EFFECTS OF STREAM CHANNELIZATION ON AQUATIC MACROINVERTEBRATES, BUENA VISTA MARSH, PORTAGE COUNTY, WISCONSIN

by

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ABSTRACT

Project objectives were to determine the effects of stream channelization on biomass and composition of stream benthos and drift and on water quality and temperature. Drift and substrate-stratified, quantitative benthos samples were collected and stream discharge measured in upstream and downstream new ditch, old ditch, and natural stream sites, at approximately 6-week intervals during the ice-free period of the year. Water chemistry samples were collected at approximately 6-week intervals throughout the year and temperatures recorded continuously with thermographs.

Benthic biomass and density were lowest in sand and higher in aquatic vegetation, silt-detritus, and gravel (productive substrates), which provided stable surfaces for reattachment of drifting invertebrates and interstices for entrapment of drifting seston. Benthic biomass and density were positively correlated, whereas drifting invertebrate biomass and density, and density of drifting seston, were negatively correlated with percent composition of the productive substrates.

Percent composition of the productive substrates was highest in the natural stream, followed by the old and new ditch in the upstream area, and highest in the new ditch, followed by the old ditch and natural stream in the downstream area.

Water quality and temperature, similar among sites, probably were moderated by groundwater inflow.

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CONCLUSIONS

Substrate type was an important factor affecting distribution of aquatic macroinvertebrates. Benthic biomass and density were highest in aquatic vegetation, and decreased in silt-detritus, gravel, and sand, respectively. Aquatic vegetation, silt-detritus, and gravel, the productive substrates, provided stable surfaces for attachment of drifting invertebrates and interstices for entrapment of drifting seston.

Benthic biomass and density were positively correlated, and drifting invertebrate biomass and density, and density of drifting seston, were negatively correlated, with the percent composition of the more productive substrates, i.e., vegetation, silt-detritus, and gravel. Any change in stream channels that result in more sand substrate would adversely affect aquatic invertebrates.

Percent composition of the productive substrates, in the upstream area, was highest in the natural stream and decreased in the old and new ditch, respectively. Channelization and dredging resulted in erosion and slumping of spoil banks, and a predominantly sand substrate in the new ditch during high flows associated with spring runoff. However, aquatic vegetation, the most productive substrate, increased in the new ditch after streamflow stabilized in late spring. In the natural stream, bank erosion was minimal, and all substrates were present throughout the study period.

Percent composition of the productive substrates, in the downstream area, was highest in the new ditch and decreased in the old ditch and natural stream, respectively. Decreased current velocity in the new ditch channel, originally dredged wide and deep, resulted in deposition of silt and organic material in midchannel and establishment of dense *Potamogeton* during summer with sand present only along stream banks. This abundant aquatic vegetation provided a stable, more productive substrate during most of the growing season. The downstream natural stream, located downstream from ditches and subject to the variable flow regimens of the ditches upstream as well as in-stream cattle disturbance, had some steep eroding sand banks and a predominantly shifting sand substrate.

Effects of channelization and dredging on water quality and water temperature probably were moderated and stabilized by inflow of abundant groundwater.

RECOMMENDATIONS

Realistic cost-benefit analyses incorporating fish and wildlife losses, adverse effects of possible increased downstream flooding, adverse effects to potential development on the drained flood plain, and an evaluation of the need for more agricultural land of marginal quality, should be determined for each proposed channelization project. If channelization is to be undertaken, fish and aquatic invertebrate losses can be mitigated, by controlling sediment movement and stabilizing the channel. Channel modifications that would add cover, create pools, hold the stream bed stable, and reduce inflow of sediment will provide a more productive habitat.

Bank stabilization and installation of a series of current deflectors and rock revetments in new ditches is recommended. Hansen, E.A. (1971), in a study of sediment movement in a Michigan trout stream, found that most sediment originated from large severely eroding banks and predicted a 74% reduction in eroded sediments could be achieved with stabilization of only 40% of the eroding waterline. White and Brynildson (1967) found, that where the channel could not be restored to former meanders, rapid and beneficial results were achieved with the installation of wing deflectors and rock revetments, which keep the current swift and the channel deep and sinuous. Old ditches should be evaluated on a site by site basis because disturbance, resulting from bank and instream construction activities, may outweigh the beneficial effects of installation of stream improvement structures in partially recovered, vegetation-stabilized old ditches.

Channel sinuosity, caused by deflectors, would result in establishment of erosional and depositional habitats with associated diversity of substrate, current velocity, depth, and light intensity. Shetter, et al (1946) reported diversion of shifting bottom sediment into areas where the sediment became stabilized by marginal vegetation, following installation of current deflectors. Tarzwell (1936) found current deflectors increased depth, increased the more productive aquatic macrophyte and muck substrates, uncovered gravel, and increased production of benthos by over 200%. Tarzwell (1937) reported more food organisms and increased number, growth rate, and yield of fish in an improved stream. Installation of current deflectors and revetments will probably provide more productive, well-defined, sinous channels throughout the year, but still allow the ditch to function for the purpose it was dredged, i.e., rapid drainage of excess water, primarily in the spring.

Improvements in a stream or watershed tend to cause new sediment or flow adjustments to the changed current velocity and sediment load and capacity (Apmann and Otis, 1965). Stream improvement structures, especially in channelized areas, must be well anchored to avoid erosional undercutting.

Bank stabilization would be promoted by keeping cattle off the banks. In the downstream natural stream, decreased bank erosion should permit establishment of aquatic macrophytes and stabilization of other substrates with resultant increases in benthic invertebrates.

INTRODUCTION

Objectives of this study were to determine the effects of stream channelization on water quality and temperature and on biomass and composition of stream benthos and drift. The study was part of a larger multidisciplinary project to determine the effects of stream channelization on fish, aquatic invertebrates, waterfowl, and terrestrial and aquatic wildlife associated with stream and ditch habitats in Buena Vista Marsh, Portage County, Wisconsin. Stream channelization is defined as the straightening and enlargement in width or depth of a stream or river to produce a roughly trapezoidal cross section, or more simply, a ditch.

Schneberger and Funk (1971) and A.D. Little, Inc. (1973) have provided comprehensive reviews of stream channelization and its effects on fisheries, wildlife, and recreation. Henegar and Harman (1971) and Blair (1973) have provided lists of references on channelization.

Robinson (1969) stated that stream disturbance problems are a threat to fishery resources in many sections of the country. Stream alteration projects have been carried out by private drainage districts, the Soil Conservation Service under the small watershed program of Public Law 566 - Watershed Protection and Flood Prevention Act, and the Army Corps of Engineers under the Flood Control Acts of 1948 and 1960 (Emerson, 1971). The Soil Conservation Service through 1975 had completed 396 projects affecting 6 million hectares of watershed, and there were another 728 projects on 22 million hectares proposed or under construction. Additional applications for PL-566 projects received as of July 1975, covered approximately 91.5 million hectares (SCS, 1975). The Army Corps of Engineers through 1973 had been involved in 889 projects and completed work on 9944 km of streams and rivers with 7879 km under construction or planned (A.D. Little, Inc., 1973).

The natural stream - swamp - flood plain ecosystem is composed of interacting subsystems that have evolved over time, and are in dynamic equilibrium with respect to water tables, infiltration rates, and discharge. Disruption of one subsystem, such as bottomland forest or swamp areas, may affect the productive capacity of the entire system. Channelization has involved wetland drainage, clear cutting on the flood plain, elimination of oxbows and meanders with their associated productive areas and diversity of habitat, lowering of the water table, and on-site and downstream erosion and sedimentation. These alterations usually result in losses of cover, pools, bank and instream vegetation, stable substrates, and stream length which may adversly affect fish and fish food organisms.

The effect of channelization on the physical nature of the substrate is probably of greatest importance to aquatic organisms. Substrate type is of primary importance in qualitative and quantitative distribution, and size of aquatic macroinvertebrates (Tarzwell, 1937; Smith and Moyle, 1944; Pennak and VanGerpen, 1947, Sprules, 1947; Cummins, 1966; Eriksen, 1966; Thorup, 1966; Egglishaw, 1969; Barber and Kevern, 1973). Invertebrates, which occupy intermediate trophic levels, may influence abundance or condition of top carnivores or fish species.

HYDROLOGIC CHARACTERISTICS OF UNALTERED AND ALTERED CHANNELS

Unaltered

Unaltered, or natural, stream systems involve a complex of relationships between water flow, sediment movement, and mobile channel boundaries in alluvial soil deposits (Leopold, et at, 1964). These basic hydrologic factors affect the stream's physical characteristics including width, depth, slope, current velocity, channel resistance, sediment, and substrate. A natural channel carries sediment, derived from its drainage basin, and migrates laterally by erosion of one bank and deposition at the opposite bank. Therefore, the channel tends to maintain a constant or stable cross section while the position of the channel itself is not constant.

The characteristic channel pattern of natural streams in alluvium is meandering, which may be mathematically described as a series of sine-generated curves occurring at intervals of 5 to 7 channel widths (Leopold and Langbein, 1966; Leopold, et al, 1964). A stream channel tends to assume a condition with least energy expenditure within the system. The most probable distribution of energy, one in which the rate of energy loss per unit of distance along the stream is equal, is most closely approximated by a meandering channel pattern (Leopold, et al, 1964). A meander pattern tends to eliminate concentrations of energy loss and localized areas of heavy bank erosion.

Stream flow through a meander pattern is helical with the surface water deflected toward the concave bank causing bed water and eroded material to move toward the convex bank where eroded material is deposited in a point bar (Leopold and Langbein, 1966). An erosional-depositional continuum exists in which all but coarse substrate units are washed away in areas of rapidly flowing water, erosional areas, whereas finer sediments are deposited in reduced current, depositional areas (Cummins, 1966).

Streambank erosion is a function of soil cohesiveness. Streambank and instream vegetational binding of soils exert constant pressure to reduce channel size and enhances erosional resistance of the streambank Maddock, 1972). Vegetated channels tend to be narrower and steeper than strictly alluvial channels with similar discharge and sediment load.

The natural stream and its associated flood plain and swamp areas with their respective water tables, infiltration rates, and discharge properties supplement the water requirements of each other. The combined surface and groundwater storage capacity tends to even out peak flows and augment base flows (A.D. Little, Inc., 1973). The flood plain allows for the deposition of sediment and absorption of nutrients outside of the stream channel during periods of high water.

White (1973: 64-65) discussed conditions present in natural cold water streams:

> What we have in the natural stream channel, considered from headwater to mouth, bank to bank, top to bottom, hour to hour, season to season, and in the longer term, is a diversity of habitats: main waters, side waters, back waters, eddies; turbulent versus more even-flowing, cooler versus warmer, lighter versus darker; mudbanks, sandbars, gravel riffles, rock rapids, clay flats, "weed" beds, large pools and small nooks and cranies.
>
> Diversity in ecosystems promotes productive efficiency and stability in the sense that incoming energy is thoroughly used and the community is buffered against severe environmental damage.

Altered

The major purpose of stream channelization, which has usually been accomplished by channel straightening and removal of streambank vegetation, is rapid drainage of agricultural land. Variations in discharge change physical characteristics of streams, such as depth, width, slope, and current velocity in alluvial channels (Maddock, 1972).

Channeling of floodwaters fails to dissipate the energy of high water and eliminates the resistances of a naturally meandering channel (White and Brynildson, 1967). The slope of a meandering channel increases when straightened. The increase in slope results in redistribution of streambed materials and degrading of the streambed. Removal of bankside vegetation reduces vegetational binding of streambanks and results in accelerated erosion and a wider channel. Over time, streambanks erode, sediment transport increases, and equilibrium takes place on a wider channel with steeper slope. Reestablishment and encroachment of streambank vegetation (timing depends on bank characteristics) stabilizes channel banks, reduces erosion, and is important in the reestablishment of natural stream characteristics (Maddock, 1972).

Floodwaters entering channelized streams may not transport adequate sediment to compensate for increased flows, and additional sediment may be eroded from bed and banks with resultant channel widening (Apmann and Otis, 1965; Maddock, 1972). The new channel, too wide for normal flow and sediment load, may become unstable and fill at some discharge levels.

Lackey (1975) referred to channel alteration as a potential pollutant that affects many stream parameters directly and others through secondary effects. Channelization projects have resulted in a wide variety of adverse effects including: destruction of game, waterfowl, and fish habitat; deposition of nutrients, chemicals, silt, and other pollutants in slower downstream waters; drainage, of swamps and destruction of their ability to remove silt, organic wastes, and toxic chemicals; increased erosion upstream and flooding downstream; and accelerated release of water which may have augmented flows during dry seasons (Reuss, 1971). Eroded sediments may have detrimental effects on stream bottom, aquatic vegetation, bottom fauna, and fish populations (Cordone and Kelley, 1961, Apmann and Otis, 1965). The effects of channelization, including reduction in diversity of habitats, increased seasonal variations in discharge, width, depth, and water temperature, shifting substrate, siltation, and the absence or reduction of aquatic vegetation are similar to the factors associated with low productivity mentioned by (Berner, 1951). The uniformity of channelized streams is a cause of the inefficiency and instability in the physical and biological systems (White, 1973).

STUDY AREA

HISTORY

Buena Vista Marsh, originally covered by tamarack (*Larix laricina*) swamps and open marsh, was drained by 4 streams; Buena Vista Creek, Duck Creek, Four Mile Creek, and Ten Mile Creek with its north and south branches, all of which flowed west toward the Wisconsin River.

The tamarack was logged or burned off before 1900, and most of the marsh land was under private ownership by 1903. The Portage County Drainage District was organized in 1903 and bonds were sold to purchase a floating dredge to drain the area for agriculture. Six ditches, dredged 1.5 to 3.0 m deep and in an east-west direction, were completed by 1907. Drainage, provided by the 6 ditches, was inadequate and 3 more main ditches and several lateral ditches were completed by 1913. As a result of the lowered water table, large fires burned in the dried peat and bog soils until only sand remained. Ditch siltation and reed canary grass (*Phalaris arundinaceae*) encroachment on the channels had a damming effect, and periodic redredging was necessary to keep the channels clear and the water table low. However, dredging and channel maintenance were discontinued in 1923 because of costs and agricultural problems which included acid soil and the frequency of crop killing frosts throughout the growing season. Aldo Leopold (1949: 100) described the series of events:

> They envisaged farms not only around but in the

> marsh. An epidemic of ditch digging and land booming set in. The marsh was gridironed with drainage canals, speckled with new fields and farmsteads.
>
> But crops were poor and beset by frosts, to which the expensive ditches added an aftermath of debt. Farmers moved out. Peat beds dried, shrank, caught fire.

The drainage district became inoperative after 1934, and production of bluegrass (*Poa pratensis*) for seed and raising of horses and cattle became the dominant land uses on the marsh. After dredging and channel maintenance were discontinued, the channels began to develop a meandering course within the old vegetation-stabilized spoil banks, the water table rose, and the area was reverting back to a wetland habitat.

Recently, above ground irrigation became practical and lands adjacent to the marsh became valuable for vegetable farming. Several ditches have been dredged or redredged since 1967.

DESCRIPTION

Buena Vista Marsh is a 226 km^2 drained wetland in the central Wisconsin sand plain. The plain, which covers an area of 728 km^2, is bordered on the east by a series of glacial moraines. Elevation in the upstream area, near the moraines, is 329 m and slopes from east to west at 0.6 to 1.1 m/km to an elevation of 311 m in downstream areas. Geology, hydrology and climate of the central Wisconsin sand plain has been described in detail by Holt (1965), Weeks, *et al* (1965), and Weeks and Stangland (1971).

Soils in the marsh consist of unconsolidated sediments including glacial till, outwash sand and gravel, and post-glacial deposits of peat, alluvium, and dune sand (Holt, 1965). The glacial deposits, which average 30.5 m in thickness, are highly permeable and form the main aquifer in the area (Weeks and Stangland, 1971). Groundwater velocity in the sand and gravel aquifer is approximately 0.3 m/day and the mean water table gradient is 0.95 m/km (Holt, 1965). Groundwater accounts for more than 90% of total streamflow and maintains relatively stable flow and water temperature.

A U.S. Weather Bureau recording station, located on the east side of the marsh at Coddington, reported an average growing season of 104 days, with a range of 47 to 119 days (Vandre, 1974). Average annual precipitation is 78.7 cm, of which 53.3 cm is lost to evapotranspiration, 22.9 cm to groundwater recharge, and 2.5 cm to short duration runoff (Holt, 1965). Sixty-five percent of the annual precipitation occurs during the growing season.

Three general stream types are present on the marsh: natural streams, which have never been dredged; old ditches, which have not been dredged for at least 50 years; and new ditches, which have been dredged since 1967. Two study areas chosen were an upstream area located in the zone of good brook trout (Salvelinus fontinalis) habitat and a downstream area located in the zone of marginal brook trout habitat. To avoid bias, a new ditch, old ditch, and natural stream site were chosen in each study area, before sample collection, on the basis of similar stream discharge and distance from headwater areas, and accessibility (Figure 1).

Sinuosity indices (channel length/linear length) were highest in natural streams and lowest in new ditches. The more sinuous sections had greater surface area except for the downstream new ditch which was originally dredged wide (Table 1).

The upstream new ditch site (NE¼, Sec. 26, T22N, R8E) was a lateral ditch that diverted the flow of water from Ditch 8 into Ditch 3. The spoil banks were steep, unstable, and continually slumping into the channel, particularly during spring runoff. Bank slumping and erosion resulted in a predominantly unstable shifting sand and silt-detritus substrate in spring and early summer. Aquatic vegetation, including buttercup (*Ranunculus aquatilus*), *Veronica sp.*, waterweed (*Elodea canadensis*), and water cress (*Nasturtium officinale*) increased in abundance throughout the growing season. The channel was of uniform depth during spring and early summer, but depth became more varied during summer when the current cut deep channels between dense beds of vegetation, primarily *Ranunculus*. Land use, adjacent to the ditch, was grazed pasture and mint and potato farming.

The upstream old ditch site (NE¼, Sec. 16, T21N, R8E) was the channelized part of the north branch of Ten Mile Creek, or Ditch 5. The old spoil banks had become stabilized with reed canary grass, shrubs, and small trees.

Figure 1. Buena Vista Marsh, Portage County, Wisconsin. Only streams with trout waters are shown. Study areas identified by number: 1 = upstream new ditch, 2 = upstream old ditch, 3 = upstream natural, 4 = downstream new ditch, 5 = downstream old ditch, 6 = downstream natural.

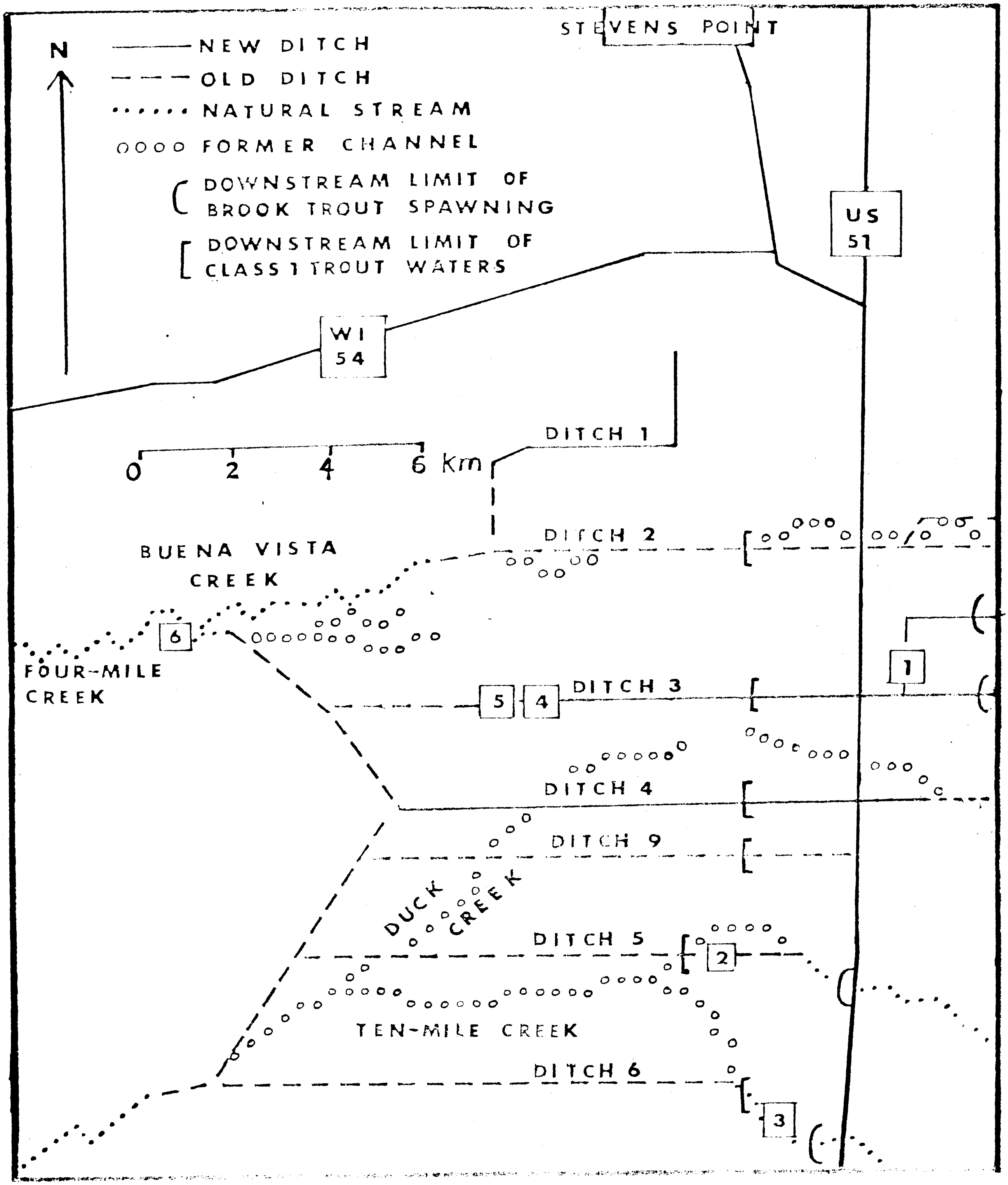

Table 1. Description of study sites in Buena Vista Marsh, Portage County, Wisconsin.

	Upstream			Downstream		
	new ditch	old ditch	natural	new ditch	old ditch	natural
Dredged (year)	1968	1913	----	1967	1922	----
Sinuosity index[a]	1.00	1.02	1.15	1.00	1.03	1.58
Area (ha/km)	0.42	0.48	0.92	0.96	0.65	0.98
Mean discharge for study period (m^3/sec)	0.262	0.246	0.236	0.726	0.726	1.162
Temperature (°C). Sept., 1974 - Sept., 1975.						
annual mean	8.0	7.9	7.9	8.9	9.0	7.9
mean daily fluctuation	4.6	2.5	3.4	3.0	3.4	2.4
Substrate (m^2/100m). Percent in parentheses.						
sand	315 (75.1)	353 (73.4)	431 (47.1)	97 (10.1)	547 (80.4)	853 (87.0)
gravel	14 (3.4)	0 (0)	93 (10.2)	0 (0)	0 (0)	31 (3.2)
vegetation	43 (10.2)	13 (2.7)	232 (25.3)	257 (26.7)	64 (9.4)	25 (2.5)
silt-detritus	47 (11.3)	115 (24.0)	159 (17.4)	607 (63.2)	69 (10.2)	71 (7.2)
total	419	481	915	961	680	980

[a] Channel length/linear length, July, 1975.

Small holes and undercut banks were present at the cutting areas of the weakly meandering channel. Bank slumping was minimal and the substrate was primarily sand. Narrow areas of silt-detritus, which had become stabilized with Elodea and Nasturtium, occurred near the water's edge. Corn and hay were grown in fields adjacent to the ditch and a cattle crossing was present approximately 100 m upstream from the study site.

The upstream natural site (NW¼, Sec. 27, T21N, R8E) was the south branch of Ten Mile Creek. The channel had a meander pattern without a riffle-pool sequence, which is a condition typical of natural channels carrying uniform sand and silt (Leopold, et al, 1964). The channel had cutting edges, runs, and depositional areas which maintained diversity in substrate, current velocity, depth, and light intensity. Sand, gravel, silt-detritus, and vegetation (Ranunculus) substrates were present throughout the study period. The stream channel, which flowed through a pasture, was not fenced and was subjected to some disturbance from cattle crossing and grazing.

The downstream new ditch site (W½, Sec. 30, T22N, R8E) was located on the recently dredged part of Ditch 3. Decreased current velocity in the wide and deep channel resulted in deposition of approximately 1 m of silt and organic material in midchannel. Sand substrate was present only along the streambank whereas the rest of the substrate was silt-detritus, and was covered with dense Potamogeton sp.

during summer. Wild celery (*Valisneria americana*), arrowhead (*Sagittaria sp.*), and sedges were present within the channel, which was similar to an elongated pond during summer. Adjacent land was grazed by cattle and managed for prairie chickens (*Tympanuchus cupido pinnatus*).

The downstream old ditch site (E½, Sec. 25, T22N, R7E) was located approximately 150 m downstream from the new ditch section of Ditch 3. The channel was narrower and had a greater current velocity than the new ditch section. The substrate was primarily sand with small areas of silt-detritus and sparce *Potamogeton*, *Valisneria*, and *Nasturtium*.

The downstream natural site (SE¼, Sec. 20, T22N, R7E) was the unchannelized part of Four Mile Creek. The section was located downstream from channelized reaches, cattle disturbances, and upstream dredging. Islands, bars, and fallen trees, indicators of rapid erosion, were present. Portions of the stream had steep eroding sand banks that resulted in a predominantly shifting sand substrate. Small areas of silt-detritus and gravel substrates were present. The shifting sand substrate inhibits establishment of aquatic vegetation (Fassbender and Nelson, 1971). *Valisneria*, when present, was sparce and scattered. Deep holes were present where the current was deflected by fallen and submerged trees. Land adjacent to the study site was a wooded pasture.

METHODS

BENTHOS

Five replicate quantitative benthos samples were collected from each available substrate at each study site, at approximately 6-week intervals during the ice-free period of the year. Substrate-stratified sampling was suggested by Pennak and VanGerpen (1947), Bourdeau (1953), Cummins (1962), and Barber and Kevern (1973) to reduce variation. A modified circular 0.05 m^2 bottom sampler, similar to that of Waters and Knapp (1961), with a net mesh of 7.5 mesh/cm was used in the upstream area where it was not too deep for efficient sampler use. A standard Ekman grab, which sampled an area of 0.025 m^2, was used in the deeper downstream area.

Substrate composition was determined for each study site on each sample date, and sample biomass and density were pro-rated into total benthic biomass (g/m^2) and density (organisms/m^2) according to the percent each substrate was of the total. Transect samples, were collected in the downstream old ditch in April, 1975 and the downstream natural stream in April and May, 1975 because at these times the sites were too turbid for determination of substrate composition.

Benthic variability within each study site on each sample date was determined by calculation of standard deviations and coefficients of variation for samples collected within each substrate. Total variation for biomass and density of each taxa was calculated by weighting standard deviations according to substrate composition. Total variation for each substrate type was calculated by weighting standard deviations of taxa biomass and density according to the percent each was of the total biomass or density within that substrate (Appendix A).

Qualitative benthic samples were collected with nets and screens periodically throughout the sample period to record the presence of organisms not normally collected with quantitative samplers.

DRIFT

Drifting organisms and seston (suspended particulate matter) were collected on the day and night before benthic sampling to avoid substrate disturbance resulting from instream sampling activities. Twenty minute samples were collected, in nets of 7.5 mesh/cm on a 0.1 m^2 square frame, at midday and ½ hour before and after sunrise and sunset to correspond with major periods of drift (Waters, 1972; Braatz, 1974). Drift net frames had welded or split rings that slid over 1.27 cm diameter steel rods that were driven into the stream bottom. One set of rods was positioned in the thalweg and another in the side current. Drift nets and frames were stacked on the rods to cover the entire column of water from substrate to water surface. Stream discharge and discharge through the drift columns were measured with a F 583 Weathermeasure Corporation Water Current Meter.

Sample biomass and density were pro-rated into total drift biomass (g/100 m^3) and drift density (organisms/100 m^3) according to the percent of the total discharge that flowed through the drift columns. Drift rate (number per unit time) is not presented because of differences in discharge, water depth, and water velocity between the 6 study sites.

Benthos and drift samples were labelled and preserved in the field in a 9-1 mixture of 70% isopropyl alcohol - 10% formalin and were taken to the University of Wisconsin-Stevens Point. Samples were washed on a No. 35 soil screen. Invertebrates were sorted from detritus, identified to Genus, if possible, and counted. Invertebrates were not wet-weighed because of weight change in preservative (Leonard, 1939; Howmiller, 1972). Invertebrate biomass, excluding that of Decapoda, Oligochaeta, and large insects such as Nepidae and Zygoptera, was calculated from organism length, using a modification of the method described by Hynes and Coleman (1968), which assumes that insect shape is that of a cylinder, that its volume increases by the cube of the length, and that its specific gravity is 1.05. Weights of 1 mm length units were 3.3×10^{-5} grams for insects excluding Chironomidae and Ceratopogonidae, 1.4×10^{-5} grams for Chironomidae and Ceratopogonidae, and 3.2×10^{-3} grams for Molluscs, which were considered as spheres or half-spheres (Jacobi, personal communication). Nepidae, Zygoptera, and Decapoda were soaked in water for 30 minutes, blotted dry, and weighed to the nearest 0.01 g. Oligochaeta were soaked in water for 30 minutes, centrifuged at 650 rpm for 3 minutes including acceleration and deceleration, and weighed to the nearest 0.01 g (Stanford, 1973).

Drifting seston was dried at 65°C for approximately 24 hours to a constant weight and expressed as drift seston density, or weight of seston per volume of water (g/100 m^3). The dried seston was ignited at 600°C for 1 hour in a muffle furnace, cooled in a descicator, and weighed. Loss on ignition gives estimates of organic material of an accuracy acceptable for many ecological studies (Ball, 1964).

Water samples were collected at each site, at approximately 6-week intervals throughout the year, with a Van Dorn water bottle and were analyzed by the Environmental Task Force Laboratory at the University of Wisconsin - Stevens Point. Methods of analysis were those described in Standard Methods for the Examination of Water and Wastewater (A.P.H.A., 1971). Water temperature was recorded continually with thermographs from September, 1974 through May, 1975. Thermographs were checked and calibrated weekly.

RESULTS AND DISCUSSION

Substrate, as defined in this study, includes mineral and organic sediments and aquatic vegetation. Substrate composition was the most important single factor affecting biomass and density of stream benthos and drift, and density of drifting seston. Benthic biomass and density (Figure 2) were positively correlated, whereas drifting invertebrate biomass and density (Figure 3) and density of drifting seston (Figure 4) were negatively correlated, with the percent composition of the more productive substrates, i.e., vegetation, silt-detritus, and gravel.

Other investigators have found substrate type to be of primary importance in the distribution of aquatic invertebrates. Morris (1964), in a survey of channelized and unchannelized sections of the Missouri River, stated that the percent of productive substrates is the most important consideration in estimating total standing crop of benthic invertebrates. Smith and Moyle (1944 : 145) found the physical nature of the substrate to be the most important factor affecting benthic production in streams. A general increase in benthic productivity has been found to occur with increasing sediment particle size (Smith and Moyle, 1944; Pennak and VanGerpen, 1947; Sprules, 1947; Cordone and Kelley, 1961). Invertebrate abundance and diversity is related to habitable surface area and variety of microhabitats and interstices, which

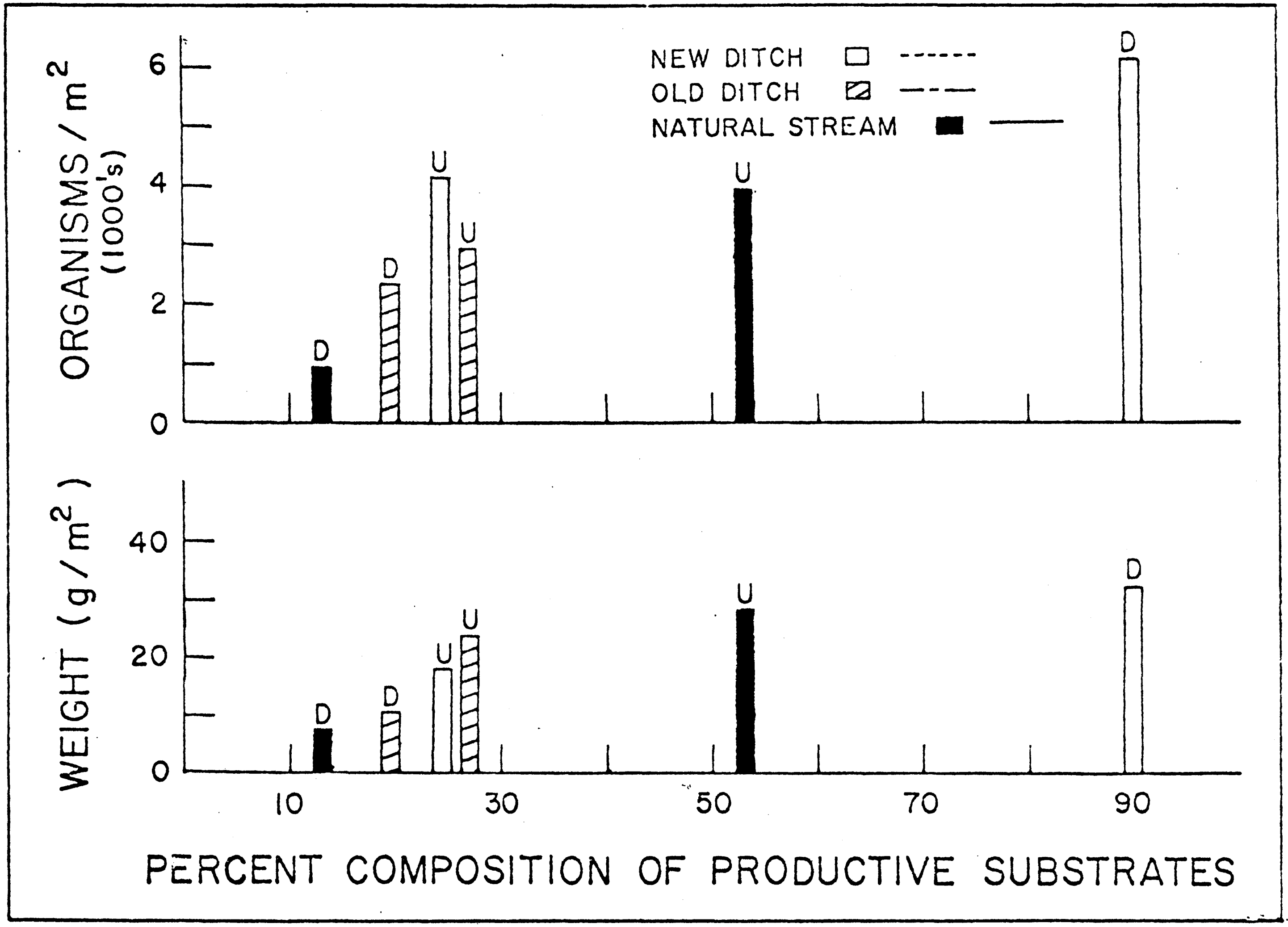

Figure 2. Benthic biomass and density of upstream (U) and downstream (D) sites in relation to percent composition of productive substrates, i.e., vegetation, silt-detritus, and gravel, Buena Vista Marsh, Portage County, Wisconsin. (use of key is consistent throughout figures)

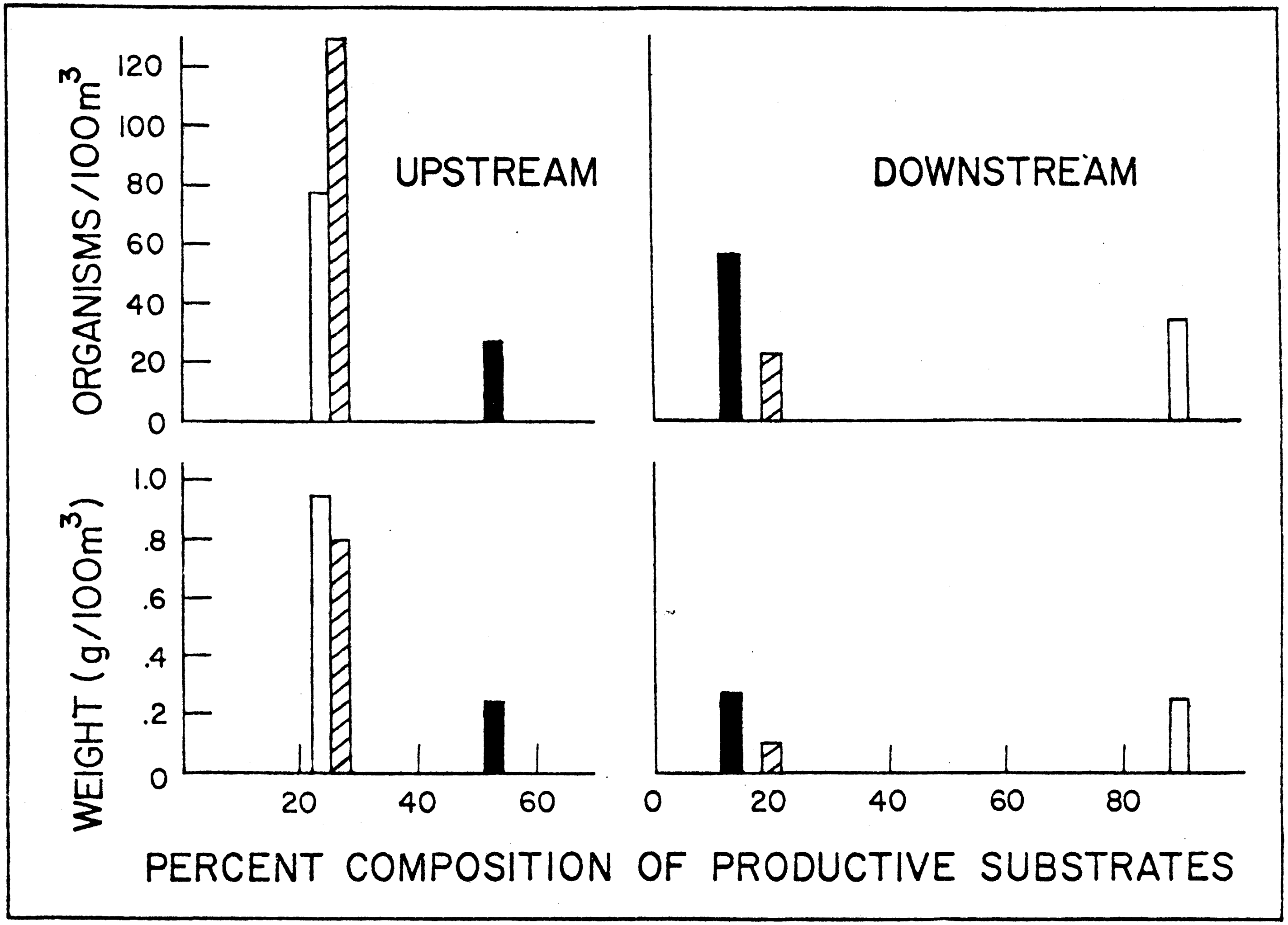

Figure 3. Drift biomass and density of upstream and downstream sites in relation to percent composition of productive substrates, i.e., vegetation, silt-detritus, and gravel, Buena Vista Marsh, Portage County, Wisconsin.

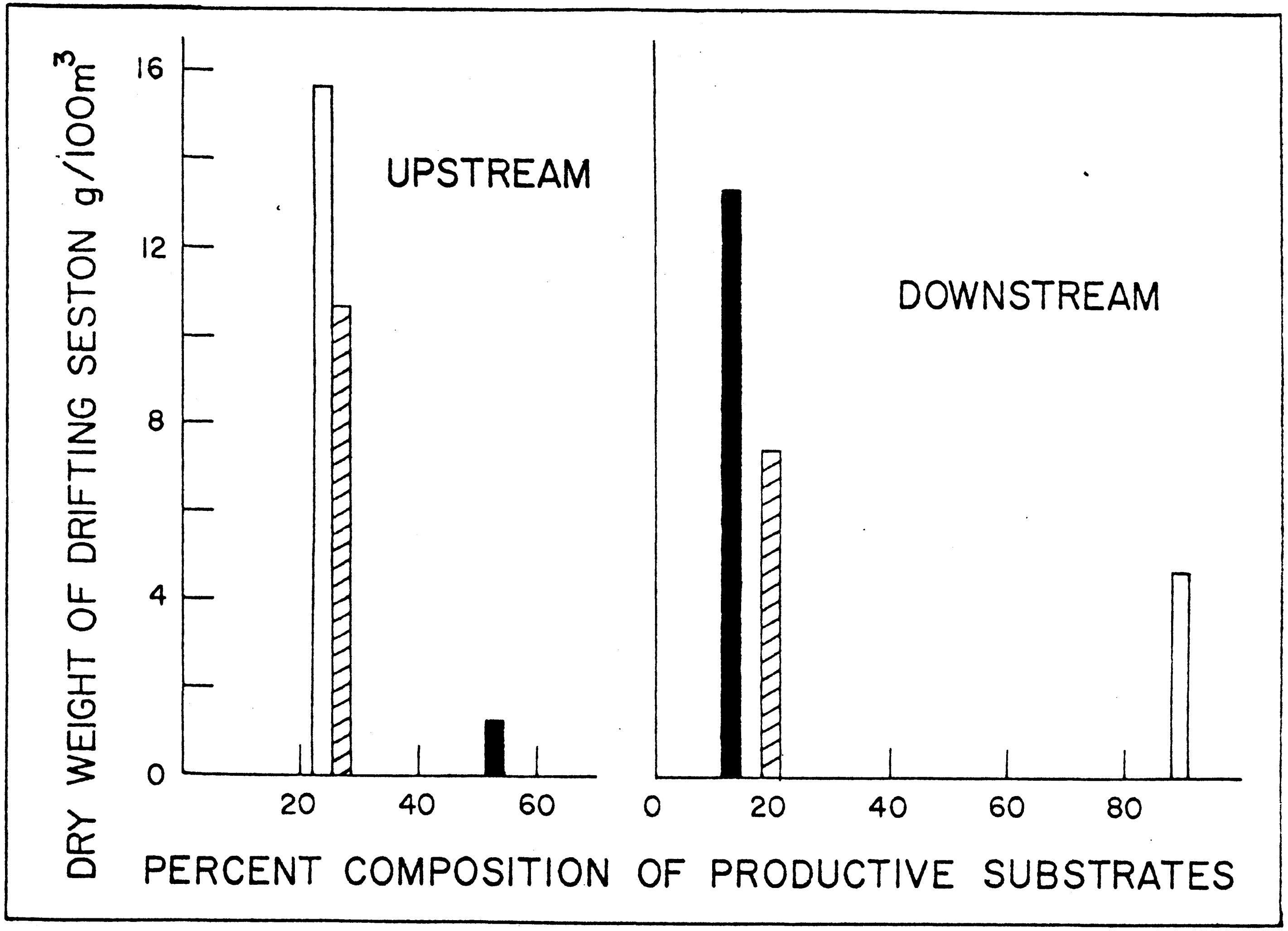

Figure 4. Drifting seston density of upstream and downstream sites in relation to percent composition of productive substrates, i.e., vegetation, silt-detritus, and gravel, Buena Vista Marsh, Portage County, Wisconsin.

provide shelter for organisms (Smith and Moyle, 1944; Sprules, 1947). Substrate particle size, through its effect on turbulence, crevices, and interstitial spaces, affects oxygen renewal and respiration of benthic invertebrates (Eriksen, 1966). Cummins and Lauff (1969) determined the effects of varied current direction and substrate particle size on 10 species of benthic organisms in an artificial stream in a laboratory, and concluded that current, water temperature, and chemical parameters may limit macrodistribution but substrate particle size or food supply probably exert primary microdistributional influences.

Other authors investigated substrate effects on deposition of organic detritus, an important invertebrate food source. The effects of substrate may be indirect and dependent upon presence of crevices for detrital deposition (Cummins, 1962; Buscemi, 1966). Barber and Kevern (1973) reported extensive use of macrophyte beds, primarily by drifting Trichoptera, Ephemeroptera, and Diptera, and a reduction of current velocity and deposition of detrital materials as the plants grew. Egglishaw (1969) found numbers of organisms to be significantly related to the amount of detritus trapped among stones and vegetation in streams.

Giger (1973) and Hooper (1973) reviewed the effects of streamflow on trout stream ecology and listed the following as factors affecting qualitative and quantitative distribution of aquatic invertebrates: current velocity and its effects on oxygen renewal, food aquisition, and substrate type; depth and its effect on light penetration and photosynthesis; biotic factors including periphytic algae and detrital food; and water chemistry and temperature. Substrate differences associated with different environmental conditions result in nonuniform distribution of invertebrates (Cummins, 1962). Therefore, investigation of bottom fauna is one of the most significant approaches that can be made in the detection and measurement of sediment problems associated with channelization (Cordone and Kelley, 1961).

In this study, benthic biomass and density, within substrates, were generally highest in vegetation and decreased in silt-detritus, gravel, and sand, respectively (Appendix A). An exception, high biomass for silt-detritus in the downstream natural stream, was primarily due to the abundance and high biomass associated with the large burrowing mayfly, <u>Hexagenia</u>.

Mean substrate biomass and density were similar for new ditch, old ditch, and natural stream in upstream and downstream areas (Appendix A). Exceptions were the high values for the silt-detritus substrate in the upstream old ditch which was probably due to the scarcity of the most productive substrate, vegetation, throughout most of the study period. More organisms may have occupied the next most suitable available substrate, silt-detritus.

Any alteration of the stream channel that would increase sand substrate would tend to adversely affect aquatic invertebrates and their food source. Bank slumping and erosion, from dredging, resulted in higher percent substrate composition of the least productive substrate, sand, in the upstream area. Mean percentages of sand substrate were 75.1%, 73.4%, and 47.0% for upstream new ditch, old ditch, and natural stream, respectively (Figure 5).

On the other hand, decreased current velocity in the downstream new ditch, originally dredged wide and deep, resulted in deposition of silt and organic material in midchannel and establishment of dense Potamogeton during summer with sand present only along stream banks. The downstream natural stream, located downstream from ditches and subject to seasonal high flows from the ditches upstream as well as instream cattle activity, had steep eroding sand banks and a predominantly shifting sand substrate. Mean percentages of sand substrate were 10.1%, 80.4%, and 87.0% for downstream new ditch, old ditch, and natural stream, respectively (Figure 6).

BENTHOS

Differences in benthic biomass and density, among sites, were primarily due to differences in substrate composition among sites. Consistent trends were evident and will be discussed, although high variability associated with invertebrate sampling probably contributed to the lack of statistically significant differences among sites.

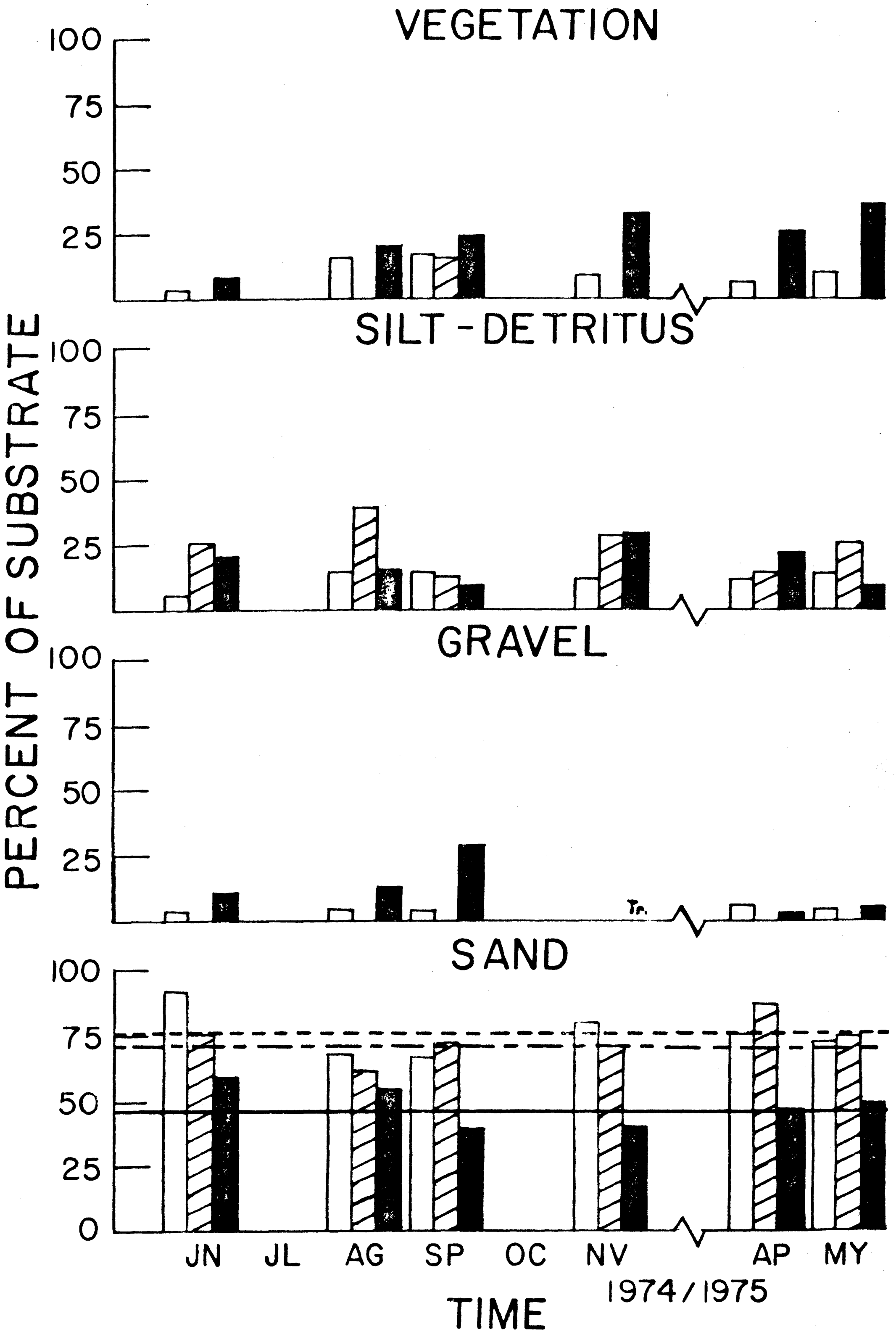

Figure 5. Substrate composition of upstream sites, Buena Vista Marsh, Portage County, Wisconsin. (horizontal lines represent mean percent composition for the study period)

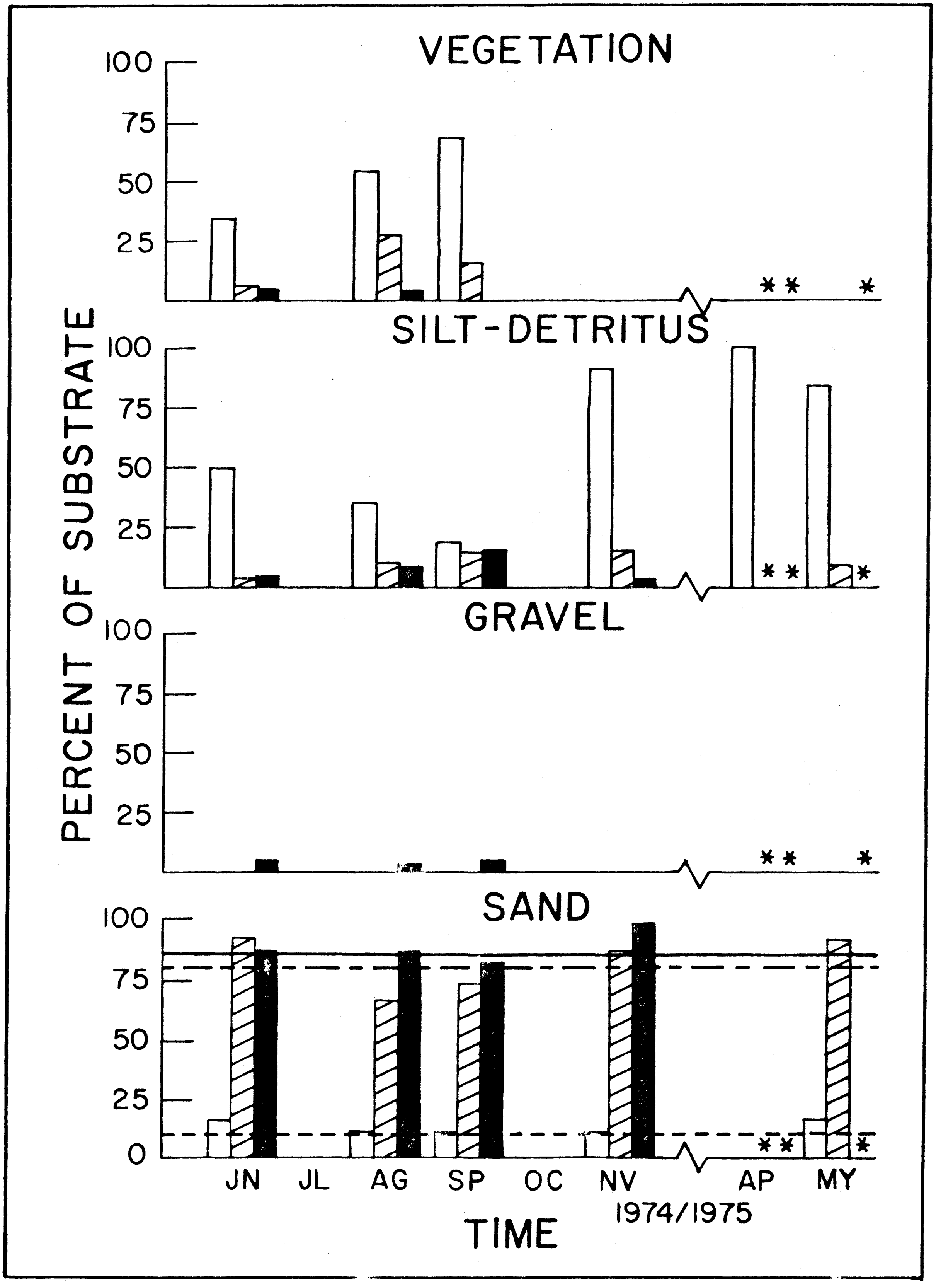

Figure 6. Substrate composition of downstream sites, Buena Vista Marsh, Portage County, Wisconsin. (horizontal lines represent mean percent composition for the study period) (* substrate composition not determined because of high turbidity)

Benthic biomass (Figure 7) and density (Figure 8) in all study sites, fluctuated throughout the study period, as would be expected with seasonal hatch, growth, and emergence patterns of different taxa of insects. Increases or decreases in benthic biomass and density also occurred with seasonal changes in the more productive substrates, particularly aquatic macrophytes.

Upstream

Mean benthic biomass was highest in the natural stream, 28.38 g/m^2, followed by the old ditch, 24.08 g/m^2, and the new ditch, 18.32 g/m^2. Mean benthic density was highest in the new ditch, 4173 organisms/m^2, followed by the natural stream, 3938 organisms/m^2, and the old ditch, 2939 organisms/m^2. The generally higher biomass and density in the natural stream was due to the higher percent substrate composition of the more productive substrates (Figure 2).

High numbers of Chironomidae, relatively small organisms, in the new ditch during the August and September sample periods (Appendix A) resulted in the highest mean density in the site with the lowest mean biomass. Morris (1964) and Etnier (1972) reported high densities of Chironomidae in channelized areas. Holz (1969) reported a decrease in percent composition of Trichoptera and Ephemeroptera, relatively large organisms, in channelized sections of the Missouri River.

Stream channelization has been found to adversely affect stream benthos. Morris (1964) and Holz (1969)

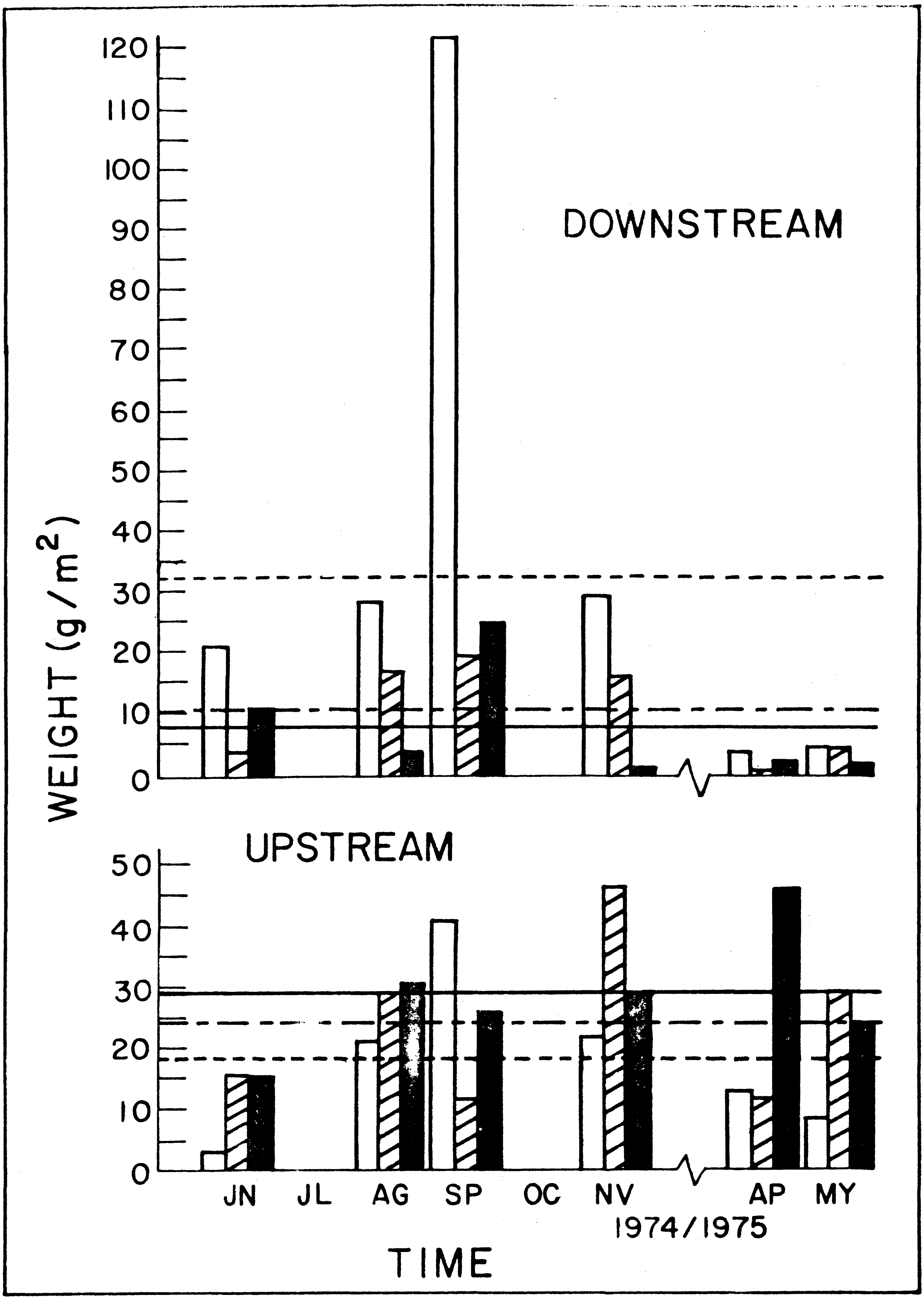

Figure 7. Benthic biomass, Buena Vista Marsh, Portage County, Wisconsin. (horizontal lines represent mean biomass for the study period)

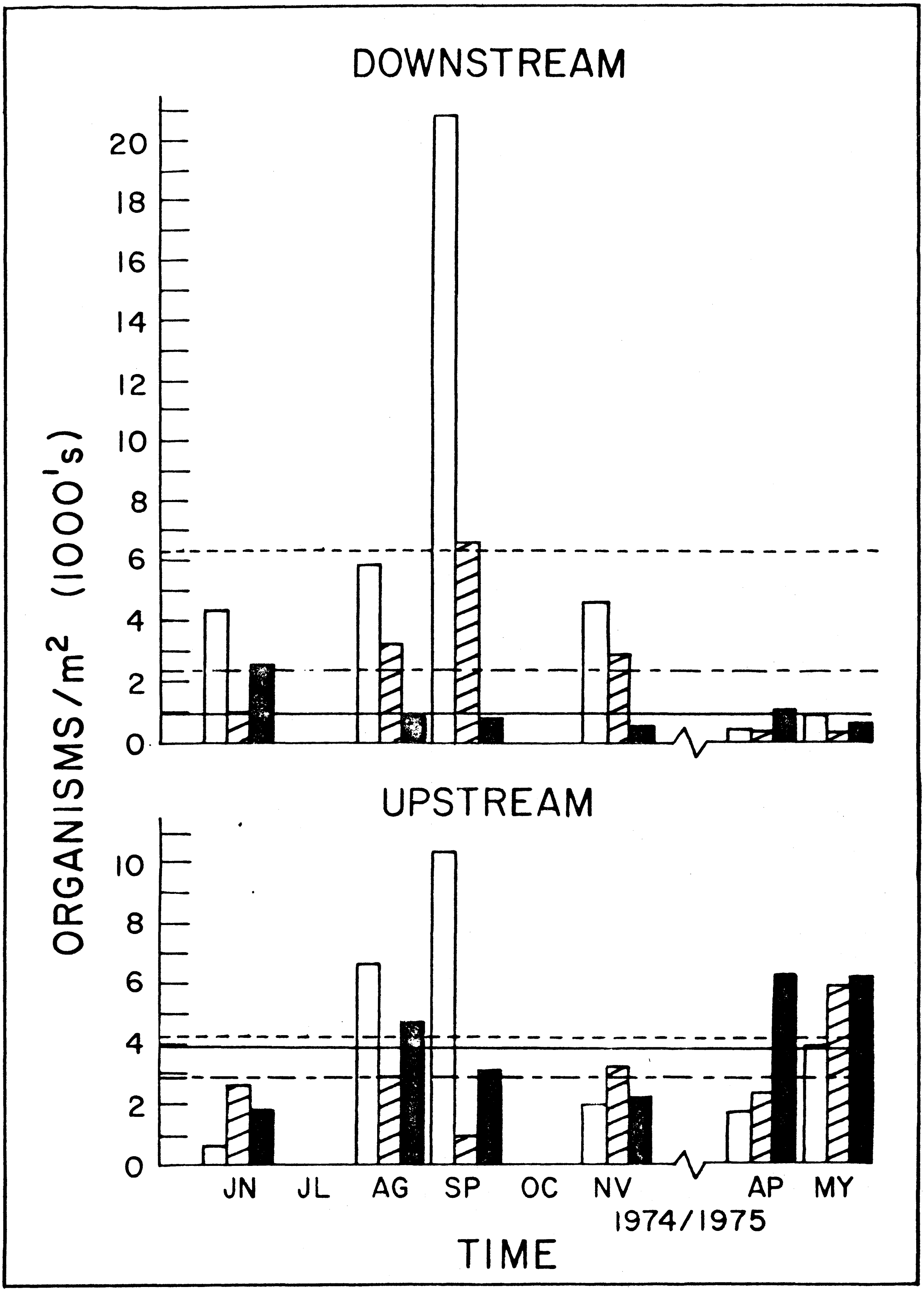

Figure 8. Benthic density, Buena Vista Marsh, Portage County, Wisconsin. (horizontal lines represent mean density for the study period)

reported reduced benthic biomass in channelized portions of the Missouri River, and Tarplee, et al, (1971), in a survey of 74 North Carolina streams, reported a 79% reduction in volume of invertebrates following channelization. Rees (1959), Warner and Porter (1960), Burkhard (1967), and Winger (1972) reported an initial decrease but rapid recovery of stream benthos following channelization.

The natural stream was generally more stable than the ditches. Benthic sample variability, determined for each site on each sample date, was generally lowest in the natural stream and highest in the new ditch. Mean coefficients of variation for the study period, were 0.20, 0.24, and 0.30 for benthic biomass and 0.33, 0.34, and 0.36 for benthic density in natural stream, old ditch, and new ditch, respectively (Table 2). Higher coefficients of variation, particularly in the new ditch, occurred during periods of instability associated with high discharge and stream bank and bed erosion (April) and periods of substrate adjustment to decreasing discharge and increasing aquatic vegetation (May and June). Annual ranges of biomass and density estimates were narrowest for the natural stream and widest for the new ditch (Figures 7 and 8).

Downstream

Mean benthic biomass was highest in the new ditch, 32.32 g/m^2, followed by the old ditch, 10.05 g/m^2, and the natural stream, 7.81 g/m^2. Mean benthic density was also

Table 2. COEFFICIENTS OF VARIATION (standard deviation/mean) FOR BENTHIC SAMPLES COLLECTED IN BUENA VISTA MARSH, PORTAGE COUNTY, WISCONSIN.

		UPSTREAM			DOWNSTREAM		
		NEW DITCH	OLD DITCH	NATURAL	NEW DITCH	OLD DITCH	NATURAL
JUNE, 1974	organisms	0.40	0.33	0.24	0.66	0.37	0.39
	biomass	0.43	0.23	0.20	0.32	0.34	0.84
AUG., 1974	organisms	0.32	0.49	0.19	0.22	0.31	0.39
	biomass	0.30	0.26	0.22	0.17	0.44	0.45
SEPT., 1974	organisms	0.24	0.32	0.18	0.18	0.17	0.20
	biomass	0.20	0.26	0.22	0.22	0.16	0.68
NOV., 1974	organisms	0.13	0.27	0.29	0.19	0.27	0.71
	biomass	0.17	0.18	0.24	0.20	0.27	0.58
APR., 1975	organisms	0.52	0.50	0.41	0.19	0.95	1.13
	biomass	0.38	0.25	0.14	0.69	0.42	0.60
MAY, 1975	organisms	0.58	0.15	0.69	0.76	0.57	0.99
	biomass	0.29	0.29	0.21	0.60	0.48	0.77
MEAN	organisms	0.36	0.34	0.33	0.37	0.44	0.64
	biomass	0.30	0.24	0.20	0.37	0.35	0.65

highest in the new ditch, 6176 organisms/m^2, followed by the old ditch, 2348 organisms/m^2, and the natural stream, 980 organisms/m^2. Again, higher biomass and density in the new ditch were due to higher percent composition of the most productive substrate, aquatic vegetation, in the growing season.

Coefficients of variation for benthic samples were generally higher during the periods of instability mentioned above (Table 2). Variability decreased in the new ditch, and to a lesser degree in the old ditch, during summer months when flow stabilized and aquatic vegetation became established. High benthic variability in the natural stream, throughout the study period, probably resulted from steep eroding sand banks and shifting sand substrate. Mean coefficients of variation were 0.65, 0.35, and 0.37 for benthic biomass and 0.64, 0.44, and 0.37 for benthic density in natural stream, old ditch, and new ditch, respectively.

Annual ranges of benthic biomass and density estimates were widest for the new ditch (Figures 7 and 8). High benthic biomass and density estimates were associated with stable stream conditions and dense aquatic vegetation during summer, and low estimates were associated with stream scour and the instability of the new ditch during spring runoff.

DRIFTING SESTON

Drifting seston was composed of 2 fractions; an inorganic portion, primarily allochthonous, and an organic portion, which was plant detritus, allochthonous during spring runoff and periods of leaf fall and autochthonous during summer and winter low flow periods. The inorganic portion, or sediments, can damage and reduce benthic fauna (Cordone and Kelley, 1961). The organic portion, or plant detritus, has been found to be one of the chief sources of food for invertebrates (Egglishaw, 1969). Buscemi (1966) listed current velocity, thickness of the "dead water layer" adjacent to the stream bottom, bottom irregularities, feeder stream flow, source of runoff water, duration and volume of flow above typical low water values, and channel morphometry as factors affecting seston deposition.

Upstream

Dry weight of drifting seston was generally highest in the new ditch and lowest in the natural stream (Figure 9). The absence of depositional areas, generally associated with the diversity of habitats in meandering channels, and smaller areas of aquatic macrophyte and gravel substrates to trap drifting seston, probably contributed to higher drifting seston densities in the new ditch. The weak sinuosity of the old ditch channel, within the vegetation-stabilized spoil banks, probably accounted for intermediate drifting seston densities. The increase in drifting seston density, which occurred with increased discharge during May in the new and old ditch, did not occur in the more stable natural channel.

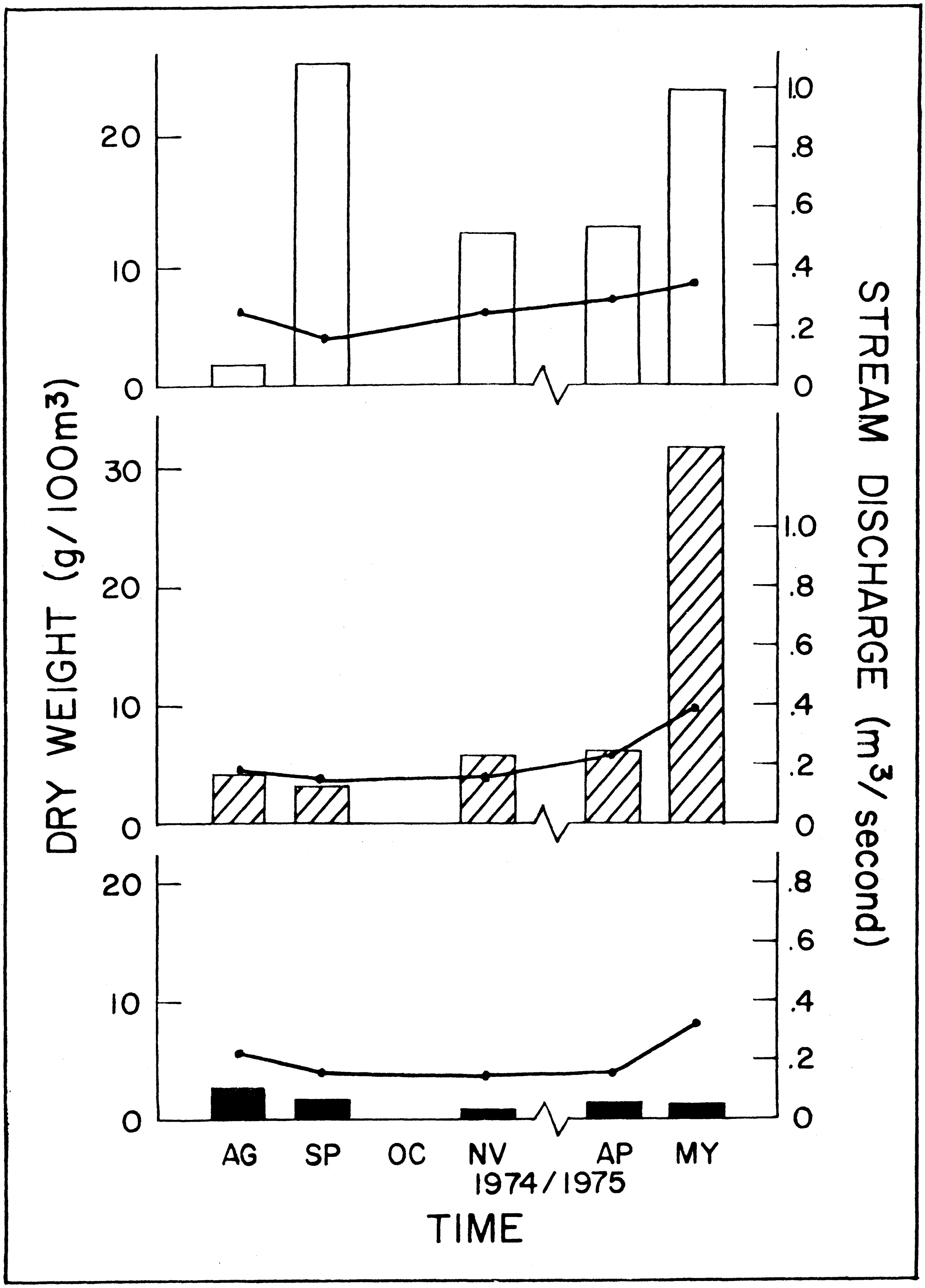

Figure 9. Drifting seston density (▭) and stream discharge (•—•) in upstream area, Buena Vista Marsh, Portage County, Wisconsin.

The percent of drifting seston that was organic detritus was consistently highest in the natural stream (Figure 10 and Appendix E). The higher inorganic portion of drifting seston in the new ditch probably resulted from erosion and slumping of unstable banks and may have contributed to low mean benthic biomass and high benthic variability. Based on the assumption that seston bases were similar in all sites, these results indicated that higher amounts of organic detritus were retained and available for use by invertebrates in the natural stream.

Downstream

The new ditch, originally dredged wide and deep and heavily vegetated during summer, was primarily depositional and resulted in generally lower drifting seston density (Figure 11). High drifting seston density in the natural stream was due to steep eroding banks and upstream dredging during April and May. Consistent organic detritus relationships among sites were not evident (Figure 10).

DRIFTING INVERTEBRATES

Stream drift is a phenomenon in which organisms are dislodged from the substrate by mechanical action of the current, usually during periods of increased activity before emergence and while foraging for food during periods of reduced light: they then drift downstream and reattach to the substrate. Drifting increases visibility and accessibility of invertebrates to fish and may transport organisms from productive to less productive areas

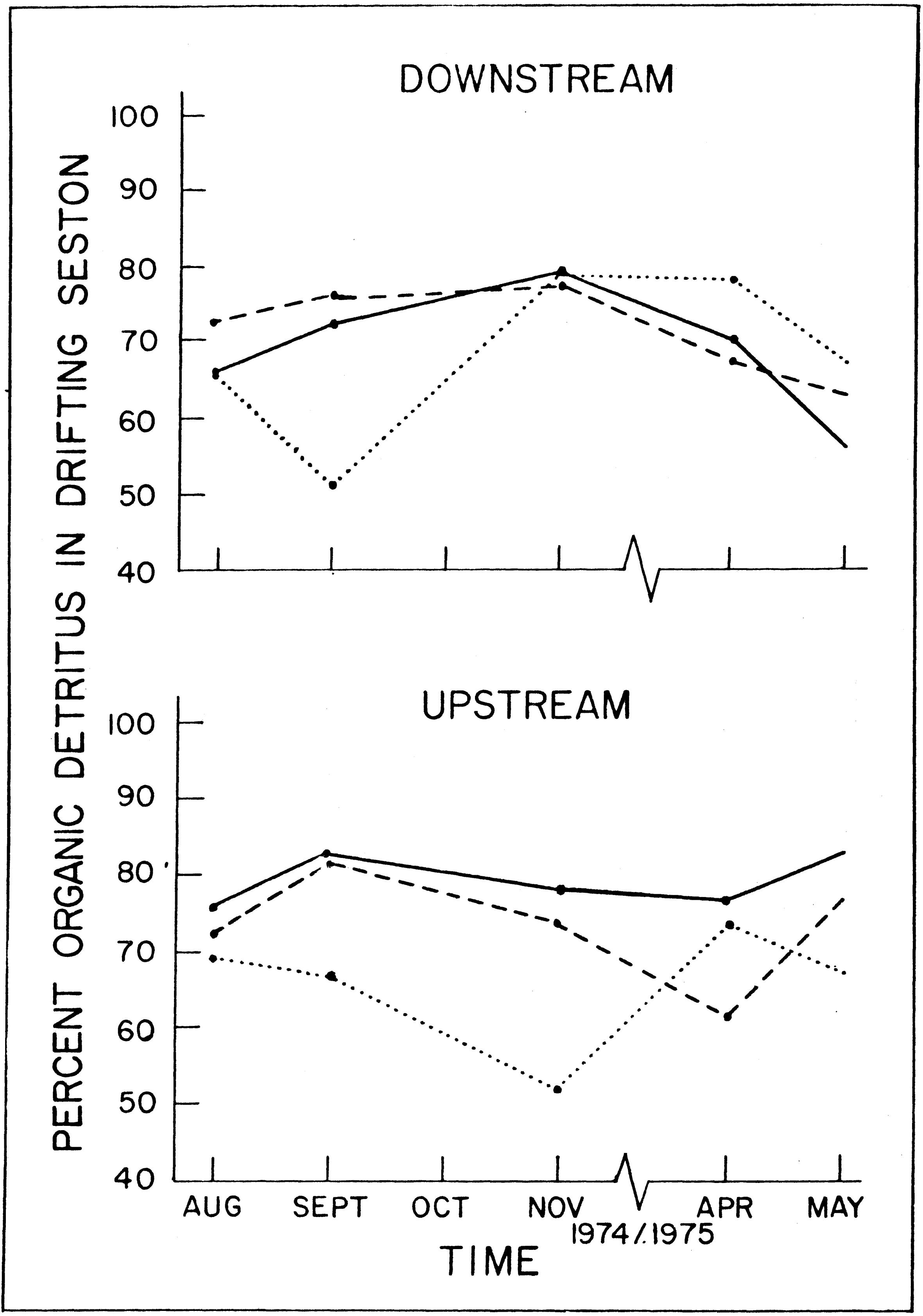

Figure 10. Percent organic detritus in drifting seston, Buena Vista Marsh, Portage County, Wisconsin.

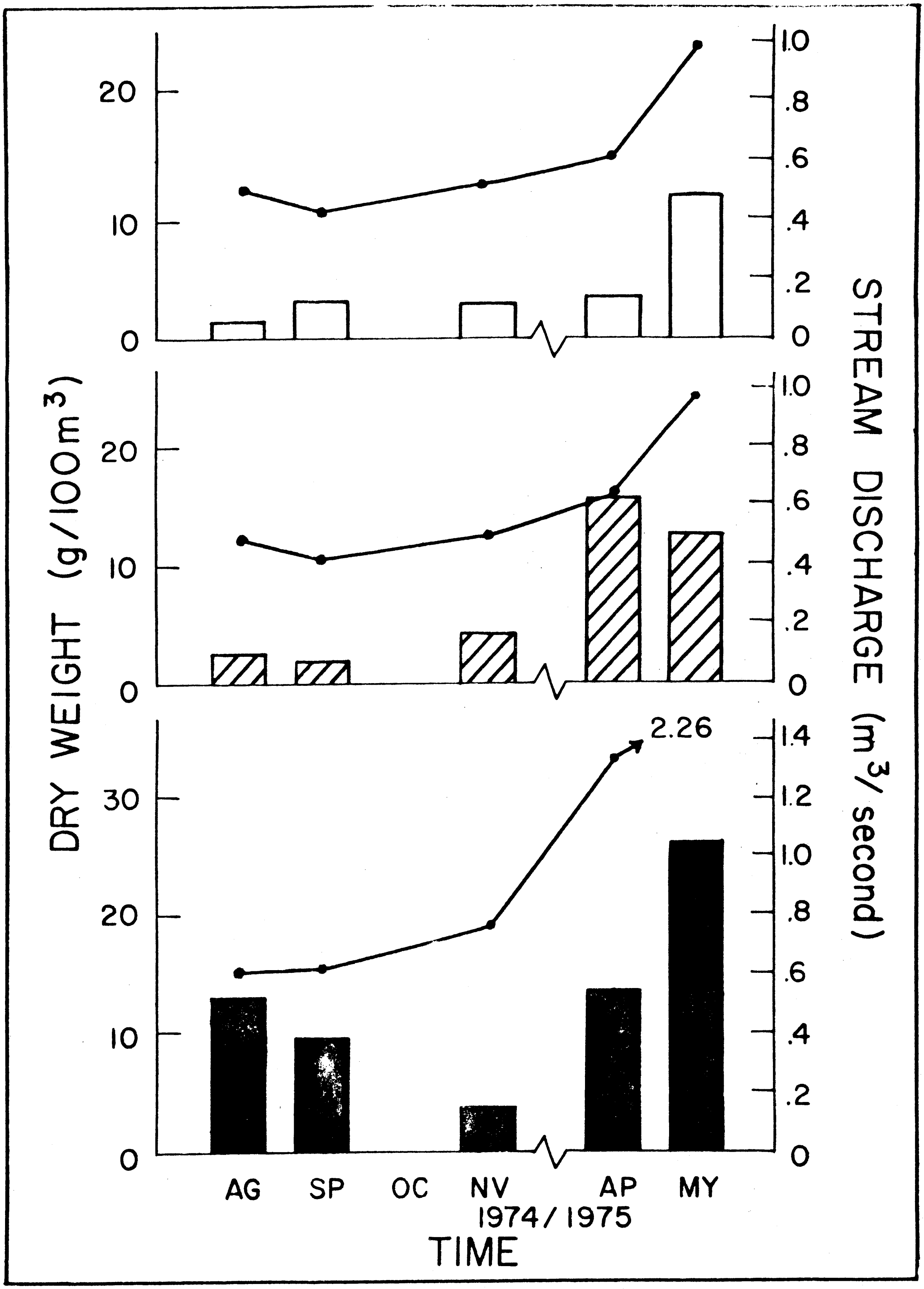

Figure 11. Drifting seston density (☐) and stream discharge (•—•) in downstream area, Buena Vista Marsh, Portage County, Wisconsin.

(Waters, 1972).

Physical factors affecting quantity of drift and downstream displacement include current velocity, discharge, water temperature, and substrate type. Waters (1972), in a review of drift studies, stated that aquatic vegetation may act as a seive to drifting invertebrates. Waters (1966) and Dimond (1967) suggested that drift may be a function of the extent to which the carrying capacity of the stream is exceeded. Substrate, in addition to providing suitable surface for reattachment, affects drift through effects on production rate, species composition, and population density (Waters, 1961). Drift, at a given location, is not a function of the benthic population at that location, but a function of upstream conditions (Waters, 1965).

Stream drift may be important in the recovery of areas with reduced benthos, provided suitable substrates are available. Denuded areas can recover quickly. Waters (1964) reported rapid recolonization of a denuded gravel riffle by drifting *Baetis* and *Gammarus*. Investigations showing rapid recovery of benthic invertebrates following channelization (Rees, 1959; Warner and Porter, 1960; Burkhard, 1967; Winger, 1972) occurred in streams with stable gravel, rubble, and vegetation-silt substrates for attachment of drifting organisms.

Upstream

Chironomidae were the most important organisms numerically, whereas the Amphipod, *Gammarus*, and various

Mollusca contributed most biomass in the drift of all sites (Appendix B). Drift biomass (Figure 12) and density (Figure 13) were higher in the ditches than in the natural stream. Drift biomass and density were directly related to the amount of sand substrate present. The predominance of sand substrate, less suitable for reattachment than the more stable substrates, may have maintained organisms in the drift for longer times and distances, and resulted in higher drift in the ditches. Conversely, higher amounts of more suitable substrates for reattachment, i.e., aquatic vegetation, stabilized silt-detritus, and gravel probably resulted in lower drift biomass and density in the natural stream. Higher densities of drifting seston, through molar action, may have increased dislodgement of organisms in the ditches. Morris, *et al* (1968), Holz (1969), and Hansen, D.R. (1971) reported higher aquatic insect drift in channelized areas.

Downstream

Chironomidae were numerically important at all sites, whereas *Simulium* and various Ephemeroptera and Trichoptera were numerous in the natural stream and a Hemipteran, *Hesperocorixa*, was numerous in new and old ditch drift. Drift biomass was composed primarily of *Hesperocorixa* in the ditches and various Trichoptera in the natural stream (Appendix B). The effects of stable substrates on drift biomass and density, discussed in relation to the upstream sites, were also observed in downstream sites. Lower

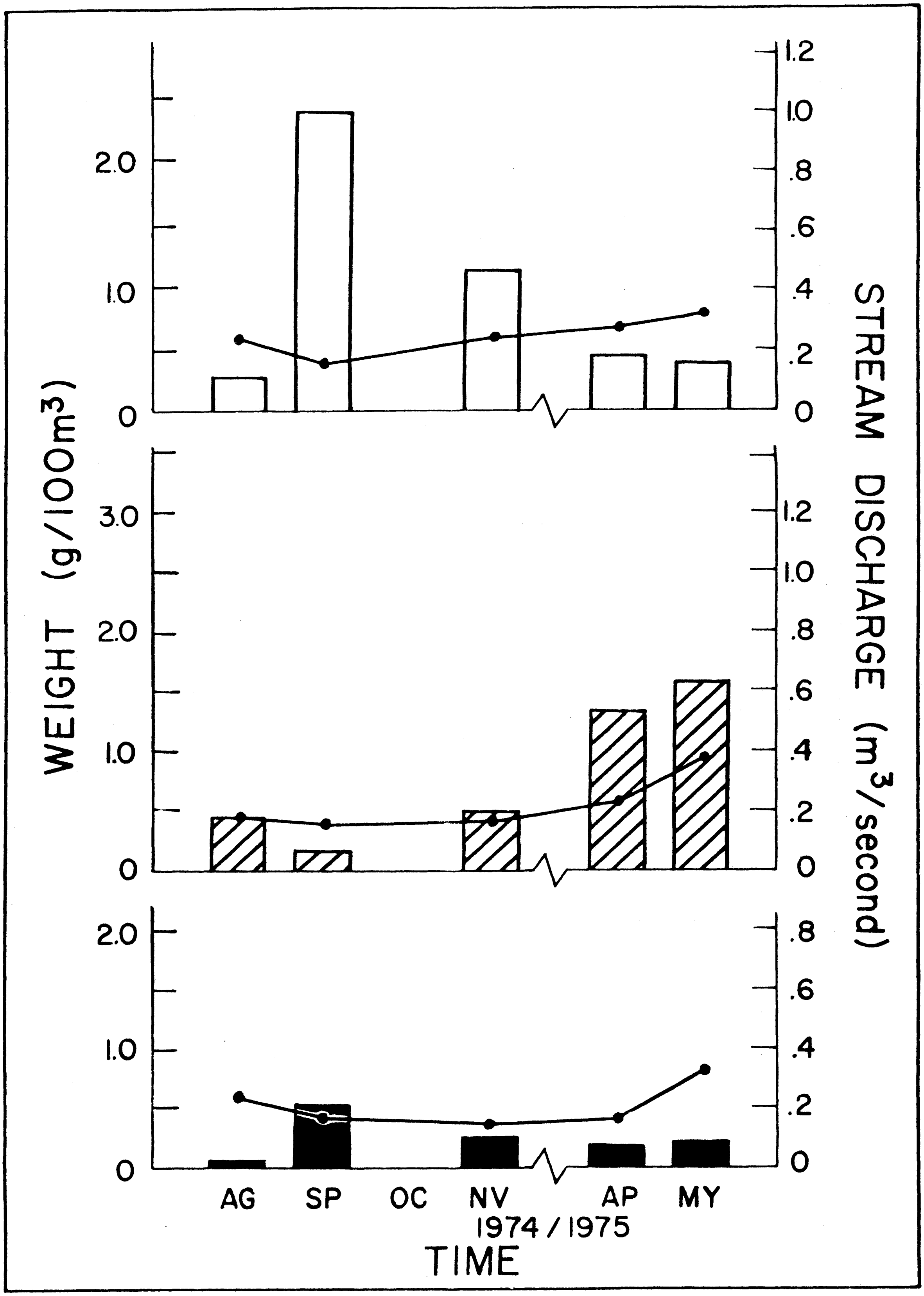

Figure 12. Drifting organism biomass (☐) and stream discharge (•—•) in upstream area, Buena Vista Marsh, Portage County, Wisconsin.

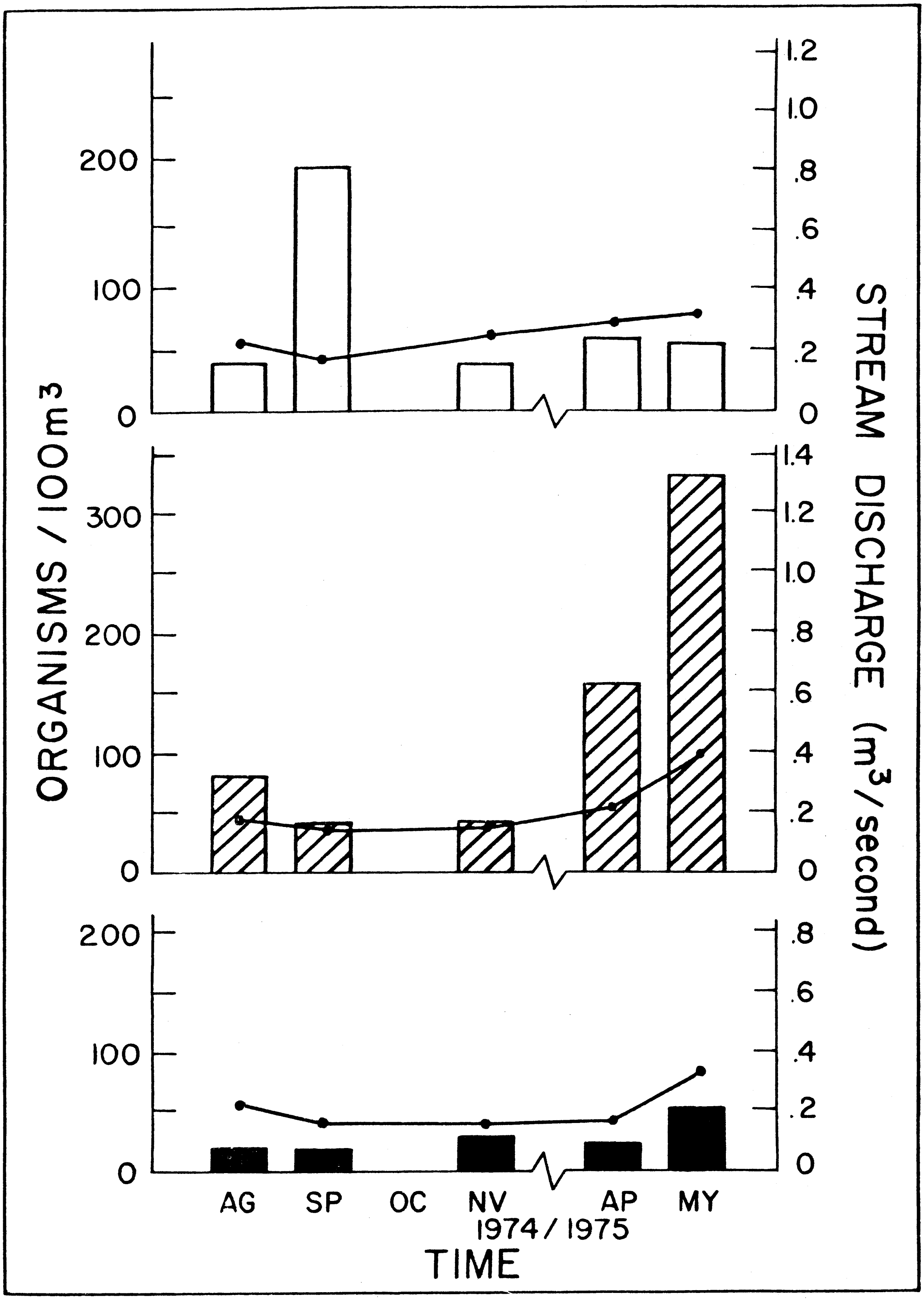

Figure 13. Drifting organism density (▭) and stream discharge (•—•) in upstream area, Buena Vista Marsh, Portage County, Wisconsin.

drift biomass (Figure 14) and density (Figure 15), despite highest benthic biomass and density, occurred in the new ditch, which contained higher proportions of vegetation and silt-detritus substrates, except during the November and April sample periods when aquatic vegetation was not present and drift biomass and density increased. The predominantly shifting sand substrate of the natural stream resulted in generally higher drift biomass and density despite low benthic biomass and density.

TAXONOMIC DIFFERENCES

Higher numbers of invertebrate taxa were collected from natural streams and lower numbers of taxa from new ditches in upstream and downstream areas. Total taxa collected were 61, 63, and 68 with 32 common to all sites in the upstream area, and 54, 59, and 66 with 34 common to all sites in the downstream area for new ditches, old ditches, and natural streams, respectively (Table 3). Plecoptera were collected only in natural streams. Etnier (1972) reported reduced diversity of invertebrates, especially Ephemeroptera, Trichoptera, and Plecoptera, following channelization of a small stream in Tennessee.

Numbers of drifting taxa were highest in the upstream new ditch and downstream natural stream, which were the sites with the highest sand substrate composition in their respective areas. Numbers of drifting taxa were 36, 31, and 30 for the upstream area, and 20, 30, and 46 (significantly different, $X^2 = \frac{(\text{observed-expected})^2}{\text{expected}}$,

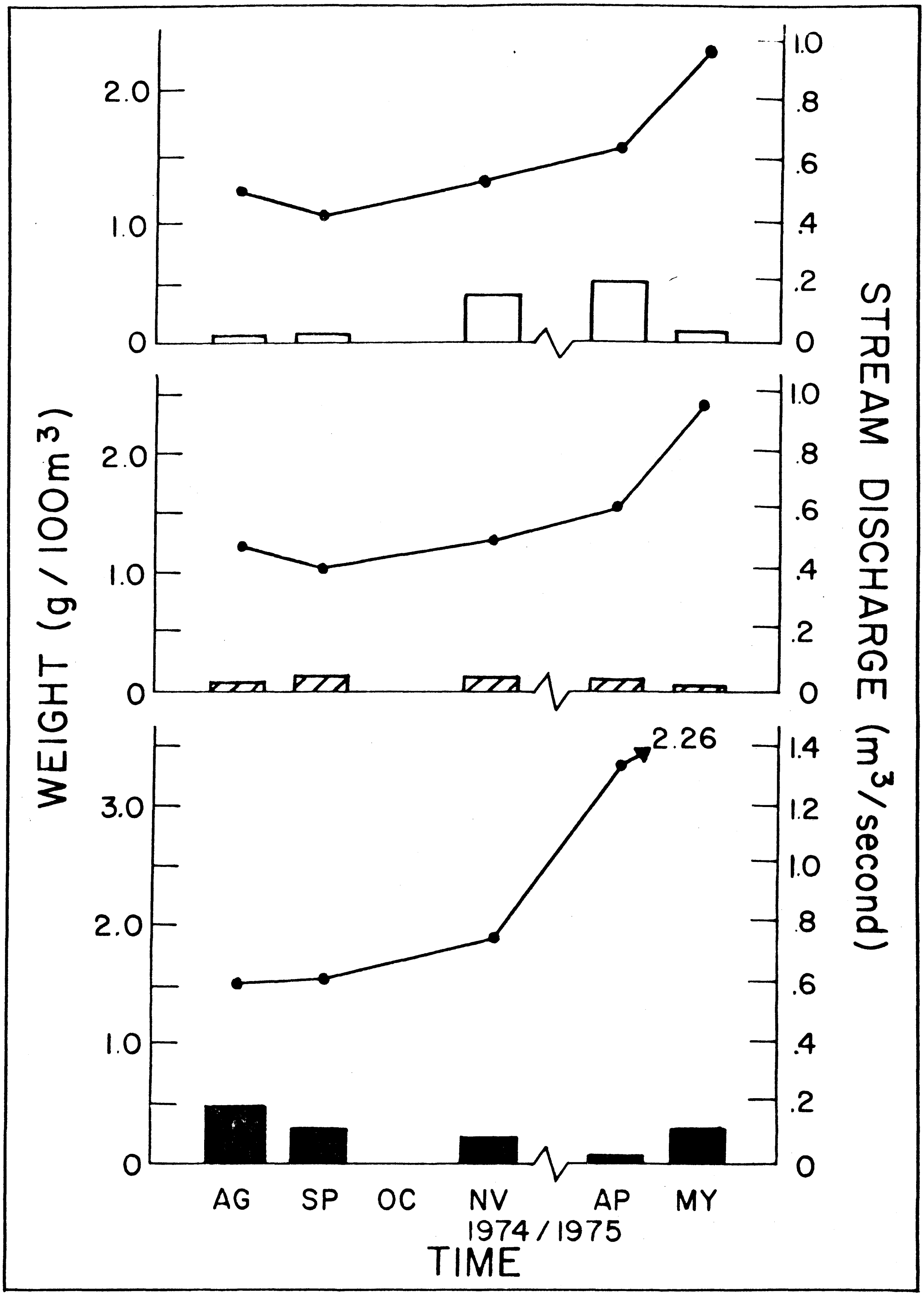

Figure 14. Drifting organism biomass (▭) and stream discharge (•—•) in downstream area, Buena Vista Marsh, Portage County, Wisconsin.

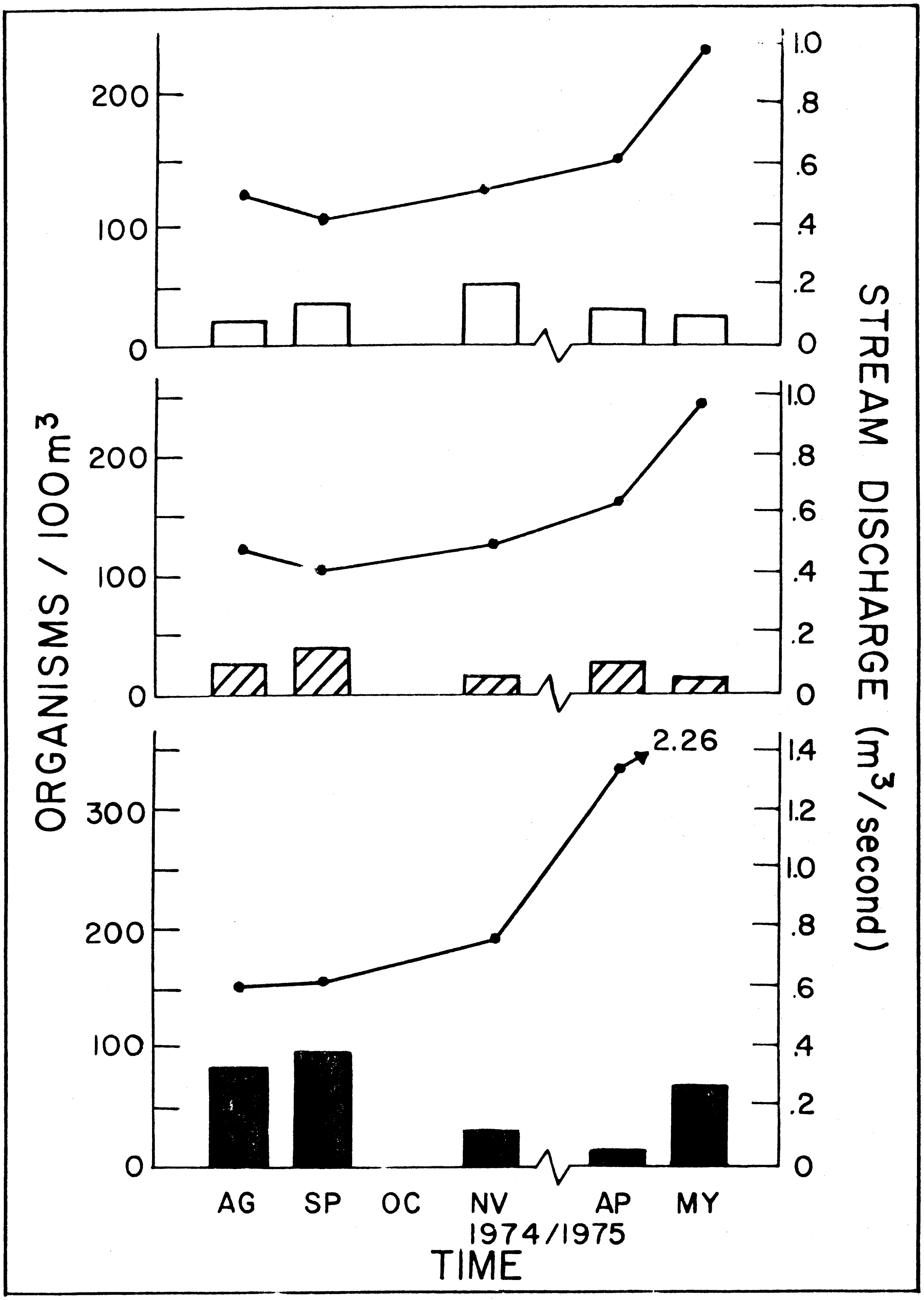

Figure 15. Drifting organism density (☐) and stream discharge (•—•) in downstream area, Buena Vista Marsh, Portage County, Wisconsin.

Table 3. AQUATIC MACROINVERTEBRATES COLLECTED FROM VARIOUS STATIONS, JUNE, 1974, THROUGH MAY, 1975, BUENA VISTA MARSH, PORTAGE COUNTY, WISCONSIN. (B - present in quantitative benthos samples; D - present in drift samples; Q - present only in qualitative samples)

	UPSTREAM			DOWNSTREAM		
	NEW DITCH	OLD DITCH	NATURAL	NEW DITCH	OLD DITCH	NATURAL
Artropoda						
C. Insecta						
O. Coleoptera - beetles						
F. Chrysomelidae - leaf beetles						
Donacia	D		D		B	B
F. Curculionidae - weevils	D	BD		D	D	
F. Dytiscidae - predaceous diving beetles						
Agabus	BD	BD				
Copotomus					Q	
Deronectes	B		B			
Hydaticus		Q	D	Q	Q	
Hydroporus	B	B	B	B	D	D
Hygrotus						D
Ilybius					B	
Laccophilus		Q	D	BD	D	
Liodessus	D	D	BD			BD
F. Elmidae - riffle beetles						
Dubiraphia	B	B		BD	BD	BD
Optioservus	B	BD	BD		BD	BD
F. Gyrinidae - whirligig beetles						
Dineutus	Q					
Gyrinus	BD	Q	Q	BD	BD	BD
F. Haliplidae - crawling water beetles						
Haliplus	BD	D		BD	BD	D
Peltodytes		D	D		B	D
F. Hydraenidae						
Hydraena			D			D

Table 3 (cont.)

	UPSTREAM			DOWNSTREAM		
	NEW DITCH	OLD DITCH	NATURAL	NEW DITCH	OLD DITCH	NATURAL
F. Hydrophilidae - water scavenger beetles						
Berosus				Q		
Enochrus	D					
Helophorus	B	D	D		D	D
Hydrobius			B			
Hydrochus	D					
Tropisternus	D	Q	D	B	D	Q
O. Diptera - flies						
F. Ceratopogonidae - biting midges	BD	BD	BD	B	B	B
F. Chironomidae - midges	BD	BD	BD	BD	BD	BD
F. Culicidae - mosquitoes						
Anopheles				Q		
F. Empididae						
Clinocera		Q				
Hemerodromia	BD	BD	B	B	B	D
F. Ephydridae - shore flies	B		B		B	
Hydrellia	D					
F. Muscidae - anthomyiids		D		B	D	D
Limnophora	BD					
F. Psychodidae - moth flies						
Pericoma			B			
F. Ptychopteridae - phantom crane flies						
Liriope		B				
F. Rhagionidae - snipe flies						
Atherix	BD	BD	B	BD	BD	BD
F. Sciomyzidae	D					
Sepedon				Q		
F. Simulidae - black flies						
Simulium	BD	BD	BD	BD	BD	BD
F. Stratiomyidae						
Eulalia		B				

Table 3 (cont.)

	UPSTREAM			DOWNSTREAM		
	NEW DITCH	OLD DITCH	NATURAL	NEW DITCH	OLD DITCH	NATURAL
Euparyphus	D					
Stratiomys			D			
F. Tabanidae - horse flies						
Chrysops	BD	BD	B	B	B	BD
F. Tipulidae - crane flies						
Antocha			B		B	BD
Dicranota	BD	BD	BD			
Erioptera						B
Hexatoma	BD	B	B	B	B	BD
Pilaria		B	B	B		B
Prionocera						Q
Tipula		BD	B		Q	
O. Ephemeroptera - mayflies						
F. Baetidae						
Baetis	B	B	BD	BD	BD	BD
Callibaetis				B	D	D
F. Baetiscidae						
Baetisca					B	
F. Caenidae						
Caenis	BD		BD	BD	BD	BD
F. Ephemerellidae						
Ephemerella						D
F. Ephemeridae						
Hexagenia	BD		BD	B	BD	BD
F. Heptageniidae						
Heptagenia						B
Stenonema			B			BD
F. Leptophlebiidae						
Leptophlebia	D	B	B			BD
Paraleptophlebia		B		D		

Table 3 (cont.)

	UPSTREAM					
	NEW DITCH	OLD DITCH	NATURAL	NEW DITCH	OLD DITCH	NATURAL
F. Siphlonuridae						
Isonychia						B
F. Tricorythodes						
Tricorythodes	B		BD	B		
O. Hemiptera - bugs						
F. Belostomatidae - giant water bugs						
Belostoma		B	Q	Q	B	Q
F. Corixidae - water boatmen						
Hesperocorixa	BD	BD	BD	BD	BD	BD
F. Geridae - water striders						
Gerris		Q	Q			
F. Nepidae - water scorpions						
Ranatra		Q	D		Q	Q
F. Notonectidae - back swimmers						
Notonecta			Q	Q	Q	Q
F. Saldidae	D	D				
O. Odonata						
S.O. Anisoptera - dragonflies			D			
F. Aeshnidae						
Aeshna		B		B	B	
Anax				Q		
F. Cordulegastridae						
Cordulegaster						B
S.O. Zygoptera						
F. Calopterygidae						
Agrion	Q		B	B	B	Q
F. Coenagrionidae						
Anomalagrion	B					D
Ischnura	D			Q	D	D
O. Plecoptera						
S.O. Filipalpia						

Table 3 (cont.)

	UPSTREAM			DOWNSTREAM		
	NEW DITCH	OLD DITCH	NATURAL	NEW DITCH	OLD DITCH	NATURAL
F. Nemouridae						
Taeniopteryx			B			B
F. Pteronarcidae						
Pteronarcys						B
S.O. Setipalpia						B
F. Perlidae						
Perlesta						B
F. Perlodidae						
Isoperla			B			BD
O. Trichoptera - caddis flies						
F. Brachycentridae						
Brachycentrus	BD	BD	BD		B	BD
F. Hydropsychidae						
Cheumatopsyche	B	D	B	B	BD	D
Hydropsyche	BD	BD	BD		D	BD
F. Hydroptilidae						
Ochrotrichia					B	
F. Lepidostomatidae						
Lepidostoma		D	B			
F. Leptoceridae				B	B	D
Athripsodes			B			B
Mystacides						D
F. Limnephilidae						
Hesperophylax		B	B			
Hydatophylax	D					
Limnephilus	BD	BD	BD	D	B	D
Nemotaulius		Q	B			
Platycentropus	B	B		Q		D
Pseudostenophylax	B					
Psychoglypha	B		B			
Pycnopsyche	B	BD	BD		BD	BD

Table 3 (cont.)

	UPSTREAM			DOWNSTREAM		
	NEW DITCH	OLD DITCH	NATURAL	NEW DITCH	OLD DITCH	NATURAL
F. Molannidae						
Molanna		B	B	D		D
F. Phryganeidae						
Ptilostomus		B				
C. Crustacea						
O. Amphipoda - sideswimmers						
F. Gammaridae						
Gammarus	BD	BD	BD	B	BD	BD
O. Decapoda - crayfish						
F. Cambarinae						
Orconectes	Q	B		B	B	B
Annelida - segmented worms						
C. Hirudinea - leeches						
F. Erpobdellidae						
Erpobdella		B	B	B		
F. Glossiphoniidae						
Glossiphonia complanata		B	B			
Glossiphonia sp.					B	
Placobdella montifera				B		
Placobdella sp.				B		
F. Hirudidae						
Haemopis		B	B	B	B	
Macrobdella decora	B					
C. Oligochaeta - aquatic earthworms	BD	BD	BD	BD	BD	BD
Nematoda - roundworms	B	B	B	B	B	BD
Hydracarina - water mites	B	D	BD	BD	B	BD
Mollusca						
C. Gastropoda - snails						

Table 3 (cont.)

	UPSTREAM			DOWNSTREAM		
	NEW DITCH	OLD DITCH	NATURAL	NEW DITCH	OLD DITCH	NATURAL
F. Ancylidae - limpets						
Ferrissia	B	B		BD	BD	
F. Lymnaeidae - pond snails						
Lymnaea	BD	B	B	BD	BD	D
F. Planorbidae - orb snails						
Gyraulus	BD	BD	B	B	BD	
Helisoma	BD	D		BD	BD	
Planorbula	B					
F. Physidae - pouch snails						
Physa	BD	BD	BD	B	BD	BD
Aplexa			B			
C. Pelecypoda - clams						
F. Sphaeriidae						
Musculium					B	
Pisidium	B	B	B	BD	B	B
Sphaerium	B	B	B			B
Nemertea - proboscis worms						
Prostoma				B	BD	D
Total Taxa	61	63	68	54	59	66
Benthic Taxa	46	45	53	41	45	39
Drift Taxa	36	31	30	20	30	46

2 d.f., p 0.05) for the downstream area in new ditches, old ditches, and natural streams, respectively (Table 3).

WATER TEMPERATURE AND CHEMISTRY

Water temperatures were similar in ditches and natural stream in both upstream and downstream areas. Mean daily water temperature fluctuation, in the upstream area, was slightly greater in the new ditch (Appendix C). Hansen, D.R. (1971) found greater daily temperature fluctuation in channelized sections of the Little Sioux River, Iowa. Abundant groundwater seepage probably moderated and stabilized water temperatures in this study.

Many measured chemical parameters were similar or did not exhibit consistent trends (Appendix D). High concentrations of aquatic plant nutrients (N and P), present in all study sites, were also reported in marsh drainage waters by Lee, _et al_ (no date). Use of fertilizers in the agricultural areas of Buena Vista Marsh probably contributed nutrients to the streams and ditches. Alkalinity, total hardness, and calcium hardness were generally higher in the new ditches and decreased in old ditches and natural streams, respectively, in both upstream and downstream areas. Higher conductivity, a measure of dissolved solids, in the ditches may have resulted from increased dissolution of newly exposed eroding sediments.

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APPENDIX A1. BENTHIC BIOMASS AND DENSITY FOR EACH AVAILABLE SUBSTRATE TYPE IN UPSTREAM SITES, BUENA VISTA MARSH, PORTAGE COUNTY, WISCONSIN. (standard deviation in parentheses)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Substrate composition (%)															
June, 1974		2.5	5.0	2.5	90.0	100	Tr	25.0	75.0	100	9.5	21.2	10.6	58.7	100
Aug., 1974		16.4	12.7	3.6	67.3	100	Tr	38.1	61.9	100	20.9	13.2	12.2	53.7	100
Sep., 1974		17.0	13.1	3.4	66.5	100	16.0	12.5	71.5	100	24.7	9.4	28.9	37.0	100
Nov., 1974		9.1	11.5	--	79.4	100	Tr	29.1	70.9	100	33.0	29.3	Tr	37.7	100
Apr., 1975		6.1	12.2	6.6	75.1	100	Tr	13.2	86.8	100	26.7	22.7	3.7	46.8	99.9
May, 1975		10.0	13.2	4.5	72.3	100	Tr	25.9	74.1	100	37.2	8.8	5.5	48.4	99.9
Arthropoda															
C. Insecta															
O. Coleoptera															
F. Elmidae															
Dubiraphia															
June, 1974	$\#/m^2$	28(11)	48(36)	12(11)		3.4(2.4)		12(18)		3.0(4.5)					
	g/m^2	.04(.02)	.09(.05)	.02(.02)		.01(.01)		.02(.03)		.01(.01)					
Aug., 1974	$\#/m^2$	128(95)	44(50)	8(18)		26.9(22.6)									
	g/m^2	.41(.41)	.12(.13)	.02(.05)		.08(.09)									
Sep., 1974	$\#/m^2$	200(94)			4(9)	36.7(22.0)									
	g/m^2	.66(.30)			.01(.01)	.12(.06)									
Nov., 1974	$\#/m^2$	160(85)	40(40)			19.2(12.3)									
	g/m^2	.47(.32)	.10(.16)			.06(.05)									
Apr., 1975	$\#/m^2$	92(48)	20(35)	4(9)		8.3(7.8)									
	g/m^2	.17(.09)	.01(.03)	Tr(Tr)		.01(.01)									
May, 1975	$\#/m^2$	28(18)	56(22)			10.2(4.7)									
	g/m^2	.03(.01)	.05(.03)			.01(.01)									

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
O. Diptera															
F. Chironomidae															
June, 1974	$\#/m^2$	3428(2923)	3364(2768)	1024(675)	24(17)	301.1(243.6)		8756(3320)	120(181)	2279.0(965.8)	556(365)	3236(1692)	508(138)	324(142)	982.9(491.4)
	g/m^2	8.75(6.20)	9.64(8.79)	.97(.74)	.05(.04)	.77(.65)		30.59(15.63)	.29(.38)	7.87(4.19)	1.21(.98)	7.90(3.70)	1.24(.48)	1.21(.68)	2.63(1.33)
Aug., 1974	$\#/m^2$	8104(4446)	368(252)	4212(2315)	5420(1839)	5175.1(2082.1)		1480(601)	1312(1635)	1376.0(1241.0)	808(505)	460(374)	1468(655)	128(86)	477.4(281.0)
	g/m^2	9.86(3.02)	.74(.59)	3.18(1.71)	5.28(2.23)	5.38(2.13)		3.54(.93)	1.01(.96)	1.97(.95)	1.86(2.12)	.84(.48)	2.91(1.13)	.33(.03)	1.03(.66)
Sep., 1974	$\#/m^2$	8996(3296)			9892(3507)	8107.5(2892.5)	973(751)	107(46)	516(398)	538.0(410.5)	1240(367)	630(285)	428(388)	540(553)	689.0(434.2)
	g/m^2	16.96(6.77)			14.01(9.08)	12.20(7.19)	2.02(1.37)	.30(.10)	1.51(1.13)	1.44(1.04)	2.15(.94)	1.77(.92)	.69(.72)	.40(.58)	1.04(.74)
Nov., 1974	$\#/m^2$	1992(2040)	832(452)		272(226)	492.9(417.1)		4992(2041)	424(218)	1753.3(748.5)	832(1016)	2456(1309)		72(150)	1021.3(775.4)
	g/m^2	.92(1.22)	1.92(1.37)		.07(.11)	.36(.36)		13.29(5.31)	2.58(1.69)	5.70(2.74)	1.33(1.46)	3.65(2.25)		.01(.01)	1.51(1.14)
Apr., 1975	$\#/m^2$	5096(3901)	6516(5978)	732(591)	30(11)	1176.7(1014.6)		13088(8150)	320(166)	2005.4(1219.9)	14504(7509)	4396(2153)	1700(1585)	620(746)	5223.5(2901.4)
	g/m^2	4.25(3.54)	8.07(6.26)	.89(.82)	.08(.05)	1.28(1.07)		30.92(20.66)	2.61(1.61)	6.35(4.12)	40.24(16.53)	17.75(10.55)	1.84(2.11)	.88(1.06)	15.25(7.38)
May, 1975	$\#/m^2$	9872(4917)	6864(2644)	6140(3619)	1952(2015)	3580.8(2460.4)		19460(2770)	468(364)	5386.9(987.2)	3776(1952)	3042(3171)	2904(2207)	4512(6885)	4015.9(4458.9)
	g/m^2	14.32(7.24)	14.11(8.88)	5.71(3.17)	1.70(1.68)	4.78(3.25)		35.42(13.76)	1.82(1.92)	10.5(5.00)	7.04(6.49)	7.19(9.35)	2.61(1.64)	2.83(3.49)	4.77(5.02)
F. Simuliidae															
Simulium															
June, 1974	$\#/m^2$	4660(4546)	32(33)	196(405)		123.0(125.4)			12(11)	9.0(8.2)	76(62)		16(26)		8.9(8.6)
	g/m^2	21.62(21.51)	.15(.16)	1.16(2.50)		.58(.61)			.04(.04)	.03(.03)	.26(.21)		.06(.11)		.03(.03)
Aug., 1974	$\#/m^2$	208(214)	4(9)			34.6(36.2)		72(161)		27.4(61.3)	12(27)		4(9)		3.0(6.7)
	g/m^2	.95(.79)	.20(.45)			.18(.19)		.14(.33)		.05(.13)	.03(.08)		.01(.01)		.01(.02)
Sep., 1974	$\#/m^2$	136(159)			4(9)	25.8(33.0)	27(23)		4(9)	7.2(10.1)	48(72)				11.9(17.8)
	g/m^2	.75(.92)			.06(.15)	.17(.26)	.17(.18)		Tr(.01)	.03(.04)	.11(.15)				.03(.04)

APPENDIX A1. (cont.)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Simulium (Cont.)															
Nov., 1974	$\#/m^2$	1120(338)			4(9)	105.1(37.9)			4(9)	2.8(6.4)	44(36)				14.5(11.9)
	g/m^2	3.24(1.11)			Tr(.01)	.30(.11)			.02(.06)	.01(.04)	.24(.26)				.08(.09)
Apr., 1975	$\#/m^2$	40(37)		8(18)		3.0(3.4)					16(22)		24(26)		5.2(6.8)
	g/m^2	.50(.59)		.11(.25)		.04(.05)					.14(.20)		.16(.15)		.04(.06)
May, 1975	$\#/m^2$	296(177)		8(11)		30.0(18.2)		8(18)		2.1(4.7)	1780(1059)		148(232)	4(9)	672.2(411.1)
	g/m^2	.43(.16)		.02(.03)		.04(.02)		.04(.10)		.01(.03)	4.57(3.12)		.37(.66)	Tr(.01)	1.72(1.20)
F. Tabanidae															
Chrysops															
June, 1974	$\#/m^2$	188(106)	52(58)	164(168)	8(11)	18.6(19.6)		48(44)	48(33)	48.0(35.8)	304(164)	8(18)	52(41)	28(11)	52.5(30.2)
	g/m^2	9.26(5.41)	3.02(2.87)	8.74(13.36)	.36(.63)	.93(1.18)		2.82(4.01)	1.67(1.37)	1.96(2.03)	27.18(18.44)	1.09(2.45)	4.58(4.68)	3.16(1.49)	5.15(3.64)
Aug., 1974	$\#/m^2$	112(91)	20(45)	208(158)	32(23)	49.9(41.9)		92(134)	72(54)	79.6(84.5)	64(68)	188(236)	60(60)	32(30)	62.7(68.8)
	g/m^2	10.29(11.06)	1.18(2.63)	2.89(2.58)	3.45(2.32)	4.26(3.80)		8.08(11.71)	4.08(3.53)	5.60(6.65)	3.79(4.62)	8.27(9.76)	2.40(3.35)	4.44(4.79)	4.56(5.24)
Sep., 1974	$\#/m^2$	64(22)			196(75)	141.2(53.6)	20(20)	27(46)	40(79)	35.2(65.4)	124(65)	85(98)	68(46)	72(52)	84.9(57.8)
	g/m^2	5.22(5.10)			4.16(14.61)	4.52(10.58)	2.38(2.24)	2.69(4.66)	3.09(5.52)	2.93(4.89)	11.53(11.21)	5.68(9.05)	3.71(2.39)	2.69(2.75)	5.45(5.33)
Nov., 1974	$\#/m^2$	104(62)	12(18)		8(11)	17.2(16.4)			44(54)	31.2(38.3)	176(170)	24(43)		144(46)	119.4(86.0)
	g/m^2	11.19(6.35)	2.06(2.97)		.65(.90)	1.77(1.64)			2.25(2.47)	1.60(1.75)	7.86(7.71)	2.02(3.42)		9.02(4.21)	6.59(5.13)
Apr., 1975	$\#/m^2$	92(56)	20(24)	24(22)	40(28)	39.6(28.7)		8(11)	40(68)	35.8(60.5)	332(253)	4(9)	88(91)	100(51)	139.6(96.8)
	g/m^2	8.22(7.55)	1.78(2.70)	1.04(1.03)	3.00(2.52)	3.04(2.75)		.73(1.04)	1.06(1.06)	1.02(1.06)	31.18(20.78)	.64(1.44)	4.50(4.39)	2.28(1.45)	9.70(6.72)
May, 1975	$\#/m^2$	20(20)		32(23)	20(14)	17.9(13.2)		40(32)	20(20)	25.2(23.1)	104(78)		8(11)	16(26)	46.9(42.2)
	g/m^2	.55(.52)		1.83(1.69)	.52(.37)	.51(.40)		1.77(22.4)	.40(.38)	.75(.86)	4.68(4.04)		.46(.66)	.62(.90)	2.07(1.98)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
F. Tipulidae															
Dicranota															
June, 1974	$\#/m^2$	20(24)		68(48)		2.2(1.8)			8(11)	6.0(8.2)	8(18)		12(18)		2.0(3.6)
	g/m^2	.37(.44)		1.24(.81)		.04(.03)			.20(.29)	.15(.22)	.01(.03)		.17(.24)		.02(.03)
Aug., 1974	$\#/m^2$	152(72)	4(9)	204(71)	76(52)	83.9(50.5)		8(18)	44(55)	30.3(40.9)	32(72)	16(22)	752(612)	16(17)	109.1(101.7)
	g/m^2	.76(.52)	.01(.03)	6.21(3.57)	3.54(3.36)	2.73(2.48)		.05(.12)	.64(.77)	.42(.52)	.12(.26)	.10(.15)	7.55(4.65)	.27(.26)	1.10(.78)
Sep., 1974	$\#/m^2$	180(147)			32(39)	51.9(50.9)			4(9)	2.9(6.4)	72(82)		152(214)	16(17)	61.9(88.4)
	g/m^2	1.04(.88)			.48(.52)	.50(.50)			.04(.10)	.03(.07)	.42(.60)		1.80(2.24)	.47(.86)	.80(1.11)
Nov., 1974	$\#/m^2$	348(149)			92(92)	104.7(86.6)		32(44)	72(56)	60.4(52.5)	132(136)			76(50)	72.2(63.7)
	g/m^2	11.68(7.31)			3.72(4.35)	4.02(4.12)		1.40(1.92)	2.38(2.54)	2.09(2.36)	4.23(3.91)			2.06(2.07)	2.17(2.07)
Apr., 1975	$\#/m^2$	32(41)	4(9)	4(9)		2.7(4.2)			8(11)	6.9(9.5)	156(108)	12(18)	104(62)	52(64)	72.6(65.2)
	g/m^2	2.22(3.56)	.29(.64)	.54(1.20)		.21(.37)			.06(.10)	.05(.09)	7.08(5.17)	.24(.48)	3.76(2.80)	2.04(2.53)	3.04(2.78)
May, 1975	$\#/m^2$										12(18)		32(23)	4(9)	8.2(12.3)
	g/m^2										.61(1.12)		1.05(.81)	.22(.50)	.39(.70)
Hexatoma															
June, 1974	$\#/m^2$								4(9)	3.0(6.8)	4(9)				.4(.9)
	g/m^2								.04(.10)	.03(.08)	.13(.29)				.01(.03)
Aug., 1974	$\#/m^2$	16(36)	24(26)	24(33)	16(17)	17.3(21.8)			12(18)	7.4(11.1)	16(36)		16(17)		5.3(9.6)
	g/m^2	.19(.42)	.41(.56)	.35(.49)	.45(.57)	.40(.54)			.39(.79)	.24(.49)	.25(.55)		.39(.37)		.10(.16)
Sep., 1974	$\#/m^2$	12(18)			72(48)	49.9(35.0)	27(46)		20(20)	18.6(21.7)	40(40)			12(27)	14.3(19.9)
	g/m^2	.44(.76)			5.36(4.98)	3.64(3.44)	.46(.80)		.97(.93)	.77(.79)	.19(.24)			.61(1.38)	.27(.57)
Nov., 1974	$\#/m^2$	104(78)	8(11)		32(18)	35.8(22.7)			24(26)	17.0(18.4)	20(24)	8(18)		40(35)	24.0(26.4)
	g/m^2	6.48(5.24)	.20(.29)		1.83(1.16)	2.07(1.43)			2.08(2.39)	1.48(1.70)	.33(.52)	.58(1.29)		2.97(2.73)	1.40(1.58)

APPENDIX A1. (cont.)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Hexatoma (Cont.)															
Apr., 1975	#/m^2 g/m^2	48(41) 4.45(5.21)	24(54) 2.95(6.61)	4(9) .54(1.20)	5(10) .02(.04)	9.9(17.2) .69(1.24)		4(9) .77(1.72)		.53(1.19) .10(.23)	68(33) 1.21(.95)	8(18) .09(.20)	12(11) .09(.09)	28(33) .18(.21)	33.5(28.7) .43(.40)
May, 1975	#/m^2 g/m^2		8(18) .19(.42)		8(11) .16(.22)	6.8(10.3) .14(.21)			20(20) .56(.71)	14.8(14.8) .42(.53)	52(64) .68(.77)		4(9) .04(.10)		19.6(24.3) .26(.29)
Pilaria															
June, 1974	#/m^2 g/m^2								8(18) .30(.68)	6.0(13.5) .22(.51)		8(11) .17(.28)			1.7(2.3) .04(.06)
Aug., 1974	#/m^2 g/m^2							8(18) .35(.78)		3.0(6.9) .13(.30)					
Sep., 1974	#/m^2 g/m^2						73(12) .65(.17)	7(16) .05(.09)		12.6(3.9) .11(.04)		20(40) .04(.08)			1.9(3.8) Tr(.01)
Nov., 1974	#/m^2 g/m^2							104(119) 4.10(5.37)		30.3(34.6) 1.19(1.56)					
Apr., 1975	#/m^2 g/m^2							24(33) .28(.40)		3.17(4.36) .04(.05)					
May, 1975	#/m^2 g/m^2							16(26) .60(.86)		4.1(6.7) .16(.22)		4(9) .09(.21)		4(9) .09(.21)	2.3(5.1) .05(.12)
O. Ephemeroptera															
F. Baetidae															
Baetis															
June, 1974	#/m^2 g/m^2	376(326) 1.49(1.15)	96(85) .31(.29)	416(462) 2.14(2.54)		24.6(24.0) .11(.11)					432(302) 1.96(.80)	52(116) .32(.72)	68(63) .39(.44)		59.3(60.0) .30(.28)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Baetis (Cont.)															
Aug., 1974	#/m^2 g/m^2	8(18) .03(.07)				1.3(3.0) .01(.01)					36(41) .14(.24)		300(168) .71(.36)	4(9) .01(.01)	46.3(33.9) .12(.10)
Sep., 1974	#/m^2 g/m^2	52(48) .15(.10)				8.8(8.2) .03(.02)	153(214) .80(1.04)		12(18) .04(.07)	33.1(47.1) .16(.22)	240(315) .99(1.42)		184(200) .62(.68)		112.5(135.6) .42(.55)
Nov., 1974	#/m^2 g/m^2	8(11) .09(.12)				.7(1.00) .01(.01)					4(9) .01(.01)				1.3(3.0) Tr(Tr)
Apr., 1975	#/m^2 g/m^2	4(9) .02(.06)		4(9) Tr(.01)		.51(1.14) Tr(.01)							8(11) .09(.12)		.3(.4) Tr(Tr)
May, 1975	#/m^2 g/m^2	64(86) .13(.17)		56(46) .15(.12)		8.9(10.7) .02(.02)					576(243) 2.09(.88)		116(163) .31(.40)		220.7(99.4) .79(.35)
F. Caenidae															
Caenis															
June, 1974	#/m^2 g/m^2	52(46) .18(.15)	40(51) .09(.10)			3.3(3.7) .01(.01)									
Aug., 1974	#/m^2 g/m^2	20(35) .09(.14)				3.3(5.7) .02(.02)									
Sep., 1974	#/m^2 g/m^2	528(457) .38(.21)				89.8(77.7) .06(.04)					32(72) .13(.29)				7.9(17.8) .03(.07)
Nov., 1974	#/m^2 g/m^2														
Apr., 1975	#/m^2 g/m^2	8(18) .01(.01)	40(89) .03(.08)	8(11) Tr(.01)		5.9(12.7) Tr(.01)									

APPENDIX A1. (cont.)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Caenis (Cont.)															
May, 1975	#/m^2	88(67)	12(18)			10.4(9.1)									
	g/m^2	.15(.12)	.02(.03)			.02(.02)									
F. Ephemeridae															
Hexagenia															
June, 1974	#/m^2											8(11)			1.7(2.3)
	g/m^2											4.42(6.21)			.94(1.32)
Aug., 1974	#/m^2		28(23)			3.6(2.9)					8(11)	4(9)			2.2(3.5)
	g/m^2		1.39(2.80)			.18(.36)					5.04(7.33)	3.56(7.96)			1.52(2.58)
Sep., 1974	#/m^2											5(10)			.5(.9)
	g/m^2											.55(1.11)			.05(.10)
Nov., 1974	#/m^2														
	g/m^2														
Apr., 1975	#/m^2														
	g/m^2														
May, 1975	#/m^2											4(9)			.4(.8)
	g/m^2											.36(.80)			.03(.07)
O. Hemiptera															
F. Corixidae															
Hesperocorixa															
June, 1974	#/m^2	20(14)				.5(.4)		24(36)		6.0(9.0)	4(9)	4(9)			1.2(2.8)
	g/m^2	.09(.06)				Tr(Tr)		.10(.14)		.02(.04)	.01(.03)	.02(.06)			.01(.02)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Hesperocorixa (Cont.)															
Aug., 1974	#/m^2	32(44)	416(540)	8(18)	4(9)	61.1(82.5)					4(9)	44(36)			6.6(6.6)
	g/m^2	.07(.14)	1.00(1.48)	.01(.01)	.01(.03)	.14(.23)					.04(.10)	.10(.11)			.02(.04)
Sep., 1974	#/m^2							13(23)		1.6(2.9)		20(40)			1.9(3.8)
	g/m^2							.05(.09)		.01(.01)		.08(.16)			.01(.02)
Nov., 1974	#/m^2		592(569)			68.1(65.4)		20(35)		5.8(10.2)	4(9)	32(52)			10.7(18.2)
	g/m^2		2.90(2.56)			.33(.29)		.28(.59)		.08(.17)	.01(.03)	.53(1.07)			.16(.32)
Apr., 1975	#/m^2		496(367)	12(18)		61.3(44.7)		20(20)		2.6(2.6)		72(30)			16.3(6.8)
	g/m^2		3.25(2.64)	.07(.10)		.40(.33)		.22(.34)		.03(.04)		.69(.29)			.16(.07)
May, 1975	#/m^2	112(91)	20(14)			13.8(10.9)		24(36)		6.2(9.3)		8(18)			.7(1.6)
	g/m^2	.45(.37)	.07(.06)			.05(.04)		.14(.24)		.04(.06)		.03(.07)			Tr(.01)
O. Megaloptera															
F. Sialidae															
Sialis															
June, 1974	#/m^2		4(9)			.2(.4)		116(84)	4(9)	32.0(27.8)		8(11)			1.7(2.3)
	g/m^2		.02(.06)			Tr(Tr)		4.63(4.09)	.22(.50)	1.32(1.40)		.27(.39)			.06(.08)
Aug., 1974	#/m^2	16(36)				2.6(5.9)		192(115)		73.2(43.8)	4(9)	16(36)			2.9(6.6)
	g/m^2	.01(.03)				Tr(.01)		9.41(6.17)		3.58(2.35)	.54(1.20)	.01(.03)			.11(.26)
Sep., 1974	#/m^2	52(66)				8.8(11.2)	207(31)	33(58)		37.2(12.2)	24(36)	5(10)			6.4(9.8)
	g/m^2	.40(.57)				.07(.10)	8.73(5.13)	2.05(3.55)		1.65(1.26)	.30(.47)	.55(1.11)			.13(.22)
Nov., 1974	#/m^2	4(9)	8(11)			1.3(2.1)		44(30)		12.8(8.7)	20(20)	24(26)			13.6(14.2)
	g/m^2	.01(.03)	.46(.98)			.05(.12)		5.51(3.78		1.61(1.10)	1.47(1.47)	.78(.98)			.71(.77)

APPENDIX A1. (cont.)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Sialis (Cont.)															
Apr., 1975	$\#/m^2$							96(65)		12.7(8.6)	17(20)				4.5(5.3)
	g/m^2							6.05(5.50)		.80(.73)	.81(.88)				.22(.24)
May, 1975	$\#/m^2$		4(9)			.5(1.2)		20(14)		5.2(3.6)					
	g/m^2		.13(.29)			.02(.04)		.23(.16)		.06(.04)					
O. Trichoptera															
F. Brachycentridae															
Brachycentrus															
June, 1974	$\#/m^2$										176(149)		52(41)	4(9)	24.6(23.8)
	g/m^2										2.24(2.59)		.66(.52)	Tr(.01)	.29(.31)
Aug., 1974	$\#/m^2$	40(40)		12(18)		7.0(7.2)					8(11)	8(18)	424(254)	32(72)	71.6(74.3)
	g/m^2	.23(.24)		.09(.13)		.04(.04)					.09(.14)	.05(.12)	4.30(3.07)	.36(.81)	.74(.86)
Sep., 1974	$\#/m^2$										120(150)		1100(914)	4(9)	349.0(304.5)
	g/m^2										.09(.11)		13.78(11.34)	.06(.15)	4.03(3.36)
Nov., 1974	$\#/m^2$	8(18)				.7(1.6)		4(9)	8(18)	6.8(15.4)	56(67)				18.5(22.1)
	g/m^2	.01(.01)				Tr(Tr)		.22(.50)	.40(.90)	.35(.78)	.46(.46)				.15(.15)
Apr., 1975	$\#/m^2$										68(141)		212(250)	4(9)	27.9(51.1)
	g/m^2										.31(.66)		1.53(1.54)	.02(.06)	.15(.26)
May, 1975	$\#/m^2$										144(157)		180(250)		63.5(72.2)
	g/m^2										2.26(2.64)		3.18(4.44)		1.02(1.23)
F. Hydropsychidae															
Cheumatopsyche															
June, 1974	$\#/m^2$	4(9)				.10(.22)									
	g/m^2	.04(.09)				Tr(Tr)									

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Cheumatopsyche (Cont.)															
Aug., 1974	$\#/m^2$				4(9)	2.7(6.1)									
	g/m^2				.02(.06)	.01(.04)									
Sep., 1974	$\#/m^2$	8(18)				1.4(3.1)									
	g/m^2	.19(.42)				.03(.07)									
Nov., 1974	$\#/m^2$														
	g/m^2														
Apr., 1975	$\#/m^2$				4(9)	.30(.60)					4(9)				1.1(2.4)
	g/m^2				.04(.10)	Tr(.01)					.09(.21)				.02(.06)
May, 1975	$\#/m^2$												8(11)		.4(.6)
	g/m^2												.19(.26)		.01(.01)
Hydropsyche															
June, 1974	$\#/m^2$	8(11)		8(18)		.40(.70)							12(11)		1.3(1.2)
	g/m^2	.36(.52)		.51(1.15)		.02(.04)							.91(.95)		.10(.10)
Aug., 1974	$\#/m^2$			4(9)		.10(.30)							108(112)		13.2(13.7)
	g/m^2			.02(.06)		Tr(Tr)							.33(.45)		.04(.06)
Sep., 1974	$\#/m^2$						13(23)			2.1(3.7)			68(52)		19.7(15.0)
	g/m^2						.02(.04)			Tr(.01)			.77(.68)		.22(.20)
Nov., 1974	$\#/m^2$										20(20)				6.6(6.6)
	g/m^2										.14(.16)				.05(.05)
Apr., 1975	$\#/m^2$										4(9)				1.1(2.4)
	g/m^2										.04(.10)				.01(.03)
May, 1975	$\#/m^2$										4(9)		8(18)		1.9(4.3)
	g/m^2										.35(.78)		.36(.80)		.15(.33)

APPENDIX A1. (cont.)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
F. Limnephilidae															
Limnephilus															
June, 1974	#/m^2	4(9)				.1(.2)		8(18)	4(9)	5.0(11.2)	60(82)	20(45)	4(9)	4(9)	12.7(23.6)
	g/m^2	.54(1.20)				.01(.03)		4.12(9.22)	.77(1.72)	1.61(3.60)	10.80(17.82)	3.43(7.67)	.90(2.02)	.90(2.02)	2.38(4.72)
Aug., 1974	#/m^2												4(9)		.5(1.1)
	g/m^2												.01(.01)		Tr(Tr)
Sep., 1974	#/m^2														
	g/m^2														
Nov., 1974	#/m^2							4(9)		1.2(2.6)					
	g/m^2							.77(1.72)		.22(.50)					
Apr., 1975	#/m^2		4(9)			.5(1.1)		12(18)		1.6(2.4)	8(18)				2.1(4.8)
	g/m^2		.29(.64)			.04(.08)		1.41(1.95)		.19(.26)	.26(.59)				.07(.16)
May, 1975	#/m^2	16(17)				1.6(1.7)		204(196)		52.8(50.8)	28(41)	44(57)			14.3(20.3)
	g/m^2	1.64(1.88)				.16(.19)		18.24(21.00)		4.72(5.44)	1.66(3.10)	1.95(2.14)			.79(1.34)
Pycnopsyche															
June, 1974	#/m^2										4(9)				.4(.9)
	g/m^2										.64(1.44)				.06(.14)
Aug., 1974	#/m^2							8(18)		3.0(6.9)			16(36)		2.0(4.4)
	g/m^2							1.67(3.74)		.64(1.42)			2.02(4.5)		.25(.55)
Sep., 1974	#/m^2						7(12)			1.1(1.9)	4(9)				1.0(2.2)
	g/m^2						1.76(3.04)			.28(.49)	.29(.64)				.07(.16)
Apr., 1975	#/m^2							20(35)		5.8(10.2)	8(11)	16(36)			7.3(14.2)
	g/m^2							.83(1.40)		.24(.41)	.30(.64)	.11(.25)			.13(.28)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Pycnopsyche (Cont.)															
Apr., 1975	#/m^2										12(11)	8(11)	16(22)		5.6(6.2)
	g/m^2										2.73(3.35)	.65(.90)	2.29(3.15)		.96(1.22)
May, 1975	#/m^2	8(11)				.8(1.1)					8(11)		8(11)		3.4(4.7)
	g/m^2	2.31(3.28)				.23(.33)					2.17(3.18)		2.66(3.77)		.95(1.39)
C. Crustacea															
O. Amphipoda															
Gammarus															
June, 1974	#/m^2	256(357)	760(471)	364(336)	4(9)	57.1(49.0)		456(606)	16(17)	126.0(164.2)	1496(626)	1532(891)	168(140)	84(57)	534.0(296.7)
	g/m^2	1.39(1.38)	2.85(2.28)	3.44(3.11)	Tr(Tr)	.26(.23)		4.81(5.95)	.06(.09)	1.25(1.56)	7.62(3.88)	7.26(2.05)	1.21(2.05)	.25(.20)	2.54(1.10)
Aug., 1974	#/m^2	5576(5940)	1072(522)	224(245)	28(11)	1077.5(1056.7)		3128(2267)	192(77)	1310.6(911.4)	12440(2301)	4832(2197)	1348(850)	364(257)	3597.7(1012.6)
	g/m^2	29.92(38.39)	6.73(3.02)	1.52(2.65)	.10(.09)	5.88(6.84)		29.21(25.11)	.59(.17)	11.49(9.67)	72.20(19.99)	28.82(13.64)	6.53(5.23)	1.39(.60)	20.44(6.94)
Sep., 1974	#/m^2	7324(1258)			380(209)	1497.8(352.8)	680(280)	600(386)	84(68)	243.9(141.7)	4232(879)	1515(560)	688(659)	312(355)	1502.0(591.6)
	g/m^2	55.10(19.52)			1.84(1.30)	10.59(4.18)	5.36(1.58)	7.40(6.07)	.50(.50)	2.14(1.37)	31.51(11.45)	7.79(3.11)	4.42(4.11)	1.47(1.30)	10.34(4.79)
Nov., 1974	#/m^2	7920(795)	780(422)		56(22)	854.9(138.3)		216(240)	1012(649)	780.4(526.4)	1640(768)	228(315)		228(267)	694.0(446.4)
	g/m^2	76.96(23.98)	18.26(7.77)		.27(.11)	9.32(3.16)		5.19(4.69)	15.22(8.84)	12.30(7.63)	34.50(18.67)	3.98(5.08)		3.23(4.32)	13.77(9.28)
Apr., 1975	#/m^2	376(289)	1424(1558)	284(265)	5(10)	219.1(232.7)		284(313)	4(9)	41.0(49.1)	1220(348)	684(290)	28(39)	12(18)	487.7(168.6)
	g/m^2	2.50(2.68)	22.20(28.19)	1.08(1.00)	.06(.12)	2.98(3.76)		4.99(3.99)	.06(.15)	.71(.66)	32.35(10.74)	19.57(8.07)	.48(.70)	.15(.26)	13.17(4.85)
May, 1975	#/m^2	512(304)	1124(1793)	32(61)	4(9)	203.4(276.3)		460(627)		119.1(162.4)	1892(2720)	1996(1627)	24(33)	20(14)	890.5(1163.6)
	g/m^2	2.72(2.41)	6.21(7.92)	.02(.03)	.13(.29)	1.19(1.50)		5.52(9.92)		1.43(2.57)	15.86(14.03)	19.81(16.68)	.06(.09)	.05(.03)	7.67(6.71)
Annelida															
C. Oligochaeta															

APPENDIX A1. (cont.)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Letritus	Gravel	Sand	Total
O. Plesiopora															
F. Enchytraeidae															
F. Naididae															
F. Tubificidae															
June, 1974	$\#/m^2$ g/m^2	.01(.01)	.05(.05)	.01(.02)	Tr(.01)	.01(.01)		2.53(1.37)	.13(.16)	.73(.46)	.05(.07)	.01(.01)	.02(.03)	.01(.01)	.01(.02)
Aug., 1974	$\#/m^2$ g/m^2	.21(.33)	.19(.20)	.03(.03)	.01(.01)	.07(.09)		4.52(1.61)	.25(.29)	1.88(.80)	.29(.25)	.08(.08)	.06(.06)	.26(.15)	.22(.15)
Sep., 1974	$\#/m^2$ g/m^2	.07(.04)			Tr(.01)	.01(.01)	2.87(1.44)	.85(.64)	.39(.54)	.85(.70)	.30(.55)	.21(.06)	.01(.02)	.09(.16)	.13(.21)
Nov., 1974	$\#/m^2$ g/m^2	Tr(.01)	.06(.06)			.01(.01)		.56(.24)	.60(1.16)	.59(.89)	.04(.06)	.04(.05)		Tr(.01)	.02(.04)
Apr., 1975	$\#/m^2$ g/m^2	.04(.05)	.02(.02)	Tr(.01)	.01(.01)	.01(.01)		1.42(1.27)	.04(.07)	.22(.23)	.57(1.25)	.09(.17)	.01(.01)		.17(.37)
May, 1975	$\#/m^2$ g/m^2	.05(.08)	.09(.08)	Tr(Tr)	Tr(Tr)	.02(.02)		10.16(3.41)	.11(.15)	2.72(.99)	.63(1.32)	.24(.37)	Tr(.01)	.12(.23)	.32(.63)
O. Prosopora															
F. Lumbriculidae															
June, 1974	$\#/m^2$ g/m^2										.30(1.33)				.03(.13)
Aug., 1974	$\#/m^2$ g/m^2												.46(1.02)		.06(.12)
Sep., 1974	$\#/m^2$ g/m^2														

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
F. Lumbriculidae (Cont.)															
Nov., 1974	$\#/m^2$ g/m^2								.23(.50)	.16(.36)					
Apr., 1975	$\#/m^2$ g/m^2	.20(.45)				.01(.03)									
May, 1975	$\#/m^2$ g/m^2								2.40(5.37)	1.78(3.98)					
Mollusca															
C. Gastropoda															
O. Pulmonata															
F. Ancylidae															
Ferrissia															
June, 1974	$\#/m^2$ g/m^2														
Aug., 1974	$\#/m^2$ g/m^2	4(9) .02(.05)				.7(1.5) Tr(.01)									
Sep., 1974	$\#/m^2$ g/m^2														
Nov., 1974	$\#/m^2$ g/m^2														
Apr., 1975	$\#/m^2$ g/m^2								8(18) .11(.25)	6.9(15.6) .10(.22)					
May, 1975	$\#/m^2$ g/m^2														

APPENDIX A1. (cont.)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
F. Lymnaeidae															
Lymnaea															
June, 1974	#/m^2														
	g/m^2														
Aug., 1974	#/m^2		8(18)			1.0(2.3)								8(18)	4.3(9.7)
	g/m^2		.21(.48)			.03(.06)								.25(.57)	.13(.31)
Sep., 1974	#/m^2								4(9)	2.9(6.4)					
	g/m^2								.05(.11)	.04(.08)					
Nov., 1974	#/m^2				12(11)	9.5(8.7)		16(36)		4.7(10.5)					
	g/m^2				.48(.66)	.38(.52)		.20(.45)		.06(.13)					
Apr., 1975	#/m^2		4(9)		5(10)	4.3(8.6)									
	g/m^2		.01(.02)		.06(.13)	.05(.10)									
May, 1975	#/m^2				12(27)	8.7(19.5)					12(11)	4(9)			4.8(4.9)
	g/m^2				.83(1.86)	.60(1.34)					1.22(1.68)	.32(.71)			.48(.69)
F. Physidae															
Physa															
June, 1974	#/m^2				4(9)	3.6(8.1)					12(27)	4(9)	4(9)		2.4(5.4)
	g/m^2				.46(1.02)	.41(.92)					.94(2.11)	.46(1.02)	.46(1.02)		.24(.52)
Aug., 1974	#/m^2	16(17)	4(9)			3.1(3.9)					96(104)				20.1(21.7)
	g/m^2	2.39(3.00)	.20(.45)			.42(.55)					2.25(2.67)				.47(.56)
Sep., 1974	#/m^2	1160(797)			16(36)	207.8(159.4)	47(64)		4(9)	10.4(16.7)	100(111)	5(10)	8(11)		27.5(31.6)
	g/m^2	40.90(25.41)			.25(.57)	7.12(4.70)	3.18(3.20)		1.28(2.86)	1.42(2.56)	4.92(5.29)	.25(.51)	.52(.74)		1.39(1.57)
Nov., 1974	#/m^2	84(133)	64(48)		24(17)	34.1(31.1)		56(67)	4(9)	19.1(25.9)	28(23)	4(9)			10.4(10.3)
	g/m^2	3.77(5.81)	6.69(4.52)		1.16(.69)	2.03(1.60)		5.19(4.98)	.20(.45)	1.65(1.77)	1.94(1.96)	.20(.45)			.70(.78)
Physa (Cont.)															
Apr., 1975	#/m^2	8(11)		16(36)	140(114)	106.7(88.7)		68(41)		9.0(5.4)	76(54)	8(11)			22.1(16.9)
	g/m^2	.26(.44)		1.08(2.43)	5.52(4.04)	4.19(3.22)		7.06(5.35)		.93(.71)	4.5(3.8)	.92(1.25)			1.41(1.30)
May, 1975	#/m^2	4(9)			4(9)	3.3(7.4)		36(36)	32(61)	33.0(54.5)	56(33)				20.8(12.3)
	g/m^2	.62(1.40)			.32(.71)	.29(.65)		5.65(5.51)	5.28(11.25)	5.38(9.76)	6.32(2.82)				2.35(1.05)
F. Planorbidae															
Gyraulus															
June, 1974	#/m^2	4(9)	4(9)		4(9)	3.9(8.8)									
	g/m^2	.11(.25)	.11(.25)		.32(.71)	.30(.66)									
Aug., 1974	#/m^2														
	g/m^2														
Sep., 1974	#/m^2	808(341)			8(18)	142.7(69.9)									
	g/m^2	11.94(3.10)			.06(.14)	2.07(.62)									
Nov., 1974	#/m^2	32(52)	8(18)		108(81)	89.6(71.1)									
	g/m^2	.51(.72)	.10(.23)		1.18(.56)	1.00(.54)									
Apr., 1975	#/m^2	8(18)	8(18)	4(9)	30(26)	24.3(23.4)		4(9)	4(9)	4.0(9.0)					
	g/m^2	.10(.22)	.10(.22)	.05(.11)	.34(.26)	.28(.25)		.01(.02)	.01(.02)	.01(.02)					
May, 1975	#/m^2	12(11)			84(46)	61.9(34.4)		8(18)	16(17)	13.9(17.3)		4(9)			.4(.8)
	g/m^2	.28(.29)			.65(.31)	.50(.25)		.10(.22)	.33(.30)	.27(.28)		.05(.11)			Tr(.01)
Helisoma															
June, 1974	#/m^2														
	g/m^2														
Aug., 1974	#/m^2														
	g/m^2														

APPENDIX A1. (cont.)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Helisoma (Cont.)															
Sep., 1974	#/m^2														
	g/m^2														
Nov., 1974	#/m^2	8(18)			4(9)	3.9(8.8)									
	g/m^2	.64(1.43)			.62(1.40)	.55(1.24)									
Apr., 1975	#/m^2														
	g/m^2														
May, 1975	#/m^2														
	g/m^2														
C. Pelecypoda															
F. Sphaeriidae															
Pisidium															
June, 1974	#/m^2							64(89)	28(33)	37.0(47.0)	4(9)	12(18)	4(9)	16(17)	12.7(15.6)
	g/m^2							.61(.82)	.11(.20)	.24(.59)	.01(.01)	.05(.11)	.02(.05)	.06(.07)	.05(.07)
Aug., 1974	#/m^2							4(9)	2.5(5.6)	92(102)	92(102)	264(172)	4(9)	168(142)	144.8(121.4)
	g/m^2							.02(.05)	.01(.05)	.64(.89)	.64(.89)	1.59(.99)	.01(.01)	.67(.67)	.70(.68)
Sep., 1974	#/m^2						20(35)		20(35)	17.5(30.6)	64(100)	735(567)	8(18)	32(52)	99.0(102.4)
	g/m^2						.06(.10)		.12(.25)	.10(.20)	.26(.31)	2.41(2.12)	.03(.07)	.12(.18)	.34(.36)
Nov., 1974	#/m^2				8(11)	6.4(8.7)		384(364)	16(26)	123.1(124.4)	8(18)	96(46)		32(23)	42.8(28.1)
	g/m^2				.04(.06)	.03(.05)		2.48(2.62)	.08(.12)	.78(.85)	.03(.07)	.80(.47)		.10(.07)	.28(.19)
Apr., 1975	#/m^2							16(26)	100(100)	88.9(90.2)			12(18)	28(33)	13.5(16.1)
	g/m^2							.06(.09)	.29(.35)	.26(.32)			.11(.18)	.16(.18)	.08(.09)
May, 1975	#/m^2	4(9)			4(9)	3.3(7.4)		140(147)	100(119)	110.4(126.3)	8(11)	4(9)	16(17)	100(130)	52.6(68.7)
	g/m^2	.01(.01)			.01(.01)	.01(.01)		.76(.77)	.42(.56)	.51(.61)	.08(.12)	.01(.01)	.02(.02)	.21(.27)	.13(.18)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Sphaerium															
June, 1974	#/m^2				4(9)	3.6(8.1)			24(9)	18(6.8)	8(11)				.8(1.0)
	g/m^2				.02(.05)	.02(.04)			.07(.06)	.05(.04)	1.66(2.72)				.16(.26)
Aug., 1974	#/m^2										8(18)				1.7(3.8)
	g/m^2										.01(.02)				Tr(Tr)
Sep., 1974	#/m^2				4(9)	2.7(6.0)						20(40)			1.9(3.8)
	g/m^2				.02(.05)	.01(.03)						.03(.06)			Tr(.01)
Nov., 1974	#/m^2														
	g/m^2														
Apr., 1975	#/m^2							8(18)	4(9)	4.5(10.2)			4(9)		.10(.30)
	g/m^2							.05(.11)	.64(1.43)	.56(1.26)			.92(2.06)		.03(.08)
May, 1975	#/m^2										4(9)				1.5(3.3)
	g/m^2										.31(.70)				.12(.26)
Miscellaneous															
June, 1974	#/m^2	12(11)	8(11)	24(43)	4(11)	4.9(11.8)		4(9)	4(9)	4.0(9.0)	64(71)	8(11)	32(23)		11.2(11.5)
	g/m^2	.05(.09)	.65(1.44)	.02(.03)	Tr(.01)	.04(.08)		.77(1.72)	.01(.01)	.20(.44)	2.54(4.39)	.02(.03)	.09(.08)		.26(.43)
Aug., 1974	#/m^2	164(74)		68(36)	4(9)	32.0(19.5)		28(33)	8(18)	15.6(23.7)	60(32)	52(84)	140(126)	4(9)	38.6(38.0)
	g/m^2	.30(.15)		.22(.14)	.01(.03)	.06(.05)		7.44(16.16)	.06(.14)	2.87(6.24)	.29(.33)	.28(.42)	.40(.34)	.01(.03)	.15(.18)
Sep., 1974	#/m^2	80(65)			8(11)	18.9(18.4)	20(20)	20(20)	16(17)	17.1(17.9)	80(57)	25(38)	48(39)	4(9)	37.5(32.2)
	g/m^2	1.61(2.86)			.39(.79)	.53(1.01)	.02(.02)	.27(.24)	.14(.19)	.14(.17)	.27(.27)	.13(.17)	.14(.11)	.01(.03)	.12(.13)
Nov., 1974	#/m^2	180(94)	4(9)			16.7(9.6)		60(63)	268(422)	207.5(317.5)	104(54)	60(20)			51.9(23.7)
	g/m^2	4.09	Tr(Tr)			.37(.16)		7.69(13.88)	20.16(14.34)	16.53(14.21)	.70(.35)	.27(.18)			.31(.17)
Apr., 1975	#/m^2	72(86)	72(82)	12(18)		14.16.4)		52(48)	56(114)	55.5(105.3)	200(85)	20(14)	4(9)		58.1(26.2)
	g/m^2	.46(.40)	.36(.38)	.25(.49)		.09(.10)		.29(.45)	.92(1.31)	.84(1.63)	4.55(5.34)	.04(.04)	.06(.15)		1.23(1.44)

APPENDIX A1. (cont.)

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Miscellaneous (Cont.)															
May, 1975	$\#/m^2$	92(48)	32(23)	12(18)		14.0(8.6)		112(61)	4(9)	32.0(22.5)	12(18)		16(36)		5.3(8.7)
	g/m^2	.40(.22)	.96(1.92)	.02(.03)		.17(.28)		.73(.38)	.01(.01)	.20(.10)	.11(.21)		.01(.03)		.04(.08)
TOTAL															
June, 1974	$\#/m^2$	9060(3467.8)	4408(2196.7)	2276(491.0)	48(14.2)	550.6(221.6)		9488(3095.4)	280(90.2)	2582(841.5)	3216(423.2)	4900(1397.2)	932(111.3)	460(111.8)	1712.8(413.8)
	g/m^2	44.34(12.96)	16.98(5.95)	18.25(7.57)	1.22(.76)	3.51(1.50)		51.00(11.38)	3.91(1.06)	15.68(3.64)	57.76(13.01)	25.41(3.93)	10.71(2.64)	5.59(1.32)	15.32(3.12)
Aug., 1974	$\#/m^2$	14596(4743.1)	1992(442.6)	4972(1982.2)	5584(1786.7)	6583.7(2107.9)		5016(1601.2)	1644(1317.8)	2928.6(1425.8)	13688(2123.7)	5884(1349.4)	4644(594.0)	756(174.6)	4610(854.2)
	g/m^2	55.74(23.34)	12.38(2.41)	14.60(2.69)	12.87(2.48)	19.89(5.90)		64.41(15.91)	7.04(2.32)	28.88(7.50)	87.48(17.25)	43.70(11.53)	28.07(3.71)	7.99(2.89)	31.77(7.13)
Sep., 1974	$\#/m^2$	19600(2060.8)			10616(3278.0)	10391.7(2530.2)	2267(426.7)	807(297.8)	724(298.4)	981.4(318.9)	6420(671.4)	3065(475.4)	2752(619.2)	992(418.8)	3036.2(544.4)
	g/m^2	135.81(16.94)			27.94(8.46)	41.67(8.51)	28.48(2.90)	13.66(4.79)	8.14(2.93)	12.09(3.16)	53.46(9.74)	19.49(4.30)	26.49(7.14)	5.93(1.83)	24.88(5.55)
Nov., 1974	$\#/m^2$		12072(898.6)	2349(446.0)	620(131.1)	1860.9(232.2)		5952(1749.1)	1876(463.7)	3062.1(837.5)	3096(699.6)	2948(1118.2)		592(142.3)	2108.6(612.1)
	g/m^2		120.06(17.25)	32.75(5.77)	10.02(2.15)	22.65(3.94)		47.71(5.92)	46.21(9.65)	46.65(8.56)	53.59(13.62)	12.96(2.93)		17.39(3.70)	28.03(6.75)
Apr., 1975	$\#/m^2$	5876(3405.2)	8632(4791.5)	1120(455.2)	255(71.2)	1676.9(826.3)		13684(2802.5)	544(133.4)	2278.5(1145.7)	16685(6560.9)	5212(1854.5)	2212(1249.8)	844(560.5)	6114.9(2481.3)
	g/m^2	23.40(4.94)	30.36(18.03)	5.72(1.22)	9.08(3.30)	13.43(5.06)		54.26(13.58)	5.80(1.39)	12.20(3.00)	126.06(13.89)	40.68(8.56)	15.84(2.91)	5.71(1.66)	46.15(6.54
May, 1975	$\#/m^2$	11128(4383.2)	8120(2483.5)	6280(3530.2)	2088(1586.0)	3926.9(2289.0)		20528(2643.4)	660(280.8)	5805.8(992.7)	8468(1721.7)	5110(2523.8)	3472(1875.0)	4660(6669.3)	6046.1(4193.6)
	g/m^2	24.09(5.08)	21.93(8.09)	7.75(2.74)	4.32(1.18)	9.76(2.55)		70.36(12.56)	11.33(6.77)	28.95(8.22)	50.64(6.79)	30.05(13.39)	11.32(2.68)	4.14(2.57)	24.11(5.10)

NOT INCLUDED IN BENTHIC CALCULATIONS

NOT INCLUDED IN BENTHIC CALCULATIONS

Arthropoda

C. Crustacea

O. Decapoda

F. Camberinae

		NEW DITCH					OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Gravel	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Orconectes															
June, 1974	$\#/m^2$														
	g/m^2														
Aug., 1974	$\#/m^2$	4				0.7		4		1.5					
	g/m^2	0.80				0.13		28.[illegible]		10.97					
Sep., 1974	$\#/m^2$														
	g/m^2														
Nov., 1974	$\#/m^2$														
	g/m^2														
Apr., 1975	$\#/m^2$														
	g/m^2														
May, 1975	$\#/m^2$														
	g/m^2														
Annelida															
C. Hirudinea															
June, 1974	$\#/m^2$								4	3.0	4				0.4
	g/m^2								0.12	0.9	0.30				0.03
Aug., 1974	$\#/m^2$	4				0.7		4		1.5	4				0.8
	g/m^2	8.20				1.34		0.14		0.05	0.30				0.06
Sep., 1974	$\#/m^2$										16		4	4	6.6
	g/m^2										7.77		0.01	0.20	1.99
Nov., 1974	$\#/m^2$							4	4	4.0	4			4	2.8
	g/m^2							0.73	0.04	0.24	0.23			0.03	0.09
Apr., 1975	$\#/m^2$										24				6.4
	g/m^2										2.57				0.69
May, 1975	$\#/m^2$							4	4	4.0	20				7.44
	g/m^2							0.24	Tr	0.06	0.88				0.33

APPENDIX A2. BENTHIC BIOMASS AND DENSITY FOR EACH AVAILABLE SUBSTRATE TYPE IN DOWNSTREAM SITES, BUENA VISTA MARSH, PORTAGE COUNTY, WISCONSIN. (standard deviation in parentheses)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Substrate composition (%)														
June, 1974		35.0	50.0	15.0	100	6.0	4.4	89.6	100	5.0	5.0	5.0	85.0	100
Aug., 1974		55.0	35.0	10.0	100	26.5	9.2	64.3	100	5.0	7.0	3.0	85.0	100
Sep., 1974		70.0	20.0	10.0	100	14.5	13.5	72.0	100	0	15.0	5.0	80.0	100
Nov., 1974		0	90.0	10.0	100	0	15.0	85.0	100	0	2.0	0	98.0	100
Apr., 1975		0	100.0	0	100	*	*	*	100	*	*	*	*	100
May, 1975		0	84.5	15.5	100	0	9.1	90.9	100	*	*	*	*	100
Arthropoda														
C. Insecta														
O. Coleoptera														
F. Elmidae														
Dubiraphia														
June, 1974	#/m^2 g/m^2	232(186) .63(.63)	176(227) .60(.87)		169.2(178.6) .52(.67)	1080(493) 1.60(.79)	592(426) .98(.77)	104(189) .12(.22)	134.0(217.7) .25(.28)	20(23) .05(.06)				1.0(1.2) Tr(Tr)
Aug., 1974	#/m^2 g/m^2	176(308) .43(.69)	184(173) .61(.68)	48(52) .19(.25)	166.0(235.2) .47(.64)	960(686) 2.54(2.15)	960(1435) 1.91(2.20)	136(282) .50(1.01)	430.2(495.1) 1.17(1.42)	56(54) .10(.10)	64(54) .12(.11)	20(23) .01(.01)		7.9(7.2) .01(.01)
Sep., 1974	#/m^2 g/m^2	728(514) 2.11(2.00)	1984(1862) 6.11(5.27)	32(33) .09(.16)	909.6(735.5) 2.71(2.47)	7136(5411) 8.85(6.59)	96(67) .39(.36)	456(408) .39(.33)	1376.0(1097.4 1.62(1.24			24(36) .08(.16)	16(36) Tr(.01)	14.0(30.6) .01(.01)
Nov., 1974	#/m^2 g/m^2		608(193) 1.51(.62)	220(167) .54(.54)	569.2(190.4) 1.41(.61)		1696(1896) 6.18(6.67)	664(316) .61(.39)	818.8(553.0) 1.45(1.33)		27(46) .01(.01)		8(18) Tr(.01)	8.4(18.6) Tr(.01)
Apr., 1975	#/m^2 g/m^2		64(61) .05(.04)		64(61) .05(.04)									4.0(13.0) Tr(Tr)
May, 1975	#/m^2 g/m^2		8(18) .01(.03)	8(18) .01(.03)	8(18) .01(.03)		36(41) .09(.13)	8(18) .02(.05)	10.5(20.1) .03(.06)					10.0(28.0) Tr(.01)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
O. Diptera														
F. Chironomidae														
June, 1974	#/m^2 g/m^2	7936(8546) 15.68(13.20)	1576(887) 6.29(3.28)		3565.6(3434.6) 8.63(6.26)	4827(5689) 5.53(6.81)	280(198) 1.21(1.13)	232(145) .52(.76)	509.8(480.0) .85(1.14)	4930(2960) 5.34(3.65)	2333(720) 4.77(1.80)	944(854) 1.06(1.34)	12(77) .15(.13)	420.6(292.2) .71(.45)
Aug., 1974	#/m^2 g/m^2	5336(2778) 8.03(4.17)	512(166) 1.79(1.06)	200(150) .66(.37)	3134.0(1601.0) 5.11(2.70)	3436(4594) 4.65(5.29)	152(128) .65(1.13)	720(417) .66(.35)	1387.5(1497.3) 1.72(1.73)	2184(1154) 1.87(1.63)	496(224) .77(.44)	590(128) .13(.09)	216(373) .04(.05)	345.2(394.3) .19(.16)
Sep., 1974	#/m^2 g/m^2	6728(4143) 7.92(5.31)	1768(703) 4.39(1.64)	64(104) .03(.04)	5069.6(3051.1) 6.24(4.05)	11344(5315) 11.60(4.25)	3728(1662) 8.89(5.78)	1040(546) 1.23(.70)	2897.0(1388.2) 3.77(1.90)		330(321) .92(1.37)	248(444) .11(.16)	112(186) .12(.19)	151.5(219.2) .24(.37)
Nov., 1974	#/m^2 g/m^2		3424(1242) 11.46(4.51)	696(609) .34(.44)	3151.2(1178.7) 10.35(4.11)		1056(1277) 11.11(20.91)	1464(959) 3.00(3.05)	1402.8(1006.7) 4.22(5.73)		5160(7317) 3.38(4.48)		264(328) .02(.03)	361.9(467.8) .09(.12)
Apr., 1975	#/m^2 g/m^2		224(128) .18(.19)		224.0(128.0) .18(.19)				312.0(343.0) .25(.32)					747.0(1444.0) .43(1.15)
May, 1975	#/m^2 g/m^2		940(924) 1.80(1.73)	472(427) 1.32(1.39)	867.5(847.0) 1.73(1.68)		464(213) 1.15(.77)	212(246) .58(.59)	234.9(243.0) .63(.61)					440.0(640.0) .96(2.12)
F. Simuliidae														
Simulium														
June, 1974	#/m^2 g/m^2	416(728) 1.90(3.30)			145.6(254.8) .66(1.16)	1460(1424) 3.68(3.60)		8(18) .01(.03)	94.8(101.6) .23(.24)	27760(17043) 68.05(42.70)	27(23) .14(.14)	464(462) .50(.58)		1412.6(876.4) 3.44(2.17)
Aug., 1974	#/m^2 g/m^2	1840(2275) 5.77(7.90)	8(18) .01(.03)		1014.8(1257.6) 3.18(4.36)	960(1969) 2.45(4.95)			254.4(521.9) .65(1.31)	1992(1622) 4.88(4.72)		130(210) .21(.26)		103.5(87.4) .25(.24)
Sep., 1974	#/m^2 g/m^2	2352(4283) 3.26(4.19)			1646.4(2998.1) 2.28(2.93)	6896(4053) 24.73(16.36)			999.9(587.7) 3.59(2.37)			24(54) .03(.07)	56(104) .05(.09)	46.0(85.9) .04(.08)

APPENDIX A2. (cont.)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Simulium (Cont.)														
Nov., 1974	#/m^2							16(36)	13.6(30.6)					
	g/m^2							.01(.03)	.01(.03)					
Apr., 1975	#/m^2													
	g/m^2													
May, 1975	#/m^2		56(67)		47.3(56.6)									
	g/m^2		.08(.15)		.07(.13)									
F. Tabanidae														
Chrysops														
June, 1974	#/m^2									20(23)				1.0(1.2)
	g/m^2									3.37(4.32)				.17(.22)
Aug., 1974	#/m^2	24(54)		8(18)	14.0(31.5)			8(18)	5.1(11.6)	8(18)	40(40)			3.2(3.7)
	g/m^2	2.67(5.98)		.13(.30)	1.48(3.32)			.08(.19)	.05(.12)	.26(.59)	2.49(4.25)			.19(.33)
Sep., 1974	#/m^2	8(18)			5.6(12.6)	8(18)	8(18)		2.2(5.0)		80(86)	24(36)	16(36)	26.0(43.5)
	g/m^2	.45(1.01)			.32(.71)	.45(1.01)	1.81(4.04)		.31(.69)		8.38(8.41)	1.46(2.41)	.49(1.09)	1.72(2.26)
Nov., 1974	#/m^2		8(18)	16(36)	8.8(19.8)		8(18)	8(18)	8.0(18.0)		27(46)			.5(.9)
	g/m^2		2.11(4.72)	.09(.20)	1.91(4.27)		1.54(3.44)	1.54(3.44)	1.54(3.44)		.64(1.10)			.01(.02)
Apr., 1975	#/m^2													
	g/m^2													
May, 1975	#/m^2		8(18)		6.8(15.2)		8(18)		.7(1.6)					15.0(30.0)
	g/m^2		.35(.78)		.30(.66)		.05(.12)		.01(.01)					.17(.35)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
F. Tipulidae														
Dicanota														
June, 1974	#/m^2													
	g/m^2													
Aug., 1974	#/m^2													
	g/m^2													
Sep., 1974	#/m^2													
	g/m^2													
Nov., 1974	#/m^2													
	g/m^2													
Apr., 1975	#/m^2													
	g/m^2													
May, 1975	#/m^2													
	g/m^2													
Hexatoma														
June, 1974	#/m^2							8(18)	7.2(16.1)			80(18)		4.0(.9)
	g/m^2							.08(.19)	.07(.17)			.05(.12)		Tr(.01)
Aug., 1974	#/m^2			88(67)	8.8(8.7)	24(54)	8(18)	16(36)	17.4(39.1)					
	g/m^2			1.84(1.83)	.18(.18)	.40(.91)	.05(.12)	.32(.73)	.32(.72)					
Sep., 1974	#/m^2	192(429)		40(69)	138.4(307.2)							40(57)	32(33)	27.6(29.2)
	g/m^2	7.23(16.17)		2.25(3.88)	5.29(11.71)							2.74(4.05)	.03(.03)	.16(.23)
Nov., 1974	#/m^2			24(54)	2.4(5.4)		32(33)	16(22)	18.4(23.6)		293(227)		24(36)	29.4(39.8)
	g/m^2			1.33(2.99)	.13(.30)		2.15(2.13)	1.61(2.23)	1.69(2.22)		.94(.57)		.12(.23)	.14(.24)

APPENDIX A2. (cont.)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Hexatoma (Cont.)														
Apr., 1975	$\#/m^2$ g/m^2													18.0(21.0) .06(.07)
May, 1975	$\#/m^2$ g/m^2													5.0(14.0) .03(.09)
Pilaria														
June, 1974	$\#/m^2$ g/m^2													
Aug., 1974	$\#/m^2$ g/m^2													
Sep., 1974	$\#/m^2$ g/m^2												8(18) .01(.01)	6.4(14.4) .01(.01)
Nov., 1974	$\#/m^2$ g/m^2			8(18) .03(.07)	.8(1.8) Tr(.01)						27(23) .41(.49)			.5(.5) .01(.01)
Apr., 1975	$\#/m^2$ g/m^2													
May, 1975	$\#/m^2$ g/m^2													
O. Ephemeroptera														
F. Baetidae														
Baetis														
June, 1974	$\#/m^2$ g/m^2		8(18) .05(.12)		4.0(9.0) .02(.06)	27(21) .14(.18)			1.6(1.3) .01(.01)	130(183) .33(.28)		32(52) .06(.12)	8(18) .01(.01)	14.9(27.0) .03(.03)
Baetis (Cont.)														
Aug., 1974	$\#/m^2$ g/m^2	16(22) .08(.12)			8.3(12.1) .04(.07)	8(18) .01(.03)			2.1(4.8) Tr(.01)	368(273) .62(.34)		130(154) .21(.21)		22.3(18.3) .04(.02)
Sep., 1974	$\#/m^2$ g/m^2	32(44) .22(.31)	8(18) .05(.12)		24.0(34.4) .16(.24)							88(197) .32(.72)	128(264) .26(.46)	106.8(221.0) .22(.40)
Nov., 1974	$\#/m^2$ g/m^2						8(18) .05(.12)		1.2(2.7) .01(.02)					
Apr., 1975	$\#/m^2$ g/m^2													
May, 1975	$\#/m^2$ g/m^2													
F. Caenidae														
Caenis														
June, 1974	$\#/m^2$ g/m^2	48(52) .11(.11)	72(161) .29(.66)		52.8(98.7) .18(.37)	907(716) 4.54(5.16)	1248(954) 5.47(4.09)	24(36) .02(.03)	130.8(117.2) .53(.52)	20(40) .04(.09)	67(115) .79(1.37)			4.4(7.8) .04(.07)
Aug., 1974	$\#/m^2$ g/m^2	16(22) .04(.07)	48(72) .20(.30)	8(18) .01(.03)	26.4(39.1) .09(.15)	376(394) 1.15(1.20)	608(1074) 1.45(2.30)		155.6(203.2) .44(.53)	168(197) .33(.48)	16(36) .03(.07)	80(73) .13(.11)		11.9(12.4) .02(.03)
Sep., 1974	$\#/m^2$ g/m^2	184(211) .14(.16)	96(88) .06(.07)		148.0(165.3) .11(.13)	1384(1710) 1.33(1.45)		64(92) .02(.03)	246.8(314.2) .21(.23)					
Nov., 1974	$\#/m^2$ g/m^2		48(72) .07(.13)	24(36) .01(.02)	45.6(69.4 .06(.14			200(339) .11(.14)	170.0(288.2) .09(.12)					
Apr., 1975	$\#/m^2$ g/m^2								8.0(18.0) .01(.03)					

APPENDIX A2. (cont.)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Caenis (Cont.)														
May, 1975	#/m^2 g/m^2		64(83) .07(.09)	8(18) Tr(Tr)	55.3(72.9) .06(.08)		136(282) .32(.67)	16(36) .03(.07)	26.9(58.4) .06(.12)					
F. Ephemeridae														
Hexagenia														
June, 1974	#/m^2 g/m^2					7(16) 3.44(8.42)	40(40) 15.69(20.36)		2.2(2.7) .90(1.40)		353(200) 41.95(50.82)			17.6(10.0) 2.10(2.54)
Aug., 1974	#/m^2 g/m^2		24(36) .09(.14)		8.4(12.6) .03(.05)	184(187) 1.57(1.91)		104(211) 1.37(2.98)	115.6(182.5) 1.30(2.98)	16(36) .08(.17)	128(107) 18.76(20.86)			9.8(9.3) 1.32(1.47)
Sep., 1974	#/m^2 g/m^2	32(33) 4.74(6.21)	16(22) 3.93(6.95)		25.6(27.5) 4.10(5.74)	32(52) 4.19(7.15)	8(18) 2.44(5.46)		5.7(10.0) .94(1.77)		280(163) 131.8(99.55)		48(107) 2.94(6.58)	80.4(110.0) 22.03(20.20)
Nov., 1974	#/m^2 g/m^2		40(40) 7.42(13.05)		36.0(36.0) 6.68(11.74)		16(36) 8.24(18.42)	24(54) 2.76(6.17)	22.8(51.3) 3.58(8.01)		40(40) 17.66(30.44)			.8(.8) .35(.61)
Apr., 1975	#/m^2 g/m^2		8(18) 2.11(4.72)		8(18) 2.11(4.74)									
May, 1975	#/m^2 g/m^2						56(46) 24.97(19.44)		5.1(4.2) 2.27(1.27)					30.0(85.0) .27(.77)
O. Hemiptera														
F. Corixidae														
Hesperocorixa														
June, 1974	#/m^2 g/m^2	8(18) .01(.03)	64(100) .11(.13)		34.8(56.3) .06(.08)						413(716) .06(.10)			20.6(35.8) Tr(.01)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Hesperocorixa (Cont.)														
Aug., 1974	#/m^2 g/m^2	48(107) .10(.22)		32(18) .06(.06)	29.6(60.6) .06(.13)	152(180) .28(.33)	112(186) .08(.11)	40(57) .11(.17)	76.3(101.5) .15(.21)		136(119) .16(.20)			9.5(8.3) .01(.01)
Sep., 1974	#/m^2 g/m^2			232(455) .52(1.09)	23.2(45.5) .05(.11)		176(143) 1.40(2.80)		23.8(19.3) .19(.39)		140(101) .40(.29)		16(36) .09(.20)	33.8(44.0) .13(.20)
Nov., 1974	#/m^2 g/m^2		56(78) .35(.48)	120(126) .98(.90)	62.4(82.8) .41(.52)		48(72) .17(.28)		7.2(10.8) .03(.04)					
Apr., 1975	#/m^2 g/m^2		24(36) .36(.52)		24(36) .36(.52)				8.0(18.0) .03(.07)					4.0(13.0) .01(.05)
May, 1975	#/m^2 g/m^2			8(18) .03(.07)	1.2(2.8) .01(.01)		16(36) .09(.20)		1.5(3.3) .01(.02)					
O. Megaloptera														
F. Sialidae														
Sialis														
June, 1974	#/m^2 g/m^2													
Aug., 1974	#/m^2 g/m^2													
Sep., 1974	#/m^2 g/m^2													
Nov., 1974	#/m^2 g/m^2													

APPENDIX A2. (cont.)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Sialis (Cont.)														
Apr., 1975	$\#/m^2$													
	g/m^2													
May, 1975	$\#/m^2$													
	g/m^2													
O. Trichoptera														
F. Brachycentridae														
Brachycentrus														
June, 1974	$\#/m^2$					40(36)			2.4(2.2)	2460(1538)	27(46)	116(78)		130.2(83.1)
	g/m^2					.49(.89)			.03(.05)	5.18(5.72)	.08(.13)	.41(.29)		.28(.31)
Aug., 1974	$\#/m^2$					16(22)			4.2(5.8)	480(385)		290(376)		32.7(30.5)
	g/m^2					.14(.20)			.04(.05)	3.51(2.94)		1.95(1.82)		.24(.20)
Sep., 1974	$\#/m^2$													
	g/m^2													
Nov., 1974	$\#/m^2$													
	g/m^2													
Apr., 1975	$\#/m^2$													
	g/m^2													
May, 1975	$\#/m^2$													
	g/m^2													
F. Hydropsychidae														
Cheumatopsyche														
June, 1974	$\#/m^2$	944(1596)	8(18)		334.4(567.6)	80(91)			4.8(5.5)					
	g/m^2	.59(.64)	Tr(Tr)		.21(.23)	.15(.28)			.01(.02)					

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Cheumatopsyche (Cont.														
Aug., 1974	$\#/m^2$	1768(1775)	56(125)		992.0(1020.0)	1056(1681)	352(701)		312.2(510.0)					
	g/m^2	9.57(9.61)	.26(.59)		5.36(5.49)	1.94(2.68)	1.35(2.30)		.64(.92)					
Sep., 1974	$\#/m^2$	2496(1399)		8(18)	1748.8(982.9)	1312(728)		24(54)	207.5(144.4)					
	g/m^2	4.78(3.81)		.01(.01)	3.35(2.67)	2.41(2.12)		.02(.04)	.36(.34)					
Nov., 1974	$\#/m^2$		48(72)		43.2(64.8)									
	g/m^2		.28(.54)		.25(.49)									
Apr., 1975	$\#/m^2$													
	g/m^2													
May, 1975	$\#/m^2$													
	g/m^2													
Hydropsyche														
June, 1974	$\#/m^2$									30(38)		136(262)		8.3(15.0)
	g/m^2									.25(.47)		5.05(11.05)		.27(.58)
Aug., 1974	$\#/m^2$									752(719)		470(519)	8(18)	58.5(66.8)
	g/m^2									1.28(1.79)		1.93(1.32)	Tr(.01)	.12(.13)
Sep., 1974	$\#/m^2$											16(36)		.8(1.8)
	g/m^2											.03(.08)		Tr(Tr)
Nov., 1974	$\#/m^2$													
	g/m^2													
Apr., 1975	$\#/m^2$													4.0(13.0)
	g/m^2													Tr(.01)
May, 1975	$\#/m^2$													
	g/m^2													

APPENDIX A2. (cont.)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
F. Limnephilidae														
Limnephilus														
June, 1974	#/m^2						8(18)		.4(.8)					
	g/m^2						3.64(8.15)		.16(.36)					
Aug., 1974	#/m^2													
	g/m^2													
Sep., 1974	#/m^2													
	g/m^2													
Nov., 1974	#/m^2													
	g/m^2													
Apr., 1975	#/m^2													
	g/m^2													
May, 1975	#/m^2							8(18)	7.2(16.4)					
	g/m^2							.35(.79)	.32(.71)					
Pycnopsyche														
June, 1974	#/m^2						16(36)		.7(1.6)			8(18)	8(18)	7.2(16.2)
	g/m^2						3.92(8.76)		.17(.38)			.72(1.61)	2.81(6.28)	2.42(5.42)
Aug., 1974	#/m^2									8(18)		10(20)		.7(1.5)
	g/m^2									1.29(2.89)		1.92(3.84)		.12(.26)
Sep., 1974	#/m^2					32(72)			4.6(10.4)					
	g/m^2					.36(.80)			.05(.12)					
Nov., 1975	#/m^2										27(23)			.5(.5)
	g/m^2										5.28(6.27)			.11(.12)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Pycnopsyche (Cont.)														
Apr., 1975	#/m^2													4.0(13.0)
	g/m^2													.49(1.48)
May, 1975	#/m^2													
	g/m^2													
C. Crustacea														
O. Amphipoda														
Gammarus														
June, 1974	#/m^2		8(18)		4.0(9.0)	87(109)	648(1076)		33.7(53.9)	190(276)	67(83)	152(234)	16(36)	34.0(60.2)
	g/m^2		Tr(Tr)		Tr(Tr)	.20(.31)	4.97(7.05)		.23(.33)	1.01(1.83)	.14(.18)	.17(.30)	.03(.08)	.09(.18)
Aug., 1974	#/m^2	16(36)	8(18)	64(100)	18.0(36.1)	16(36)	376(819)		38.8(84.9)	1488(1067)	336(241)	1020(1695)		128.5(121.1)
	g/m^2	.11(.25)	.01(.03)	.10(.20)	.08(.17)	.03(.07)	1.77(3.94)		.17(.38)	9.16(9.37)	1.75(2.38)	3.23(6.03)		.68(.82)
Sep., 1974	#/m^2	24(54)	16(22)		20.0(42.2)						110(171)	56(88)	24(36)	38.5(58.9)
	g/m^2	.18(.40)	.04(.07)		.13(.29)						.34(.48)	.24(.37)	.07(.13)	.12(.20)
Nov., 1974	#/m^2			40(28)	4.0(2.8)		8(18)		1.2(2.7)		1427(2299)			28.5(46.0)
	g/m^2			1.12(.97)	.11(.10)		.09(.20)		.01(.03)		42.31(66.72)			.85(1.33)
Apr., 1975	#/m^2													18.0(53.0)
	g/m^2													.76(2.28)
May, 1975	#/m^2			8(18)	1.2(2.8)									18.0(36.0)
	g/m^2			Tr(Tr)	Tr(Tr)									.91(2.58)

Annelida

C. Oligochaeta

APPENDIX A2. (cont.)

	NEW DITCH				OLD DITCH				NATURAL				
	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Detritus	Gravel	Sand	Total
O. Plesiopora													
F. Enchytraeidae													
F. Naididae													
F. Tubificidae													
June, 1974 #/m^2 g/m^2	1.14(1.32)	1.99(1.19)		1.39(1.06)	2.33(2.94)	.46(.64)	.07(.06)	.22(.25)	.07(.14)	.02(.03)	.01(.01)	.01(.01)	.01(.02)
Aug., 1974 #/m^2 g/m^2	3.66(3.47)	5.17(4.03)	.99(1.05)	3.92(3.43)	1.75(2.64)	1.19(1.38)	.66(.94)	1.00(1.43)	.01(.01)	.08(.13)	.01(.02)	.01(.01)	.01(.02)
Sep., 1974 #/m^2 g/m^2	3.37(3.89)	2.21(.86)	.27(.29)	2.83(2.93)	2.54(1.19)	1.88(1.38)	.53(.32)	1.01(.59)		1.63(1.33)		.01(.02)	.25(.21)
Nov., 1974 #/m^2 g/m^2	.50(.35)		.02(.05)	.45(.32)		.62(.26)	.42(.78)	.45(.70)		.12(.19)		.05(.10)	.05(.11)
Apr., 1975 #/m^2 g/m^2		.45(.23)		.45(.23)				.26(.23)					.01(.02)
May, 1975 #/m^2 g/m^2		.42(.28)	.24(.32)	.39(.29)		.69(.35)	.22(.13)	.26(.15)					.05(.12)
O. Prospora													
F. Lumbriculidae													
June, 1974 #/m^2 g/m^2		1.27(2.83)		.63(1.42)									
Aug., 1974 #/m^2 g/m^2			2.52(3.45)	.25(.34)									
Sep., 1974 #/m^2 g/m^2										1.00(2.00)			.15(.30)

	NEW DITCH				OLD DITCH				NATURAL				
	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
F. Lumbriculidae (Cont.)													
Nov., 1974 #/m^2 g/m^2	.14(.31)		.03(.06)	.13(.28)		.56(.68)		.08(.10)					
Apr., 1975 #/m^2 g/m^2													
May, 1975 #/m^2 g/m^2		2.20(4.91)		1.86((4.15)		1.91(2.15)		.17(.20)					
Mollusca													
C. Gastropoda													
O. Pulmonata													
F. Ancylidae													
Ferrissia													
June, 1974 #/m^2 g/m^2													
Aug., 1974 #/m^2 g/m^2	624(547) 6.10(5.14)	48(107) .87(1.94)		360.0(332.3) 3.66(3.51)	304(421) 2.49(3.25)			80.6(111.6) .66(.86)					
Sep., 1974 #/m^2 g/m^2	12320(7595) 89.60(53.90)	8(18) .05(.11)	24(54) .07(.16)	8628.0(5325.5) 62.74(37.77)	1776(1558) 11.44(11.17)			257.5(225.9) 1.66(1.62)					
Nov., 1974 #/m^2 g/m^2		464(182) 3.10(1.42)	48(33) .30(.21)	422.2(167.1) 2.82(1.30)		16(36) .10(.22)		2.4(5.4) .02(.03)					
Apr., 1975 #/m^2 g/m^2		72(59) .38(.40)		72(59) .38(.40)				8(18) .05(.11)					
May, 1975 #/m^2 g/m^2						8(18) .05(.11)	8(18) .23(.51)	8.0(18.0) .21(.47)					

APPENDIX A2. (cont.)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Detritus	Gravel	Sand	Total
F. Lymnaeidae														
Lymnaea														
June, 1974	$\#/m^2$	8(18)			2.8(6.3)									
	g/m^2	.64(1.43)			.22(.50)									
Aug., 1974	$\#/m^2$	8(18)			4.4(9.9)									
	g/m^2	2.56(5.72)			1.41(3.15)									
Sep., 1974	$\#/m^2$	824(502)	8(18)		578.4(355.0)	112(72)			16.2(10.4)					
	g/m^2	21.42(15.95)	.23(.51)		15.04(11.27)	.81(.77)			.12(.11)					
Nov., 1974	$\#/m^2$		72(100)	8(18)	65.6(91.8)									
	g/m^2		2.50(3.86)	.10(.22)	2.26(3.50)									
Apr., 1975	$\#/m^2$													
	g/m^2													
May, 1975	$\#/m^2$													
	g/m^2													
F. Physidae														
Physa														
June, 1974	$\#/m^2$													
	g/m^2													
Aug., 1974	$\#/m^2$					200(256)			53.0(67.8)	140(83)				7.0(4.2)
	g/m^2					7.17(11.02)			1.90(2.92)	2.79(3.22)				.14(.16)
Sep., 1974	$\#/m^2$					448(485)			65.0(70.3)					
	g/m^2					9.73(10.56)			1.41(1.53)					
Nov., 1974	$\#/m^2$			8(18)	.8(1.8)		48(107)	16(36)	20.8(46.6)		187(227)			3.7(4.5)
	g/m^2			.41(.91)	.04(.09)		.71(1.60)	.46(1.02)	.50(1.11)		5.16(7.13)			.10(.14)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Physa (Cont.														
Apr., 1975	$\#/m^2$													
	g/m^2													
May, 1975	$\#/m^2$													
	g/m^2													
F. Planorbidae														
Gyraulus														
June, 1974	$\#/m^2$													
	g/m^2													
Aug., 1974	$\#/m^2$													
	g/m^2													
Sep., 1974	$\#/m^2$	312(205)		16(36)	220.0(147.1)	64(143)			9.3(20.7)					
	g/m^2	3.43(3.11)		.10(.22)	2.41(2.20)	.82(1.83)			.12(.26)					
Nov., 1974	$\#/m^2$			24(36)	2.4(3.6)		16(36)		2.4(5.4)					
	g/m^2			.46(.89)	.05(.09)		.20(.45)		.03(.07)					
Apr., 1975	$\#/m^2$													
	g/m^2													
May, 1975	$\#/m^2$													
	g/m^2													
Helisoma														
June, 1974	$\#/m^2$	8(18)			2.8(6.3)									
	g/m^2	.69(1.54)			.24(.54)									
Aug., 1974	$\#/m^2$	80(136)			44.0(74.8)									
	g/m^2	1.07(1.75)			.59(.96)									

APPENDIX A2. (cont.)

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Helisoma (Cont.)														
Sep., 1974	#/m^2 g/m^2	24(36) 1.30(2.77)			16.8(25.2) .91(1.94)	32(72) .10(.22)			4.6(10.4) .02(.03)					
Nov., 1974	#/m^2 g/m^2						8(18) 1.63(3.66)		1.2(2.7) .24(.55)					
Apr., 1975	#/m^2 g/m^2													
May, 1975	#/m^2 g/m^2													
C. Pelecypoda														
F. Sphaeriidae														
Pisidium														
June, 1974	#/m^2 g/m^2					7(16) .04(.10)	8(18) .05(.11)		.8(1.[illegible]) Tr(.01)		13(23) .08(.15)		8(18) .01(.02)	7.4(16.4) .01(.02)
Aug., 1974	#/m^2 g/m^2		16(36) .02(.05)	8(18) .01(.02)	6.4(14.4) .01(.02)	192(267) .83(1.47)	40(90) .20(.45)	16(36) .16(.37)	64.8(102.2) .34(.67)	16(22) .11(.15)				.8(.11) .01(.01)
Sep., 1974	#/m^2 g/m^2	176(67) .30(.14)	40(89) .10(.22)	32(44) .09(.14)	134.4(69.1) .24(.16)	64(88) .06(.11)	192(230) .94(1.53)	104(169) .20(.35)	110.1(165.5) .28(.48)		290(183) 1.05(1.05)	16(22) .64(.93)	32(52) .08(.16)	69.9(70.2) .25(.33)
Nov., 1974	#/m^2 g/m^2			72(82) .19(.29)	7.2(8.2) .02(.03)		216(199) 1.32(1.55)	168(250) .69(1.06)	175.2(242.4) .78(1.13)		67(115) .47(.81)		16(22) .02(.03)	17.0(23.9) .03(.04)
Apr., 1975	#/m^2 g/m^2		56(46) .31(.34)		56.0(46.0) .31(.34)									
May, 1975	#/m^2 g/m^2						8(18) .05(.11)	32(52) .09(.12)	29.8(49.9) .09(.12)					

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Sphaerium														
June, 1974	#/m^2 g/m^2													
Aug., 1974	#/m^2 g/m^2									8(18) .01(.01)				.40(.90) Tr(Tr)
Sep., 1974	#/m^2 g/m^2										10(20) .01(.03)			1.5(3.0) Tr(.01)
Nov., 1974	#/m^2 g/m^2													
Apr., 1975	#/m^2 g/m^2													
May, 1975	#/m^2 g/m^2													
Miscellaneous														
June, 1974	#/m^2 g/m^2	104(100) 6.74(11.99)	16(22) .37(.84)		44.4(46.0) 2.54(4.62)	347(169) 2.51(2.87)	48(87) .07(.15)		22.9(14.0) .15(.18)	130(161) 1.01(1.15)	27(46) .26(.46)	144(36) .47(.28)	184(195) .57(.45)	171.4(177.9) .57(.48)
Aug., 1974	#/m^2 g/m^2	128(131) .72(.89)		16(36) .05(.11)	72.0(75.6) .40(.50)	200(172) 18.13(34.93)	16(36) 14.67(32.80)	32(33) .18(.34)	75.0(70.1) 6.27(12.49)	112(82) 8.96(17.00)		260(307) .64(.60)	88(59) .09(.06)	88.2(63.5) .54(.92)
Sep., 1974	#/m^2 g/m^2	2112(2343) 8.06(13.34)		24(22) .14(.20)	1480.8(1642.3) 5.66(9.36)	1056(128) 4.44(6.09)	32(72) 1.40(3.14)	184(115) 2.11(1.68)	289.9(111.1) 2.35(2.52)		10(20) .01(.02)	416(292) 4.40(8.02)	152(111) .18(.07)	143.9(106.4) .37(.46)
Nov., 1974	#/m^2 g/m^2		96(131) .19(.31)	128(143) .04(.06)	99.2(132.2) .18(.28)		80(75) 1.13(2.28)	172(116) 1.08(.84)	158.2(109.8) 1.01(1.06)		200(120) .56(.24)		48(52) .06(.10)	51.0(53.4) .07(.10)
Apr., 1975	#/m^2 g/m^2		20(28) .06(.12)		20(28) .06(.12)									200.0(243.0) 1.07(1.71)

APPENDIX A2. (cont.)

										NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detriuts	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Miscellaneous (Cont.)														
May, 1975	$\#/m^2$						8(18)	8(18)	8.0(18.0)					20.0(30.0)
	g/m^2						.07(.16)	.05(.12)	.05(.12)					.08(.13)
TOTAL														
June, 1974	$\#/m^2$	9704(7181.2)	1928(755.5)		4360.4(2891.2)	8869(3469.7)	2888(762.5)	376(144.8)	996.1(371.5)	35730(13758.3)	3327(620.0)	2076(534.3)	244(155.0)	2264.0(877.4)
	g/m^2	28.13(10.61)	10.97(2.52)		15.34(4.54)	24.65(4.82)	36.46(12.16)	.82(.54)	3.82(1.31)	85.48(34.80)	48.29(44.35)	8.49(6.95)	3.59(4.99)	10.17(8.55)
Aug., 1974	$\#/m^2$	10080(2239.9)	904(148.4)	472(102.0)	5907.6(1294.1)	8084(2456.5)	2624(1002.2)	1072(340.6)	3073.0(962.2)	7796(1054.8)	1216(187.2)	3000(763.7)	312(275.3)	830.1(322.8)
	g/m^2	40.91(6.08)	9.03(2.77)	6.56(2.05)	26.31(4.52)	45.53(17.10)	23.32(21.49)	4.04(1.44)	16.80(7.44)	35.26(8.23)	24.16(16.82)	10.37(3.23)	.14(.06)	3.88(1.74)
Sep., 1974	$\#/m^2$	28544(4937.8)	3904(1268.0)	472(254.2)	20808.8(3735.5)	31696(4206.3)	4240(1479.8)	1880(425.5)	6521.9(1116.0)		1250(195.9)	952(273.2)	640(137.4)	747.1(153.0)
	g/m^2	158.51(34.89)	17.18(4.00)	3.57(2.65)	116.75(2[illegible].49)	83.86(9.69)	19.17(4.41)	5.54(1.30)	18.74(2.94)		144.92(90.64)	10.05(5.06)	4.33(4.64)	25.70(17.56)
Nov., 1974	$\#/m^2$		4864(922.5)	1436(352.8)	4521.2(865.5)		3256(1420.5)	2756(633.7)	2831(751.7)		7482(5504.1)		360(251.2)	502.4(356.3)
	g/m^2		29.62(5.88)	5.99(1.22)	27.25(5.41)		35.80(12.50)	12.75(3.00)	16.21(4.42)		76.89(44.84)		.27(.15)	1.80(.79)
Apr., 1975	$\#/m^2$		468(87.5)		468(87.5)				336(319.8)					999.0(1128.8)
	g/m^2		3.90(2.70)		3.90(2.70)				.60(.25)					2.83(1.69)
May, 1975	$\#/m^2$		1076(815.9)	504(401.0)	987.3(751.6)		740(192.4)	292(188.2)	332.8(188.6)					538.0(532.0)
	g/m^2		4.92(2.91)	1.60(1.20)	4.40(2.64)		29.44(16.68)	1.57(.50)	4.11(1.97)					2.47(1.89)

NOT INCLUDED IN BENTHIC CALCULATIONS

NOT INCLUDED IN BENTHIC CALCULATIONS

Arthropoda

C. Crustacea

O. Decapoda

F. Cambarinae

		NEW DITCH				OLD DITCH				NATURAL				
		Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Sand	Total	Vegetation	Silt Detritus	Gravel	Sand	Total
Orconectes														
June, 1974	$\#/m^2$													
	g/m^2													
Aug., 1974	$\#/m^2$										24			1.7
	g/m^2										1.08			0.08
Sep., 1974	$\#/m^2$	8			5.6	8			1.2					
	g/m^2	4.01			2.81	4.00			0.58					
Nov., 1974	$\#/m^2$													
	g/m^2													
Apr., 1975	$\#/m^2$													
	g/m^2													
May, 1975	$\#/m^2$													
	g/m^2													
Annelida														
C. Hirudinea														
June, 1974	$\#/m^2$	24	16		16.4	8	8		0.8					
	g/m^2	5.10	7.16		5.36	0.26	0.58		0.05					
Aug., 1974	$\#/m^2$	8	8		7.2		8		0.7					
	g/m^2	2.13	1.90		1.83		0.60		0.05					
Sep., 1974	$\#/m^2$	8	8		7.2									
	g/m^2	10.28	1.44		7.49									
Nov., 1974	$\#/m^2$		16		14.4									
	g/m^2		2.13		1.92									
Apr., 1975	$\#/m^2$													
	g/m^2													
May, 1975	$\#/m^2$													
	g/m^2													

APPENDIX B. BIOMASS AND DENSITY OF DRIFTING INVERTEBRATES, BUENA VISTA MARSH, PORTAGE COUNTY, WISCONSIN.

	UPSTREAM						DOWNSTREAM					
	New Ditch		Old Ditch		Natural		New Ditch		Old Ditch		Natural	
	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3
Insecta												
Coleoptera												
Aug., 1974	2.06	.01	2.40	Tr	5.37	.01	1.21	.04	2.60	.01	.46	Tr
Sep., 1974	1.48	.01	1.26	Tr	.95	.16	.63	Tr	1.27	Tr	1.78	Tr
Nov., 1974	1.31	.01	.46	Tr	1.39	.02	2.90	.01	1.06	.02	8.78	.02
Apr., 1975	1.14	Tr	1.79	Tr	3.01	Tr	5.01	.04	2.63	.01	1.01	Tr
May, 1975	1.44	.01	1.75	.01	--	--	--	--	.29	Tr	.62	Tr
Diptera												
Chironomidae												
Aug., 1974	22.49	.03	22.01	.02	1.31	Tr	6.13	Tr	4.25	.01	7.40	.01
Sep., 1974	83.26	.15	8.84	.01	2.60	Tr	14.41	.02	9.31	.01	10.24	.01
Nov., 1974	3.93	.01	9.25	.01	1.39	Tr	4.36	Tr	3.34	.01	1.76	.01
Apr., 1975	12.09	.01	94.18	.26	8.69	.02	15.02	.02	18.34	.03	7.09	.02
May, 1975	33.76	.04	250.30	.67	28.63	.03	16.49	.01	9.15	.02	22.50	.06
Simulidae												
Simulium												
Aug., 1974	4.88	.02	10.46	.02	--	--	1.82	Tr	1.77	.01	.93	.01
Sep., 1974	.50	Tr	5.05	.02	.24	Tr	3.13	.01	5.50	.01	20.47	.05
Nov., 1974	.33	Tr	1.39	Tr	.70	Tr	3.63	.01	2.44	.01	2.34	Tr
Apr., 1975	.68	.01	1.18	.01	1.67	.01	1.00	Tr	.38	Tr	--	--
May, 1975	.72	Tr	12.71	.05	16.68	.05	3.09	.01	1.07	Tr	31.73	.11
Ephemeroptera												
Aug., 1974	.38	Tr	5.02	.02	5.87	.01	--	--	.73	.01	26.29	.06
Sep., 1974	--	--	13.89	.08	4.26	.02	4.38	.02	2.54	.02	46.72	.13
Nov., 1974	1.97	.01	--	--	--	--	2.90	Tr	1.41	.01	4.10	.03
Apr., 1975	.23	Tr	.30	Tr	.33	Tr	--	--	.38	Tr	.14	Tr
May, 1975	.36	Tr	.44	.01	.31	.01	2.75	Tr	1.24	Tr	3.42	.03

APPENDIX B. CONTINUED

	UPSTREAM						DOWNSTREAM					
	New Ditch		Old Ditch		Natural		New Ditch		Old Ditch		Natural	
	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3
Insecta (Cont.)												
Hemiptera												
Hesperocorixa												
Aug., 1974	3.20	.01	.87	Tr	--	--	12.90	.03	11.31	.03	2.94	.01
Sep., 1974	6.94	.02	1.90	.01	.47	.01	15.04	.03	16.50	.05	2.22	.01
Nov., 1974	8.84	.13	.46	Tr	2.09	.03	35.58	.39	4.96	.08	10.25	.09
Apr., 1975	16.20	.08	3.25	.01	1.34	.02	9.02	.05	3.04	.03	.72	Tr
May, 1975	--	--	--	--	--	--	2.06	.01	.25	Tr	3.32	.02
Trichoptera												
Aug., 1974	.89	.01	5.24	.15	1.94	.01	--	--	2.81	.03	29.61	.27
Sep., 1974	--	--	--	--	2.60	.02	--	--	1.69	Tr	4.45	.04
Nov., 1974	1.31	.39	1.32	.05	16.36	.12	2.18	.01	--	--	1.46	.04
Apr., 1975	.68	Tr	2.09	.04	3.34	.03	1.00	.40	--	--	.43	Tr
May, 1975	--	--	3.07	.26	3.78	.12	.34	Tr	--	--	1.24	.03
Amphipoda												
Gammarus												
Aug., 1974	2.06	.02	31.38	.19	5.37	.01	--	--	--	--	13.51	.12
Sep., 1974	12.39	.17	10.10	.03	5.91	.04	--	--	--	--	4.45	.01
Nov., 1974	19.66	.59	25.90	.33	4.52	.09	--	--	--	--	--	--
Apr., 1975	.91	Tr	36.37	.87	2.67	.07	--	--	--	--	.58	.01
May, 1975	17.24	.31	14.03	.28	--	--	--	--	.25	Tr	1.55	.02
Mollusca												
Aug., 1974	3.99	.18	.87	.01	--	--	.45	Tr	--	--	.70	.02
Sep., 1974	80.78	1.98	--	--	.24	Tr	--	--	1.69	.04	.44	Tr
Nov., 1974	1.31	.07	--	--	--	--	--	--	--	--	--	--
Apr., 1975	29.67	.35	1.79	.01	--	--	2.00	.02	.19	.05	.14	Tr
May, 1975	3.23	.04	2.19	.16	--	--	.69	.08	.29	Tr	--	--

APPENDIX B. CONTINUED

	UPSTREAM						DOWNSTREAM					
	New Ditch		Old Ditch		Natural		New Ditch		Old Ditch		Natural	
	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3	#/100m^3	g/100m^3
Total Aquatic												
Aug., 1974	40.35	.29	79.99	.43	18.06	.05	22.92	.07	25.13	.08	82.74	.49
Sep., 1974	189.31	2.40	41.04	.15	17.98	.52	37.58	.08	39.34	.14	94.34	.29
Nov., 1974	40.29	1.21	41.16	.47	38.28*	.25	53.00	.43	14.08	.13	29.86	.21
Apr., 1975	62.07	.46	156.15	1.33	21.73	.18	34.05	.53	25.32	.13	11.57	.06
May, 1975	57.46	.40	331.40	1.58	50.34	.20	26.12	.12	13.20	.03	67.91	.29
Aerial Aquatic												
Emerging adults												
Insects												
Aug., 1974	47.17	.85	12.00	.04	4.06	.01	1.50	Tr	8.08	.36	10.31	.13
Sep., 1974	133.80	.05	53.66	.02	14.90	.01	13.15	.01	27.91	.01	13.35	.01
Nov., 1974	13.76	.01	3.70	Tr	2.44	Tr	.73	Tr	.35	Tr	1.76	Tr
Apr., 1975	--	--	964.15	1.96	7.02	.01	1.00	Tr	.19	Tr	--	--
May, 1975	10.42	.01	5.70	.01	51.60	.03	1.38	Tr	.12	Tr	1.55	Tr
Terrestrial												
Hymenoptera												
Aug., 1974	6.55	.01	2.61	.01	2.11	Tr	--	--	.73	Tr	5.02	.01
Sep., 1974	7.43	.01	1.90	Tr	.71	Tr	--	--	.84	Tr	8.46	.01
Nov., 1974	--	--	--	--	--	--	--	--	--	--	--	--
Apr., 1975	--	--	--	--	--	--	--	--	.19	Tr	.29	Tr
May, 1975	2.16	.03	1.75	.01	.31	Tr	--	--	--	--	3.94	.02
Total Terrestrial												
Aug., 1974	8.36	.04	7.40	.01	3.75	.01	1.95	Tr	3.21	.02	7.27	.02
Sep., 1974	297.34	.07	22.10	.01	5.68	Tr	194.81	.03	189.90	.04	16.46	.02
Nov., 1974	5.24	.01	--	--	--	--	.73	Tr	.35	Tr	3.22	Tr
Apr., 1975	--	--	--	--	--	--	--	--	.19	Tr	.43	Tr
May, 1975	3.23	.07	10.52	.09	1.57	Tr	.34	Tr	.50	Tr	7.57	.04

*27.84 without collembola

APPENDIX C. MONTHLY WATER TEMPERATURE (^{o}C), BUENA VISTA MARSH, PORTAGE COUNTY, WISCONSIN. SEPT., 1974 THROUGH MAY, 1975. (--- thermograph results not available)

	UPSTREAM			DOWNSTREAM		
	NEW DITCH	OLD DITCH	NATURAL	NEW DITCH	OLD DITCH	NATURAL
MEAN DAILY MAXIMUM						
SEPT.	15.0	13.3	14.3	16.4	15.3	14.9
OCT.	11.4	12.1	10.9	10.4	10.3	9.9
NOV.	6.8	9.2	6.5	4.8	4.6	4.5
DEC.	4.8	4.7	3.2	1.4	1.2	1.1
JAN.	4.3	3.2	1.3	0.6	0.2	0.7
FEB.	4.9	---	1.7	1.2	0.7	1.4
MAR.	---	4.2	4.5	5.4	4.6	3.0
APR.	7.9	8.1	10.5	9.5	10.9	6.1
MAY	15.6	12.7	15.2	14.3	17.1	15.3
MEAN DAILY MINIMUM						
SEPT.	8.4	8.1	8.8	12.0	10.9	10.6
OCT.	6.1	4.2	5.5	7.1	5.4	6.1
NOV.	3.3	1.4	3.7	2.4	2.2	1.8
DEC.	1.8	-0.4	0.8	0.2	0.0	-0.3
JAN.	1.6	-0.3	0.5	0.3	-0.2	0.1
FEB.	0.5	---	-0.2	0.2	-0.3	-0.6
MAR.	---	1.7	0.4	1.5	1.7	0.4
APR.	2.8	4.4	4.0	6.4	5.4	5.1
MAY	8.4	8.6	9.5	9.8	11.7	11.3
MEAN TEMPERATURE						
SEPT.	12.0	10.8	12.9	14.0	13.0	12.7
OCT.	7.6	8.2	7.8	8.7	8.5	7.9
NOV.	4.9	5.2	5.1	3.6	3.4	3.2
DEC.	3.2	2.2	2.0	0.6	0.5	0.2
JAN.	2.6	1.4	0.8	0.4	0.0	0.3
FEB.	2.2	---	0.6	0.7	0.1	0.1
MAR.	---	2.8	2.4	3.2	3.0	1.5
APR.	5.1	5.8	7.0	7.8	8.0	5.2
MAY	11.1	10.8	12.7	11.9	14.5	13.1
MEAN DAILY FLUCTUATION						
SEPT.	6.5	5.1	5.4	4.4	4.4	4.3
OCT.	5.5	---	4.7	3.5	3.9	3.9
NOV.	3.4	---	2.8	2.4	2.4	2.7
DEC.	3.0	---	2.4	1.2	1.2	1.3
JAN.	2.7	---	0.7	0.3	0.3	0.7
FEB.	4.4	---	2.3	0.6	0.9	2.1
MAR.	---	2.5	4.1	3.8	2.9	2.7
APR.	5.1	3.7	6.3	3.1	5.8	0.9
MAY	7.3	4.2	5.7	4.3	5.4	3.9

APPENDIX D. MAXIMUM, MINIMUM, AND MEAN VALUES FOR VARIOUS MEASURED CHEMICAL PARAMETERS, JUNE, 1974 - MAY 1975, BUENA VISTA MARSH, PORTAGE COUNTY, WISCONSIN. (all values are ppm unless otherwise stated) (n=8)

	UPSTREAM			DOWNSTREAM		
	NEW DITCH	OLD DITCH	NATURAL	NEW DITCH	OLD DITCH	NATURAL
Dissolved oxygen						
mean	10.5	9.8	11.3	10.3	10.3	9.6
maximum	11.7	12.0	13.9	12.2	12.1	12.5
minimum	9.3	7.3	9.1	7.9	7.8	7.6
Chemical oxygen demand						
mean	12.82	7.68	6.21	20.98	15.83	19.81
maximum	16.90	12.66	18.98	33.22	23.12	30.96
minimum	7.40	4.61	0.77	11.52	2.30	11.52
pH						
maximum	8.1	8.3	8.4	8.3	8.4	7.9
minimum	7.8	7.5	7.6	7.7	7.5	7.5
Alkalinity						
mean	183	117	113	184	185	162
maximim	194	124	120	194	198	170
minimum	160	112	106	170	174	154
Conductivity (mhos)						
mean	429	332	293	440	440	378
maximum	550	390	345	550	540	455
minimum	362	268	239	390	393	325
Total hardness						
mean	237	171	163	244	246	215
maximum	270	182	204	258	279	230
minimum	226	165	144	222	228	200
Calcium hardness						
mean	165	119	113	168	175	156
maximum	200	166	174	226	220	200
minimum	136	92	88	132	128	122

APPENDIX D, (cont.)

	UPSTREAM			DOWNSTREAM		
	NEW DITCH	OLD DITCH	NATURAL	NEW DITCH	OLD DITCH	NATURAL
Ortho phosphate						
mean	0.022	0.335	0.083	0.258	0.017	0.220
maximum	0.030	1.900	0.370	1.600	0.026	1.400
minimum	0.012	0.005	0.021	0.018	0.007	0.016
Total phosphate						
mean	0.098	0.419	0.082	0.289	0.027	0.233
maximum	0.430	2.240	0.250	1.900	0.037	1.450
minimum	0.018	0.028	0.036	0.014	0.016	0.017
NH_4-N						
mean	0.005	0.14	0.02	0.04	0.02	0.03
maximum	0.04	0.32	0.14	0.14	0.07	0.04
minimum	0.00	0.00	0.00	0.00	0.00	0.00
NO_3-NO_2-N						
mean	3.06	5.32	4.67	2.89	2.90	2.12
maximum	3.82	5.46	5.29	3.64	3.61	2.91
minimum	2.49	4.73	3.96	2.06	2.06	1.47
Total N						
mean	0.64	0.59	0.51	0.64	0.78	0.78
maximum	1.09	0.77	1.09	0.77	1.19	1.26
minimum	0.39	0.28	0.11	0.25	0.56	0.42

APPENDIX E. DRIFTING DETRITUS (dry weight and loss-on-ignition) FROM BUENA VISTA MARSH, PORTAGE COUNTY, WISCONSIN. (August 1974, through May, 1975)

	UPSTREAM			DOWNSTREAM		
	New Ditch	Old Ditch	Natural	New Ditch	Old Ditch	Natural
Aug., 1974						
Dry weight (g/m^3)	1.78	6.94	2.90	1.49	2.30	12.94
Loss-on-ignition	69.1	72.3	76.4	65.6	72.6	65.8
Sept., 1974						
Dry weight	26.50	3.23	1.61	3.03	1.78	9.51
Loss-on-ignition	67.1	81.7	82.9	51.9	76.1	72.4
Nov., 1974						
Dry weight	12.68	5.70	0.93	2.90	4.01	3.71
Loss-on-ignition	52.2	73.9	78.3	79.1	77.0	79.2
April, 1975						
Dry weight	13.32	6.11	1.40	3.62	16.54	13.30
Loss-on-ignition	73.4	61.9	77.1	78.1	67.2	70.6
May, 1975						
Dry weight	23.81	31.83	1.25	12.34	12.39	26.77

APPENDIX E. CONTINUED

	UPSTREAM			DOWNSTREAM		
	New Ditch	Old Ditch	Natural	New Ditch	Old Ditch	Natural
May, 1975						
Loss-on-ignition	67.4	77.0	82.9	67.3	63.0	56.1
Mean for study period						
Dry weight	15.62	10.76	1.62	4.68	7.40	13.25
Loss-on-ignition	65.8	73.4	79.5	68.4	71.2	68.8