750	1500	0	750	NR	NR	P	P	P	P	P	150
Anstey River	50	750	75	25	75	25	0	25	25	25	25	0	25	25	25
Barriere River	200	750	750	75	400	750	400	200	400	750	750	463	400	350	1500
Bessette River	NR	NR	200	75	1500	3500	1500	25	1500	1500	750	750	2000	750	1500
Bonaparte River	0	0	0	0	0	50	75	0	0	50	50	50	25	25	25
Brookfield Creek	NR	NR	NR	NR	NR	NR	NR	NR	75	25	25	2	25	0	0
Clearwater River	P	NR	NR	NR	NR	0	NR	P	P	NR	P	P	P	2000	2000
Coldwater River	400	400	75	75	0	750	3500	75	750	3500	750	400	250	1500	750
Deadmans Creek	1500	750	400	750	75	1500	400	75	50	50	75	50	25	75	25
Eagle River	1500	3500	3500	750	1500	3500	1500	750	1500	750	1500	1500	1200	1800	3500
Finn Creek	0	200	200	200	75	1500	400	200	400	400	200	179	25	50	75
Tappen Creek	25	25	150	25	25	25	0	0	25	25	25	25	25	25	0
Joseph Creek	0	25	0	0	0	750	200	200	75	200	NR	NR	NR	NR	0
Lemieux Creek	400	1500	750	200	750	3500	1500	750	750	1500	1500	1500	400	725	750
Lion Creek	3500	7500	7500	1500	3500	1500	750	650	1250	1500	1500	1810	650	2250	750
Louis Creek	1500	1500	1500	750	200	1500	750	400	1500	1500	1500	3327	2500	700	3500
Mann Creek	0	200	75	25	25	400	200	0	75	25	75	143	25	90	25
Momich River	400	400	750	200	200	0	50	0	75	200	NR	75	25	25	25
Nicola River	400	200	400	400	50	3500	1500	50	1500	3500	1500	750	300	400	750
Raft River	50	750	75	25	1500	1500	750	200	750	750	750	750	550	450	750
Reg Christie Creek	0	0	0	0	0	0	200	0	75	25	25	17	25	30	0
Salmon River	1500	1500	750	1500	750	3500	400	200	1250	1500	750	1500	2000	400	1500
Scotch Creek	50	0	0	0	NR	0	P	25	25	0	200	25	25	25	25
Seymour River	0	0	0	0	0	25	NR	0	0	NR	NR	NR	NR	NR	NR
Lower Shuswap River	1500	750	750	750	750	200	400	200	400	750	400	75	300	250	100
Middle Shuswap River	200	200	1500	1500	750	400	400	200	400	750	400	400	400	500	500
Sinmax River	200	200	750	200	75	400	200	75	400	200	200	213	104	165	200
Spius Creek	50	50	50	50	0	75	200	50	50	75	1500	750	400	400	750
Thompson River	0	0	0	0	0	0	200	400	400	200	200	200	200	200	200
North Thompson River	P	750	750	750	750	750	750	750	750	750	750	750	200	P	2000
South Thompson River	0	0	0	0	0	0	0	0	50	0	0	0	P	P	0
TOTAL	15675	25600	22200	11325	14850	30350	17375	5700	14875	21250	15750	16004	12304	13510	21525

P - salmon present but not enumerated

NR - no report available

1 - These values are estimates of abundance derived from the ranges in spawner abundance observed by Fishery Officers.

Table 2

Estimates of annual chinook salmon escapements

Name of Stream	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Adams River	1500	1500	1500	1500	500	1500	3500	1500	3500	5000	1500	750	1900	16500	1500
Upper Adams River	0	0	0	0	25	0	0	0	0	0	0	0	0	0	150
Barriere River	25	25	75	75	200	400	25	0	0	50	25	10	25	0	25
Bessette River	NR	NR	25	25	25	0	0	25	0	0	25	25	25	0	25
Bonaparte River	0	0	75	50	50	0	0	50	50	50	50	50	25	200	25
Clearwater River	700	1500	3500	1500	700	750	1500	1500	750	1500	750	1500	1500	1500	1200
Coldwater River	200	200	200	200	160	200	200	200	200	200	750	400	100	750	200
Deadmans Creek	750	200	750	750	200	200	25	750	25	25	75	50	25	200	75
Eagle River	1500	750	3500	1500	400	750	750	750	200	400	300	750	300	350	400
Finn Creek	25	50	750	750	200	750	400	500	500	750	750	750	400	373	750
Lemieux Creek	50	0	75	0	0	0	0	0	0	25	0	0	25	0	0
Lion Creek	0	0	0	0	0	0	0	0	0	50	0	0	25	0	0
Little River	200	750	750	400	750	200	400	400	400	200	750	200	200	200	300
Louis Creek	400	400	400	400	75	0	25	25	75	25	25	200	200	50	25
Mahood River	P	P	P	P	P	P	P	P	P	P	200	136	109	400	200
Mann Creek	0	0	0	0	0	0	0	0	25	0	0	0	25	0	0
Nicola River	3500	400	3500	3500	4500	3500	400	3500	3500	3500	3500	1500	1500	3500	3500
Raft River	200	200	200	200	400	750	400	200	25	200	75	200	200	200	200
Salmon River	200	25	400	200	75	200	200	200	275	200	200	400	0	0	200
Scotch Creek	0	0	0	0	NR	0	0	25	25	0	0	0	0	0	0
Seymour River	0	0	400	200	0	75	25	75	0	25	0	0	0	0	0
Lower Shuswap River	3500	3500	3500	3500	3500	1500	3500	15000	7500	7500	7500	7500	4500	9000	10000
Middle Shuswap River	750	1500	750	750	400	400	400	1500	400	500	750	750	300	400	750
Spius Creek	50	0	50	50	40	75	50	50	50	75	750	200	400	750	750
Thompson River	1500	700	1500	1500	3500	1500	750	1500	3500	2500	3500	3500	1500	3500	1500
North Thompson River	P	1720	1720	1720	2500	3500	1500	1500	750	1500	1500	1000	1500	1000	1000
South Thompson River	3500	3500	3500	1500	7500	3500	1500	3500	3500	7500	7500	3500	5000	5000	3500
TOTAL	18550	16920	27120	20270	25700	19750	15550	38025	25250	31775	30475	23371	19784	43873	26275

P - salmon present but not enumerated

NR - no report available

Table 3
Estimates of annual sockeye salmon escapements

Name of Stream	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Adams River	1500	35000	1000000	151373	796	55041	1163400	765000	3983	45908	1315000	280000	4325	40546	>100000
Upper Adams River	0	0	100	6	162	0	63	0	0	0	25	0	25	0	25
Anstey River	0	0	0	0	0	41	1352	200	0	0	500	50	0	0	1500
Barriere River	50	75	25	92	85	104	4	16	275	25	25	4	94	0	25
Clearwater River	0	NR	NR	NR	NR	NR	25	0	0	P	NR	NR	25	0	0
Eagle River	0	50	7700	0	0	398	10148	25	0	75	7525	200	25	50	3700
Little River	75	3500	125000	5148	0	3236	105288	74490	0	6775	222400	12500	75	1500	100000
Momich River	1000	50	75	0	823	0	400	0	617	0	200	25	750	0	25
Raft River	7500	3500	7500	8724	5500	6624	6250	1303	10697	7500	3500	750	11500	2900	1500
Scotch Creek	50	1500	3500	0	0	1910	5229	7500	126	3395	6300	750	0	7500	3900
Seymour River	3500	7500	75000	71690	3000	6954	28745	13361	3870	7327	14375	15000	3500	3500	35000
Lower Shuswap River	0	400	400	35000	23	583	24629	5951	25	1500	29000	7500	200	7452	75000
Middle Shuswap River	0	0	400	0	0	0	1872	25	0	0	4559	200	0	0	3500
Sinmax River	0	200	200	0	0	75	344	0	0	50	200	3	25	69	200
Thompson River	0	0	0	0	0	0	1600	0	0	0	0	0	0	0	0
North Thompson River	0	70	70	70	38	72	46	0	0	0	200	205	400	P	150
South Thompson River	0	400	3500	45	0	192	10586	270	0	750	7500	1500	0	750	3500
TOTAL	13675	52245	1223470	272148	10427	75230	1359981	868141	19593	73305	1611309	318687	20944	64267	328025

P - salmon present but not enumerated
NR - no report available

Table 4

Estimates of annual pink salmon escapements

Name of Stream	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Adams River	0	0	0	0	0	53	0	0	0	25	0	25	0	0	0
Bonaparte River	0	0	0	1700	0	1750	0	3500	0	400	0	200	0	750	0
Deadmans Creek	0	0	0	100	0	40	0	75	0	0	0	50	0	0	0
Little River	0	0	0	0	0	0	0	0	0	25	0	25	0	25	0
Nicola River	0	200	0	400	0	50	0	1500	0	1500	0	1500	0	750	0
Thompson River	0	85000	0	282300	0	230400	0	240000	0	240000	0	240000	0	100000	0
South Thompson River	0	0	0	0	0	400	0	200	0	25	0	25	0	25	0
TOTAL	0	85200	0	284500	0	232693	0	245275	0	241975	0	241825	0	10155	0

Table 5

Mean water depth and current velocity at each benthic invertebrate sampling station in April of each year.

Station	1973		1974		1975	
	Depth (m)	Velocity (m sec ⁻¹)	Depth (m)	Velocity (m sec ⁻¹)	Depth (m)	Velocity (m sec ⁻¹)
Little Fort	0.35	0.60	0.45	0.39	0.30	0.31
Chase	0.30	0.23	0.30	0.37	0.30	0.18
Savona	0.30	0.48	0.40	0.11	0.30	0.18
Walachin	Not Determined		0.45	0.18	0.30	0.18

Table 6

Artificial substrate depths and current velocities at each periphyton sampling station.¹

1973-74 (April 1974)

	Depth (m)	Mean Velocity (m sec ⁻¹)	Velocity Range (m sec ⁻¹)
McLure	0.45	0.42	0.41 - 0.44
Chase	0.45	0.24	0.16 - 0.30
Savona	0.45	0.11	0.09 - 0.12
Walachin	0.45	0.18	0.15 - 0.21

1974-75 (November 1974)

	Depth (m)	Mean Velocity (m sec ⁻¹)	Velocity Range (m sec ⁻¹)
McLure	0.50	0.42	0.41 - 0.44
Chase	0.50	0.26	0.26 - 0.28
Savona	0.50	0.11	0.09 - 0.12
Walachin	0.50	0.18	0.15 - 0.21
Sewage Lagoon	0.50	0.25	0.18 - 0.29
Mill Diffuser	0.50	0.24	0.09 - 0.36
Control	0.50	0.24	0.22 - 0.26

¹ Velocities were determined adjacent to the artificial substrates.

Table 7

Site locations and exposure times for the in situ fish tainting experiments.

Station	Depth	Time of Initial Exposure	Sampling Time	Exposure Time	No. Fish
North Thompson	0.3 m	March 25	-	-	-
			March 28	3 days	6
			April 1	7 days	6
			April 7	13 days	6
South Thompson	1.0 m	March 25	-	-	-
			March 28	3 days	6
			April 1	7 days	6
			April 7	13 days	6
Diffuser	0.6 m	March 25	-	-	-
			March 28	3 days	6
			April 2	(fish lost, replaced with 12 from N. & S. Thompson cages)	
			April 9	7 days	6
			April 16	14 days	6
Lagoon #1	0.6 m	March 25	-	-	-
			March 28	3 days	6
			March 30	(all fish lost, replaced with 12 from Savona)	
			April 7	8 days*	6
			April 14	15 days*	6
Lagoon #2	0.3 m	March 25	-	-	-
			March 28	3 days*	6
			April 2	8 days	6
			April 7	13 days	6
Savona	0.6 m	March 25	-	-	-
			March 28	3 days	6
			April 1	7 days	6
			April 7	13 days	6

* On April 1, the Weyerhaeuser pulp mill shut down for one day so the fish were left in cages an extra day.

Table 8

Analysis of variance comparison of oligochaete abundance between stations, 1973.

Station	Mean	Std. Dev.	Sample Size	F-Value
1 Little Fort	15.80	9.78	5	
2 Chase	18.66	12.87	6	
3 Savona	68.66	29.76	6	9.232***
4 Walachin	2784.66	2144.58	6	

Individual degree of freedom comparisons

	<u>F</u>		<u>F</u>	
1/2	0.00	N/S	2/3	0.01 N/S
1/3	0.01	N/S	2/4	18.96 ***
1/4	17.27	***	3/4	18.28 ***

N.B. Significance levels for this table and all subsequent tables are indicated as follows.

Significance Level

N/S	=	Not Significant
*	=	P < 0.05
**	=	P < 0.01
***	=	P < 0.001

Table 9

Analysis of variance comparison of oligochaete abundance between stations, 1974.

Station	Mean	Std. Dev.	Sample Size	F-Value
1 Little Fort	25.33	5.08	6	
2 Chase	39.66	20.05	6	
3 Savona	89.66	86.88	8	7.436**
4 Walachin	273.66	185.15	6	

Individual degree of freedom comparisons

	<u>F</u>		<u>F</u>	
1/2	0.06	N/S	2/3	0.71 N/S
1/3	1.18	N/S	2/4	15.55***
1/4	17.51	***	3/4	9.61**

See Table 8 for explanation of significance levels.

Table 10

Analysis of variance comparison of oligochaete abundance between stations, 1975.

Station	Mean	Std. Dev.	Sample Size	F-Value
1 Little Fort	49.33	28.88	6	
2 Chase	105.66	67.31	6	
3 Savona	398.66	74.77	6	20.103 ^{***}
4 Walachin	199.33	130.78	6	

Individual degree of freedom comparisons

	<u>F</u>		<u>F</u>	
1/2	1.36	N/S	2/3	36.71 ^{***}
1/3	52.19 ^{***}		2/4	3.75 N/S
1/4	9.62 ^{**}		3/4	16.99 ^{***}

See Table 8 for explanation of significance levels.

Table 11

Analysis of variance comparison of total diversity (H'), 1973

Station	Mean	Std. Dev.	Sample Size	F-Value
1 Little Fort	1.328	0.101	5	
2 Chase	1.018	0.264	6	
3 Savona	2.151	0.364	6	7.315**
4 Walachin	1.433	0.708	6	

Comparison of insect diversity (H'), 1973

Station	Mean	Std. Dev.	Sample Size	F-Value
1 Little Fort	1.183	0.113	5	
2 Chase	0.688	0.237	6	14.98***
3 Savona	0.816	0.149	6	
4 Walachin	0.351	0.274	6	

Individual degree of freedom comparisons (Insect Diversity)

	<u>F</u>		<u>F</u>	
1/2	15.47***	2/3	1.14	N/S
1/3	8.50**	2/4	7.91*	
1/4	43.75***	3/4	15.05***	

See Table 8 for explanation of significance levels.

Table 12

Analysis of variance comparison of total diversity (H'), 1974

Station	Mean	Std. Dev.	Sample Size	F-Value
1 Little Fort	1.328	0.097	6	
2 Chase	2.277	0.219	6	
3 Savona	2.379	0.064	6	55.60***
4 Walachin	1.953	0.188	6	

Comparison of insect diversity (H'), 1974

Station	Mean	Std. Dev.	Sample Size	F-Value
1 Little Fort	1.207	0.103	6	
2 Chase	1.089	0.381	6	
3 Savona	1.136	0.291	6	3.590*
4 Walachin	0.771	0.091	6	

Individual degree of freedom comparisons (Insect Diversity)

	<u>F</u>		<u>F</u>	
1/2	0.67	N/S	2/3	0.10 N/S
1/3	0.25	N/S	2/4	4.90 *
1/4	9.19	**	3/4	6.42 *

See Table 8 for explanation of significance levels.

Table 13

Analysis of variance comparison of total diversity (H'), 1975.

Station	Mean	Std. Dev.	Sample Size	F-Value
1 Little Fort	2.445	0.098	6	
2 Chase	2.189	0.141	6	44.44***
3 Savona	2.773	0.298	6	
4 Walachin	1.245	0.338	6	

Comparison of Insect Diversity (H'), 1975

Station	Mean	Std. Dev.	Sample Size	F-Value
1 Little Fort	2.207	0.060	6	
2 Chase	1.065	0.160	6	
3 Savona	1.000	0.114	6	150.68***
4 Walachin	0.552	0.193	6	

Individual degree of freedom comparisons (Insect Diversity)

	<u>F</u>		<u>F</u>	
1/2	197.57***	2/3	0.65	N/S
1/3	220.82***	2/4	39.84	***
1/4	414.86***	3/4	30.34	***

See Table 8 for explanation of significance levels.

Table 14
Mean dry weight (g m^{-2}) of benthic invertebrates.

Station	<u>1973</u>		<u>1974</u>		<u>1975</u>	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Little Fort	1.109	.492	1.829	.735	2.220	.863
Chase	1.495	.797	1.819	.898	5.005	4.91
Savona	1.454	1.59	1.614	.904	1.487	.509
Walachin	0.914	.748	0.929	.324	1.222	.746

Table 15

Total sediment load (g m^{-2}) from each invertebrate sampling station which passed the 2.38 mm sieve.

Year	Little Fort	Chase	Savona	Walachin
1973	5134.	6373.	7253.	174.
1974	6939.	4909.	730.	418.
1975	9935.	5381.	5310.	809.
(\bar{X})	7336.	5554.	4431.	467.

Table 16

Percentage of the total sediment fraction which passed the 2.38 mm sieve and was retained on the 1.19 mm, 0.297 mm and 0.074 mm sieve. The percentage of the total that passed the 0.074 mm sieve is also listed.

1973

<u>Sieve Size (mm)</u>	<u>Little Fort</u>	<u>Chase</u>	<u>Savona</u>	<u>Walachin</u>
1.19	1.1	7.4	17.3	1.2
0.297	78.3	43.1	70.7	60.8
0.074	20.2	48.9	11.5	33.7
<0.074	0.2	0.4	0.2	4.1

1974

<u>Sieve Size (mm)</u>	<u>Little Fort</u>	<u>Chase</u>	<u>Savona</u>	<u>Walachin</u>
1.19	1.8	2.4	6.3	5.7
0.297	79.2	55.3	79.3	71.3
0.074	18.3	34.9	12.9	20.8
<0.074	0.6	8.4	1.2	2.1

1975

<u>Sieve Size (mm)</u>	<u>Little Fort</u>	<u>Chase</u>	<u>Savona</u>	<u>Walachin</u>
1.19	0.8	2.7	17.9	8.0
0.297	74.1	71.0	74.4	70.8
0.074	24.7	26.1	7.3	19.4
<0.074	0.1	0.08	0.2	1.6

Table 17

Between station analysis of variance comparison of total organic biomass (g) excluding invertebrates collected in Mundie samples.

Station	1973		Sample Size	F-Value
	Mean	Std. Dev.		
1 Little Fort	4.089	3.861	5	
2 Chase	14.157	8.179	6	
3 Savona	29.417	16.056	6	4.569*
4 Walachin	14.612	12.974	6	

Individual degree of freedom comparisons

	<u>F</u>		<u>F</u>	
1/2	2.08 N/S	2/3	5.26 *	
1/3	13.17 **	2/4	0.00 N/S	
1/4	2.27 N/S	3/4	4.95 *	
		1&2 / 3&4	<u>F</u> 6.68*	

See Table 8 for explanation of significance levels.

Table 18

Between station analysis of variance comparison of total organic biomass (g) excluding invertebrates, collected in Mundie samples.

1974

Station	Mean	Std. Dev.	Sample Size	F-Value
1 Little Fort	3.579	1.147	6	
2 Chase	4.648	3.970	6	
3 Savona	0.783	0.637	6	4.493 *
4 Walachin	5.946	2.876	6	

Individual degree of freedom comparisons

1/2	$\frac{F}{0.53}$ N/S	2/3	$\frac{F}{6.96}$ *
1/3	3.64 N/S	2/4	0.78 N/S
1/4	2.61 N/S	3/4	12.42 ***

1&2 / 3&4	$\frac{F}{0.52}$ N/S
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See Table 8 for explanation of significance levels.

Table 19

Between station analysis of variance comparison of total organic biomass (g) excluding invertebrates collected in Mundie samples.¹

1975

<u>Station</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Sample Size</u>	<u>F-Value</u>
1 Little Fort	4.139	1.982	6	
2 Chase	1.860	1.239	6	3.473 *
3 Savona	3.366	2.095	6	
4 Walachin	5.434	2.362	6	

Individual degree of freedom comparisons

	<u>F</u>		<u>F</u>	
1/2	4.04 N/S	2/3	1.76 N/S	
1/3	0.47 N/S	2/4	9.94 **	
1/4	1.30 N/S	3/4	3.33 N/S	
	1&2 / 3&4		<u>F</u>	
			3.05 N/S	

1 Mundie sample size in 1975 was 0.11 m²

See Table 8 for explanation of significance levels.

Table 20

Two-way analysis of variance comparison of chlorophyll a and ash-free dry weight between months and stations, 1973-74.

A) Chlorophyll a

<u>Source</u>	<u>D.F.</u>	<u>M.S.</u>	<u>F.</u>
Months	6	5.878	11.496 ***
Station	3	5.302	10.370 ***
Error	214	0.511	

Duncan's Multiple Range Test $p < 0.05$

Month	Jan	Feb	Apr	Dec	Nov	Oct	Nov
Mean	<u>0.115</u>	<u>0.130</u>	<u>0.157</u>	<u>0.269</u>	<u>0.451</u>	<u>0.479</u>	<u>1.138</u>

Station	Chase	McLure	Savona	Walachin
Mean	<u>0.122</u>	<u>0.145</u>	<u>0.556</u>	<u>0.742</u>

B) Ash-free dry weight

<u>Source</u>	<u>D.F.</u>	<u>M.S.</u>	<u>F.</u>
Months	4	0.988	11.544 ***
Station	3	0.246	2.876 *
Error	182	0.085	

Duncan's Multiple Range Test $p < 0.05$

Month	Apr	Feb	Jan	Dec	Mar
Mean	<u>0.064</u>	<u>0.072</u>	<u>0.091</u>	<u>0.109</u>	<u>0.409</u>

Station	Chase	McLure	Walachin	Savona
Mean	<u>0.082</u>	<u>0.099</u>	<u>0.169</u>	<u>0.246</u>

N.B. Solid lines under groups indicate homogenous subsets ($p < 0.05$).

See Table 8 for explanation of significance levels.

Table 21

Two-way analysis of variance comparisons of chlorophyll a and ash-free dry weight between months and stations at the three sewage lagoon stations (shore, midstream and downstream) 1973-74.

A) Chlorophyll a

<u>Source</u>	<u>D.F.</u>	<u>M.S.</u>	<u>F.</u>
Month	4	1.235	3.687**
Station	2	0.368	1.100 N/S
Error	64		

Duncan's Multiple Range Test $p < 0.05$

Month	Nov	Jan	Dec	Feb	Mar
Mean	<u>0.135</u>	<u>0.252</u>	<u>0.306</u>	<u>0.648</u>	<u>0.857</u>

B) Ash-free dry weight

<u>Source</u>	<u>D.F.</u>	<u>M.S.</u>	<u>F.</u>
Month	3	0.316	1.064 N/S
Station	2	0.344	1.159 N/S
Error	63	0.296	

N.B. Solid lines under groups indicate homogenous subsets ($p < 0.05$)

See Table 8 for explanation of significance levels.

Table 22

Two-way analysis of variance comparisons of chlorophyll a and ash-free dry weight between months and stations, 1974-75.

A) Chlorophyll a

<u>Source</u>	<u>D.F.</u>	<u>M.S.</u>	<u>F.</u>
Months	4	1.439	5.744 ***
Station	3	1.999	7.980 ***
Error	117	0.250	

Duncan's Multiple Range Test $p < 0.05$

Month	Jan	Feb	Nov	Dec	Mar
Mean	<u>0.087</u>	<u>0.374</u>	0.482	0.649	0.660

Station	McLure	Chase	Walachin	Savona
Mean	<u>0.157</u>	<u>0.417</u>	<u>0.446</u>	<u>0.780</u>

B) Ash-free dry weight

<u>Source</u>	<u>D.F.</u>	<u>M.S.</u>	<u>F.</u>
Month	4	11.774	1.699 N/S
Station	3	147.143	21.233 ***
Error	113	6.929	

Duncan's Multiple Range Test $p < 0.05$

Station	Chase	McLure	Walachin	Savona
Mean	<u>0.299</u>	<u>0.346</u>	<u>0.789</u>	<u>4.646</u>

N.B. Solid lines under groups indicate homogenous subsets ($p < 0.05$).

See Table 8 for explanation of significance levels.

Table 23

Two-way analysis of variance comparisons of chlorophyll a and ash-free dry weight between months and stations (control, diffuser and sewage lagoon), 1974-75.

A) Chlorophyll a

<u>Source</u>	<u>D.F.</u>	<u>M.S.</u>	<u>F.</u>
Month	4	1.418	7.942 ***
Station	2	2.362	13.229 ***
Error	67	0.178	

Duncan's Multiple Range Test $p < 0.05$

Month	Feb	Dec	Jan	Nov	Mar
Mean	<u>-0.288</u>	<u>0.192</u>	<u>0.214</u>	<u>0.321</u>	<u>0.738</u>

Station	Control	Diffuser	Sewage Lagoon
Mean	<u>0.023</u>	<u>0.074</u>	<u>0.609</u>

B) Ash-free dry weight

<u>Source</u>	<u>D.F.</u>	<u>M.S.</u>	<u>F.</u>
Month	4	3.010	1.578 N/S
Station	2	20.954	10.983 ***
Error	64	1.907	

Duncan's Multiple Range Test $p < 0.05$

Station	Diffuser	Control	Sewage Lagoon
Mean	<u>0.242</u>	<u>0.402</u>	<u>2.098</u>

N.B. Solid lines under groups indicate homogenous subsets ($p < 0.05$)

See Table 8 for explanation of significance levels.

Table 24

Three-way analysis of variance comparisons of chlorophyll a and ash-free dry weight between sampling years, months and stations.

A) Chlorophyll a

<u>Source</u>	<u>D.F.</u>	<u>M.S.</u>	<u>F.</u>
Year	1	0.0006	0.001 N/S
Month	6	5.857	13.334 ***
Station	3	5.874	13.372 ***
Error	338	0.439	

Duncan's Multiple Range Test $p < 0.05$

Month	Jan	Apr	Feb	Nov	Dec	Oct	Mar
Mean	<u>0.104</u>	<u>0.156</u>	<u>0.252</u>	<u>0.426</u>	<u>0.427</u>	<u>0.538</u>	<u>0.994</u>

Station	Chase	McLure	Walachin	Savona
Mean	<u>0.186</u>	<u>0.187</u>	<u>0.620</u>	<u>0.663</u>

B) Ash-free dry weight

<u>Source</u>	<u>D.F.</u>	<u>M.S.</u>	<u>F.</u>
Year	1	131.86	37.593 ***
Month	5	3.043	0.862 N/S
Station	3	68.288	19.346 ***
Error	301	3.529	

Duncan's Multiple Range Test $p < 0.05$

Year	1973-74	1974-75
Mean	<u>0.167</u>	<u>1.694</u>

Station	Chase	McLure	Walachin	Savona
Mean	<u>0.396</u>	<u>0.447</u>	<u>0.533</u>	<u>2.347</u>

N.B. Solid lines under groups indicate homogenous subsets ($p < 0.05$).

See Table 8 for explanation of significance levels.

Table 25

Analysis of variance comparison of chlorophyll a levels on artificial versus natural substrates.

A) McLure

<u>Substrate</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Sample Size</u>	<u>F</u>
Natural	0.387	0.179	4	1.179 N/S
Artificial	0.252	0.209	7	

B) Chase

<u>Substrate</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Sample Size</u>	<u>F</u>
Natural	4.472	1.754	4	0.861 N/S
Artificial	5.918	2.781	7	

C) Savona

<u>Substrate</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Sample Size</u>	<u>F</u>
Natural	3.704	0.897	4	14.93 **
Artificial	1.330	1.046	8	

D) Walachin

<u>Substrate</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Sample Size</u>	<u>F</u>
Natural	0.970	0.492	4	7.577 **
Artificial	0.384	0.263	8	

See Table 8 for explanation of significance levels.

Table 26

The effect of river velocity on periphyton standing crop at Chase.

Replicate	Velocity (m sec ⁻¹)	Depth (m)	Chlorophyll <u>a</u> ($\mu\text{g cm}^{-2}$)	Ash-Free Dry Weight (mg cm^{-2})
A ₁	0.094	0.3	1.923	2.422
A ₂			2.897	3.624
B ₁	0.112	0.4	1.532	2.397
B ₂			1.722	2.546
C ₁	0.115	0.6	0.294	0.128
C ₂			0.517	0.189
D ₁	0.246	0.5	0.173	0.221
D ₂			0.325	0.291
E ₁	0.431	0.3	0.631	1.321
E ₂			0.586	1.323

Table 27

Results from laboratory fish tainting experiments.

Treatment	Exposure	Odour Score	Standard Deviation	Flavour Score	Standard Deviation
Control	8 hours	7.0	1.6	7.0	1.6
	2 days	7.2	1.5	7.0	1.6
	7 days	7.0	1.6	7.0	1.5
0.5% (Effluent Conc)	8 hours	7.4	1.5	7.1	1.5
	2 days	5.8	2.4	6.6	1.5
	6 days	4.0	0.8	*	*
2%	8 hours	7.0	1.6	7.8	1.1
	2 days	6.0	2.4	6.6	1.8
	6 days	3.0	0.8	*	*
4%	8 hours	6.2	1.8	7.0	1.6
	2 days	6.0	2.5	7.2	1.1
	6 days	1.0	0.6	*	*

Odour and flavour scores are based on a scale from 0-10 where 10 represents best flavour and odour.

Scores are a mean of five people tasting one fish each.

* No taste score as sample rejected on smell.

Table 28

Summary of in situ fish tainting results

A. Taste Results

Exposure Time	<u>Station</u>						Control
	North Thompson	South Thompson	Diffuser	Lagoon 1	Lagoon 2	Savona	
3 days	3.50	3.34	3.26	3.87	4.20	3.42	4.85
7 days	3.24	3.62	2.90	3.36	3.70	4.46	
13 days	3.53	3.47	2.18	2.16	3.52	3.20	

B. Odour Results

Exposure Time	<u>Station</u>						Control
	North Thompson	South Thompson	Diffuser	Lagoon 1	Lagoon 2	Savona	
3 days	3.57	3.32	3.22	3.53	3.64	3.80	4.39
7 days	3.68	3.98	3.53	3.74	3.94	4.26	
13 days	3.94	3.67	2.96	3.26	3.76	3.62	

Odour and flavour scores are based on a scale from 0-6 where 6 represents best flavour and odour.

Each value is a mean value of five taste panelists.

Refer to Figure 1 and 2 for station locations.

Figure 1
Thompson River system study area.

Figure 2

Periphyton sampling stations, benthic invertebrate sampling stations and in situ fish bioassay locations at Kamloops.

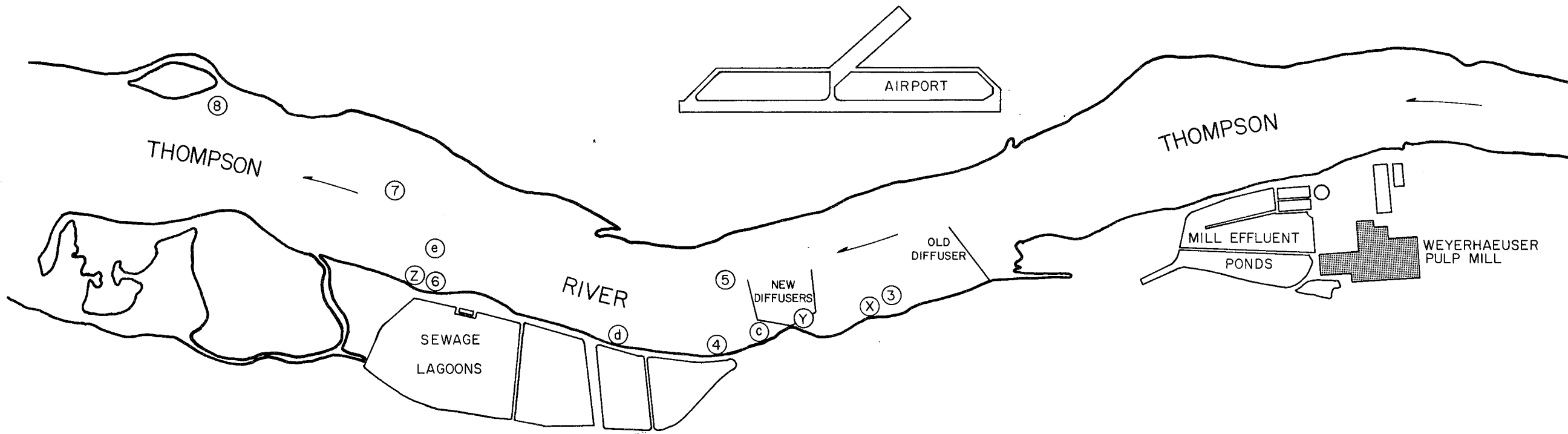
Station Locations

- a - e In situ fish tainting stations
- 1 - 8 Artificial substrate stations, 1973-1974
- x - z Artificial substrate stations, 1974-1975

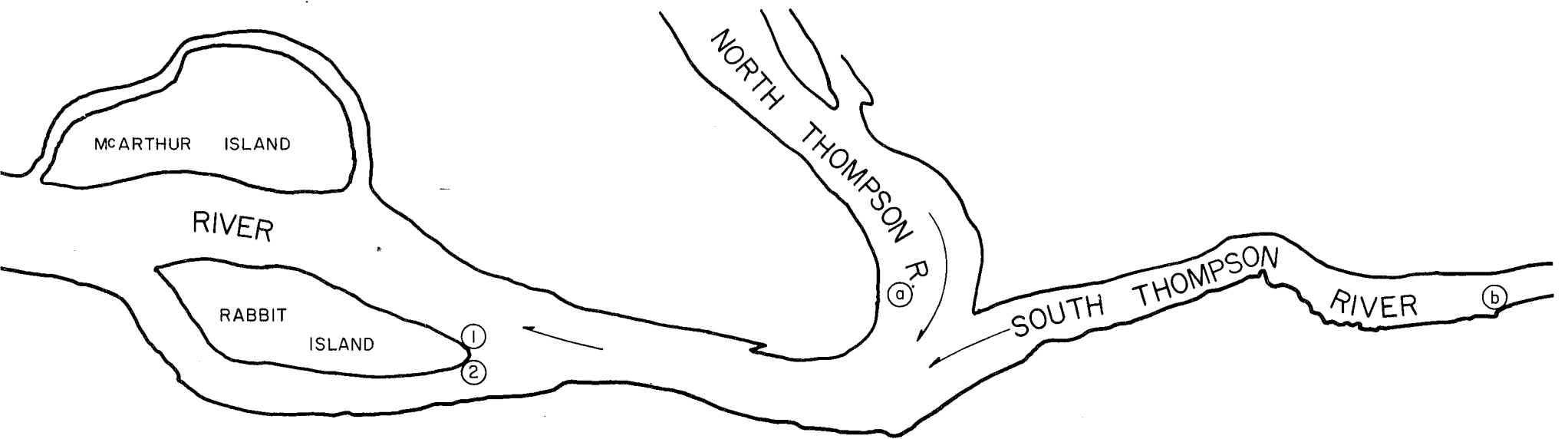
Station Names

- a North Thompson station
 - b South Thompson station
 - c Diffuser
 - d Lagoon #1
 - e Lagoon #2
-
- 1 North Thompson, Kamloops
 - 2 South Thompson, Kamloops
 - 3 Old Diffuser (non functional)
 - 4 New Diffuser, Shore
 - 5 New Diffuser, Mid-Stream
 - 6 Sewage Lagoon, Shore
 - 7 Sewage Lagoon, Mid-Stream
 - 8 Sewage Lagoon, Down-Stream
-
- X Control
 - Y Diffuser
 - Z Sewage Lagoon

CIT



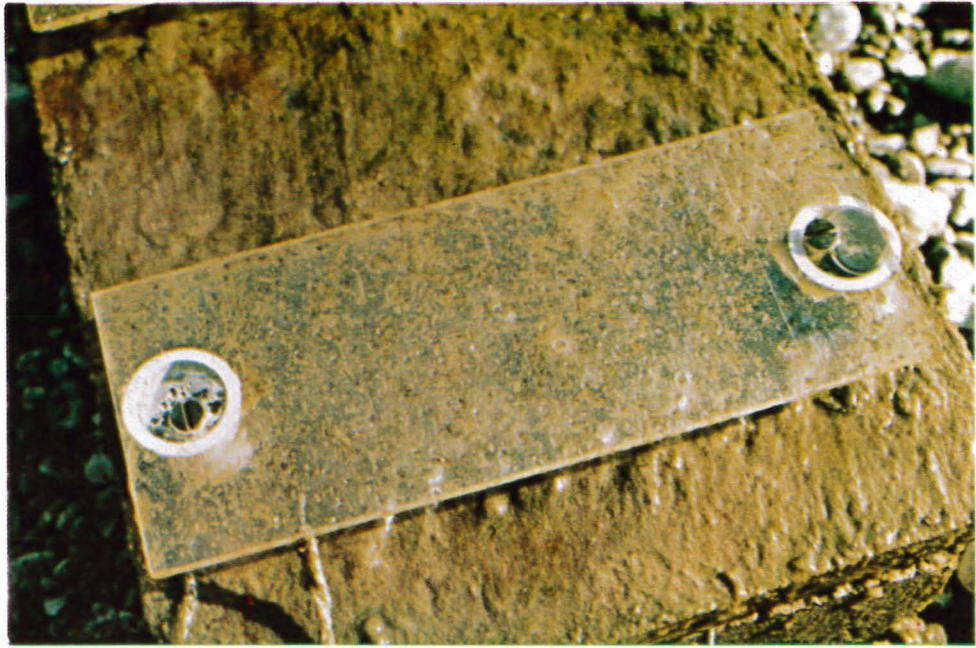
CITY OF KAMLOOPS



CITY OF KAMLOOPS

Figure 3

- (a) Horizontal arrangement of an artificial substrate showing periphyton which developed at Chase in April, 1974.
- (b) Photograph of water samples from locations on the Thompson, South Thompson and North Thompson Rivers. The stations were the same as those utilized in the in situ fish tainting experiment. From left to right the samples were (1) South Thompson River, (2) North Thompson River, (3) Diffuser, (4) Sewage Lagoon #1, (5) Sewage Lagoon #2, (6) Savona. The depth of water photographed was 20 cm. The photograph was taken in bright noon sun with a 300 mm lens using Kodak Ektochrome High Speed film.



(a)



(b)

Figure 4

- (a) Vertical arrangement of the artificial substrates and the appearance of the periphyton community which developed at the sewage lagoon station, March, 1975.
- (b) Periphyton sampler in use showing scraping brush and pipette.



(a)



(b)

Figure 5

Mean number of Oligochaeta m^{-2} at each sampling station

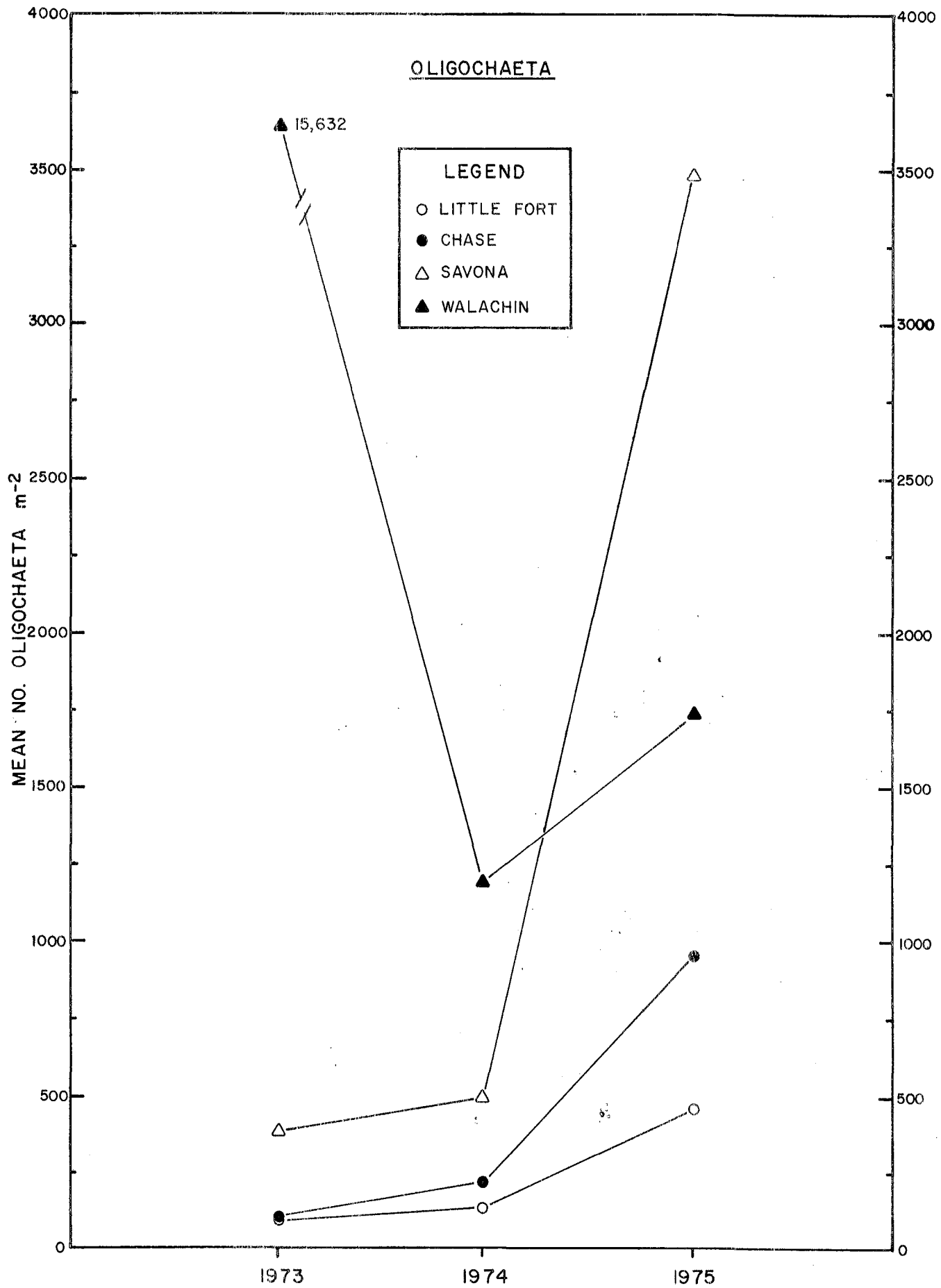


Figure 6

Total diversity (H') at each sampling station.

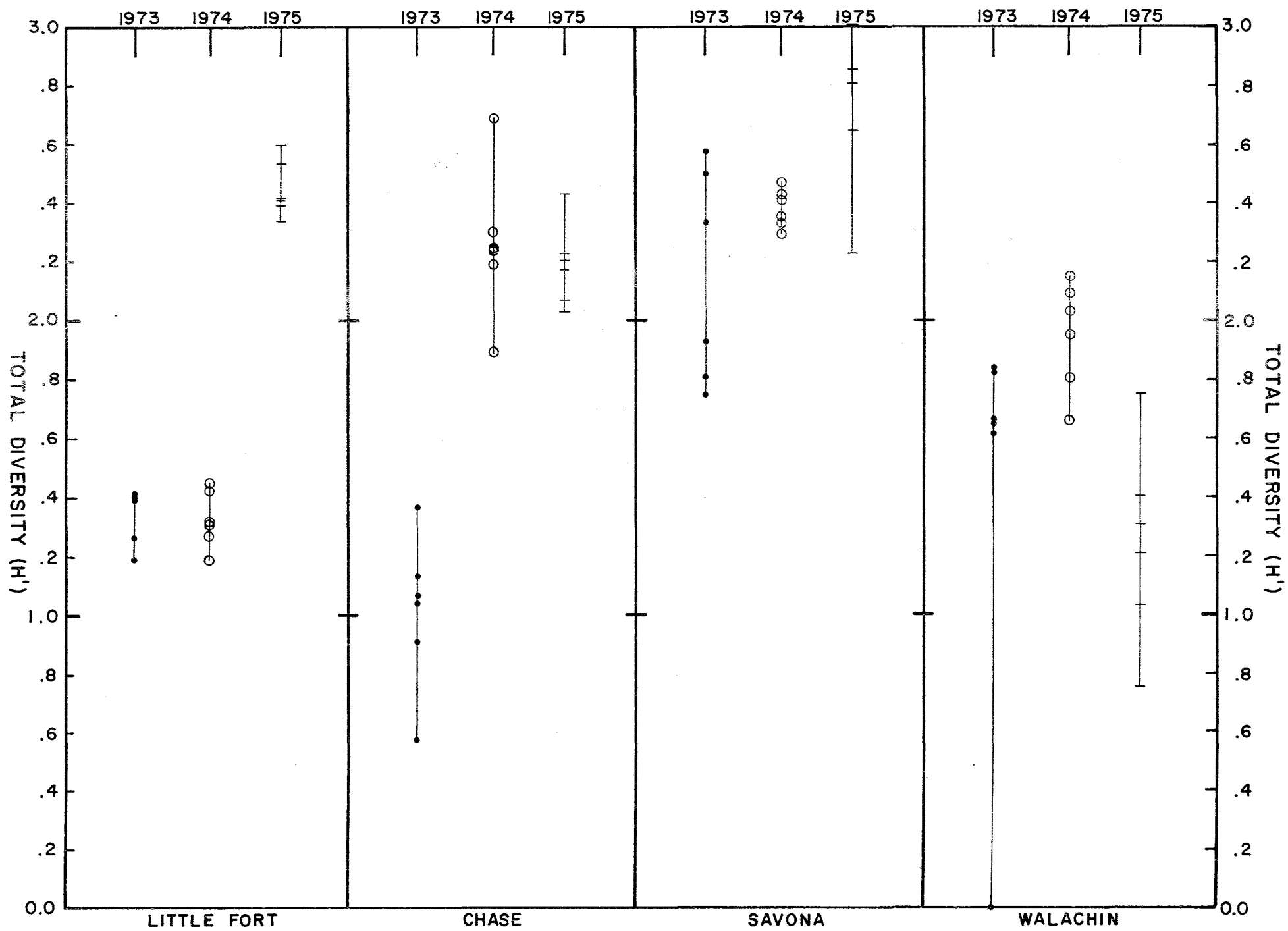


Figure 7

Insect diversity (H') at each sampling station

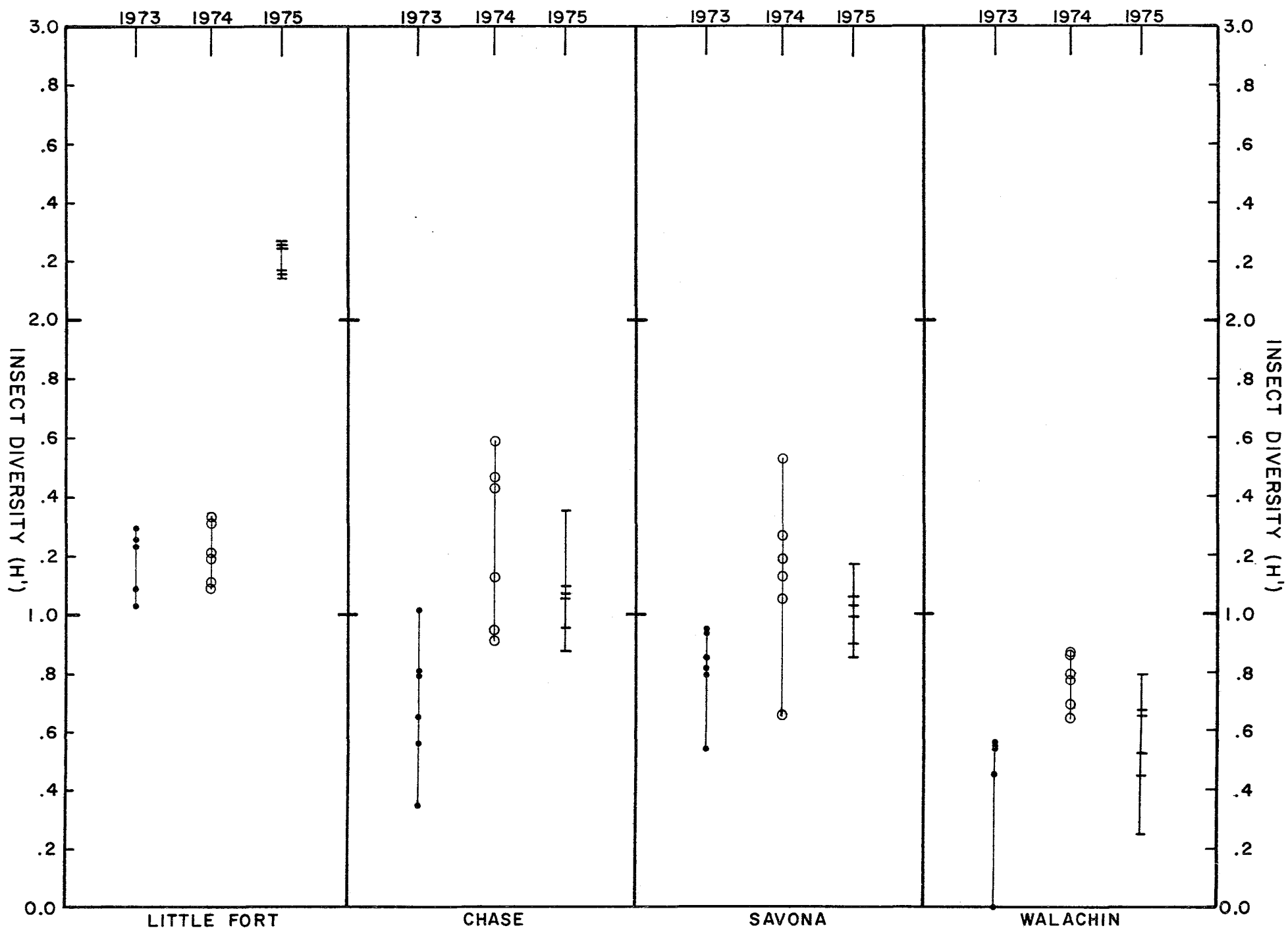


Figure 8

Mean number of Plecoptera m^{-2} at each sampling station.

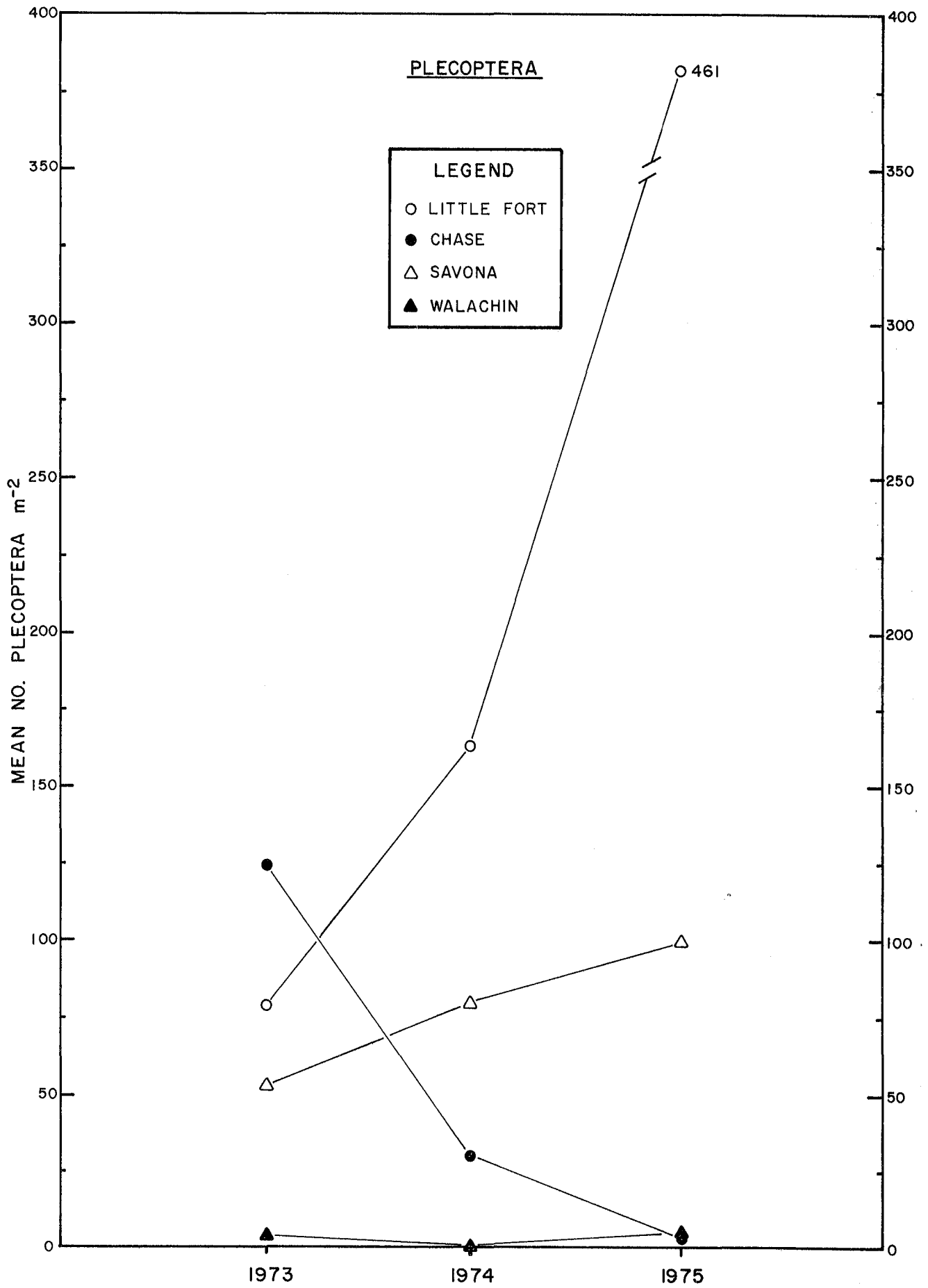


Figure 9

Mean number of Ephemeroptera m^{-2} at each sampling station.

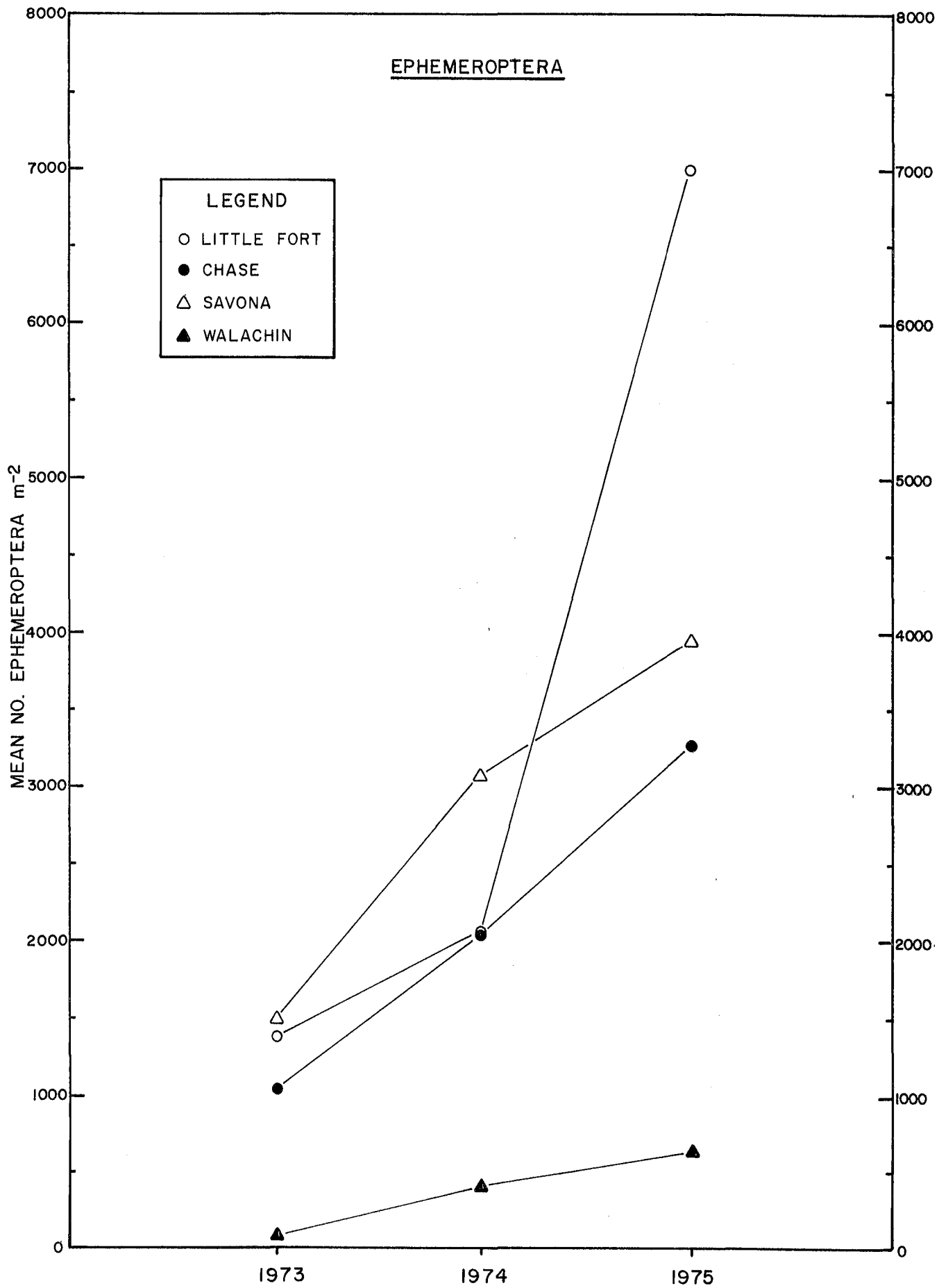


Figure 10

Mean number of Diptera m^{-2} at each sampling station.

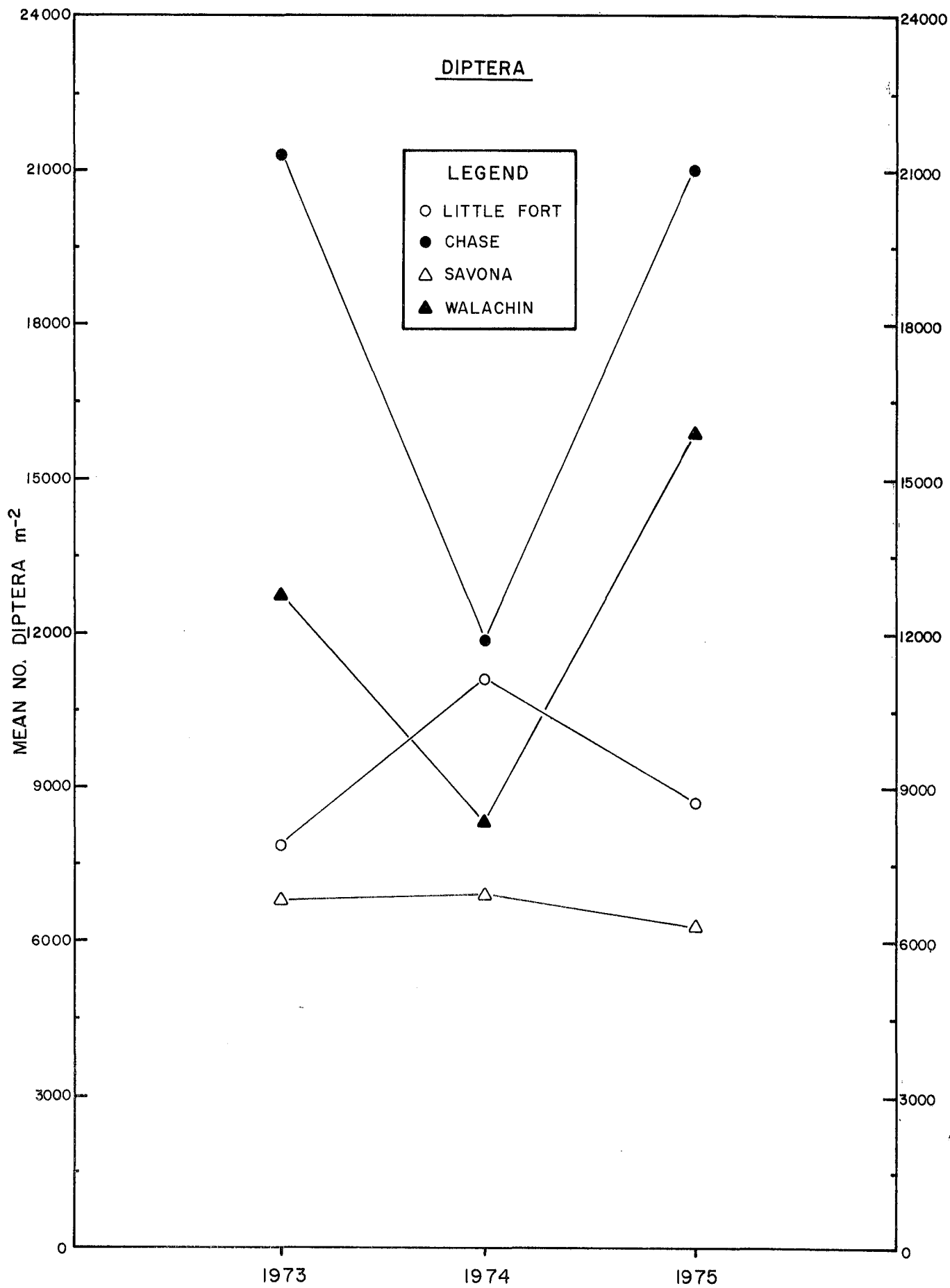


Figure 11

Mean number of Trichoptera m^{-2} at each sampling station.

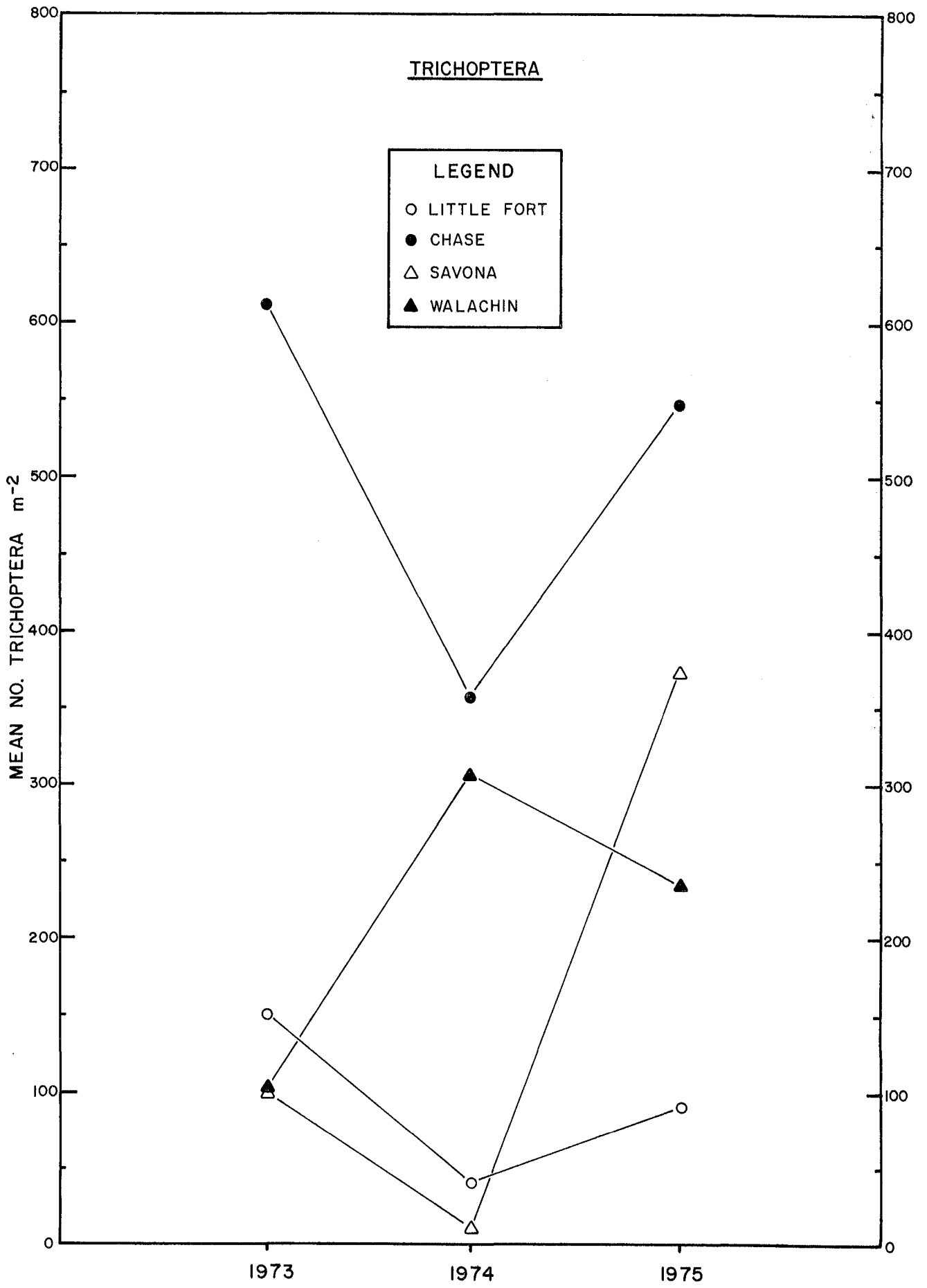


Figure 12

Monthly variation in periphyton chlorophyll a
at McLure, Chase, Savona and Walachin, 1973-74.

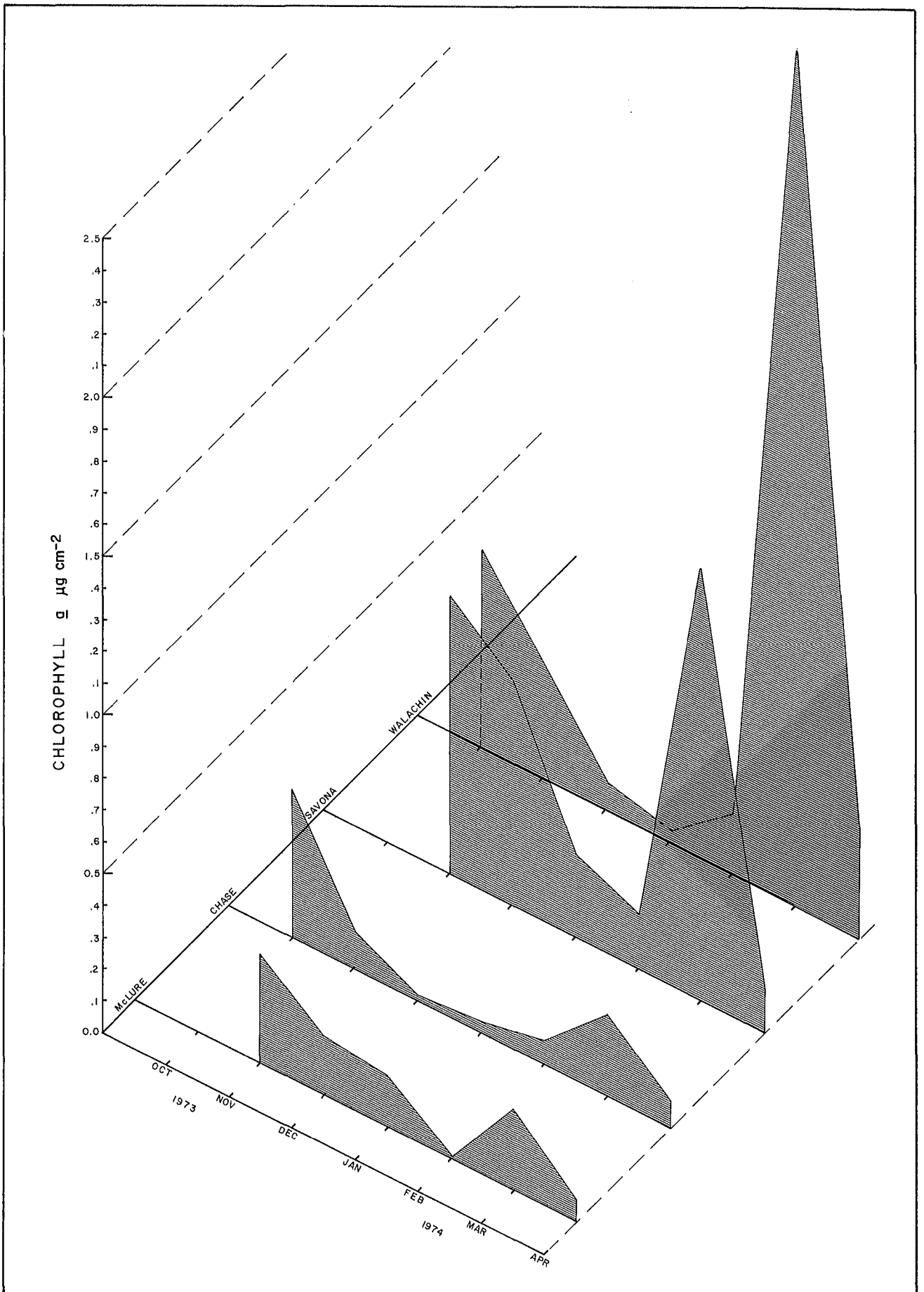


Figure 13

Monthly variation in periphyton ash-free dry weight
at McLure, Chase, Savona and Walachin, 1973-74.

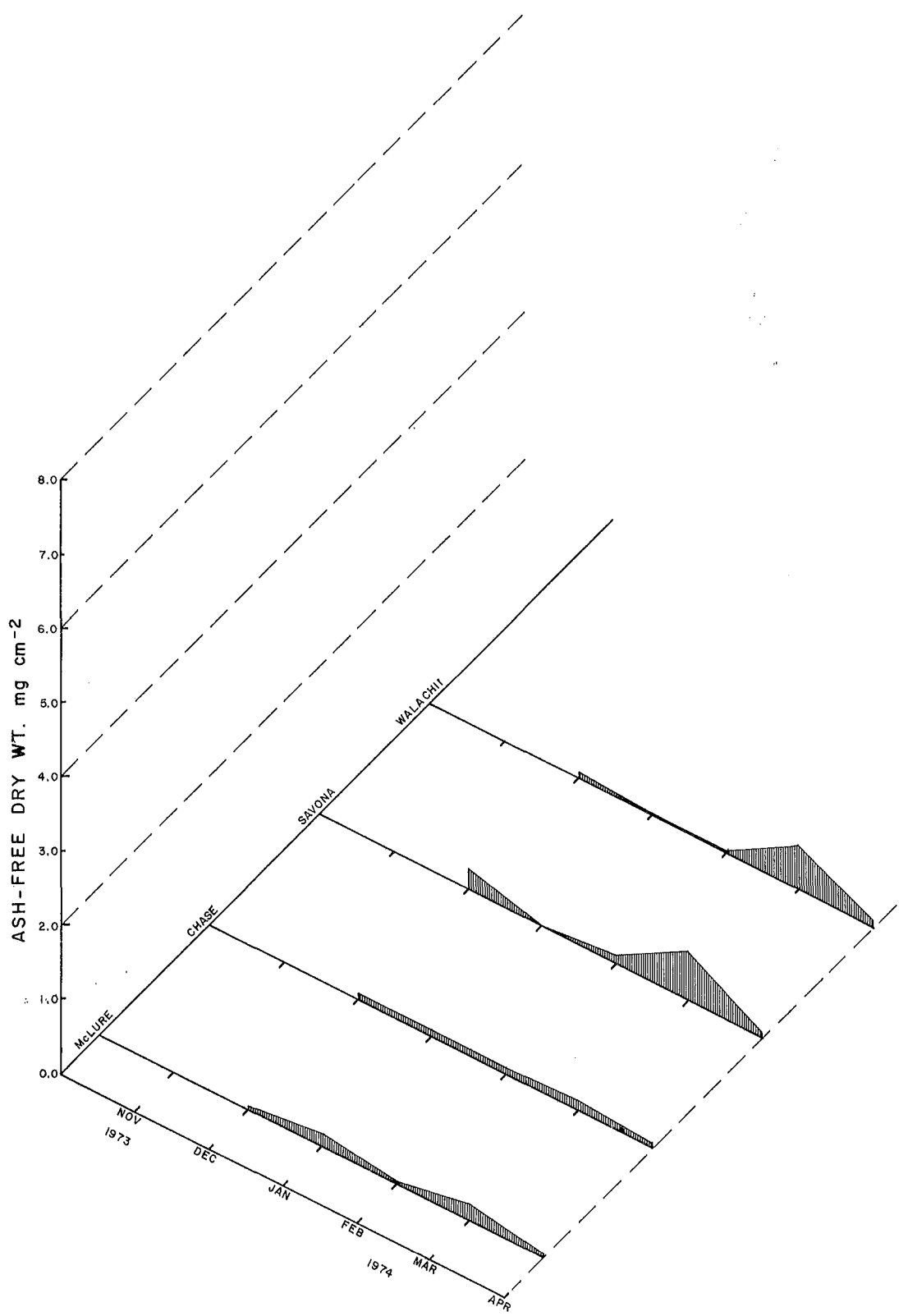


Figure 14

Monthly variation in periphyton chlorophyll a at the three sewage lagoon stations, 1973-74.

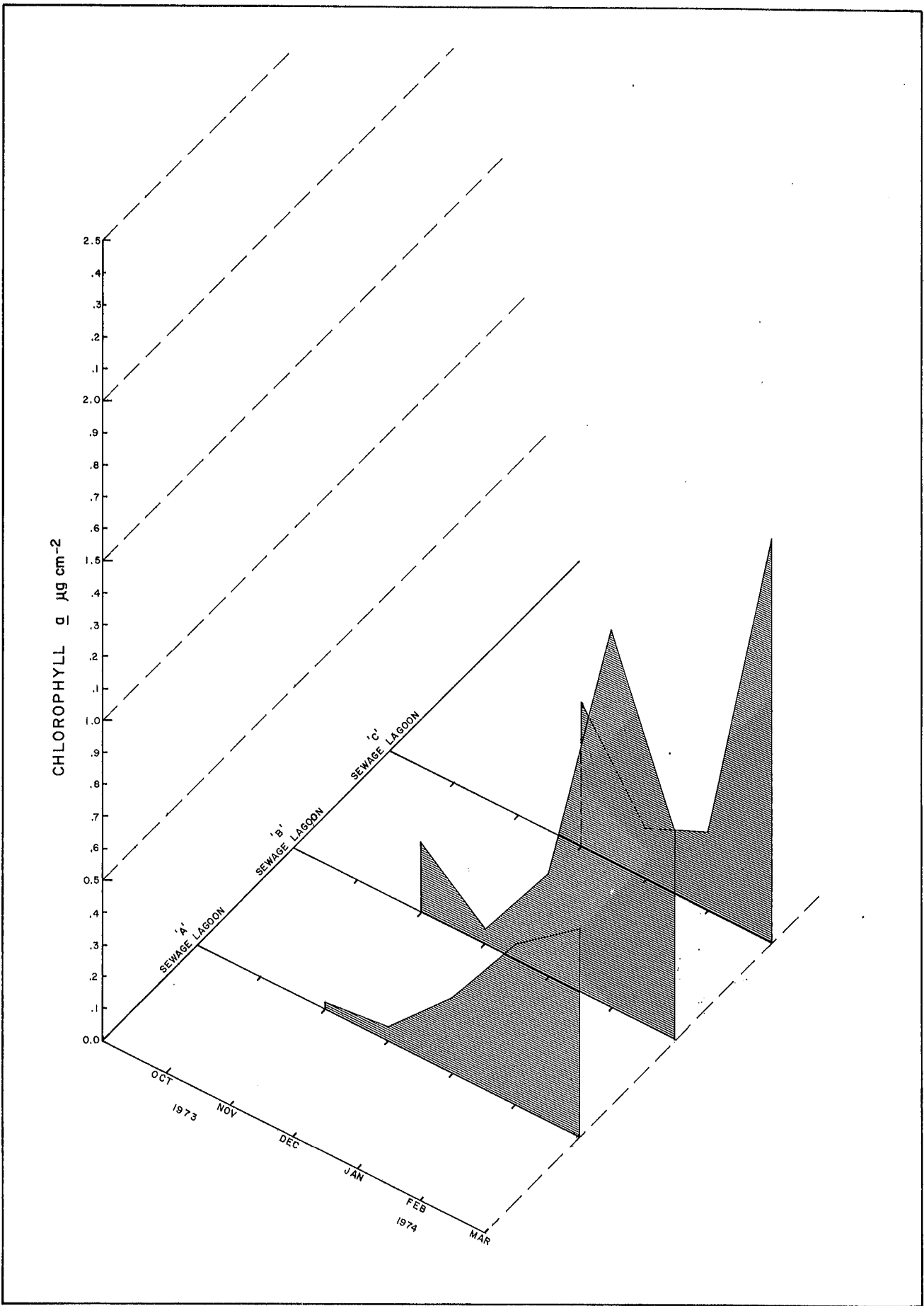


Figure 15

Monthly variation in periphyton ash-free dry weight
at the three sewage lagoon stations, 1973-74.

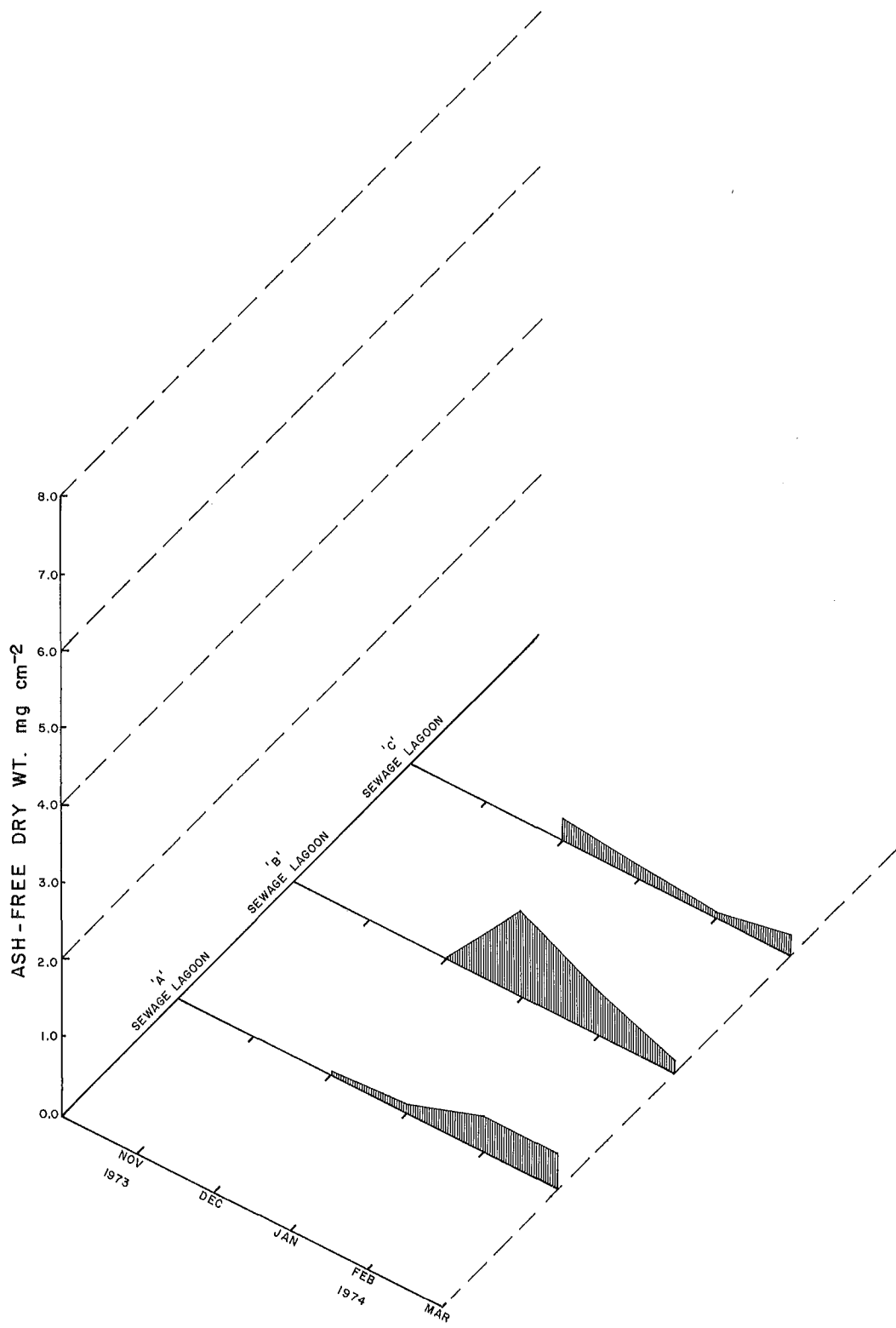


Figure 16

Monthly variation in periphyton chlorophyll a at
McLure, Chase, Savona and Walachin, 1974-75.

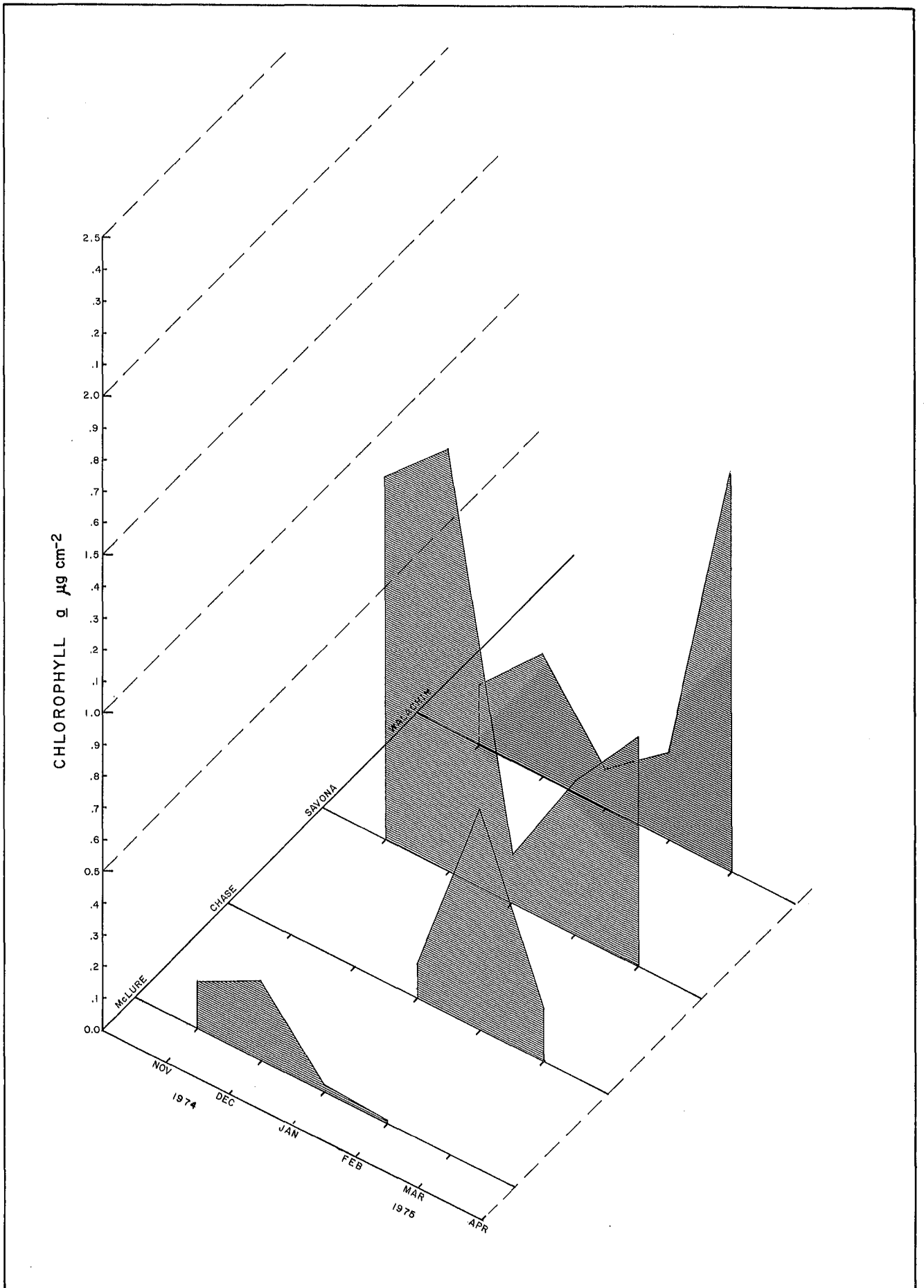


Figure 17

Monthly variation in periphyton ash-free dry weight at
McLure, Chase, Savona and Walachin, 1974-75.

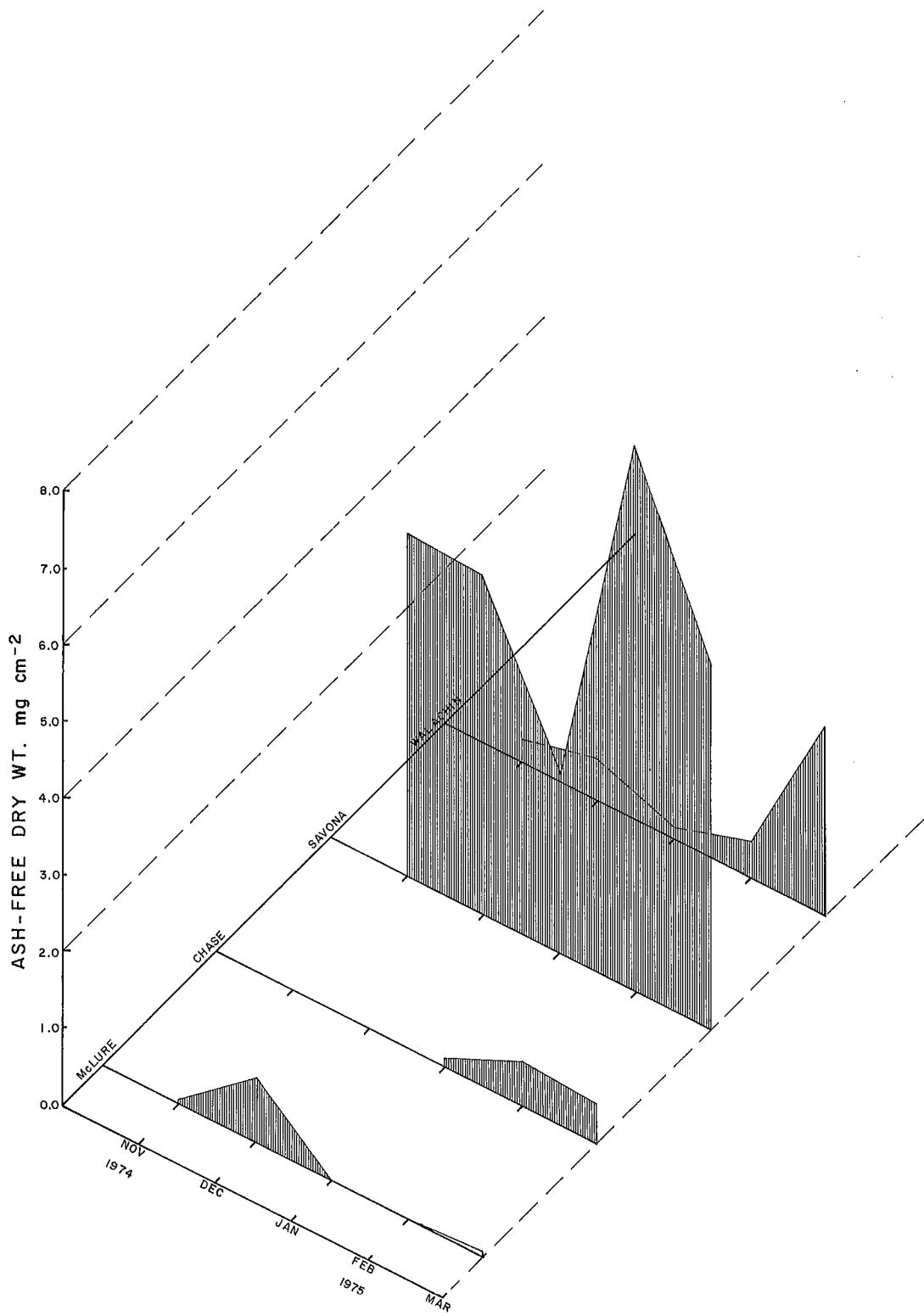


Figure 18

Monthly variation in periphyton chlorophyll a at the control, diffuser and sewage lagoon stations, 1974-75.

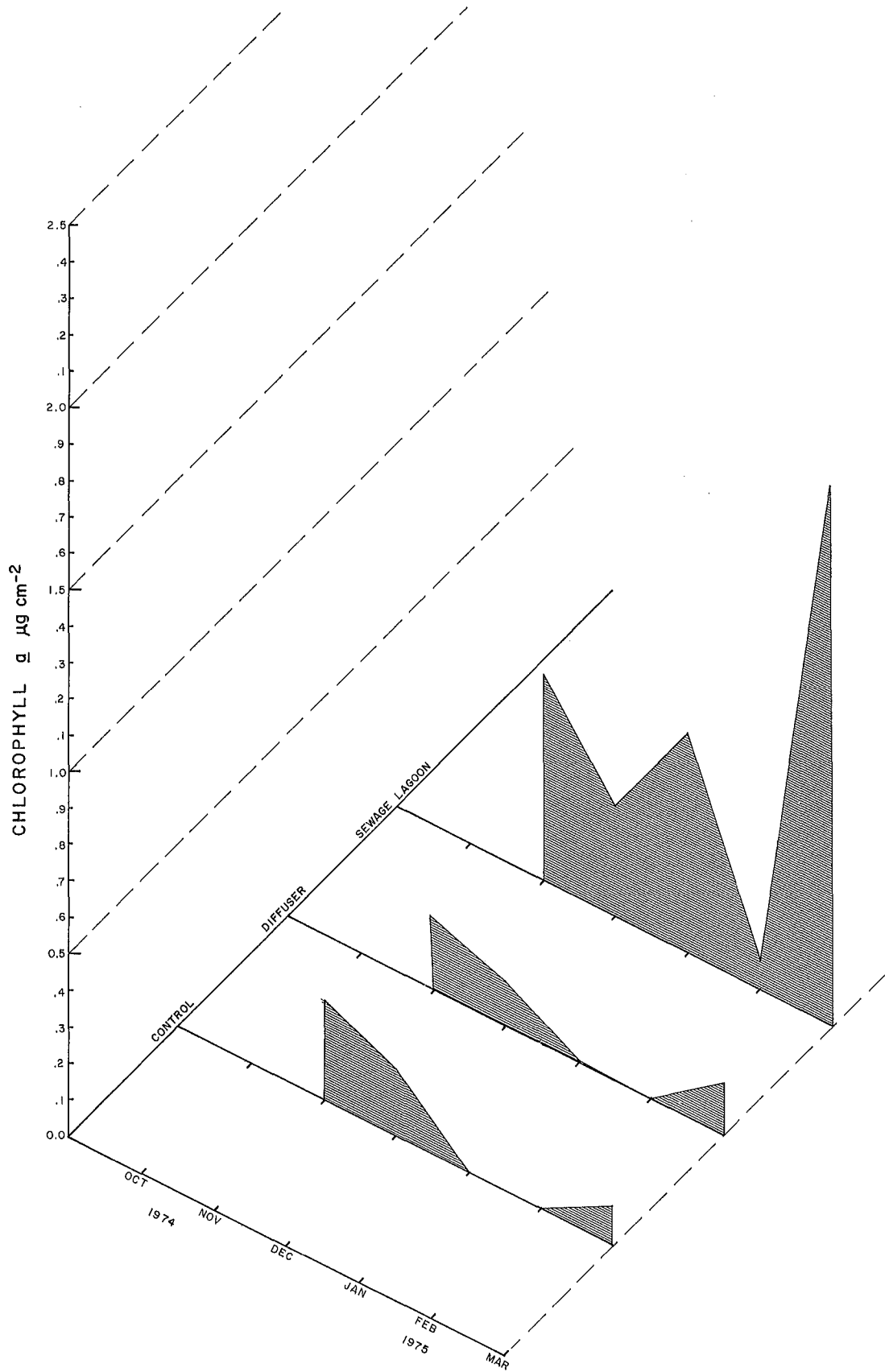


Figure 19

Monthly variation in periphyton ash-free dry weight
at the control, diffuser and sewage lagoon stations,
1974-75.

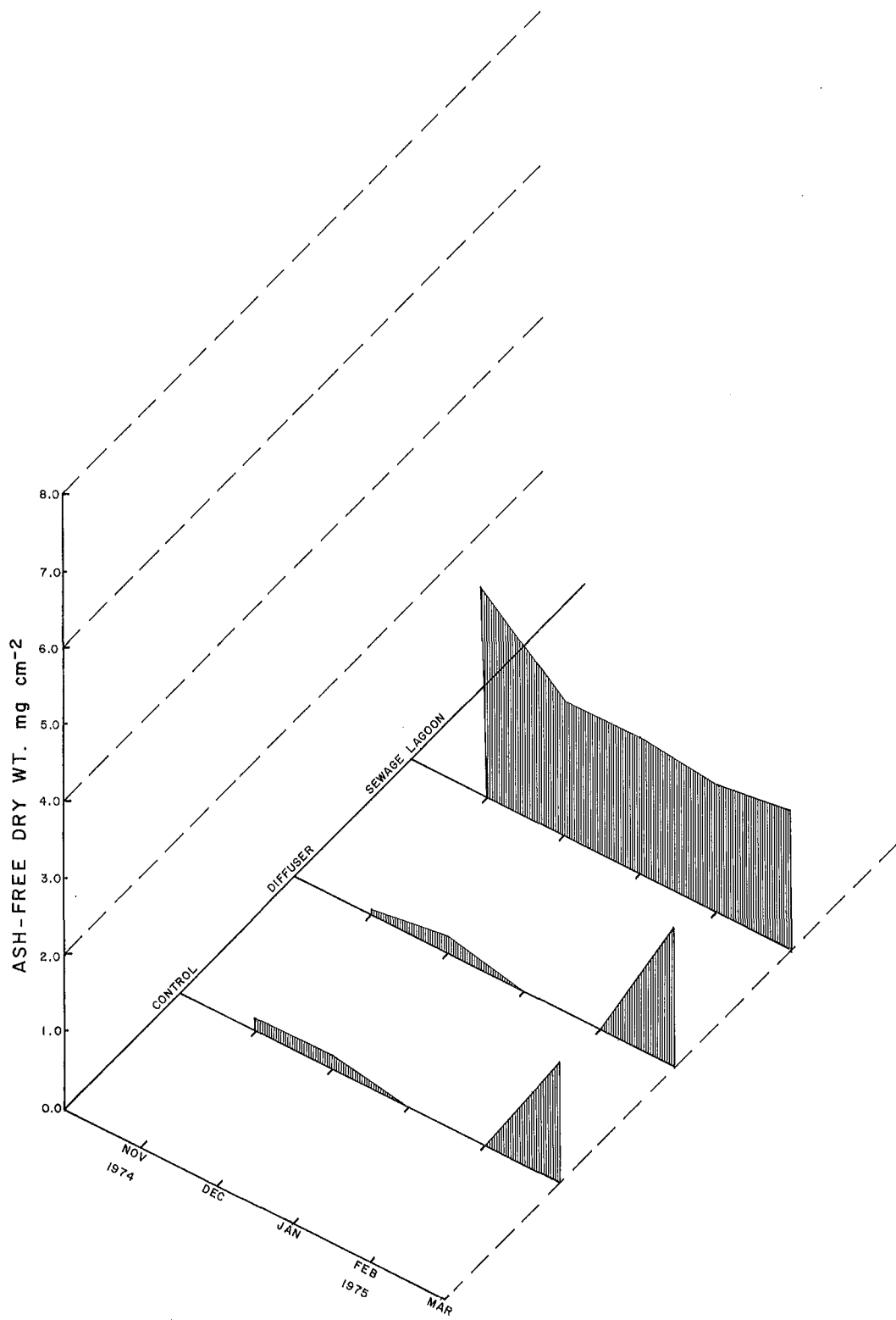


Figure 20

Photographs of the river bottom at (a) Savona (b) Walachin (c) Little Fort and (d) Chase taken in early April, 1975. The figure clearly illustrates the noticeable difference in algal abundance between stations below Kamloops Lake (Savona and Walachin) and those above (Little Fort and Chase). A photograph of McLure was not available however the bottom at Little Fort provides a good representation of most areas in the North Thompson River.



(a)



(b)



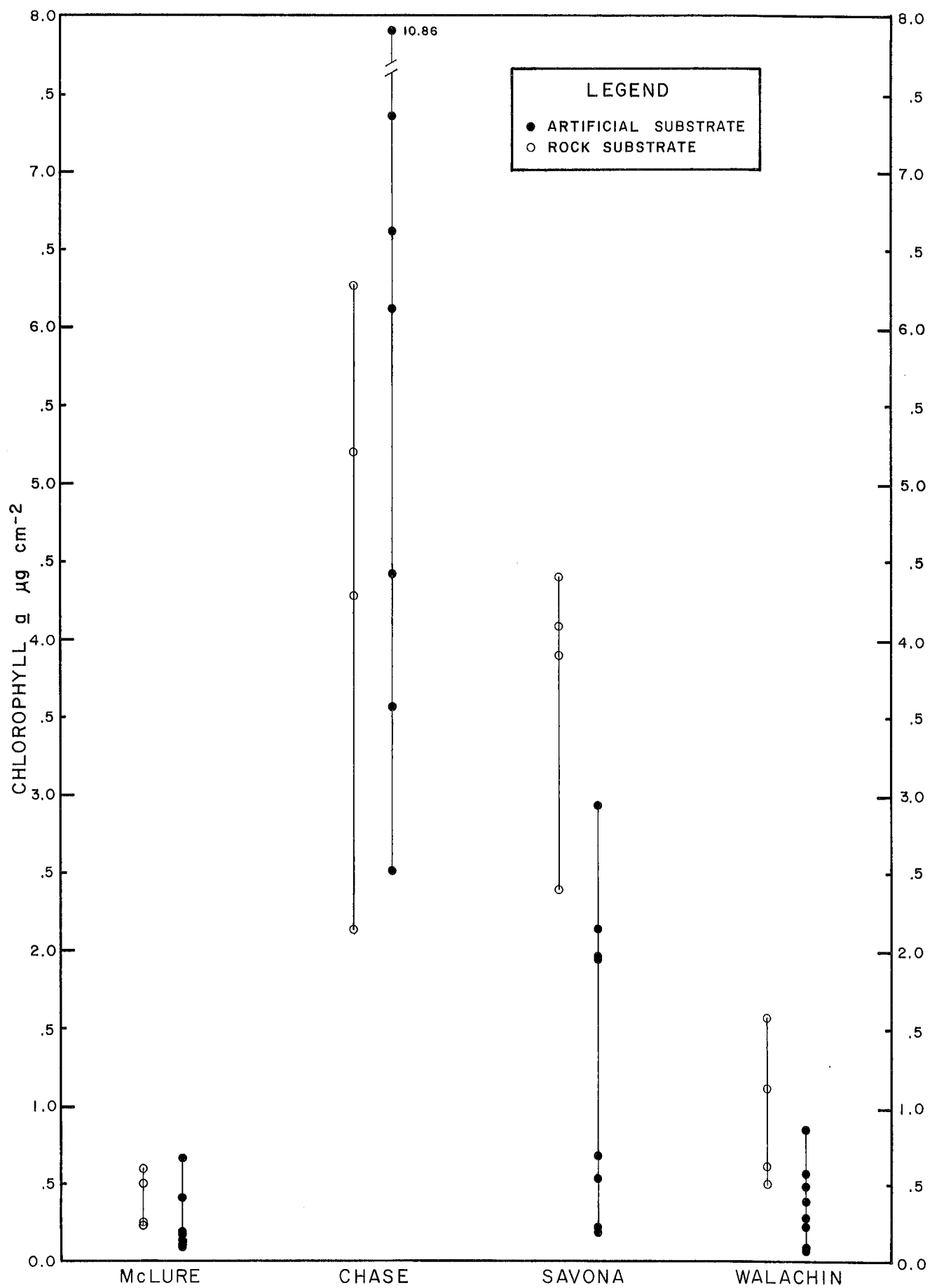
(c)



(d)

Figure 21

Comparison of periphyton chlorophyll a from
artificial versus natural substrates.



Appendix 1

Methods used in determination of chlorophyll, phaeopigments, and ash-free dry weight. Taken from: Environment Canada, Fisheries Service - Environmental Protection Service Laboratory Manual.

Chlorophyll a, b, c & Carotenoids

REAGENTS

Acetone

Shake 900 mls good grade reagent acetone with a little granular anhydrous sodium carbonate and decant directly.

90% Acetone

900 mls acetone treated as above and made up to 1 liter with distilled water.

PROCEDURE

Apparatus

Tissue grinder with approximately 20 ml capacity. Wrap black tape around the exterior surface area. Wrap a large wad of masking tape around handle to prevent blisters.

KEEP SAMPLE OUT OF DIRECT SUNLIGHT AND DO AS MUCH AS POSSIBLE IN SUBDUED LIGHT. GLASSWARE MUST BE ACID FREE.

1. Scrape algae into a tissue grinder.
2. Add 2-3 mls 90% acetone.
3. Grind for a few minutes by pushing tube hard against the bottom of the pestle occasionally pushing up and down.
4. Rinse sample into 15 ml graduated centrifuge tube and make up to approx. 8 mls. Stopper.
5. Place sample in the refrigerator for 3 hours.
6. Bring to room temperature in a dark place.
7. Make up extract to exactly 10 mls and centrifuge for 10 minutes at 3,000 - 4,000 RPM.
8. Decant the clear supernatant into 5 cm cell and run on scan spec. reading at λ 7500, 6650, 6450, and 6300 A° .

CALCULATIONS

The Parsons and Strickland equation is based on a 10 cm light path. This is corrected for a 5 cm light path in the computer program. The absorbance reading at λ 7500 is for turbidity correction.

eg. $E_{6650} = \text{absorb. at } \lambda 6650 - \lambda 7500 \text{ A}$

$$\text{Chlorophyll a} = 11.6E_{6650} - 1.31E_{6450} - 0.14E_{6300}$$

$$\text{Chlorophyll b} = 20.7E_{6450} - 4.34E_{6650} - 4.42E_{6300}$$

$$\text{Chlorophyll c} = 55E_{6300} - 4.64E_{6650} - 16.3E_{6450}$$

$$\text{Carotenoids} = 4.0E_{4800} \text{ (predominantly Chlorophyta or Cyanophyta in fresh water)}$$

Results reported as mg/m^3 if 1 liter sample used.

If sample volumes vary $\text{mg/m}^3 = \frac{\text{value calculated as above}}{\text{volume of sample filtered in liters}}$

As there are several equations it is important to indicate in the results that the Parsons and Strickland equation was used.

Phaeopigments

REAGENTS

1:1 HCl - dilute 50 mls conc. HCl to 100 mls with distilled H_2O

PROCEDURE

1. Carry out procedure for chlorophylls and read required extinctions.
2. Add 2 drops HCl to cuvette, swirl and invert to mix, wait 4 minutes and read extinctions at 7500 A and 6650 A.

CALCULATION

$$\text{Phaeopigments } (\text{mg/m}^3) = \frac{26.7 (1.7 (6650 \text{ acidified}) - 6650 \text{ before acid}) \times 2}{\text{Volume in liters}}$$

Total Volatile Residue

PROCEDURE

1. Place a large porcelain crucible in the furnace at 550°C for 20 minutes.
2. Place crucible in dessicator and weigh it as soon as it is cool enough.
3. Measure out 100 mls of sample into crucible and place it in oven overnight at 90°C .
4. Turn oven to 103°C for 2 hours.
5. Cool crucible in dessicator and weigh.
6. Place crucible in muffle furnace for 20 minutes at 550°C (see note).
7. Cool crucible in dessicator and weigh.
8. Difference between weight in step 7 and weight in step 5 represents Total Volatile Residue in 100 mls.
9. Express results in mg/l .

Notes:

1. Do not muffle, and leave the crucibles overnight to be weighed. They must be weighed as soon as they are cool enough.
2. If the sample is a sludge or an effluent containing large amounts of residue (eg. 20%) it will be necessary to ash them for 1 hour. The crucibles must be premuffled for 1 hour also. Report these results in %.
3. If filterable volatile residue is requested, carry out a similar procedure using sample which has previously been filtered through in Whatman GF/C paper.

Appendix 2

Organoleptic scoring techniques used in laboratory
fish tainting analysis.

Organoleptic Analysis

Technique for scoring to be used in sensory evaluation of fish samples.

The terms used here are ones which have been used by:

1. Fisheries Research Board of Canada, Halifax Station.
J. Fish. Res. Bd. Canada 7, 449-470 (1947-1950).
2. Torry Research Station, Aberdeen, Scotland.
J. Sci. Food Agric. 4, 283-298 (1953).
3. Department of Food Science and Technology, University of California at Davis.
Food Technol. 19, 238-245 (1965).
Food Technol. 19, 1268-1272 (1965).

Odour

10. Fresh odour
9. Some loss of fresh odour - no off odour
8. Lack of odour
7. Just detectable off odour
- 6.
5. → Increasingly strong off odours e.g. cabbage-like odour
4. →
3. →
2. Distinctly noticeable ammoniacal or fishy (trimethylamine) and or rancid odours
1. Strong ammoniacal or fishy odours and/or stale or rancid odours (Objectionable)
0. Very strong putrid (ammonia indole) and or rancid odours (very objectionable)

Tenderness (force of bite)

10. Extremely tender (almost no force)
9. Very tender (very little force)
- 8.
7. Tender, flakes well.
6. Moderately tender.
5. Not tough, but only slightly tender (moderate force).
4. Slightly tough
3. Tough
- 2.
1. Very tough, rubbery (extreme force)
0. Extremely tough, leathery (almost impossible to bite)

Juiciness

10. Very juicy
- 9.
8. Juicy
- 7.
6. Moderately juicy
5. Moist
4. Slightly dry
3. Dry
- 2.
1. Very dry
0. Extremely dry

Flavour

10. Fresh, sweet flavours characteristic of species
9. Some loss of sweetness, still very good, natural flavour, no off-flavour
8. Good, slight sweetness, loss of flavour characteristic of species
7. Moderately good but neutral flavour, definite loss of flavour but no off-flavour
6. Absolutely no flavour, tasteless
5. Trace of off-flavours, some sourness, no bitterness, slightly fishy (trimethylamine)
4. Slightly poor, some off-flavours, some bitterness
3. Poor, strong bitter flavours, rubber-like and slight sulphide-like flavours, slight rancidity
2. Strong bitter flavours, not nauseating, stale (enough trimethylamine to be objectionable), or fairly strong rancidity
1. Very poor, strong bitter flavours, rancid, nauseating
0. Extremely poor, strong putrid flavours (sulphides), tasted with difficulty

Texture

10. Extremely fine
9. Very fine, mealy
- 8.
7. Fine
6. Moderately fine
5. Slightly fine
4. Slightly coarse
3. Coarse, fibrous
- 2.
1. Very coarse, stringy
0. Extremely coarse, hard

Under remarks, the panel member should give any special comments he has for this sample. In particular, appearance, rancidity and saltiness.

Fisheries Research Board of Canada
Vancouver Laboratory, Vancouver, B.C.

Panel Member _____

Date _____

Organoleptic Evaluation Scoresheet

Sample _____

To panel member: Please rate all samples for odour, tenderness, juiciness, flavour, and texture using the numbers 0 to 10 as described on the technique for scoring sheet.

Sample	Odour	Tenderness (force of bite)	Juiciness	Flavour	Texture	Remarks
A	_____	_____	_____	_____	_____	_____
B	_____	_____	_____	_____	_____	_____
C	_____	_____	_____	_____	_____	_____
D	_____	_____	_____	_____	_____	_____
E	_____	_____	_____	_____	_____	_____
F	_____	_____	_____	_____	_____	_____
G	_____	_____	_____	_____	_____	_____
H	_____	_____	_____	_____	_____	_____
I	_____	_____	_____	_____	_____	_____

Appendix 3

Invertebrate sampling data 1973 to 1975. Numbers of individuals collected per Mundie sample. Sampling area in 1973 and 1974 was 0.18 m². In 1975, sampling area was 0.11 m².

Invertebrate Sampling Data, 1973, Little Fort,
Numbers Of Individuals Per Mundie Sample (0.18 m²)

	<u>Replicate</u>					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
<u>Ephemeroptera</u>						
- Ephemerellidae	64	95	53		132	131
- Baetidae	10	9	8		30	37
- Siphonuridae	42	76	29		56	49
- Leptophlebiidae						
- Heptageniidae	73	60	38		136	98
<u>Plecoptera</u>						
- Nemouridae	2	8	2		12	11
- Perlodidae	1	3	1		8	1
- Perlidae	1					
- Chloroperlidae	6	3	5		4	
- Pteronarcidae	1		1			
<u>Trichoptera</u>						
- Hydropsychidae	3	3	7		8	4
- Hydroptilidae	22	23	11		30	14
- Leptoceridae	2	1				
- Glossosomatidae			2			
- Psychomyiidae					2	
- Brachycentridae						1
- Limnephilidae						
- Rhyacophilidae						
<u>Diptera</u>						
- Tendipedidae	1003	1559	1009		1680	1673
- Simuliidae	5	1	7		2	21
- Empididae	5	10	6		12	15
- Ceratopogonidae	2		14		2	3
- Tipulidae						1
- Rhagionidae						1
<u>Coleoptera</u>						
- Dryopidae						
- Dytiscidae						
- Elmidae						
- (unidentified)						1
<u>Crustacea</u>						
- Cyclopoid Copepod	1	4	2		2	2
- Harpacticoid Copepod						
- Calanoid Copepod						
- Ostracoda						
- Cladocera	2					
- Amphipoda						
Nematoda	26	9	13		6	12
Acarina	4	8	5		6	10
Gastropoda						
Pelecypoda						
Oligochaeta	3	17	9		24	26
Hirudinea						
Collembola						

Invertebrate Sampling Date, 1973, Chase
 Numbers Of Individuals Per Mundie Sample (0.18 m²)

	<u>Replicate</u>					
	1	2	3	4	5	6
<u>Ephemeroptera</u>						
- Ephemerellidae	204	164	364	44	12	4
- Baetidae	12	40	8	48	12	10
- Siphonuridae	4		4	64	58	42
- Leptophlebiidae	2					
- Heptageniidae		8	8		2	
<u>Plecoptera</u>						
- Nemouridae	14	4		72	30	8
- Perlodidae		4				
- Perlidae						
- Chloroperlidae						
- Pteronarcidae						
<u>Trichoptera</u>						
- Hydropsychidae	118	28	180	20	2	2
- Hydroptilidae	6					
- Leptoceridae	18	4	96	140	26	8
- Glossosomatidae						
- Psychomyiidae					6	
- Brachycentridae						
- Limnephilidae						
- Rhyacophilidae						
<u>Diptera</u>						
- Tendipedidae	4534	3932	6780	2684	2204	2146
- Simuliidae	10		16		2	
- Empididae	98	8	112	48	34	4
- Ceratopogonidae	76	20	68	8	6	
- Tipulidae				8		4
- Rhagionidae						
<u>Coleoptera</u>						
- Dryopidae	2					
- Dytiscidae						
- Elmidae						
- (unidentified)						
<u>Crustacea</u>						
- Cyclopoid Copepod	4	16	4	16	28	6
- Harpacticoid Copepod	22	28	48	24	10	8
- Calanoid Copepod	140	136	72	24	20	16
- Ostracoda						
- Cladocera	18	16	8		10	16
- Amphipoda		8	12			
Nematoda	42	160	128	100	12	22
Acarina	14	8	16	4	2	2
Gastropoda						
Pelecypoda						
Oligochaeta	32	16	32	24	6	2
Hirudinea						
Collembola						

Invertebrate Sampling Data, 1973, Savona
 Numbers Of Individuals Per Mundie Sample (0.18 m²)

<u>Ephemeroptera</u>	<u>Replicate</u>					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
- Ephemerellidae	128	320	40	16	696	400
- Baetidae						
- Siphoneuridae						
- Leptophlebiidae						
- Heptageniidae						
<u>Plecoptera</u>						
- Nemouridae						
- Perlodidae	8	32			8	8
- Perlidae						
- Chloroperlidae						
- Pteronarcidae						
<u>Trichoptera</u>						
- Hydropsychidae	4		16			
- Hydroptilidae						
- Leptoceridae						
- Glossosomatidae	28	32	8		8	8
- Psychomyiidae						
- Brachycentridae						
- Limnephilidae						
- Rhyacophilidae						
<u>Diptera</u>						
- Tendipedidae	1584	632	512	1152	2080	1288
- Simuliidae	4		8			
- Empididae						
- Ceratopogonidae						
- Tipulidae	8	16				
- Rhagionidae						
<u>Coleoptera</u>						
- Dryopidae						
- Dytiscidae						
- Elmidae						
- (unidentified)						
<u>Crustacea</u>						
- Cyclopoid Copepod	8	16	16	8	16	136
- Harpacticoid Copepod	104	8	240	176	456	672
- Calanoid Copepod	972	2024	408	420	824	712
- Ostracoda						
- Cladocera	16	32	16	8	32	16
- Amphipoda			16	4	24	
Nematoda	224	152	256	96	1112	1056
Acarina						
Gastropoda			8			
Pelecypoda						8
Oligochaeta	52	16	80	80	96	88
Hirudinea						
Collembola						

Invertebrate Sampling Data, 1973, Walachin
 Numbers Of Individuals Per Mundie Sample (0.18 m²)

	<u>Replicate</u>					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
<u>Ephemeroptera</u>						
- Ephemerellidae			8	16	16	52
- Baetidae						
- Siphonuridae						
- Leptophlebiidae						
- Heptageniidae				4		
<u>Plecoptera</u>						
- Nemouridae				4		
- Perlodidae						
- Perlidae						
- Chloroperlidae						
- Pteronarcidae						
<u>Trichoptera</u>						
- Hydropsychidae						4
- Hydroptilidae			16	16	64	12
- Leptoceridae						
- Glossosomatidae						
- Psychomyiidae						
- Brachycentridae						
- Limnephilidae						
- Rhyacophilidae						
<u>Diptera</u>						
- Tendipedidae	2256		1576	1240	7216	1328
- Simuliidae						
- Empididae						
- Ceratopogonidae						
- Tipulidae						
- Rhagionidae						
<u>Coleoptera</u>						
- Dryopidae						
- Dytiscidae						
- Elmidae						
- (unidentified)						
<u>Crustacea</u>						
- Cyclopoid Copepod			24			16
- Harpacticoid Copepod	96		88	76	96	120
- Calanoid Copepod	160		56	48	48	176
- Ostracoda						
- Cladocera	144		56	60	576	44
- Amphipoda						
Nematoda	2416	1	1688	1952	11392	5420
Acarina				4	16	8
Gastropoda						
Pelecypoda						
Oligochaeta	6496		2568	2004	3456	2184
Hirudinea						
Collembola						

Invertebrate Sampling Data, 1974, Little Fort
 Numbers Of Individuals Per Mundie Sample (0.18 m²)

	<u>Replicate</u>					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
<u>Ephemeroptera</u>						
- Ephemerellidae	130	151	127	68	107	205
- Baetidae	19	12	12	12	13	27
- Siphonuridae	16	22	14	30	7	23
- Leptophlebiidae						
- Heptageniidae	234	198	146	123	191	320
<u>Plecoptera</u>						
- Nemouridae	13	12	7	12	20	29
- Perlodidae	1	2	1	3	1	5
- Perlidae	1	1				3
- Chloroperlidae	10	4	6	9	10	9
- Pteronarcidae	3			3	2	7
<u>Trichoptera</u>						
- Hydropsychidae	3	1	3	3	3	11
- Hydroptilidae	1	1				1
- Leptoceridae	1					
- Glossosomatidae	2	2	3		4	1
- Psychomyiidae						
- Brachycentridae						
- Limnephilidae						1
- Rhyacophilidae	2					
<u>Diptera</u>						
- Tendipedidae	1722	1822	2146	1658	1678	2476
- Simuliidae	26	18	35	34	18	46
- Empididae	30	36	27	22	25	29
- Ceratopogonidae	8	6	19	7	3	3
- Tipulidae	7		2	1	2	1
- Rhagionidae		1	2		3	
<u>Coleoptera</u>						
- Dryopidae						
- Dytiscidae						
- Elmidae						
- (unidentified)						
<u>Crustacea</u>						
- Cyclopoid Copepod		3		3	2	1
- Harpacticoid Copepod						
- Calanoid Copepod				2		
- Ostracoda						
- Cladocera						
- Amphipoda						
Nematoda	9	12	20	12	10	21
Acarina	5		3	8	4	
Gastropoda						
Pelecypoda						
Oligochaeta	23	26	35	21	22	25
Hirudinea						1
Collembola						

Invertebrate Sampling Data, 1974, Chase
 Numbers Of Individuals Per Mundie Sample (0.18 m²)

	<u>Replicate</u>					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
<u>Ephemeroptera</u>						
- Ephemerellidae	318	212	588	534	320	124
- Baetidae	1		4			
- Siphonuridae	25	32	8	12	8	
- Leptophlebiidae	1	1				
- Heptageniidae		2		2	4	
<u>Plecoptera</u>						
- Nemouridae	8	4	12		8	
- Perlodidae						
- Perlidae						
- Chloroperlidae						
- Pteronarcidae						
<u>Trichoptera</u>						
- Hydropsychidae	32	34	72	64	40	52
- Hydroptilidae						
- Leptoceridae	7		28	22	16	12
- Glossosomatidae						
- Psychomyiidae						
- Brachycentridae						
- Limnephilidae	2					
- Rhyacophilidae						
<u>Diptera</u>						
- Tendipedidae	1353	620	2016	1740	2052	1640
- Simuliidae	586	980	1200	296	112	52
- Empididae	3	3	12	6	4	12
- Ceratopogonidae	1	4		14	8	
- Tipulidae						
- Rhagionidae						
<u>Coleoptera</u>						
- Dryopidae						
- Dytiscidae		1				
- Elmidae					4	4
- (unidentified)						
<u>Crustacea</u>						
- Cyclopoid Copepod	233	256	229	216	112	124
- Harpacticoid Copepod	26	15	136	14	64	228
- Calanoid Copepod	401	463	404	422	184	228
- Ostracoda						
- Cladocera	215	309	148	238	76	176
- Amphipoda						
Nematoda	17	11	4	16	12	20
Acarina	15	2	8	8	4	8
Gastropoda			4	2		4
Pelecypoda						
Oligochaeta	18	30	72	42	24	52
Hirudinea	2	4	4	2		
Collembola						

Invertebrate Sampling Data, 1974, Savona
 Numbers Of Individuals Per Mundie Sample (0.18 m²)

	<u>Replicate</u>					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
<u>Ephemeroptera</u>						
- Ephemerellidae	772	280	124	112	44	628
- Baetidae	688	220	42	68		224
- Siphoneuridae						
- Leptophlebiidae						
- Heptageniidae	44	20	4	2		12
<u>Plecoptera</u>						
- Nemouridae						
- Perlodidae						12
- Perlidae			2			
- Chloroperlidae	28	24		2		16
- Pteronarcidae						
<u>Trichoptera</u>						
- Hydropsychidae			2	2		
- Hydroptilidae						
- Leptoceridae						
- Glossosomatidae	8					
- Psychomyiidae						
- Brachycentridae						
- Limnephilidae						
- Rhyacophilidae						
<u>Diptera</u>						
- Tendipedidae	1872	1704	606	461	820	1536
- Simuliidae						
- Empididae						
- Ceratopogonidae						
- Tipulidae	4			2		
- Rhagionidae						
<u>Coleoptera</u>						
- Dryopidae						
- Dytiscidae						
- Elmidae						
- (unidentified)						
<u>Crustacea</u>						
- Cyclopoid Copepod	172	280	132	62	80	436
- Harpacticoid Copepod	84	16	16	6	468	4
- Calanoid Copepod	408	704	222	240	180	852
- Ostracoda						
- Cladocera	108	308	112	72	52	148
- Amphipoda						
Nematoda	32	4	2	2	64	
Acarina						
Gastropoda						
Pelecypoda						
Oligochaeta	44	36	34	40	248	136
Hirudinea						
Collembola						

Invertebrate Sampling Data, 1974, Walachin
 Numbers Of Individuals Per Mundie Sample (0.18 m²)

	<u>Replicate</u>					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
<u>Ephemeroptera</u>						
- Ephemerellidae	28	52	42	58	40	36
- Baetidae	4	38	28	10	34	20
- Siphonuridae					2	
- Leptophlebiidae		4		6	4	8
- Heptageniidae		2	4	6		
<u>Plecoptera</u>						
- Nemouridae						
- Perlodidae						
- Perlidae						
- Chloroperlidae						
- Pteronarcidae						
<u>Trichoptera</u>						
- Hydropsychidae	2	20	10	12	26	4
- Hydroptilidae	38	26	18	14	74	68
- Leptoceridae		2			2	4
- Glossosomatidae		4			2	
- Psychomyiidae						
- Brachycentridae						
- Limnephilidae						
- Rhyacophilidae						
<u>Diptera</u>						
- Tendipedidae	698	1308	1740	1118	1636	2388
- Simuliidae	2	2	2		2	
- Empididae			2			
- Ceratopogonidae						
- Tipulidae						
- Rhagionidae	2					
<u>Coleoptera</u>						
- Dryopidae						
- Dytiscidae						
- Elmidae						
- (unidentified)						
<u>Crustacea</u>						
- Cyclopoid Copepod	36	20	16	10	6	8
- Harpacticoid Copepod	8	26	18	14	58	80
- Calanoid Copepod	80	90	74	42	48	44
- Ostracoda						
- Cladocera	104	34	46	74	122	184
- Amphipoda						
Nematoda	810	346	260	228	814	792
Acarina		14	4	2	10	4
Gastropoda						
Pelecypoda						
Oligochaeta	162	148	202	212	278	640
Hirudinea	2		2			
Collembola			2			

Invertebrate Sampling Data, 1975, Little Fort
 Numbers Of Individuals Per Mundie Sample* (0.11 m²)

	<u>Replicate</u>					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
<u>Ephemeroptera</u>						
- Ephemerellidae	258	236	154	161	208	150
- Baetidae	169	192	151	178	163	82
- Siphonuridae	6	8	6	10	12	14
- Leptophlebiidae						
- Heptageniidae	540	420	356	462	575	302
<u>Plecoptera</u>						
- Nemouridae	10	4	17	19	15	10
- Perlodidae	7	12	2	4	3	2
- Perlidae		4				
- Chloroperlidae	34	32	36	32	30	24
- Pteronarcidae	3	4	1	3	10	
<u>Trichoptera</u>						
- Hydropsychidae	4		1	5	4	2
- Hydroptilidae	1			1	1	2
- Leptoceridae						
- Glossosomatidae	5	8	11	2	4	
- Psychomyiidae						
- Brachycentridae						
- Limnephilidae		8	1		1	
- Rhyacophilidae						
<u>Diptera</u>						
- Tendipedidae	964	1048	708	1102	821	624
- Simuliidae	93	56	50	162	94	40
- Empididae	19	4	6	14	18	14
- Ceratopogonidae	36	28	18	19	13	6
- Tipulidae	5		3	5	2	
- Rhagionidae	3		3	2	1	2
<u>Coleoptera</u>						
- Dryopidae						
- Dytiscidae						
- Elmidae						
- (unidentified)						
<u>Crustacea</u>						
- Cyclopoid Copepod	26			4	4	10
- Harpacticoid Copepod						
- Calanoid Copepod	9	4	2	1		14
- Ostracoda						
- Cladocera	3			1	1	
- Amphipoda						
Nematoda	24	12	10	15	4	4
Acarina	7	8		4	8	
Gastropoda						
Pelecypoda						
Oligochaeta	61	40	17	62	94	22
Hirudinea						
Collembola						

* Sampling area in 1975 was somewhat smaller than in previous years
 (0.11 m²)

Invertebrate Sampling Data, 1975, Chase
 Numbers Of Individuals Per Mundie Sample (0.11 m²)

	<u>Replicate</u>					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
<u>Ephemeroptera</u>						
- Ephemerellidae	318	502	208	352	368	244
- Baetidae						
- Siphonuridae	16	30	18	48	80	68
- Leptophlebiidae						
- Heptageniidae						
<u>Plecoptera</u>						
- Nemouridae						
- Perlodidae		2				
- Perlidae						
- Chloroperlidae						
- Pteronarcidae						
<u>Trichoptera</u>						
- Hydropsychidae	50	108	14	72	56	32
- Hydroptilidae						
- Leptoceridae	2	14		16		12
- Glossosomatidae						
- Psychomyiidae						
- Brachycentridae						
- Limnephilidae						
- Rhyacophilidae						
<u>Diptera</u>						
- Tendipedidae	2202	3010	1558	1932	2632	1696
- Simuliidae	8	74	12	744	216	264
- Empididae	42	18	4	4	8	8
- Ceratopogonidae			2		8	12
- Tipulidae						
- Rhagionidae						
<u>Coleoptera</u>						
- Dryopidae						
- Dytiscidae						
- Elmidae						
- (unidentified)						
<u>Crustacea</u>						
- Cyclopoid Copepod	1058	1618	1160	1580	2272	2752
- Harpacticoid Copepod	16	14	2	8	24	4
- Calanoid Copepod	278	444	368	532	480	828
- Ostracoda						
- Cladocera	70	114	48	112	64	196
- Amphipoda						
Nematoda	56	44	26	24	64	44
Acarina	4	4	2	8		
Gastropoda						
Pelecypoda		2				
Oligochaeta	102	168	88	52	200	24
Hirudinea					8	
Collembola						

Invertebrate Sampling Data, 1975, Savona
 Numbers Of Individuals Per Mundie Sample (0.11 m²)

	<u>Replicate</u>					
	1	2	3	4	5	6
<u>Ephemeroptera</u>						
- Ephemerellidae	116	672	448	408	660	192
- Baetidae	4	48		40	24	2
- Siphonuridae				8	8	
- Leptophlebiidae						
- Heptageniidae		32		32	24	
<u>Plecoptera</u>						
- Nemouridae						
- Perlodidae		16	16		32	4
- Perlidae						
- Chloroperlidae						
- Pteronarcidae						
<u>Trichoptera</u>						
- Hydropsychidae	28	32	32	24	40	24
- Hydroptilidae						4
- Leptoceridae			16			4
- Glossosomatidae	24			16		12
- Psychomyiidae						
- Brachycentridae						
- Limnephilidae						
- Rhyacophilidae						
<u>Diptera</u>						
- Tendipedidae	1072	848	768	592	616	460
- Simuliidae						2
- Empididae						
- Ceratopogonidae						
- Tipulidae						
- Rhagionidae						
<u>Coleoptera</u>						
- Dryopidae						
- Dytiscidae						
- Elmidae						
- (unidentified)						
<u>Crustacea</u>						
- Cyclopoid Copepod	120	256	784	488	700	174
- Harpacticoid Copepod	44	416	192	424	380	56
- Calanoid Copepod	244	576	1744	856	1264	408
- Ostracoda	4	80	16	24	20	2
- Cladocera	28	96	144	416	164	62
- Amphipoda						
Nematoda	12	96	128	48	28	42
Acarina	20					4
Gastropoda					4	
Pelecypoda						
Oligochaeta	336	512	464	400	336	344
Hirudinea		32			4	
Collembola						

Invertebrate Sampling Data, 1975, Walachin
 Numbers Of Individuals Per Mundie Sample (0.11 m²)

	<u>Replicate</u>					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
<u>Ephemeroptera</u>						
- Ephemerellidae	48	48	24	128	56	16
- Baetidae	48	8	24	16	16	
- Siphonuridae						
- Leptophlebiidae						
- Heptageniidae						
<u>Plecoptera</u>						
- Nemouridae						
- Perlodidae		4				
- Perlidae						
- Chloroperlidae						
- Pteronarcidae						
<u>Trichoptera</u>						
- Hydropsychidae	48	24	16	32	16	16
- Hydroptilidae		8				
- Leptoceridae						
- Glossosomatidae						
- Psychomyiidae						
- Brachycentridae						
- Limnephilidae						
- Rhyacophilidae						
<u>Diptera</u>						
- Tendipedidae	1312	1632	1400	1920	1040	2352
- Simuliidae						
- Empididae						
- Ceratopogonidae						
- Tipulidae						
- Rhagionidae						
<u>Coleoptera</u>						
- Dryopidae						
- Dytiscidae						
- Elmidae						
- (unidentified)						
<u>Crustacea</u>						
- Cyclopoid Copepod	64	20	48			32
- Harpacticoid Copepod	16	16	8		16	16
- Calanoid Copepod	32	72	40	112	8	48
- Ostracoda						
- Cladocera						16
- Amphipoda						
Nematoda	96	72	48	96	40	
Acarina						
Gastropoda						
Pelecypoda						
Oligochaeta	384	100	40	320	192	160
Hirudinea						
Collembola						

Appendix 4

Periphyton data obtained from artificial substrate sampling program from sampling years of 1973-74 (October 1973 to April 1974) and 1974-75 (November 1974 to March 1975). In cases where means, standard deviations, and "N" of certain variables are expressed as "0.0" no data were available and the "0" values were not incorporated into any statistical analysis.

		YEAR 1973-1974		MONTH OCTOBER		STATION CHASE	
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.401	0.168	0.342	0.157			
	0.195	0.086	0.168	0.094			
	0.512	0.084	0.375	0.110			
	0.967	0.266	0.716	0.096			
	0.233	0.042	0.166	0.019			
MEAN	0.462	0.129	0.353	0.095	0.0	0.0	0.0
STD DEV	0.310	0.089	0.224	0.050	0.0	0.0	0.0
N	5.	5.	5.	5.	0.	0.	0.

		YEAR 1973-1974		MONTH OCTOBER		STATION WALACHIN	
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.451	0.094	0.328	0.009			
	0.671	0.475	0.726	0.358			
	0.780	0.332	0.840	0.526			
	0.489	0.127	0.405	0.137			
	0.757	0.136	0.554	0.045			
	0.580	0.323	0.661	0.394			
MEAN	0.621	0.248	0.586	0.245	0.0	0.0	0.0
STD DEV	0.137	0.152	0.195	0.210	0.0	0.0	0.0
N	6.	6.	6.	6.	0.	0.	0.

		YEAR 1973-1974		MONTH NOVEMBER		STATION MCLURE	
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.486	0.093	0.332	0.222			
	0.586	0.261	0.470	0.272			
	0.131	0.028	0.061	0.042			
	0.303	0.128	0.218	0.153			
	0.426	0.096	0.255	0.138			
	0.126	0.065	0.108	0.067			
MEAN	0.343	0.112	0.241	0.149	0.0	0.0	0.0
STD DEV	0.190	0.080	0.149	0.088	0.0	0.0	0.0
N	6.	6.	6.	6.	0.	0.	0.

		YEAR 1973-1974		MONTH NOVEMBER		STATION CHASE	
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.056	0.031	0.045	0.032			
	0.063	0.010	0.069	0.012			
	0.246	0.066	0.167	0.092			
	0.005	0.002					
	0.093	0.011		0.146			
	0.071	0.035	0.053	0.069			
	0.237	0.089		0.016			
MEAN	0.110	0.035	0.083	0.061	0.0	0.0	0.0
STD DEV	0.094	0.032	0.057	0.052	0.0	0.0	0.0
N	7.	7.	4.	6.	0.	0.	0.

		YEAR 1973-1974		MONTH NOVEMBER		STATION SAVONA	
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.829	0.366	0.791	0.528			
	1.252	1.094	1.430	0.940			
	0.523	3.161	0.408	0.197			
	0.889	0.356	3.958	0.535			
MEAN	0.873	1.244	1.649	0.550	0.0	0.0	0.0
STD DEV	0.299	1.324	1.597	0.304	0.0	0.0	0.0
N	4.	4.	4.	4.	0.	0.	0.

YEAR 1973-1974							
MONTH NOVEMBER							
STATION WALACHIN							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.360	0.102	0.294	0.123			
	0.436	0.241	0.367	0.143			
	0.260	0.157	0.288	0.208			
MEAN	0.352	0.167	0.316	0.158	0.0	0.0	0.0
STD DEV	0.088	0.070	0.044	0.044	0.0	0.0	0.0
N	3.	3.	3.	3.	0.	0.	0.

YEAR 1973-1974							
MONTH NOVEMBER							
STATION CLD DIFFUSER							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.243	0.116	0.221	0.195			
	0.392	0.161	0.249	0.190			
	1.010	0.135	0.565				
	0.315	0.105	0.221	0.089			
	0.299	0.069	0.187				
MEAN	0.452	0.117	0.289	0.158	0.0	0.0	0.0
STD DEV	0.317	0.034	0.156	0.060	0.0	0.0	0.0
N	5.	5.	5.	3.	0.	0.	0.

YEAR 1973-1974							
MONTH NOVEMBER							
STATION NEW DIFFUSER, SHORE							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.093	0.048	0.052	0.029			
	0.096	0.036	0.066	0.038			
	0.251						
	0.012	0.009	0.004				
	0.196	0.071	0.130				
	0.188	0.040	0.108	0.058			
MEAN	0.139	0.041	0.072	0.042	0.0	0.0	0.0
STD DEV	0.088	0.022	0.049	0.015	0.0	0.0	0.0
N	6.	5.	5.	3.	0.	0.	0.

YEAR 1973-1974							
MONTH NOVEMBER							
STATION SEWAGE LAGOON, SHORE							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.020	0.007		0.013			
	0.012	0.010	0.033				
	0.054	0.017	0.023	0.023			
MEAN	0.029	0.011	0.028	0.018	0.0	0.0	0.0
STD DEV	0.022	0.005	0.007	0.007	0.0	0.0	0.0
N	3.	3.	2.	2.	0.	0.	0.

YEAR 1973-1974							
MONTH NOVEMBER							
STATION SEWAGE LAGOON, MID STREAM							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.068	0.029	0.050	0.024			
	0.008	0.002					
	0.587	0.247	0.412	0.297			
MEAN	0.221	0.093	0.231	0.160	0.0	0.0	0.0
STD DEV	0.318	0.134	0.256	0.193	0.0	0.0	0.0
N	3.	3.	2.	2.	0.	0.	0.

YEAR 1973-1974							
MONTH DECEMBER							
STATION MCLURE							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.138	0.020	0.098	0.034	1.611	1.566	0.045
	0.189	0.031	0.108	0.021	0.940	0.895	0.045
	0.054	0.009	0.072	0.066	1.029	0.984	0.045
	0.395	0.051	0.260	0.110	2.192	2.148	0.045
	0.119	0.025	0.091	0.038	0.850	0.805	0.045
	0.223	0.045	0.140	0.453	0.537	0.492	0.045
MEAN	0.186	0.030	0.128	0.110	1.193	1.148	0.045
STD DEV	0.118	0.016	0.068	0.172	0.602	0.602	0.000
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974
MONTH DECEMBER
STATION CHASE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.013	0.002			0.085	0.040	0.045
	0.033	0.001			0.112	0.116	0.004
	0.015	0.004			0.367	0.103	0.264
	0.004	0.007			0.121	0.076	0.045
	0.010	0.005			0.027	0.022	0.004
					0.076	0.049	0.027
MEAN	0.015	0.004	0.0	0.0	0.131	0.068	0.065
STD DEV	0.011	0.002	0.0	0.0	0.120	0.037	0.099
N	5.	5.	0.	0.	6.	6.	6.

YEAR 1973-1974
MONTH DECEMBER
STATION SAVONA

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.934	0.162	0.615	0.191	9.485	8.993	0.492
	1.095	0.155	0.769	0.593	1.566	1.477	0.089
	0.350	0.038	0.169	0.236	3.758	3.356	0.403
	0.310	0.174	0.274	0.190	0.313	0.273	0.040
	1.355	0.185	0.915	0.309	10.022	9.620	0.403
	0.182	0.014	0.089	0.028			
MEAN	0.704	0.121	0.472	0.258	5.029	4.744	0.285
STD DEV	0.486	0.075	0.341	0.188	4.490	4.313	0.206
N	6.	6.	6.	6.	5.	5.	5.

YEAR 1973-1974
MONTH DECEMBER
STATION WALACHIN

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.239	0.035	0.159	0.117	0.537	0.492	0.045
	0.009				0.036	0.022	0.013
	0.060	0.012	0.040	0.025	0.492	0.403	0.089
					0.157	0.089	0.067
	0.017	0.008	0.016	0.030	0.224	0.134	0.089
	0.103	0.011	0.076	0.119	0.116	0.085	0.031
MEAN	0.086	0.016	0.073	0.073	0.260	0.204	0.056
STD DEV	0.094	0.012	0.063	0.052	0.207	0.194	0.031
N	5.	4.	4.	4.	6.	6.	6.

YEAR 1973-1974
MONTH DECEMBER
STATION OLD DIFFUSER

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.033	0.004	0.004	0.023	18.121	17.897	0.224
	0.353	0.019	0.096	0.153	10.738	10.425	0.313
	0.042	0.011	0.010	0.021	29.754	29.306	0.447
	0.086	0.042	0.138	0.132			
	0.072	0.025	0.083	0.045	29.575	29.172	0.403
	0.057	0.021	0.036	0.032	30.694	30.246	0.447
MEAN	0.107	0.020	0.061	0.068	23.776	23.409	0.367
STD DEV	0.122	0.013	0.053	0.059	8.933	8.856	0.097
N	6.	6.	6.	6.	5.	5.	5.

YEAR 1973-1974
MONTH DECEMBER
STATION NEW DIFFUSER, SHORE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.005				0.228	0.224	0.004
	0.159	0.011	0.104	0.018	3.043	2.998	0.045
	0.008				0.107	0.098	0.009
					0.282	0.268	0.013
	0.132	0.003	0.078	0.028	3.843	3.767	0.076
	0.017		0.002		1.562	1.365	0.197
MEAN	0.064	0.007	0.061	0.023	1.511	1.453	0.057
STD DEV	0.075	0.006	0.053	0.007	1.607	1.581	0.074
N	5.	2.	3.	2.	6.	6.	6.

YEAR 1973-1974
MONTH DECEMBER
STATION SEWAGE LAGOON, SHORE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.095	0.007	0.035	0.013	1.163	1.163	0.000
	0.072	0.012	0.026	0.007	1.521	1.477	0.045
					0.228	0.166	0.063
	0.006	0.003			0.215	0.192	0.022
	0.010	0.004			0.179	0.076	0.103
					0.210	0.166	0.045
MEAN	0.046	0.006	0.030	0.010	0.586	0.540	0.046
STD DEV	0.045	0.004	0.006	0.004	0.597	0.614	0.035
N	4.	4.	2.	2.	6.	6.	6.

YEAR 1973-1974
MONTH DECEMBER
STATION SEWAGE LAGOON, MID STREAM

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.050	0.007	0.036		0.085	0.067	0.018
					0.398	0.389	0.009
					0.143	0.121	0.022
					0.304	0.268	0.036
					0.121	0.094	0.027
					0.255	0.233	0.022
MEAN	0.050	0.007	0.036	0.0	0.218	0.195	0.022
STD DEV	0.0	0.0	0.0	0.0	0.122	0.124	0.009
N	1.	1.	1.	0.	6.	6.	6.

YEAR 1973-1974
MONTH DECEMBER
STATION DOWNSTREAM, SEWAGE LAGOON

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.828	0.053	0.546	0.124	11.320	10.872	0.447
	0.250	0.004	0.103	0.034	2.864	2.774	0.089
	0.604	0.039	0.329	0.055	9.978	9.620	0.358
	0.595	0.043	0.314	0.019	5.101	4.966	0.134
	0.452	0.074	0.296	0.087			
	0.434	0.030	0.235	0.139	9.351	8.993	0.358
	0.025	0.004	0.018				
MEAN	0.453	0.035	0.263	0.076	7.723	7.445	0.277
STD DEV	0.264	0.025	0.171	0.049	3.576	3.422	0.156
N	7.	7.	7.	6.	5.	5.	5.

YEAR 1973-1974
MONTH JANUARY
STATION MCLURE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.111	0.017	0.057	0.064	3.714	3.624	0.089
	0.006				0.089	0.089	0.000
	0.277	0.026	0.144	0.110	6.264	6.085	0.179
	0.056	0.002	0.004	0.009	6.980	6.756	0.224
	0.355	0.030	0.177	0.163	0.309	0.264	0.045
	0.044	0.003	0.009	0.009	0.040	0.000	0.040
	0.049	0.003	0.007	0.013			
	0.041	0.001		0.020	0.103	0.000	0.103
	0.270	0.032	0.132	0.119			
	0.113	0.012	0.056	0.059	1.834	0.984	0.850
	0.438	0.051	0.216	0.210	0.761	0.761	0.000
MEAN	0.160	0.018	0.089	0.078	2.233	2.063	0.170
STD DEV	0.148	0.017	0.080	0.071	2.760	2.719	0.266
N	11.	10.	9.	10.	9.	9.	9.

YEAR 1973-1974
MONTH JANUARY
STATION CHASE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.005	0.004		0.139	0.040	0.040	0.098
	0.019	0.014	0.019	0.017	0.121	0.040	0.081
	0.003				0.157	0.054	0.103
	0.033	0.018	0.027		0.049	0.036	0.013
					0.103	0.027	0.076
	0.053	0.022	0.062		0.192	0.081	0.112
	0.013	0.010	0.013		0.036	0.027	0.009
	0.010	0.004			0.201	0.049	0.152
	0.013	0.009	0.008		0.058	0.036	0.022
	0.007				0.255	0.063	0.192
	0.155	0.090	0.166	0.078	0.098	0.045	0.054
MEAN	0.031	0.021	0.049	0.047	0.128	0.045	0.083
STD DEV	0.046	0.028	0.060	0.043	0.069	0.016	0.058
N	10.	8.	6.	2.	11.	11.	11.

YEAR 1973-1974
MONTH JANUARY
STATION SAVONA

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.132	0.058	0.076	0.074			
	0.030	0.009	0.005				
	0.901	0.072	0.515	0.165			
	0.014	0.007					
	0.126	0.046	0.081	0.019	0.022	0.022	0.000
	0.102	0.036	0.065	0.007			
	0.152	0.047	0.099	0.018			
	0.284	0.079	0.169	0.248			
	0.164	0.028	0.110		0.492	0.492	0.000
	0.315	0.106	0.211	0.320	0.027	0.027	0.000
	0.206	0.038	0.105	0.005			
	0.602	0.329	0.441	0.424			
MEAN	0.252	0.071	0.171	0.142	0.180	0.180	0.0
STD DEV	0.257	0.086	0.162	0.156	0.270	0.270	0.0
N	12.	12.	11.	9.	3.	3.	3.

YEAR 1973-1974
MONTH JANUARY
STATION WALACHIN

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.050	0.010	0.021	0.002	0.197	0.188	0.009
	0.006	0.003			0.027	0.022	0.004
	0.006	0.005			0.031	0.027	0.004
	0.062	0.023	0.048	0.008	0.385	0.367	0.018
	0.012	0.010			0.036	0.031	0.004
	0.043	0.020	0.023	0.021	0.072	0.063	0.009
	0.018	0.009			0.049	0.022	0.027
	0.006	0.005			0.233	0.210	0.022
	0.057	0.016	0.022		0.022	0.022	0.000
	0.071	0.021	0.044	0.011	0.188	0.183	0.004
	0.069	0.055	0.061	0.080	0.089	0.085	0.004
					0.022	0.022	0.000
MEAN	0.036	0.016	0.036	0.024	0.113	0.103	0.009
STD DEV	0.027	0.015	0.017	0.032	0.114	0.110	0.009
N	11.	11.	6.	5.	12.	12.	12.

YEAR 1973-1974
MONTH JANUARY
STATION NORTH THOMPSON, KAMLCCPS

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.001	0.001	0.001	0.002	0.166	0.143	0.022
	0.001	0.001	0.001	0.002	0.179	0.179	0.000
	0.067	0.006	0.044	0.002	0.716	0.671	0.045
	0.010	0.005	0.001	0.002	1.521	1.432	0.089
	0.021	0.001	0.001	0.002	0.089	0.081	0.009
	0.016	0.001	0.001	0.002	0.286	0.264	0.022
MEAN	0.019	0.002	0.008	0.002	0.493	0.462	0.031
STD DEV	0.025	0.002	0.018	0.000	0.551	0.520	0.032
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974
MONTH JANUARY
STATION SOUTH THOMPSON, KAMLCCPS

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	1.342	0.001	0.537	0.761	38.523	37.539	0.984
	1.342	0.010	0.447	0.582	45.190	43.846	1.342
	1.298	0.009	0.626	0.206	60.403	59.060	1.342
	3.266	0.001	1.655	0.895	68.904	67.114	1.790
	0.984	0.015	0.421	0.251	55.034	53.691	1.342
	2.953	0.023	1.387	0.805	89.933	87.248	2.685
	1.298	0.001	0.626	0.313	60.850	59.508	1.342
	1.655	0.001	0.716	0.582	69.351	67.114	2.237
	4.474	0.042	2.461	2.595	73.378	71.141	2.237
	5.817	0.001	2.461	1.611	64.430	62.640	1.790
MEAN	2.443	0.010	1.134	0.860	62.600	60.890	1.709
STD DEV	1.641	0.013	0.809	0.733	14.529	14.037	0.536
N	10.	10.	10.	10.	10.	10.	10.

YEAR 1973-1974
MONTH JANUARY
STATION OLD DIFFUSER

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.358	0.007	0.112	0.085	8.501	8.367	0.134
	0.107	0.001	0.027	0.002	4.564	4.474	0.089
	0.219	0.001	0.103	0.002	5.145	5.056	0.089
	0.166	0.001	0.049	0.002	1.678	1.624	0.054
	0.286	0.001	0.094	0.030	12.170	11.946	0.224
	0.183	0.001	0.067	0.002	5.235	5.101	0.134
MEAN	0.220	0.002	0.075	0.020	6.215	6.095	0.121
STD DEV	0.090	0.002	0.033	0.034	3.636	3.580	0.059
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974
MONTH JANUARY
STATION NEW DIFFUSER, SHRE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.005	0.001	0.001	0.002	0.277	0.273	0.004
	0.010	0.001	0.001	0.002	0.980	0.949	0.031
	0.005	0.001	0.001	0.002	0.286	0.282	0.004
	0.016	0.001	0.001	0.002	0.116	0.103	0.013
	0.021	0.001	0.001	0.002	0.510	0.488	0.022
	0.001	0.001	0.001	0.002	0.174	0.161	0.013
MEAN	0.010	0.001	0.001	0.002	0.390	0.376	0.014
STD DEV	0.008	0.000	0.000	0.000	0.319	0.310	0.011
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974
MONTH JANUARY
STATION SEWAGE LAGOON, SHORE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.206	0.001	0.058	0.018	0.582	0.550	0.031
	0.081	0.012	0.094	0.002	3.311	3.221	0.089
	0.492	0.001	0.219	0.098	10.067	9.888	0.179
	0.001	0.001	0.001	0.002	0.188	0.166	0.022
	0.582	0.001	0.264	0.094	9.888	9.620	0.268
	0.058	0.001	0.001	0.011	0.089	0.072	0.018
	0.255	0.001	0.063	0.094	4.922	4.787	0.134
MEAN	0.239	0.003	0.100	0.046	4.150	4.043	0.106
STD DEV	0.223	0.004	0.103	0.047	4.362	4.272	0.094
N	7.	7.	7.	7.	7.	7.	7.

YEAR 1973-1974
MONTH JANUARY
STATION SEWAGE LAGOON, MID STREAM

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.009	0.010	0.049	0.002	2.774	2.729	0.045
	1.119	0.174	0.671	0.492	21.029	20.582	0.447
	0.019	0.010	0.058	0.009	2.506	2.461	0.045
	0.143	0.038	0.152	0.042	25.503	21.477	4.027
MEAN	0.322	0.058	0.232	0.136	12.953	11.812	1.141
STD DEV	0.534	0.078	0.296	0.238	12.048	10.650	1.933
N	4.	4.	4.	4.	4.	4.	4.

YEAR 1973-1974
MONTH JANUARY
STATION DOWNSTREAM, SEWAGE LAGOON

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.246	0.017	0.112	0.188	2.698	2.268	0.430
	0.001	0.001	0.001	0.002	0.201	0.188	0.013
	0.282	0.018	0.143	0.103	1.709	1.575	0.134
	0.183	0.004	0.042	0.017	2.890	2.685	0.206
	0.255	0.020	0.130	0.041	1.293	1.123	0.170
	0.001	0.001	0.001	0.002	0.125	0.116	0.009
MEAN	0.161	0.010	0.071	0.059	1.486	1.326	0.160
STD DEV	0.128	0.009	0.065	0.074	1.186	1.058	0.155
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974							
MONTH FEBRUARY							
STATION MCLURE							
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
0.001	0.001	0.001	0.002	0.112	0.098	0.013	
0.001	0.001	0.001	0.002	2.103	1.969	0.134	
0.026	0.026	0.107	0.002	0.304	0.264	0.040	
0.001	0.001	0.001	0.002	0.022	0.022	0.000	
0.001	0.001	0.001	0.002	0.022	0.022	0.000	
				1.119	1.029	0.089	
0.001	0.001	0.001	0.002	0.045	0.045	0.000	
				0.022	0.022	0.000	
MEAN	0.005	0.005	0.019	0.469	0.434	0.034	
STD DEV	0.010	0.010	0.043	0.758	0.708	0.051	
N	6.	6.	6.	8.	8.	8.	

YEAR 1973-1974							
MONTH FEBRUARY							
STATION CHASE							
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
0.012	0.001	0.001	0.002	0.094	0.081	0.013	
0.107	0.094	0.040	0.192	0.626	0.582	0.045	
0.121	0.001	0.030	0.014	0.242	0.148	0.094	
0.017	0.001	0.001	0.002	1.208	1.119	0.089	
0.103	0.006	0.030	0.011	0.394	0.340	0.054	
0.028	0.001	0.001	0.002	0.157	0.130	0.027	
0.036	0.001	0.001	0.010	3.848	3.624	0.224	
0.045	0.001	0.001	0.004	0.492	0.447	0.045	
0.001	0.001	0.001	0.002	0.022	0.022	0.000	
0.215	0.161	0.076	0.002	0.228	0.201	0.027	
0.112	0.007	0.038	0.027	1.611	1.163	0.447	
MEAN	0.072	0.025	0.020	0.811	0.714	0.097	
STD DEV	0.065	0.053	0.025	1.121	1.042	0.131	
N	11.	11.	11.	11.	11.	11.	

YEAR 1973-1974							
MONTH FEBRUARY							
STATION SAVONA							
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
				2.013	1.834	0.179	
0.201	0.201	0.001	0.002	0.984	0.895	0.089	
				3.758	3.579	0.179	
0.001	0.001	0.001	0.002	0.067	0.049	0.018	
				0.626	0.582	0.045	
0.166	0.049	0.224	0.045	3.311	3.132	0.179	
0.063	0.001	0.001	0.002	0.260	0.242	0.018	
0.626	0.161	0.309	0.072	5.414	5.145	0.268	
0.001	0.001	0.001	0.002	0.206	0.179	0.027	
				2.282	2.192	0.089	
MEAN	0.176	0.069	0.089	1.892	1.783	0.109	
STD DEV	0.235	0.090	0.140	1.805	1.723	0.087	
N	6.	6.	6.	10.	10.	10.	

YEAR 1973-1974							
MONTH FEBRUARY							
STATION WALACHIN							
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
0.081	0.001	0.013	0.002	0.094	0.089	0.004	
0.112	0.028	0.021	0.125	0.072	0.040	0.031	
0.183	0.001	0.058	0.002	0.492	0.492	0.000	
0.001	0.001	0.001	0.002	0.022	0.022	0.000	
0.537	0.001	0.228	0.002	1.029	0.984	0.045	
0.006	0.001	0.001	0.002	0.152	0.125	0.027	
0.353	0.003	0.152	0.002	1.700	1.611	0.089	
0.251	0.001	0.112	0.002	0.228	0.197	0.031	
MEAN	0.190	0.005	0.073	0.474	0.445	0.028	
STD DEV	0.185	0.009	0.083	0.596	0.571	0.030	
N	8.	8.	8.	8.	8.	8.	

YEAR 1973-1974							
MONTH FEBRUARY							
STATION CONTROL							
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
0.626	0.001	0.331	0.148	2.255			
1.790	0.031	0.940	0.389	65.324			
MEAN	1.208	0.016	0.635	33.789	0.0	0.0	
STD DEV	0.823	0.021	0.431	44.596	0.0	0.0	
N	2.	2.	2.	2.	0.	0.	

YEAR 1973-1974
MONTH FEBRUARY
STATION NORTH THOMPSON, KAMLCCPS

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.313	0.001	0.107	0.072	39.374	38.479	0.895
	0.174	0.004	0.067	0.089	18.345	17.897	0.447
	0.058	0.001	0.001	0.002	18.792	18.345	0.447
	0.492	0.004	0.206	0.228	13.423	12.975	0.447
	0.805	0.006	0.412	0.166	1.834	1.790	0.045
MEAN	0.368	0.003	0.159	0.111	18.354	17.897	0.456
STD DEV	0.293	0.002	0.160	0.087	13.595	13.299	0.301
N	5.	5.	5.	5.	5.	5.	5.

YEAR 1973-1974
MONTH FEBRUARY
STATION SOUTH THOMPSON, KAMLCCPS

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	2.148	0.170	1.387	0.421	20.089	19.508	0.582
	3.982	0.984	2.506	0.295	27.740	26.846	0.895
	1.834	0.054	0.984	0.398	37.718	36.734	0.984
	1.298	0.008	0.671	0.300	12.215	11.991	0.224
	6.711	0.850	4.295	1.566	53.691	52.349	1.342
	2.192	0.139	1.119	0.805	75.615	74.720	0.895
MEAN	3.027	0.367	1.827	0.631	37.845	37.025	0.820
STD DEV	2.018	0.432	1.363	0.495	23.460	23.208	0.380
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974
MONTH FEBRUARY
STATION CLD DIFFUSER

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	1.208	0.157	0.537	0.286	22.864	22.371	0.492
	1.700	0.228	0.850	0.537	49.217	49.217	0.000
	0.850	0.152	0.407	0.255	43.400	42.506	0.895
	1.432	0.125	0.716	0.434	30.872	29.978	0.895
	1.477	0.219	0.850	0.537	58.166	55.928	2.237
	1.029	0.268	0.671	0.058	11.633	11.409	0.224
MEAN	1.283	0.191	0.672	0.351	36.025	35.235	0.790
STD DEV	0.313	0.055	0.175	0.187	17.398	16.955	0.794
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974
MONTH FEBRUARY
STATION NEW DIFFUSER, MID STREAM

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.984	0.037	0.582	0.183	40.984	40.268	0.716
	0.850	0.026	0.430	0.371	14.497	14.094	0.403
	0.582	0.009	0.304	0.210	17.987	17.673	0.313
	1.253	0.025	0.425	0.358	41.477	40.716	0.761
MEAN	0.917	0.024	0.435	0.280	28.736	28.188	0.548
STD DEV	0.279	0.012	0.114	0.098	14.499	14.284	0.223
N	4.	4.	4.	4.	4.	4.	4.

YEAR 1973-1974
MONTH FEBRUARY
STATION SEWAGE LAGOON, SHORE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.394	0.002	0.219	0.143	5.817	5.593	0.224
	0.295	0.001	0.188	0.067	0.532	0.488	0.045
	0.716	0.027	0.398	0.139	61.298	60.403	0.895
	0.671	0.001	0.336	0.112	21.700	21.233	0.447
	0.582	0.001	0.286	0.072	81.432	80.537	0.895
	0.385	0.001	0.197	0.148	22.819	22.595	0.224
MEAN	0.507	0.005	0.271	0.113	32.266	31.811	0.455
STD DEV	0.173	0.011	0.084	0.036	32.148	31.801	0.364
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974
MONTH FEBRUARY
STATION SEWAGE LAGOON,MID STREAM

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.152	0.063	0.098	0.085	1.879	1.790	0.089
	3.445	0.058	1.342	1.879	37.673	35.928	1.745
	0.984	0.174	0.492	0.210	4.340	4.161	0.179
	0.940	0.014	0.805	0.167	1.235	0.895	0.340
	0.850	0.098	0.447	0.179	16.555	15.660	0.895
	0.761	0.103	1.074	0.002	8.725	8.233	0.492
MEAN	1.189	0.085	0.710	0.410	11.734	11.111	0.623
STD DEV	1.146	0.054	0.454	0.723	13.908	13.300	0.618
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974
MONTH FEBRUARY
STATION DOWNSTREAM,SEWAGE LAGOON

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.094	0.001	0.058	0.002	0.201	0.188	0.013
	0.492	0.039	0.251	0.197	0.582	0.537	0.045
	0.210	0.030	0.116	0.011	1.029	0.984	0.045
	0.340	0.024	0.242	0.045	3.266	3.132	0.134
	0.139	0.192	0.049	0.023	1.119	1.074	0.045
	0.228	0.001	0.143	0.031			
MEAN	0.250	0.048	0.143	0.051	1.239	1.183	0.056
STD DEV	0.145	0.072	0.087	0.073	1.191	1.146	0.046
N	6.	6.	6.	6.	5.	5.	5.

YEAR 1973-1974
MONTH MARCH
STATION MCLURE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.166	0.001	0.076	0.054	3.839	3.682	0.157
	0.255	0.001	0.130	0.063	0.327	0.318	0.009
	1.298	0.001	0.716	0.345	51.902	51.007	0.895
	0.049	0.001	0.031	0.002	0.130	0.130	0.000
	0.103	0.001	0.492	0.537	10.559	10.201	0.358
	0.001	0.001	0.001	0.002	0.022	0.022	0.000
	0.054	0.001	0.313	0.031	3.503	3.383	0.121
	0.001	0.001	0.001	0.002	0.031	0.022	0.009
	0.434	0.001	0.174	0.152	6.935	6.667	0.268
	0.116	0.001	0.049	0.030	0.774	0.734	0.040
	0.045	0.001	0.005	0.014	2.931	2.832	0.098
	0.492	0.001	0.228	0.143	21.790	20.895	0.895
MEAN	0.251	0.001	0.185	0.115	8.562	8.324	0.237
STD DEV	0.367	0.000	0.224	0.166	15.030	14.737	0.327
N	12.	12.	12.	12.	12.	12.	12.

YEAR 1973-1974
MONTH MARCH
STATION CHASE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.103	0.001	0.030	0.005	0.103	0.085	0.018
	0.850	0.001	0.447	0.130	1.011	1.351	0.107
	0.188	0.001	0.041	0.005	1.651	0.747	0.904
	0.671	0.001	0.362	0.076	0.224	0.170	0.054
	0.197	0.001	0.063	0.021	0.483	0.398	0.040
	0.081	0.001	0.014	0.002	0.206	0.192	0.013
	0.112	0.001	0.001	0.042	0.022	0.022	0.000
	0.327	0.008	0.148	0.036	0.309	0.304	0.004
	0.228	0.006	0.121	0.054	1.490	1.324	0.166
	0.192	0.001	0.085	0.076	0.197	0.179	0.018
	0.031	0.001	0.001	0.002			
	0.089	0.001	0.010	0.029	0.067	0.063	0.004
MEAN	0.256	0.002	0.110	0.040	0.524	0.440	0.121
STD DEV	0.252	0.002	0.146	0.039	0.585	0.487	0.265
N	12.	12.	12.	12.	11.	11.	11.

YEAR 1973-1974
MONTH MARCH
STATION SAVONA

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.492	0.015	0.246	0.058	2.421	2.251	0.170
	2.103	0.031	1.119	0.492	2.872	2.796	0.076
	0.805	0.001	0.412	0.210	2.787	2.434	0.353
	1.879	0.001	0.940	0.412	2.183	0.022	2.161
	0.376	0.015	0.246	0.098	1.539	1.436	0.103
	0.246	0.003	0.161	0.044	9.351	8.412	0.940
	1.521	0.089	0.850	0.192	24.922	23.221	1.700
	2.819	0.001	1.477	0.313	5.906	4.787	1.119
	2.327	0.001	1.253	0.850	3.736	3.311	0.425
	0.380	0.001	0.224	0.067	1.083	1.051	0.031
	3.043	0.001	1.432	1.745	2.148	1.964	0.183
	0.327	0.005	0.174	0.157	4.698	4.116	0.582
MEAN	1.360	0.014	0.711	0.386	5.304	4.650	0.654
STD DEV	1.046	0.025	0.521	0.487	6.583	6.232	0.694
N	12.	12.	12.	12.	12.	12.	12.

YEAR 1973-1974
MONTH MARCH
STATION WALACHIN

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	3.669	0.001	1.834	0.805	4.966	4.474	0.492
	2.550	0.001	0.895	0.602	2.277	1.978	0.300
	2.819	0.001	1.432	0.492	3.799	3.468	0.331
	0.984	0.024	0.492	0.143	1.078	0.975	0.103
					0.823	0.720	0.103
	1.029	0.001	0.447	0.407	0.864	0.711	0.152
	3.221	0.001	1.700	0.492	0.653	0.532	0.121
	4.027	0.001	2.103	0.805	10.291	9.306	0.984
	8.456	0.001	0.940	1.253	13.512	11.141	2.371
	0.242	0.001	0.089	0.016	0.940	0.810	0.130
					5.414	4.474	0.940
	0.895	0.001	0.425	0.019	6.935	6.667	0.268
	2.998	0.001	1.521	0.358	8.993	7.919	1.074
	1.342	0.001	0.671	0.076	7.785	7.025	0.761
MEAN	2.686	0.003	1.046	0.406	4.881	4.300	0.581
STD DEV	2.197	0.007	0.652	0.393	4.133	3.587	0.625
N	12.	12.	12.	12.	14.	14.	14.

YEAR 1973-1974
MONTH MARCH
STATION NORTH THOMPSON, KAMLCCPS

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.004	0.001	0.001	0.002	0.112	0.112	0.000
	0.009	0.001	0.001	0.002	0.112	0.112	0.000
	0.022	0.001	0.001	0.002	0.112	0.112	0.000
	0.049	0.001	0.027	0.002	0.112	0.112	0.000
	0.022	0.001	0.001	0.002	0.112	0.112	0.000
	0.009	0.001	0.001	0.002	0.112	0.112	0.000
MEAN	0.019	0.001	0.005	0.002	0.112	0.112	0.0
STD DEV	0.016	0.000	0.011	0.000	0.0	0.0	0.0
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974
MONTH MARCH
STATION SOUTH THOMPSON, KAMLCCPS

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.434	0.034	0.268	0.058	42.103	41.181	0.922
	0.984	0.219	0.761	0.300	45.235	43.826	1.409
	0.134	0.024	0.134	0.023	1.503	1.445	0.058
	2.953	0.023	1.387	0.805	89.933	87.248	2.685
	1.208	0.049	0.671	0.353	37.432	36.796	0.635
	0.850	0.032	0.492	0.170	35.682	34.752	0.931
	0.157	0.002	0.076	0.016	9.638	9.418	0.219
	5.817	0.001	2.461	1.611	64.430	62.640	1.790
MEAN	1.567	0.048	0.781	0.417	40.744	39.663	1.081
STD DEV	1.938	0.071	0.799	0.548	28.149	27.307	0.863
N	8.	8.	8.	8.	8.	8.	8.

YEAR 1973-1974
MONTH MARCH
STATION CLO DIFFUSER

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.063	0.001	0.022	0.039	44.787	43.767	1.020
	2.371	0.002	1.253	0.805	160.224	156.555	3.669
	2.685	0.045	1.432	0.537	104.966	102.998	1.969
	3.087	0.002	1.521	1.163	144.519	141.611	2.908
	0.940	0.001	0.506	0.251	157.360	154.631	2.729
	1.566	0.015	0.805	0.353	96.823	95.481	1.342
MEAN	1.785	0.011	0.923	0.525	118.113	115.840	2.273
STD DEV	1.147	0.018	0.587	0.407	44.752	43.819	1.009
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974
MONTH MARCH
STATION NEW DIFFUSER, MID STREAM

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	2.013	0.166	1.298	0.224	6.371	6.192	0.179
	1.163	0.112	0.716	0.089	3.790	3.673	0.116
	1.969	0.049	0.984	0.447	31.275	30.559	0.716
	1.611	0.161	1.029	0.206	2.519	2.358	0.161
	0.353	0.001	0.139	0.058	28.770	28.277	0.492
	0.850	0.121	0.582	0.121	19.902	19.481	0.421
	0.761	0.044	0.492	0.085	7.374	7.177	0.197
	2.103	0.001	0.984	0.492	71.588	70.246	1.342
	2.058	0.116	1.163	0.340	9.414	9.199	0.215
	2.908	0.001	1.163	0.805	96.644	94.407	2.237
	1.924	0.027	0.895	0.582	27.472	26.890	0.582
	1.119	0.009	0.492	0.210	18.658	18.345	0.313
MEAN	1.569	0.067	0.828	0.305	26.981	26.400	0.581
STD DEV	0.727	0.064	0.345	0.233	28.980	28.364	0.624
N	12.	12.	12.	12.	12.	12.	12.

YEAR 1973-1974
MONTH MARCH
STATION NEW DIFFUSER, SHORE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	1.029	0.072	0.555	0.380	55.839	54.407	1.432
	1.119	0.045	0.537	0.626	65.861	64.832	1.029
	0.148	0.021	0.103	0.049	6.430	6.094	0.336
	1.879	0.085	0.984	0.626	93.199	91.633	1.566
	0.139	0.017	0.085	0.031	1.799	1.723	0.076
MEAN	0.863	0.048	0.453	0.342	44.626	43.738	0.888
STD DEV	0.735	0.030	0.373	0.294	39.462	38.843	0.659
N	5.	5.	5.	5.	5.	5.	5.

YEAR 1973-1974
MONTH MARCH
STATION SEWAGE LAGOON, SHORE

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.492	0.033	0.273	0.134	22.063	21.324	0.738
	0.291	0.012	0.166	0.018	3.047	2.953	0.094
	0.761	0.031	0.425	0.081	4.676	4.438	0.237
	0.201	0.017	0.103	0.030	22.233	21.776	0.456
	0.072	0.004	0.042	0.016	1.074	1.034	0.040
	2.103	0.121	1.074	0.492	64.474	63.535	0.940
MEAN	0.653	0.036	0.347	0.128	19.594	19.177	0.417
STD DEV	0.750	0.043	0.381	0.184	23.944	23.616	0.362
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974
MONTH MARCH
STATION SEWAGE LAGOON, MID STREAM

	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.210	0.021	0.125	0.045	1.101	1.096	0.604
	0.081	0.001	0.038	0.012	1.360	1.311	0.049
	0.761	0.043	0.398	0.139	3.776	3.633	0.143
	0.349	0.021	0.183	0.076	6.859	6.568	0.291
	1.611	0.049	0.850	0.125	6.752	6.465	0.286
	0.895	0.049	0.443	0.121	5.374	5.226	0.148
MEAN	0.651	0.031	0.339	0.086	4.204	4.050	0.153
STD DEV	0.566	0.019	0.295	0.051	2.562	2.448	0.118
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974							
MONTH MARCH							
STATION DOWNSTREAM, SEWAGE LAGOON							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.492	0.029	0.282	0.081	6.174	5.826	0.349
	1.163	0.089	0.671	0.260	1.092	1.074	0.018
	0.313	0.044	0.197	0.039	8.421	7.911	0.510
	1.472	0.161	0.796	0.170	9.562	9.347	0.215
	1.298	0.537	0.940	0.260	1.767	1.463	0.304
	2.872	0.376	1.700	0.447	6.694	6.300	0.394
MEAN	1.268	0.206	0.764	0.209	5.618	5.320	0.298
STD DEV	0.910	0.206	0.542	0.147	3.470	3.378	0.169
N	6.	6.	6.	6.	6.	6.	6.

YEAR 1973-1974							
MONTH APRIL							
STATION MCLURE							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.016	0.001	0.001	0.025	0.247	0.229	0.017
	0.140	0.015	0.107	0.051	2.197	2.130	0.067
	0.216	0.001	0.124	0.075	2.765	2.680	0.085
	0.005	0.001	0.001	0.002	1.324	1.271	0.054
	0.075	0.009	0.064	0.044	1.016	0.971	0.045
	0.001	0.001	0.001	0.002	0.041	0.039	0.001
	0.049	0.019	0.074	0.023	0.801	0.765	0.036
	0.045	0.006	0.028	0.014	0.470	0.436	0.034
	0.044	0.014	0.052	0.034	0.333	0.325	0.009
	0.045	0.006	0.028	0.034	0.090	0.101	0.011
	0.025	0.005	0.038	0.002	0.105	0.099	0.006
	0.239	0.029	0.209	0.056	2.823	2.743	0.081
MEAN	0.075	0.009	0.061	0.030	1.018	0.982	0.037
STD DEV	0.080	0.009	0.062	0.023	1.038	1.008	0.030
N	12.	12.	12.	12.	12.	12.	12.

YEAR 1973-1974							
MONTH APRIL							
STATION CHASE							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.064	0.013	0.068	0.048	0.217	0.173	0.044
	0.185	0.012	0.136	0.025	0.237	0.235	0.002
	0.016	0.001	0.001	0.002	0.694	0.640	0.054
	0.015	0.001	0.017	0.005	0.065	0.064	0.000
	0.026	0.001	0.001	0.002	0.373	0.288	0.085
	0.005	0.001	0.001	0.002	0.179	0.133	0.046
	0.039	0.006	0.055	0.026	0.541	0.317	0.225
	0.001	0.001	0.001	0.002	0.022	0.022	0.000
	0.001	0.001	0.001	0.002	0.034	0.034	0.000
	0.051	0.001	0.027	0.043	0.022	0.022	0.000
	0.290	0.017	0.212	0.099	0.828	0.770	0.058
	0.337	0.001	0.192	0.215	0.315	0.214	0.101
MEAN	0.086	0.005	0.059	0.039	0.294	0.262	0.056
STD DEV	0.118	0.006	0.078	0.063	0.270	0.242	0.066
N	12.	12.	12.	12.	12.	11.	11.

YEAR 1973-1974							
MONTH APRIL							
STATION SAVGNA							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.076	0.007	0.058	0.012	0.078	0.053	0.025
	0.146	0.001	0.058	0.019	2.246	2.148	0.098
	0.264	0.027	0.222	0.077	0.855	0.787	0.067
	0.065	0.004	0.068	0.027	0.030		
	0.060	0.001	0.022	0.019	0.194	0.170	0.024
	0.194	0.021	0.205	0.042	1.374	1.289	0.085
	0.350	0.029	0.209	0.057	5.145	4.877	0.268
	0.065	0.001	0.021	0.048	0.068	0.049	0.019
	0.256	0.011	0.130	0.061	0.890	0.779	0.112
	0.035	0.010	0.033	0.002	0.390	0.329	0.061
	0.045	0.006	0.028	0.002	0.208	0.185	0.023
	0.035	0.003	0.009	0.018	0.022	0.022	0.000
MEAN	0.133	0.010	0.089	0.032	0.958	0.972	0.071
STD DEV	0.108	0.010	0.081	0.025	1.482	1.452	0.075
N	12.	12.	12.	12.	12.	11.	11.

YEAR 1973-1974							
MONTH APRIL							
STATION WALACHIN							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.264	0.029	0.197	0.098	0.796	0.729	0.067
	0.131	0.002	0.089	0.034	0.446	0.370	0.076
	0.174	0.021	0.189	0.049	1.078	0.971	0.107
	0.160	0.014	0.123	0.044	2.483	2.188	0.295
	0.328	0.042	0.265	0.105	1.266	1.114	0.152
	0.379	0.035	0.317	0.128	0.609	0.532	0.076
	0.138	0.030	0.155	0.072	0.613	0.555	0.058
	0.456	0.032	0.308	0.111	1.535	1.459	0.076
	1.387	0.066	0.846	0.204	0.247	0.189	0.058
	0.065	0.004	0.068	0.027	0.456	0.377	0.079
	0.121	0.001	0.093	0.018	0.189	0.187	0.002
	0.445	0.025	0.337	0.155	0.456	0.428	0.028
MEAN	0.337	0.025	0.249	0.087	0.848	0.758	0.089
STD DEV	0.356	0.019	0.210	0.057	0.657	0.592	0.074
N	12.	12.	12.	12.	12.	12.	12.

YEAR 1974-1975							
MONTH NOVEMBER							
STATION MCLURE							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.076	0.002	0.006	0.080	0.062	0.022	0.040
	0.214	0.002	0.044	0.131	0.114	0.022	0.092
	0.109	0.002	0.013	0.051	0.114	0.022	0.092
	0.123	0.002	0.015	0.062	0.181	0.022	0.159
	0.087	0.002	0.020	0.076	0.062	0.022	0.040
					0.035	0.022	0.013
	0.176	0.002	0.033	0.080	0.042	0.022	0.020
	0.199	0.002	0.033	0.096	0.091	0.022	0.069
MEAN	0.141	0.002	0.023	0.082	0.088	0.022	0.066
STD DEV	0.055	0.000	0.014	0.026	0.048	0.000	0.048
N	7.	7.	7.	7.	8.	8.	8.

YEAR 1974-1975							
MONTH NOVEMBER							
STATION CHASE							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.425	0.002	0.085	0.451	0.210	0.080	0.130
	1.400	0.002	0.400	0.872	0.380	0.156	0.224
	4.190	0.089	1.371	2.910	3.050	0.729	2.320
	1.550	0.002	0.463	1.130	0.503	0.176	0.327
	1.200	0.002	0.263	1.080	13.300	0.539	12.760
	1.250	0.002	0.158	1.180	0.545	0.225	0.320
	0.340	0.002	0.069	0.351	0.393	0.114	0.279
	0.604	0.002	0.109	0.577	0.530	0.123	0.407
MEAN	1.370	0.013	0.365	1.069	2.364	0.268	2.096
STD DEV	1.229	0.031	0.432	0.809	4.514	0.236	4.368
N	8.	8.	8.	8.	8.	8.	8.

YEAR 1974-1975							
MONTH NOVEMBER							
STATION SAVONA							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.559	0.002	0.069	0.085	1.610	0.154	1.460
	1.990	0.096	0.326	0.355	7.290	0.472	6.820
	1.290	0.055	0.263	0.393	2.210	0.201	2.010
	1.730	0.029	0.346	0.418	2.220	0.315	1.900
	1.250	0.042	0.167	0.272	3.280	0.302	2.980
	0.268	0.006	0.033	0.020	1.180	0.082	1.100
	1.550	0.120	0.284	0.331	6.240	0.472	5.760
	0.503	0.008	0.082	0.116	13.800	0.102	13.700
MEAN	1.142	0.045	0.196	0.249	4.729	0.262	4.466
STD DEV	0.630	0.044	0.124	0.153	4.279	0.154	4.271
N	8.	8.	8.	8.	8.	8.	8.

		YEAR 1974-1975		MONTH NOVEMBER		STATION WALACHIN	
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.319	0.017	0.089	0.038			
	0.205	0.004	0.044	0.029	0.161	0.022	0.139
	0.125	0.002	0.011	0.004	0.324	0.044	0.280
	0.194	0.002	0.031	0.004	0.353	0.055	0.298
	0.082	0.002	0.006	0.006	0.277	0.029	0.248
	0.279	0.020	0.058	0.071	0.993	0.134	0.859
	0.174	0.004	0.011	0.033	0.279	0.026	0.253
	0.145	0.002	0.011	0.008	0.149	0.022	0.127
MEAN	0.190	0.007	0.033	0.024	0.362	0.047	0.315
STD DEV	0.078	0.007	0.029	0.024	0.289	0.040	0.249
N	8.	8.	8.	8.	7.	7.	7.

		YEAR 1974-1975		MONTH NOVEMBER		STATION SEWAGE LAGOON	
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.322	0.020	0.167	0.004	0.255	0.046	0.209
	0.543	0.006	0.100	0.004	6.400	0.161	6.239
	0.628	0.002	0.105	0.100	3.480	0.212	3.260
	0.116	0.011	0.055	0.004	0.704	0.046	0.658
	0.416	0.002	0.055	0.060	2.280	0.170	2.110
	1.123	0.002	0.172	0.067	6.030	0.608	5.420
	1.194	0.002	0.223	0.255	4.450	0.536	3.914
	0.232	0.013	0.076	0.004	0.422	0.058	0.364
MEAN	0.572	0.007	0.119	0.062	3.003	0.230	2.772
STD DEV	0.397	0.007	0.062	0.086	2.480	0.221	2.325
N	8.	8.	8.	8.	8.	8.	8.

		YEAR 1974-1975		MONTH NOVEMBER		STATION DIFFUSER	
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.011	0.002	0.006	0.004	0.022	0.022	0.000
	0.129	0.002	0.022	0.013	0.044	0.022	0.022
	0.022	0.002	0.006	0.004	0.022	0.022	0.000
	0.183	0.002	0.026	0.020	0.035	0.022	0.013
	0.561	0.033	0.158	0.154	0.232	0.053	0.179
	0.033	0.002	0.006	0.004	0.024	0.022	0.002
	0.002	0.002	0.006	0.004	0.022	0.022	0.000
	0.680	0.038	0.158	0.071	0.483	0.085	0.398
MEAN	0.203	0.010	0.048	0.034	0.110	0.034	0.077
STD DEV	0.267	0.016	0.068	0.053	0.167	0.023	0.143
N	8.	8.	8.	8.	8.	8.	8.

		YEAR 1974-1975		MONTH NOVEMBER		STATION CONTROL	
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.212	0.002	0.024	0.026	0.109	0.033	0.076
	0.214	0.002	0.031	0.040	0.152	0.035	0.117
	0.615	0.015	0.145	0.049	0.284	0.064	0.220
	0.040	0.002	0.006	0.004	0.033	0.022	0.011
MEAN	0.270	0.005	0.051	0.030	0.144	0.038	0.106
STD DEV	0.244	0.007	0.063	0.020	0.105	0.018	0.088
N	4.	4.	4.	4.	4.	4.	4.

		YEAR 1974-1975		MONTH DECEMBER		STATION WCLURE	
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.671	0.247	0.098	0.089	0.722	0.117	0.605
	0.156	0.001	0.054	0.032	0.848	0.032	0.816
	0.139	0.001	0.038	0.047	1.442	0.025	1.417
					1.463	0.346	1.117
	0.407	0.009	0.134	0.097	1.230	0.130	1.100
	0.112	0.001	0.033	0.045	0.451	0.025	0.426
	0.173	0.002	0.051	0.042	0.897	0.048	0.849
	0.109	0.005	0.019	0.023	0.508	0.076	0.432
MEAN	0.252	0.038	0.061	0.053	0.945	0.100	0.845
STD DEV	0.209	0.090	0.042	0.026	0.395	0.107	0.353
N	7.	7.	7.	7.	8.	8.	8.

		YEAR 1974-1975		MONTH DECEMBER		STATION CHASE	
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
4.418	0.049	1.275	1.185	6.624	1.219	5.405	
10.860	0.043	3.959	6.935	3.078	0.568	2.510	
3.568	0.001	1.208	1.834	10.500	2.237	8.263	
6.118	0.009	1.879	3.411	2.666	0.542	2.124	
2.505	0.001	0.873	0.677	7.517	1.621	5.896	
6.610	0.049	2.020	2.829	1.822	0.370	1.452	
7.348	0.001	1.968	7.673	6.636	1.364	5.272	
				8.469	1.711	6.758	
MEAN	5.918	0.022	1.883	3.506	5.914	4.710	
STD DEV	2.781	0.024	1.015	2.762	3.082	0.661	
N	7.	7.	7.	7.	8.	8.	

		YEAR 1974-1975		MONTH DECEMBER		STATION SAVONA	
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
2.147	0.002	0.585	0.805	8.200	0.011	7.643	
2.941	0.001	0.711	1.174	8.829	0.710	8.119	
0.192	0.002	0.057	0.066	0.447	0.034	0.412	
1.979	0.048	0.437	0.554	7.239	0.420	6.818	
0.533	0.017	0.158	0.076	2.116	0.167	1.948	
1.946	0.013	0.426	0.468	8.570	0.488	8.081	
0.213	0.004	0.068	0.040	0.412	0.039	0.373	
0.689	0.021	0.189	0.253	2.034	0.189	1.845	
MEAN	1.330	0.013	0.329	0.429	4.731	4.405	
STD DEV	1.046	0.016	0.246	0.406	3.798	0.255	
N	8.	8.	8.	8.	8.	8.	

		YEAR 1974-1975		MONTH DECEMBER		STATION WALACHIN	
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
0.578	0.005	0.153	0.074	0.912	0.110	0.794	
0.300	0.001	0.044	0.156	0.379	0.058	0.321	
0.075	0.001	0.011	0.015				
0.869	0.007	0.307	0.334	1.163	0.177	0.986	
0.242	0.001	0.105	0.074	0.319	0.042	0.277	
0.500	0.001	0.192	0.063	0.488	0.081	0.407	
0.401	0.007	0.142	0.135	0.834	0.095	0.739	
0.110	0.002	0.021	0.030	0.177	0.026	0.151	
MEAN	0.384	0.003	0.122	0.110	0.610	0.525	
STD DEV	0.263	0.003	0.100	0.102	0.362	0.313	
N	8.	8.	8.	8.	7.	7.	

		YEAR 1974-1975		MONTH DECEMBER		STATION SEWAGE LAGOON	
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
0.026	0.003	0.034	0.002	0.485	0.043	0.442	
0.158	0.014	0.088	0.011	1.012	0.166	0.846	
0.548	0.074	0.131	0.203	2.923	0.714	2.209	
0.733	0.025	0.288	0.077	3.691	0.552	3.139	
0.062	0.012	0.041	0.005	0.487	0.062	0.425	
0.571	0.054	0.313	0.152	3.806	0.434	3.372	
0.206	0.022	0.131	0.002	1.582	0.184	1.398	
0.154	0.016	0.093	0.002	2.682	0.178	2.504	
MEAN	0.307	0.027	0.140	0.057	2.083	0.292	
STD DEV	0.268	0.024	0.106	0.080	1.369	0.245	
N	8.	8.	8.	8.	8.	8.	

		YEAR 1974-1975		MONTH DECEMBER		STATION DIFFUSER	
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
0.014	0.001	0.003	0.052	0.119	0.046	0.073	
0.045	0.001	0.006	0.003	0.073	0.027	0.046	
0.172	0.000	0.051	0.011	0.544	0.042	0.502	
0.325	0.011	0.094	0.090	0.299	0.069	0.230	
0.083	0.001	0.009	0.019	0.172	0.034	0.138	
0.162	0.001	0.045	0.017	0.287	0.041	0.246	
MEAN	0.133	0.002	0.035	0.032	0.249	0.043	
STD DEV	0.113	0.004	0.036	0.033	0.170	0.014	
N	6.	6.	6.	6.	6.	6.	

YEAR 1974-1975							
MONTH DECEMBER							
STATION CONTROL							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.011	0.001	0.017	0.002	0.213	0.035	0.178
	0.253	0.001	0.072	0.029	0.011	0.025	0.014
	0.010	0.001	0.003	0.002	0.039	0.023	0.041
	0.272	0.001	0.083	0.060	0.615	0.033	0.582
	0.119	0.001	0.012	0.002	0.190	0.033	0.157
	0.157	0.001	0.048	0.027	0.143	0.033	0.110
	0.489	0.006	0.152	0.103	0.373	0.080	0.293
MEAN	0.187	0.002	0.055	0.032	0.226	0.037	0.196
STD DEV	0.169	0.002	0.052	0.038	0.209	0.019	0.194
N	7.	7.	7.	7.	7.	7.	7.

YEAR 1974-1975							
MONTH JANUARY							
STATION MCLURE							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.003	0.001	0.003	0.002	0.000	0.000	0.000
	0.042	0.001	0.006	0.002	0.000	0.000	0.000
	0.010	0.001	0.003	0.002	0.000	0.000	0.000
	0.051	0.001	0.005	0.002	0.000	0.000	0.000
	0.011	0.001	0.003	0.002	0.000	0.000	0.000
	0.034	0.001	0.021	0.005	0.000	0.000	0.000
MEAN	0.025	0.001	0.007	0.002	0.0	0.0	0.0
STD DEV	0.020	0.000	0.007	0.001	0.0	0.0	0.0
N	6.	6.	6.	6.	0.	0.	0.

YEAR 1974-1975							
MONTH JANUARY							
STATION CHASE							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.071	0.001	0.019	0.035	0.209	0.105	0.104
	0.100	0.001	0.028	0.057	0.239	0.086	0.153
	0.042	0.001	0.003	0.010	0.161	0.101	0.060
	0.493	0.011	0.151	0.325	0.520	0.208	0.312
	0.011	0.001	0.011	0.042	0.234	0.138	0.096
	0.049	0.001	0.004	0.011	0.121	0.045	0.076
	0.025	0.001	0.005	0.002	0.070	0.058	0.012
	0.053	0.001	0.006	0.014	0.172	0.144	0.028
MEAN	0.105	0.002	0.028	0.062	0.216	0.111	0.105
STD DEV	0.159	0.004	0.050	0.108	0.136	0.052	0.095
N	8.	8.	8.	8.	8.	8.	8.

YEAR 1974-1975							
MONTH JANUARY							
STATION SAVONA							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.053	0.001	0.003	0.002	0.694	0.038	0.656
	0.209	0.001	0.022	0.007	5.167	0.114	5.053
	0.069	0.001	0.003	0.002	0.760	0.040	0.720
	0.222	0.004	0.068	0.002	0.000	0.000	0.000
	0.094	0.001	0.003	0.002	1.510	0.058	1.452
	0.286	0.001	0.028	0.040	4.921	0.158	4.763
	0.161	0.001	0.005	0.007	1.845	0.070	1.775
	0.114	0.001	0.006	0.002	1.834	0.060	1.774
MEAN	0.151	0.001	0.017	0.008	2.390	0.077	2.313
STD DEV	0.083	0.001	0.023	0.013	1.872	0.044	1.831
N	8.	8.	8.	8.	7.	7.	7.

YEAR 1974-1975							
MONTH JANUARY							
STATION WALACHIN							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.106	0.001	0.021	0.010	0.131	0.022	0.109
	0.049	0.001	0.002	0.002	0.074	0.025	0.049
	0.035	0.001	0.003	0.002	0.051	0.001	0.050
	0.193	0.001	0.016	0.016	0.167	0.030	0.137
	0.136	0.001	0.019	0.003	0.171	0.025	0.146
	0.213	0.003	0.041	0.058	0.383	0.057	0.326
	0.206	0.001	0.030	0.028	0.370	0.067	0.303
	0.056	0.001	0.004	0.002	0.097	0.022	0.075
MEAN	0.124	0.001	0.017	0.015	0.180	0.031	0.149
STD DEV	0.074	0.001	0.014	0.020	0.128	0.021	0.108
N	8.	8.	8.	8.	8.	8.	8.

YEAR 1974-1975							
MONTH JANUARY							
STATION SEHAGE LAGOON							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.303	0.042	0.256	0.002	1.071	0.337	0.734
	0.194	0.005	0.067	0.002	0.828	0.261	0.567
	1.420	0.001	0.370	0.002	6.711	0.576	6.135
	0.337	0.018	0.158	0.002	1.789	0.256	1.533
	0.485	0.101	0.388	0.436	2.147	0.383	1.764
	0.912	0.001	0.231	0.009	1.241	0.345	0.896
	0.569	0.018	0.247	0.002	1.498	0.304	1.194
	0.585	0.004	0.324	0.002	1.677	0.241	1.436
MEAN	0.601	0.024	0.255	0.057	2.120	0.338	1.782
STD DEV	0.398	0.034	0.108	0.153	1.902	0.108	1.806
N	8.	8.	8.	8.	8.	8.	8.

YEAR 1974-1975							
MONTH JANUARY							
STATION DIFFUSER							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.001	0.001	0.003	0.002			
	0.003	0.001	0.003	0.002			
MEAN	0.002	0.001	0.003	0.002	0.0	0.0	0.0
STD DEV	0.001	0.0	0.000	0.000	0.0	0.0	0.0
N	2.	2.	2.	2.	0.	0.	0.

YEAR 1974-1975							
MONTH FEBRUARY							
STATION MCLURE							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.001	0.001	0.003	0.002			
	0.001	0.001	0.003	0.002			
	0.001	0.001	0.003	0.002			
	0.001	0.001	0.003	0.002			
MEAN	0.001	0.001	0.003	0.002	0.0	0.0	0.0
STD DEV	0.000	0.000	0.000	0.000	0.0	0.0	0.0
N	4.	4.	4.	4.	0.	0.	0.

YEAR 1974-1975							
MONTH FEBRUARY							
STATION CHASE							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.640	0.025	0.084	0.230	1.174	0.694	0.480
	0.186	0.001	0.038	0.002	0.570	0.153	0.417
	2.505	0.487	0.323	0.904	1.140	0.585	0.555
	0.282	0.001	0.035	0.080	0.541	0.181	0.360
	0.791	0.001	0.114	0.314	0.809	0.342	0.467
	0.431	0.001	0.068	0.082	0.843	0.193	0.650
	0.354	0.001	0.073	0.058	0.868	0.204	0.664
	0.369	0.001	0.060	0.094	1.111	0.136	0.975
MEAN	0.695	0.065	0.099	0.220	0.882	0.311	0.571
STD DEV	0.757	0.171	0.094	0.294	0.246	0.214	0.195
N	8.	8.	8.	8.	8.	8.	8.

YEAR 1974-1975							
MONTH FEBRUARY							
STATION SAVONA							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.431	0.001	0.043	0.026	6.689	0.240	6.449
	0.325	0.001	0.044	0.087	2.270	0.115	2.155
	1.073	0.001	0.124	0.081	18.310	0.554	17.750
	0.317	0.001	0.020	0.068	7.751	0.222	7.531
	0.482	0.001	0.047	0.039	2.158	0.243	1.915
	0.240	0.001	0.022	0.011	1.957	0.083	1.874
	0.350	0.001	0.011	0.051	8.590	0.268	8.322
	0.653	0.001	0.065	0.096	11.080	0.364	10.710
MEAN	0.484	0.001	0.047	0.057	7.351	0.261	7.088
STD DEV	0.270	0.000	0.036	0.031	5.581	0.147	5.441
N	8.	8.	8.	8.	8.	8.	8.

YEAR 1974-1975							
MONTH FEBRUARY							
STATION WALACHIN							
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
0.563	0.019	0.121	0.307	1.521	0.353	1.168	
0.266	0.001	0.077	0.111	0.580	0.114	0.446	
0.110	0.001	0.022	0.002	0.343	0.071	0.272	
0.208	0.010	0.075	0.081	0.365	0.100	0.265	
0.151	0.001	0.061	0.027	0.197	0.053	0.144	
0.271	0.006	0.093	0.069	0.492	0.076	0.416	
0.438	0.060	0.003	0.272	0.788	0.197	0.591	
0.209	0.010	0.087	0.073	0.413	0.080	0.333	
MEAN	0.277	0.013	0.067	0.118	0.587	0.130	0.454
STD DEV	0.152	0.020	0.038	0.111	0.416	0.100	0.318
N	8.	8.	8.	8.	8.	8.	8.

YEAR 1974-1975							
MONTH FEBRUARY							
STATION SEWAGE LAGOON							
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
0.100	0.011	0.003	0.002	1.364	0.220	1.144	
0.075	0.004	0.003	0.002	0.925	0.162	0.764	
0.074	0.001	0.003	0.002	1.308	0.244	1.064	
0.088	0.007	0.003	0.002	2.225	0.170	2.055	
0.155	0.022	0.003	0.007	1.331	0.194	1.137	
0.050	0.001	0.003	0.002	1.554	0.240	1.314	
0.001	0.001	0.003	0.002	2.651	0.346	2.305	
0.139	0.003	0.003	0.002	3.503	0.362	3.441	
MEAN	0.085	0.006	0.003	1.858	0.242	1.653	
STD DEV	0.049	0.007	0.000	0.002	0.867	0.075	0.891
N	8.	8.	8.	8.	8.	8.	8.

YEAR 1974-1975							
MONTH MARCH							
STATION MCLURE							
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
				0.061	0.031	0.030	
				0.021	0.011	0.010	
				0.130	0.089	0.041	
				0.064	0.032	0.032	
				0.042	0.011	0.031	
MEAN	0.0	0.0	0.0	0.064	0.035	0.029	
STD DEV	0.0	0.0	0.0	0.041	0.032	0.011	
N	0.	0.	0.	5.	5.	5.	

YEAR 1974-1975							
MONTH MARCH							
STATION CHASE							
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
0.109	0.012	0.059	0.108	0.467	0.067	0.400	
0.115	0.001	0.017	0.042	0.333	0.071	0.262	
0.083	0.001	0.011	0.002	0.344	0.039	0.305	
0.073	0.002	0.008	0.002	0.275	0.057	0.218	
0.574	0.142	0.174	0.246	2.150	0.279	1.871	
0.128	0.009	0.040	0.065	0.560	0.115	0.445	
0.075	0.006	0.012	0.002	0.568	0.093	0.475	
				0.201	0.026	0.175	
MEAN	0.165	0.025	0.046	0.052	0.612	0.093	0.519
STD DEV	0.181	0.052	0.060	0.089	0.635	0.080	0.557
N	7.	7.	7.	7.	8.	8.	8.

YEAR 1974-1975							
MONTH MARCH							
STATION SAVONA							
CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS	
0.397	0.001	0.054	0.188	1.059	0.115	0.944	
				0.092	0.015	0.077	
1.174	0.012	0.095	0.260	15.990	0.760	15.230	
1.140	0.001	0.182	0.686	2.144	0.288	1.856	
0.361	0.005	0.082	0.105	1.418	0.117	1.301	
0.118	0.001	0.006	0.055	1.015	0.070	0.945	
1.196	0.001	0.164	0.390	13.560	0.703	12.850	
MEAN	0.731	0.003	0.097	0.281	5.040	0.295	4.743
STD DEV	0.491	0.004	0.066	0.231	6.715	0.310	6.410
N	6.	6.	6.	6.	7.	7.	7.

YEAR 1974-1975							
MONTH MARCH							
STATION WALACHIN							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	1.688	0.067	0.468	0.317	5.815	0.647	5.168
	1.442	0.035	0.397	0.289	2.634	0.653	1.981
	0.769	0.030	0.195	1.286	2.162	0.348	1.814
	1.945	0.001	0.432	1.218	2.451	0.542	1.909
	0.950	0.025	0.230	0.134	5.074	0.536	4.538
	1.487	0.001	0.352	0.533	2.228	0.679	1.549
	0.726	0.007	0.176	0.175	1.344	0.230	1.114
	1.026	0.006	0.248	0.149	1.827	0.325	1.502
MEAN	1.254	0.021	0.312	0.513	2.942	0.495	2.447
STD DEV	0.449	0.023	0.114	0.474	1.606	0.172	1.519
N	8.	8.	8.	8.	8.	8.	8.

YEAR 1974-1975							
MONTH MARCH							
STATION SEWAGE LAGOON							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.630	0.069	0.072	0.002	1.982	0.575	1.407
	2.572	0.155	0.263	0.002			
	1.075	0.046	0.093	0.002	2.805	0.798	2.007
	2.672	0.152	0.290	0.002	7.838	1.553	6.285
	0.422	0.043	0.068	0.002	1.676	0.507	1.169
	1.856	0.118	0.202	0.002	2.499	0.889	1.610
	1.252	0.050	0.120	0.002	3.492	0.833	2.659
	1.375	0.105	0.312	0.002	2.730	0.830	1.900
MEAN	1.482	0.092	0.177	0.002	3.289	0.855	2.434
STD DEV	0.830	0.047	0.102	0.000	2.090	0.340	1.765
N	8.	8.	8.	8.	7.	7.	7.

YEAR 1974-1975							
MONTH MARCH							
STATION DIFFUSER							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.079	0.001	0.003	0.002	0.120	0.055	0.065
	0.216	0.001	0.031	0.008	3.756	0.183	3.573
MEAN	0.147	0.001	0.017	0.005	1.938	0.119	1.819
STD DEV	0.097	0.0	0.020	0.004	2.571	0.091	2.481
N	2.	2.	2.	2.	2.	2.	2.

YEAR 1974-1975							
MONTH MARCH							
STATION CONTROL							
	CHLOROPHYLL 'A'	CHLOROPHYLL 'B'	CHLOROPHYLL 'C'	PHAEOPIGMENTS	DRY WEIGHT	ASH WEIGHT	VOLATILE SOLIDS
	0.089	0.009	0.006	0.002	0.294	0.059	0.235
	0.142	0.003	0.003	0.002	2.893	0.093	2.800
	0.101	0.003	0.003	0.002	0.376	0.067	0.309
	0.065	0.002	0.003	0.002	0.403	0.039	0.364
	0.144	0.005	0.028	0.002	4.350	0.145	4.205
MEAN	0.108	0.004	0.009	0.002	1.663	0.081	1.583
STD DEV	0.034	0.003	0.011	0.000	1.861	0.041	1.822
N	5.	5.	5.	5.	5.	5.	5.

Appendix 5

Dominant species, cell counts and percentage contribution of dominant species to total cell counts from February 1974 artificial substrates. Species identification was carried out under contract by Western Botanical Services Ltd., Vancouver, B.C.

Dominant Species, Cell Counts And Percentage Contribution Of
Dominant Species To Total Cell Counts From February 1974,
Artificial Substrates¹

<u>Algae</u>	<u>McLure</u>		<u>Chase</u>	
	<u>No. cm⁻²</u>	<u>%</u>	<u>No. cm⁻²</u>	<u>%</u>
<u>Bacillariophyceae</u>				
<i>Achnanthes minutissima</i>	112	10.0		
<i>Cymbella ventricosa</i>	127	11.0		
<i>Diatoma vulgare</i>				
<i>Fragilaria capucina</i> ²				
<i>Fragilaria construens</i>				
<i>Fragilaria vaucheriae</i>			288	5.0
<i>Gomphonema olivaceum</i>	380	35.0		
<i>Hannaea arcus</i>	54	5.0	558	10.0
<i>Synedra ulna</i>	350	32.0	177	3.0
<i>Tabellaria fenestrata</i>			2640	48.0
<u>Chrysophyceae</u>				
<i>Dinobryon sp.</i>				
<u>Xanthophyceae</u>				
<i>Tribonema sp.</i>				
<u>Chlorophyceae</u>				
<i>Ulothrix sp.</i>				
<u>Others</u> (mainly diatoms)	51	4.0	1794	32.0
TOTAL CELLS	1074	97.0	5457	98.0

1 Cell counts are based on a mean of two cm² quadrats

2 Specimen not exactly fitting description, but very similar to species indicated

* Taxa present at less than 10% of total

Dominant Species, Cell Counts And Percentage Contribution Of
Dominant Species To Total Cell Counts, From February 1974,
Artificial Substrates¹

<u>Algae</u>	<u>Savona</u>		<u>Walachin</u>	
	<u>No. cm⁻²</u>	<u>%</u>	<u>No. cm⁻²</u>	<u>%</u>
<u>Bacillariophyceae</u>				
<i>Achnanthes minutissima</i>				
<i>Cymbella ventricosa</i>				
<i>Diatoma vulgare</i>				
<i>Fragilaria capucina</i> ²				
<i>Fragilaria construens</i>				
<i>Fragilaria vaucheriae</i>	2945	37.0	1785	9.0
<i>Gomphonema olivaceum</i>	1779	22.0	10318	55.0
<i>Hannaea arcus</i>			1171	6.0
<i>Synedra ulna</i>				
<i>Tabellaria fenestrata</i>				
<u>Chrysophyceae</u>				
<i>Dinobryon sp.</i>				
<u>Xanthophyceae</u>				
<i>Tribonema sp.</i>				
<u>Chlorophyceae</u>				
<i>Ulothrix sp.</i>				
<u>Others</u> (mainly diatoms)	3036	39.0	5354	28.0
TOTAL CELLS	7760	98.0	18628	98.0

1 Cell counts are based on a mean of two cm² quadrats

2 Specimen not exactly fitting description, but very similar to species indicated

* Taxa present at less than 10% of total

Dominant Species, Cell Counts And Percentage Contribution Of
Dominant Species To Total Cell Counts¹ From February 1974,
Artificial Substrates

<u>Algae</u>	<u>North Thompson</u> (Kamloops)		<u>South Thompson</u> (Kamloops)	
	<u>No. cm⁻²</u>	<u>%</u>	<u>No. cm⁻²</u>	<u>%</u>
<u>Bacillariophyceae</u>				
<i>Achnanthes minutissima</i>				
<i>Cymbella ventricosa</i>				
<i>Diatoma vulgare</i>				
<i>Fragilaria capucina</i> ²	41168	10.7	368875	18.9
<i>Fragilaria construens</i>	24049	6.2		
<i>Fragilaria vaucheriae</i>				
<i>Gomphonema olivaceum</i>				
<i>Hannaea arcus</i>	50399	13.1	559277	28.7
<i>Synedra ulna</i>	6884	1.7		
<i>Tabellaria fenestrata</i>	153786	40.0	261512	13.4
<u>Chrysophyceae</u>				
<i>Dinobryon</i> sp.				
<u>Xanthophyceae</u>				
<i>Tribonema</i> sp.				
<u>Chlorophyceae</u>				
<i>Ulothrix</i> sp.				
<u>Others</u> (mainly diatoms)	107844	28.0	753242	38.7
TOTAL CELLS	384130	99.7	1942906	99.7

1 Cell counts are based on a mean of two cm² quadrats

2 Specimen not exactly fitting description, but very similar to species indicated

* Taxa present at less than 10% of total

Dominant Species, Cell Counts And Percentage Contribution Of
Dominant Species To Total Cell Counts From February 1974,
Artificial Substrates¹

<u>Algae</u>	<u>Old Diffuser</u>		<u>New Diffuser</u>	
	<u>No. cm⁻²</u>	<u>%</u>	<u>No. cm⁻²</u>	<u>%</u>
<u>Bacillariophyceae</u>				
<i>Achnanthes minutissima</i>				
<i>Cymbella ventricosa</i>				
<i>Diatoma vulgare</i>				
<i>Fragilaria capucina</i> ²	58562	13.9	49576	4.1
<i>Fragilaria construens</i>				
<i>Fragilaria vaucheriae</i>	21977	5.2		
<i>Gomphonema olivaceum</i>				
<i>Hannaea arcus</i>	101819	24.2	195204	16.2
<i>Synedra ulna</i>	21977	5.2		
<i>Tabellaria fenestrata</i>	72074	17.1	237344	19.7
<u>Chrysophyceae</u>				
<i>Dinobryon sp.</i>	42295	10.0		
<u>Xanthophyceae</u>				
<i>Tribonema sp.</i>	17582	4.1		
<u>Chlorophyceae</u>				
<i>Ulothrix sp.</i>			79941	6.6
<u>Others</u> (mainly diatoms)	84183	20.0	641077	53.2
TOTAL CELLS	420469	99.7	1203142	99.8

1 Cell counts are based on a mean of two cm² quadrats

2 Specimen not exactly fitting description, but very similar to species indicated

* Taxa present at less than 10% of total

Dominant Species, Cell Counts And Percentage Contribution Of
Dominant Species To Total Cell Counts¹ From February 1974,
Artificial Substrates

<u>Algae</u>	<u>Sewage Lagoon, Shore</u>		<u>Sewage Lagoon, Midstream</u>	
	<u>No. cm⁻²</u>	<u>%</u>	<u>No. cm⁻²</u>	<u>%</u>
<u>Bacillariophyceae</u>				
<i>Achnanthes minutissima</i>				
<i>Cymbella ventricosa</i>				
<i>Diatoma vulgare</i>				
<i>Fragilaria capucina</i> ²	114226	15.7	3068	7.9
<i>Fragilaria construens</i>				
<i>Fragilaria vaucheriae</i>				
<i>Gomphonema olivaceum</i>	157056	21.6		
<i>Hannaea arcus</i>	177002	24.4	8355	21.7
<i>Synedra ulna</i>	23234	3.2		
<i>Tabellaria fenestrata</i>	108274	14.9	10960	28.5
<u>Chrysophyceae</u>				
<i>Dinobryon</i> sp.			7669	19.9
<u>Xanthophyceae</u>				
<i>Tribonema</i> sp.				
<u>Chlorophyceae</u>				
<i>Ulothrix</i> sp.				
<u>Others</u> (mainly diatoms)	144319	19.9	8357	21.7
TOTAL CELLS	724111	99.7	38409	99.7

1 Cell counts are based on a mean of two cm² quadrats

2 Specimen not exactly fitting description, but very similar to species indicated

* Taxa present at less than 10% of total

Dominant Species, Cell Counts And Percentage Contribution Of
Dominant Species To Total Cell Counts¹ From February 1974,
Artificial Substrates

<u>Algae</u>	Sewage Lagoon, Downstream		<u>No. cm⁻²</u>	<u>%</u>
	<u>No. cm⁻²</u>	<u>%</u>		
<u>Bacillariophyceae</u>				
<i>Achnanthes minutissima</i>				
<i>Cymbella ventricosa</i>				
<i>Diatoma vulgare</i>				
<i>Fragilaria capucina</i> ²	95585	25.6		
<i>Fragilaria construens</i>				
<i>Fragilaria vaucheriae</i>				
<i>Gomphonema olivaceum</i>				
<i>Hannaea arcus</i>	162662	43.6		
<i>Synedra ulna</i>				
<i>Tabellaria fenestrata</i>	54841	14.7		
<u>Chrysophyceae</u>				
<i>Dinobryon sp.</i>	21687	5.8		
<u>Xanthophyceae</u>				
<i>Tribonema sp.</i>				
<u>Chlorophyceae</u>				
<i>Ulothrix sp.</i>				
<u>Others</u> (mainly diatoms)	37954	10.1		
TOTAL CELLS	372729	99.8		

1 Cell counts are based on a mean of two cm² quadrats

2 Specimen not exactly fitting description, but very similar to species indicated

* Taxa present at less than 10% of total

Appendix 6

Report of techniques and results obtained from
analysis of trout used in situ tainting experiment.

SENSORY EVALUATION OF TROUT

Submitted by

Department of Food Science

University of British Columbia

Re: Agreement with

Environment Canada

Fisheries Operation

(Order No. 532767)

Principal Investigator: J.F. Richards

July 1975

Introduction

This report contains the procedures and results pertaining to a series of sensory panels conducted to assess odor and taste effects of a set of time-location treatments on young trout.

The objective of the study was to obtain data on the quality variation among treatments and to assess treated fish in relation to untreated control samples.

General Procedures

Five experienced and trained panelists conducted scaling difference tests for odor and taste of cooked fish samples. Six individual sittings were conducted (3 at 11 a.m. and 3 at 2:30 p.m.) on 3 consecutive days. At each sitting panelists evaluated 6 treatment-combinations (i.e. time-location combinations) except for the occasions when controls were also evaluated in which case 7 samples were judged.

The treatment combinations were allocated randomly to days. Each combination was evaluated once in a morning sitting and once in an afternoon sitting. Three fish from each treatment combination were used for each sitting. The frozen fish were partially thawed by rinsing under cool ($\approx 50^{\circ}\text{F}$) tap water. The excess water was removed by absorption onto paper towelling, the tail was removed and the fish trimmed to uniform weight

within treatments. Samples were prepared by cutting the fish in half along the back and removing the backbone. Each half-fish sample was placed skin-side down in a disposable plastic weigh boat and taped closed with a second weigh boat as a lid. The 6 samples arising from each treatment per sitting were cooked together in a Litton Microwave Menumaster (Model #70-50) allowing one second per gram. The 6 treatment combinations for any one sitting were prepared a few hours in advance and held at approximately 40°F until needed. Each set of 6 samples from a treatment was served to panelists immediately after cooking (the smallest of the 6 samples in a set was not served) and the subsequent set cooked and presented after evaluation of the preceding sample allowing a few minutes for panelists to clear the palate (apple juice). The sequence of service of the treatment combinations within a sitting was random.

Panelists rated each sample on odor and then taste, recorded their assessment on a bar graph and entered comments when appropriate. The bar graph was 3 inches in length and the grid used to interpret the scores created 6 categories and was read to the nearest tenth of an inch. (Note that means are presented to the nearest hundredth of an inch in the following tables)

The data were subjected to analysis of variance according to the following key-out of degrees of freedom. All treatments were considered fixed and tested against the term "Sitting within Treatments". Treatment and interaction means were compared by Duncan's New Multiple Range Test.

DATE: _____ NAME: _____

SCALING

DIFFERENCE TEST

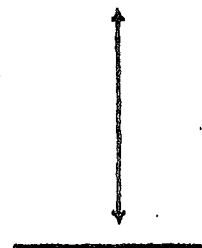
Evaluate each fish sample for odor and taste. Place a line across each bar at the level you feel would best describe the odor and taste of each sample. If you feel there is an off odor or taste define it under comments.

ODOR QUALITY

--	--	--	--	--	--

Sample Nos. .

Excellent



Poor

TASTE QUALITY

--	--	--	--	--	--

COMMENTS:

Useful terms for defining off flavours in fish: sour, stale, metallic, fishy, fatty acid, ammonical, sulfide, chemical, bitter, rancid, putrid.

Source of Variation	d.f.
Treatments	18
Control vs all others	1
Times	2
Locations	5
Time x Location	10
Sittings within treatments	19
Error term	
Panelists within sittings within treatments	<u>152</u>
Total	189

NOTE: Sittings represent two sittings per time by location using three fish for samples each time.

Results

The findings are presented in tabular form in Tables 1-5 on the following pages.

The analyses of variance (Table 1) indicate significant treatment effects for both odor and taste. In the latter instance the general treatment effect and the breakdown comparisons were significant at $p \leq 0.001$. Control samples were rated consistently and significantly superior to other treatments on both odor and taste (Tables 2 and 3). This was also true when the control means were compared to respective "time" and location mean (Tables 2 and 3).

The mean taste score for the 13 day treatment was the lowest (3.01) and significantly lower than the mean scores for 3 and 7 days (Table 3). The mean odor score for the 13 day treatment was low (3.54) and similar to the score for the 3 day treatment (3.51). The low 3 day value reflects the consistently low scores given to 3 day samples relative to 7 day samples from all locations (see Table 4). This finding is anomalous if one assumes a linear decline in quality with length of exposure to treatment. No explanation is apparent from the information at hand.

Analysis of the location means revealed that 1) none of the treated samples were equivalent to controls in odor or taste quality and 2) samples from Diffuser and Lagoon 1 were noticeably and significantly poorer in odor and taste quality than those from the other treatments and particularly poor in comparison with control samples (Tables 2 and 3).

Comparison of all treatment combination means with each other revealed a group of 11 treatment combinations (those designated with a lower case letter a) none of which differed significantly from the control in mean odor score (Table 4). Similarly, only 2 treatment combinations were equivalent to the control in mean taste score (Table 5).

The comments of panelists summarized in the Appendix generally are supportive of the findings of the numerical analysis. Off flavors detected in Lagoon 1 and Diffuser samples were

characterized as stale, rancid, earthy, sour and strongly fishy. Almost all treatments received some comments about a noticeable and undesirable fishy odor and to a lesser extent fishy taste.

It should be noted that these effects were detected even though the very small size of the fish made consistent preparation difficult and undoubtedly reduced precision. It is recommended that to ensure a higher degree of precision fish size should be doubled at the very least and preferably tripled. Similarly a larger number of control fish would be advisable to increase the validity of comparisons of treatments with controls.

Table 1. Anova Summary for Odor and Taste

S.V.	d.f.	Mean Squares	
		Odor	Taste
Treatment	18	1.22*	4.21***
Cont. vs others	1	5.41**	20.36***
Time	2	2.20*	6.40***
Location	5	1.64*	4.30***
Ti x Loc	10	.40	2.12*
Sittings/Trt.	19	.51	.63
Residual	152	.83	1.10

* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

Table 2. Summary of Duncan's Multiple Range Test Results of Mean Comparisons - Odor¹

		<u>Control</u>	<u>Treated</u>			
		4.39 ^a	3.63 ^b			
		(10)	(180)			
		<u>Control</u>	<u>3 days</u>	<u>7 days</u>	<u>13 days</u>	
		4.39 ^a	3.51 ^b	3.86 ^c	3.54 ^b	
		(10)	(60)	(60)	(60)	
<u>Control</u>	<u>S. Thomp</u>	<u>N. Thomp</u>	<u>Diffuser</u>	<u>Lagoon 1</u>	<u>Lagoon 2</u>	<u>Savona</u>
4.39 ^a	3.65 ^b	3.73 ^b	3.24 ^c	3.51 ^{bc}	3.78 ^b	3.89 ^{ab}
(10)	(30)	(30)	(30)	(30)	(30)	(30)

¹ Means in the same row sharing a common superscript letter are not significantly different ($p \leq 0.05$). The no. of observations contributing to each mean appears in parentheses.

Table 3. Summary of Duncan's Multiple Range Test Results of Mean Comparisons - Taste¹

		<u>Control</u>	<u>Treated</u>			
		4.85 ^a	3.38 ^b			
		(10)	(180)			
		<u>Control</u>	<u>3 days</u>	<u>7 days</u>	<u>13 days</u>	
		4.85 ^a	3.60 ^b	3.55 ^b	3.01 ^c	
		(10)	(60)	(60)	(60)	
<u>Control</u>	<u>S. Thomp</u>	<u>N. Thomp</u>	<u>Diffuser</u>	<u>Lagoon 1</u>	<u>Lagoon 2</u>	<u>Savona</u>
4.85 ^a	3.48 ^{bc}	3.42 ^{bc}	2.78 ^d	3.13 ^{bd}	3.80 ^c	3.69 ^c
(10)	(30)	(30)	(30)	(30)	(30)	(30)

¹ Means in the same row sharing a common superscript letter are not significantly different ($p \leq 0.05$). The no. of observations contributing to each mean appears in parentheses.

Table 4. Summary of Overall Duncan's Multiple Range Test - Odor

Treatment	Mean Value ¹
Control	4.39 a
7 days Savona	4.26 ab
7 days South Thompson	3.98 abc
13 days North Thompson	3.94 abc
7 days Lagoon 2	3.94 abc
3 days Savona	3.80 abc
13 days Lagoon 2	3.76 abc
7 days Lagoon 1	3.74 abc
7 days North Thompson	3.68 abcd
13 days South Thompson	3.67 abcd
3 days Lagoon 2	3.64 abcd
13 days Savona	3.62 abcd
3 days North Thompson	3.57 bcd
7 days Diffuser	3.53 bcd
3 days Lagoon 1	3.53 bcd
3 days South Thompson	3.32 cd
13 days Lagoon 1	3.26 cd
3 days Diffuser	3.22 cd
13 days Diffuser	2.96 d

¹ Means with a lower case letter in common are not significantly different ($p \leq 0.05$). Each treatment mean is based on 10 observations.

Table 5. Summary of Overall Duncan's Multiple Range Test - Taste

Treatment	Mean Value ¹
Control	4.85 a
7 days Savona	4.46 ab
3 days Lagoon 2	4.20 abc
3 days Lagoon 1	3.87 bcd
7 days Lagoon 2	3.70 bcde
7 days South Thompson	3.62 cde
13 days North Thompson	3.53 cde
13 days Lagoon 2	3.52 cde
3 days North Thompson	3.50 cde
13 days South Thompson	3.47 cde
3 days Savona	3.42 cde
7 days Lagoon 1	3.36 cde
3 days South Thompson	3.34 de
3 days Diffuser	3.26 de
7 days North Thompson	3.24 de
13 days Savona	3.20 de
7 days Diffuser	2.90 ef
13 days Diffuser	2.18 f
13 days Lagoon 1	2.16 f

¹ Means with a lower case letter in common are not significantly different ($p \leq 0.05$). Each treatment mean is based on 10 observations.

Appendix

Summary of Panelists' Comments

Control

- metallic, ammonical odour
- good tasting
- fishy odour; bland tasting
- odour OK, flavour OK

3 days South Thompson

- slight metallic odour and flavour
- fishy off flavour
- fishy odour; slightly bitter taste
- rancid taste
- odour a bit fishy; flavour OK, very slightly metallic
- bitter flavour
- stale off-flavour
- fishy odour; bland taste
- slight rancid taste

3 days North Thompson

- very fishy odour; alkaline, metallic flavour
- fishy off-flavour
- fishy odour; bland taste
- odour OK, flavour metallic
- slight metallic odour; slight bitter taste
- rather bland
- fishy odour; bland taste

3 days Diffuser

- fishy "sea water-like" odour; very rancid flavour
- off-flavour but rather bland taste
- fishy-plastic odour; bland taste
- odour OK; flavour slightly metallic
- fishy, rancid odour and flavour
- good
- fishy odour; bland taste
- fishy odour

3 days Lagoon 1

- fishy odour and flavour
- no off-flavour but rather bland taste
- fishy odour; bland - no flavour
- slightly sour odour
- odour a bit fishy but acceptable; flavour OK
- fishy, bitter odour and flavour
- stale off-flavour
- fishy odour; bland taste
- slight sour taste

3 days Lagoon 2

- bland - slight metallic flavour
- good flavour
- fishy odour; good fish flavour
- odour OK, flavour a bit bland
- fishy odour; bland flavour
- nice flavour
- fishy odour; bland taste
- sour taste

3 days Savona

- slight ammonical odour; very bitter flavour
- not too bad; a bit bland
- fishy odour; bland almost no flavour
- slight chemical taste (bitter)
- odour OK, flavour OK
- little flavour, dry
- metallic? taste
- fishy odour; fishy-bland taste
- no off-flavour but tasteless
- metallic, fishy odour and flavour

7 days South Thompson

- bitter smelling; sour tasting
- no off-flavour; fairly good flavour
- fishy odour; bland taste
- slightly more fishy odour than 7 days Lagoon 1 sample which had an agreeable fish-like odour. Very good flavour but still a bit bland
- acceptable odour; slightly metallic off-flavour
- bitter and sour - lingering after-taste
- fishy odour; bland taste
- slightly sour
- slight fishy odour

7 days North Thompson

- bitter smelling; very bitter flavour
- tasteless, no off-flavours
- off odour; stale flavour
- slightly fishy odour; flavour too bland
- a bit too fishy odour; flavour too bland but no off-flavour
- fishy odour; bland taste
- slight fishy flavour
- ammonical odour; bitter flavour

7 days Diffuser

- slightly sour smelling; very slightly bitter flavour
- stale flavour
- fishy odour; slight bitterness
- sour, rancid taste
- odour OK; earthy flavour
- a bit too fishy odour; stale, earthy off-flavour
- rancid
- fishy odour; bland taste
- good flavour
- metallic odour; bitter fishy flavour

7 days Lagoon 1

- smells extremely fishy; very bitter
- bitter off-flavour
- fishy odour; bland taste
- agreeable fish-like odour; flavor OK but a bit bland
- odour OK but slightly fishy; flavour a bit metallic
- fishy smell; chemical? taste
- fishy odour; bland taste
- sour flavour
- chemical odour; watery flavour

7 days Lagoon 2

- bland smelling; slightly bitter metallic flavour
- bland flavour; no off-flavour
- fishy odour; bland taste
- agreeable odour; flavour too bland
- odour slightly fishy but acceptable; flavour good
- fishy taste
- fishy odour; fishy (old) flavour
- no off-flavours but bland taste
- very fishy odour; bitter oily flavour

7 days Savona

- odour OK; flavour OK
- bland flavour
- fishy odour; bland taste
- odour slightly too fishy; good flavour but a bit bland
- acceptable; but slightly fishy odour; flavour OK
- fishy odour; bland taste
- very nice
- flavour and odor OK

13 days South Thompson

- very fishy bitter odour; bitter flavour
- stale
- rather bland
- fishy odour; very little flavour (fresh)
- fishy odour; bland taste
- bitter
- slightly fishy odour (not undesirable); flavour OK
but too bland
- slightly fishy odour; flavour OK

13 days North Thompson

- bitter, slightly metallic aftertaste
- fishy, metallic odour and flavour
- not bad flavour, no off flavour
- fishy odour; very little flavour (fresh)
- fishy odour; bland taste
- sour
- fishy
- odour OK; flavour very good
- odour slightly fishy; flavour OK

13 days Diffuser

- very chemical, metallic odour; bitter flavour
- bitter off-flavour
- stale off-flavour
- old fish odour; stale taste
- fishy odour; sour (rancid) taste
- sour, metallic
- odour too fishy; poor flavour, slightly rancid, fishy, acid
- odour too fishy; flavour slightly earthy

13 days Lagoon 1

- sour
- slight chemical odour; bitter sour flavour
- fishy
- fishy off-flavour
- fishy odour; very little flavour (fresh)
- fishy, stale odour; stale taste
- rancid and metallic very fishy odour
- sour, metallic
- slightly fishy odour; poor flavour, stale and earthy taste
- slightly fishy odour; metallic, chemical off-flavour

13 days Lagoon 2

- ammonia odour, bitter flavour
- fishy off-flavour
- bland flavour
- fishy odour; stale taste
- fishy odour; bland taste
- slightly sour
- odour OK; flavour OK but a bit bland
- odour OK; flavour too bland

13 days Savona

- slightly sour and bitter
- slight bitter odour; bitter flavour
- stale
- good taste
- hardly any odour; very little flavour (fresh)
- fishy odour; bland taste
- rancid
- fishy odour, less desirable than South Thompson; flavour much too bland - almost non-existent
- odour OK, flavour OK