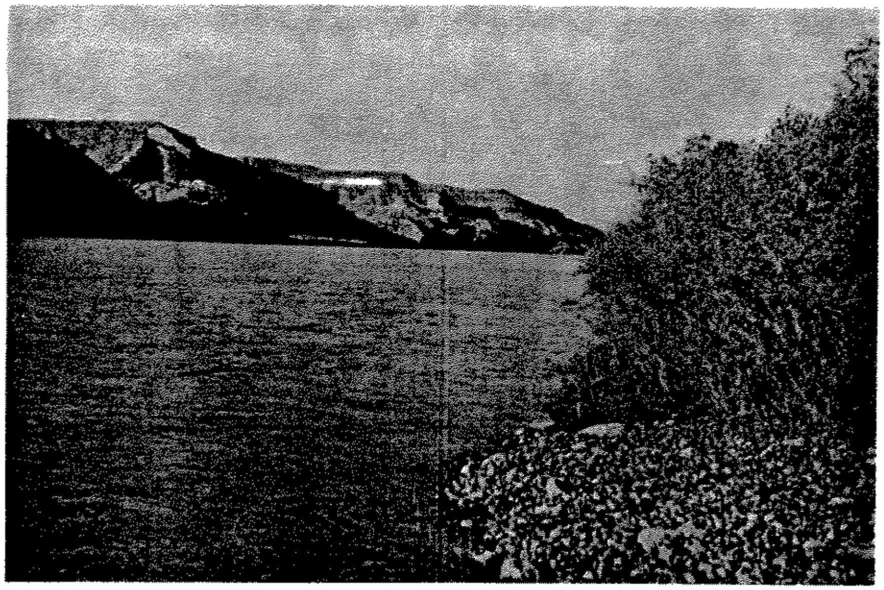
YELLOWSTONE RIVER STUDY

FINAL REPORT



RESEARCH CONDUCTED BY:

MONTANA DEPARTMENT OF FISH AND GAME

AND

INTAKE WATER COMPANY

PREPARED BY:

ROBERT L. NEWELL
AQUATIC ECOLOGIST

AUGUST 1976

ACKNOWLEDGMENTS

The author would like to thank all biologists and friends who contributed time, effort and specimens for this study. He would also like to thank the Intake Water Company for funding the majority of the work and the Old West Regional Commission which also contributed research funds.

The author also thanks the following experts who helped identify organisms: Trichoptera (D. G. Denning); Plecoptera (R. W. Bauman, B. Stark); Coleoptera-Elmidae (H. P. Brown); Diptera-Chironomidae (L. Curry); Oligochaeta and Mollusca (D. Klemm); Odonata and Hemiptera (G. Roemhild).

A special thanks is given to R. Berg, D. Workman and D. Schwehr for taking bottom samples on the middle and upper Yellowstone River and to A. Elser and R. McFarland for taking samples on the Tongue River. Mr. Burwell Gooch of the Systems Development Bureau, Data Processing Division, Montana State Department of Administration was very helpful in constructing computer programs for species diversity analyses and regression analysis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Objectives of this research task were to gain insights into the environmental requirements of the dominant macroinvertebrate genera and species of the Yellowstone River and to describe the distribution of macroinvertebrates in the Yellowstone and Tongue Rivers. Current velocity and water depth were chosen as the two independent variables that would be examined. Since current affects invertebrate distribution in several ways, e.g., distribution of food, size of substratum and current force, and because current and discharge are closely interrelated, studies of the effects of current on invertebrate distribution would be meaningful and would permit predictions about changes in invertebrate communities if flows were altered. Because of the gently sloping morphometry of the river channel, it was believed depth might be a valuable parameter as well; both current and depth are functions of discharge. Once environmental requirements are established, one may predict how the population could change as the flow environment changes.

Species diversity and river zonation analyses were made in an attempt to understand distributional patterns of invertebrates, provide baseline data and record differences and similarities between populations at different sampling stations.

The classification of river zones is helpful in comparing the results of studies on the ecology of different rivers and is useful in fishery and river management. Most attempts at river classification have been instigated by the needs of fishery management.

With an increasing need for water conservation, both quantitatively and qualitatively, a system of river-zone classification is invaluable in predicting the likely effect on the ecology of the river of projected management policies such as water removal and flow regulation.

River zonation studies began at the end of the last century with German biologists who developed a system of classifying river zones on the basis of the dominant fish species present, by which they named the zones - Trout, Grayling, Barbel and Bream. Similar methods of classification were also developed in other regions. Subsequent studies were carried out throughout the world to establish whether the German zonation scheme was generally applicable. These and further studies on German rivers have attempted to characterize the different zones more precisely in physiographical, physio-chemical and biotic terms (Whitton 1975).

Carpenter (1928), an early British reseracher, attempted to classify the mountain streams of North Wales and she was obviously influenced by the earlier German workers.

Carpenter described a typical river as arising as several sources at high altitude to give rise to streams characterized by swift current, steep gradient and extensive erosion. Downstream as the gradient decreases the current slows and the stream deepens and widens. With the reduction in current, stones, gravel and sand are successively deposited on the streambed. Aquatic macrophytes may take root in silted areas. Still further downstream current is further reduced, the river widens and meanders and the bed is covered with deposited silt.

Carpenter's classification of streams included a taxonomic list of the flora and fauna of each zone. High altitude zones included headstreams, trout becks and minnow reaches. Lowland stream zones included upper and lower reaches.

Huet (1949, 1954) using stream data in Europe, refined the European system which recognized four zones, each identified by key fish species. The trout zones had a steep gradient, fast currents, cool temperatures and oxygenated water. The grayling zone was deeper, had less gradient, gravel bottom with cool temperatures and oxygenated water. The barbel zone had moderate gradient with an alternating riffle-pool morphometry and a few trout still were present. The bream zone was characterized by slight current, high temperatures and deep, turbid water. The four zones represent two fish faunistic regions - an upper, cool water containing salmonid fish and the lower, warmer waters containing cyprinids.

From longitudinal profiles of many European streams, Huet concluded that the fish fauna was directly related to the gradient of the stream, and in nearly all rivers of comparable size, stretches with similar gradients have similar fish faunas. From these conclusions he formulated his "slope rule." "In a given bio-geographical area, rivers or stretches of rivers of like breadth, depth and slope have nearly identical biological characteristics and very similar fish populations."

Other European researchers have found that the concept of fish-faunal zones is useful in river and fish management; it is necessary to realize its limitations due to historic, geographic and climatic influences, however. Generally the greater the distance from the original streams studied, the more the original scheme of zonation needs to be modified to meet local conditions. Pollution can change zonation in localized areas, also.

The zonal distribution of fish in North American rivers has been demonstrated by a succession of workers. Shelford (1911) studied the distribution of fish in a number of Lake Michigan tributaries and concluded that fishes have definite habitat preferences which cause them to be definitely arranged in streams which have a graded series of conditions from mouth to source. Burton and Odum (1945) and Funk and Campbell (1953) all report fish distributed in zones in North American streams.

From these studies in different parts of the world, it is evident that in general there is a longitudinal distribution of fish species in rivers in which a succession of different fish populations occur from source to mouth. Other generalizations regarding the pattern of this distribution are more difficult to make. Funk and Campbell (1953) report that succession is by gradual transition along the length of a river. Other workers report a zonal distribution in which there is a sharp border between zones.

With this general introduction to fish zonation in mind, the next question is - to what extent do fish zones represent different river biocoenoses?

Numerous studies have been conducted on the longitudinal distribution of different benthic invertebrates in rivers. Again, the earliest research occurred in Europe, but studies have taken place throughout the world

(Beauchamp and Ullyott 1932, Carpenter 1928, Chandler 1966). The longitudinal distribution of several insect orders has been investigated (Dodds and Hisaw 1925; Ide 1935; Hynes 1941, 1948; Macon 1957).

Past studies of the longitudinal distribution of aquatic insects have found them to be distributed zonally along the length of rivers. It appears that each taxon exhibits a zonal distribution of its different species along the length of a river. Within taxa some species have a restricted distribution, especially those in the upper reaches, while others extend over a long stretch of river. Over some distances, there may be little change in species present; their relative abundance changes along the length of river, reflecting a change in the ecological structure of the community (Hynes 1961).

The conclusion is that both fish and benthic invertebrates are longitudinally distributed along rivers, with different species occupying different sections of the river. One would expect, therefore, a correlation between fish species and benthic invertebrates.

Some authors have concluded generally that different biocoenoses, associated with the different fish zones, can be recognized. Thorup (1966) is critical of these studies and suggests that pollution is responsible for the observed zonation of invertebrates and fish. Maitland's (1966) work supports the views expressed by Thorup.

It appears from available evidence that although fish zones can be recognized, the association of benthic biocoenoses with them, does not always exist.

A new theory has recently emerged to explain the distribution of groups of invertebrates on the bottom of streams and rivers. This theory is known as the river continuum theory as proposed by Vannote (1975) in Cummins (1975b). This theory makes use of theoretical relationships between stream order (Leopold et al. 1964, Hynes 1970), size of organic matter and production, respiration (P/R) ratios.

Headwater streams are characteristically heavily dependent upon terrestrial contributions (allochthonous) of particulate organic matter, especially coarse particles (CPOM) such as leaf litter, with little or no photosynthetic production of organic matter. CPOM feeding invertebrates, or shredders and detritivores feeding on fine particulate organic matter, or collectors, are the dominant macroconsumers. Thus headwaters can be described as: CPOM - fungi - shredder - FPOM - bacteria - collector systems (Figures 1 and 2).

Intermediate-sized rivers are less dependent upon allochthonous inputs and more on organic production by producer organisms along with input of FPOM from upstream. The ratio of photosynthetic production to community respiration is often greater than one ($P/R > 1$) in contrast to headwater and large rivers where $P/R < 1$ (Figure 2).

Large rivers tend to be turbid with heavy sediment loads or the culmination of all upstream processes. These systems possess plankton communities. These rivers could be characterized as: FPOM - bacteria - collector systems (Figure 2).

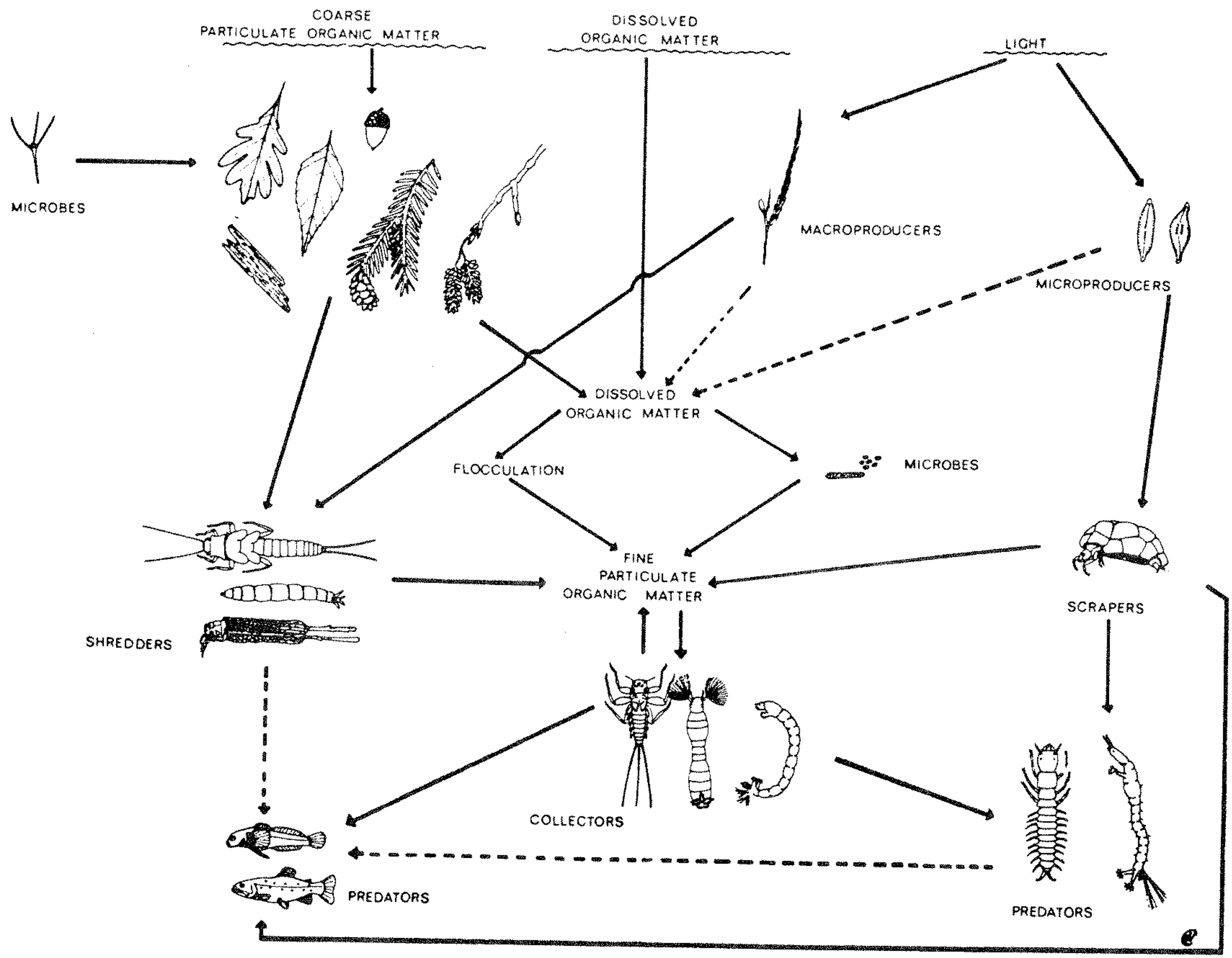


Figure 1. Relationships between detritus and stream consumers (from Cummins 1975).

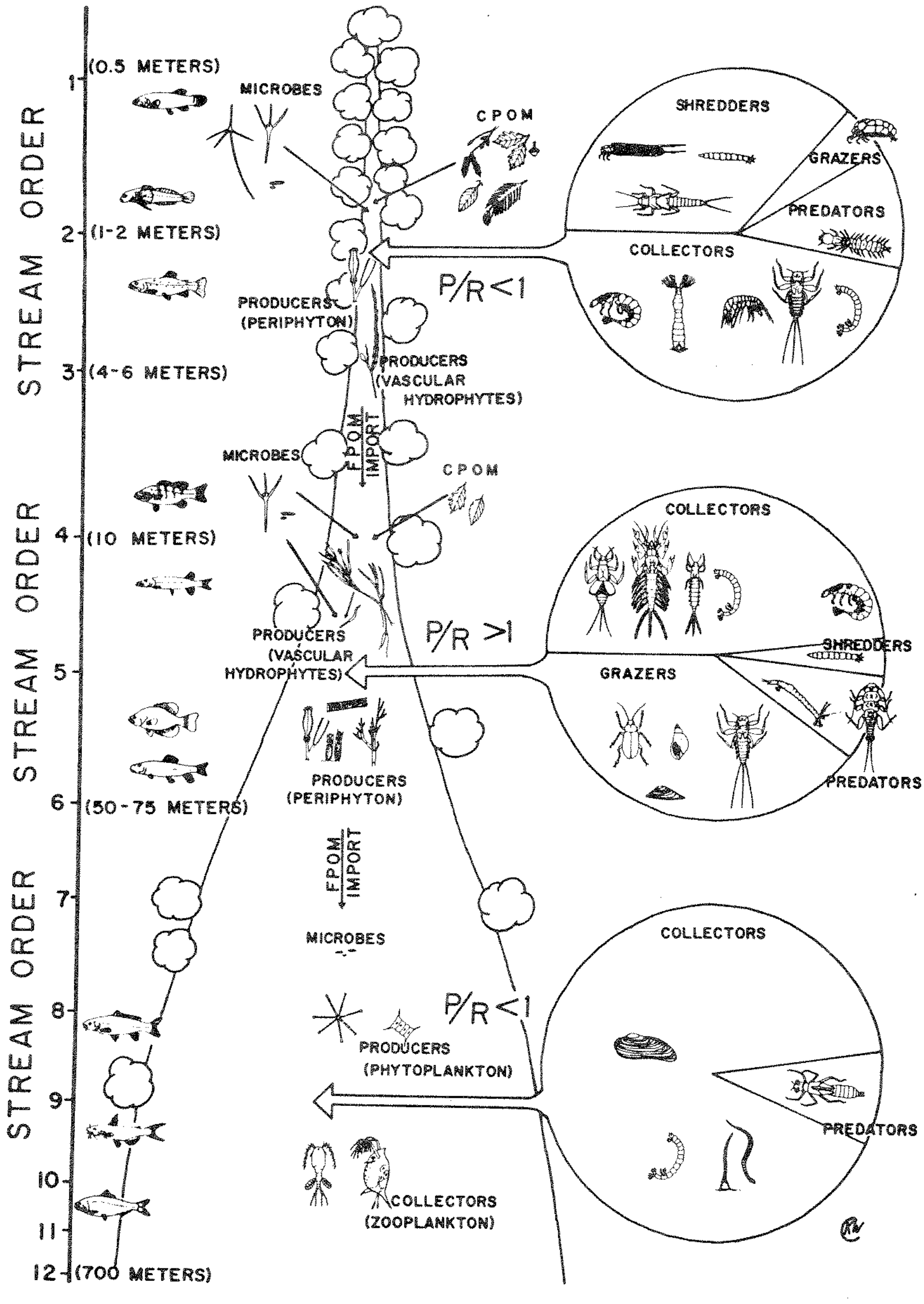


Figure 2. Relationships between detritus, producers and consumers in different order streams - stream continuum - (Cummins 1975).

Fish populations generally show a transition from cold water invertivores, to warm water invertivores and piscivores, to planktivores.

Many factors regulate the distribution and abundance of stream dwelling invertebrates. Some of these factors include current speed, temperature, the substratum, vegetation and dissolved substances (Hynes 1970). Other factors include competition, zoogeography and food. This is the more autecological approach to distribution of aquatic invertebrates in aquatic ecosystems.

Temperature and water chemistry exert the greatest influence on the composition of living communities considered over large areas, but because of feeding and respiratory requirements, it is largely current that determines how communities actually are composed (Jaag and Ambuhl 1964, Chutter 1969). The ecological niche of many macroinvertebrates which inhabit flowing water is partially determined by current. In fact, some species are confined to fairly narrow ranges of current speed. In the case of certain organisms, namely the net-building caddisflies (e.g., *Hydropsyche, Cheumatopsyche, Parapsyche)*, it has been established that the nets require a definite current in order for them to function properly (Philipson 1954).

Many organisms need the current to be nearby, but cannot tolerate being actually in it. There is often a tremendous difference in current velocity for an insect living on top of a rock to that for one living under that rock, yet both may have current requirements. Because of the impossibility of taking measurements at most points where macroinvertebrates exist, current velocity is usually measured at some reproducible depth; e.g., mid-depth, 0.6 of the total depth, or near the bottom (Hynes 1970).

There are unmistakable current specialists (e.g., *Baetis, Simulium* and *Hydropsyche*), while some other organisms find their optimum at low velocities (e.g., *Gammarus, Hyalella, Tricorythodes*). It seems that each species prefers a certain range of current velocity.

In every turbulent flowing system, marginal effects develop in what are called boundary layers. Close to the substratum, movement of the water gradually slows owing to friction, and a boundary layer is formed in which the flow is strongly retarded, until, close to the substratum, it is stagnant (Jaag and Ambuhl 1964). The thickness of this boundary layer depends, among other things, on the velocity of the current above and the shape and roughness of the substratum. Extremely flattened organisms (e.g., *Epeorus, Rhithrogena*) make use of the boundary layer to avoid the current.

Many animals that live in flowing water can be maintained only in such water. These species either possess no ventilating organs or have changed or lost the function of those organs in the course of their evolutionary development. They are extremely sensitive to still water and quickly die in it (e.g., most Plecoptera).

Macrodistribution of aquatic invertebrates can be explained with difficulty as habitat gradually changes moving downstream. Cummins (1975a) described food as the ultimate determinant of macroinvertebrate distribution and abundance in non-disturbed running waters. The current regime, velocity and turbulence set the limits on the range of sediment particle sizes present as well as controlling such features as the growth of periphyton, macrophytes and accumulation of particulate detritus. The size of particles present decreases in a downstream direction (Macan 1974, Hynes 1970) and this results in community variation in primary producers, macroinvertebrates and fish. These community changes may be generally placed into three categories or habitat subsystems: (1) erosional zone, (2) intermediate zone, and (3) depositional zone. Each zone has a charactistic physical-chemical makeup and a characteristic fauna.

Aggregations or communities of aquatic organisms are subjected to almost continual stress due to environmental changes, some of which are "natural" and others are caused by wastes from our industrialized society. It is stresses of the latter sort that are often operating in streams and lakes throughout the United States. It is a generally accepted axiom in ecology that a gross environmental stress exerted upon a diverse biological community, consisting of a large number of species, results in a reduction of species diversity (i.e., number) or a simplification of the system (Cairns 1969). Slobodkin and Sanders (1969) developed the stability-time hypothesis to suggest the kinds of animals that must live in low and high diversity places. This hypothesis states: that all places of high diversity would have stable or predictable environments and that all places of low diversity would either be places of unpredictable hazard or they would be short-lived. This theory was tested in one widespread, stable environment - the ocean floor, and although the investigation is far from complete, the theory appears to hold.

In unstable areas, or where there is not much time, the dangers of extinction are great. Populations of opportunistic animals must frequently be decreased by weather, and the possibility exists of an entire breeding failure. The loss of several consecutive year-classes means extinction, even for long-lived animals. But such year-class failure is less likely in stable climates, and a series of failures is unlikely. Extinction is thus more likely as environmental stress increases. But the actual number of species present in any place is a product both of the loss of species by extinction and of their replacement with new species. In a few specialized organisms such as birds, a limit to the number of species that can accumulate is set by a restricted number of possible niches. For most other kinds of animals and plants the possible number of niches is much larger than the existing number of species. The actual patterns of diversity presently evident are the products of different environments of the earth (Colinvaux 1973).

The use of species diversity indices to analyze biological communities originates from efforts to apply communications information theory to complex biological problems. Various workers who have explored the theoretical use of diversity indices in biology, suggested refinements, or attempted studies include Brillouin (1960), Cairns and Dickson (1971), Lloyd and Ghelardi (1964), Lloyd, Zar and Karr (1968), Margalef (1968), Pielou (1969), Wilhm (1967, 1970abc, 1972), and Wilhm and Dorris (1966, 1968). Several indices have been generally accepted for uniformity: mean diversity ($\overline{d}$); equitability (E_m); redundancy (R); evenness (J'); and richness (SR).

In general, the fundamental objective of information theory as applied to biology is to provide insight into community structure. The biological information theorist asks how much new knowledge or "information" about the species composition of a community can be obtained by drawing individuals at random. If the community is composed of only one species, then no new information is obtained after the first drawing. But if the community is composed of numerous species, possibly with each individual being a different species, then much new information is gained with each drawing. Information theory attempts to quantify this "knowledge" or "information" contained in the community in terms of "bits" of information per individual.

Mathematically stated, "information" equals the uncertainty of correctly predicting the identity of an individual randomly chosen from a community. Where uncertainty is high, information per individual is high and conversely. The mean amount of uncertainty of prediction of any individual's identity equals the mean number of bits of information per individual, and this number is referred to as the species diversity index. Mean information per individual is commonly measured using the function developed by and named after Shannon and Weaver (1964). The formula for the Shannon-Weaver function is:

$$\bar{d} = - \sum_{i=1}^{s} (Ni/N) \log_2 (Ni/N)$$

where $\bar{d}$ = mean number of bits of information per individual or the species diversity index, also written as $\bar{D}$

S = number of species

Ni = number of individuals in the i^{th} species

N = total number of individuals

A few of the authors cited earlier in this section, and especially Hurlbert (1971), have criticized the Shannon-Weaver function as improperly used in many studies. However, the U. S. Environmental Protection Agency (1973) has provisionally accepted and recommended the function for aquatic macrobenthos studies.

The index, $\bar{d}$, possesses features that make it a useful method for summarizing community diversity. The index is dimensionless and expresses the relative importance of each species in the community. As sample size is increased, the $\bar{d}$ of the progressively pooled samples increases rapidly at first and then levels off. Since diversity of progressively pooled samples reaches an asymptote and since diversity of individual samples are highly variable, it is preferable to report asymptotic diversity. Diversity had leveled off the fifth pooled sample in most of the areas sampled (Wilhm 1970abc). The range of $\bar{d}$ varies from zero to any positive number. A value of zero is obtained when all individuals belong to the same species. The maximum value of $\bar{d}$ depends on the number of individuals counted and is obtained when all individuals belong to different species. The $\bar{d}$ usually varies between three and four in clean-water stream areas and is usually less than one in polluted stream areas.

EQUITABILITY (E_m)

As measured by Margalef (1957) and Krebs (1972), equitability (E_m) is a ratio of the observed $\bar{d}$ to a maximum theoretical diversity (d_{max}) computed as though all individuals were equally distributed among the species. Maximum diversity here is measured simply as $\log_2 S$, therefore:

$$E_m = \bar{d}/\log_2 S$$

As equitability increases the more evenly distributed the species become or the more closely their distributions conform to perfect theoretical distributions. Equitability (E_m) may range from 0 to 1 except in the unusual situation where the distribution in the sample is more than the distribution resulting from the MacArthur model. Such an eventuality will result in values of E_m greater than 1, and this occasionally occurs in samples containing only a few specimens with several taxa represented. The estimates of E_m and $\bar{d}$ improve with increased sample size, and samples containing less than 100 specimens should be evaluated with caution if at all (EPA 1973).

Equitability has been found to be very sensitive to even slight levels of degradation. An improved equitability formula is presented below and must be used with tables presented in Lloyd and Ghelardi (1964) and EPA (1973):

$$E_{m2} = S^1/S$$

where S = number of taxa in the sample
S^1 = tabulated value

Because a table is required to calculate E_{m2}, it is not easily applied to computer operations. Equitability levels below 0.5 have not been encountered in southeastern streams known to be unaffected by oxygen-demanding wastes, and in such streams, E_{m2} generally range between 0.6 and 0.8. Even slight levels of degradation have been found to reduce E_{m2} below 0.5 and generally to a range of 0.0 to 0.3.

REDUNDANCY (R)

Redundancy (R) as measured by Wilhm and Dorris (1968) and Cairns and Dickson (1971) gives the relative position of the observed diversity index ($\bar{d}$) between theoretical maximum and minimum diversities (d_{max} and d_{min}). Calculated as follows:

$$R = \frac{d_{max} - \bar{d}}{d_{max} - d_{min}}$$

Theoretical maximum (d_{max}) and minimum (d_{min}) are calculated as follows:

$$d_{max} = (1/N)\left[\log_2 N! - S \log_2 (N/S)!\right]$$

$$d_{min} = (1/N)\{\log_2 N! - \log_2 \left[N-(S-1)\right]!\}$$

Redundancy (R) is a measure of the repetition of information within a community and thereby expresses the dominance of one or more species and is inversely proportional to the wealth of species. Redundancy (R) is maximal when no choice of species exists and minimal when there is more choice of species. A second d_{max} calculated is $d_{max} = \log_2 N$ but is not widely used.

EVENNESS (J')

If an investigator is dealing with data consisting of the numbers of individuals, $N, N_2, \ldots, N_s$, in each of the $\underline{S}$ species and if the data are portrayed in histogram form, $\underline{S}$ is the range of data or the width of the histogram. The shape of the histogram is best described in terms of what may be called its "evenness." Thus the distribution has maximum evenness if all the species abundances are equal; and the greater the disparities among the different species abundances, the smaller the evenness. Evenness is calculated as follows (Pielou 1969):

$$\text{EVENNESS} = \frac{\text{diversity}}{\log_2 S}$$

where S = number of species
diversity = Shannon-Weaver diversity index ($\bar{d}$)

Egloff and Brakel (1973) calculated evenness for a population of aquatic macroinvertebrates in a stream receiving large inputs of domestic sewage. Above the outfall evenness values ranged from 0.6 to 0.7 when diversity was 3.0 and greater, while below the outfall evenness dropped to 0.4 and below and diversity decreased to less than one. The number of species and evenness appeared to be reciprocals of one another along the stream except at the outfall where both decrease. The evenness index has not been widely used in aquatic studies.

SPECIES RICHNESS (SR)

A further component of diversity, richness, was calculated in the computer program furnished by Orr et al. (1973), but no reference to it could be found in the literature. It was calculated as follows:

$$SR = \bar{d} - \bar{d} / \log_2 N$$

Species richness is more commonly calculated by summing the total number of species present in a sample.

FORTRAN computer programs for calculating species diversity indices are available from the following sources: Wilhm (1970b), Cairns and Dickson (1971), and Orr et al. (1973).

As commonly used by biologists, species diversity indices provide insight into the structure of natural communities and may suggest qualitative aspects about their surrounding environments. A low diversity index ($\bar{d}$) indicates a largely monotypic community dominated by a few abundant organisms. Often the total number of species is considerably reduced. In addition, a low diversity index often suggests that degradational environmental conditions exist which favor the proliferation of a few tolerant species and the removal of intolerant forms. A high diversity index indicates a heterogeneous community in which abundance is distributed more evenly among a number of species. The total number of species is generally large.

A modification of the Shannon indices is the Brillouin index (Pielou 1969). In the final stages of this study the Brillouin index was calculated and compared with the Shannon values. Formulas are presented in Appendix A.

DESCRIPTION OF THE STUDY AREA

The Yellowstone River originates in Yellowstone National Park as a tributary of Yellowstone Lake. From Yellowstone Lake the river flows northward for about 60 miles before entering Montana near Gardiner. After entering Montana, the Yellowstone River continues a northward route for about 70 miles until near Livingston, where the river turns eastward as it leaves the mountains and flows across the prairie of southern Montana. The Yellowstone River joins the Missouri River just inside North Dakota about 30 miles east of Sidney, Montana. About 570 miles of river are found in Montana and sampling stations included 550 miles of this total.

Table 1 lists the longitudinal and elevational location of the 20 sampling stations and the stations are more graphically shown in Figure 3. The Tongue River was extensively studied also, and the macroinvertebrate fauna there influence the fauna of the lower Yellowstone River and so it is included in this study (Figure 4).

METHODS AND MATERIALS

Many sampling methods were used to collect aquatic macroinvertebrates on the Yellowstone River, including kick nets (Figure 11), Water's Round Sampler (Figure 12) and Hester-Dendy multiple plate artificial substrates.

The kick net was a modified Turtox bottom net with dimensions of 8"x8" and 10" deep (46x20x25.4 cm). A six-foot wooden handle was used to hold the net perpendicular to the current. A wire frame 17"x16" (43.2x40.6 cm) was attached to the bottom lip of the net frame perpendicular to the net opening in such a way that the wire frame rested on the stream bottom. The area within the frame was 272 in.^{2} (0.175 m^2) and when the area within the frame was disturbed, the bottom organisms were carried into the number 20 (0.70 mm) mesh net. This sampler is essentially a Surber Sampler on a pole.

Net material was added to each side of the wire frame to minimize side washout of organisms. This technique can be used as long as the water is shallow enough to wade. The bottom outlined by the frame is merely stirred with the foot. This sampler was used at the Glendive and Intake sampling stations during 1975 only. Water depth and current speed at six-tenths the depth were determined in the center of each sampling site. A timed (2-minute) kick sample without the 17"x16" frame was taken at many stations during 1974 in the Yellowstone and Tongue rivers to determine relative abundance of organisms.

Table 1. Yellowstone River sampling stations.

No.	Location	County	Elevation (msl)	River Mile**
1	Corwin Springs	Park	5110 ft.	549
2	Mallard Rest Access	"	4620	515
3	above Livingston	"	4490	501
4	above Shields River	"	4380	497
5	Grey Bear Access	Sweetgrass	4100	468
6	below Greycliff	"	3880	444
7	Columbus	Stillwater	3566	411
8	Laurel	Yellowstone	3294	391
9	Duck Creek Bridge	"	3140	360
10	Huntley	"	3110	349
11	Custer	"	2720	300
12	Bighorn River	Treasure	2700	296
13	Myers	"	2640	279
14	Forsyth	Rosebud	2490	234
15	Miles City	Custer	2335	184
16	Terry	Prairie	2190	138
17	Glendive	Dawson	2045	93
18	Intake	"	1998	71
19	Sidney	Richland	1892	30
20	Cartwright, N.D.	McKenzie	1850	9

**Mouth of the Yellowstone River is river mile 0.0.

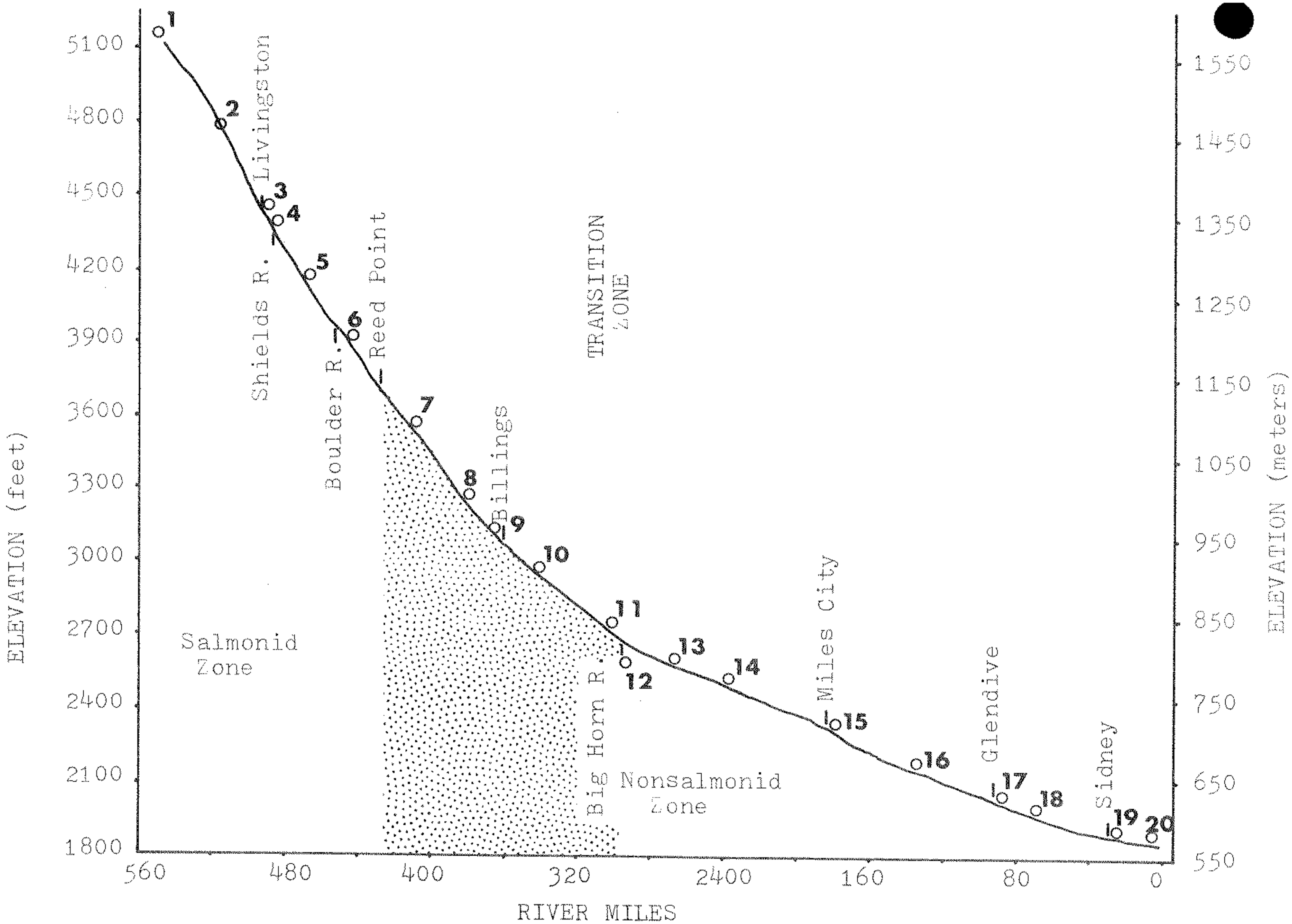


Figure 3. Invertebrate sampling stations established on the Yellowstone River and their relative position along a longitudinal and elevational gradient and probable fish distribution zones.

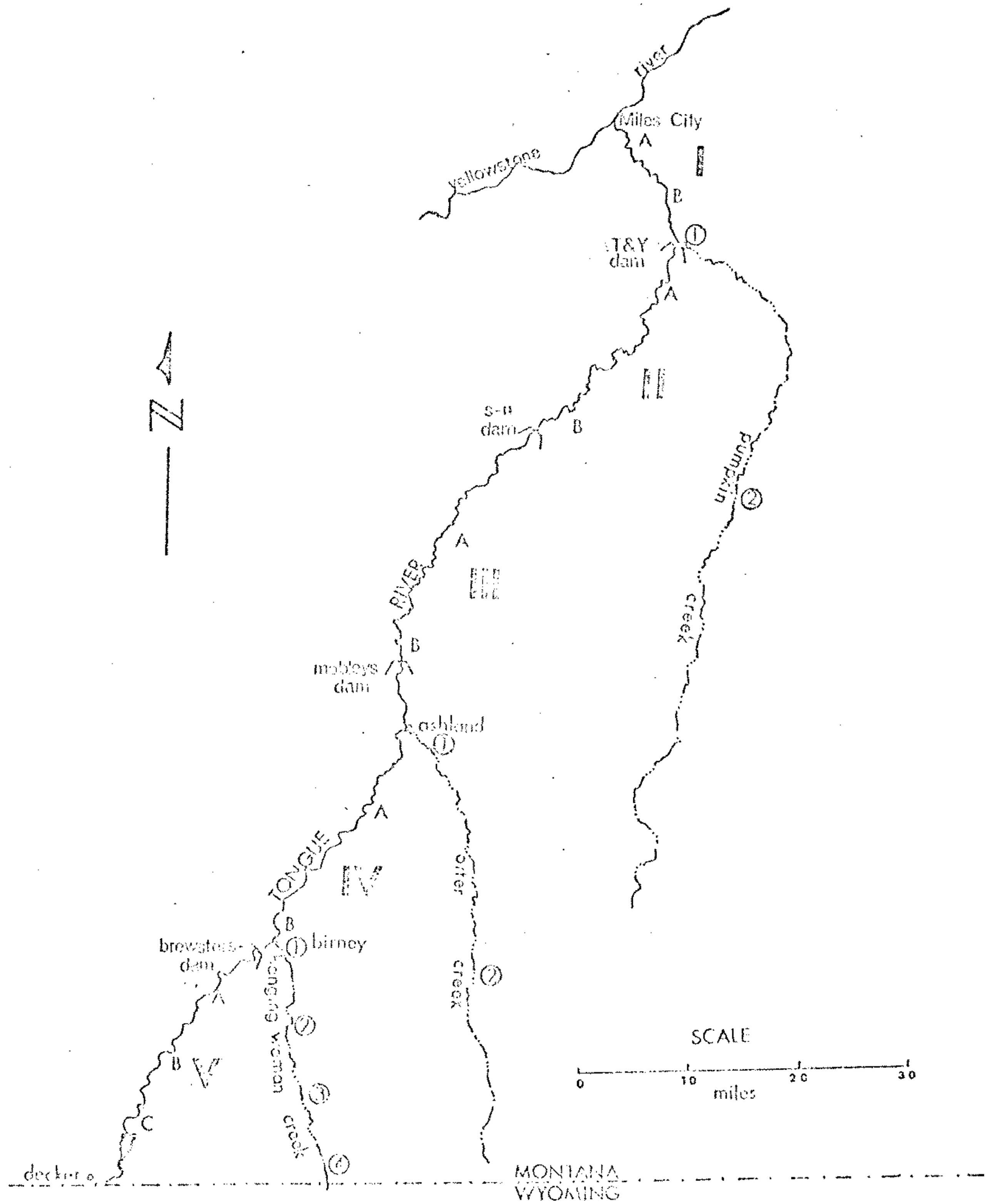


FIGURE 4. Map of the Tongue River, showing sampling sections and major tributaries.

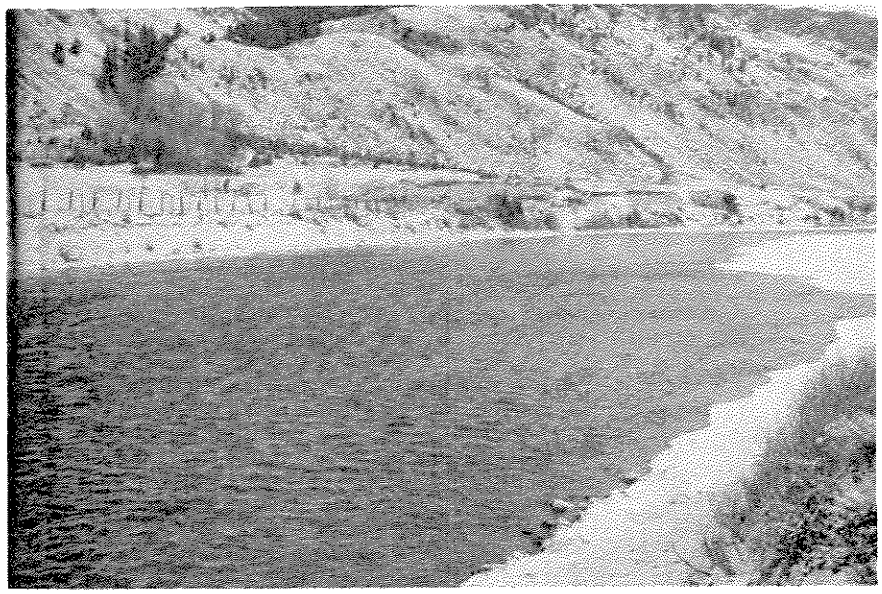


Figure 5. Sampling Station 1, Corwin Springs.

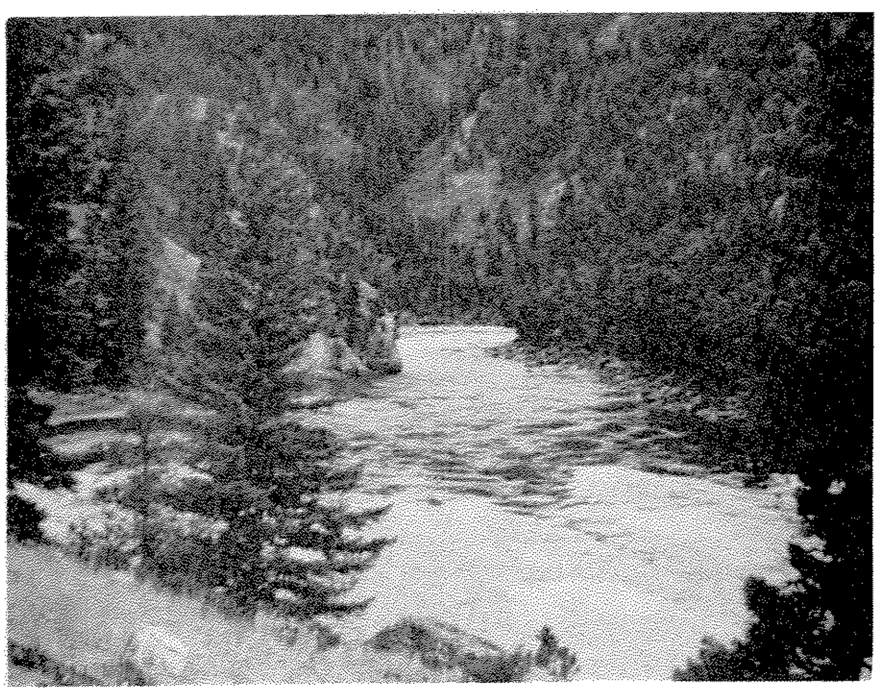


Figure 6. Yankee Jim Canyon between sampling Stations 1 and 2.

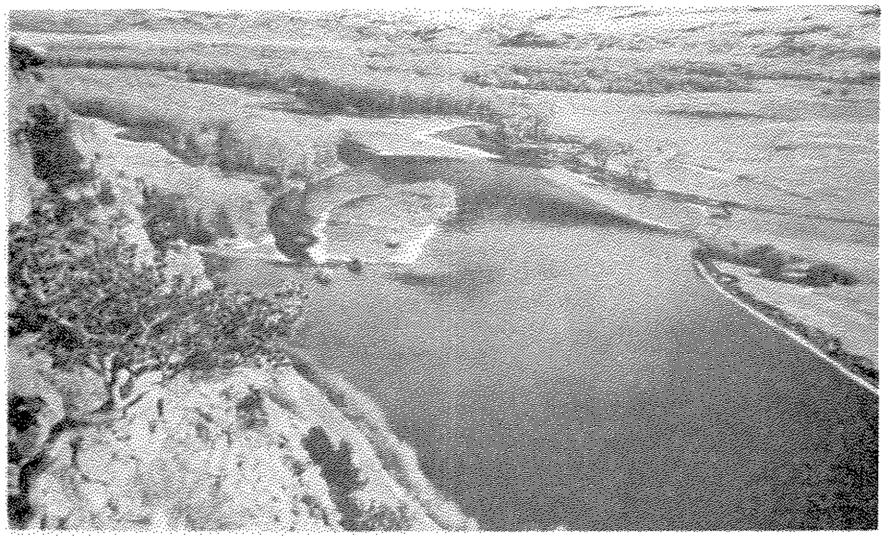


Figure 7. Near Station 3 above Livingston.

Figure 8. Station 4 at Livingston.

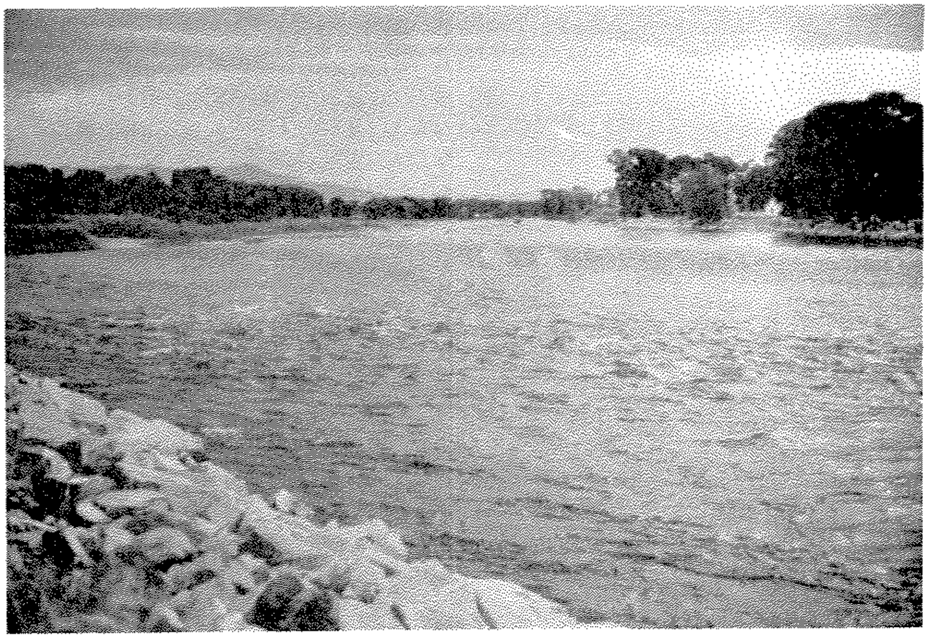


Figure 9. Station 5 at Greybear fishing access.

Figure 10. Aerial view of Yellowstone River above Miles City.

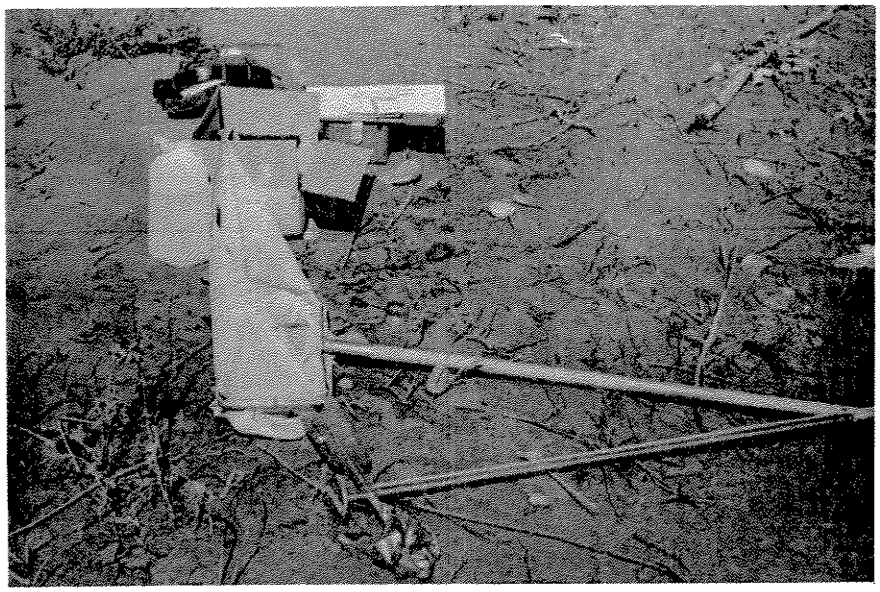


Figure 11. Kick net and other data collecting gear

A Water's round sampler (Figure 12) was used to take six samples per month at 10 of the 20 sampling stations in the Yellowstone River from August-November 1975.

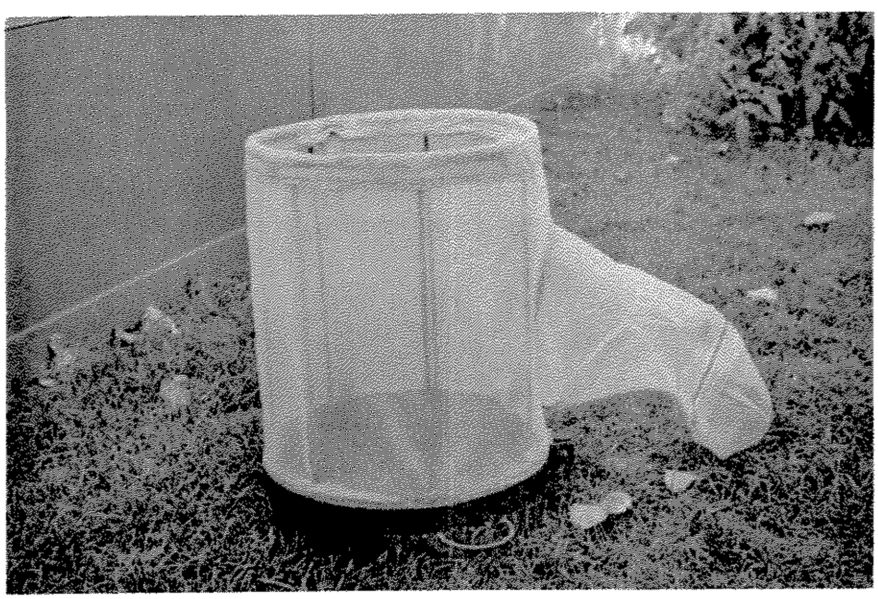


Figure 12. Water's round bottom sampler.

The Water's sampler is 19.5 in. in height and encloses an area just slightly less than 1-foot square (143.14 $in.^2$) or 0.093 m^2. The area to be sampled is approached from downstream and is randomly selected. The sampler is forced into the bottom and the investigator reaches down through the open top and stirs the bottom with his hand. Water current carries the organisms into the trailing net with a 20-mesh net. All organisms were preserved in the field in 70 percent ethyl alcohol (Appendix B).

Hester-Dendy multiple plate artificial samplers were used occasionally during 1974, but proved to be unsatisfactory and were discontinued (Hester and Dendy 1962, Fullner 1971, Parsons and Tatum 1974).

In the laboratory, all organisms were picked from bottom detritus and gravel under a dissecting microscope. In most cases immature invertebrates were identified to genus and species and less commonly to family using appropriate taxonomic keys. Adult insects were used whenever possible to confirm species identifications. Experts were consulted when difficulties were encountered.

Current velocity and depth measurements were made to determine velocity/ depth requirements for invertebrates. All measurements were made with a Price model AA type current meter obtained from Scientific Instruments, Inc. of Wisconsin, Milwaukee. All velocity measurements were made at the 0.6 depth.

RESULTS

Macroinvertebrate Distribution

A checklist of the macroinvertebrates found in the Tongue and Yellowstone rivers is presented in Table 2. This list is as complete as possible, and utilizes all published sources available, as well as data gathered during this study. Distributional records were taken from Stadnyk (1971), Gaufin et al. (1972), and Thurston et al. (1975).

When a precise species identification was not possible, the most probable species is listed in parentheses using the most recent available distribution data. In the order Diptera, several genera are listed under the family Chironomidae; this is the only place these genera will appear in this report because of unconfirmed identifications.

This group is difficult to identify and it is difficult to have identifications confirmed. This group is being examined more closely, but this work is incomplete at this time.

The distribution of all mayflies (Ephemeroptera) known to occur in the Yellowstone River is presented in Table 3. The mayfly fauna consists of 37 species variously distributed. In this table and in several others, stations 7-12 are shaded and represent the probable location of the transition zone between salmonid and nonsalmonid fish. It would also correspond to the intermediate zone between the erosional and depositional habitat subsystems

Table 2. Checklist of the aquatic macroinvertebrates of the Tongue River (t) and the Yellowstone River (y).

Phylum Arthropoda		
Order Ephemeroptera		
Family Siphlonuridae		
Ameletus (oregonensis McD.?)	y	
Isonychia (sicca campestris McD.?)	y	
Family Baetidae		
Baetis (alexanderi M.S. Edmunds & Jensen)	y	t
Baetis parvus Dodds	y	t
Baetis (propinquus Walsh)	y	
Baetis tricaudatus Dodds	y	
Centroptilum sp. A	y	
Dactylobaetis cepheus Traver & Edmunds	y	t
Pseudocloeon sp. A	y	
Family Oligoneuriidae		
Lachlania powelli Edmunds	y	
Family Heptageniidae		
Epeorus (Iron) albertae (McD.)	y	
" " *longimanus* (Eaton)	y	
Heptagenia elegantula (Eaton)	y	t
Rhithrogena undulata (Bks.)	y	t
Stenonema terminatum (Walsh)	y	t
Stenomena prob n. sp.	y	
Family Ametropodidae		
Ametropus (neavei McD.) ?	y	
Family Leptophlebiidae		
Choroterpes albiannulata McD.	y	t
Leptophlebia gravastella Eaton	y	t
Paraleptophlebia bicornuta (McD.)	y	
" *heteronea* (McD.)	y	
Traverella albertana (McD.)	y	t
Family Ephemerellidae		
Ephemerella (Attenuatella) margarita N.	y	
" *(Caudatella) h. heterocaudata* McD.	y	
" " *hystrix* Traver	y	
" *(Drunella) doddsi* Needham	y	
" " *g. grandis* Eaton	y	
" *(Ephemerella) inermis* Eaton	y	t
" *(Serratella) tibialis* McD.	y	
" *(Timpanoga) h. hecuba* (Eaton)	y	
Family Tricorythidae		
Tricorythodes minutus Traver	y	t
" sp. A	y	
Family Ephemeridae		
Ephemera sp. A	y	
Family Polymitarcidae		
Ephoron album (Say)	y	
Family Caenidae		
Brachycercus (prudens McD.?)	y	t
Caenis latipennis	y	
Family Baetiscidae		
Baetisca sp. A	y	t

Table 2 continued. Checklist of the aquatic macroinvertebrates of the Tongue River (t) and the Yellowstone River (y).

Order Trichoptera		
Family Rhyacophilidae		
Rhyacophila bifila Bks.	y	
Family Helicopsychidae		
Helicopsyche borealis (Hagen)	y	
Family Glossosomatidae		
Glossosoma sp A.	y	t
" *traviatum* Bks.	y	
" *velona* Ross	y	
Family Psychomyiidae		
Polycentropus cinereus Hagen	y	
Psychomyia flavida Hagen	y	
Family Hydropsychidae		
Arctopsyche grandis Bks.	y	
Cheumatopsyche sp. A	y	t
" *analis* (Bks.)	y	
" *campyla* Ross	y	
" *lasia* Ross	y	
" *enonis* Ross	y	
Hydropsyche sp. A	y	t
" near *alhedra* Ross		t
" *cockerelli* Bks.	y	
" *corbeti* Nimmo	y	
" *occidentalis* Bks.	y	
" *oslari* Bks.	y	
" *separata* Bks.	y	
Family Hydroptilidae		
Hydroptila sp. A	y	t
" *waubesiana* Betten	y	
Agraylea multipunctata Curtis	y	
Ochrotrichia potomas Denning	y	
Neotrichia sp. A	y	
Family Leptoceridae		
Athripsodes sp. A	y	
Leptocella sp. A	y	
Oecetis sp. A	y	t
" *avara* (Bks.)	y	
" *disjuncta* (Bks.)	y	
Triaenodes frontalis Bks.	y	
Family Lepidostomatidae		
Lepidostoma n. sp.	y	
" *pluvialis* Milne	y	
" *veleda* Denning	y	
Family Brachycentridae		
Amiocentrus aspilus (Ross)	y	
Brachycentrus sp. A	y	t
" *americanus* (Bks)	y	
" *occidentalis* Bks.	y	
Family Limnephilidae		
Hesperophylax incisus Bks.	y	
Limnephilus taloga Ross	y	

Table 2 continued (2). Checklist of the aquatic macroinvertebrates of the Tongue River (t) and the Yellowstone River (y).

Order Plecoptera		
Family Nemouridae		
Nemoura (Prostoia) besametsa Ricker	y	
" *(Zapada) cinctipes* Bks.	y	
Paraleuctra sara Claassen	y	
Capnia (Capnia) confusa Claassen	y	
" " *gracilaria* Claassen	y	
" " *limata* Frison	y	
" *(Utacapnia) distincta* Frison	y	
" " *poda* Nebeker & Gaufin	y	
Eucapnopsis vedderensis Ricker	y	
Isocapnia missourii Ricker	y	
" *vedderensis* (Ricker)	y	
Brachyptera (Taenionema) fosketti Ricker	y	t
" " *nigripennis* Bks.	y	
" " *pacifica* (Bks)	y	
Family Pteronarcidae		
Pteronarcella badia (Hagen)	y	
Pteronarcys californica Newport	y	
Family Perlodidae		
Arcynopteryx (Skwala) parallela (Frison)	y	
Isogenus (Cultus) aestivalis (N & C)	y	
" " *tostonus* Ricker	y	
" *(Isogenoides) frontalis colubrinus* Hagen	y	t
" " *elongatus* Hagen	y	
Isoperla fulva Claassen	y	
" *mormona* Bks.	y	
" *longiseta* Bks.	y	
" *patricia* Frison	y	
Family Chloroperlidae		
Alloperla (Suwallia) pallidula (Bks)	y	
" *(Sweltsa) coloradensis* (Bks)	y	
" *(Alloperla) severa* Hagen	y	
" *(Triznaka) signata* (Bks)	y	
Family Perlidae		
Acroneuria abnormis	y	t
" *(Hesperoperla) pacifica* Bks.	y	
Claassenia sabulosa (Bks)	y	
Order Isopoda		
Family Asellidae		
Asellus racovitzai racovitzai Williams	y	
Order Lepidoptera		
Family Pyralidae		
Cataclysta sp. A	y	t

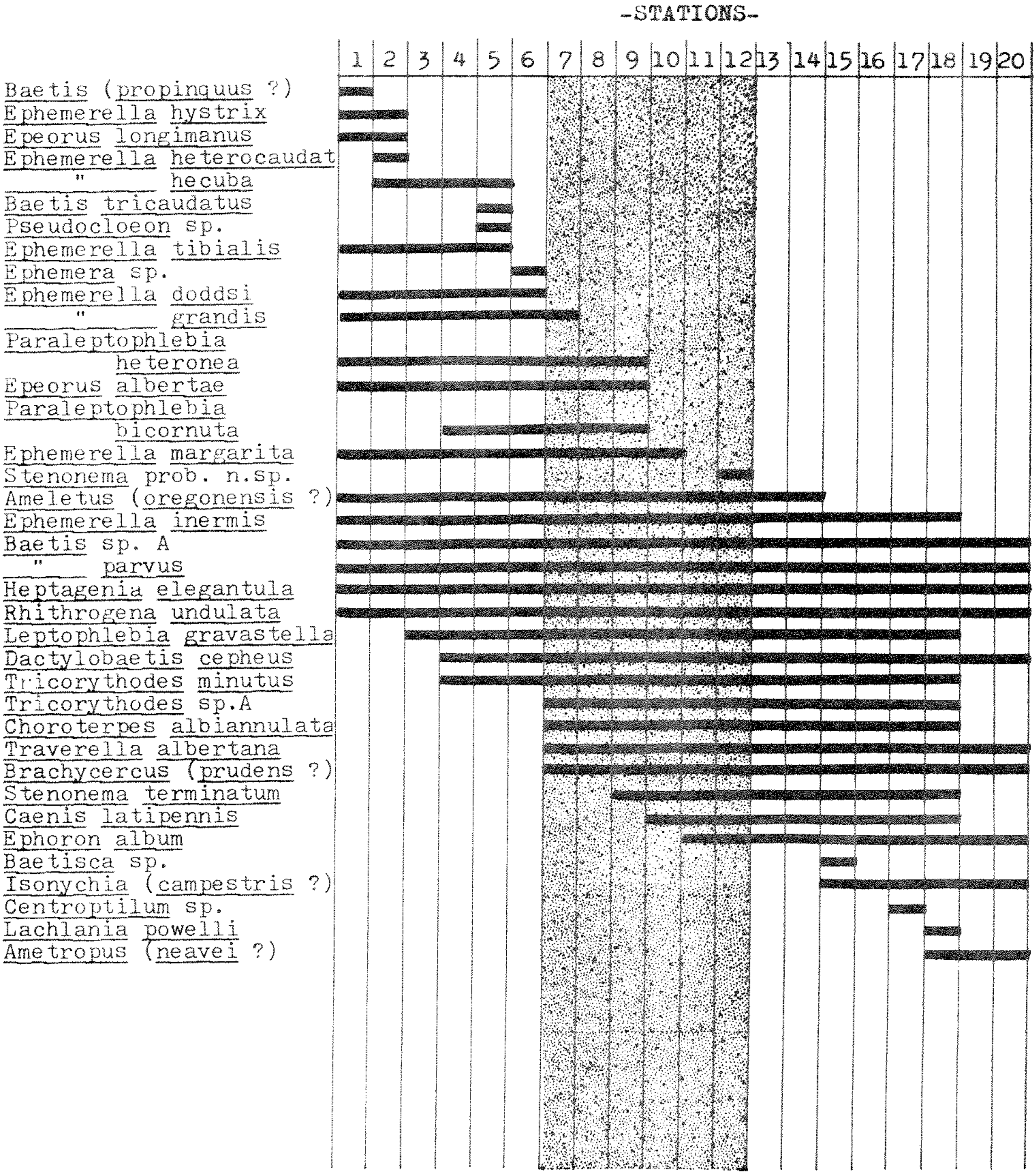
Table 2 continued (3). Checklist of the aquatic macroinvertebrates of the Tongue River (t) and the Yellowstone River (y).

Order Hemiptera		
Family Corixidae		
Callicorixa utahensis (Hung.)	y	
Cenocorixa audeni (Hung.)	y	
Sigara alternata Say	y	
Trichocorixa borealis Sailer	y	
Family Naucoridae		
Ambrysis mormon Mont.	y	
Family Veliidae		
Rhagovelia distincta Champion	y	t
Family Gerridae		
Gerris remigis Say	y	
Family Nepidae		
Ranatra fusca P.B.	y	
Order Odonata		
Family Gomphidae		
Gomphus sp. A	y	t
Ophiogomphus sp. A	y	t
Family Agrionidae		
Calopteryx sp. A		t
Family Coenagrionidae		
Argia sp. A		t
Amphiagrion sp. A	y	t
Enallagma sp. A	y	
" *ebrium* (Hagen)		t
Ischnura sp. A		t
Order Coleoptera		
Family Dytiscidae		
Oreodytes sp. A	y	
Family Dryopidae		
Helichus sp. A	y	
Family Elmidae		
Dubiraphia sp. A	y	t
Microcylloepus pusillus (LeConte)	y	t
Optioservus quadrimaculatus (Horn)	y	
Stenelmis sp. A	y	t
Zaitzevia parvula (Horn)	y	
Family Gyrinidae		
Gyrinus sp. A	y	
Order Diptera		
Family Blepharoceridae		
Agathon sp. A	y	
Family Ceratopogonidae	y	

Table 2 continued (4). Checklist of the aquatic macroinvertebrates of the Tongue River (t) and the Yellowstone River (y).

Family Chironomidae		
Subfamily Tanypodinae		
Ablabesmyia sp. A	y	
Clinotanypus sp. A	y	
Cryptocladius sp. A	y	
Procladius sp. A	y	
Subfamily Chironominae		
Chironomus sp. A	y	
Cryptochironomus sp. A	y	
Microtendipes sp. A	y	
Paralauterborniella sp. A	y	
Rheotanytarsus sp. A	y	t
Stictochironomus sp. A	y	
Subfamily Diamesinae		
Diamesa sp. A	y	t
Monodiamesa sp. A	y	
Subfamily Orthocladiinae		
Brillia sp. A	y	
Cardiocladius sp. A	y	t
Cricotopus sp. A	y	
Eukiefferiella sp. A	y	t
Metriocnemus sp. A	y	
Orthocladius sp. A	y	t
Trichocladius sp. A	y	
Family Dolochopodidae		
Family Empididae		
Hemerodromia sp. A	y	
Family Muscidae		
Limnophora sp. A	y	

Table 3. EPHEMEROPTERA OF THE YELLOWSTONE RIVER.



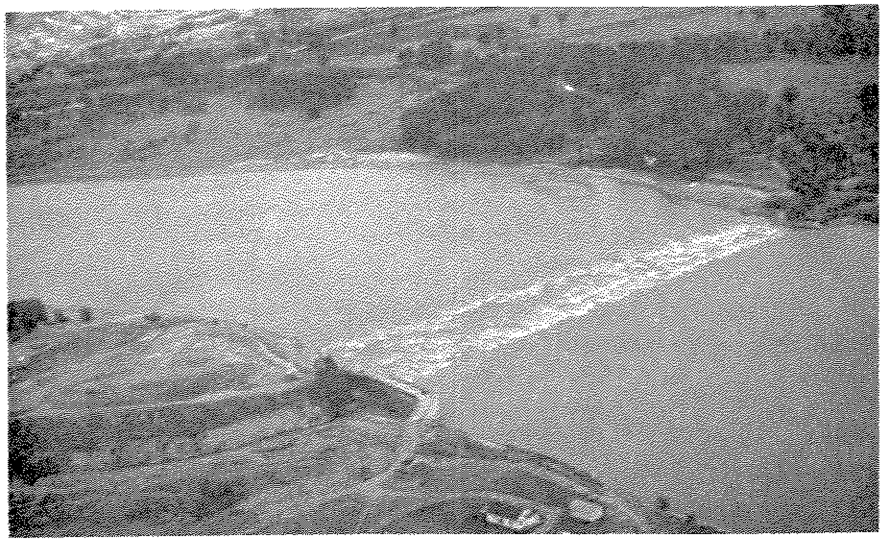


Figure 13. Aerial view of the Intake diversion, sampling station No. 18.

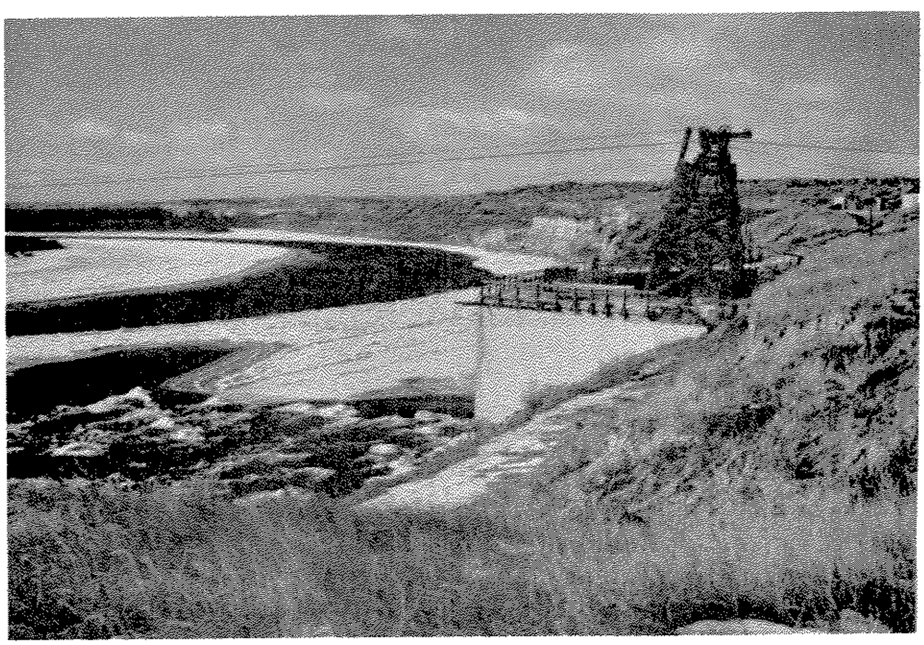


Figure 14. Yellowstone River at Intake diversion.

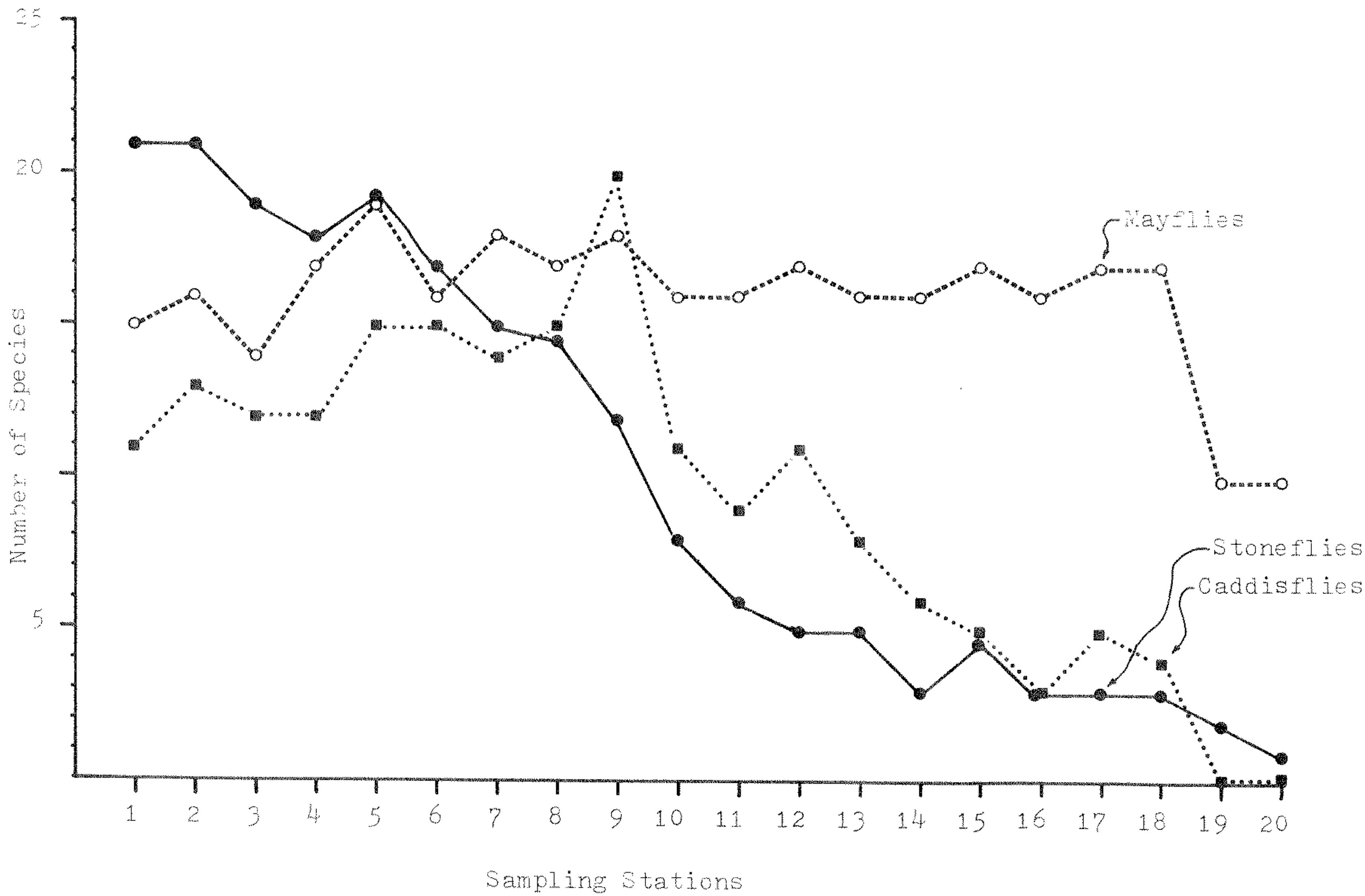


Figure 15 . Number of species of the three major orders found at each sampling station in the Yellowstone River.

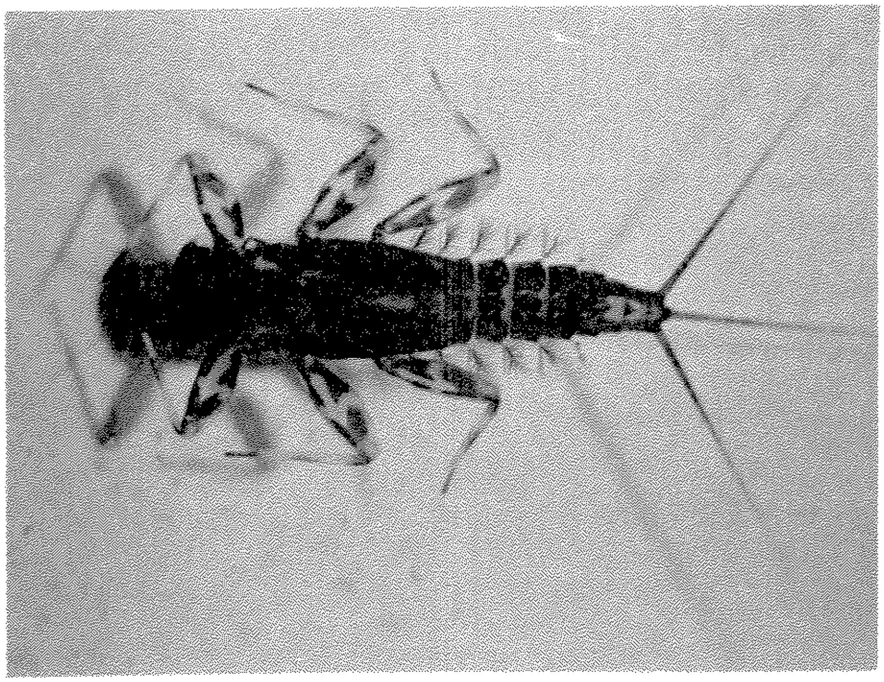


Figure 16. Mature nymph of the mayfly *Heptagenia elegantula*.

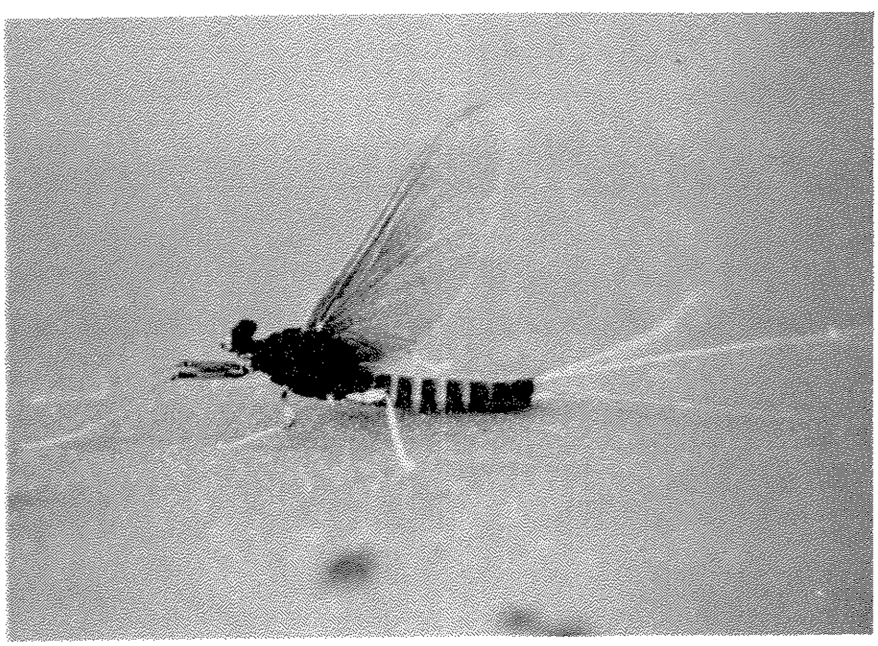


Figure 17. Adult mayfly *Traverella albertana*.

outlined by Cummins (1975b) for large rivers. Four species were collected throughout the study area and a fifth species *(Ephemerella inermis)* was missing only from the lowermost sampling station. There is some question that the species *Baetis alexanderi* may actually be *B. insignificans*.

The number of mayfly species found at each station is illustrated in Figure 15. Station 5 yielded the largest number of species (19) and stations 19 and 20 the fewest with 10 species. No pattern of mayfly distribution is apparent throughout the transition zone. Along a longitudinal gradient the community exhibits a gradual shift from mountain fauna to prairie fauna or a fauna more adapted to slower flow, warmer temperatures and a silty substratum, but the number of species is quite constant along the entire river.

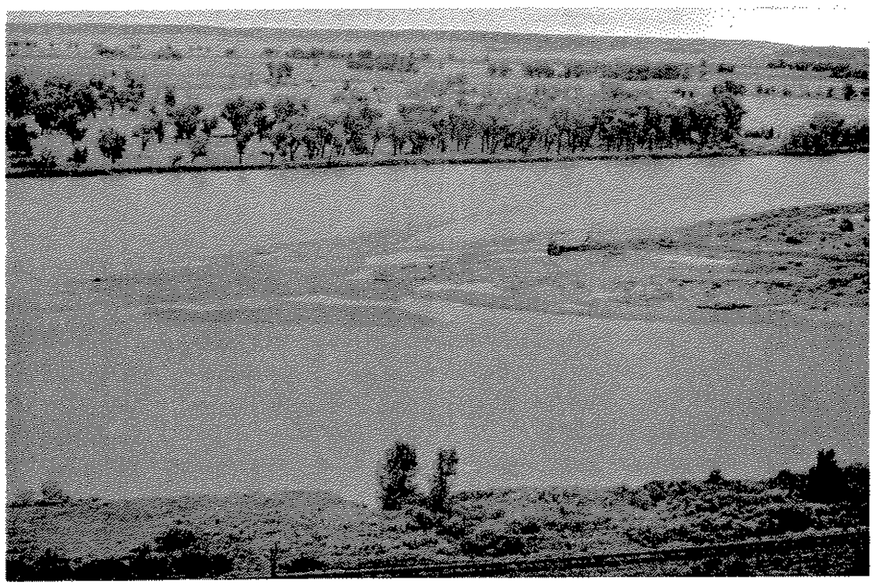
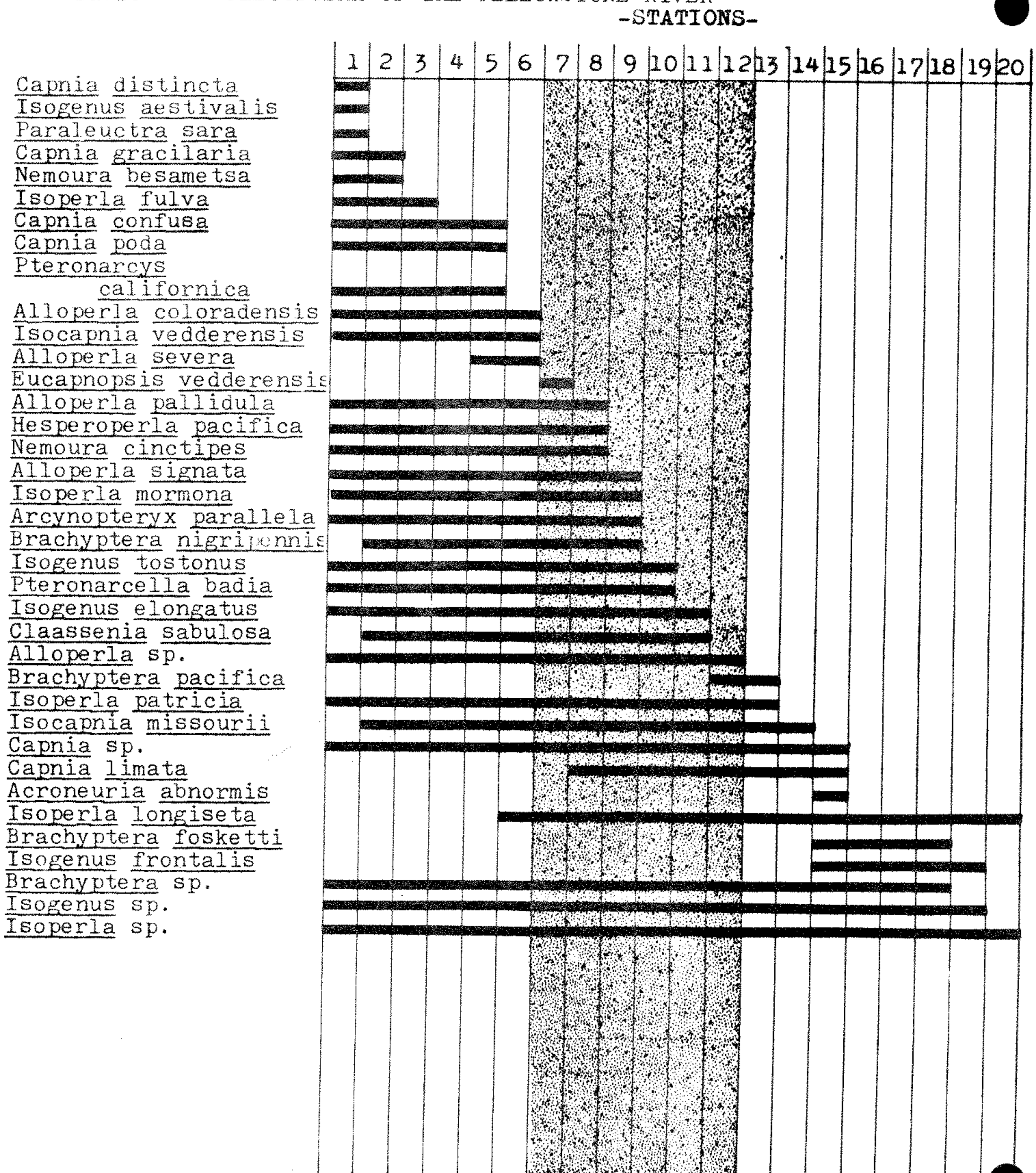


Figure 18. Photo of the Yellowstone River taken about 10 miles upstream from Miles City.

The longitudinal distribution of the stoneflies (Plecoptera) differs considerably from that of the Ephemeroptera (Table 4). A total of 32 species was identified in the study area. No single species was collected at every station. Data available for this order are probably the most accurate because of the work of Stadnyk (1971) and Gaufin et al. (1972). Most of the fauna are probably adapted to the conditions found in the upper river. A total of 12 species drop out in the transition zone and five species could be classified as prairie stream forms. *Acroneuria abnormis*, probably washed out of the Tongue River where it is very abundant, and was collected only at Station 15. The number of Plecoptera species decreases steadily downstream (Figure 15). Generally the non-prairie stoneflies appear to have habitat requirements similar to those of the salmonid fishes.

Table 4. PLECOPTERA OF THE YELLOWSTONE RIVER



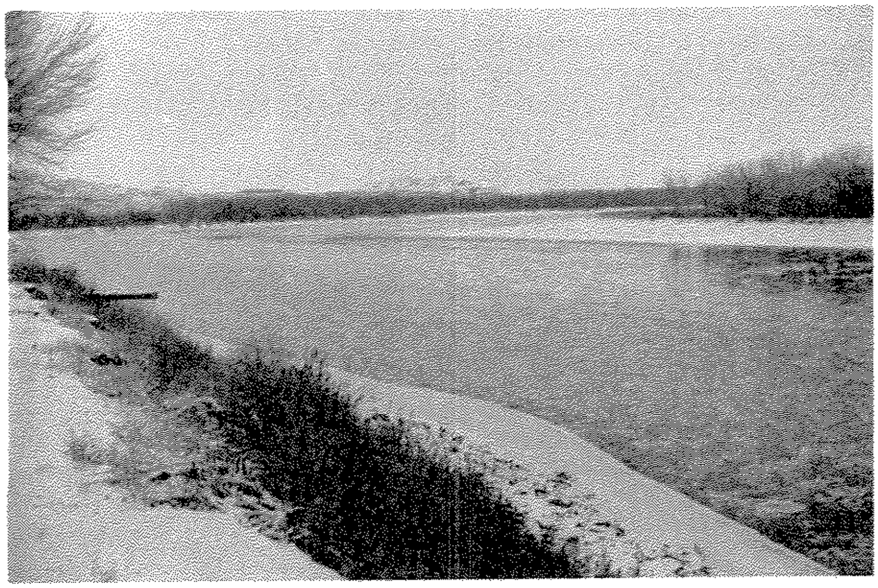


Figure 19. Yellowstone River at Glendive during early winter.

Figure 20. Yellowstone River at Terry during late winter.

Caddisfly (Trichoptera) distribution in the Yellowstone River is presented in Table 5. The present species list contains 36 species and additional species will probably be collected. Distributional patterns are less distinct than with the Ephemeroptera and Plecoptera. In most cases caddisfly larvae cannot be identified to species; adult males are necessary. The present distribution is incomplete because all stations were not sampled with equal frequency. For example, Station 9 had the largest number of species and was sampled most intensively. Generally, caddisfly distribution is similar to that of the Plecoptera with a steady decline in species downstream. The genera *Hydropsyche* and *Cheumatopsyche* are abundant throughout the river, but dominate in the lower 10 stations.

The distribution of the remaining aquatic orders is given in Table 6. The order Diptera is widely distributed throughout the river with the family Chironomidae being the most abundant and diverse. *Protanyderus margarita*, an interesting species previously unreported from Montana, was captured at several stations. Representatives of the remaining orders did not illustrate any distributional trends and, with the exception of the Oligochaeta, were never abundant.

The distribution of macroinvertebrates found in the Tongue River, shown in Table 7, is very complex and is not easily explained. The fauna is similar to the Yellowstone fauna in many ways, but there are several differences. The stonefly *Acroneuria abnormis*, the elmid beetle *Stenelmis* sp. and the mussel *Lampsilis* sp. are very abundant in the Tongue but are rare in the Yellowstone River. Odonates are more abundant and diverse in the Tongue River.

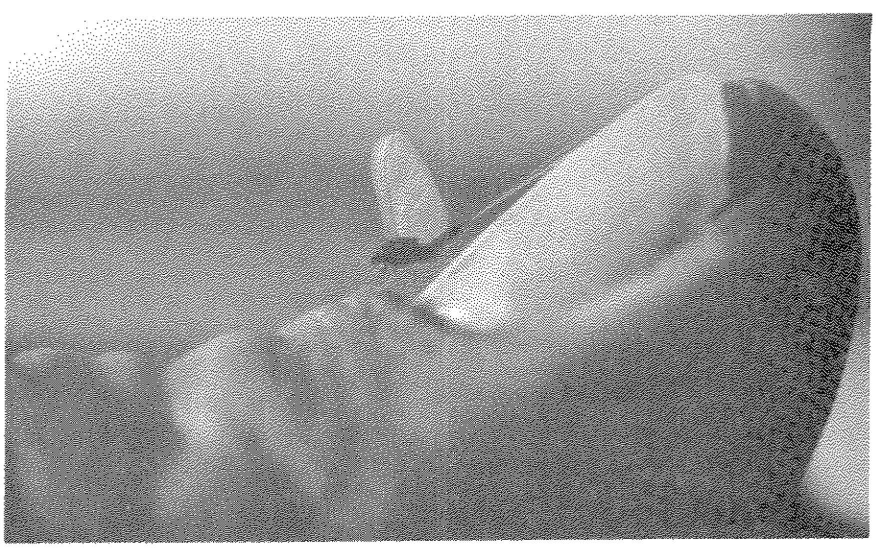


Figure 21. Photo of an adult mayfly, *Tricorythodes minutus*.

Table 5. TRICHOPTERA OF THE YELLOWSTONE RIVER.

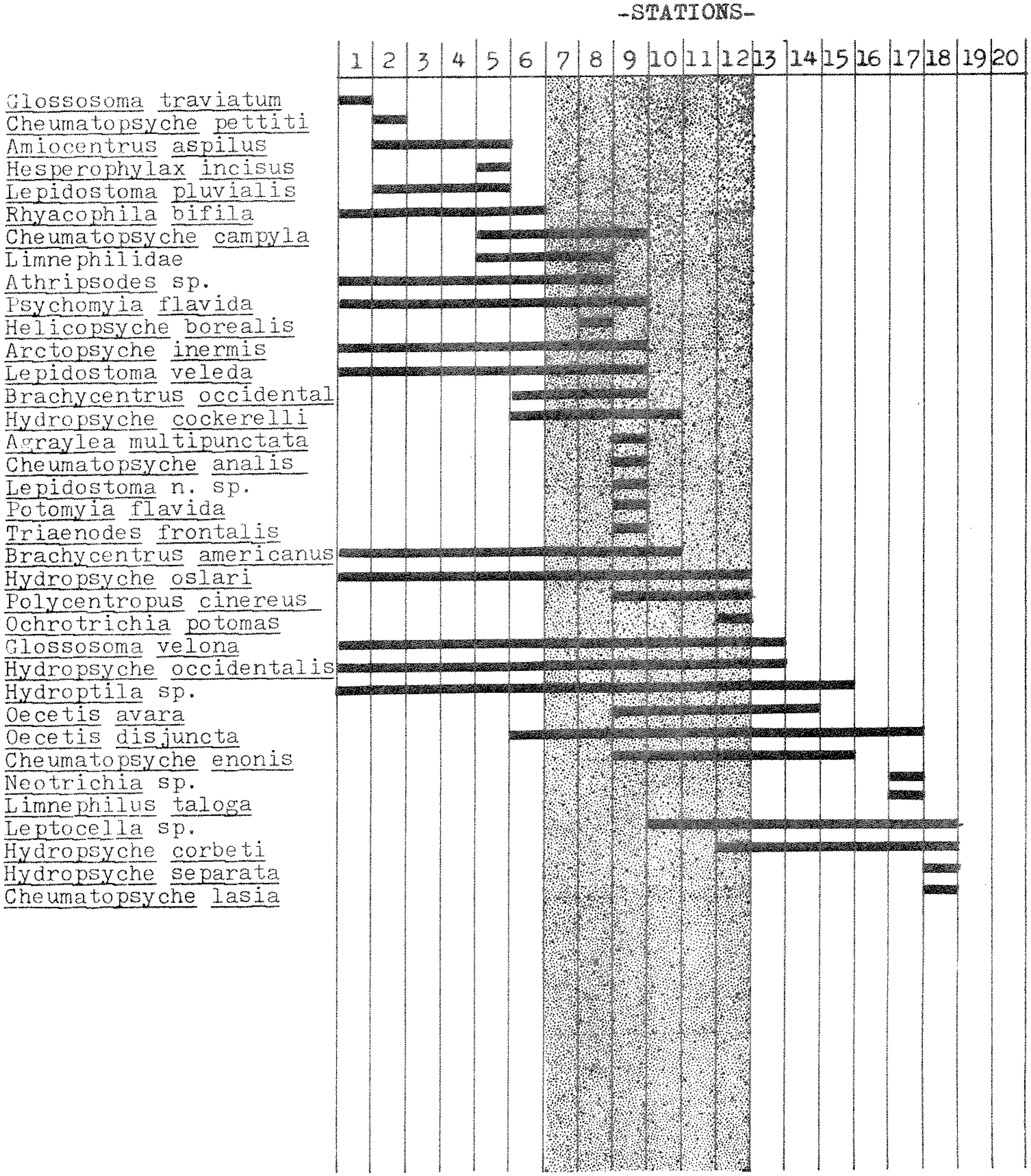


Table 6. AQUATIC INVERTEBRATES OF THE YELLOWSTONE RIVER.

-STATIONS-

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DIPTERA																				
Ceratopogonidae													X	X	X	X	X	X		
Dolichopodidae				X																
Agathon sp.	X	X																		
Hemerodromia sp.	X	X	X	X	X	X	X	X	X	X	X									
Protanyderus sp.				X	X	X	X	X	X											
Atherix sp.	X	X	X	X	X	X	X	X	X	X	X									
Simulium sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dicranota sp.		X									X	X	X	X	X					
Hexatoma sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
Holorusia sp.			X				X													
Tipula sp.								X	X											
Limnophora sp.					X				X											
Chironomidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ISOPODA																				
Asellus sp.					X	X	X	X	X	X										
LEPIDOPTERA																				
Cataclysta sp.						X							X							
HEMIPTERA																				
Rhagovelia sp.								X												
Ambrysis sp.												X								
Callicorixa sp.																	X	X		
Cenocorixa sp.												X								
Trichocorixa sp.												X	X							
Sigara sp.							X	X	X	X	X	X						X		
Gerris sp.								X												
Ranatra sp.																	X			
COLEOPTERA																				
Oreodytes sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Gyrinus sp.							X			X				X						
Dubiraphia sp.							X	X	X	X	X				X					
Microcylloepus sp.					X	X	X	X	X	X	X				X					
Optioservus sp.	X	X	X	X	X	X	X	X	X	X	X	X								
Stenelmis sp.											X				X	X	X			
Zaitzevia sp.	X	X	X	X	X	X	X	X	X	X	X									
Helichus sp.						X														

Table 6. AQUATIC INVERTEBRATES OF THE YELLOWSTONE RIVER.

-STATIONS-

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ODONATA																				
Gomphus sp.							X										X	X	X	X
Ophiogomphus sp.								X	X	X	X	X								
Amphiagrion sp.									X											
Libellulidae								X	X											
AMPHIPODA																				
Gammarus sp.							X										X			
Hyalella sp.							X				X							X		
ACARI																				
Hydracarina	X	X	X	X	X	X	X	X	X	X	X									
MOLLUSCA																				
Ferrissia sp.																	X	X		
Gyraulus sp.																				X
Lampsilis sp.															X	X	X			
Lymnaea sp.																	X			
Physa sp.							X			X										
TURBELLARIA																				
Phagocata sp.					X															
OLIGOCHAETA																				
Nais sp.												X								
Ophidonais sp.												X								

Table 7. Macroinvertebrate fauna of the Tongue River, Montana.

Station No. -	8	7	6	5	4	3	2	1
Taxa	Dam Section	Hosford	Birney	Ashland	Viall	S - H	Orcutt	Keogh
Ephemeroptera								
Baetis spp.	X	X	X		X	X		
Baetisca sp.						X		
Brachycercus sp.					X			
Choroterpes sp.				X		X		
Dactylobaetis sp.						X		
Ephemerella sp.	X	X	X	X	X	X	X	
Heptagenia sp.			X	X	X	X	X	
Leptophlebia sp.			X	X			X	
Rhithrogena sp.			X	X	X	X	X	X
Stenonema sp.		X				X		
Traverella sp.			X	X	X	X	X	
Tricorythodes sp.	X	X	X	X	X	X	X	
Trichoptera								
Brachycentrus sp.	X		X	X	X	X	X	X
Cheumatopsyche sp.	X	X	X	X	X	X	X	X
Glossosoma sp.		X	X					
Hydropsyche sp.	X	X	X	X	X	X	X	X
Hydroptila sp.	X	X	X				X	X
Mystacides sp.			X	X			X	
Oecetis sp.			X	X		X	X	
Plecoptera								
Acroneuria sp.			X			X	X	X
Brachyptera sp.			X		X	X	X	X
Isogenus sp.			X	X	X	X	X	X
Coleoptera								
Dubiraphia sp.		X	X					
Microcylloepus sp.		X	X	X				
Stenelmis sp.		X	X	X	X	X	X	X
Mollusca								
Ferrissia sp.	X	X	X					
Gyraulus sp.		X						
Lymnaea sp.	X	X						
Lampsilis sp.								X
Physa sp.	X	X	X					
Pisidium sp.		X				X		
Sphaerium sp.		X						

Table 7 continued. Macroinvertebrate fauna of the Tongue River, Montana.

Station No. -	8	7	6	5	4	3	2	1
Taxa	Dam Section	Hosford	Birney	Ashland	Viall	S - H	Orcutt	Keogh
Odonata								
Argia sp.		X					X	
Calopteryx sp.		X			X	X		
Enallagma sp.								
Ischnura sp.		X						
Gomphus sp.			X					
Ophiogomphus sp.	X	X	X	X	X	X		
Lepidoptera								
Cataclysta sp.	X	X				X	X	
Turbellaria								
Dugesia sp.	X	X	X	X		X	X	
Hemiptera								
Corixidae	X	X	X				X	X
Rhagovelia sp.				X				
Diptera								
Chironomidae	X	X	X	X	X	X	X	X
Cardiocladius sp.	X		X					
Diamesa sp.	X		X					
Eukiefferiella sp.			X					X
Orthocladius sp.	X					X		
Rheotanytarsus sp.			X					
Simuliidae								
Simulium sp.	X	X	X	X	X	X	X	
Tipulidae								
Hexatoma sp.			X	X		X	X	X
Oligochaeta		X	X					

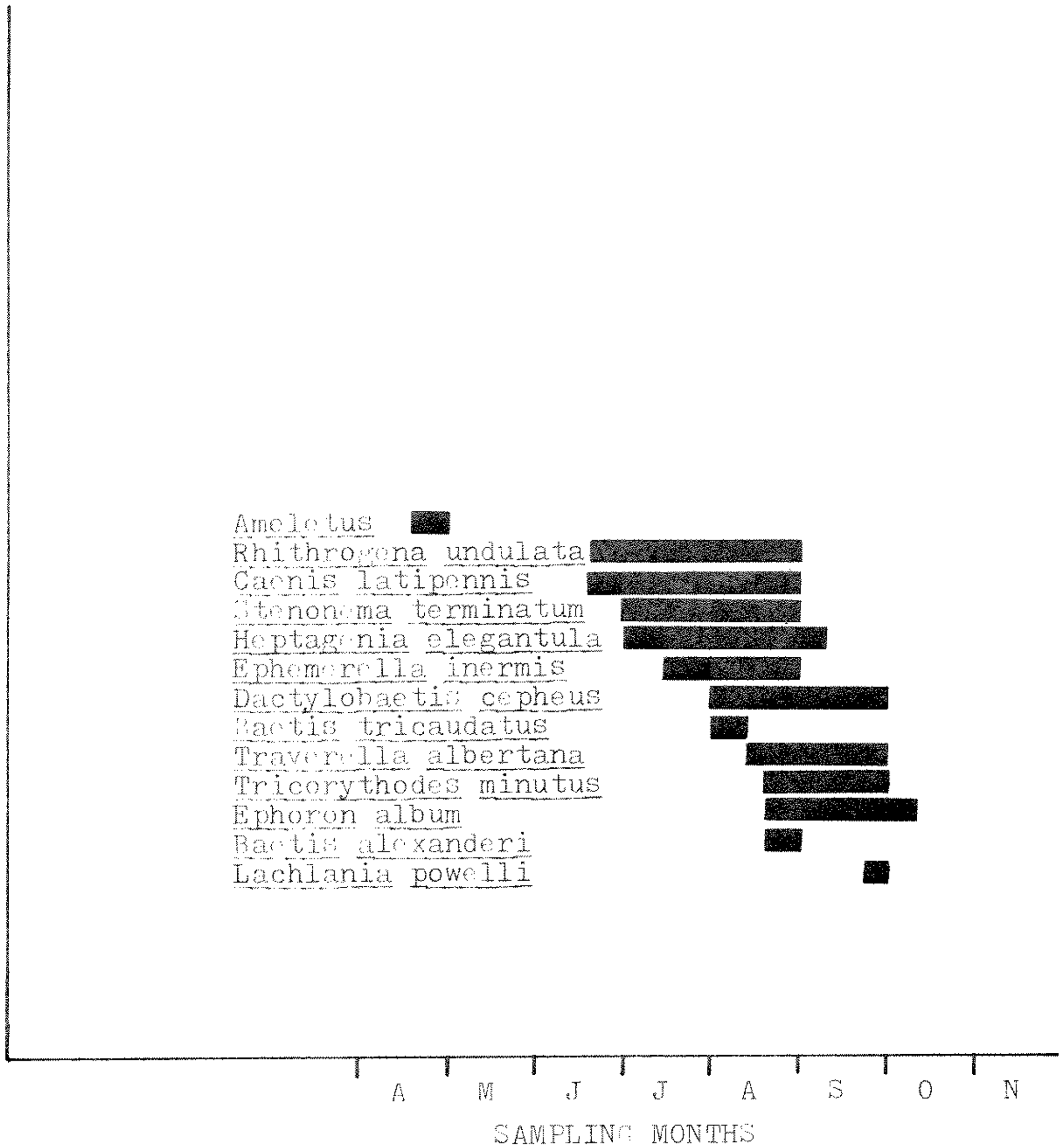


Figure 22 . Emergence and flight patterns of mayflies from the Yellowstone River, 1974-76.

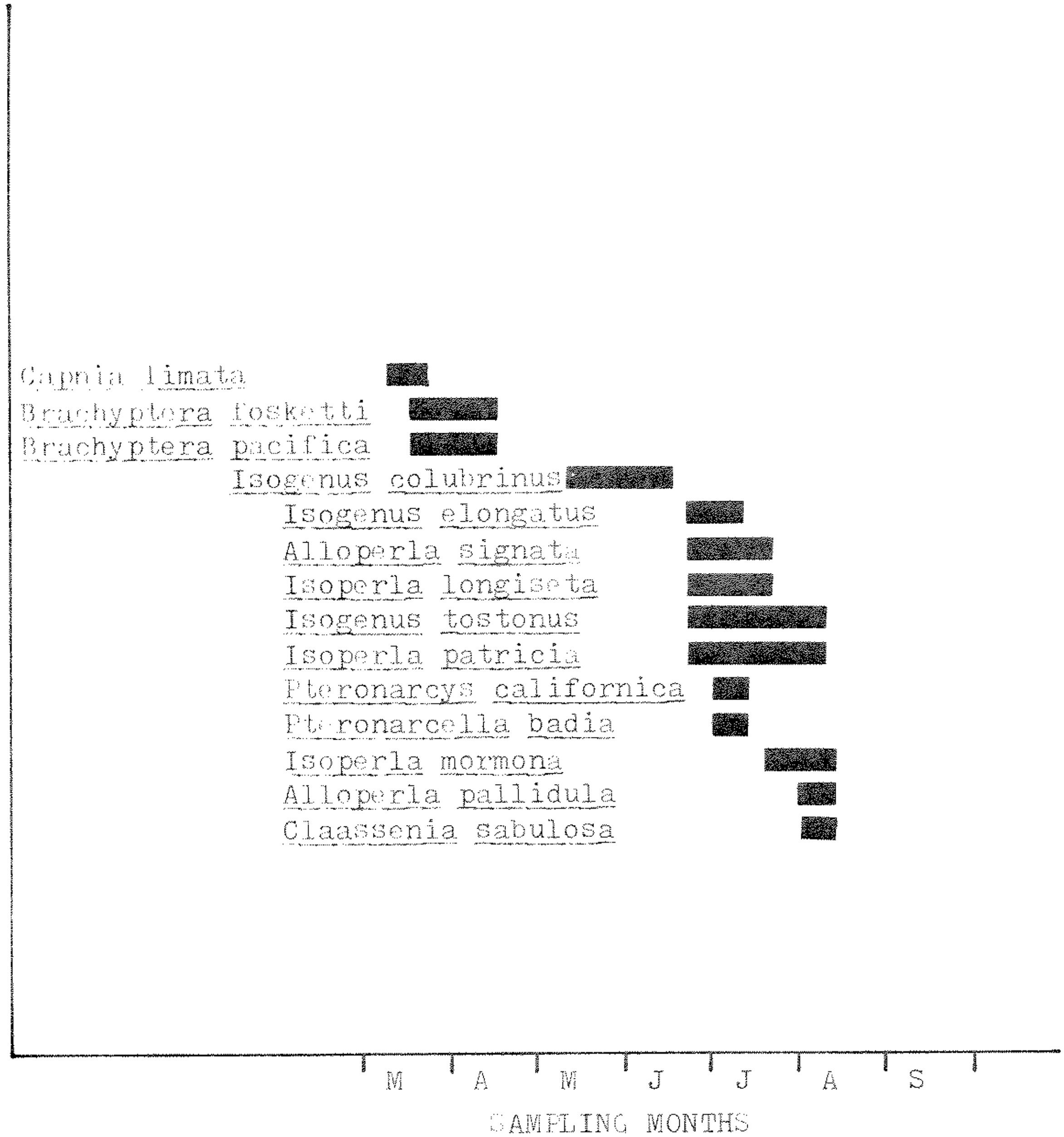


Figure 23 . Emergence and flight patterns of stoneflies from the Yellowstone River, 1974-76.

Insect Emergence

Emergence times were determined for only 13 species of mayflies (Figure 22). Generally these species are common in the lower reaches of the Yellowstone River. Most mayfly adults live from a few days to a few hours and most emerge at dawn or dusk and a considerable amount of time is necessary to accumulate a thorough collection of the majority of species. Emergence of mayfly adults in the lower river is concentrated in the June-September period. Adult *Ephoron album* emerged very late in the summer. Their emergence was so late in the year that many adults were influenced by cold morning temperatures and many were observed fluttering on the beaches unable to fly. One of the largest mayfly emergences ever observed by the author was witnessed in late August 1974. It was first observed at Huntley (Station 11) where thousands of adult *Traverella albertana* (Figure 17) were emerging. The adults were so thick on the water surface that carp were surface feeding on the adults. It was a wet day and the adults hovered over the wet highway from Huntley to Miles City and the emergence probably involved hundreds of thousands of insects. The emergence of *Tricorythodes minutus* (Figure 21) and *Ephoron album* also involved large numbers of individuals and was very conspicuous.

The emergence of adult stoneflies occurs over a longer time span than does that of mayflies. Emergence of stoneflies occured from March-August (Figure 23). Three species, *Capnia limata, Brachyptera fosketti* and *B. pacifica* emerged when the river was still covered with ice. Stoneflies are not as abundant as mayflies, spend less time in flight and are therefore less conspicuous when emerging. The most spectacular stonefly emergence is that of *Pteronarcys californica*, the giant stonefly or the "salmonfly" of fly fishermen. This species is confined to the upper river where adult insect sampling was less intense. A small yellow stonefly, *Isoperla longiseta* (Figure 24) emerges in large numbers in the lower river.

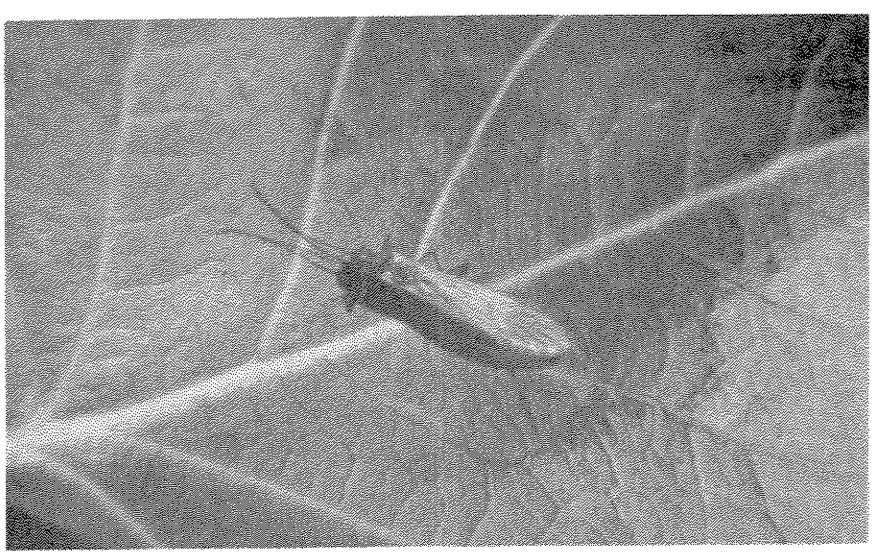


Figure 24. Photo of an adult stonefly *Isoperla longiseta*.

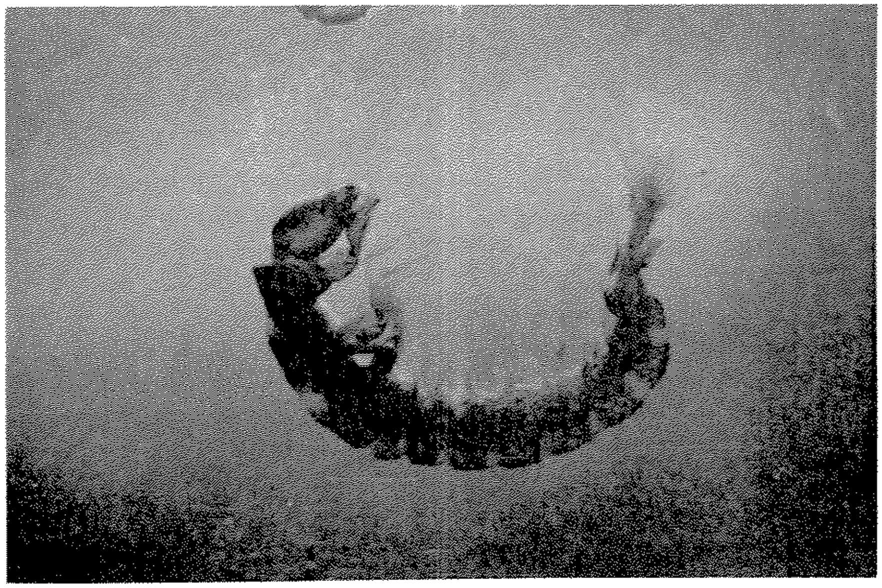


Figure 25. Photo of the larvae of the caddisfly *Hydropsyche*.

Figure 26. Photo of an adult of the genus *Hydropsyche*.

The emergence patterns of caddisflies is presented in Figure 27. Emergence and flight times ranged from May-September. Caddisflies and stoneflies can live for several weeks as adults; therefore the presence of an adult does not necessarily signify recent emergence. In most cases larval caddisflies can be identified only to genus; adult males are necessary for species identification. The number of species presented in Figure 27 is much larger than either the mayfly or stonefly lists because the fauna is very rich and because adult caddisflies are readily attracted to collecting lights and are easily collected.

The family Hydropsychidae dominates the caddisfly fauna of the Yellowstone River. Representatives of this family are all net spinners and include the genera *Cheumatopsyche*, *Hydropsyche* and *Arctopsyche*, and total 13 species (Figures 25 and 26). One species *Hydropsyche corbeti* was not known from the United States until collected in the Yellowstone River.

Bottom Fauna Standing Crop

Bottom samples taken during the fall of 1974 were designed to survey the bottom fauna and to test equipment. The data are, therefore, semi-quantitative and very difficult to compare with later sampling. Results of bottom sampling during 1974 are presented in Appendix C.

Quantitative bottom fauna sampling began in the summer of 1975. No sampling is possible in the lower river during the winter because of ice cover and shortly after the ice is removed, spring runoff begins and bottom samples from this period would be of little value. The data gathered by Schwehr (1976) were added here to compare the density of invertebrates of the mid-river (Stations 5-11) to that of the lower river (Stations 12-20). Field data from these samples are presented in Appendix D.

In August standing crop estimates ranged from about 2000 m^{-2} at Station 5 to about 50 m^{-2} at Station 9 (Figure 28). Station 19 exhibited the lowest mean of 250 m^{-2}. Generally there was a gradual decrease in mean standing crop in a downstream direction.

September standing crop estimates exhibited a greater range, from 8500 (Station 5) to 20 m^{-2} at Station 19. Estimates from the lower river were much lower than from upper river stations (Figure 29).

In October less variation in range was observed (Figure 30). The maximum standing crop estimate was 4000 m^{-2} (Station 11) and the low was 250 m^{-2} at Station 18. The trend again was a gradual decrease in the density of organisms as one moves downstream.

In the November samples data from Stations 1 and 3 were available (Figure 31). Standing crop estimates at Stations 1 and 3 were very similar and much higher than for the remaining sampling stations (range 4500-12,000 m^{-2}). The trend along a longitudinal gradient was a decrease in standing crop downstream.

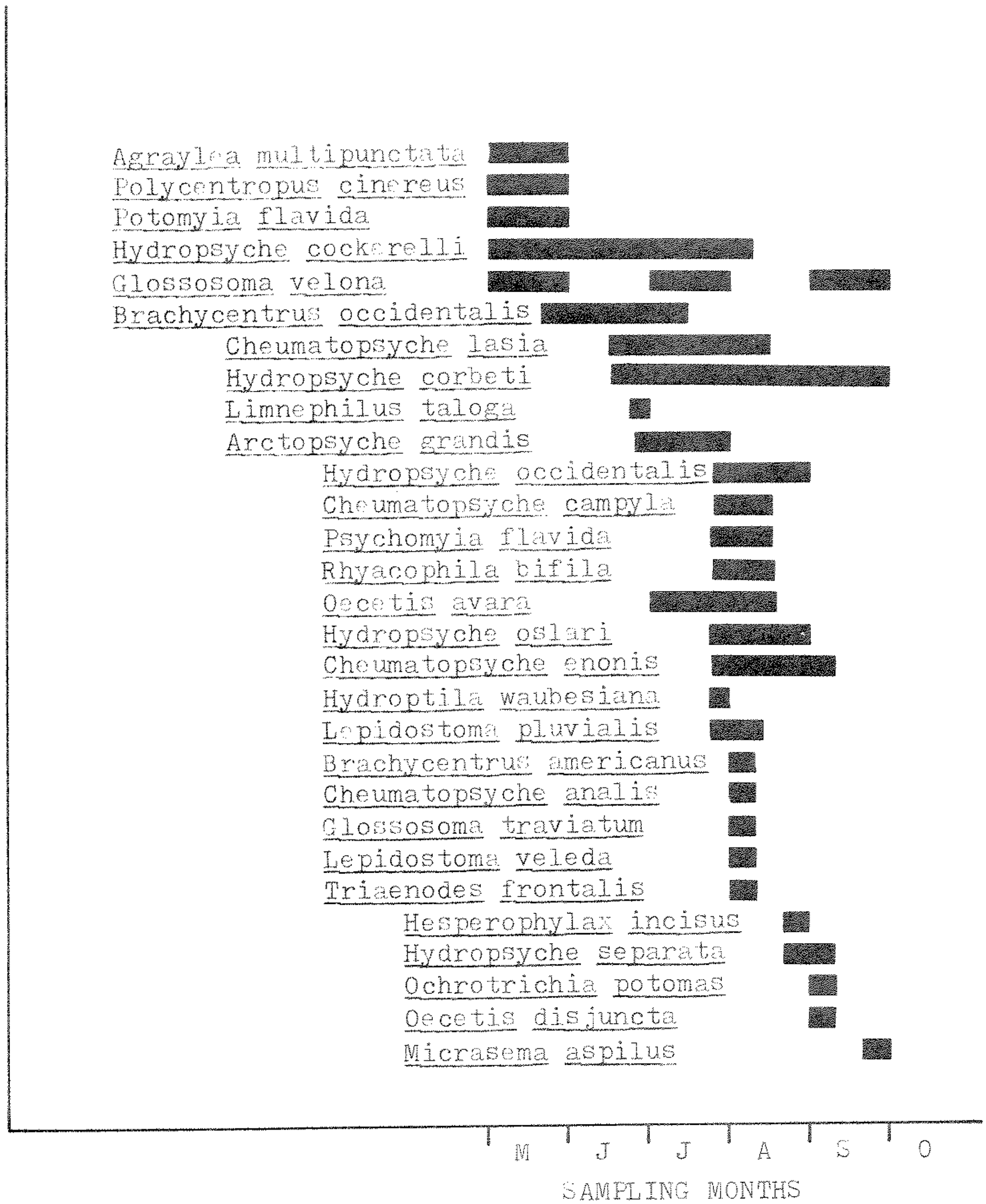


Figure 27 . Emergence and flight patterns of caddisflies from the Yellowstone River, 1974-76.

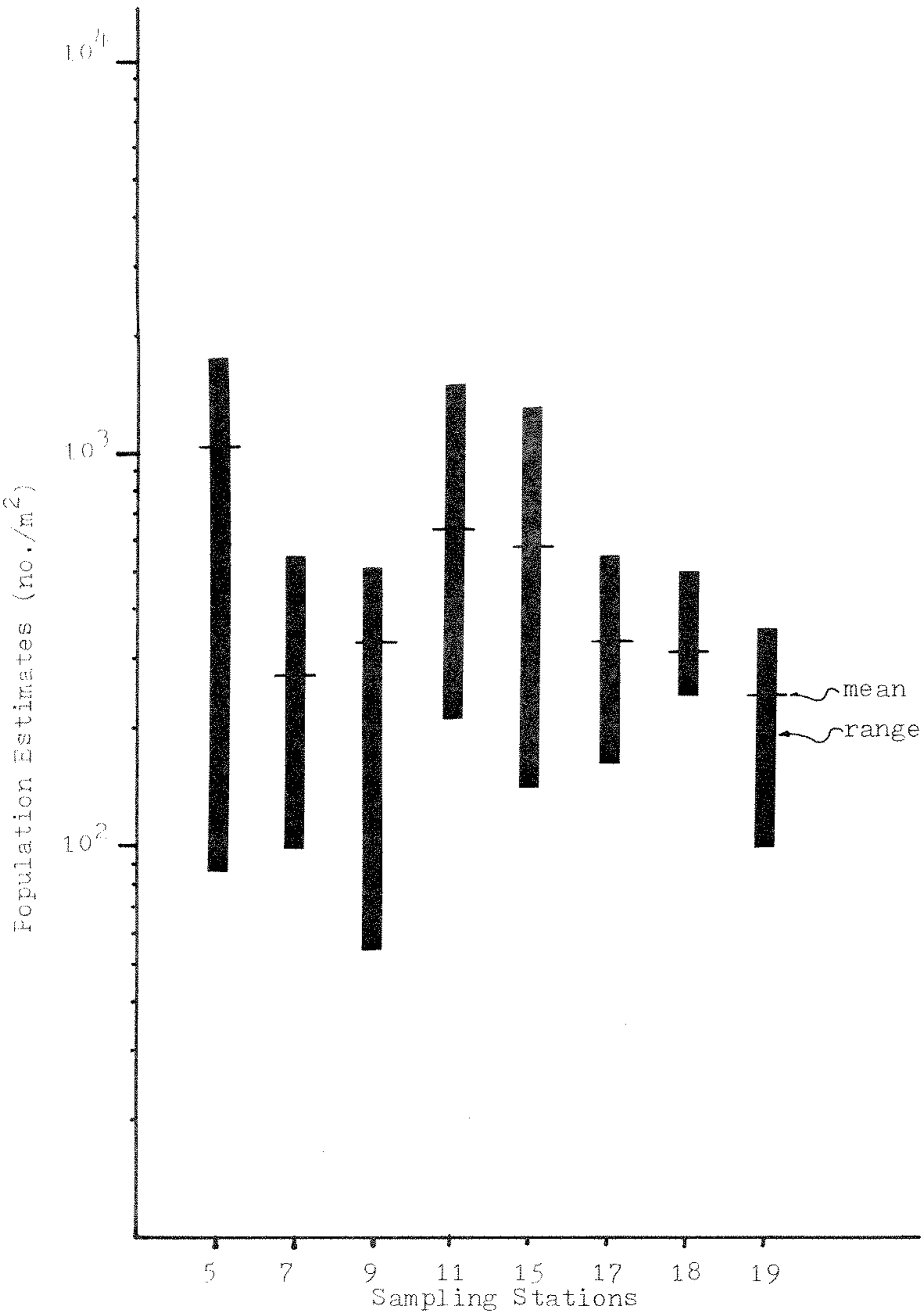


Figure 28 . Population estimates, August 1975, mean and range of six Water's samples.

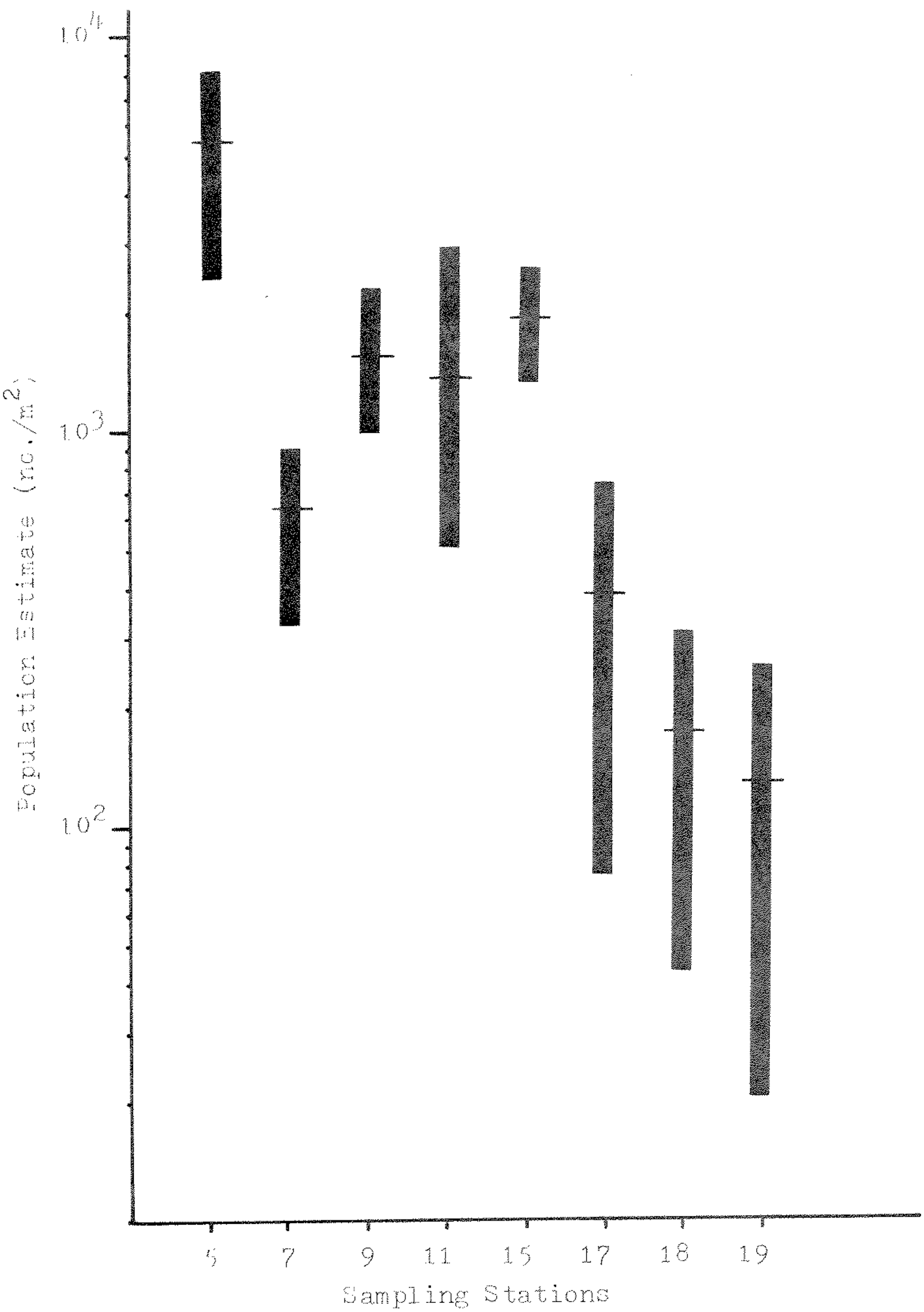


Fig. 29 Population estimates for September 1975, mean and range of six Water's samples.

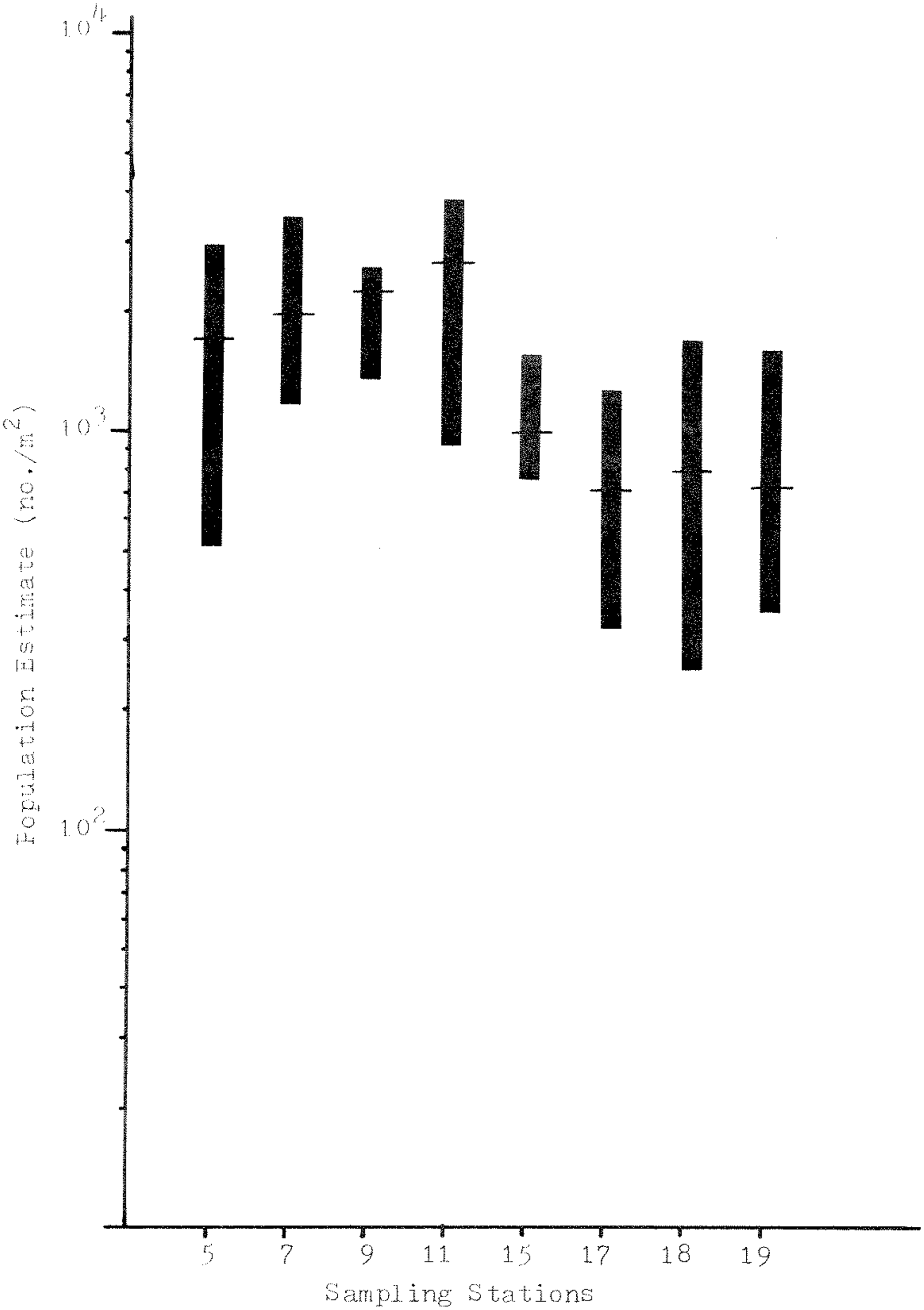


Fig. 30 Population estimates for October 1975, mean and range of six Water's samples.

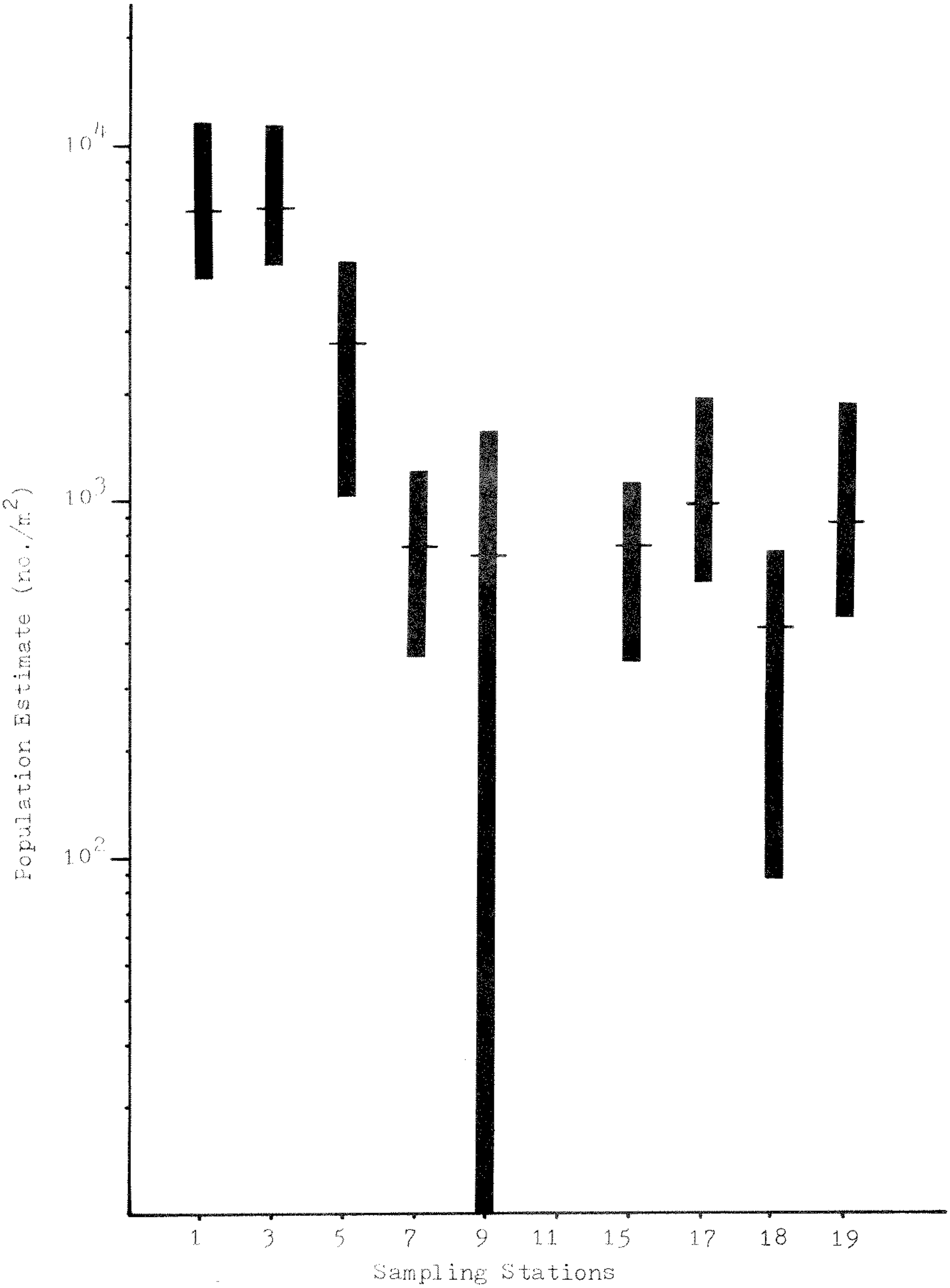


Figure 31 . Population estimates for November 1975, mean and range of six Water's samples.

The percent composition of all invertebrate orders collected in 1975 are presented in Tables 8-11. The mean percent composition of each order is found in Table 12. Mayflies dominate the fauna in August and Trichoptera begin to dominate in September and October while the Diptera became dominant in November. Plecoptera are a minor portion of the fauna as are remaining fauna. Figure 32 graphically illustrates the longitudinal changes in percent composition of invertebrate orders.

Species Diversity

Species diversity indices were calculated from Water's samples taken during August-November 1975. The rationale behind species diversity indices was the desire to begin a monitoring study of the Yellowstone River. Mathematical indices are one way of condensing long species lists to a single mathematical value that can be compared and contrasted with other stations and other time periods. Four different diversity indices are graphed and presented in Figures 33-36 (Appendix E-F).

The Shannon index ($\bar{D}$) appears to be the most sensitive to community changes and these data are presented in Figure 37. The Miles City and Sidney stations exhibited the greatest season change. The Glendive and Intake stations were extremely constant and very similar (Tables 13-16).

Species diversity calculations showed that the Shannon index for all stations was near or below 3.0 for most stations. Generally an index above 3.0 illustrates a healthy, unstressed community, while an index below 1.0 is indicative of a monospecific community under stress. The index range of 1.0-3.0 seems to illustrate a community under some stress. Stresses upon certain Yellowstone communities might be due to large amounts of inorganic sediments and non-diverse, uniform substrate types of the riverbottom in some areas.

CURRENT AND DEPTH REQUIREMENTS FOR INVERTEBRATES

Data from the current-depth studies at Glendive and Intake are summarized in Table 17. In general, current and depth means are similar for both stations and all sampling times. Taxa and number of individuals varied greatly, however. At Glendive the mean number of taxa increased from 3.9 in August to 9.0 in November; a similar trend was evident in the Intake samples. The mean number of individuals increased from 9.1 to 149 at Glendive and from 37.9 to 65.8 at Intake. More taxa and more individuals were captured in the October and November samples at both stations than during August and September. December samples would have been valuable, but were unavailable because the lower river froze on November 30, 1975.

Population estimates from 24 samples at each station expressed in numbers per m^2 are shown in Tables 18-21. In August (Table 18) the fauna was dominated by *Traverella* and *Hydropsyche*. There was a large difference in the total number of individuals collected at Glendive (1222) and Intake (5199).

Table 8. Percent composition of benthos from the Yellowstone River using Water's samplers for the month of August 1975.

Order	Station 5	7	9	11	15	17	18	19
Ephemeroptera	24.4	40.1	67.4	84.7	52.3	49.7	68.8	75.2
Plecoptera	6.7	25.7	17.4	0.8	2.8		0.6	
Trichoptera	4.3	22.4	5.8	8.6	31.9	48.7	30.1	19.7
Diptera	63.2	11.8	9.5	5.6	9.9	1.6		5.1
Coleoptera	1.4				3.1			
Odonata				0.5				
Oligochaeta							0.6	

Table 9. Percent composition of benthos from the Yellowstone River using Water's samplers for the month of September 1975.

Order	Station 5	7	9	11	15	17	18	19
Ephemeroptera	18.2	71.1	50.4	50.7	37.4	30.1	37.8	28.8
Plecoptera	3.1	5.0	1.7	0.1	0.2		2.0	
Trichoptera	21.2	1.7	0.9	18.7	48.1	52.1	57.1	46.6
Diptera	56.5	21.8	47.0	30.3	14.2	14.6	3.0	19.2
Coleoptera	0.9	0.2			0.1			
Hemiptera	0.04							
Turbellaria	0.04							
Odonata								1.4
Oligochaeta						3.2		4.1
Acari				0.1				

Table 10. Percent composition of benthos from the Yellowstone River using Water's samplers for the month of October 1975.

Order	Station 5	7	9	11	15	17	18	19
Ephemeroptera	8.3	35.6	50.8	26.1	35.0	19.8	22.9	21.8
Plecoptera	7.8	13.4	2.9	0.2	0.2			
Trichoptera	12.2	12.0	14.1	29.9	39.7	47.4	17.9	44.8
Diptera	71.2	38.7	32.0	44.0	23.3	12.9	29.3	27.0
Coleoptera	0.1	0.2		0.1			0.2	0.5
Odonata					0.2			
Oligochaeta					1.6	19.8	29.7	6.0
Acari	0.3	0.1	0.2					

Table 11. Percent composition of benthos from the Yellowstone River using Water's samplers for the month of November 1975.

Order	Station 1	3	5	7	9	11	15	17	18	19
Ephemeroptera	14.5	25.4	33.4	22.9	24.8		12.7	7.4	19.6	4.3
Plecoptera	1.4	1.6	8.3	13.8	4.8		1.7	0.4	4.5	1.0
Trichoptera	62.3	43.5	26.3	20.3	16.5		24.7	24.5	29.4	10.8
Diptera	21.1	29.4	29.6	40.6	53.8		54.2	48.4	35.9	75.4
Coleoptera	0.1		0.7	2.4	0.3		0.4			
Oligochaeta	0.1	0.1	0.8				6.2	19.7	10.6	8.6
Acari	0.5		0.1							

Table 12. Percent composition of benthos from the Yellowstone River using Water's samples, mean percentages for August-November 1975.

Order	Station 1	3	5	7	9	11	15	17	18	19
Ephemeroptera	14.5	25.4	21.1	42.4	48.4	53.8	34.4	26.8	37.3	32.5
Plecoptera	1.4	1.6	6.5	14.5	6.7	0.4	1.2	0.1	1.8	0.3
Trichoptera	62.3	43.5	16.0	14.1	9.3	19.1	36.1	43.2	33.6	30.5
Diptera	21.1	29.4	55.1	28.2	35.6	26.6	25.4	19.4	17.1	31.7
Coleoptera	0.1		0.8	0.7	0.1		1.0			
Hemiptera			0.01							
Turbellaria			0.01							
Odonata						0.1	<0.1			0.4
Oligochaeta	0.1	0.1					2.0	10.7	10.2	3.7
Acari	0.5		0.1							

Table 13. Species diversity, range of six Water's samples and results of pooling all samples, August 1975.

		Station 5	7	9	11	15	17	18	19
$\bar{D}$	Max	2.79	3.11	2.95	3.17	3.22	2.70	2.27	2.43
	Min	1.24	1.66	2.19	2.58	2.16	1.51	1.59	1.69
	Pooled	2.22	3.43	3.25	3.08	3.19	2.15	2.12	2.49
Redundancy	Max	.72	.22	.94	.36	.50	.65	.52	.49
	Min	.27	.00	.02	.01	.24	.23	.33	.14
	Pooled	.49	.08	.28	.26	.32	.44	.45	.30
Evenness	Max	.78	.96	1.00	.92	.89	.90	.81	.95
	Min	.18	.83	.12	.70	.65	.62	.68	.76
	Pooled	.53	.88	.75	.74	.73	.62	.61	.75
Equitability	Max	.52	.72	1.00	.65	.68	.60	.50	.60
	Min	.18	.52	.45	.36	.31	.27	.29	.39
	Pooled	.24	.47	.43	.36	.38	.29	.28	.35

Table 14. Species diversity, range of six Water's samples and results of pooling all samples, September 1975.

Index		Station 5	7	9	11	15	17	18	19
$\bar{D}$	Max					2.50	1.86	1.85	2.43
	Min					1.84	1.38	0.83	1.69
	Pooled					2.49	2.14	2.09	2.49
Redundancy	Max					.55	.59	1.00	.49
	Min					.33	.25	.43	.14
	Pooled					.39	.43	.48	.30
Evenness	Max					.72	.87	.95	.95
	Min					.55	.61	.53	.76
	Pooled					.62	.62	.63	.75
Equitability	Max					.33	.49	.58	.60
	Min					.26	.30	.20	.39
	Pooled					.25	.27	.32	.35

Table 15. Species diversity, range of six Water's samples and results of pooling all samples, October 1975.

Index		Station 5	7	9	11	15	17	18	19
$\bar{D}$	Max					2.50	1.86	1.85	2.33
	Min					1.84	1.38	0.83	0.99
	Pooled					2.41	2.14	2.09	2.42
Redundancy	Max					.55	.59	1.00	1.00
	Min					.33	.25	0.43	.38
	Pooled					.39	.43	0.48	0.00
Evenness	Max					.72	.87	.95	1.00
	Min					.55	.61	.53	.62
	Pooled					.62	.62	.63	.73
Equitability	Max					.33	.49	.75	1.00
	Min					.26	.30	.20	.31
	Pooled					.25	.29	.32	.39

Table 16. Species diversity, range of six Water's samples and results of pooling all samples, November 1975.

Index		Station 1	3	5	7	9	11	15	17	18	19
$\bar{D}$	Max	2.88	2.82					1.96	2.45	2.24	1.97
	Min	2.01	2.18					1.41	0.84	1.06	0.24
	Pooled	2.64	2.81					2.00	2.11	2.46	1.30
Redundancy	Max	.53	.44					.64	.82	1.00	.91
	Min	.31	.32					.26	.33	.36	.32
	Pooled	.43	.39					.50	.51	.33	.56
Evenness	Max	.72	.70					.80	.74	.75	.76
	Min	.49	.59					.54	.32	.61	.15
	Pooled	.58	.62					.54	.53	.71	.46
Equitability	Max	.32	.31					.35	.36	.39	.36
	Min	.28	.25					.29	.13	.28	.03
	Pooled	.23	.25					.23	.23	.33	.14

Table 17. Mean and standard deviation for four variables measured in the invertebrate/current investigation in the Yellowstone River at Glendive, 1975.

Date		Depth (ft.)	Current (f/s.)	Taxa	Indiv.
August 7	Mean	1.8	1.202	3.9	9.1
	S. Dev.	0.9	0.575	1.6	8.2
September 17		1.2	0.744	6.5	21.7
		0.9	0.613	2.4	11.1
October 9		1.4	0.786	10.9	126.9
		1.0	0.570	2.2	86.6
November 7		1.6	1.029	9.0	149.0
		0.9	0.678	3.8	133.9
Data taken at Yellowstone River, Intake					
August 6		1.3	1.653	4.8	37.9
		0.6	0.782	1.8	32.4
September 9		1.4	0.970	6.0	28.9
		1.0	0.623	1.7	12.2
October 15		0.8	1.124	8.5	84.0
		0.6	1.031	2.9	53.1
November 11		1.6	1.477	7.0	65.8
		0.9	0.921	3.2	44.8

Table 18. Population estimates from the invertebrate-current samples, 24 samples from each station taken on August 6 and 7, 1975 (no./m^2).

Taxa	Glendive	Intake
Baetis alexanderi	17	6
Baetis parvus	34	74
Brachycercus sp.	80	17
Choroterpes sp.	0	11
Dactylobaetis sp.	11	11
Ephemerella sp.	6	0
Heptagenia sp.	57	28
Isonychia sp.	11	40
Rhithrogena sp.	11	210
Traverella sp.	193	3111
Tricorythodes minutus	63	734
Hydropsyche spp.	569	751
Leptocella sp.	28	6
Isoperla sp.	6	46
Chironomidae	119	114
Simuliidae	11	23
Dytiscidae	0	6
Oligochaeta	6	11
Totals	1222	5199
Means	51	217

Table 19. Population estimates from the invertebrate-current samples, 24 pooled samples taken September 9, 1975 (no./m^2).

Taxa	Glendive	Intake
Baetis alexanderi	28	102
Baetis parvus	28	108
Brachycercus sp.	34	17
Caenis sp.	6	0
Choroterpes sp.	23	57
Dactylobaetis sp.	28	97
Ephemerella sp.	0	0
Ephoron sp.	28	17
Heptagenia sp.	131	14
Isonychia sp.	0	6
Ametropus sp.	0	6
Traverella sp.	74	682
Tricorythodes minutus	279	347
Tricorythodes sp.	0	57
Stenonema sp.	0	6
Cheumatopsyche sp.	63	23
Hydropsyche sp.	779	1763
Leptocella sp.	0	6
Acroneuria sp.	0	6
Isoperla sp.	6	6
Microcylleopus sp.	6	0
Ranatra sp.	6	0
Ceratopogonidae	6	0
Chironomidae	1314	239
Simuliidae	6	51
Oligochaeta	119	28
Totals	2964	3638
Mean	124	152

Table 20. Population estimates from the invertebrate-current samples, 24 pooled samples taken on October 9 and 15, 1975 (no./m^2).

Taxa	Glendive	Intake
Baetis alexanderi	1772	1490
Baetis parvus	142	182
Brachycercus sp.	28	11
Caenis sp.	0	6
Centroptilum sp.	11	0
Choroterpes sp.	46	11
Dactylobaetis sp.	791	301
Ephemerella sp.	0	6
Heptagenia sp.	1879	943
Isonychia sp.	0	6
Rhithrogena sp.	0	742
Stenonema sp.	6	0
Traverella sp.	165	642
Tricorythodes minutus	267	91
Tricorythodes sp.	11	0
Unknown	6	0
Gammarus sp.	6	6
Hyalella sp.	0	6
Brachycentrus sp.	11	0
Cheumatopsyche sp.	199	51
Hydropsyche sp.	9845	4448
Hydroptila sp.	0	6
Oecetis sp.	11	0
Gomphidae	17	0
Isogenus sp.	6	80
Isoperla sp.	6	23
Corixidae	23	0
Dolochopodidae	0	6
Empididae	11	0
Chironomidae	1973	2314
Simuliidae	11	154
Stenelmis sp.	6	0
Ferrissia sp.	23	0
Lymnaea sp.	6	0
Oligochaeta	2776	1104
Totals	20,037	12,640
Mean	835	527

Table 21. Population estimates from the invertebrate-current samples, 24 pooled samples taken on November 7 and 11, 1975 (no./m^2).

Taxa		Glendive	Intake
Baetis alexanderi		751	392
Baetis parvus		17	85
Brachycercus sp.		6	0
Caenis sp.		11	0
Dactylobaetis sp.		63	40
Ephemerella sp.		63	0
Heptagenia sp.		956	427
Leptophlebia sp.		6	6
Rhithrogena sp.		80	330
Stenonema sp.		11	0
Traverella sp.		51	11
Tricorythodes minutus		97	34
Tricorythodes sp.		6	6
Cheumatopsyche sp.		927	114
Hydropsyche sp.		10608	4846
Hyalella sp.		6	0
Brachyptera sp.		256	239
Isogenus sp.		6	142
Corixidae		46	0
Chironomidae		1905	1758
Empididae		6	0
Ceratopogonidae		0	6
Simuliidae		0	6
Dytiscidae		11	6
Ferrissia sp.		17	11
Lymnaea sp.		11	0
Oligochaeta		4374	529
	Totals	20,245	8988
	Mean	844	375

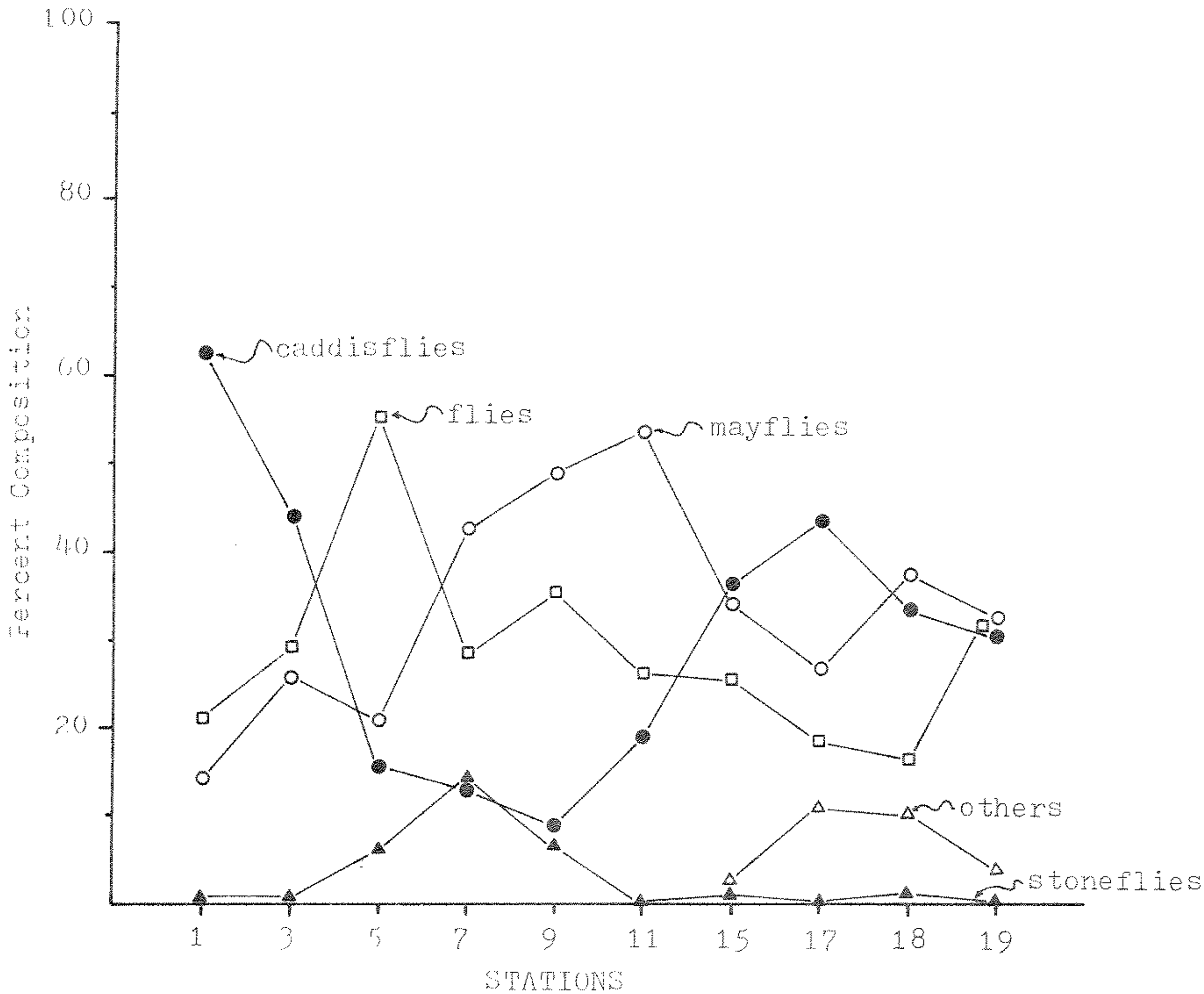


Figure 32 . Percent composition of invertebrate orders from Water's samplers, mean of samples taken Aug.-Nov.

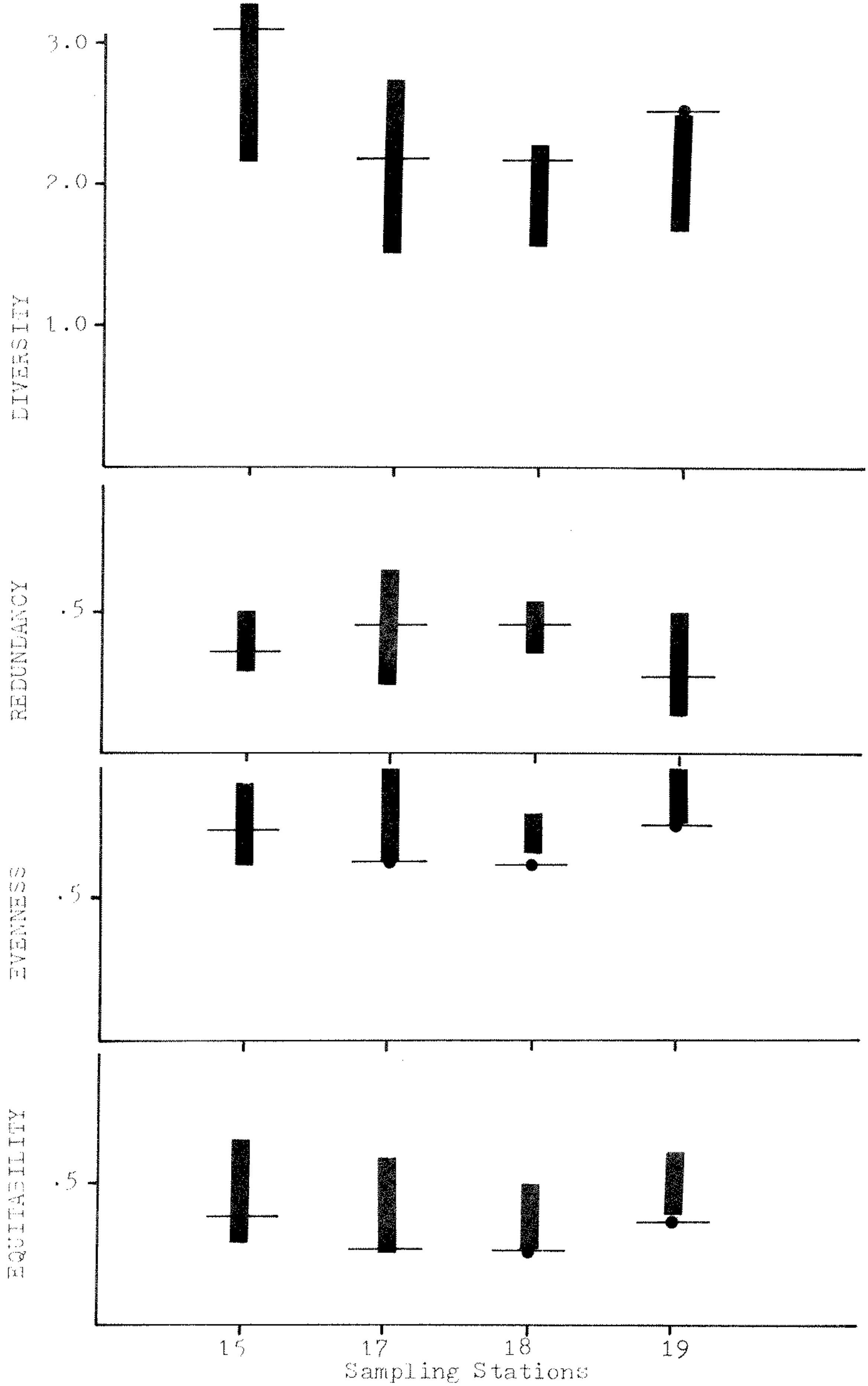


Figure 33 . Species diversity indices for August 1975 range of six Water's samples and all six pooled.

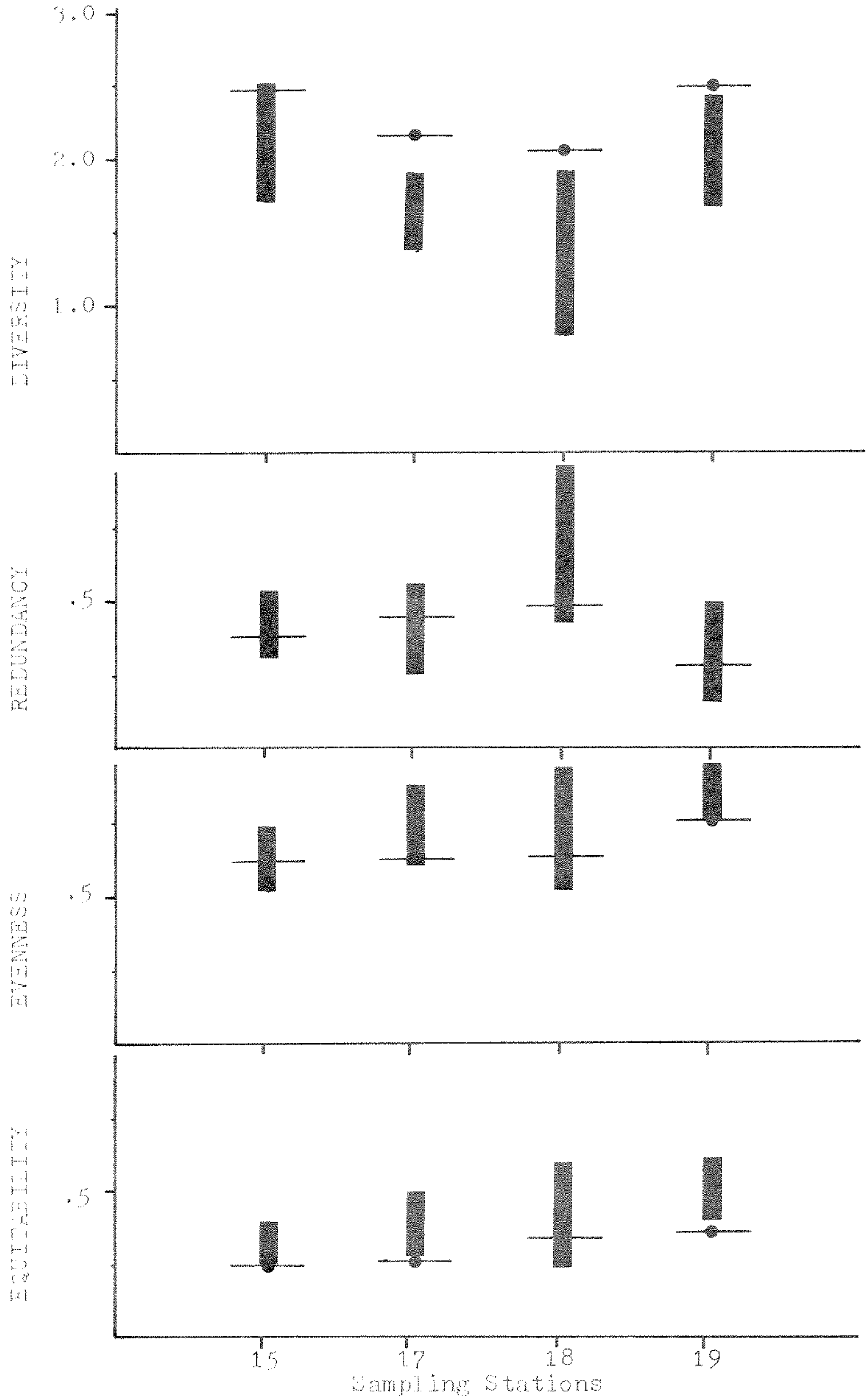


Figure 34 . Species diversity indices for September 1975 range of six Water's samples and all six pooled.

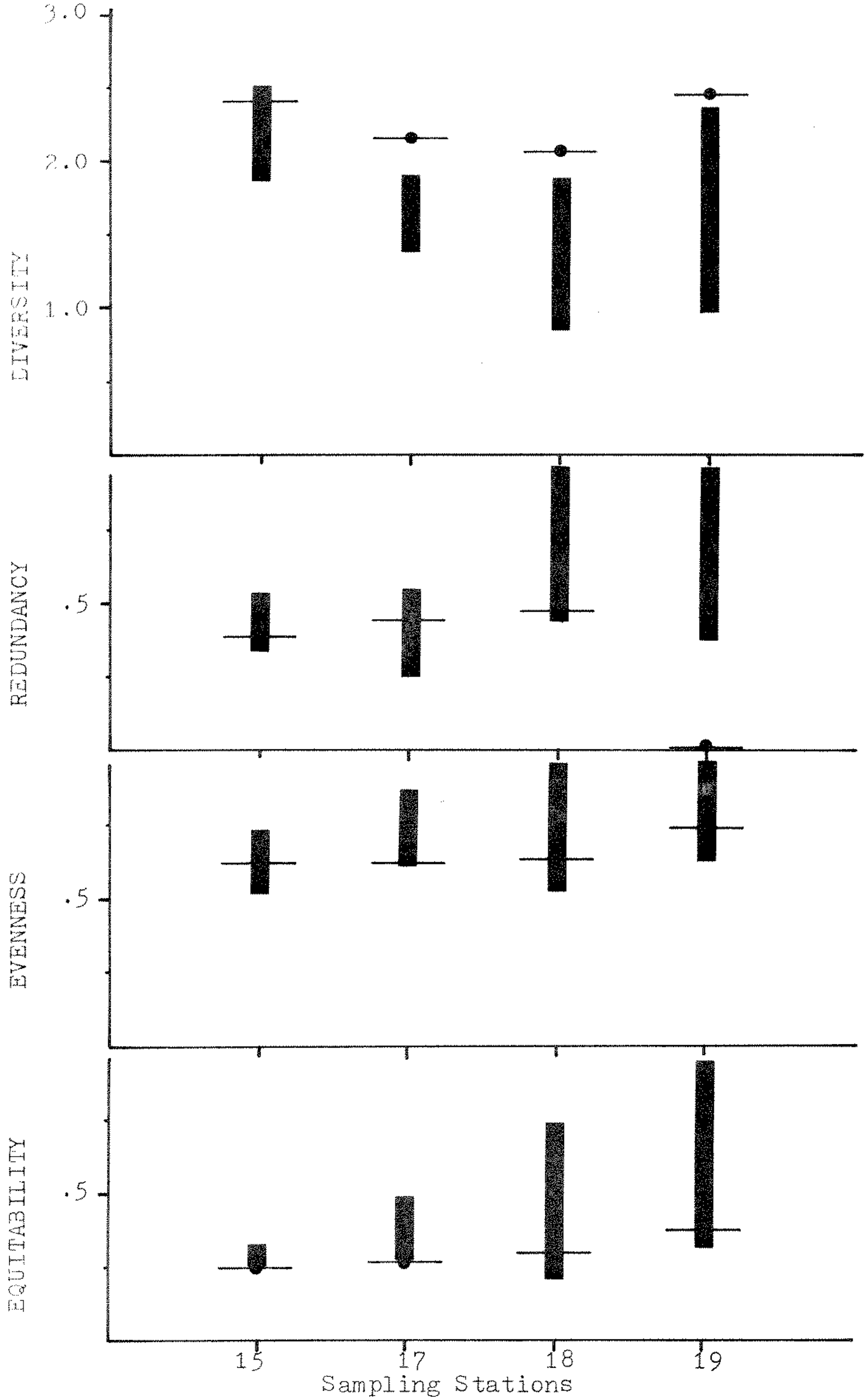


Figure 35 . Species diversity indices for October 1975 range of six Water's samples and all six pooled.

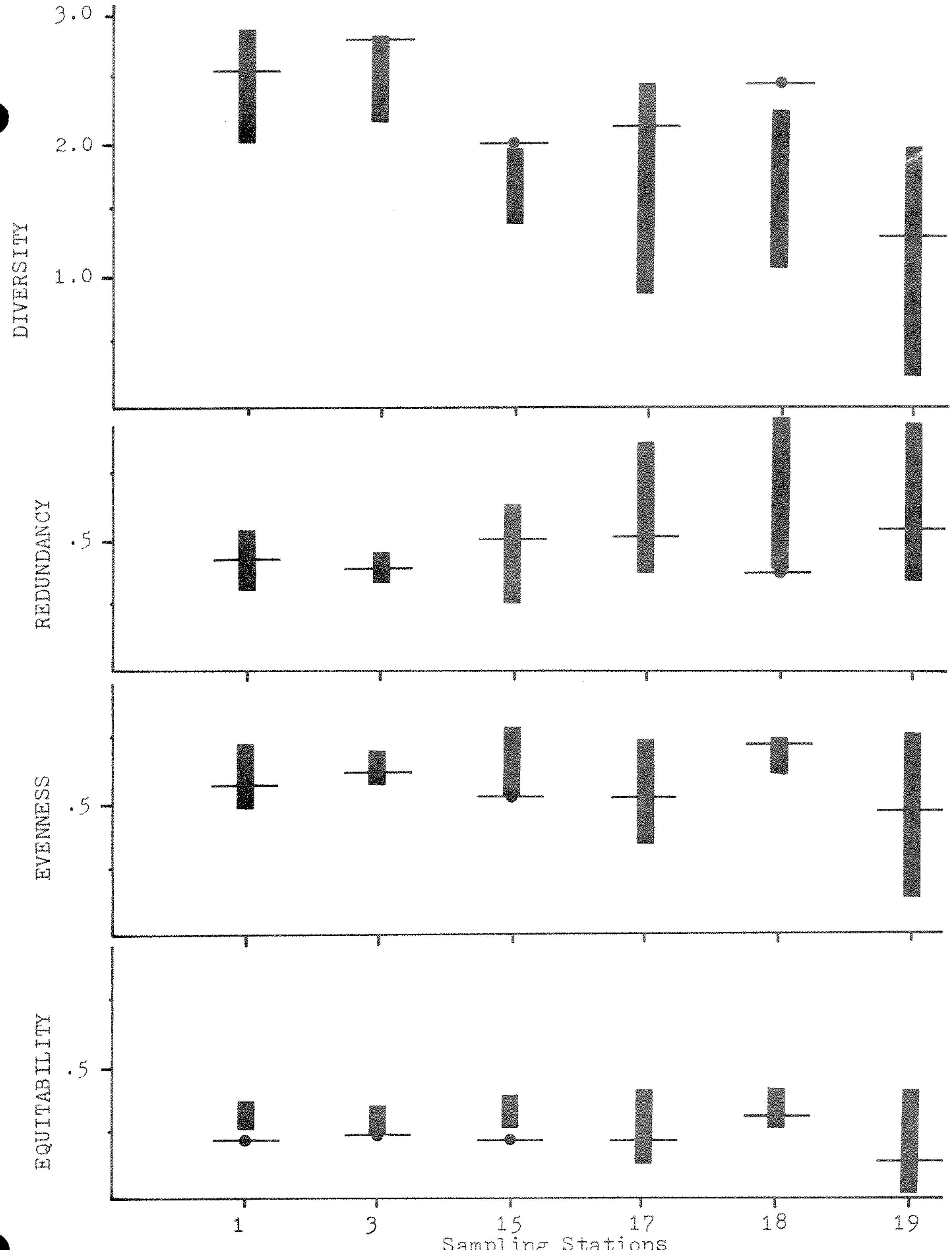


Figure 36 . Species diversity indices for November 1975, range of six Water's samples and all six pooled.

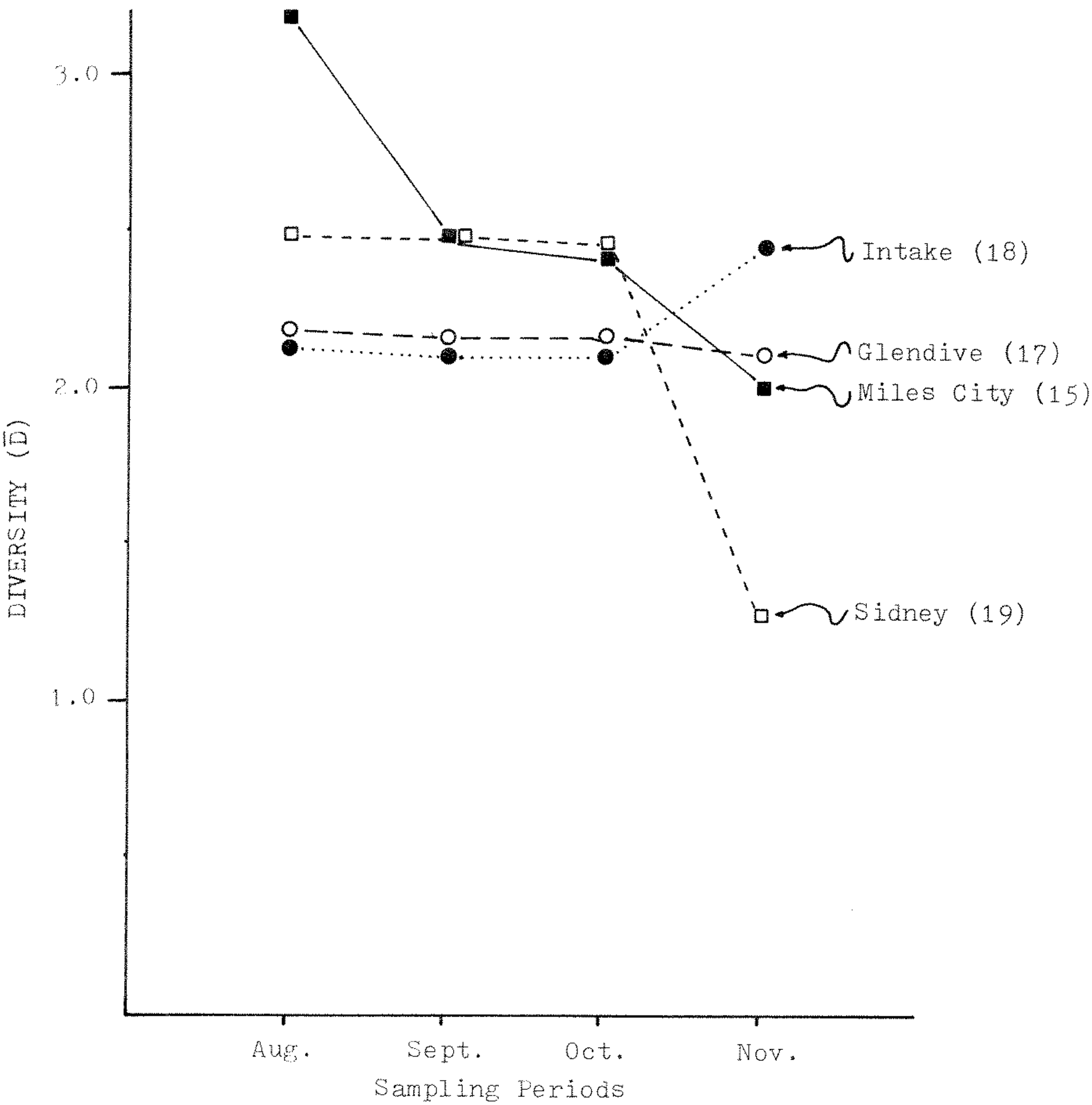


Figure 37 . Seasonal changes in Shannon diversity indices, all points are the result of pooling six Water's samples each month at each station during 1975.

In September (Table 19) *Hydropsyche* again were very abundant as were Chironomidae. Totals were comparable for Glendive (2964) and Intake (3638).

Hydropsyche and Chironomidae again dominated in the October samples (Table 20). Number of taxa and total number of individuals greatly increased at both stations.

November samples again found *Hydropsyche* and Chironomidae dominant (Table 21). Totals were again high at Glendive (20,245) but were considerably reduced at Intake (8988).

All 48 samples taken each month were pooled to illustrate which orders dominate the fauna (Table 22). The fauna was dominated by Ephemeroptera and Trichoptera with Diptera a close third. Ephemeroptera monthly percentages ranged from 11.7 to 73.6 percent while Trichoptera totals varied from 21.1 to 56.3 percent of total. It is obvious that the October and November samples contained more information than the August-September samples. This is probably due to summer emergence losses and presence in August and September of very small larvae and nymphs, most of which passed through the collecting net. Mean population estimates varied from 138 m^2 (August) to 681 m^2 (October). Percent composition of orders at each station is available in Table 23).

Table 22. Population estimates and percent composition taken from the invertebrate-current samples. Numbers are expressed in no./m^2 and the values in parentheses are percent of monthly pooled totals from the Glendive and Intake samples.

Orders	August	September	October	November	Mean
EPHEMEROPTERA	2175 (32.9)	4725 (73.6)	9555 (29.2)	3449 (11.7)	(36.9)
TRICHOPTERA	2634 (39.9)	1354 (21.1)	14,571 (44.6)	16,495 (56.3)	(40.5)
PLECOPTERA	18 (0.3)	52 (0.3)	115 (0.4)	643 (2.2)	(0.8)
DIPTERA	1616 (24.5)	267 (4.2)	4469 (13.7)	3681 (12.6)	(13.8)
OLIGOCHAETA	147 (2.2)	17 (0.3)	3880 (11.9)	4903 (16.7)	(8.0)
Others	12 (0.2)	6 (0.1)	87 (0.2)	108 (0.4)	(0.2)
Totals	6602	6421	32,677	29,279	
Means	138	134	681	610	
N	48	48	48	48	

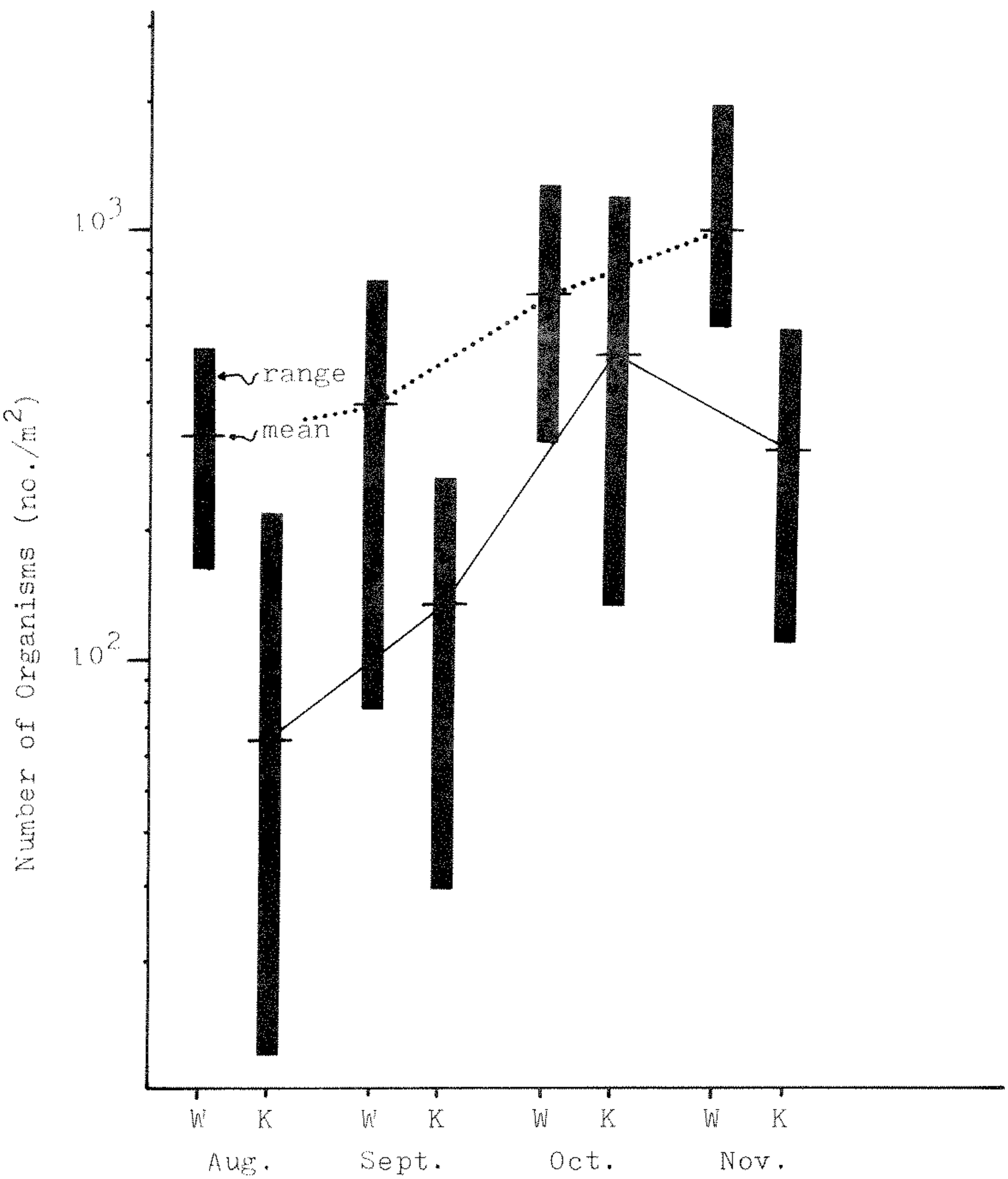


Fig. 38 . Comparison of sampling methods, Water's (W) and kick net (K) at Glendive using kick samples taken in depths less than 19.5 in. (no./m^2).

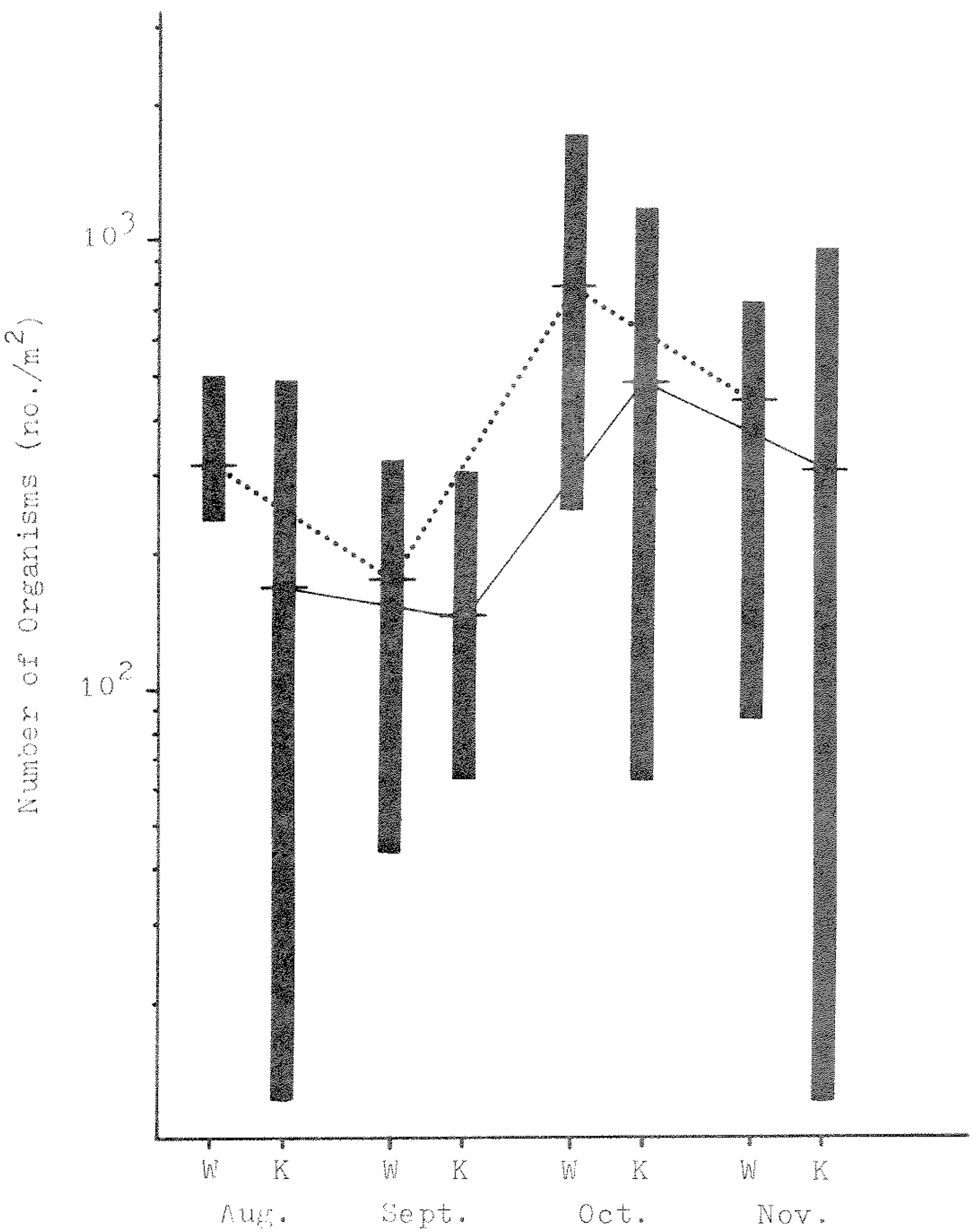


Fig. 39 . Comparison of sampling methods, Water's (W) and kick net (K) at Intake using kick samples taken in depths less than 19.5 in. (no./m^2).

Table 23. Percent composition of invertebrate orders taken with kick samples at Glendive (17) and Intake (18), 1975.

Order	August 17	August 18	September 17	September 18	October 17	October 18	November 17	November 18
Ephemeroptera	39.5	81.6	22.2	41.7	25.6	35.1	10.5	14.8
Trichoptera	48.9	14.6	28.4	49.3	50.2	35.6	57.0	55.2
Plecoptera	0.5	0.9	0.2	0.2	0.05	0.8	1.3	4.2
Diptera	10.6	2.6	44.7	8.0	10.0	19.6	9.4	19.7
Hempitera	0	0	0.2	0	0.1	0	0.2	-
Coleoptera	0	0.1	0.2	0	0.05	0	0.1	0.1
Odonata	0	0	0	0	0.1	0	0	0
Amphipoda	0	0	0	0	-	0.2	0.1	0
Mollusca	0	0	0	0	0.1	0	0.1	0.1
Oligochaeta	0.5	0.2	4.0	0.8	13.9	8.7	21.6	5.9

Results obtained with the kick net were compared with results of the Water's sampler. Results were similar, but the number of organisms obtained with the kick net was always lower than numbers obtained with the Water's sampler (Figures 38-39). Several kick samples were taken at the water's edge and in water too shallow to sample with the Water's sampler. This would tend to expand the range and reduce the mean. At both stations both samplers followed the same trend and a line joining the means of both methods is almost parallel. The Water's sampler is 19.5 in. high; thus only kick samples taken in depths less than 19.5 in. were compared.

Environmental Requirements

Multiple regression analyses were performed on the current-depth data with current and depth as independent variables and number of taxa and number of individuals as dependent variables. Three models were applied: I) untransformed; II) semilog transformation (of dependent variables); and III) log-log transformation (Appendix G).

It is obvious from Tables 24 and 25 that depth is less frequently significant than current velocity as a means of predicting the number of taxa or the total number of individuals per sample. Number of taxa and number of individuals are very similar when regressed against current velocity. Figures 40-42 are plots of the regression data showing how these data can be expressed to predict the numbers of individuals at any particular current or depth. The deviation of the data from the regression line is demonstrated in Figure 42, for example, where the regression coefficients (r) are 0.774 for current and 0.808 for depth.

Mayfly diversity was very great in the current-depth samples with as many as 15 species present in some samples. Ephemeroptera nymphs are much easier to identify to the species level and so some information was obtained on current preferences for several abundant species. These data provide some insight into niche separation in the mayfly community and how separation and current preference changes throughout the life cycle of several species.

Densities of *Traverella albertana* and *Tricorythodes minutus* are presented in Figure 43. Peak densities in August at Intake for *Traverella albertana* occurred at about 2.25 feet per second (fps). Nymphs of *T. albertana* were more abundant in August than in any other month. This species emerges in September and October and nymphs do not reappear in any number until November.

At the Intake station during the October samples peak population densities were determined for several species (Figure 44). *Heptagenia elegantula* was more abundant in slower currents and was most abundant at 0.5 fps. *Traverella albertana* was abundant near 2.5 fps as in the August samples. *Baetis alexanderi* was also most abundant at 2.5 - 3.0 fps but there was no way to determine at what velocity this population would reach its peak. A similar situation exists with *Rhithrogena undulata* although the population seems to be reaching its greatest density at about 2.75 fps. In November *H. elegantula* and *B. alexanderi* exhibited low densities at Intake but peak densities appear to have occurred at 1.5 fps and 2.5 fps, respectively (Figure 45).

Some current preferences were apparent for mayflies at the Glendive station (Figure 46). Population extremes were evident for *H. elegantula* (0.5 fps), *B. alexanderi* (1.75 fps) and *Dactylobaetis cepheus* (1.75 fps). In the November samples highest densities were *H. elegantula* (1.75 fps) and *B. alexanderi* (2.0 fps) (Figure 47).

Table 24. Synopsis of regression analysis on the current-depth data showing significance for the three models for both sampling stations. Regression of number of taxa and depth (ft.) and current velocity (cfs).

Model	Depth	Current	Depth & Current	Date	Sta.
I	NS	NS	NS	Aug.	17
II	NS	NS	NS	Aug.	17
III	NS	NS	NS	Aug.	17
I	NS	NS	NS	Sept.	17
II	NS	NS	NS	Sept.	17
III	NS	*	*	Sept.	17
I	NS	NS	*	Oct.	17
II	NS	NS	*	Oct.	17
III	NS	*	**	Oct.	17
I	**	**	**	Nov.	17
II	**	**	**	Nov.	17
III	**	**	**	Nov.	17
I	NS	NS	NS	Aug.	18
II	NS	NS	NS	Aug.	18
III	NS	**	**	Aug.	18
I	NS	NS	NS	Sept.	18
II	NS	NS	NS	Sept.	18
III	NS	NS	NS	Sept.	18
I	**	*	**	Oct.	18
II	**	*	**	Oct.	18
III	**	**	**	Oct.	18
I	*	NS	**	Nov.	18
II	*	NS	**	Nov.	18
III	**	**	**	Nov.	18

NS = not significant at $p \leq .05$
* = significant at $p \leq .05$
** = highly significant at $p \leq .01$

Table 25. Synopsis of the regression analysis on the current-depth data showing significance for the three models for both sampling stations. Regression of number of organisms and depth (ft.) and current (cfs).

Model	Depth	Current	Depth & Current	Date	Sta.
I	NS	NS	NS	Aug.	17
II	NS	NS	NS	Aug.	17
III	NS	NS	NS	Aug.	17
I	*	*	*	Sept.	17
II	NS	NS	NS	Sept.	17
III	*	**	**	Sept.	17
I	**	**	**	Oct.	17
II	**	**	**	Oct.	17
III	**	*	**	Oct.	17
I	**	**	**	Nov.	17
II	**	**	**	Nov.	17
III	**	*	**	Nov.	17
I	**	*	**	Aug.	18
II	**	**	**	Aug.	18
III	**	**	**	Aug.	18
I	*	**	**	Sept.	18
II	**	**	**	Sept.	18
III	*	NS	**	Sept.	18
I	**	**	**	Oct.	18
II	**	**	**	Oct.	18
III	**	**	**	Oct.	18
I	**	NS	**	Nov.	18
II	**	**	**	Nov.	18
III	**	**	**	Nov.	18

NS = not significant at $p \leq .05$
* = significant at $p \leq .05$
** = highly significant at $p \leq .01$

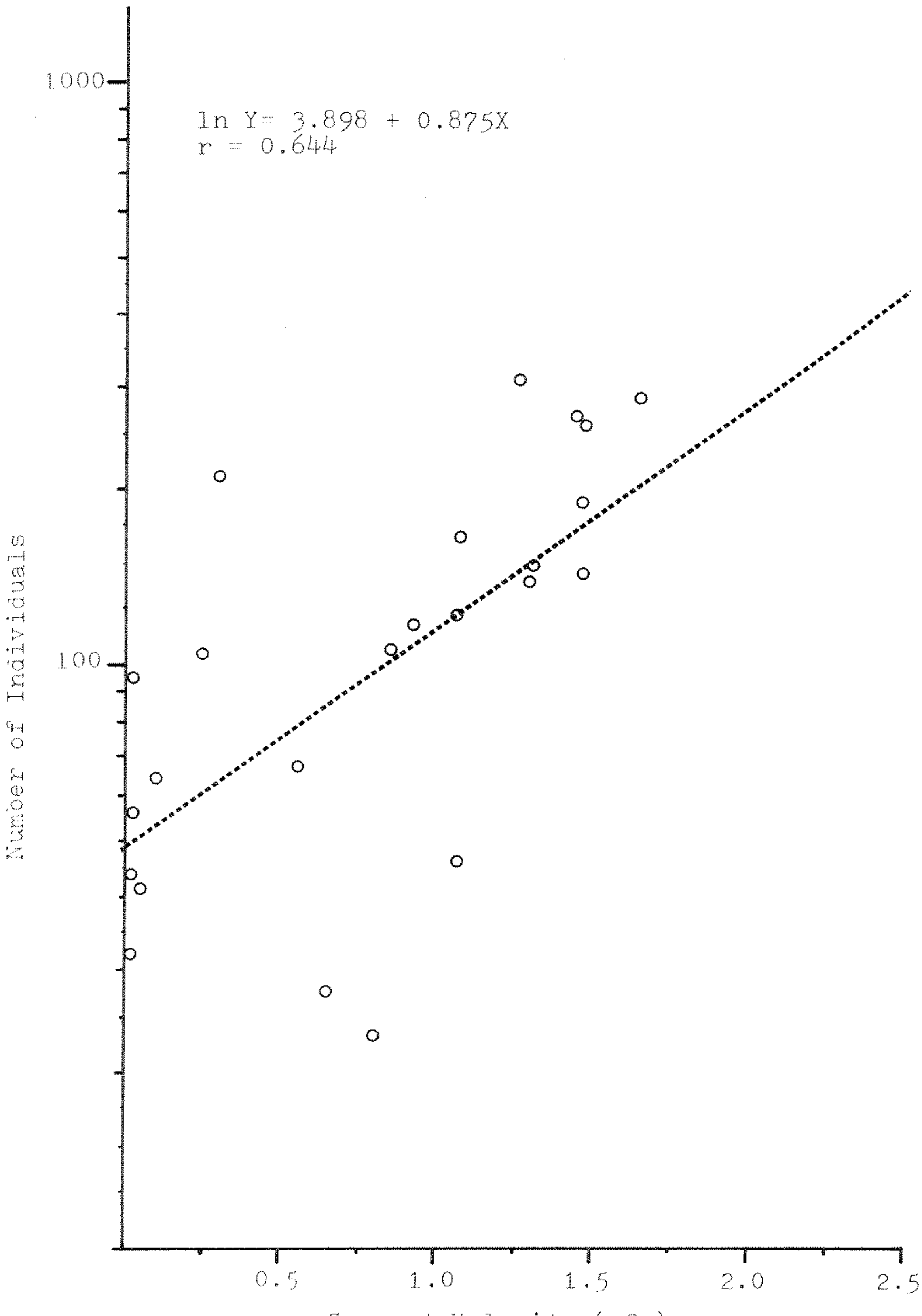


Figure 40 . Current/invertebrate relationships, Yellowstone River, Glendive, Oct. 9,1975.

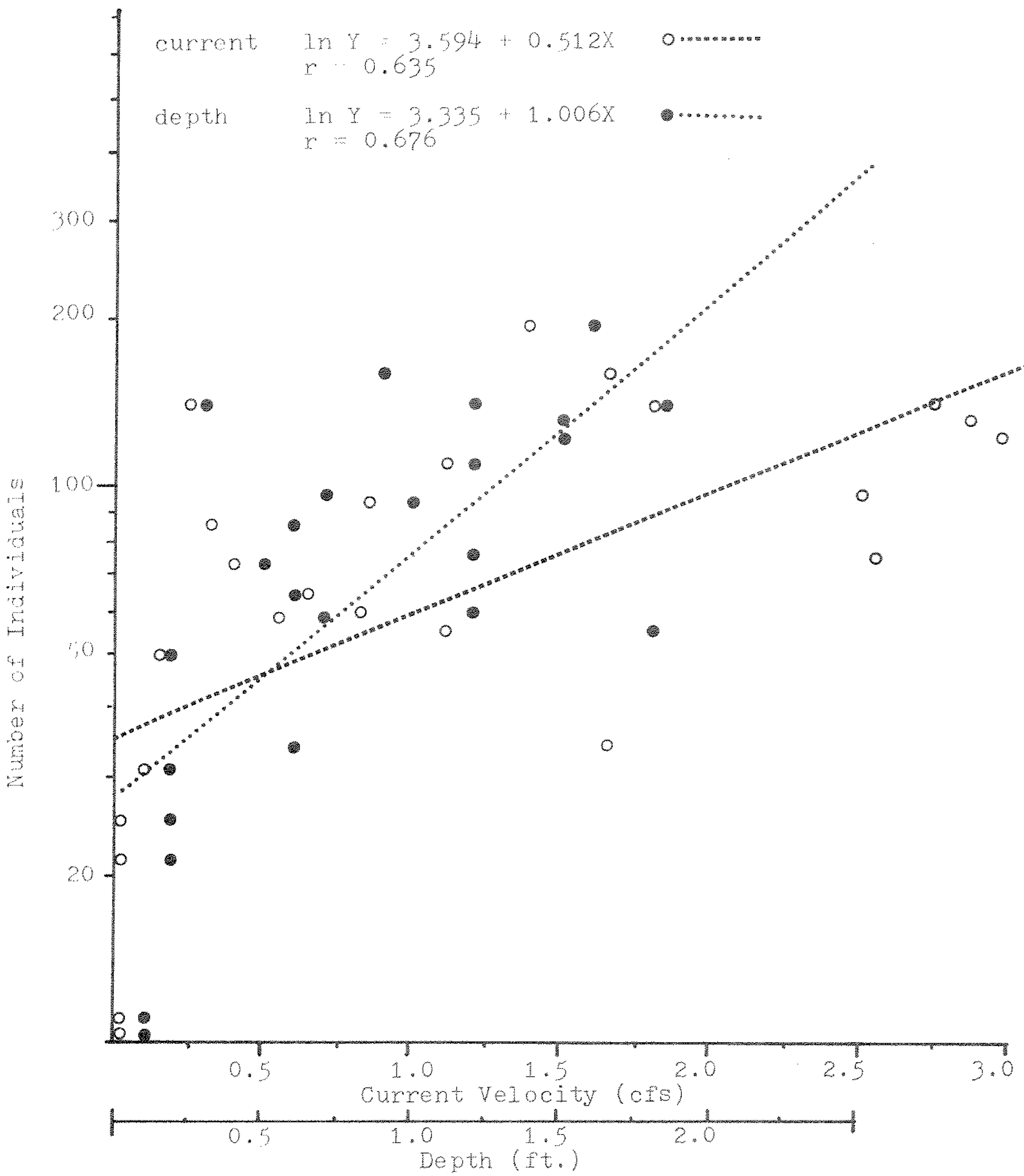


Figure 41 . Current/depth/invertebrate relationships, Yellowstone River, Intake, Oct. 15,1975.

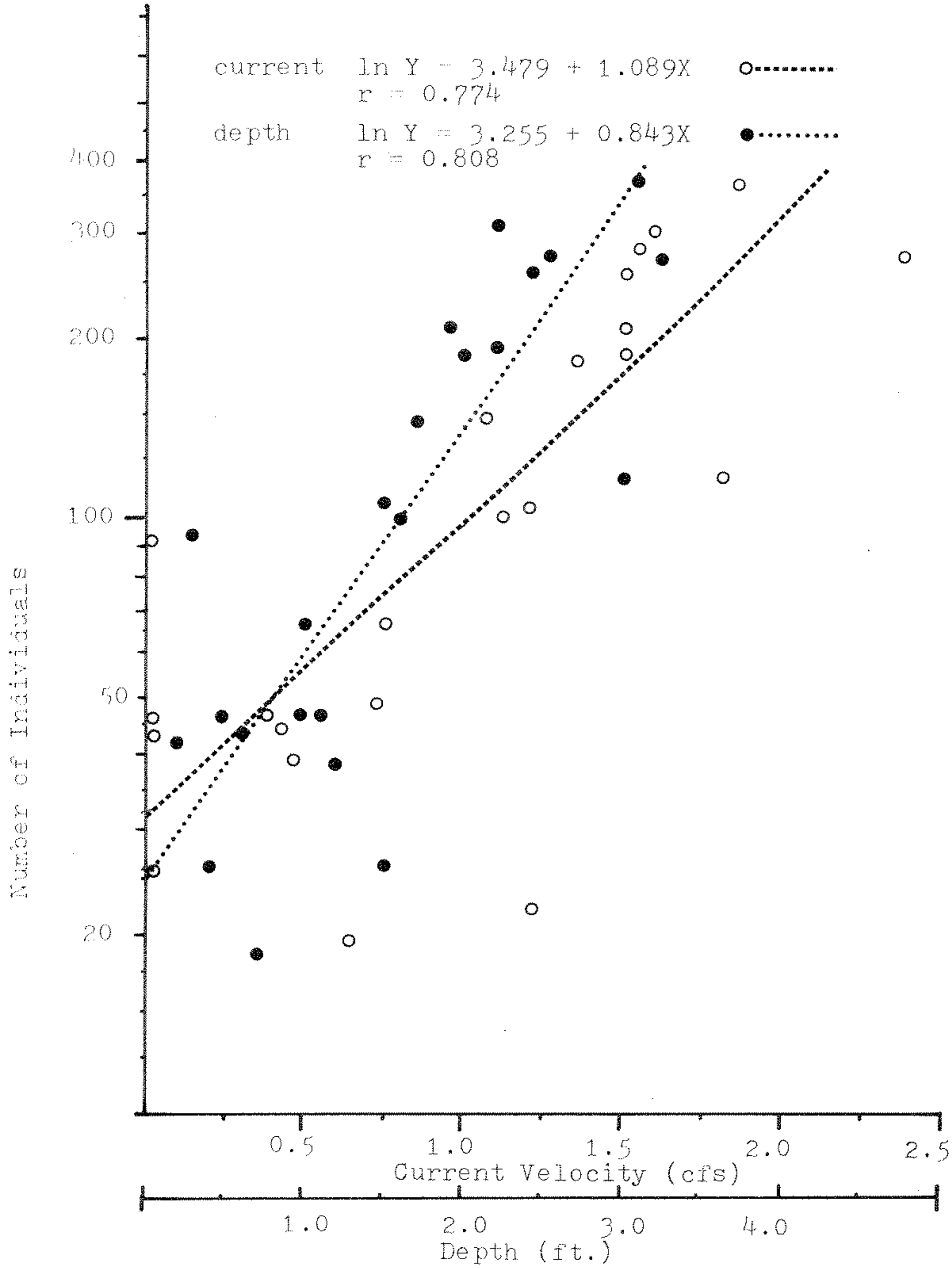


Figure 42 . Current/depth/invertebrate relationships, Yellowstone River, Glendive, Nov. 7,1975.

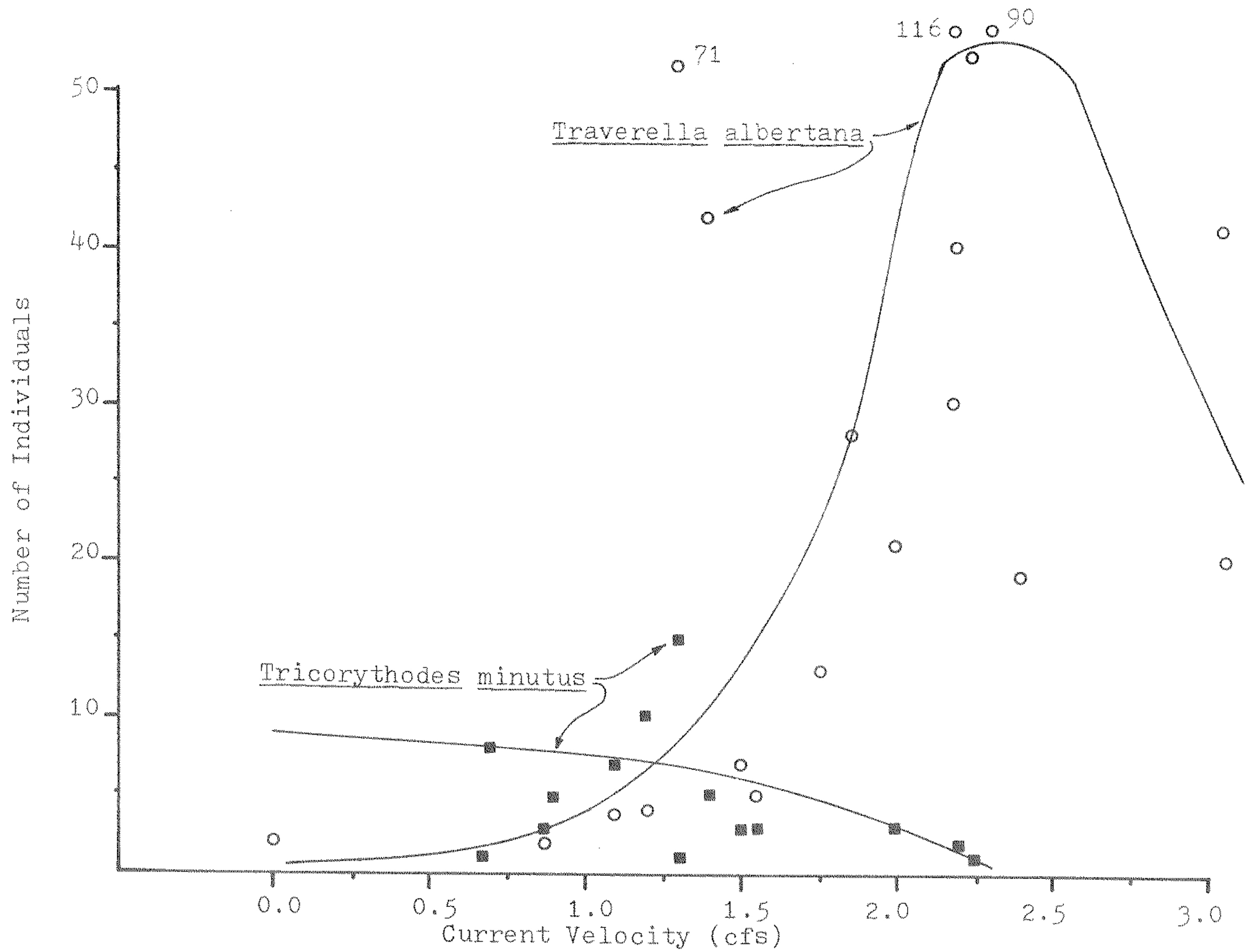


Figure 43 . Mayfly distribution at various currents, Intake, Aug.1975.

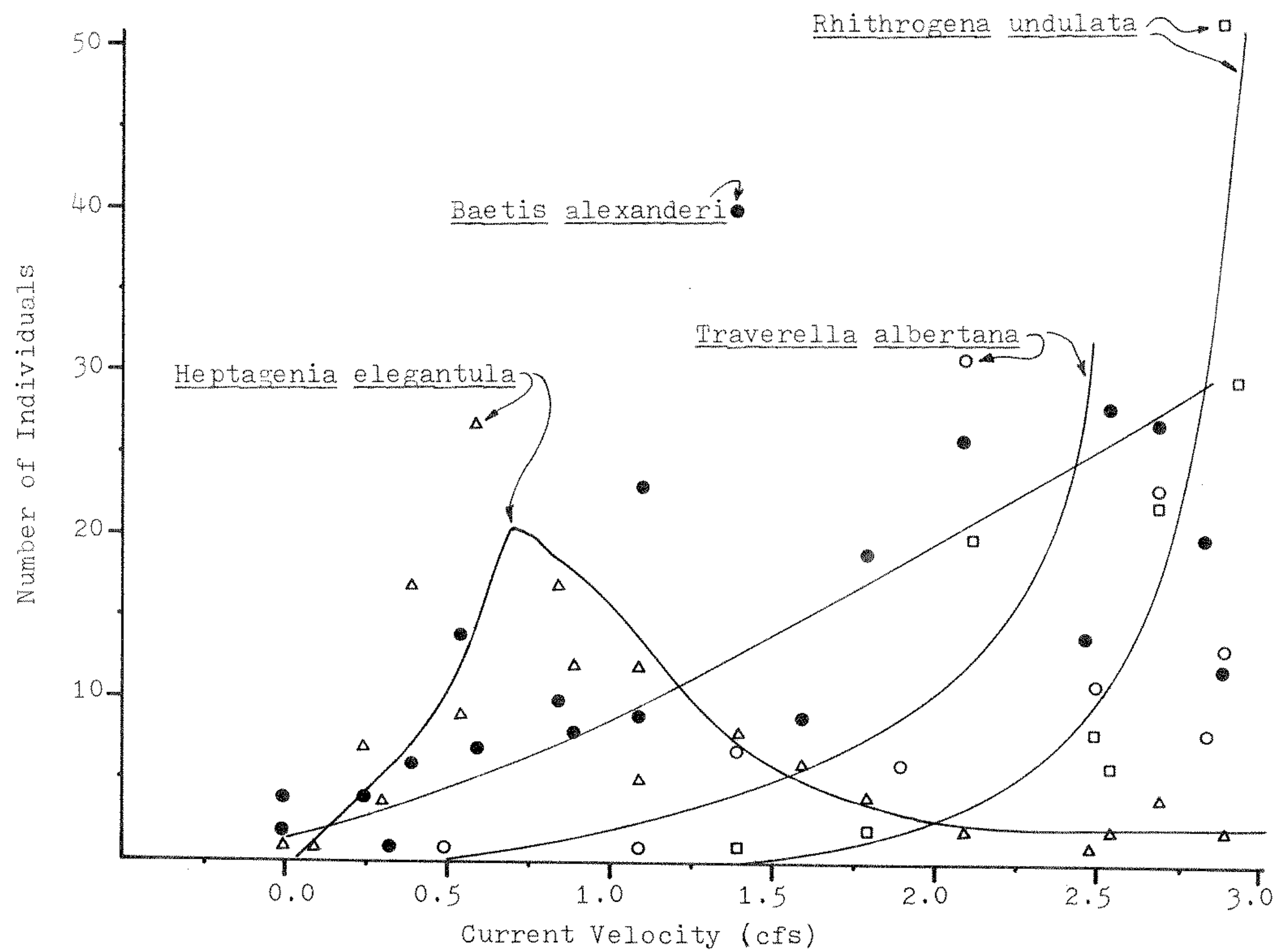


Figure 44 . Mayfly distribution at various currents, Intake, Oct.,1975.

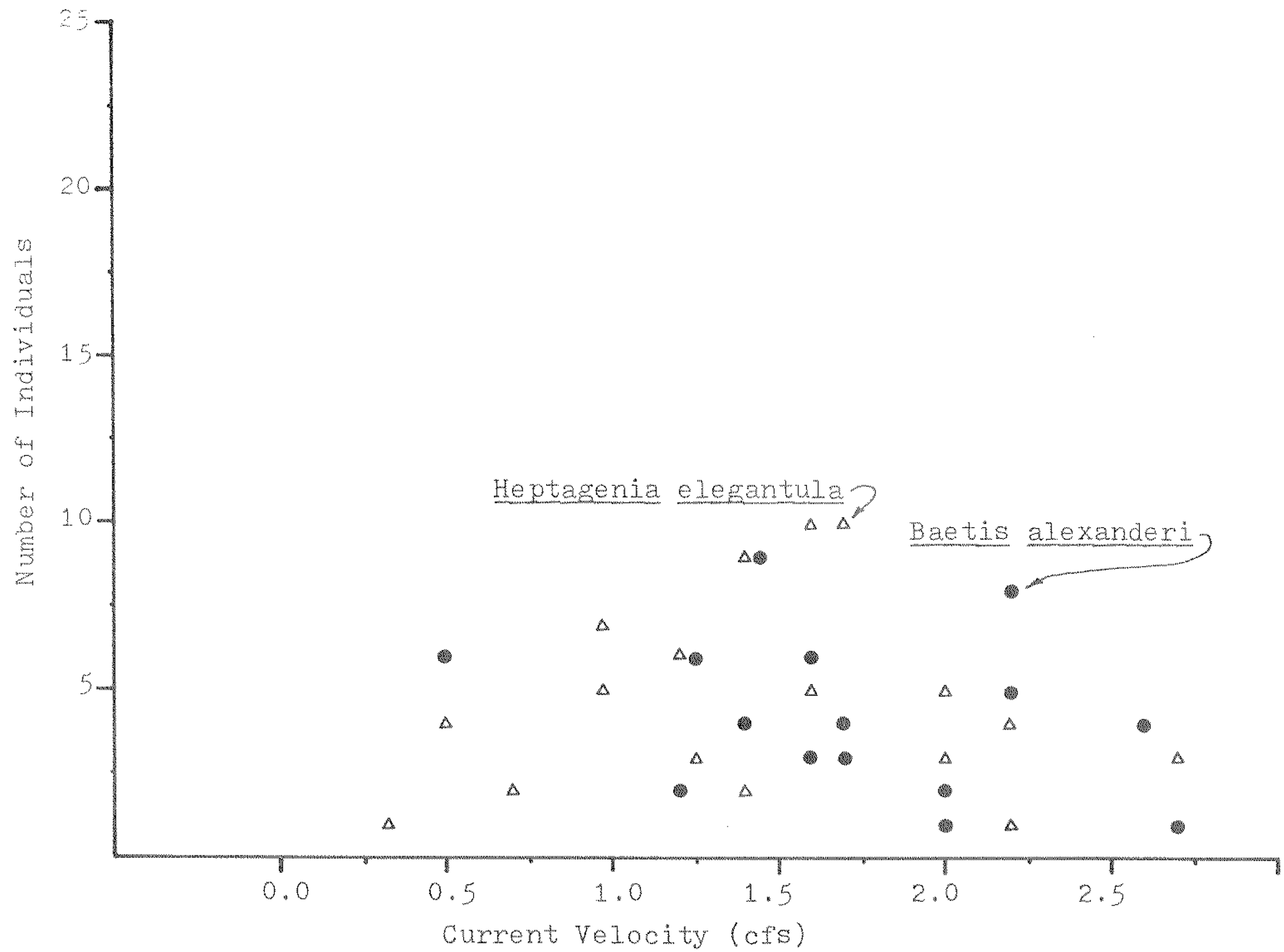


Figure 45. Mayfly distribution at various currents, Intake, Nov.1975.

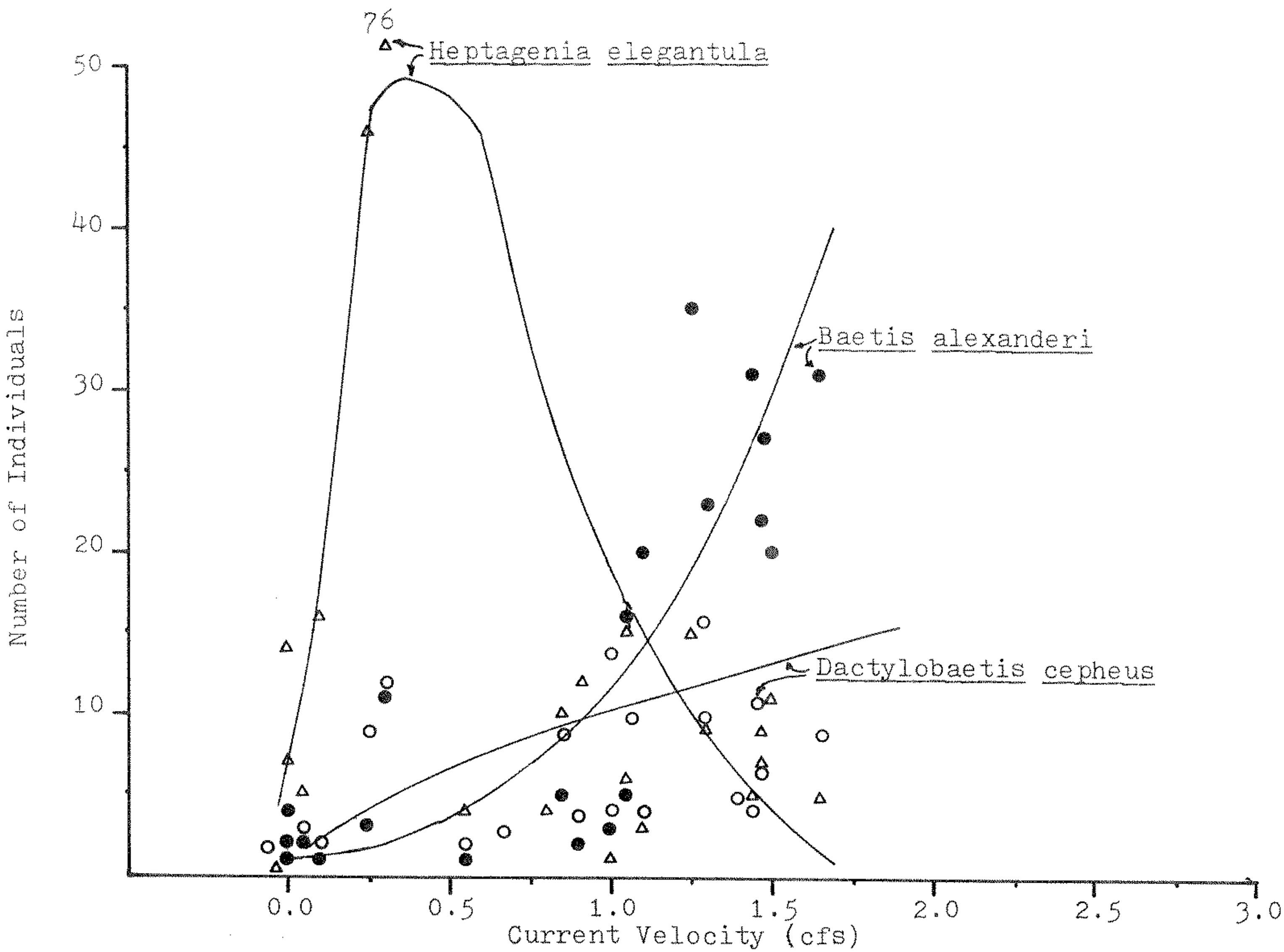


Figure 46 . Mayfly distribution at various currents, Glendive, Oct.1975.

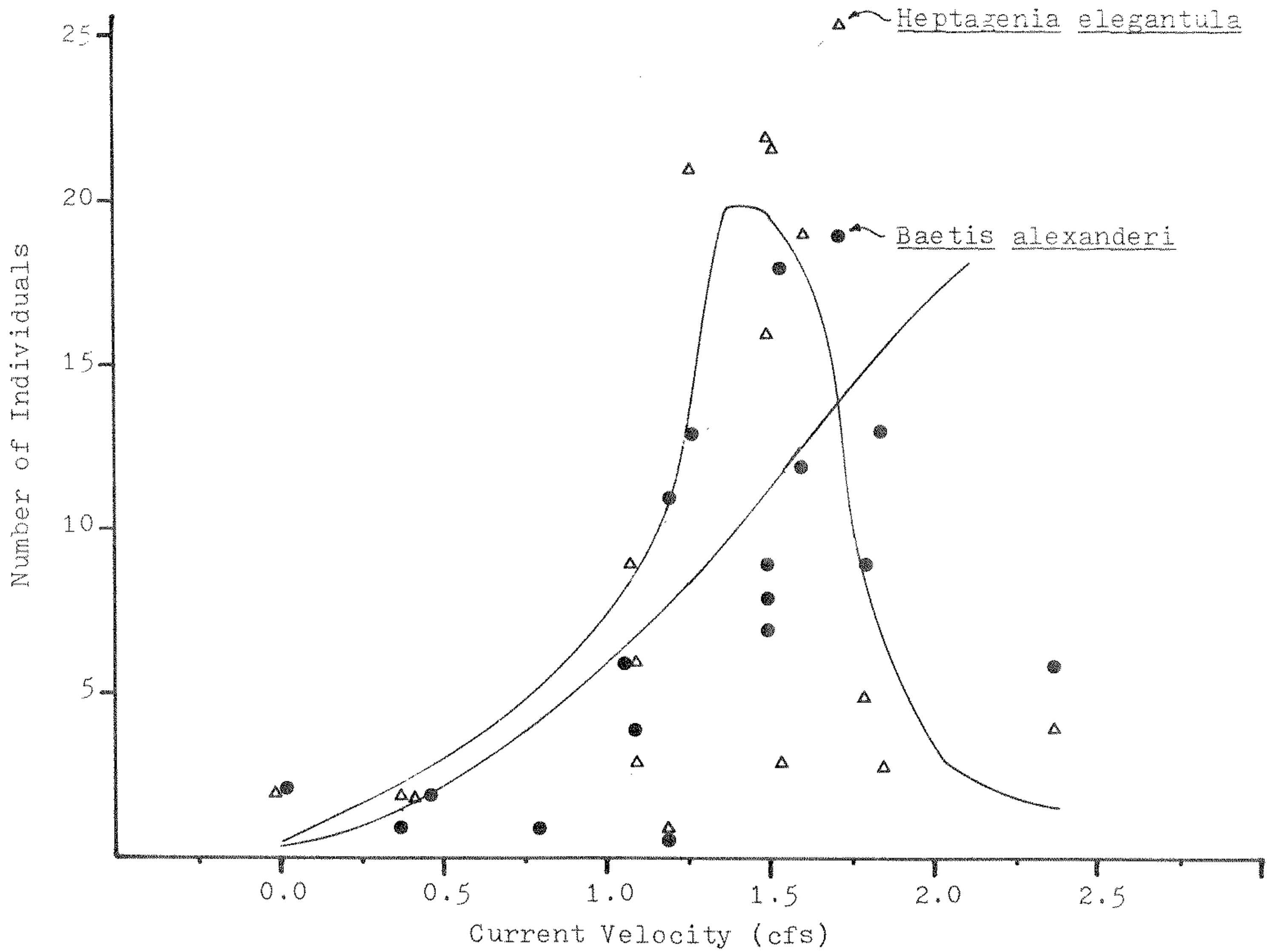


Figure 47 . Mayfly distribution at various currents, Glendive, Nov. 1975.

All of the data on mayfly current preference were pooled and are presented in Figure 48. Several points are evident. Current preference changes with different periods in the life cycle of a species. Greatest population densities for *Heptagenia elegantula* changed from 0.5 fps in October to 1.5 fps in November. Populations of *Baetis alexanderi* exhibited a similar trend. The two samples of *Traverella albertana*, however, were very similar (2.5 fps).

Figure 48 gives some insight into niche separation of six species of Ephemeroptera. Each of these species had its highest densities at slightly different current velocities thus reducing interspecific competition for food and resting areas. The remaining mayflies species were present in numbers too small to illustrate current preference and made up an insignificant part of the fauna in the lower Yellowstone River.

Plecoptera nymphs were not common in the lower Yellowstone River and little information on current preference was obtained. At Intake, however, Plecoptera were only found at the fastest currents.

Trichoptera larvae, *Hydropsyche* in particular, exhibited a distinct current preference with the greatest number of larvae found at the fastest currents sampled. Larvae could not be identified to species and at least three species of *Hydropsyche* have been collected at Glendive and Intake. Samples taken in August and September were not significant ($p \leq 0.05$) when relating numbers of individuals to current. Samples taken in October and November at both stations were highly significant. It is interesting to note that regression lines varied little from October to November at Glendive and at Intake (Figures 49-50).

There is some evidence that *Hydropsyche* reached its greatest densities at about 1.5 fps at Intake in October (Figure 49) and 2.0 fps in November (Figure 50) after which densities decreased at greater velocities (Appendix H).

Discharge data above and below the study stations are shown in Table 26 (USGS 1976).

Table 26. Discharges at Miles City and Sidney during sampling periods (cfs).

Date	Miles City	Sidney
August 6, 1975	20,200	21,200
August 7, 1975	18,500	20,300
September 9, 1975	9,890	10,100
September 17, 1975	8,440	8,980
October 9, 1975	8,000	9,730
October 15, 1975	8,850	10,300
November 7, 1975	8,620	10,400
November 11, 1975	10,300	10,100

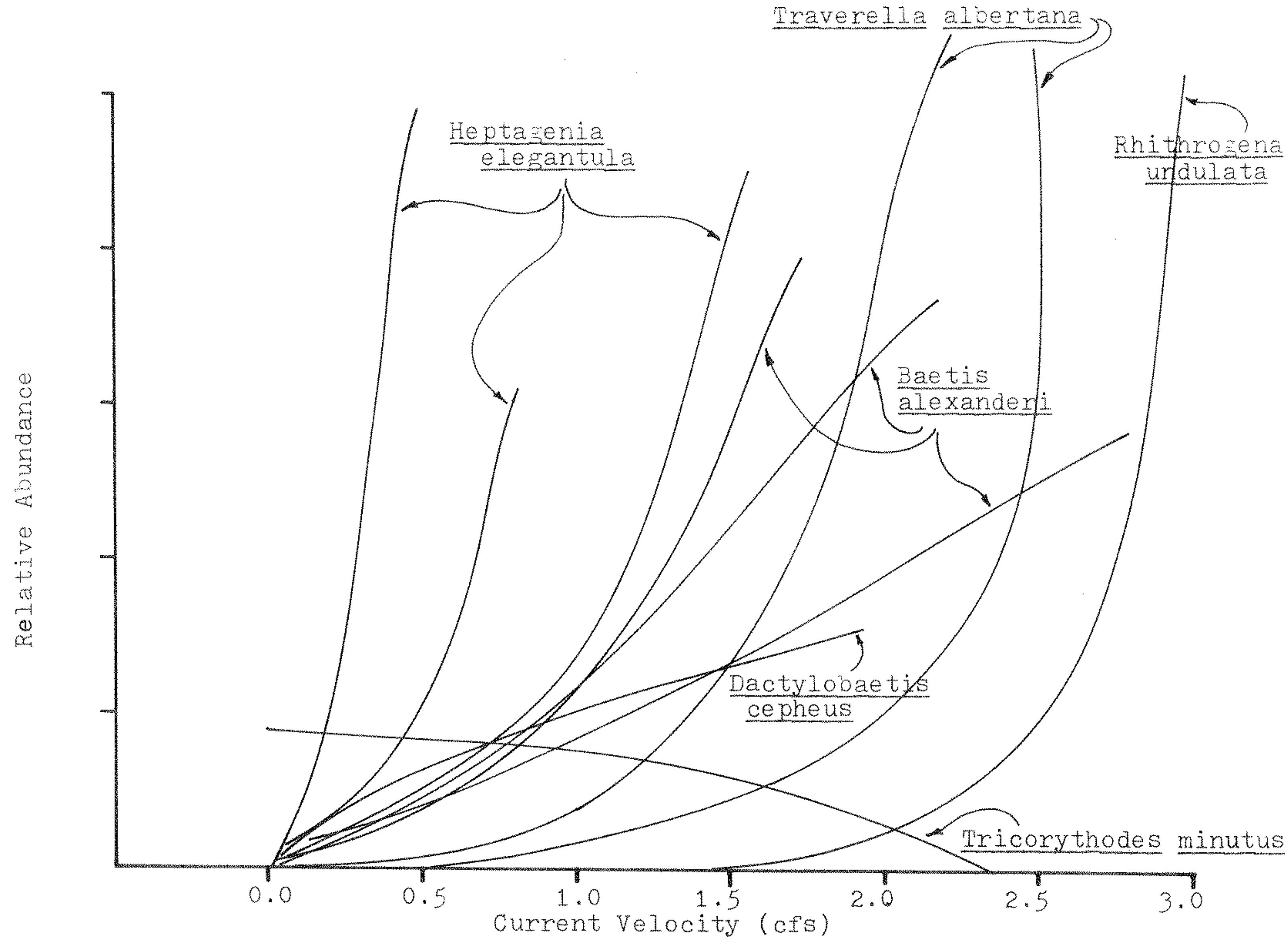


Figure 48 . Synopsis of mayfly/current relationships from both stations and for all sampling months.

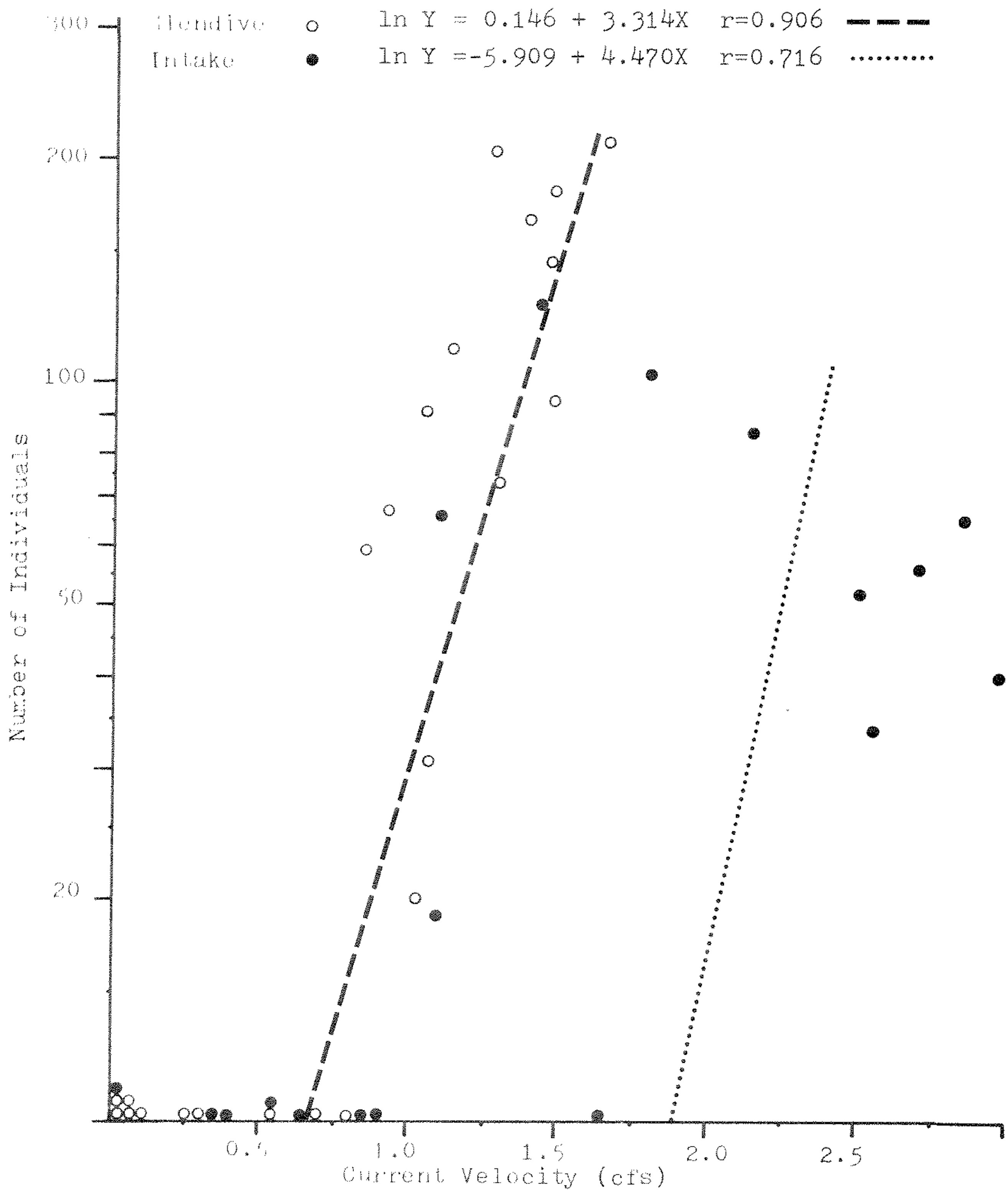


Figure 49 . Distribution of Hydropsyche larvae at various currents during October 1975.

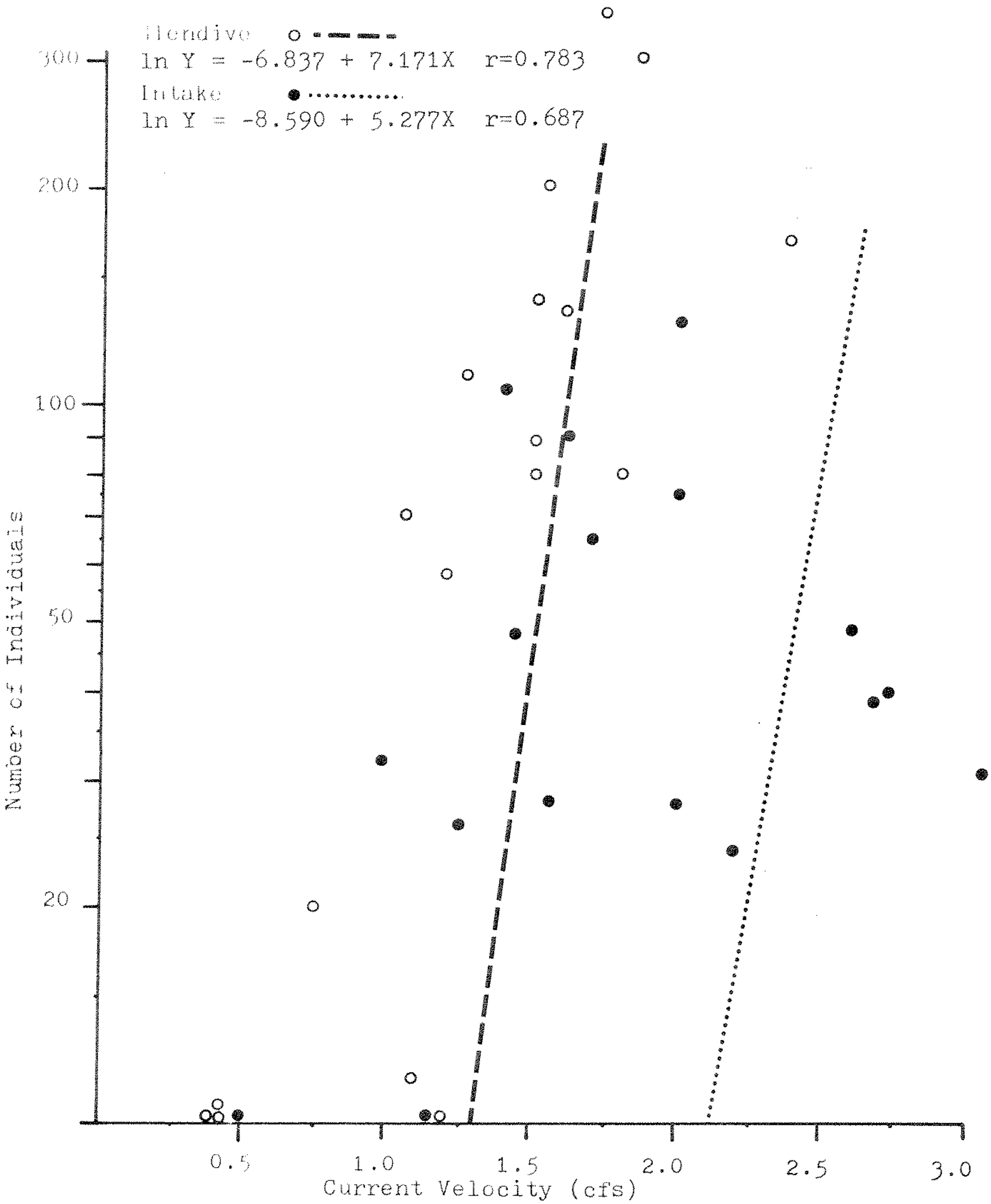


Figure 50 . Distribution of Hydropsyche larvae at various currents during November 1975.

DISCUSSION

It is difficult to predict the effects of flow reduction on the invertebrate fauna of a stream because of the large number of species involved and the inability to discuss the environmental requirements and tolerances of a group as large as the Ephemeroptera or Trichoptera. Even within a genus there are large variations in tolerance. The need to know environmental requirements of a species is complicated in the west because few western species have been intensively examined. Roback (1974) lists the habitat requirements of many aquatic insects in terms of chemical concentrations but few western species are listed. Because of these problems, predictions of effects of reduced flows will be general in scope at least at the present time.

Chemical

Attempts to explain the distribution of species in terms of chemical differences have not had much success except where conditions are extreme (Macan 1974).

At present, dissolved oxygen concentrations are sufficiently high to sustain invertebrates and fish. Dissolved oxygen could influence invertebrate communities if reduced flows are so low that the BOD of domestic sewage or decaying organisms tax the reaeration capacity of the river.

With reduced flows, increased concentrations of nutrients could result in an increase in periphyton growth especially in the present dominant alga *Cladophora*. A large mat of *Cladophora* would increase the diversity of benthic habitats and would probably result in a larger standing crop of benthic organisms although there would probably be a shift in benthic species composition (Percival and Whitehead 1929).

Silt

Currently the Yellowstone River carries large amounts of suspended material mostly inorganic in nature. There appears to be enough current to remove much of this material and silt deposits are not frequent along the river. The high spring runoff is one factor that keeps the river flushed of inorganic sediment. The macroinvertebrate fauna of the lower Yellowstone is predominantly silt tolerant. Genera known to be silt tolerant include: *Isonychia, Tricorythodes, Caenis, Traverella, Brachycercus, Stenonema, Dactylobaetis,* and *Ephoron* ((Berner 1959, Jensen 1966). It is not known how much silt the benthic fauna of the lower river can tolerate. Sampling station 20 has the lowest gradient, the greatest silt concentrations, and the lowest benthic diversity of all sampling stations. If station 20 is used as an example of what could happen at other stations if the high development scenario is achieved, the result will be a poorer fauna in numbers and species.

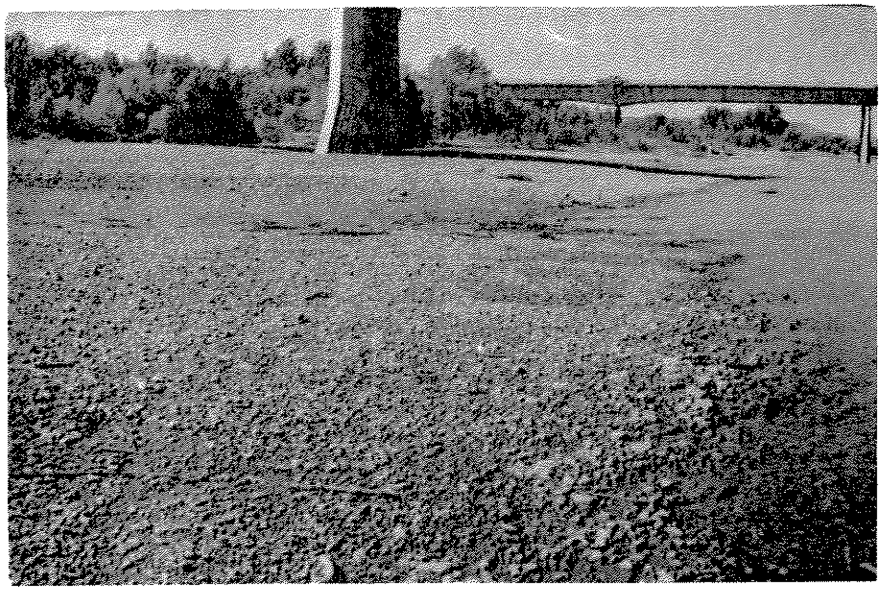


Figure 51. Typical rubble substrate in the lower Yellowstone, low summer flow at Glendive.

Figure 52. Closeup of typical rubble substrate in the lower Yellowstone at Glendive.

Temperature

Reduced flows resulting in a shallower river will probably result in higher water temperatures that will have an influence on the benthos. Increased temperatures would affect growth, emergence, egg hatching, dissolved oxygen and metabolism. The net effect would probably be a reduction of the fauna.

Another factor associated with temperature is ice. In the lower Yellowstone River a solid ice cover lasts for several months (Figure 20). Ice cover at Glendive lasted from late December to April during the winter of 1974-75 and late November to mid-March during 1975-76 (Figure 53). Surface ice can act in several ways to kill invertebrates. Brown et al. (1953) found that surface ice killed invertebrates. Low flows would permit thicker ice conditions, freezing of large areas of shallow water, and increased gouging and molar action during the time of ice break-up (Figure 54).

Food

It is interesting to note that Egglishaw (1964), Macan (1974), and Cummins (1975a) all believe that the microdistribution of a species is more determined by food preferences than any other factor. Current distributes allochthonous detritus and periphyton which in turn determines invertebrate distribution. Cummins (1972) presented a table on how food influences microdistribution of aquatic macroinvertebrates (Figure 55).

In attempting to determine if faunal zonation occurs in the Yellowstone River, aquatic genera found in the Yellowstone River were grouped according to feeding mechanism (Table 27). It becomes immediately evident that a grouping of organisms into zones is very difficult. One can see that it is necessary to go to a lower taxonomic level than family in describing its distribution, e.g. the family Chironomidae is listed under all three categories and this family is found at all 20 stations. Four genera in the shredder category are confined to the upper river and at least in part they define the erosional habitat of Cummins (1975a). Genera found in the collector and scraper category are variously distributed along the entire river thus obscuring the intermediate and depositional zones, if they do exist in the Yellowstone River. It may be necessary to graph the abundance of each genus or each species in order to separate the fauna into habitat zones. More information on feeding habits of individual species is necessary before this can be done.

Current and Bottom Habitat

Bottom samples taken at Glendive and Intake during 1975 revealed that invertebrate densities are directly proportional to current velocity up to velocities of 3.0 fps. No samples were taken at velocities greater than 3.0 fps and, therefore, predictions of standing crop at faster currents would not be appropriate.

Table 27. Characterization of running water habitats on the basis of narrowly defined typical biotic dominants (after Cummins 1973, 1975a).

Feeding Mechanism	Dominant Order	Taxa Family	Genus	Distribution in Yellowstone R. (sta).
Shredders (large particle detritivores)	Trichoptera	Leptoceridae	*Leptocella*	10-18
			Oecetis	6-17
		Lepidostomatidae	*Lepidostoma*	1- 9
	Plecoptera	(Filipalpia)	*Nemoura*	1- 8
			Capnia	1-15
			Pteronarcella	1-10
			Pteronarcys	1- 5
	Diptera	Chironomidae		1-20
Collectors (fine particle detritivores)	Trichoptera	Hydropsychidae	*Hydropsyche*	1-18
			Cheumatopsyche	2-18
			Arctopsyche	1- 9
	Ephemeroptera	Leptophlebiidae	*Leptophlebia*	3-18
		Baetidae	*Baetis*	1-20
		Ephemerellidae	*Ephemerella*	1-18
		Heptageniidae	*Heptagenia*	1-20
	Diptera	Simuliidae	*Simulium*	1-20
		Chironomidae		1-20
Scrapers (grazers)	Ephemeroptera	Heptageniidae	*Heptagenia*	1-20
		Baetidae	*Baetis*	1-20
		Ephemerellidae	*Ephemerella*	1-18
		Caenidae	*Caenis*	10-20
	Diptera	Chironomidae		1-20
Predators	Odonata	Gomphidae		
	Plecoptera	(Setipalpia)	*Arcynopteryx*	1- 9
			Isogenus	1-19
			Isoperla	1-20
			Alloperla	1-12
	Trichoptera	Rhyacophilidae	*Rhyacophila*	1- 6
		Hydropsychidae	*Hydropsyche*	1-18
	Diptera	Chironomidae		1-20
		Rhagionidae	*Atherix*	1-11

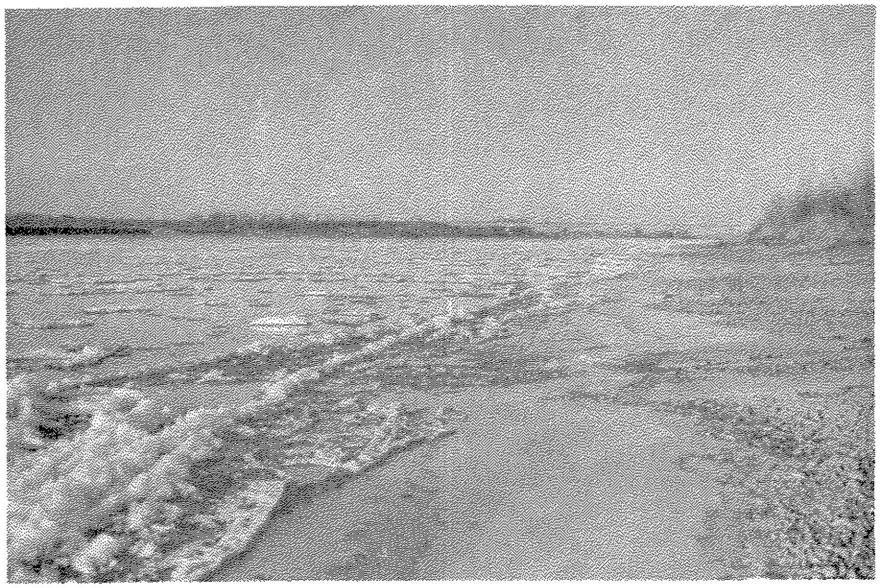


Figure 53. Floating ice just prior to freeze-up at Glendive.

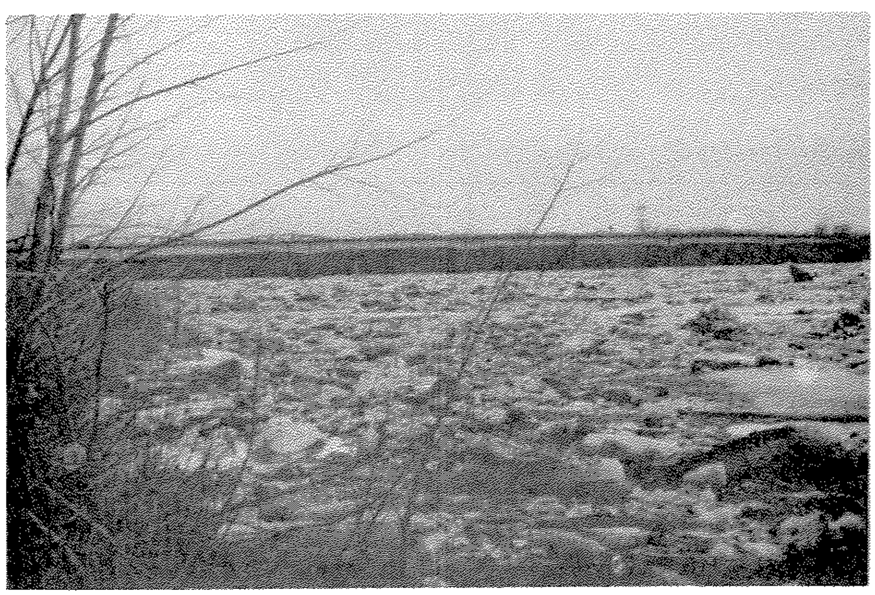
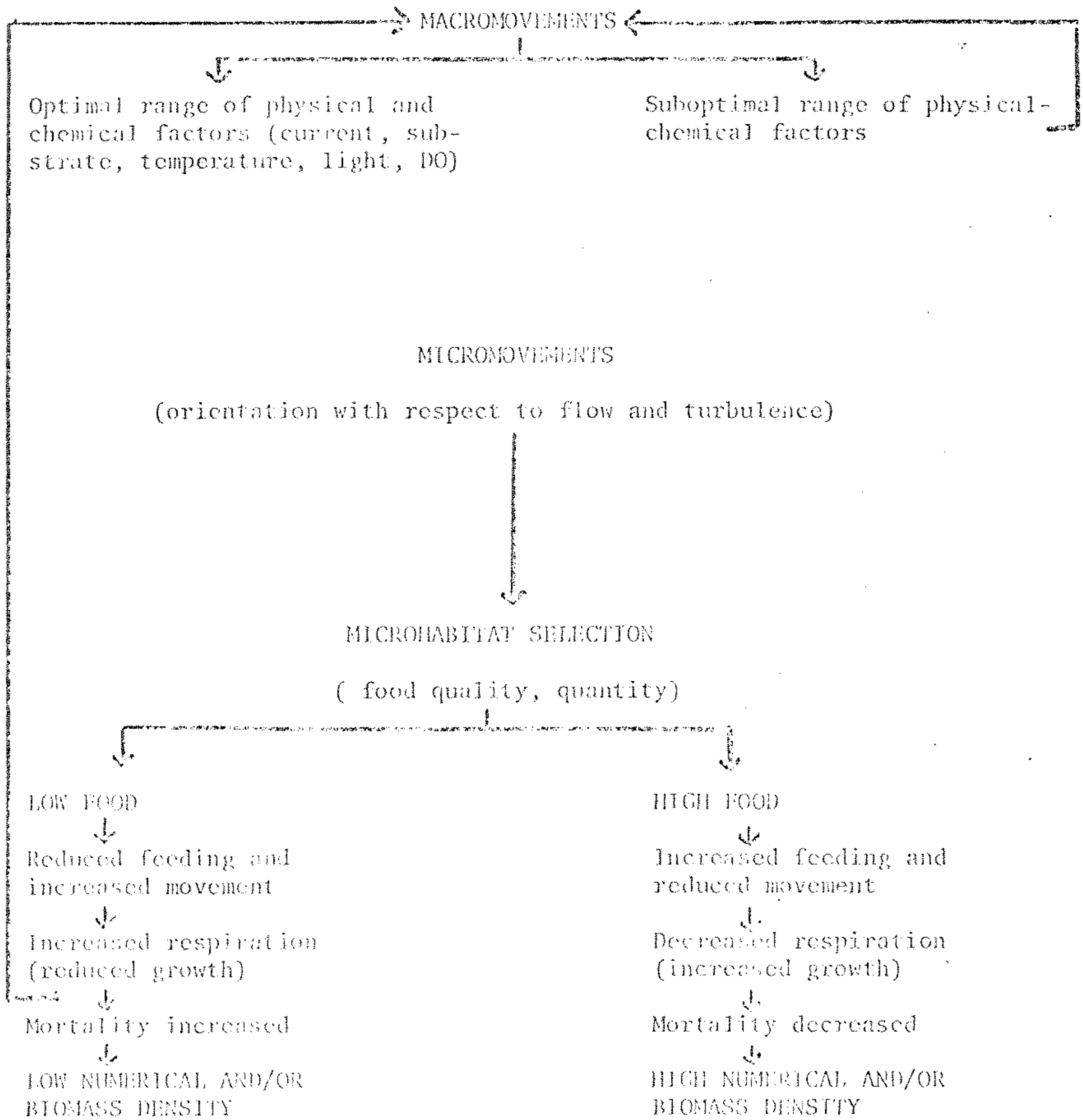


Figure 54. Ice jam during late winter at Glendive.

Figure 55 . Proposed relationships between invertebrates and the factors that determine their distribution and abundance (from Cummins 1972).



Flow reductions in the Yellowstone would result in reduction in current velocities across the entire river channel because of its "U" shaped configuration. A general reduction in flow would result in a faunal reduction because of reduced preference for slow currents for most species. Minshall and Winger (1968) found that a reduction in flow caused a large increase in the number of drifting organisms. Increases in drift expose a greater number of invertebrates to predation by fish and may remove them from a section of stream.

It is possible to relate invertebrate densities to discharge if mean current velocities across the river at several points are known. The Bureau of Reclamation Water Surface Profile (WSP) Computer Program (U.S. Department of Interior 1968) does this. It utilizes current and depth measurements from several transects to compute area and mean current velocity in several subsections of all transects at any desired discharge. This technique was used at the Intake station, the WSP Program was used to predict mean current velocities in 15 subsections at three discharges (Table 28). After the width of each subsection was calculated, the mean current velocity was placed in the regression equation obtained from kick samples in November 1975 (Appendix D). November was selected because this was the last month bottom samples were obtained.

The standing crop in each subsection was summed. At a discharge of 9000 cfs (about mean low summer discharge) the standing crop estimate is 208,847 for a one meter wide strip of river bottom at Intake. This number decreases to 189,895 at 8000 cfs and 171,602 at 7000 cfs, or about a ten percent reduction in standing crop with each 1000 cfs reduction in discharge. The mean current velocities and standing crop in each subsection at Intake are presented in Table 28.

Standing crop estimates at 7000, 8000 and 9000 cfs are graphed in Figure 56 along with a diagramatic representation of loss of habitat due to water withdrawal. Stage height at 9000 cfs is 1985.30 feet at cross section 5; this cross section was taken opposite the boat launch at Intake. Stage height decreases to 1985.15 at 8000 cfs and 1984.90 at 7000 cfs. Thus the river drops only a few inches as discharges decrease by 1000 cfs and only a few square feet of river bottom are exposed. All of these calculations apply to transect 5 at Intake and river bottom figuration will change at other locations as will current and standing crop.

When standing crop estimates derived at 7000, 8000 and 9000 cfs are plotted against discharge the following regression equation results (Figure 56):

$$\log \text{Standing Crop} = 4.9384 + 0.000042 \text{ Discharge (cfs)}$$

This equation permits a prediction of standing crop of invertebrates at any discharge. One should remember that a regression equation is a mathematical tool that may or may not predict a future biological event. Therefore, standing crop estimates may continue decreasing

Table 28. Invertebrate population estimates utilizing data from Intake station 18, subsections from WSP, regression equation from Nov. kick samples, (no. m^{-2}).

	at 9000 cfs		at 8000 cfs		at 7000 cfs	
Sub Section	Mean Velocity (fps)	Population Estimate	Mean Velocity (fps)	Population Estimate	Mean Velocity (fps)	Population Estimate
1	0	-	0	-	0	-
2	1.02	-	0.91	-	0.81	-
3	2.53	20,819	2.32	18,640	2.15	16,704
4	3.42	39,563	3.17	34,306	2.96	30,433
5	2.94	30,156	2.72	26,560	2.54	24,070
6	2.09	25,868	1.90	22,825	1.73	20,923
7	1.88	16,600	1.70	14,940	1.58	14,110
8	2.13	11,931	1.94	10,721	1.77	9,683
9	2.56	15,217	2.35	13,487	2.18	12,277
10	2.39	16,600	2.66	19.297	2.49	17,430
11	2.85	17,983	2.68	16,254	2.45	14,352
12	1.97	10,894	1.79	9,856	1.62	8,819
13	0.72	3,216	0.62	3,009	0.50	2,801
14	0	-	0	-	0	-
15	0	0	0	0	0	0
Totals		208,847		189,895		171,602

linearly as the regression equation states. In this case the regression line is probably roughly accurate. Because of the channel morphometry in the Intake area, decreases in discharge result in decreasing currents across the entire channel and little bottom (habitat) is exposed in the process. However, at some low discharge large amounts of riverbottom would be exposed with resultant loss of habitat and a dramatic decrease in fauna. The effects of reduced current velocity and loss of bottom habitat are separable in their effect on fauna. Reduced current velocities (due to lowered streamflow) could adversely affect bottom fauna before a significant loss in bottom habitat occurred.

If the regression equation (Figure 56) is utilized, standing crop estimates can be calculated for various discharges in a 1-meter wide strip at Intake:

6000 cfs	155,800 organisms
5000 cfs	141,300 organisms
4000 cfs	128,200 organisms
3000 cfs	116,300 organisms
2000 cfs	105,400 organisms
1000 cfs	95,600 organisms

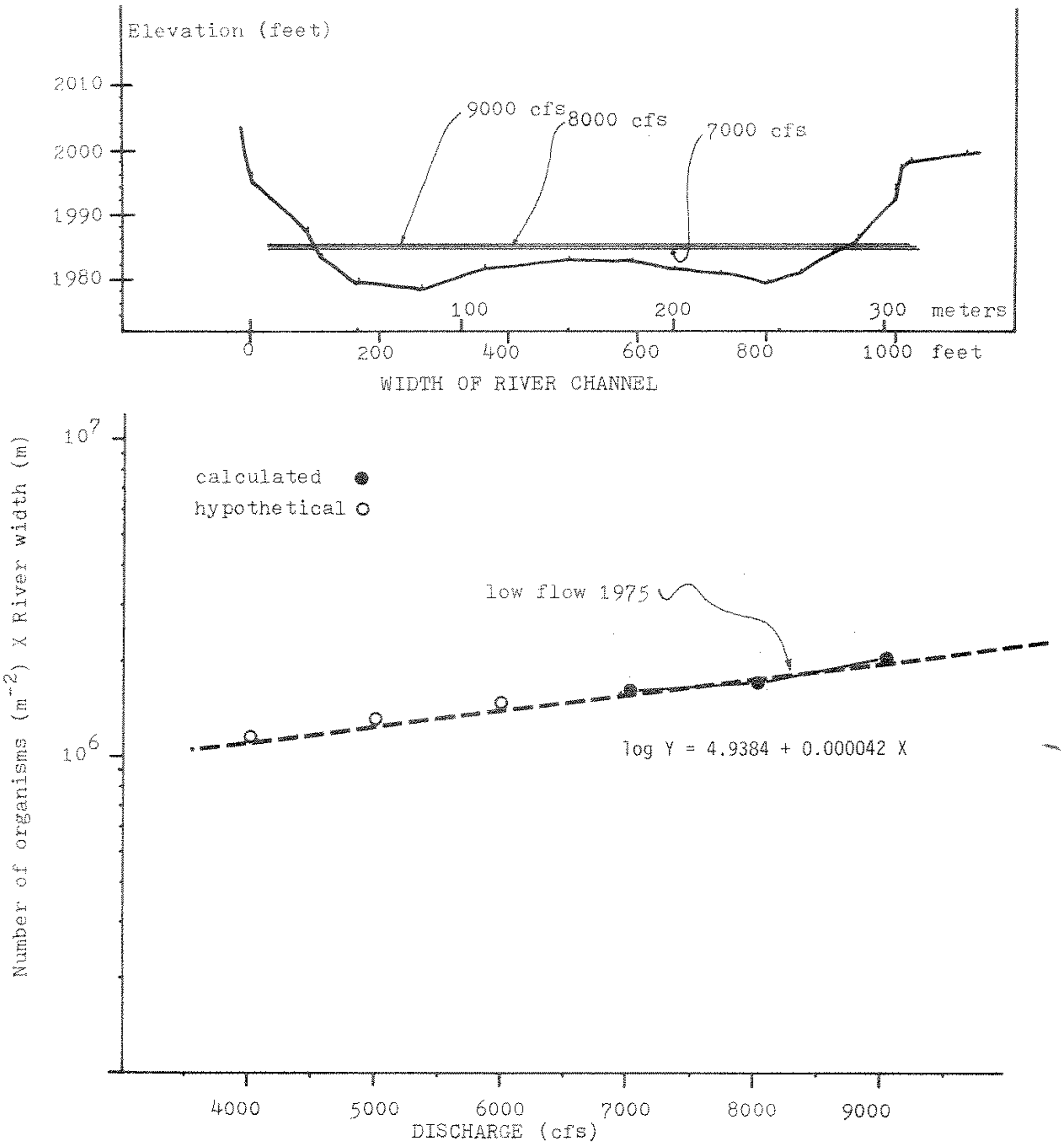


Figure 56 . Upper figure is cross section no. 5 at Intake showing water depth at various flows; lower figure contains invertebrate population estimates at various discharges.

These standing crop estimates are based on data gathered in November and are higher than estimates would be later in the winter or spring because of natural mortality and drift out of the study area. As flows decrease, several other events would undoubtedly result in a higher than normal mortality of invertebrates - these are ice and silt. With decreased discharges, ice cover would tend to be thicker than normal thus freezing larger than normal areas of river bottom. The additional ice and shallow areas would result in a greater amount of molar action during spring ice break up.

Low discharges and reduced currents would permit greater amounts of silt to accumulate which is very detrimental to bottom dwelling organisms.

Evidence confirming the "stream continuum" theory is apparent although not in large quantities. One major problem with implementing this theory in the west involves stream order. With the multitude of tributaries to every stream a large creek might be an order 10-15 by the time it reaches a larger river. The Yellowstone River could conceivably be an order 20 or more although this has never been calculated. Some of the basic tenants of the theory are evident. The invertebrate fauna in stations 1-8 is dominated by shredder-type organisms. The fauna in the middle and lower river is dominated by organisms that are collectors, i.e. the Trichoptera family Hydropsychidae, which build small nets to collect small food particles and small organisms carried along by the current. Scraper or grazing organisms are found throughout the river and silt tolerant organisms become abundant in the low gradient portions.

Faunal zones are broad and not distinctly defined. This is true for fish and bottom dwelling organisms. Throughout the upper half of the river the salmonid community gradually decreases as does the Plecoptera fauna. Mayflies, however, exhibit a gradual shift from one community to another with the exception of several species that are very adaptable and are present throughout the entire river.

SUMMARY

The invertebrate fauna of the Yellowstone River is rich in numbers and species. The number of species and standing crop is greatest in the upper river, stations 1-5, and both decrease downstream.

The invertebrate fauna is dominated by mayflies, caddisflies and true flies. The stonefly fauna is diverse but not abundant and there is a steady decrease in number of species downstream. The mayfly fauna is composed of a mountain fauna, a prairie fauna and several species found throughout the river. In the lower five sampling stations, mayflies are the most diverse order. Caddisflies are very abundant and diverse throughout the Yellowstone River. The family Hydropsychidae dominates the invertebrate fauna in the lower half of the river. True flies (Diptera) and in particular the midge family, Chironomidae, are abundant and diverse througout the river.

The invertebrate fauna of the Tongue River is somewhat similar to the fauna of the lower Yellowstone River.

Baseline species diversity calculations showed that the Shannon index for all stations was near or below 3.0 for most stations. Generally an index above 3.0 illustrates a healthy unstressed community while an index below 1.0 is indicative of a monospecific community under stress. The index range of 3.0-1.0 seems to illustrate a community under some stress.

The current preference for many species and genera was examined. For most species increasing current (to 3 fps) means a larger standing crop.

The standing crop of invertebrates for a one meter wide piece of river bottom at Intake was calculated and a regression equation was formulated to calculate standing crop at various discharges.

LITERATURE CITED

Beauchamp, R.S.A. and P. Ullyott. 1932. Competitive relationships between certain species of freshwater triclads. J. Ecol. 20:200-208.

Bergersen, E.P. and W. J. McConnell. 1973. Pollution investigations on the Yellowstone River, Yellowstone National Park, Wyoming. Colorado Coop. Fish. Unit, 140 pp.

Berner, L. 1959. A tabular summary of the biology of North American mayfly nymphs (Ephemeroptera). Bull. Florida St. Mus. Biol. Sci. 4:1-58.

Brillouin, L. 1960. Science and information theory. Academic Press, New York. 351 pp.

Brown, C.J.D., W.D. Clothier, and W. Alvord. 1953. Observations on ice conditions in the West Gallatin River, Montana. Proc. Mont. Acad. Sci. 13:21-27.

Burton, G.W. and E.P. Odum. 1945. The distribution of stream fish in the vicinity of Mountain Lake, Virginia. Ecology 26:182-194.

Cairns, J., Jr. 1969. Rate of species diversity restoration following stress in freshwater protozoan communities. University of Kansas Sci. Bull., 48:209-224.

__________, D.W. Albaugh, F. Busey, and M.D. Chanay. 1968. The sequential comparison index - a simplified method for non-biologists to estimate relative differences in biological diversity in stream pollution studies. J. Water Pollut. Contr. Fed. 40:1607-1613.

__________, and K. L. Dickson. 1971. A simple method for the biological assessment of the effects of waste discharge on aquatic bottom-dwelling organisms. J. Water Pollut. Contr. Fed. 43:755-772.

Carpenter, K.E. 1928. Life in inland waters. Sidgwick and Jackson, London. 267 pp.

Chandler, C.M. 1966. Environmental factors affecting the local distribution and abundance of four species of stream dwelling triclads. Invest. Indiana Lakes Streams. 7:1-56.

Chutter, F.M. 1969. The distribution of some stream invertebrates in relation to current speed. Int. Rev. Ges. Hydrobiol. 54:413-422.

Colinvaux, P.A. 1973. Introduction to ecology. John Wiley and Sons. N.Y. 621 pp.

Cummins, K.W. 1972. What is a river? - Zoological description. In: River Ecology and Man. R.T. Oglesby, C.A. Carlson, and J.A. McCann, eds. Academic Press, New York. pp. 33-52.

__________, 1973. Trophic relations of aquatic insects. Ann. Rev. Ent. 18:183-206.

Cummins, K.W. 1975a. Macroinvertebrates. *In*: River Ecology. B.A. Whitton, ed. Univ. of Calif. Press, Berkley. pp. 170-198.

__________. 1975b. The ecology of running waters; theory and practice, Proc. Sandusky River Basin Symp. Tiffin, Ohio. pp. 277-293.

Dodds, G.S. and F.L. Hisaw. 1925. Ecological studies of aquatic insects. IV. Altitudinal range and zonation of mayflies, stoneflies and caddisflies in the Colorado Rockies. Ecology 6:380-390.

Egglishow, H.J. 1964. The distributional relationship between the bottom fauna and plant detritus in streams. J. Animal Ecology 33:463-476.

Egloff, D.A. and W.H. Brakel. 1973. Stream pollution and a simplified diversity index. J. Water Pollut. Contr. Fed. 4S:2269-2275.

Fullner, R.W. 1971. A comparison of macroinvertebrates collected by basket and modified multiple-plate samplers. J. Water Pollut. Contr. Fed. 43:494-499.

Funk, J.L. and R.S. Campbell. 1953. The population of large fishes in Black River, Missouri. Univ. Mo. stud. 26:69-82.

Gaufin, A.R., W.E. Ricker, M. Miner, P. Milam, and R.A. Hays. 1972. The stoneflies (Plecoptera) of Montana. Trans. Amer. Ent. Soc. 98:1-161.

Harima, H., and P.R. Mundy. 1974. Diversity indices applied to the fish biofacies of a small stream. Trans. Amer. Fish. Soc. 105:457-461.

Harrel, R.C. and T.C. Dorris. 1968. Stream order, morphometry, physico-chemical conditions, and community structure of benthic macroinvertebrates in an intermittent stream system. Amer. Mid. Nat. 80:220-251.

Hester, F.E. and J.S. Dendy. 1962. A multiple-plate sampler for aquatic macroinvertebrates. Trans. Amer. Fish. Soc. 91:420-421.

Huet, M. 1949. Apercu, des relations entre la pente et les populations des eaux courantes. Schweiz, Z. Hydrol. 11:333-351.

__________. 1954. Biologie, profils en long et en travers des eaux courantes. Bull. fr. Piscic. 175:41-53.

Hurlbert, S.H. 1971. The nonconcept of species diversity: a critique and alternative parameters. Ecol. 52:577-586.

Hynes, H.B.N. 1941. The taxonomy and ecology of the nymphs of British Plecoptera with notes on the adults and eggs. Trans. R. Ent. Soc., London. 91:459-557.

Hynes, H.B.N. 1948. Notes on the aquatic Hemiptera-Heteroptera of Trinidad and Tobago, B.W.I., with a description of a new species of Martarego B. White (Notonectidae). Trans. R. Ent. Soc., London. 99:341-360.

__________. 1961. The invertebrate fauna of a Welsh mountain stream. Arch. Hydrobiol. S7:344-388.

__________. 1970. The ecology of running waters. Univ. of Toronto Press. Toronto, Canada 555 pp.

Ide, F.P. 1935. The effect of temperature on the distribution of the mayfly fauna of a stream. Publs. Ont. Fish Res. Lab. SO:1-76.

Jaag, O. and H. Ambuhl. 1964. The effect of the current on the composition of biocoenoses in flowing water streams. Adv. in Water Pol. Res., Proc. Internat. Conf. 1962. pp. 31-49.

Jensen, S.L. 1966. The mayflies of Idaho. Unpublished m.s. thesis. Univ. of Utah. Salt Lake City.

Jones, J.R., D.M. Coon, and R.W. Bachmann. 1974. Limnological and fisheries survey of the upper Skunk River, Iowa. Iowa St. J. Res. 48:255-266.

Krebs, C.J. 1972. Ecology: the experimental analysis of distribution and abundance. Harper and Row, N.Y. 696 pp.

Leopold, L.B., M.G. Gordon and J.P. Miller. 1964. Fluvial processes in geomorphology. W.H. Freeman and Co., San Francisco. 522 pp.

Lloyd, M., and R.J. Ghelardi. 1964. A table for calculating the "equitability" component of species diversity. J. Amin. Ecol. 33:217-225.

Lloyd, M., J.H. Zar, and J.R. Karr. 1968. On the calculation of information theoretical measures of diversity. Am. Mid. Nat. 79:257-272.

Macan, T.T. 1957. The Ephemeroptera of a stony stream. J. Anim. Ecol. 26:317-342.

__________. 1974. Freshwater ecology. Longman, London.

Maitland, P.S. 1966. The fauna of the River Endrick. Studies on Loch Lomond 2. Univ. of Glasgow, Glasgow, Scotland. 194 pp.

Margalef, D.R. 1957. Information theory in ecology. Gen Syst. 3:36-71.

__________. 1968. Perspectives in ecological theory. University of Chicago Press, Chicago, Illinois. 112 pp.

Mathis, B.J. 1968. Species diversity of benthic macroinvertebrates in three mountain streams. Trans. Ill. Acad. Sci. 61:171-176.

__________ and T.C. Dorris. 1968. Community structure of benthic macroinvertebrates in an intermittent stream receiving oil field brines. Am. Mid. Nat. 80:428-439.

Minshall, G.W. and P.V. Winger. 1968. The effect of reduction in stream flow on invertebrate drift. Ecology. 49:580-582.

Orr, H., J.C. Marshall, T.L. Isenhour, and P.C. Jurs. 1973. Introduction to computer programming for biological sciences. Allyn and Bacon, Inc., Boston. 396 pp.

Parsons, D.S. and J.W. Tatum. 1974. A new shallow water multiple-plate sampler. Prog. Fish Cult. 36:179-180.

Percival, E. and H. Whitehead. 1929. A quantitative study of some types of streambed. J. Ecol. 17:282-314.

Philipson, G.N. 1954. The effect of water flow and oxygen concentration on six species of caddisfly (Trichoptera) larvae. Proc. Zool. Soc. London (U.K.) 124:547-564.

Pielou, E.C. 1966a. Shannon's formula as a measurement of specific diversity: its use and misuse. Am. Natur. 100:463-465.

__________. 1966b. Species-diversity and pattern-diversity in the study of ecological succession. J. Theoret. Biol. 10:370-383.

__________. 1969. An introduction to mathematical ecology. Wiley-Interscience, John Wiley and Sons, N.Y. 286 pp.

Poole, R.W. 1970. Temporal variation in the species diversity of a woodland caddisfly fauna from Central Illinois. Trans. Ill. Acad. Sci. 63:383-385.

Ransom, J.D. and T.C. Dorris. 1972. Analyses of benthic community structure in a reservoir by use of diversity indices. Am. Mid. Nat. 87:434-447.

Roback, S.S. 1974. Insects (Arthropoda: Insecta). *In*: Pollution Ecology of freshwater invertebrates. C.W. Hart, Jr., and S.L.H. Fuller, eds. Academic Press, New York. pp. 313-376.

Shannon, C.E. and W. Weaver. 1964. The mathematical theory of communication. Univ. of Illinois Press, Urbana. 125 pp.

Shelford, V.E. 1911. Ecological succession I. Stream fishes and the method of physiographic analysis. Biol. Bull. 21:9-35.

Slobodkin, L.B. and H.L. Sanders. 1969. On the contribution of environmental predictability to species diversity. Diversity and stability in ecological systems, Brookhaven Symposium in Biology No. 22:82-95.

Stadnyk, L. 1971. Factors affecting the distribution of stoneflies in the Yellowstone River, Montana. Unpubl. Ph. D. Dissertation. Montana State Univ., Bozeman. 36 pp.

Thorup, J. 1966. Substrate type and its value as a basis for the delimination of bottom fauna communities in running waters. Spec. Publs. Pymatuning Lab. Fld. Biol. 4:59-74.

Thurston, R.V., R.J. Luedtke, and R.C. Russo. 1975. Upper Yellowstone River water quality. August 1973-August 1974. Montana Univ. Joint Water Resources Research Center. Bozeman, Mt.

U.S. Dept. Interior, Bureau of Reclamation. 1968. The Bureau of Reclamation's Water Surface Profile Computation Method B. Engineering Research Center, Denver, Colo. 17 pp.

U.S. Environmental Protection Agency. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. Nat. Environ. Res. Center, Cincinnati, Ohio. EPA-670/4-73-001, 176pp.

U.S. Geological Survey. 1976. Personal communication with Water Resources Division Personnel. Helena, Mt.

Whitton, B.A. (ed.) 1975. River ecology studies in Ecol., Vol. 2, Univ. of Calif. press. 725 pp.

Wilhm, J.L. 1967. Comparison of some diversity indices applied to populations of benthic macroinvertebrates in a stream receiving organic wastes. J. Water Pollut. Control. Fed. 39:1673-1683.

__________. 1968 Biomass units versus numbers of individuals in species diversity indices. Ecol. 49:153-156.

__________. 1970a. Effect of sample size on Shannons formula. Southwestern Natur. 14:441-445.

__________. 1970b. Range of diversity index in benthic macroinvertebrate populations. J. Water Pollut. Control Fed. 42:R221-R224.

__________. 1970c. Some aspects of structure and function of benthic macroinvertebrate populations in a spring. Am. Mid. Nat. 84:20-35

__________. 1972. Graphic and mathematical analyses of biotic communities in polluted streams. Am. Rev. Entomol. 17:223-252.

Wilhm, J.L. and T.C. Dorris. 1966. Species diversity of benthic macroinvertebrates in a stream receiving domestic and oil refinery effluents. Am. Midl. Nat. 76:427-449.

__________. 1968. Biological parameters for water quality criteria. Bioscience. 18:477-481.

APPENDIX A

SHANNON DIVERSITY INDEXES

$$D = -\sum_{i}^{s} (N_i/N)\log(N_i/N) = \log(N) - \sum_{i}^{s} (N_i/N)\log(N_i)$$

$$DMAX = \log(S)$$

$$DMIN = \log(N) - \left(\frac{N-S+1}{N}\right)\log(N-S+1)$$

$$RD = \frac{DMAX - D}{DMAX - DMIN}$$

$$EV = D/DMAX = D/\log S$$

$$EQ = D/\log(N)$$

$$SR = D - EQ$$

BRILLOUIN DIVERSITY INDEXES

$$D = \frac{1}{N}\log\left\{N!/\prod_i^s N_i!\right\} = \frac{1}{N}\left\{\log(N!) - \sum_i^s \log(N_i!)\right\}$$

$$DMAX = \frac{1}{N}\log\left\{\frac{N!}{(X!)^{s-R}(Y!)^R}\right\} = \frac{1}{N}\left\{\log(N!) - (s-R)\log(X!) - R\log(Y!)\right\}$$

$$DMIN = \frac{1}{N}\log\left\{\frac{N!}{(N-s+1)!}\right\} = \frac{1}{N}\left\{\log(N!) - \log[(N-s+1)!]\right\}$$

$$RD = \frac{DMAX - D}{DMAX - DMIN}$$

$$EV = D/DMAX$$

$$EQ = D/\left\{\frac{1}{N}\log(N!)\right\}$$

$$SR = D - EQ$$

NOTATION

D = DIVERSITY

DMAX = MAXIMUM DIVERSITY

DMIN = MINIMUM DIVERSITY

RD = REDUNDANCY

EV = EVENNESS

EQ = EQUITABILITY

SR = SPECIES RICHNESS

S = NUMBER OF TAXA IN SAMPLE

N_i = NUMBER OF INDIVIDUALS IN TAXON i

$N = \sum_{i}^{S} N_i$

X = LARGEST INTEGER $\leq N/S$

$Y = X + 1$

$R = N - S*X$

APPENDIX B

CONVERSION FACTORS

1 inch = 2.54 cm
1 cm = 0.393 in. or 0.032 ft
1 foot = 0.304 m
1 m = 3.28 feet
1 square foot = 0.093 sq. m
1 square m = 10.744 sq. ft. = 1547.136 sq. in.

Sampler Areas

Water's Round Sampler

Diameter = 13.5 in. (34.3 cm) (143.139 in^2) or 0.093 m^2
Height = 19.75 in., 50.5 cm
Mesh = #20 (20 apertures/inch)
to convert area to m^2 multiply by 10.808

Quantitative Kick Net

Area 17" x 16" = 43.18 cm x 40.64 cm
272 in^2 or 0.176 m^2
Mesh = #20
to convert to m^2 multiply by 5.688

Appendix C. Bottom fauna analyses, Yellowstone River station 17 (Glendive), April 17, 1975. Sampled by: kick.

Taxa	Number
Ephemeroptera	
Baetis	13
Ephemerella	7
Leptophlebia	1
Heptagenia	37
Stenonema	1
Trichoptera	
Hydropsyche	33
Brachycentrus	4
Plecoptera	
Isoperla	29
Isogenus	2
Coleoptera	
Stenelmis	1
Hydroporus	3
Unknown	1
Diptera	
Ceratopogonidae	1
Orthocladius	145
Ablabesmyia	5
Eukiefferiella	9
Trichocladius	2
Oligochaeta	36

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 15-Miles City (Yellowstone River), April 18, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Baetis	498
Ephemerella	40
Rhithrogena	7
Heptagenia	13
Stenonema	5
Baetisca	4
Trichoptera	
Hydropsyche	11
Brachycentrus	2
Plecoptera	
Isogenus	1
Isoperla	12
Acroneuria	1
Odonata	
Ophiogomphus	1
Coleoptera	
Stenelmis	7
Oligochaeta	11
Diptera	
Hemerodromia	1
Orthocladius	53
Chironomus	4
Microtendipes	1
Cardiocladius	1
Unknown	1

Appendix C . Bottom Fauna Analyses, Yellowstone River Station 14-Forsyth (Yellowstone River), April 18, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Baetis	516
Rhithrogena	140
Ephemerella	13
Heptagenia	2
Tricorythodes	1
Trichoptera	
Cheumatopsyche	5
Plecoptera	
Isoperla	44
Isogenus	6
Diptera	
Orthocladius	13
Cardiocladius	3
Eukiefferiella	1
Parlauterborniella	1
Hemiptera	
Hesperocorixa	1

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 13-Myers (Yellowstone River), April 18, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Baetis	207
Ephemerella	13
Rhithrogena	4
Heptagenia	7
Plecoptera	
Isoperla	9
Isogenus	2
Trichoptera	
Cheumatopsyche	5
Hemiptera	
Hesperocorixa	59
Diptera	
Simulium	2
Tribelos	2
Eukiefferiella	2
Orthocladius	35
Paralauterborniella	3

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 12-Bighorn River (Yellowstone River), April 18, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Baetis	6
Ephemerella	4
Leptophlebia	1
Heptagenia	4
Plecoptera	
Isoperla	2
Hemiptera	
Hesperocorixa	9
Diptera	
Orthocladius	5
Oligochaeta	6

Appendix C . Bottom Fauna Analyses, Yellowstone River Station 1-Corwin Springs (Yellowstone River), April 7, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Baetis	274
Ephemerella	423
Rhithrogena	65
Epeorus	2
Trichoptera	
Hydropsyche	473
Cheumatopsyche	5
Psychomyia	6
Lepidostoma	16
Hydroptila	33
Arctopsyche	1
Plecoptera	
Acroneuria	14
Pteronarcys	16
Alloperla	26
Isoperla	70
Nemoura	3
Isogenus	8
Diptera	
Agathon	1
Atherix	14
Hexatoma	1
Hemerodromia	1
Rheotanytarsus	40
Orthocladius	349
Diamesa	40
Cardiocladius	120
Ablabesmyia	2
Microtendipes	80
Hydracarina	6

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 15 (Miles City), March 19, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Baetis	67
Ephemerella	14
Heptagenia	4
Rhithrogena	5
Trichoptera	
Hydropsyche	16
Cheumatopsyche	7
Hydroptila	1
Plecoptera	
Capnia	1
Brachyptera	3
Isoperla	15
Coleoptera	
Dytiscidae	1
Dubiraphia	1
Stenelmis	1
Diptera	
Dicranota	4
Orthocladius	328
Eukiefferiella	8

Appendix C . Bottom Fauna Analyses, Yellowstone River Station 14 (Forsyth), March 19, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Ameletus	2
Baetis	20
Rhithrogena	6
Heptagenia	10
Leptophlebia	5
Ephemerella	2
Plecoptera	
Capnia	1
Isoperla	40
Trichoptera	
Hydropsyche	1
Hemiptera	
Hesperocorixa	90
Gyrinus	1
Oligochaeta	28
Turbellaria	1
Diptera	
Ceratopogonidae	1
Simulium	1
Unknown	1
Orthocladius	36
Cardiocladius	1
Rheotanytarsus	1
Cryptochironomus	2
Unknown	3

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 13 (Myers), March 19, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Baetis	118
Rhithrogena	7
Ephemerella	11
Heptagenia	9
Leptophlebia	3
Ameletus	2
Plecoptera	
Isogenus	4
Isoperla	2
Trichoptera	
Hydropsyche	4
Cheumatopsyche	26
Hydroptila	1
Hemiptera	
Hesperocorixa	170
Coleoptera	
Dytiscidae	1
Lepidoptera	
Cataclysta	1
Oligochaeta	
Nias	4
Unknown A	15
Diptera	
Dicranota	3
Simulium	4
Ceratopogonidae	1
Orthocladius	1,350
Candiocladius	60
Unknown	17

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 12 (Bighorn River), March 19, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Baetis	5
Ephemerella	5
Heptagenia	1
Stenonema	1
Leptophlebia	2
Trichoptera	
Cheumatopsyche	2
Hydroptila	2
Diptera	
Orthocladius	30
Eukiefferiella	1
Oligochaeta	6
Hemiptera	
Hesperocorixa	2

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 4-above Shields River (Yellowstone River), March 10, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Ephemerella	1,276
Baetis	232
Rhithrogena	4
Plecoptera	
Isoperla	80
Alloperla	60
Nemoura	4
Isogenus	20
Trichoptera	
Brachycentrus	36
Hydroptila	12
Lepidostoma	80
Hydropsyche	364
Cheumatopsyche	4
Athripsodes	4
Hemiptera	
Corixidae	4
Diptera	
Atherix	16
Hexatoma	8
Dolichopodidae	4
Orthocladius	520
Cardiocladius	192

Appendix C. Bottom Fauna Analyses, Tenneco Station Mallard Rest, March 10, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Ephemerella	2,459
Baetis	23
Rhithrogena	100
Trichoptera	
Arctopsyche	6
Hydropsyche	420
Glossosoma	11
Lepidostoma	606
Hydroptila	48
Psychomyia	1
Cheumatopsyche	5
Rhyacophila	1
Brachycentrus	1
Plecoptera	
Isoperla	209
Alloperla	198
Nemoura	12
Isogenus	5
Pteronarcella	3
Pternarcys	4
Diptera	
Atherix	5
Hexatoma	6
Agathon	2
Simulium	3
Diamesa	61
Cardiocladius	208
Orthocladius	110
Rheotanytarsus	10
Coleoptera	
Dytiscidae	15
Optioservus	1
Acari	10

Appendix C. Bottom Fauna Analyses, Tenneco Station Corwin Springs, March 10, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Baetis	294
Ephemerella	389
Heptagenia	4
Ameletus	2
Paraleptophlebia	1
Rhithrogena	60
Epeorus	2
Diptera	
Diamesa	60
Orthocladius	51
Cardiocladius	61
Microtendipes	20
Rheotanytarsus	51
Agathon	3
Atherix	2
Hexatoma	1
Trichoptera	
Arctopsyche	5
Hydropsyche	310
Lepidostoma	43
Brachycentrus	1
Hydroptila	18
Athripsodes	1
Glossosoma	2
Rhyacophila	1
Psychomyia	2
Plecoptera	
Pteronarcys	18
Acroneuria	7
Alloperla	24
Isoperla	63
Nemoura	7
Acari	3
Coleoptera	
Optioservus	1

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 4 (above Shields River), February 14, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Ephemerella	440
Baetis	7
Rhithrogena	4
Trichoptera	
Hydropsyche	512
Cheumatopsyche	3
Arctopsyche	5
Brachycentrus	35
Lepidostoma	42
Hydroptila	5
Plecoptera	
Alloperla	28
Isoperla	3
Nemoura	1
Capnia	2
Pteronarcella	5
Diptera	
Atherix	29
Hexatoma	7
Empididae	3
Orthocladius	648
Cardiocladius	20
Diamesa	3
Ablabesmyia	2
Unknown	1
Coleoptera	
Hydroporus	3

Appendix C . Bottom Fauna Analyses, Yellowstone River Station 3 (Livingston), February 14, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Ephemerella	432
Baetis	209
Rhithrogena	227
Trichoptera	
Lepidostoma	103
Hydroptila	42
Brachycentrus	7
Psychomyia	18
Athripsodes	3
Hydropsyche	57
Plecoptera	
Pteronarcella	2
Isogenus	5
Isoperla	93
Alloperla	38
Nemoura	1
Diptera	
Holorusia	1
Hexatoma	4
Empididae	1
Simulium	4
Atherix	4
Diamesa	10
Cardiocladius	130
Orthocladius	80
Microtendipes	88
Hydracarina	2

Appendix C . Bottom Fauna Analyses, Yellowstone River Station 2-Mallard Rest (Yellowstone River), February 14, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Ephemerella	141
Baetis	5
Rhithrogena	17
Plecoptera	
Isogenus	3
Isoperla	42
Alloperla	5
Trichoptera	
Glossosoma	6
Lepidostoma	46
Hydroptila	13
Amiocentrus	2
Athripsodes	1
Hydropsyche	264
Cheumatopsyche	16
Diptera	
Hexatoma	4
Simulium	2
Diamesa	91
Orthocladius	40
Cardiocladius	273

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 1 (Corwin Springs), February 14, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Ephemerella	640
Baetis	83
Rhithrogena	30
Heptagenia	4
Trichoptera	
Hydropsyche	1,184
Cheumatopsyche	30
Hydroptila	12
Lepidostoma	94
Arctopsyche	17
Glossosoma	8
Athripsodes	1
Plecoptera	
Pteronarcys	107
Pteronarcella	1
Hesperoperla	43
Alloperla	25
Isoperla	103
Isogenus	4
Nemoura	5
Coleoptera	
Hydroporus	2
Heterlimnius	3
Diptera	
Agathon	2
Hexatoma	8
Empididae	2
Simulium	2
Atherix	32
Diamesa	150
Cardiocladius	170
Orthocladius	54
Hydracarina	1

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 12 (Bighorn River), January 13, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Baetis	1
Ephemerella	11
Stenonema	36
Tricorythodes	8
Trichoptera	
Cheumatopsyche	12
Hydroptila	36
Polycentropus	7
Plecoptera	
Capnia	1
Alloperla	4
Isoperla	1
Hemiptera	
Ambrysis	1
Diptera	
Brillia	4
Clinotanypus	4
Ablabesmyia	36
Microtendipes	100
Orthocladius	220
Unknown	9
Oligochaeta	
Tubificidae	20

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 4 (below Livingston), January 13, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Ephemerella	8
Baetis	17
Rhithrogena	15
Trichoptera	
Hydropsyche	2
Hydroptila	1
Psychomyia	1
Glossosoma	2
Plecoptera	
Capnia	2
Diptera	
Simulium	4
Diamesa	20
Cardiodadius	160
Orthocldius	47
Hydracarina	1

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 3 (Livingston), January 13, 1975, sampled by Hester-Dendy.

Taxa	Number
Ephemeroptera	
Ephemerella	48
Baetis	4
Rhithrogena	1
Trichoptera	
Arctopsyche	1
Hydropsyche	157
Brachycentrus	4
Cheumatopsyche	8
Hydroptila	1
Genus A	15
Athripsodes	1
Plecoptera	
Isogenus	3
Diptera	
Atherix	1
Orthocladius	271
Cardiodadius	173
Hydracarina	2

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 2 (Mallard's Rest), January 13, 1975, sampled by Kick.

Taxa	Number
Ephemeroptera	
Ephemerella	28
Baetis	2
Rhithrogena	6
Trichoptera	
Athripsodes	2
Micrasema	4
Genus A	7
Hydropsyche	90
Arctopsyche	1
Cheumatopsyche	4
Hydroptila	80
Glossosoma	3
Lepidostoma	34
Plecoptera	
Isoperla	2
Alloperla	1
Diptera	
Diamesa	15
Ablabesmyia	1
Unknown A	1
Microtendipes	40
Unknown B	5
Orthocladius	10

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 19 (Sidney), December 17, 1974, sampled by Hester-Dendy.

Taxa	Number
Ephemeroptera	
Heptagenia	16
Baetis	2
Rhithrogena	1
Trichoptera	
Hydropsyche	27
Cheumatopsyche	2
Plecoptera	
Isogenus	5
Diptera	
Simulium	2
Orthocladius	17
Ablabesmyia	2

Appendix C . Bottom Fauna Analyses, Yellowstone River Station 18 (Intake), December 17, 1974, sampled by Hester-Dendy.

Taxa	Number
Ephemeroptera	
Heptagenia	29
Ephemerella	1
Baetis	5
Leptophlebia	1
Stenonema	1
Rhithrogena	1
Trichoptera	
Hydropsyche	2
Cheumatopsyche	2
Plecoptera	
Brachyptera	9
Isoperla	3
Diptera	
Simulium	63
Orthocladius	13
Brillia	2
Clinotanypus	1
Ablabesmyia	7
Oligochaeta	17
Mollusca	
Ferrissia	1

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 4 (below Livingston), December 16, 1974, sampled by Hester-Dendy.

Taxa	Number
Ephemeroptera	
Ephemerella	227
Rhithrogena	8
Baetis	65
Ameletus	2
Trichoptera	
Hydropsyche	30
Lepidostoma	6
Plecoptera	
Isogenus	18
Isoperla	65
Alloperla	14
Diptera	
Diamesa	10
Orthocladius	130
Cardiocladius	50

Appendix C . Bottom Fauna Analyses, Yellowstone River Station 3 (above Livingston), December 16, 1974, sampled by Hester-Dendy.

Taxa	Number
Ephemeroptera	
Ephemerella	167
Rhithrogena	64
Baetis	467
Leptophlebia	1
Trichoptera	
Hydropsyche	3
Hydroptila	1
Plecoptera	
Isogenus	5
Isoperla	9
Alloperla	9
Capnia	2
Diptera	
Simulium	13
Orthocladius	920
Cardiocladius	100
Diamesa	200
Podonominae	10

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 2 (Mallard's Rest), December 16, 1974, sampled by Hester-Dendy.

Taxa	Number
Ephemeroptera	
Ephemerella	726
Rhithrogena	175
Baetis	95
Plecoptera	
Isogenus	7
Isoperla	222
Alloperla	58
Capnia	5
Trichoptera	
Hydropsyche	38
Rhyacophila	1
Hydroptila	12
Brachycentrus	1
Lepidostoma	4
Genus A	9
Diptera	
Simulium	12
Diamesa	140
Orthocladius	30
Metriocnemus	10
Cardiocladius	120

Appendix C . Bottom Fauna Analyses, Yellowstone River Station 1 (Corwin Springs), December 16, 1974, sampled by Hester-Dendy.

Taxa	Number
Ephemeroptera	
Baetis	223
Ephemerella	20
Ameletus	6
Rhithrogena	34
Brachycercus	1
Trichoptera	
Hydropsyche	1
Plecoptera	
Capnia	13
Isoperla	11
Alloperla	1
Nemoura	3
Diptera	
Simulium	1
Diamesa	347
Orthocladius	11
Cardiocladius	24
Rheotanytarsus	12

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 1F (Glendive), September 3, 1974, sampled by Kick.

Taxa	Number
Ephemeroptera	
Traverella	37
Heptagenia	1
Dactylobaetis	5
Centroptilum	2
Baetis	43
Diptera	
Simulium	14
Chironomidae	1

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 20 (Cartwright, North Dakota), September 11, 1974, sampled by Kick.

Taxa	Number
Ephemeroptera	
Brachycercus	1
Ametropus	1
Dactylobaetis	8
Ephoron album	3
Rhithrogena	18
Traverella	11
Choroterpes	7
Baetis	20
Isonychia	1
Trichoptera	
Hydropsyche	9
Hemiptera	
Corixidae	3
Diptera	
Chironomidae	3
Simulium	4
Oligochaeta	1
Odonata	
Gomphus	2
Coleoptera	
Gyraulus	1

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 1F-6 (Glendive), September 25, 1974, sampled by Hester-Dendy.

Taxa	Number
Trichoptera	
Cheumatopsyche	11
Hydropsyche	65
Plecoptera	
Isogenus	2
Isoperla	9
Brachyptera	4
Ephemeroptera	
Rhithrogena	20
Heptagenia	6
Ephemerella	1
Tricorythodes minutus	1
Diptera	
Chironomidae	52
Simulium	4
Oligochaeta	2
Coleoptera	1

Appendix C . Bottom Fauna Analyses, Yellowstone River Station 1F-5 (Glendive), September 25, 1974, sampled by Hester-Dendy.

Taxa	Number
Trichoptera	
Cheumatopsyche	15
Hydropsyche	27
Plecoptera	
Isoperla	3
Brachyptera	1
Ephemeroptera	
Rhithrogena	3
Baetis	14
Heptagenia	13
Diptera	
Chironomidae	34
Simulium	16
Oligochaeta	3

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 1F-4 (Glendive), September 25, 1974, sampled by Hester-Dendy.

Taxa	Number
Trichoptera	
Hydropsyche	55
Plecoptera	
Isoperla	2
Brachyptera	5
Ephemeroptera	
Rhithrogena	2
Baetis	11
Heptagenia	10
Traverella	1
Tricorythodes	1
Diptera	
Chironomidae	7
Simulium	2

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 1F-3 (Glendive), September 25, 1974, sampled by Hester Dendy.

Taxa	Number
Trichoptera	
Cheumatopsyche	3
Hydropsyche	35
Plecoptera	
Isoperla	28
Ephemeroptera	
Baetis	27
Heptagenia	27
Dactylobaetis	2
Traverella	1
Ephemerella	1
Diptera	
Chironomidae	6
Simulium	24

Appendix C. Bottom Fauna Analyses, Yellowstone River Station 1F-2 (Glendive), September 25, 1974, sampled by Hester-Dendy.

Taxa	Number
Trichoptera	
Cheumatopsyche	20
Hydropsyche	19
Plecoptera	
Isoperla	6
Ephemeroptera	
Baetis	32
Heptagenia	7
Traverella	1
Diptera	
Chironomidae	2
Simulium	10
Oligochaeta	1

Appendix C . Bottom Fauna Analyses, Yellowstone River Station 1F-1 (Glendive), September 25, 1974, sampled by Hester-Dendy.

Taxa	Number
Trichoptera	
Cheumatopsyche	13
Hydropsyche	18
Plecoptera	
Isoperla	11
Ephemeroptera	
Baetis	38
Heptagenia	5
Diptera	
Dactylobaetis	4
Chironomidae	5

Appendix D. Bottom Fauna Analyses, Yellowstone River at Miles City November 10, 1975.

Organism	1	2	3	4	5	6	
	Number in Waters' Sampler						
Ephemeroptera							
Baetis two-tail	22	2	2	5	2	5	
Ephemerella	1	3		2		4	
Tricorythodes		1					
Heptagenia	2	1	1				
Plecoptera							
Isoperla		1					
Brachyptera	1				1	4	
Trichoptera							
Hydropsyche	15	20	4	40	2	17	
Cheumatopsyche				4			
Brachycentrus				1			
Diptera							
Chironomidae	49	45	23	47	32	29	
Hexatoma				1			
Coleoptera							
Microcylloepus	1				1		
Oligochaeta	3		3	9	7	4	
Total Number =	94	73	33	109	45	63	$\bar{X}$ = 70
Total Number/m^2 =	1016	789	357	1178	486	681	$\bar{X}$ = 751
							σ = 311

Appendix D. Bottom Fauna Analyses, Yellowstone River at Glendive November 10, 1975

Organism	Number in Waters' Sampler 1	2	3	4	5	6	
Ephemeroptera							
Choroterpes	1	1					
Heptagenia	1		4			10	
Baetis two-tail	2		5	3	1	6	
Tricorythodes		1			1	1	
Ephemerella			1	1			
Dactylobaetis				1			
Brachycercus						1	
Ameletus						1	
Plecoptera							
Isogenus					1		
Isoperla			1				
Trichoptera							
Hydropsyche	1		33	2	2	78	
Cheumatopsyche		1	12			7	
Diptera							
Chironomidae	36	39	32	50	73	41	
Ceratopogonidae			1				
Simulium			1				
Oligochaeta	14	16	16	15	7	43	
Total Number =	55	58	106	72	85	188	$\overline{X}$ = 92
Total Number/m^2 =	594	627	1146	778	919	1924	$\overline{X}$ = 998
							σ = 497

Appendix D. Bottom Fauna Analyses, Yellowstone River at Miles City
September 8, 1975.

Organism	Number in Waters' Sampler 1	2	3	4	5	6	
Ephemeroptera							
Traverella	24	3	16	6	1	6	
Tricorythodes minutus	2	10	5	5		12	
Baetis two-tail	44	52	38	49	18	18	
Dactylobaetis	1	3	5	4	5	1	
Baetis three-tail	16	10	10	17	1	6	
Heptagenia	1	1				4	
Ephoron		4	1	2			
Rhithrogena		1	2	3	1	1	
Tricorythodes sp.x			2	1	1		
Choroterpes						2	
Trichoptera							
Hydropsyche	87	75	130	81	80	57	
Cheumatopsyche	3		10	7	3		
Diptera							
Simuliidae	13	2	1	3	6		
Chironomidae	12	25	31	15	9	40	
Coleoptera							
Microcylloepus	1	1					
Plecoptera							
Isoperla			1				
Total Number =	204	187	252	193	125	147	$\overline{X}$ = 184.7
Total Number/m^2 =	2205	2021	2724	2086	1351	1589	$\overline{X}$ = 1996.0
							σ = 482.5

Appendix D. Bottom Fauna Analyses, Yellowstone River at Intake September 9, 1975.

Organism	Number in Waters' Sampler 1	2	3	4	5	6	
Ephemeroptera							
Traverella	7	6			1	4	
Tricorythodes minutus	1	1	1			1	
Heptagenia	1		2		2		
Baetis three-tail	1	3	1				
Baetis two-tail		1					
Dactylobaetis					1	3	
Trichoptera							
Hydropsyche	8	17	4	14		13	
Diptera							
Chironomidae		2					
Simuliidae				1			
Plecoptera							
Isoperla				2			
Total Number =	18	30	8	17	4	21	$\overline{X}$ = 16.3
Total Number/m^2 =	195	324	86	184	43	227	$\overline{X}$ = 176.5
							σ = 100.7

Appendix D. Bottom Fauna Analyses, Yellowstone River at Sidney September 9, 1975.

Organism	1	2	3	4	5	6	
	Number in Waters' Sampler						
Ephemeroptera							
Brachycercus		2		2			
Tricorythodes minutus		3		1		1	
Ephoron album		1	1			1	
Ephemerella		1					
Heptagenia			1		1	5	
Choroterpes						1	
Trichoptera							
Hydropsyche	4	5	7	7	1	10	
Odonata							
Gomphus						1	
Oligochaeta	3						
Diptera							
Chironomidae	2	5		2		5	
Total Number =	9	17	9	12	2	24	$\bar{X}$ = 12.2
Total Number/m^2 =	97	184	97	130	21	259	$\bar{X}$ = 131.3
							σ = 82.0

Appendix D. Bottom Fauna Analyses, Yellowstone River at Miles City August 5, 1975.

Organism	Number in Waters' Sampler 1	2	3	4	5	6	
Ephemeroptera							
Traverella	2	3	5	7	7	38	
Tricorythodes minutus	5	4	6	3	5	9	
Heptagenia	1		1		6		
Ephemerella	1				34		
Dactylobaetis	1						
Rhithrogena		2		2	2	3	
Baetis three-tail		1			6		
Isonychia			1			6	
Baetis two-tail			1			2	
				2	2	1	
Trichoptera							
Hydropsyche	1	8	13	6	16	57	
Leptocella			1				
Brachycentrus					1		
Plecoptera							
Isogenus					2		
Isoperla					6		
Acroneuria						1	
Diptera							
Chironomidae	2	1		1	2	1	
Simuliidae		2	6	1	7	8	
Tipula sp					1		
Coleoptera							
Stenelmis				2			
Microcylloepus					8		
Total Number =	13	21	34	24	105	126	$\overline{X}$ = 54
Total Number/m^2 =	141	227	367	259	1135	1362	$\overline{X}$ = 581.8
							σ = 526.4

Appendix D. Bottom Fauna Analyses, Yellowstone River at Glendive August 7, 1975.

Organism	Number in Waters' Sampler 1	2	3	4	5	6	
Ephemeroptera							
Traverella	22	4	16	5	3	3	
Tricorythodes minutus	2	3	2	3	1	1	
Baetis three-tail	2		1		3	2	
Brachycercus	1				1		
Heptagenia		1				1	
Ephemerella		5			1		
Baetis two-tail		1			1		
Dactylobaetis		1	1	1	4		
Isonychia						1	
Trichoptera							
Hydropsyche	24	6	19	6	26	10	
Diptera							
Chironomidae		2			1		
Total Number =	51	23	39	15	41	18	$\overline{X}$ = 31
Total Number/m^2 =	551	249	422	162	443	195	$\overline{X}$ = 337
							σ = 156.7

Appendix D. Bottom Fauna Analyses, Yellowstone River at Intake August 7, 1975.

Organism	Number in Waters' Sampler 1	2	3	4	5	6	
Ephemeroptera							
Traverella	7	10	17	15	16	18	
Tricorythodes minutus	2			2	1		
Dactylobaetis	2	6	1		3		
Heptagenia	1	1					
Brachycercus		1					
Rhithrogena		1				1	
Baetis two-tail		2		3	1		
Baetis three-tail			4	2		4	
Trichoptera							
Hydropsyche	10	3	4	6	8	22	
Plecoptera							
Isoperla			1				
Oligochaeta						1	
Total Number =	22	24	27	28	29	46	$\overline{X}$ = 29
Total Number/m^2 =	238	259	292	303	313	497	$\overline{X}$ = 317
							σ = 92.6

Appendix D. Bottom Fauna Analyses, Yellowstone River at Sidney August 7, 1975.

Organism	1	2	3	4	5	6	
	Number in Waters' Sampler						
Ephemeroptera							
Traverella	11	11	16	5	4		
Brachycercus	4	6	2	3	2	3	
Tricorythodes minutus	5	4	9	1	7	3	
Baetis three-tail		1				1	
Heptagenia				1		2	
Isonychia					2		
Trichoptera							
Hydropsyche	7	8	5		5		
Leptocella		1	1				
Diptera							
Simuliidae	1						
Chironomidae		3	1		2		
Total Number =	28	34	34	10	22	9	$\overline{X}$ = 23
Total Number/m^2 =	303	367	367	108	238	97	$\overline{X}$ = 247
							σ = 121.5

Appendix D. Bottom Fauna Analyses, Yellowstone River at Miles City October 8, 1975.

Organism	Numbers in Waters' Sampler 1	2	3	4	5	6
Ephemeroptera						
Heptagenia	4	8	4	8	27	1
Traverella	1		1		1	
Ephemerella	1			3	1	
Tricorythodes minutus				1		
Baetis two-tail	21	8	40	13	12	12
Baetis three-tail	1	4	2		3	
Choroterpes	1				1	
Dactylobaetis	2	2	3	2		2
Rhithrogena					1	
Plecoptera						
Isoperla					1	
Trichoptera						
Hydropsyche	31	38	78	28	6	34
Brachycentrus		1	1			
Diptera						
Chironomidae	13	46	5	24	14	19
Empididae	2				1	1
Simuliidae					3	
Oligochaeta		2		2		4
Odonata						
Gomphus		1				
Total Number =	77	110	134	81	70	74
Total Number/m^2 =	832	1189	1448	875	757	780

$\overline{X}$ = 91

$\overline{X}$ = 980

σ = 277.62

Appendix D. Bottom Fauna Analyses, Yellowstone River at Glendive October 9, 1976.

Organism	Number in Waters' Sampler 1	2	3	4	5	6	
Ephemeroptera							
Heptagenia	8	3	1	4	1	1	
Tricorythodes minutus	2		2	2	1		
Dactylobaetis	2	2		4			
Baetis two-tail	15		8	7	2	1	
Baetis three-tail	2		4		2	1	
Tricorythodes sp.x	1						
Traverella		1					
Trichoptera							
Hydropsyche	74	6	38	46	15	5	
Oligochaeta	8	11	22	5	12	19	
Diptera							
Chironomidae	4	22	11	7	3	3	
Total Number =	116	45	86	75	36	30	$\overline{X}$ = 65
Total Number/m^2 =	1254	486	929	811	389	324	$\overline{X}$ = 698.8
							σ = 362.09

Appendix D. Bottom Fauna Analyses, Yellowstone River at Intake October 9, 1976.

Organism	Number in Waters' Sampler 1	2	3	4	5	6	
Ephemeroptera							
Traverella	1						
Heptagenia	25	2	8	2	9	22	
Tricorythodes minutus	6	1	1			4	
Stenonema	1						
Baetis two-tail	9	1				2	
Baetis three-tail		1			1		
Brachycercus	1						
Dactylobaetis				2	1		
Choroterpes					1		
Trichoptera							
Hydropsyche	45	9	10	3	5	7	
Diptera							
Chironomidae	29	3	15	26	11	45	
Oligochaeta	38	6	30	5	4	48	
Coleoptera							
Microcylloepus	1						
Total Number =	156	23	64	38	32	128	$\overline{X}$ = 74
Total Number/m^2 =	1686	249	692	411	346	1383	$\overline{X}$ = 794.5
							σ = 599.56

Appendix D. Bottom Fauna Analyses, Yellowstone River at Sidney October 9, 1975.

Organism	Number in Waters' Sampler 1	2	3	4	5	6	
Ephemeroptera							
Dactylobaetis	4	2	3	10	11	6	
Heptagenia	1		7	3	14	4	
Baetis three-tail	1	1	2	1	2	2	
Baetis two-tail			1	3	2	2	
Tricorythodes minutus					2	1	
Traverella					1	1	
Trichoptera							
Hydropsyche	16	11	28	17	84	19	
Cheumatopsyche					4		
Diptera							
Chironomidae	7	13	21	25	24	16	
Ceratopogonidae	1		1				
Oligochaeta	2	6	5	8	2	1	
Coleoptera							
Dubiraphia					1		
Microcylloepus					1		
Total Number =	32	33	68	67	148	52	$\overline{X}$ = 67
Total Number/m^2 =	346	357	735	724	1600	562	$\overline{X}$ = 720.6
							σ = 462.87

Appendix D. Bottom Fauna Analyses, Yellowstone River at Livingston November 7, 1975.

Organism	1	2	3	4	5	6
	Number in Waters' Sampler					
Ephemeroptera						
Ephemerella inermis	83	77	53	221		
Ephemerella doddsi		1		2		
Ephemerella grandis	9	2	4	24		
Baetis three-tail	1	2				
Ameletus						
Rhithrogena	18	15	61	60		
Trichoptera						
Hydropsyche	90	125	96	421		
Cheumatopsyche	7	15	8	30		
Arctopsyche	2		1	7		
Psychomyia	3	1	3	2		
Glossosoma			1	14		
Hydroptila	30		7	5		
Brachycentrus	28	11	4	42		
Lepidostoma	74	5	14	37		
Athripsodes	1		1	1		
Plecoptera						
Alloperla	6	6	5	13		
Isogenus	2		1	2		
Acroneuria			2			
Pteronarcys				3		
Diptera						
Chironomidae	201	212	157	113		
Atherix	10		11	29		
Hexatoma			1			
Simulium			1			
Oligochaeta		2				

	1	2	3	4	
Total Number =	565	474	431	1026	$\overline{X}$ = 624
Total Number/m^2 =	6107	5123	4658	11089	$\overline{X}$ = 6744
					σ = 2958

Appendix D. Bottom Fauna Analyses, Yellowstone River at Corwin Springs November 7, 1975.

Organism	Number in Waters' Sampler 1	2	3	4	5	6
Ephemeroptera						
Ephemerella inermis	83	48	59	91		
Ephemerella doddsi	1		1	2		
Baetis	2	5	2			
Ephemerella grandis		2	2			
Ameletus		1				
Rhithrogena		16	21	24		
Plecoptera						
Pteronarcys	8	1	4	4		
Acroneuria	2		2	9		
Isogenus	1					
Alloperla		1		2		
Trichoptera						
Hydropsyche	190	30	125	653		
Psychomyia	35	56	75	10		
Glossosoma	4	2	20	48		
Arctopsyche	2		5	4		
Hydroptila	49	133	47	21		
Lepidostoma			4			
Cheumatopsyche				30		
Diptera						
Chironomidae	112	91	118	186		
Atherix	6	2	1	1		
Hexatoma		2		1		
Simulium		1				
Coleoptera						
Optioservus	3					
Acari-Hydracarina	2	7	3			
Oligochaeta				2		

Total Number =	500	393	492	1090	$\overline{X}$ = 619
Total Number/m^2 =	5404	4248	5318	11781	$\overline{X}$ = 6688
					σ = 3435

Appendix D. Botton Fauna Analyses, Yellowstone River at Intake, November 11, 1975.

Organism	Number in Waters' Sampler 1	2	3	4	5	6	
Ephemeroptera							
Tricorythodes	1	1		1			
Baetis	6	4	1	3		6	
Heptagenia	4	1	3	12		1	
Ephemerella		2				1	
Dactylobaetis		1					
Plecoptera							
Brachyptera	3			1		1	
Isoperla		2		1	1	2	
Trichoptera							
Hydropsyche	21	39				12	
Diptera							
Chironomidae	1	13	20	23	6	24	
Simulium		1					
Oligochaeta	2	3	7	5	1	8	
Total Number =	38	67	31	46	8	55	$\overline{X}$ = 41
Total Number/m^2 =	411	724	335	497	86	594	$\overline{X}$ = 441
							σ = 221

Appendix D. Bottom Fauna Analyses, Yellowstone River at Sidney November 11, 1975.

Organism	Number in Waters' Sampler 1	2	3	4	5	6	
Ephemeroptera							
Baetis		5	3	4		2	
Heptagenia		6		1			
Plecoptera							
Brachyptera		2		2		1	
Trichoptera							
Hydropsyche		11	4	17	4	17	
Diptera							
Chironomidae	167	43	80	17	37	24	
Ceratopogonidae	1	1					
Oligochaeta	5	3	10	3	14	7	
Total Number =	173	71	97	44	55	51	$\overline{X}$ = 82
Total Number/m^2 =	1870	767	1048	476	594	551	$\overline{X}$ = 884
							σ = 524

Appendix D. Bottom Fauna Analyses, Yellowstone River at Glendive September 9, 1975.

Organism	1	2	3	4	5	6	
	Number in Waters' Sampler						
Ephemeroptera							
Tricorythodes minutus	1		1		2		
Baetis two-tail	4		1		1	1	
Dactylobaetis		2			1		
Traverella			1	7	9	24	
Tricorythodes sp.x				1			
Heptagenia				2	4	2	
Brachycercus						1	
Baetis three-tail						1	
Trichoptera							
Hydropsyche	8	4	9	20	38	35	
Diptera							
Chironomidae	4	1	14	5	5	3	
Oligochaeta			1	1	1	4	
Total Number =	17	7	27	36	61	71	$\overline{X}$ = 36.5
Total Number/m^2 =	184	76	292	389	659	767	$\overline{X}$ = 394.5
							σ = 270.2

APPENDIX E

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17,1975

STATION: 17-1 Hester-Dendy

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: SEPT. 25, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	38	40.4
2	18	19.1
3	13	13.8
4	11	11.7
5	5	5.3
6	5	5.3
7	4	4.3
TOTAL	94	100.0

DIVERSITY	=	2.39
MAXIMUM DIVERSITY (1)	=	6.55
MAXIMUM DIVERSITY (2)	=	2.74
MINIMUM DIVERSITY	=	0.42
REDUNDANCY	=	0.15
EVENNESS	=	0.85
EQUITABILITY	=	0.36
SPECIES RICHNESS	=	2.02

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17, 1975

STATION: 17-2 Hester-Dendy

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: SEPT. 25, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	32	32.7
2	20	20.4
3	19	19.4
4	10	10.2
5	7	7.1
6	6	6.1
7	2	2.0
8	1	1.0
9	1	1.0
TOTAL	98	100.0

DIVERSITY	=	2.56
MAXIMUM DIVERSITY (1)	=	6.61
MAXIMUM DIVERSITY (2)	=	3.22
MINIMUM DIVERSITY	=	0.54
REDUNDANCY	=	0.25
EVENNESS	=	0.81
EQUITABILITY	=	0.39
SPECIES RICHNESS	=	2.17

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17,1975

STATION: 17-3 Hester-Dendy

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: SEPT. 25. 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	35	22.7
2	28	18.2
3	27	17.5
4	27	17.5
5	24	15.6
6	6	3.9
7	3	1.9
8	2	1.3
9	1	0.6
10	1	0.6
TOTAL	154	100.0

DIVERSITY	=	2.70
MAXIMUM DIVERSITY (1)	=	7.27
MAXIMUM DIVERSITY (2)	=	3.24
MINIMUM DIVERSITY	=	0.42
REDUNDANCY	=	0.19
EVENNESS	=	0.81
EQUITABILITY	=	0.37
SPECIES RICHNESS	=	2.33

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1

SPECIES DIVERSITY ANALYSIS

MARCH 17,1975

STATION: 17-4

NUMBER OF SAMPLES: 1 Hester-Dendy

SAMPLING PERIOD: SEPT. 25, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	55	57.3
2	11	11.5
3	10	10.4
4	7	7.3
5	5	5.2
6	2	2.1
7	2	2.1
8	2	2.1
9	1	1.0
10	1	1.0
TOTAL	96	100.0

DIVERSITY	=	2.14
MAXIMUM DIVERSITY (1)	=	6.58
MAXIMUM DIVERSITY (2)	=	3.27
MINIMUM DIVERSITY	=	0.61
REDUNDANCY	=	0.42
EVENNESS	=	0.64
EQUITABILITY	=	0.33
SPECIES RICHNESS	=	1.82

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17,1975

STATION: 17-S

NUMBER OF SAMPLES: 1 Hester-Dendy

SAMPLING PERIOD: SEPT. 25, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	34	26.4
2	27	20.9
3	16	12.4
4	15	11.6
5	14	10.9
6	13	10.1
7	3	2.3
8	3	2.3
9	3	2.3
10	1	0.8
TOTAL	129	100.0

DIVERSITY	=	2.83
MAXIMUM DIVERSITY (1)	=	7.01
MAXIMUM DIVERSITY (2)	=	3.37
MINIMUM DIVERSITY	=	0.49
REDUNDANCY	=	0.19
EVENNESS	=	0.85
EQUITABILITY	=	0.40
SPECIES RICHNESS	=	2.42

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17,1975

STATION: 17-6

NUMBER OF SAMPLES: 1 Hester-Dendy

SAMPLING PERIOD: SEPT. 25, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	65	36.5
2	52	29.2
3	20	11.2
4	11	6.2
5	9	5.1
6	6	3.4
7	4	2.2
8	4	2.2
9	2	1.1
10	2	1.1
11	1	0.6
12	1	0.6
13	1	0.6
TOTAL	178	100.0

DIVERSITY	=	2.55
MAXIMUM DIVERSITY (1)	=	7.48
MAXIMUM DIVERSITY (2)	=	3.69
MINIMUM DIVERSITY	=	0.50
REDUNDANCY	=	0.36
EVENNESS	=	0.69
EQUITABILITY	=	0.34
SPECIES RICHNESS	=	2.21

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17,1975

STATION: 20

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: SEPT. 11, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	20	21.5
2	18	19.4
3	11	11.8
4	9	9.7
5	8	8.6
6	7	7.5
7	4	4.3
8	3	3.2
9	3	3.2
10	3	3.2
11	2	2.2
12	1	1.1
13	1	1.1
14	1	1.1
15	1	1.1
16	1	1.1
TOTAL	93	100.0

DIVERSITY	=	3.36
MAXIMUM DIVERSITY (1)	=	6.54
MAXIMUM DIVERSITY (2)	=	3.96
MINIMUM DIVERSITY	=	1.04
REDUNDANCY	=	0.21
EVENNESS	=	0.84
EQUITABILITY	=	0.51
SPECIES RICHNESS	=	2.84

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17,1975

STATION: 17

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: SEPT. 3, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	43	41.7
2	37	35.9
3	14	13.6
4	5	4.9
5	2	1.9
6	1	1.0
7	1	1.0
TOTAL	103	100.0

DIVERSITY	=	1.90
MAXIMUM DIVERSITY (1)	=	6.69
MAXIMUM DIVERSITY (2)	=	2.82
MINIMUM DIVERSITY	=	0.39
REDUNDANCY	=	0.38
EVENNESS	=	0.68
EQUITABILITY	=	0.28
SPECIES RICHNESS	=	1.62

STATION: 1 Yellowstone River

NUMBER OF SAMPLES: 0004 Hester-Dendy

SAMPLING PERIOD: DEC. 16, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	347	49.0
2	223	31.5
3	34	4.8
4	24	3.4
5	20	2.8
6	13	1.8
7	12	1.7
8	11	1.6
9	11	1.6
10	6	0.8
11	3	0.4
12	1	0.1
13	1	0.1
14	1	0.1
15	1	0.1
TOTAL	708	100.0

DIVERSITY	=	2.09
MAXIMUM DIVERSITY (1)	=	9.47
MAXIMUM DIVERSITY (2)	=	3.85
MINIMUM DIVERSITY	=	0.19
REDUNDANCY	=	0.48
EVENNESS	=	0.53
EQUITABILITY	=	0.22
SPECIES RICHNESS	=	1.67

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

FEBRUARY 14 1975

STATION: 2 Yellowstone River

NUMBER OF SAMPLES: 0004 Hester-Dendy

SAMPLING PERIOD: DEC. 16, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	726	43.6
2	222	13.3
3	175	10.5
4	140	8.4
5	120	7.2
6	95	5.7
7	58	3.5
8	38	2.3
9	30	1.8
10	12	0.7
11	12	0.7
12	10	0.6
13	9	0.5
14	7	0.4
15	5	0.3
16	4	0.2
17	1	0.1
18	1	0.1
TOTAL	1665	100.0

DIVERSITY	=	2.74
MAXIMUM DIVERSITY (1)	=	10.70
MAXIMUM DIVERSITY (2)	=	4.16
MINIMUM DIVERSITY	=	0.11
REDUNDANCY	=	0.35
EVENNESS	=	0.66
EQUITABILITY	=	0.26
SPECIES RICHNESS	=	2.48

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

FEBRUARY 14 1975

STATION: 3 Yellowstone River

NUMBER OF SAMPLES: 0004 Hester-Dendy

SAMPLING PERIOD: DEC. 16, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	920	46.7
2	467	23.7
3	200	10.1
4	167	8.5
5	100	5.1
6	64	3.2
7	13	0.7
8	10	0.5
9	9	0.5
10	9	0.5
11	5	0.3
12	3	0.2
13	2	0.1
14	1	0.1
15	1	0.1
TOTAL	1971	100.0

DIVERSITY	=	2.24
MAXIMUM DIVERSITY (1)	=	10.94
MAXIMUM DIVERSITY (2)	=	3.89
MINIMUM DIVERSITY	=	0.08
REDUNDANCY	=	0.43
EVENNESS	=	0.57
EQUITABILITY	=	0.20
SPECIES RICHNESS	=	2.03

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

FEBRUARY 14 1975

STATION: 4 Yellowstone River

NUMBER OF SAMPLES: 0004 Hester-Dendy

SAMPLING PERIOD: DEC. 16, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	227	36.3
2	130	20.8
3	65	10.4
4	65	10.4
5	50	8.0
6	30	4.8
7	18	2.9
8	14	2.2
9	10	1.6
10	8	1.3
11	6	1.0
12	2	0.3
TOTAL	625	100.0

DIVERSITY	=	2.72
MAXIMUM DIVERSITY (1)	=	9.29
MAXIMUM DIVERSITY (2)	=	3.52
MINIMUM DIVERSITY	=	0.16
REDUNDANCY	=	0.24
EVENNESS	=	0.76
EQUITABILITY	=	0.29
SPECIES RICHNESS	=	2.43

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

FEBRUARY 14 1975

STATION: 4 Yellowstone River

NUMBER OF SAMPLES: 0004 Hester-Dendy

SAMPLING PERIOD: DEC. 16, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	227	36.3
2	130	20.8
3	65	10.4
4	65	10.4
5	50	8.0
6	30	4.8
7	18	2.9
8	14	2.2
9	10	1.6
10	8	1.3
11	6	1.0
12	2	0.3
TOTAL	625	100.0

DIVERSITY	=	2.72
MAXIMUM DIVERSITY (1)	=	9.29
MAXIMUM DIVERSITY (2)	=	3.52
MINIMUM DIVERSITY	=	0.16
REDUNDANCY	=	0.24
EVENNESS	=	0.76
EQUITABILITY	=	0.29
SPECIES RICHNESS	=	2.43

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

FEBRUARY 14 1975

STATION: 3 Yellowstone River

NUMBER OF SAMPLES: 0004 Hester-Dendy

SAMPLING PERIOD: DEC. 16, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	920	46.7
2	467	23.7
3	200	10.1
4	167	8.5
5	100	5.1
6	64	3.2
7	13	0.7
8	10	0.5
9	9	0.5
10	9	0.5
11	5	0.3
12	3	0.2
13	2	0.1
14	1	0.1
15	1	0.1
TOTAL	1971	100.0

DIVERSITY	=	2.24
MAXIMUM DIVERSITY (1)	=	10.94
MAXIMUM DIVERSITY (2)	=	3.89
MINIMUM DIVERSITY	=	0.08
REDUNDANCY	=	0.43
EVENNESS	=	0.57
EQUITABILITY	=	0.20
SPECIES RICHNESS	=	2.03

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

FEBRUARY 14 1975

STATION: 2 Yellowstone River

NUMBER OF SAMPLES: 0004 Hester-Dendy

SAMPLING PERIOD: DEC. 16, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	726	43.6
2	222	13.3
3	175	10.5
4	140	8.4
5	120	7.2
6	95	5.7
7	58	3.5
8	38	2.3
9	30	1.8
10	12	0.7
11	12	0.7
12	10	0.6
13	9	0.5
14	7	0.4
15	5	0.3
16	4	0.2
17	1	0.1
18	1	0.1
TOTAL	1665	100.0

DIVERSITY	=	2.74
MAXIMUM DIVERSITY (1)	=	10.70
MAXIMUM DIVERSITY (2)	=	4.16
MINIMUM DIVERSITY	=	0.11
REDUNDANCY	=	0.35
EVENNESS	=	0.66
EQUITABILITY	=	0.26
SPECIES RICHNESS	=	2.48

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

FEBRUARY 14 1975

STATION: 1 Yellowstone River

NUMBER OF SAMPLES: 0004 Hester-Dendy

SAMPLING PERIOD: DEC. 16, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	347	49.0
2	223	31.5
3	34	4.8
4	24	3.4
5	20	2.8
6	13	1.8
7	12	1.7
8	11	1.6
9	11	1.6
10	6	0.8
11	3	0.4
12	1	0.1
13	1	0.1
14	1	0.1
15	1	0.1
TOTAL	708	100.0

DIVERSITY	=	2.09
MAXIMUM DIVERSITY (1)	=	9.47
MAXIMUM DIVERSITY (2)	=	3.85
MINIMUM DIVERSITY	=	0.19
REDUNDANCY	=	0.48
EVENNESS	=	0.53
EQUITABILITY	=	0.22
SPECIES RICHNESS	=	1.87

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

FEBRUARY 14 1975

STATION: 18 Yellowstone River

NUMBER OF SAMPLES: 0004 Hester-Dendy

SAMPLING PERIOD: DEC. 17, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	63	39.9
2	29	18.4
3	17	10.8
4	13	8.2
5	9	5.7
6	7	4.4
7	5	3.2
8	3	1.9
9	2	1.3
10	2	1.3
11	2	1.3
12	1	0.6
13	1	0.6
14	1	0.6
15	1	0.6
16	1	0.6
17	1	0.6
TOTAL	158	100.0

DIVERSITY	=	2.84
MAXIMUM DIVERSITY (1)	=	7.30
MAXIMUM DIVERSITY (2)	=	3.91
MINIMUM DIVERSITY	=	0.73
REDUNDANCY	=	0.34
EVENNESS	=	0.69
EQUITABILITY	=	0.39
SPECIES RICHNESS	=	2.45

MONTANA DEPARTMENT OF FISH AND GAME

FPT 2200.1 SPECIES DIVERSITY ANALYSIS

FEBRUARY 14 1975

STATION: 18 Yellowstone River

NUMBER OF SAMPLES: 0004 Hester-Dendy

SAMPLING PERIOD: DEC. 17, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	63	39.9
2	29	18.4
3	17	10.8
4	13	8.2
5	9	5.7
6	7	4.4
7	5	3.2
8	3	1.9
9	2	1.3
10	2	1.3
11	2	1.3
12	1	0.6
13	1	0.6
14	1	0.6
15	1	0.6
16	1	0.6
17	1	0.6
TOTAL	158	100.0

DIVERSITY	=	2.84
MAXIMUM DIVERSITY (1)	=	7.30
MAXIMUM DIVERSITY (2)	=	3.91
MINIMUM DIVERSITY	=	0.73
REDUNDANCY	=	0.34
EVENNESS	=	0.69
EQUITABILITY	=	0.39
SPECIES RICHNESS	=	2.45

MONTANA DEPARTMENT OF FISH AND GAME

AT 2230.1 SPECIES DIVERSITY ANALYSIS

APRIL 9, 1975

STATION: 1S

NUMBER OF SAMPLES: 4

SAMPLING PERIOD: DEC. 17, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	27	36.5
2	17	23.0
3	16	21.6
4	5	6.8
5	2	2.7
6	2	2.7
7	2	2.7
8	2	2.7
9	1	1.4
TOTAL	74	100.0

DIVERSITY	=	2.41
MAXIMUM DIVERSITY (1)	=	6.21
MAXIMUM DIVERSITY (2)	=	2.97
MINIMUM DIVERSITY	=	0.65
REDUNDANCY	=	0.24
EVENNESS	=	0.76
EQUITABILITY	=	0.39
SPECIES RICHNESS	=	2.02

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17,1975

STATION: 1

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: JAN. 13, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	343	69.0
2	33	6.6
3	33	6.6
4	20	4.0
5	15	3.0
6	15	3.0
7	12	2.4
8	11	2.2
9	4	0.8
10	4	0.8
11	2	0.4
12	2	0.4
13	1	0.2
14	1	0.2
15	1	0.2
TOTAL	497	100.0

DIVERSITY	=	1.86
MAXIMUM DIVERSITY (1)	=	8.96
MAXIMUM DIVERSITY (2)	=	3.82
MINIMUM DIVERSITY	=	0.25
REDUNDANCY	=	0.55
EVENNESS	=	0.48
EQUITABILITY	=	0.21
SPECIES RICHNESS	=	1.65

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

FEBRUARY 14 1975

STATION: 2 Yellowstone River

NUMBER OF SAMPLES: Kick

SAMPLING PERIOD: JAN. 13, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	90	26.8
2	80	23.8
3	40	11.9
4	34	10.1
5	28	8.3
6	15	4.5
7	10	3.0
8	7	2.1
9	6	1.8
10	5	1.5
11	4	1.2
12	4	1.2
13	3	0.9
14	2	0.6
15	2	0.6
16	2	0.6
17	1	0.3
18	1	0.3
19	1	0.3
20	1	0.3
TOTAL	336	100.0

DIVERSITY	=	3.11
MAXIMUM DIVERSITY (1)	=	8.39
MAXIMUM DIVERSITY (2)	=	4.33
MINIMUM DIVERSITY	=	0.47
REDUNDANCY	=	0.32
EVENNESS	=	0.72
EQUITABILITY	=	0.37
SPECIES RICHNESS	=	2.74

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17,1975

STATION: 3

NUMBER OF SAMPLES: 4

SAMPLING PERIOD: JAN. 13, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	271	39.3
2	173	25.1
3	157	22.8
4	48	7.0
5	15	2.2
6	8	1.2
7	4	0.6
8	4	0.6
9	3	0.4
10	2	0.3
11	1	0.1
12	1	0.1
13	1	0.1
14	1	0.1
15	1	0.1
TOTAL	690	100.0

DIVERSITY	=	2.19
MAXIMUM DIVERSITY (1)	=	9.43
MAXIMUM DIVERSITY (2)	=	3.83
MINIMUM DIVERSITY	=	0.19
REDUNDANCY	=	0.45
EVENNESS	=	0.56
EQUITABILITY	=	0.23
SPECIES RICHNESS	=	1.96

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17.1975

STATION: 4

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: JAN. 13. 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	160	57.1
2	47	16.8
3	20	7.1
4	17	6.1
5	15	5.4
6	8	2.9
7	4	1.4
8	2	0.7
9	2	0.7
10	2	0.7
11	1	0.4
12	1	0.4
13	1	0.4
TOTAL	280	100.0

DIVERSITY	=	2.11
MAXIMUM DIVERSITY (1)	=	8.13
MAXIMUM DIVERSITY (2)	=	3.67
MINIMUM DIVERSITY	=	0.35
REDUNDANCY	=	0.47
EVENNESS	=	0.57
EQUITABILITY	=	0.26
SPECIES RICHNESS	=	1.85

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17,1975

STATION: 12

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: JAN. 13, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	220	43.1
2	100	19.6
3	36	7.0
4	36	7.0
5	36	7.0
6	20	3.9
7	12	2.3
8	11	2.2
9	9	1.8
10	8	1.6
11	7	1.4
12	4	0.8
13	4	0.8
14	4	0.8
15	1	0.2
16	1	0.2
17	1	0.2
18	1	0.2
TOTAL	511	100.0

DIVERSITY	=	2.74
MAXIMUM DIVERSITY (1)	=	9.00
MAXIMUM DIVERSITY (2)	=	4.12
MINIMUM DIVERSITY	=	0.30
REDUNDANCY	=	0.36
EVENNESS	=	0.66
EQUITABILITY	=	0.30
SPECIES RICHNESS	=	2.43

STATION: 1

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: FEB. 14, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	1184	42.0
2	640	22.7
3	170	6.0
4	150	5.3
5	107	3.8
6	103	3.7
7	94	3.3
8	83	2.9
9	54	1.9
10	43	1.5
11	32	1.1
12	30	1.1
13	30	1.1
14	25	0.9
15	17	0.6
16	12	0.4
17	8	0.3
18	8	0.3
19	5	0.2
20	4	0.1
21	4	0.1
22	3	0.1
23	2	0.1
24	2	0.1
25	2	0.1
26	2	0.1
27	1	0.0
28	1	0.0
29	1	0.0
TOTAL	2817	100.0

DIVERSITY	=	2.84
MAXIMUM DIVERSITY (1)	=	11.46
MAXIMUM DIVERSITY (2)	=	4.82
MINIMUM DIVERSITY	=	0.11
REDUNDANCY	=	0.42
EVENNESS	=	0.59
EQUITABILITY	=	0.25
SPECIES RICHNESS	=	2.60

STATION: 2-MALLARD REST

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: FEB.14,1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	273	28.1
2	264	27.2
3	141	14.5
4	91	9.4
5	46	4.7
6	42	4.3
7	40	4.1
8	17	1.8
9	16	1.6
10	13	1.3
11	6	0.6
12	5	0.5
13	5	0.5
14	4	0.4
15	3	0.3
16	2	0.2
17	2	0.2
18	1	0.1
TOTAL	971	100.0

DIVERSITY	=	2.86
MAXIMUM DIVERSITY (1)	=	9.92
MAXIMUM DIVERSITY (2)	=	4.20
MINIMUM DIVERSITY	=	0.17
REDUNDANCY	=	0.35
EVENNESS	=	0.68
EQUITABILITY	=	0.29
SPECIES RICHNESS	=	2.57

RCP 2200.1 SPECIES DIVERSITY ANALYSIS

APRIL 9,1975

STATION: 3

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: FEB. 14,1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	432	27.7
2	227	14.5
3	209	13.4
4	130	8.3
5	103	6.6
6	93	6.0
7	88	5.6
8	80	5.1
9	57	3.7
10	42	2.7
11	38	2.4
12	18	1.2
13	10	0.6
14	7	0.4
15	5	0.3
16	4	0.3
17	4	0.3
18	4	0.3
19	3	0.2
20	2	0.1
21	2	0.1
22	1	0.1
23	1	0.1
24	1	0.1
TOTAL	1561	100.0

DIVERSITY	=	3.32
MAXIMUM DIVERSITY (1)	=	10.61
MAXIMUM DIVERSITY (2)	=	4.58
MINIMUM DIVERSITY	=	0.16
REDUNDANCY	=	0.28
EVENNESS	=	0.72
EQUITABILITY	=	0.31
SPECIES RICHNESS	=	3.00

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2206.1 SPECIES DIVERSITY ANALYSIS

APRIL 9,1975

STATION: 4

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: FEB.14,1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	646	35.8
2	512	28.3
3	440	24.3
4	42	2.3
5	35	1.9
6	29	1.6
7	28	1.5
8	20	1.1
9	7	0.4
10	7	0.4
11	5	0.3
12	5	0.3
13	5	0.3
14	4	0.2
15	3	0.2
16	3	0.2
17	3	0.2
18	3	0.2
19	3	0.2
20	2	0.1
21	2	0.1
22	1	0.1
23	1	0.1
TOTAL	1806	100.0

DIVERSITY	=	2.30
MAXIMUM DIVERSITY (1)	=	10.82
MAXIMUM DIVERSITY (2)	=	4.52
MINIMUM DIVERSITY	=	0.13
REDUNDANCY	=	0.51
EVENNESS	=	0.51
EQUITABILITY	=	0.21
SPECIES RICHNESS	=	2.09

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

OCTOBER 27, 1975

STATION: CORWIN SPRINGS

NUMBER OF SAMPLERS:

SAMPLING PERIOD: MARCH 10, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	389	25.8
2	310	20.6
3	294	19.5
4	63	4.2
5	61	4.0
6	60	4.0
7	60	4.0
8	51	3.4
9	51	3.4
10	43	2.9
11	24	1.6
12	20	1.3
13	18	1.2
14	18	1.2
15	7	0.5
16	7	0.5
17	5	0.3
18	4	0.3
19	3	0.2
20	3	0.2
21	2	0.1
22	2	0.1
23	2	0.1
24	2	0.1
25	2	0.1
26	1	0.1
27	1	0.1
28	1	0.1
29	1	0.1
30	1	0.1
31	1	0.1
TOTAL	1507	100.0

DIVERSITY	=	3.25
MAXIMUM DIVERSITY (1)	=	10.56
MAXIMUM DIVERSITY (2)	=	4.94
MINIMUM DIVERSITY	=	0.21
REDUNDANCY	=	0.36
EVENNESS	=	0.66

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

OCTOBER 27, 1975

STATION: MALLARD REST

NUMBER OF SAMPLERS:

SAMPLING PERIOD: MARCH 10, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	2459	54.1
2	606	13.3
3	420	9.2
4	209	4.6
5	208	4.6
6	198	4.4
7	110	2.4
8	100	2.2
9	61	1.3
10	48	1.1
11	23	0.5
12	15	0.3
13	12	0.3
14	11	0.2
15	10	0.2
16	10	0.2
17	6	0.1
18	6	0.1
19	5	0.1
20	5	0.1
21	5	0.1
22	4	0.1
23	3	0.1
24	3	0.1
25	2	0.0
26	1	0.0
27	1	0.0
28	1	0.0
29	1	0.0
TOTAL	4543	100.0

DIVERSITY	=	2.44
MAXIMUM DIVERSITY (1)	=	12.15
MAXIMUM DIVERSITY (2)	=	4.86
MINIMUM DIVERSITY	=	0.07
REDUNDANCY	=	0.51
EVENNESS	=	0.50
EQUITABILITY	=	0.20
SPECIES RICHNESS	=	2.24

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

OCTOBER 27, 1975

STATION: MALLARD REST

NUMBER OF SAMPLERS:

SAMPLING PERIOD: MARCH 10, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	2459	54.1
2	606	13.3
3	420	9.2
4	209	4.6
5	208	4.6
6	198	4.4
7	110	2.4
8	100	2.2
9	61	1.3
10	48	1.1
11	23	0.5
12	15	0.3
13	12	0.3
14	11	0.2
15	10	0.2
16	10	0.2
17	6	0.1
18	6	0.1
19	5	0.1
20	5	0.1
21	5	0.1
22	4	0.1
23	3	0.1
24	3	0.1
25	2	0.0
26	1	0.0
27	1	0.0
28	1	0.0
29	1	0.0
TOTAL	4543	100.0

DIVERSITY	=	2.44
MAXIMUM DIVERSITY (1)	=	12.15
MAXIMUM DIVERSITY (2)	=	4.86
MINIMUM DIVERSITY	=	0.07
REDUNDANCY	=	0.51
EVENNESS	=	0.50
EQUITABILITY	=	0.20
SPECIES RICHNESS	=	[illegible]

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

OCTOBER 27, 1975

STATION: 4-ABOVE SHIELDS R.

NUMBER OF SAMPLERS:

SAMPLING PERIOD: MARCH 10, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	1276	43.7
2	520	17.8
3	364	12.5
4	232	7.9
5	192	6.6
6	80	2.7
7	80	2.7
8	60	2.1
9	36	1.2
10	20	0.7
11	16	0.5
12	12	0.4
13	8	0.3
14	4	0.1
15	4	0.1
16	4	0.1
17	4	0.1
18	4	0.1
19	4	0.1
TOTAL	2920	100.0

DIVERSITY	=	2.59
MAXIMUM DIVERSITY (1)	=	11.51
MAXIMUM DIVERSITY (2)	=	4.25
MINIMUM DIVERSITY	=	0.07
REDUNDANCY	=	0.40
EVENNESS	=	0.61
EQUITABILITY	=	0.23
SPECIES RICHNESS	=	2.37

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

APRIL 9,1975

STATION: 13

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: MARCH 19,1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	1350	74.5
2	170	9.4
3	118	6.5
4	60	3.3
5	26	1.4
6	17	0.9
7	15	0.8
8	11	0.6
9	9	0.5
10	7	0.4
11	4	0.2
12	4	0.2
13	4	0.2
14	4	0.2
15	3	0.2
16	3	0.2
17	2	0.1
18	2	0.1
19	1	0.1
20	1	0.1
21	1	0.1
22	1	0.1
TOTAL	1813	100.0

DIVERSITY	=	1.53
MAXIMUM DIVERSITY (1)	=	10.82
MAXIMUM DIVERSITY (2)	=	4.44
MINIMUM DIVERSITY	=	0.13
REDUNDANCY	=	0.67
EVENNESS	=	0.34
EQUITABILITY	=	0.14
SPECIES RICHNESS	=	1.39

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2250.1 SPECIES DIVERSITY ANALYSIS

APRIL 9,1975

STATION: 14

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: MARCH 19,1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	90	35.6
2	40	15.8
3	36	14.2
4	28	11.1
5	20	7.9
6	10	4.0
7	6	2.4
8	5	2.0
9	3	1.2
10	2	0.8
11	2	0.8
12	2	0.8
13	1	0.4
14	1	0.4
15	1	0.4
16	1	0.4
17	1	0.4
18	1	0.4
19	1	0.4
20	1	0.4
21	1	0.4
TOTAL	253	100.0

DIVERSITY	=	2.94
MAXIMUM DIVERSITY (1)	=	7.98
MAXIMUM DIVERSITY (2)	=	4.17
MINIMUM DIVERSITY	=	0.63
REDUNDANCY	=	0.35
EVENNESS	=	0.67
EQUITABILITY	=	0.37
SPECIES RICHNESS	=	2.57

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2265.1 SPECIES DIVERSITY ANALYSIS

APRIL 9, 1975

STATION: 15

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: MARCH 19, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	328	68.9
2	67	14.1
3	16	3.4
4	15	3.2
5	14	2.9
6	8	1.7
7	7	1.5
8	5	1.1
9	4	0.8
10	4	0.8
11	3	0.6
12	1	0.2
13	1	0.2
14	1	0.2
15	1	0.2
16	1	0.2
TOTAL	476	100.0

DIVERSITY	=	1.75
MAXIMUM DIVERSITY (1)	=	8.89
MAXIMUM DIVERSITY (2)	=	4.01
MINIMUM DIVERSITY	=	0.28
REDUNDANCY	=	0.60
EVENNESS	=	0.44
EQUITABILITY	=	0.20
SPECIES RICHNESS	=	1.56

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JUNE 25, 1975

STATION: 1-CORWIN SPRINGS

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: APRIL 7,1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	473	22.6
2	423	20.2
3	349	16.7
4	274	13.1
5	120	5.7
6	80	3.8
7	70	3.4
8	65	3.1
9	40	1.9
10	40	1.9
11	33	1.6
12	26	1.2
13	16	0.8
14	16	0.8
15	14	0.7
16	14	0.7
17	8	0.4
18	6	0.3
19	6	0.3
20	5	0.2
21	3	0.1
22	2	0.1
23	2	0.1
24	1	0.0
25	1	0.0
26	1	0.0
27	1	0.0
TOTAL	2089	100.0

DIVERSITY	=	3.25
MAXIMUM DIVERSITY (1)	=	11.03
MAXIMUM DIVERSITY (2)	=	4.73
MINIMUM DIVERSITY	=	0.14
REDUNDANCY	=	0.32
EVENNESS	=	0.68
EQUITABILITY	=	0.30
SPECIES RICHNESS	=	2.96

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JUNE 25, 1975

STATION: 12-BIGHORN R

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: APRIL 18, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	9	24.3
2	6	16.2
3	6	16.2
4	5	13.5
5	4	10.8
6	4	10.8
7	2	5.4
8	1	2.7
TOTAL	37	100.0

DIVERSITY	=	2.80
MAXIMUM DIVERSITY (1)	=	5.21
MAXIMUM DIVERSITY (2)	=	2.38
MINIMUM DIVERSITY	=	0.96
REDUNDANCY	=	0.04
EVENNESS	=	0.93
EQUITABILITY	=	0.54
SPECIES RICHNESS	=	2.26

MONTANA DEPARTMENT OF FISH AND GAME

RPT 22[illegible].1 SPECIES DIVERSITY ANALYSIS

JUNE 25, 1975

STATION: 13-MYERS

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: APRIL 19,1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	207	59.1
2	59	16.9
3	35	10.0
4	13	3.7
5	9	2.6
6	7	2.0
7	5	1.4
8	4	1.1
9	3	0.9
10	2	0.6
11	2	0.6
12	2	0.6
13	2	0.5
TOTAL	350	100.0

DIVERSITY	=	2.03
MAXIMUM DIVERSITY (1)	=	8.45
MAXIMUM DIVERSITY (2)	=	3.74
MINIMUM DIVERSITY	=	0.29
REDUNDANCY	=	0.5[illegible]
EVENNESS	=	0.55
EQUITABILITY	=	0.24
SPECIES RICHNESS	=	1.79

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JUNE 25, 1975

STATION: 14-FORSYTH

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: APRIL 18,1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	516	69.2
2	140	18.8
3	44	5.9
4	13	1.7
5	13	1.7
6	6	0.8
7	5	0.7
8	3	0.4
9	2	0.3
10	1	0.1
11	1	0.1
12	1	0.1
13	1	0.1
TOTAL	746	100.0

DIVERSITY	=	1.48
MAXIMUM DIVERSITY (1)	=	9.54
MAXIMUM DIVERSITY (2)	=	3.67
MINIMUM DIVERSITY	=	0.15
REDUNDANCY	=	0.62
EVENNESS	=	0.40
EQUITABILITY	=	0.15
SPECIES RICHNESS	=	1.32

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JUNE 25, 1975

STATION: 15-MILES CITY

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: APRIL 18, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	498	73.9
2	53	7.9
3	40	5.9
4	13	1.9
5	12	1.8
6	11	1.6
7	11	1.6
8	7	1.0
9	7	1.0
10	5	0.7
11	4	0.6
12	4	0.6
13	2	0.3
14	1	0.1
15	1	0.1
16	1	0.1
17	1	0.1
18	1	0.1
19	1	0.1
20	1	0.1
TOTAL	674	100.0

DIVERSITY	=	1.66
MAXIMUM DIVERSITY (1)	=	9.40
MAXIMUM DIVERSITY (2)	=	4.32
MINIMUM DIVERSITY	=	0.26
REDUNDANCY	=	0.66
EVENNESS	=	0.38
EQUITABILITY	=	0.18
SPECIES RICHNESS	=	1.48

STATION: 17-GLENDIVE

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: APRIL 17,1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	145	43.9
2	37	11.2
3	36	10.9
4	33	10.0
5	29	8.8
6	13	3.9
7	9	2.7
8	7	2.1
9	5	1.5
10	4	1.2
11	3	0.9
12	2	0.6
13	2	0.6
14	1	0.3
15	1	0.3
16	1	0.3
17	1	0.3
18	1	0.3
TOTAL	330	100.0

DIVERSITY	=	2.75
MAXIMUM DIVERSITY (1)	=	8.37
MAXIMUM DIVERSITY (2)	=	4.08
MINIMUM DIVERSITY	=	0.43
REDUNDANCY	=	0.36
EVENNESS	=	0.66
EQUITABILITY	=	0.33
SPECIES RICHNESS	=	2.43

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

APRIL 9, 1975

STATION: 12

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: MARCH 19, 1975

RANK	ABUNDANCE	PERCENT OF TOTAL
1	30	52.6
2	6	10.5
3	5	8.8
4	5	8.8
5	2	3.5
6	2	3.5
7	2	3.5
8	2	3.5
9	1	1.8
10	1	1.8
11	1	1.8
TOTAL	57	100.0

DIVERSITY	=	2.43
MAXIMUM DIVERSITY (1)	=	5.83
MAXIMUM DIVERSITY (2)	=	3.13
MINIMUM DIVERSITY	=	1.00
REDUNDANCY	=	0.33
EVENNESS	=	0.70
EQUITABILITY	=	0.42
SPECIES RICHNESS	=	2.01

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17, 1975

STATION: 06 Tongue River

NUMBER OF SAMPLES: 1

SAMPLING PERIOD: DEC. 3, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	138	34.2
2	39	9.7
3	33	8.2
4	26	6.5
5	16	4.0
6	16	4.0
7	15	3.7
8	14	3.5
9	12	3.0
10	11	2.7
11	10	2.5
12	10	2.5
13	10	2.5
14	7	1.7
15	7	1.7
16	6	1.5
17	5	1.2
18	5	1.2
19	4	1.0
20	4	1.0
21	4	1.0
22	2	0.5
23	2	0.5
24	1	0.2
25	1	0.2
26	1	0.2
27	1	0.2
28	1	0.2
29	1	0.2
30	1	0.2
TOTAL	403	100.0

DIVERSITY	=	3.69
MAXIMUM DIVERSITY (1)	=	8.65
MAXIMUM DIVERSITY (2)	=	4.80
MINIMUM DIVERSITY	=	0.62
REDUNDANCY	=	0.27
EVENNESS	=	0.75
EQUITABILITY	=	0.43
SPECIES RICHNESS	=	3.26

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17,1975

STATION: 01 Tongue River-Keogh

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: DEC. 3,1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	60	62.5
2	11	11.5
3	10	10.4
4	4	4.2
5	3	3.1
6	2	2.1
7	2	2.1
8	1	1.0
9	1	1.0
10	1	1.0
11	1	1.0
TOTAL	96	100.0

DIVERSITY	=	1.98
MAXIMUM DIVERSITY (1)	=	6.58
MAXIMUM DIVERSITY (2)	=	3.44
MINIMUM DIVERSITY	=	0.68
REDUNDANCY	=	0.53
EVENNESS	=	0.57
EQUITABILITY	=	0.30
SPECIES RICHNESS	=	1.68

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

MARCH 17, 1975

STATION: 06 Tongue River-Birney

NUMBER OF SAMPLES: 1 Kick

SAMPLING PERIOD: DEC. 3, 1974

RANK	ABUNDANCE	PERCENT OF TOTAL
1	138	34.2
2	39	9.7
3	33	8.2
4	26	6.5
5	16	4.0
6	16	4.0
7	15	3.7
8	14	3.5
9	12	3.0
10	11	2.7
11	10	2.5
12	10	2.5
13	10	2.5
14	7	1.7
15	7	1.7
16	6	1.5
17	5	1.2
18	5	1.2
19	4	1.0
20	4	1.0
21	4	1.0
22	2	0.5
23	2	0.5
24	1	0.2
25	1	0.2
26	1	0.2
27	1	0.2
28	1	0.2
29	1	0.2
30	1	0.2
TOTAL	403	100.0

DIVERSITY	=	3.69
MAXIMUM DIVERSITY (1)	=	8.65
MAXIMUM DIVERSITY (2)	=	4.80
MINIMUM DIVERSITY	=	0.62
REDUNDANCY	=	0.27
EVENNESS	=	0.75
EQUITABILITY	=	0.43
SPECIES RICHNESS	=	3.26

APPENDIX F

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: VIII-5-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	5	38.5
2	2	15.4
3	2	15.4
4	1	7.7
5	1	7.7
6	1	7.7
7	1	7.7
TOTAL	13	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.50	1.82
MAXIMUM DIVERSITY	2.81	2.04
MINIMUM DIVERSITY	2.19	1.56
REDUNDANCY	0.50	0.46
EVENNESS	0.89	0.89
EQUITABILITY	0.68	0.73
SPECIES RICHNESS	1.82	1.09

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: VIII-5-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	8	38.1
2	4	19.0
3	3	14.3
4	2	9.5
5	2	9.5
6	1	4.8
7	1	4.8
TOTAL	21	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.45	1.95
MAXIMUM DIVERSITY	2.81	2.26
MINIMUM DIVERSITY	1.60	1.20
REDUNDANCY	0.30	0.29
EVENNESS	0.87	0.87
EQUITABILITY	0.56	0.63
SPECIES RICHNESS	1.89	1.33

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: VIII-5-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	13	38.2
2	6	17.6
3	6	17.6
4	5	14.7
5	1	2.9
6	1	2.9
7	1	2.9
8	1	2.9
TOTAL	34	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.42	2.04
MAXIMUM DIVERSITY	3.00	2.54
MINIMUM DIVERSITY	1.31	1.02
REDUNDANCY	0.34	0.33
EVENNESS	0.81	0.80
EQUITABILITY	0.48	0.54
SPECIES RICHNESS	1.94	1.50

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: VIII-5-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	7	29.2
2	6	25.0
3	3	12.5
4	2	8.3
5	2	8.3
6	2	8.3
7	1	4.2
8	1	4.2
TOTAL	24	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.67	2.15
MAXIMUM DIVERSITY	3.00	2.43
MINIMUM DIVERSITY	1.69	1.28
REDUNDANCY	0.25	0.24
EVENNESS	0.89	0.89
EQUITABILITY	0.58	0.65
SPECIES RICHNESS	2.09	1.50

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: VIII-5-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	34	32.4
2	16	15.2
3	8	7.6
4	7	6.7
5	7	6.7
6	6	5.7
7	6	5.7
8	6	5.7
9	5	4.8
10	2	1.9
11	2	1.9
12	2	1.9
13	2	1.9
14	1	1.0
15	1	1.0
TOTAL	105	100.0

	SHANNON	BRILLOUIN
DIVERSITY	3.22	2.92
MAXIMUM DIVERSITY	3.91	3.56
MINIMUM DIVERSITY	1.07	0.88
REDUNDANCY	0.24	0.24
EVENNESS	0.83	0.82
EQUITABILITY	0.48	0.55
SPECIES RICHNESS	2.74	2.37

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: VIII-5-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	57	45.2
2	38	30.2
3	9	7.1
4	8	6.3
5	6	4.8
6	3	2.4
7	2	1.6
8	1	0.8
9	1	0.8
10	1	0.8
TOTAL	126	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.16	2.00
MAXIMUM DIVERSITY	3.32	3.11
MINIMUM DIVERSITY	0.60	0.50
REDUNDANCY	0.43	0.42
EVENNESS	0.65	0.64
EQUITABILITY	0.31	0.36
SPECIES RICHNESS	1.85	1.64

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: VIII-5-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	101	31.3
2	62	19.2
3	35	10.8
4	32	9.9
5	24	7.4
6	9	2.8
7	8	2.5
8	8	2.5
9	7	2.2
10	7	2.2
11	7	2.2
12	6	1.9
13	5	1.5
14	3	0.9
15	2	0.6
16	2	0.6
17	1	0.3
18	1	0.3
19	1	0.3
20	1	0.3
21	1	0.3
TOTAL	323	100.0

	SHANNON	BRILLOUIN
DIVERSITY	3.19	3.03
MAXIMUM DIVERSITY	4.39	4.19
MINIMUM DIVERSITY	0.60	0.51
REDUNDANCY	0.32	0.32
EVENNESS	0.73	0.72
EQUITABILITY	0.38	0.44
SPECIES RICHNESS	2.81	2.59

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	24	47.1
2	22	43.1
3	2	3.9
4	2	3.9
5	1	2.0
TOTAL	51	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.51	1.35
MAXIMUM DIVERSITY	2.32	2.11
MINIMUM DIVERSITY	0.55	0.44
REDUNDANCY	0.46	0.45
EVENNESS	0.65	0.64
EQUITABILITY	0.27	0.31
SPECIES RICHNESS	1.25	1.04

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	6	26.1
2	5	21.7
3	4	17.4
4	3	13.0
5	2	8.7
6	1	4.3
7	1	4.3
8	1	4.3
TOTAL	23	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.73	2.17
MAXIMUM DIVERSITY	3.00	2.41
MINIMUM DIVERSITY	1.74	1.31
REDUNDANCY	0.24	0.22
EVENNESS	0.90	0.90
EQUITABILITY	0.60	0.67
SPECIES RICHNESS	2.11	1.50

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	19	48.7
2	16	41.0
3	2	5.1
4	1	2.6
5	1	2.6
TOTAL	39	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.52	1.33
MAXIMUM DIVERSITY	2.32	2.06
MINIMUM DIVERSITY	0.68	0.54
REDUNDANCY	0.49	0.48
EVENNESS	0.65	0.65
EQUITABILITY	0.29	0.34
SPECIES RICHNESS	1.24	0.99

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	6	40.0
2	5	33.3
3	3	20.0
4	1	6.7
TOTAL	15	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.78	1.42
MAXIMUM DIVERSITY	2.00	1.59
MINIMUM DIVERSITY	1.04	0.76
REDUNDANCY	0.23	0.21
EVENNESS	0.89	0.89
EQUITABILITY	0.46	0.53
SPECIES RICHNESS	1.33	0.89

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	26	63.4
2	4	9.8
3	3	7.3
4	3	7.3
5	1	2.4
6	1	2.4
7	1	2.4
8	1	2.4
9	1	2.4
TOTAL	41	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.95	1.62
MAXIMUM DIVERSITY	3.17	2.72
MINIMUM DIVERSITY	1.30	1.02
REDUNDANCY	0.65	0.65
EVENNESS	0.62	0.59
EQUITABILITY	0.36	0.40
SPECIES RICHNESS	1.59	1.22

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	10	55.6
2	3	16.7
3	2	11.1
4	1	5.6
5	1	5.6
6	1	5.6
TOTAL	18	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.95	1.51
MAXIMUM DIVERSITY	2.58	2.06
MINIMUM DIVERSITY	1.50	1.11
REDUNDANCY	0.58	0.58
EVENNESS	0.75	0.73
EQUITABILITY	0.47	0.52
SPECIES RICHNESS	1.48	0.99

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	91	48.7
2	53	28.3
3	12	6.4
4	8	4.3
5	7	3.7
6	6	3.2
7	3	1.6
8	2	1.1
9	2	1.1
10	2	1.1
11	1	0.5
TOTAL	187	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.15	2.02
MAXIMUM DIVERSITY	3.46	3.29
MINIMUM DIVERSITY	0.48	0.40
REDUNDANCY	0.44	0.44
EVENNESS	0.62	0.62
EQUITABILITY	0.29	0.33
SPECIES RICHNESS	1.87	1.69

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	10	45.5
2	7	31.8
3	2	9.1
4	2	9.1
5	1	4.5
TOTAL	22	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.87	1.54
MAXIMUM DIVERSITY	2.32	1.93
MINIMUM DIVERSITY	1.05	0.79
REDUNDANCY	0.35	0.34
EVENNESS	0.81	0.80
EQUITABILITY	0.42	0.48
SPECIES RICHNESS	1.45	1.05

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	10	41.7
2	6	25.0
3	3	12.5
4	2	8.3
5	1	4.2
6	1	4.2
7	1	4.2
TOTAL	24	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.27	1.84
MAXIMUM DIVERSITY	2.81	2.29
MINIMUM DIVERSITY	1.46	1.11
REDUNDANCY	0.40	0.38
EVENNESS	0.81	0.80
EQUITABILITY	0.50	0.56
SPECIES RICHNESS	1.78	1.28

RPT 2290.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	17	63.0
2	4	14.8
3	4	14.8
4	1	3.7
5	1	3.7
TOTAL	27	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.59	1.32
MAXIMUM DIVERSITY	2.32	1.98
MINIMUM DIVERSITY	0.90	0.69
REDUNDANCY	0.52	0.51
EVENNESS	0.68	0.67
EQUITABILITY	0.33	0.38
SPECIES RICHNESS	1.25	0.94

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	15	53.6
2	6	21.4
3	3	10.7
4	2	7.1
5	2	7.1
TOTAL	28	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.85	1.56
MAXIMUM DIVERSITY	2.32	1.99
MINIMUM DIVERSITY	0.88	0.68
REDUNDANCY	0.33	0.33
EVENNESS	0.80	0.78
EQUITABILITY	0.38	0.45
SPECIES RICHNESS	1.46	1.11

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	16	55.2
2	8	27.6
3	3	10.3
4	1	3.4
5	1	3.4
TOTAL	29	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.66	1.40
MAXIMUM DIVERSITY	2.32	2.00
MINIMUM DIVERSITY	0.85	0.66
REDUNDANCY	0.45	0.44
EVENNESS	0.71	0.70
EQUITABILITY	0.34	0.40
SPECIES RICHNESS	1.32	1.01

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	22	47.8
2	18	39.1
3	4	8.7
4	1	2.2
5	1	2.2
TOTAL	46	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.59	1.41
MAXIMUM DIVERSITY	2.32	2.09
MINIMUM DIVERSITY	0.60	0.48
REDUNDANCY	0.43	0.42
EVENNESS	0.68	0.67
EQUITABILITY	0.29	0.34
SPECIES RICHNESS	1.30	1.07

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	83	47.2
2	53	30.1
3	12	6.8
4	10	5.7
5	6	3.4
6	5	2.8
7	2	1.1
8	2	1.1
9	1	0.6
10	1	0.6
11	1	0.6
TOTAL	176	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.12	1.99
MAXIMUM DIVERSITY	3.46	3.28
MINIMUM DIVERSITY	0.50	0.42
REDUNDANCY	0.45	0.45
EVENNESS	0.61	0.61
EQUITABILITY	0.28	0.33
SPECIES RICHNESS	1.83	1.66

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	11	39.3
2	7	25.0
3	5	17.9
4	4	14.3
5	1	3.6
TOTAL	28	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.05	1.75
MAXIMUM DIVERSITY	2.32	1.99
MINIMUM DIVERSITY	0.88	0.68
REDUNDANCY	0.19	0.18
EVENNESS	0.88	0.88
EQUITABILITY	0.43	0.50
SPECIES RICHNESS	1.62	1.25

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	11	32.4
2	8	23.5
3	6	17.6
4	4	11.8
5	3	8.8
6	1	2.9
7	1	2.9
TOTAL	34	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.43	2.08
MAXIMUM DIVERSITY	2.81	2.40
MINIMUM DIVERSITY	1.13	0.88
REDUNDANCY	0.22	0.22
EVENNESS	0.87	0.86
EQUITABILITY	0.48	0.55
SPECIES RICHNESS	1.95	1.52

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	16	47.1
2	9	26.5
3	5	14.7
4	2	5.9
5	1	2.9
6	1	2.9
TOTAL	34	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.97	1.68
MAXIMUM DIVERSITY	2.58	2.24
MINIMUM DIVERSITY	0.94	0.74
REDUNDANCY	0.38	0.37
EVENNESS	0.76	0.75
EQUITABILITY	0.39	0.45
SPECIES RICHNESS	1.58	1.23

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	5	50.0
2	3	30.0
3	1	10.0
4	1	10.0
TOTAL	10	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.69	1.23
MAXIMUM DIVERSITY	2.00	1.46
MINIMUM DIVERSITY	1.36	0.95
REDUNDANCY	0.49	0.45
EVENNESS	0.84	0.84
EQUITABILITY	0.51	0.56
SPECIES RICHNESS	1.18	0.67

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	7	31.8
2	5	22.7
3	4	18.2
4	2	9.1
5	2	9.1
6	2	9.1
TOTAL	22	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.40	1.96
MAXIMUM DIVERSITY	2.58	2.11
MINIMUM DIVERSITY	1.30	0.98
REDUNDANCY	0.14	0.13
EVENNESS	0.93	0.93
EQUITABILITY	0.54	0.62
SPECIES RICHNESS	1.86	1.34

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	3	33.3
2	3	33.3
3	2	22.2
4	1	11.1
TOTAL	9	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.89	1.37
MAXIMUM DIVERSITY	2.00	1.43
MINIMUM DIVERSITY	1.45	1.00
REDUNDANCY	0.20	0.15
EVENNESS	0.95	0.95
EQUITABILITY	0.60	0.67
SPECIES RICHNESS	1.29	0.70

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: VIII-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	47	34.3
2	29	21.2
3	25	18.2
4	20	14.6
5	6	4.4
6	3	2.2
7	2	1.5
8	2	1.5
9	2	1.5
10	1	0.7
TOTAL	137	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.49	2.33
MAXIMUM DIVERSITY	3.32	3.12
MINIMUM DIVERSITY	0.56	0.46
REDUNDANCY	0.30	0.30
EVENNESS	0.75	0.75
EQUITABILITY	0.35	0.41
SPECIES RICHNESS	2.14	1.92

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: IX-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	87	42.6
2	44	21.6
3	24	11.8
4	16	7.8
5	13	6.4
6	12	5.9
7	3	1.5
8	2	1.0
9	1	0.5
10	1	0.5
11	1	0.5
TOTAL	204	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.41	2.29
MAXIMUM DIVERSITY	3.46	3.30
MINIMUM DIVERSITY	0.45	0.37
REDUNDANCY	0.35	0.34
EVENNESS	0.70	0.69
EQUITABILITY	0.31	0.37
SPECIES RICHNESS	2.10	1.92

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: IX-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	75	40.1
2	52	27.8
3	25	13.4
4	10	5.3
5	10	5.3
6	4	2.1
7	3	1.6
8	3	1.6
9	2	1.1
10	1	0.5
11	1	0.5
12	1	0.5
TOTAL	187	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.38	2.24
MAXIMUM DIVERSITY	3.58	3.40
MINIMUM DIVERSITY	0.53	0.44
REDUNDANCY	0.39	0.39
EVENNESS	0.66	0.66
EQUITABILITY	0.32	0.37
SPECIES RICHNESS	2.07	1.88

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: IX-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	130	51.6
2	38	15.1
3	31	12.3
4	16	6.3
5	10	4.0
6	10	4.0
7	5	2.0
8	5	2.0
9	2	0.8
10	2	0.8
11	1	0.4
12	1	0.4
13	1	0.4
TOTAL	252	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.33	2.21
MAXIMUM DIVERSITY	3.70	3.54
MINIMUM DIVERSITY	0.45	0.38
REDUNDANCY	0.42	0.42
EVENNESS	0.63	0.62
EQUITABILITY	0.29	0.34
SPECIES RICHNESS	2.04	1.87

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: IX-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	81	42.0
2	49	25.4
3	17	8.8
4	15	7.8
5	7	3.6
6	6	3.1
7	5	2.6
8	4	2.1
9	3	1.6
10	3	1.6
11	2	1.0
12	1	0.5
TOTAL	193	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.50	2.35
MAXIMUM DIVERSITY	3.59	3.40
MINIMUM DIVERSITY	0.51	0.43
REDUNDANCY	0.35	0.35
EVENNESS	0.70	0.69
EQUITABILITY	0.33	0.38
SPECIES RICHNESS	2.17	1.97

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: IX-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	80	64.0
2	18	14.4
3	9	7.2
4	6	4.8
5	5	4.0
6	3	2.4
7	1	0.8
8	1	0.8
9	1	0.8
10	1	0.8
TOTAL	125	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.84	1.68
MAXIMUM DIVERSITY	3.32	3.11
MINIMUM DIVERSITY	0.60	0.50
REDUNDANCY	0.55	0.55
EVENNESS	0.55	0.54
EQUITABILITY	0.26	0.30
SPECIES RICHNESS	1.57	1.38

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: IX-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	57	38.8
2	40	27.2
3	18	12.2
4	12	8.2
5	6	4.1
6	6	4.1
7	4	2.7
8	2	1.4
9	1	0.7
10	1	0.7
TOTAL	147	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.41	2.26
MAXIMUM DIVERSITY	3.32	3.13
MINIMUM DIVERSITY	0.53	0.44
REDUNDANCY	0.33	0.33
EVENNESS	0.72	0.72
EQUITABILITY	0.33	0.39
SPECIES RICHNESS	2.07	1.87

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: IX-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	510	46.0
2	219	19.8
3	132	11.9
4	60	5.4
5	56	5.1
6	34	3.1
7	25	2.3
8	23	2.1
9	19	1.7
10	8	0.7
11	7	0.6
12	6	0.5
13	4	0.4
14	2	0.2
15	2	0.2
16	1	0.1
TOTAL	1108	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.49	2.45
MAXIMUM DIVERSITY	4.00	3.94
MINIMUM DIVERSITY	0.16	0.14
REDUNDANCY	0.39	0.39
EVENNESS	0.62	0.62
EQUITABILITY	0.25	0.28
SPECIES RICHNESS	2.25	2.17

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	8	47.1
2	4	23.5
3	4	23.5
4	1	5.9
TOTAL	17	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.73	1.40
MAXIMUM DIVERSITY	2.00	1.63
MINIMUM DIVERSITY	0.95	0.71
REDUNDANCY	0.25	0.24
EVENNESS	0.87	0.86
EQUITABILITY	0.42	0.49
SPECIES RICHNESS	1.31	0.91

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	4	57.1
2	2	28.6
3	1	14.3
TOTAL	7	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.38	0.96
MAXIMUM DIVERSITY	1.58	1.10
MINIMUM DIVERSITY	1.15	0.77
REDUNDANCY	0.47	0.43
EVENNESS	0.87	0.87
EQUITABILITY	0.49	0.55
SPECIES RICHNESS	0.89	0.41

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	14	51.9
2	9	33.3
3	1	3.7
4	1	3.7
5	1	3.7
6	1	3.7
TOTAL	27	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.72	1.42
MAXIMUM DIVERSITY	2.58	2.17
MINIMUM DIVERSITY	1.12	0.86
REDUNDANCY	0.59	0.57
EVENNESS	0.67	0.65
EQUITABILITY	0.36	0.41
SPECIES RICHNESS	1.36	1.01

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	20	55.6
2	7	19.4
3	5	13.9
4	2	5.6
5	1	2.8
6	1	2.8
TOTAL	36	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.84	1.58
MAXIMUM DIVERSITY	2.58	2.25
MINIMUM DIVERSITY	0.90	0.71
REDUNDANCY	0.44	0.44
EVENNESS	0.71	0.70
EQUITABILITY	0.36	0.41
SPECIES RICHNESS	1.49	1.17

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	38	62.3
2	9	14.8
3	5	8.2
4	4	6.6
5	2	3.3
6	1	1.6
7	1	1.6
8	1	1.6
TOTAL	61	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.84	1.62
MAXIMUM DIVERSITY	3.00	2.70
MINIMUM DIVERSITY	0.84	0.67
REDUNDANCY	0.54	0.53
EVENNESS	0.61	0.60
EQUITABILITY	0.31	0.35
SPECIES RICHNESS	1.53	1.26

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	35	49.3
2	24	33.8
3	4	5.6
4	3	4.2
5	2	2.8
6	1	1.4
7	1	1.4
8	1	1.4
TOTAL	71	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.86	1.67
MAXIMUM DIVERSITY	3.00	2.73
MINIMUM DIVERSITY	0.74	0.60
REDUNDANCY	0.50	0.50
EVENNESS	0.62	0.61
EQUITABILITY	0.30	0.35
SPECIES RICHNESS	1.56	1.32

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	114	52.1
2	41	18.7
3	32	14.6
4	8	3.7
5	7	3.2
6	7	3.2
7	4	1.8
8	3	1.4
9	1	0.5
10	1	0.5
11	1	0.5
TOTAL	219	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.14	2.02
MAXIMUM DIVERSITY	3.46	3.31
MINIMUM DIVERSITY	0.42	0.35
REDUNDANCY	0.43	0.43
EVENNESS	0.62	0.61
EQUITABILITY	0.27	0.32
SPECIES RICHNESS	1.86	1.71

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	8	44.4
2	7	38.9
3	1	5.6
4	1	5.6
5	1	5.6
TOTAL	18	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.74	1.38
MAXIMUM DIVERSITY	2.32	1.87
MINIMUM DIVERSITY	1.21	0.90
REDUNDANCY	0.52	0.50
EVENNESS	0.75	0.74
EQUITABILITY	0.42	0.47
SPECIES RICHNESS	1.33	0.91

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	17	56.7
2	6	20.0
3	3	10.0
4	2	6.7
5	1	3.3
6	1	3.3
TOTAL	30	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.85	1.54
MAXIMUM DIVERSITY	2.58	2.21
MINIMUM DIVERSITY	1.04	0.80
REDUNDANCY	0.48	0.47
EVENNESS	0.72	0.70
EQUITABILITY	0.38	0.43
SPECIES RICHNESS	1.47	1.11

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	4	50.0
2	2	25.0
3	1	12.5
4	1	12.5
TOTAL	8	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.75	1.21
MAXIMUM DIVERSITY	2.00	1.41
MINIMUM DIVERSITY	1.55	1.05
REDUNDANCY	0.55	0.55
EVENNESS	0.87	0.86
EQUITABILITY	0.58	0.63
SPECIES RICHNESS	1.17	0.58

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	14	82.4
2	2	11.8
3	1	5.9
TOTAL	17	100.0

	SHANNON	BRILLOUIN
DIVERSITY	0.83	0.65
MAXIMUM DIVERSITY	1.58	1.32
MINIMUM DIVERSITY	0.64	0.48
REDUNDANCY	0.79	0.80
EVENNESS	0.53	0.49
EQUITABILITY	0.20	0.23
SPECIES RICHNESS	0.63	0.42

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	2	50.0
2	1	25.0
3	1	25.0
TOTAL	4	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.50	0.90
MAXIMUM DIVERSITY	1.58	0.90
MINIMUM DIVERSITY	1.50	0.90
REDUNDANCY	1.00	1.75
EVENNESS	0.95	1.00
EQUITABILITY	0.75	0.78
SPECIES RICHNESS	0.75	0.11

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	13	61.9
2	4	19.0
3	3	14.3
4	1	4.8
TOTAL	21	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.49	1.23
MAXIMUM DIVERSITY	2.00	1.68
MINIMUM DIVERSITY	0.82	0.62
REDUNDANCY	0.43	0.43
EVENNESS	0.75	0.73
EQUITABILITY	0.34	0.39
SPECIES RICHNESS	1.15	0.83

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	56	57.1
2	18	18.4
3	5	5.1
4	5	5.1
5	4	4.1
6	4	4.1
7	2	2.0
8	2	2.0
9	1	1.0
10	1	1.0
TOTAL	98	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.09	1.89
MAXIMUM DIVERSITY	3.32	3.06
MINIMUM DIVERSITY	0.73	0.60
REDUNDANCY	0.48	0.48
EVENNESS	0.63	0.62
EQUITABILITY	0.32	0.36
SPECIES RICHNESS	1.77	1.53

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	4	44.4
2	3	33.3
3	2	22.2
TOTAL	9	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.53	1.14
MAXIMUM DIVERSITY	1.58	1.19
MINIMUM DIVERSITY	0.99	0.69
REDUNDANCY	0.09	0.09
EVENNESS	0.97	0.96
EQUITABILITY	0.48	0.56
SPECIES RICHNESS	1.05	0.59

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	5	29.4
2	5	29.4
3	3	17.6
4	2	11.8
5	1	5.9
6	1	5.9
TOTAL	17	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.32	1.82
MAXIMUM DIVERSITY	2.58	2.02
MINIMUM DIVERSITY	1.56	1.15
REDUNDANCY	0.25	0.23
EVENNESS	0.90	0.90
EQUITABILITY	0.57	0.64
SPECIES RICHNESS	1.76	1.18

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	7	77.8
2	1	11.1
3	1	11.1
TOTAL	9	100.0

	SHANNON	BRILLOUIN
DIVERSITY	0.99	0.69
MAXIMUM DIVERSITY	1.58	1.19
MINIMUM DIVERSITY	0.99	0.69
REDUNDANCY	1.00	1.00
EVENNESS	0.62	0.58
EQUITABILITY	0.31	0.33
SPECIES RICHNESS	0.68	0.35

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	7	58.3
2	2	16.7
3	2	16.7
4	1	8.3
TOTAL	12	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.61	1.21
MAXIMUM DIVERSITY	2.00	1.54
MINIMUM DIVERSITY	1.21	0.86
REDUNDANCY	0.49	0.49
EVENNESS	0.81	0.79
EQUITABILITY	0.45	0.50
SPECIES RICHNESS	1.16	0.71

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	1	50.0
2	1	50.0
TOTAL	2	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.00	0.50
MAXIMUM DIVERSITY	1.00	0.50
MINIMUM DIVERSITY	1.00	0.50
REDUNDANCY	~~1.24~~ 0	~~1.99~~ 0
EVENNESS	1.00	1.00
EQUITABILITY	1.00	1.00
SPECIES RICHNESS	0.00	-0.50

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	10	41.7
2	5	20.8
3	5	20.8
4	1	4.2
5	1	4.2
6	1	4.2
7	1	4.2
TOTAL	24	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.23	1.81
MAXIMUM DIVERSITY	2.81	2.29
MINIMUM DIVERSITY	1.46	1.11
REDUNDANCY	0.43	0.41
EVENNESS	0.80	0.79
EQUITABILITY	0.49	0.55
SPECIES RICHNESS	1.75	1.26

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: IX-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	34	46.6
2	14	19.2
3	7	9.6
4	5	6.8
5	4	5.5
6	3	4.1
7	3	4.1
8	1	1.4
9	1	1.4
10	1	1.4
TOTAL	73	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.42	2.16
MAXIMUM DIVERSITY	3.32	3.00
MINIMUM DIVERSITY	0.93	0.75
REDUNDANCY	0.38	0.37
EVENNESS	0.73	0.72
EQUITABILITY	0.39	0.45
SPECIES RICHNESS	2.03	1.71

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: X-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	31	40.3
2	21	27.3
3	13	16.9
4	4	5.2
5	2	2.6
6	2	2.6
7	1	1.3
8	1	1.3
9	1	1.3
10	1	1.3
TOTAL	77	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.29	2.06
MAXIMUM DIVERSITY	3.32	3.01
MINIMUM DIVERSITY	0.89	0.72
REDUNDANCY	0.42	0.42
EVENNESS	0.69	0.68
EQUITABILITY	0.37	0.42
SPECIES RICHNESS	1.93	1.64

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: X-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	46	41.8
2	38	34.5
3	8	7.3
4	8	7.3
5	4	3.6
6	2	1.8
7	2	1.8
8	1	0.9
9	1	0.9
TOTAL	110	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.11	1.95
MAXIMUM DIVERSITY	3.17	2.96
MINIMUM DIVERSITY	0.59	0.49
REDUNDANCY	0.41	0.41
EVENNESS	0.67	0.66
EQUITABILITY	0.31	0.36
SPECIES RICHNESS	1.80	1.59

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: X-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	78	58.2
2	40	29.9
3	5	3.7
4	4	3.0
5	3	2.2
6	2	1.5
7	1	0.7
8	1	0.7
TOTAL	134	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.62	1.51
MAXIMUM DIVERSITY	3.00	2.83
MINIMUM DIVERSITY	0.44	0.37
REDUNDANCY	0.54	0.54
EVENNESS	0.54	0.53
EQUITABILITY	0.23	0.27
SPECIES RICHNESS	1.39	1.24

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: X-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	28	34.6
2	24	29.6
3	13	16.0
4	8	9.9
5	3	3.7
6	2	2.5
7	2	2.5
8	1	1.2
TOTAL	81	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.32	2.12
MAXIMUM DIVERSITY	3.00	2.76
MINIMUM DIVERSITY	0.67	0.54
REDUNDANCY	0.29	0.29
EVENNESS	0.77	0.77
EQUITABILITY	0.37	0.43
SPECIES RICHNESS	1.96	1.69

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: X-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	27	38.6
2	14	20.0
3	12	17.1
4	6	8.6
5	3	4.3
6	3	4.3
7	1	1.4
8	1	1.4
9	1	1.4
10	1	1.4
11	1	1.4
TOTAL	70	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.56	2.28
MAXIMUM DIVERSITY	3.46	3.10
MINIMUM DIVERSITY	1.07	0.86
REDUNDANCY	0.38	0.37
EVENNESS	0.74	0.74
EQUITABILITY	0.42	0.48
SPECIES RICHNESS	2.14	1.80

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: X-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	34	45.9
2	19	25.7
3	12	16.2
4	4	5.4
5	2	2.7
6	1	1.4
7	1	1.4
8	1	1.4
TOTAL	74	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.06	1.87
MAXIMUM DIVERSITY	3.00	2.74
MINIMUM DIVERSITY	0.72	0.58
REDUNDANCY	0.41	0.40
EVENNESS	0.69	0.68
EQUITABILITY	0.33	0.39
SPECIES RICHNESS	1.73	1.48

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: X-8-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	215	39.4
2	121	22.2
3	106	19.4
4	52	9.5
5	11	2.0
6	10	1.8
7	8	1.5
8	5	0.9
9	4	0.7
10	3	0.5
11	3	0.5
12	2	0.4
13	2	0.4
14	1	0.2
15	1	0.2
16	1	0.2
17	1	0.2
TOTAL	546	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.42	2.35
MAXIMUM DIVERSITY	4.09	3.98
MINIMUM DIVERSITY	0.31	0.27
REDUNDANCY	0.44	0.44
EVENNESS	0.59	0.59
EQUITABILITY	0.27	0.31
SPECIES RICHNESS	2.16	2.04

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	74	63.8
2	15	12.9
3	8	6.9
4	8	6.9
5	4	3.4
6	2	1.7
7	2	1.7
8	2	1.7
9	1	0.9
TOTAL	116	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.86	1.70
MAXIMUM DIVERSITY	3.17	2.96
MINIMUM DIVERSITY	0.57	0.47
REDUNDANCY	0.50	0.51
EVENNESS	0.59	0.57
EQUITABILITY	0.27	0.31
SPECIES RICHNESS	1.59	1.39

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	22	48.9
2	11	24.4
3	6	13.3
4	3	6.7
5	2	4.4
6	1	2.2
TOTAL	45	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.97	1.73
MAXIMUM DIVERSITY	2.58	2.30
MINIMUM DIVERSITY	0.76	0.60
REDUNDANCY	0.34	0.33
EVENNESS	0.76	0.75
EQUITABILITY	0.36	0.42
SPECIES RICHNESS	1.61	1.32

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	38	44.2
2	22	25.6
3	11	12.8
4	8	9.3
5	4	4.7
6	2	2.3
7	1	1.2
TOTAL	86	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.13	1.96
MAXIMUM DIVERSITY	2.81	2.60
MINIMUM DIVERSITY	0.55	0.45
REDUNDANCY	0.30	0.30
EVENNESS	0.76	0.75
EQUITABILITY	0.33	0.39
SPECIES RICHNESS	1.80	1.57

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	46	61.3
2	7	9.3
3	7	9.3
4	5	6.7
5	4	5.3
6	4	5.3
7	2	2.7
TOTAL	75	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.92	1.73
MAXIMUM DIVERSITY	2.81	2.58
MINIMUM DIVERSITY	0.61	0.49
REDUNDANCY	0.40	0.41
EVENNESS	0.68	0.67
EQUITABILITY	0.31	0.36
SPECIES RICHNESS	1.61	1.37

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	15	41.7
2	12	33.3
3	3	8.3
4	2	5.6
5	2	5.6
6	1	2.8
7	1	2.8
TOTAL	36	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.10	1.79
MAXIMUM DIVERSITY	2.81	2.42
MINIMUM DIVERSITY	1.08	0.84
REDUNDANCY	0.41	0.40
EVENNESS	0.75	0.74
EQUITABILITY	0.41	0.47
SPECIES RICHNESS	1.70	1.32

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	19	63.3
2	5	16.7
3	3	10.0
4	1	3.3
5	1	3.3
6	1	3.3
TOTAL	30	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.67	1.38
MAXIMUM DIVERSITY	2.58	2.21
MINIMUM DIVERSITY	1.04	0.80
REDUNDANCY	0.59	0.59
EVENNESS	0.65	0.63
EQUITABILITY	0.34	0.38
SPECIES RICHNESS	1.33	1.00

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2202.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	184	47.4
2	77	19.8
3	50	12.9
4	33	8.5
5	18	4.6
6	9	2.3
7	8	2.1
8	7	1.8
9	1	0.3
10	1	0.3
TOTAL	388	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.25	2.18
MAXIMUM DIVERSITY	3.32	3.23
MINIMUM DIVERSITY	0.23	0.20
REDUNDANCY	0.35	0.35
EVENNESS	0.68	0.68
EQUITABILITY	0.26	0.30
SPECIES RICHNESS	1.99	1.88

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	45	28.8
2	38	24.4
3	29	18.6
4	25	16.0
5	9	5.8
6	6	3.8
7	1	0.6
8	1	0.6
9	1	0.6
10	1	0.6
TOTAL	156	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.49	2.35
MAXIMUM DIVERSITY	3.32	3.14
MINIMUM DIVERSITY	0.50	0.42
REDUNDANCY	0.29	0.29
EVENNESS	0.75	0.75
EQUITABILITY	0.34	0.40
SPECIES RICHNESS	2.15	1.95

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	9	39.1
2	6	26.1
3	3	13.0
4	2	8.7
5	1	4.3
6	1	4.3
7	1	4.3
TOTAL	23	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.32	1.87
MAXIMUM DIVERSITY	2.81	2.28
MINIMUM DIVERSITY	1.50	1.14
REDUNDANCY	0.38	0.36
EVENNESS	0.82	0.82
EQUITABILITY	0.51	0.58
SPECIES RICHNESS	1.80	1.29

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	30	46.9
2	15	23.4
3	10	15.6
4	8	12.5
5	1	1.6
TOTAL	64	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.89	1.73
MAXIMUM DIVERSITY	2.32	2.14
MINIMUM DIVERSITY	0.46	0.37
REDUNDANCY	0.23	0.23
EVENNESS	0.81	0.81
EQUITABILITY	0.32	0.37
SPECIES RICHNESS	1.58	1.36

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	26	68.4
2	5	13.2
3	3	7.9
4	2	5.3
5	2	5.3
TOTAL	38	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.50	1.28
MAXIMUM DIVERSITY	2.32	2.05
MINIMUM DIVERSITY	0.70	0.55
REDUNDANCY	0.51	0.51
EVENNESS	0.64	0.62
EQUITABILITY	0.29	0.33
SPECIES RICHNESS	1.21	0.95

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	11	34.4
2	9	28.1
3	5	15.6
4	4	12.5
5	1	3.1
6	1	3.1
7	1	3.1
TOTAL	32	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.31	1.95
MAXIMUM DIVERSITY	2.81	2.38
MINIMUM DIVERSITY	1.18	0.92
REDUNDANCY	0.31	0.29
EVENNESS	0.82	0.82
EQUITABILITY	0.46	0.53
SPECIES RICHNESS	1.85	1.42

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	48	37.5
2	45	35.2
3	22	17.2
4	7	5.5
5	4	3.1
6	2	1.6
TOTAL	128	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.98	1.87
MAXIMUM DIVERSITY	2.58	2.46
MINIMUM DIVERSITY	0.33	0.27
REDUNDANCY	0.27	0.27
EVENNESS	0.76	0.76
EQUITABILITY	0.28	0.33
SPECIES RICHNESS	1.69	1.53

MONTANA DEPARTMENT OF FISH AND GAME

QPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	131	29.7
2	129	29.3
3	79	17.9
4	68	15.4
5	12	2.7
6	12	2.7
7	3	0.7
8	2	0.5
9	1	0.2
10	1	0.2
11	1	0.2
12	1	0.2
13	1	0.2
TOTAL	441	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.37	2.30
MAXIMUM DIVERSITY	3.70	3.60
MINIMUM DIVERSITY	0.28	0.24
REDUNDANCY	0.39	0.39
EVENNESS	0.64	0.64
EQUITABILITY	0.27	0.31
SPECIES RICHNESS	2.10	1.99

MONTANA DEPARTMENT OF FISH AND GAME

PRT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	16	50.0
2	7	21.9
3	4	12.5
4	2	6.3
5	1	3.1
6	1	3.1
7	1	3.1
TOTAL	32	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.07	1.74
MAXIMUM DIVERSITY	2.81	2.38
MINIMUM DIVERSITY	1.18	0.92
REDUNDANCY	0.45	0.44
EVENNESS	0.74	0.73
EQUITABILITY	0.41	0.47
SPECIES RICHNESS	1.66	1.26

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2202.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	13	39.4
2	11	33.3
3	6	18.2
4	2	6.1
5	1	3.0
TOTAL	33	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.90	1.65
MAXIMUM DIVERSITY	2.32	2.03
MINIMUM DIVERSITY	0.78	0.60
REDUNDANCY	0.27	0.26
EVENNESS	0.82	0.81
EQUITABILITY	0.38	0.44
SPECIES RICHNESS	1.53	1.21

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	28	41.2
2	21	30.9
3	7	10.3
4	5	7.4
5	3	4.4
6	2	2.9
7	1	1.5
8	1	1.5
TOTAL	68	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.19	1.97
MAXIMUM DIVERSITY	3.00	2.72
MINIMUM DIVERSITY	0.77	0.62
REDUNDANCY	0.36	0.36
EVENNESS	0.73	0.72
EQUITABILITY	0.36	0.42
SPECIES RICHNESS	1.83	1.55

RPT 2220.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	25	37.3
2	17	25.4
3	10	14.9
4	8	11.9
5	3	4.5
6	3	4.5
7	1	1.5
TOTAL	67	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.30	2.09
MAXIMUM DIVERSITY	2.81	2.56
MINIMUM DIVERSITY	0.67	0.54
REDUNDANCY	0.24	0.23
EVENNESS	0.82	0.82
EQUITABILITY	0.38	0.45
SPECIES RICHNESS	1.92	1.64

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2290.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	84	56.8
2	24	16.2
3	14	9.5
4	11	7.4
5	4	2.7
6	2	1.4
7	2	1.4
8	2	1.4
9	2	1.4
10	1	0.7
11	1	0.7
12	1	0.7
TOTAL	148	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.11	1.95
MAXIMUM DIVERSITY	3.58	3.36
MINIMUM DIVERSITY	0.64	0.53
REDUNDANCY	0.50	0.50
EVENNESS	0.59	0.58
EQUITABILITY	0.29	0.34
SPECIES RICHNESS	1.82	1.62

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	19	36.5
2	16	30.8
3	6	11.5
4	4	7.7
5	2	3.8
6	2	3.8
7	1	1.9
8	1	1.9
9	1	1.9
TOTAL	52	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.39	2.09
MAXIMUM DIVERSITY	3.17	2.79
MINIMUM DIVERSITY	1.08	0.86
REDUNDANCY	0.37	0.37
EVENNESS	0.75	0.75
EQUITABILITY	0.42	0.48
SPECIES RICHNESS	1.97	1.61

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: X-9-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	175	43.8
2	106	26.5
3	36	9.0
4	29	7.2
5	24	6.0
6	9	2.2
7	8	2.0
8	4	1.0
9	3	0.7
10	2	0.5
11	2	0.5
12	1	0.2
13	1	0.2
TOTAL	400	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.34	2.25
MAXIMUM DIVERSITY	3.70	3.59
MINIMUM DIVERSITY	0.30	0.26
REDUNDANCY	0.40	0.40
EVENNESS	0.63	0.63
EQUITABILITY	0.27	0.31
SPECIES RICHNESS	2.07	1.94

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: CORWIN SPRINGS

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: XI-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	190	38.0
2	112	22.4
3	83	16.6
4	49	9.8
5	35	7.0
6	8	1.6
7	6	1.2
8	4	0.8
9	3	0.6
10	2	0.4
11	2	0.4
12	2	0.4
13	2	0.4
14	1	0.2
15	1	0.2
TOTAL	500	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.48	2.40
MAXIMUM DIVERSITY	3.91	3.80
MINIMUM DIVERSITY	0.29	0.25
REDUNDANCY	0.40	0.39
EVENNESS	0.63	0.63
EQUITABILITY	0.28	0.32
SPECIES RICHNESS	2.20	2.08

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: CORWIN SPRINGS

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: XI-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	133	33.8
2	91	23.2
3	56	14.2
4	48	12.2
5	30	7.6
6	16	4.1
7	7	1.8
8	2	0.5
9	2	0.5
10	2	0.5
11	2	0.5
12	1	0.3
13	1	0.3
14	1	0.3
15	1	0.3
TOTAL	393	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.61	2.52
MAXIMUM DIVERSITY	3.91	3.78
MINIMUM DIVERSITY	0.36	0.31
REDUNDANCY	0.37	0.36
EVENNESS	0.67	0.67
EQUITABILITY	0.30	0.35
SPECIES RICHNESS	2.30	2.17

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: CORWIN SPRINGS

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: XI-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	125	25.4
2	118	24.0
3	75	15.2
4	59	12.0
5	47	9.6
6	21	4.3
7	20	4.1
8	5	1.0
9	5	1.0
10	4	0.8
11	4	0.8
12	3	0.6
13	2	0.4
14	2	0.4
15	1	0.2
16	1	0.2
TOTAL	492	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.88	2.79
MAXIMUM DIVERSITY	4.00	3.89
MINIMUM DIVERSITY	0.32	0.27
REDUNDANCY	0.31	0.30
EVENNESS	0.72	0.72
EQUITABILITY	0.32	0.37
SPECIES RICHNESS	2.55	2.42

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: CORWIN SPRINGS

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: XI-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	653	59.9
2	186	17.1
3	91	8.3
4	48	4.4
5	30	2.8
6	24	2.2
7	21	1.9
8	10	0.9
9	9	0.8
10	4	0.4
11	4	0.4
12	2	0.2
13	2	0.2
14	2	0.2
15	2	0.2
16	1	0.1
17	1	0.1
TOTAL	1090	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.01	1.97
MAXIMUM DIVERSITY	4.09	4.03
MINIMUM DIVERSITY	0.17	0.15
REDUNDANCY	0.53	0.53
EVENNESS	0.49	0.49
EQUITABILITY	0.20	0.23
SPECIES RICHNESS	1.81	1.74

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: CORWIN SPRINGS

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: XI-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	998	40.3
2	507	20.5
3	281	11.4
4	250	10.1
5	176	7.1
6	74	3.0
7	61	2.5
8	30	1.2
9	17	0.7
10	13	0.5
11	12	0.5
12	11	0.4
13	10	0.4
14	9	0.4
15	4	0.2
16	4	0.2
17	4	0.2
18	3	0.1
19	3	0.1
20	3	0.1
21	2	0.1
22	1	0.0
23	1	0.0
24	1	0.0
TOTAL	2475	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.64	2.61
MAXIMUM DIVERSITY	4.58	4.54
MINIMUM DIVERSITY	0.12	0.10
REDUNDANCY	0.43	0.43
EVENNESS	0.58	0.58
EQUITABILITY	0.23	0.27
SPECIES RICHNESS	2.41	2.35

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: LIVINGSTON

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: XI-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	201	35.6
2	90	15.9
3	83	14.7
4	74	13.1
5	30	5.3
6	28	5.0
7	18	3.2
8	10	1.8
9	9	1.6
10	7	1.2
11	6	1.1
12	3	0.5
13	2	0.4
14	2	0.4
15	1	0.2
16	1	0.2
TOTAL	565	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.82	2.74
MAXIMUM DIVERSITY	4.00	3.90
MINIMUM DIVERSITY	0.28	0.24
REDUNDANCY	0.32	0.32
EVENNESS	0.70	0.70
EQUITABILITY	0.31	0.36
SPECIES RICHNESS	2.51	2.38

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: LIVINGSTON

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: XI-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	212	44.7
2	125	26.4
3	77	16.2
4	15	3.2
5	15	3.2
6	11	2.3
7	6	1.3
8	5	1.1
9	2	0.4
10	2	0.4
11	2	0.4
12	1	0.2
13	1	0.2
TOTAL	474	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.18	2.11
MAXIMUM DIVERSITY	3.70	3.60
MINIMUM DIVERSITY	0.26	0.22
REDUNDANCY	0.44	0.44
EVENNESS	0.59	0.59
EQUITABILITY	0.25	0.28
SPECIES RICHNESS	1.93	1.83

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: LIVINGSTON

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: XI-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	157	36.4
2	96	22.3
3	61	14.2
4	53	12.3
5	14	3.2
6	11	2.6
7	8	1.9
8	7	1.6
9	5	1.2
10	4	0.9
11	4	0.9
12	3	0.7
13	2	0.5
14	1	0.2
15	1	0.2
16	1	0.2
17	1	0.2
18	1	0.2
19	1	0.2
TOTAL	431	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.69	2.59
MAXIMUM DIVERSITY	4.25	4.10
MINIMUM DIVERSITY	0.42	0.36
REDUNDANCY	0.41	0.41
EVENNESS	0.63	0.63
EQUITABILITY	0.31	0.35
SPECIES RICHNESS	2.38	2.23

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: LIVINGSTON

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: XI-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	421	41.0
2	221	21.5
3	113	11.0
4	60	5.8
5	42	4.1
6	37	3.6
7	30	2.9
8	29	2.8
9	24	2.3
10	14	1.4
11	13	1.3
12	7	0.7
13	5	0.5
14	3	0.3
15	2	0.2
16	2	0.2
17	2	0.2
18	1	0.1
TOTAL	1026	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.72	2.66
MAXIMUM DIVERSITY	4.17	4.10
MINIMUM DIVERSITY	0.19	0.17
REDUNDANCY	0.37	0.37
EVENNESS	0.65	0.65
EQUITABILITY	0.27	0.31
SPECIES RICHNESS	2.44	2.35

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: LIVINGSTON

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: XI-7-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	732	29.3
2	683	27.4
3	434	17.4
4	154	6.2
5	130	5.2
6	85	3.4
7	60	2.4
8	50	2.0
9	42	1.7
10	39	1.6
11	30	1.2
12	15	0.6
13	10	0.4
14	9	0.4
15	5	0.2
16	3	0.1
17	3	0.1
18	3	0.1
19	3	0.1
20	2	0.1
21	2	0.1
22	1	0.0
23	1	0.0
TOTAL	2496	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.81	2.78
MAXIMUM DIVERSITY	4.52	4.48
MINIMUM DIVERSITY	0.11	0.10
REDUNDANCY	0.39	0.39
EVENNESS	0.62	0.62
EQUITABILITY	0.25	0.28
SPECIES RICHNESS	2.56	2.50

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2220.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	49	52.1
2	22	23.4
3	15	16.0
4	3	3.2
5	2	2.1
6	1	1.1
7	1	1.1
8	1	1.1
TOTAL	94	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.89	1.73
MAXIMUM DIVERSITY	3.00	2.78
MINIMUM DIVERSITY	0.59	0.48
REDUNDANCY	0.46	0.46
EVENNESS	0.63	0.62
EQUITABILITY	0.29	0.34
SPECIES RICHNESS	1.60	1.40

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	45	61.6
2	20	27.4
3	3	4.1
4	2	2.7
5	1	1.4
6	1	1.4
7	1	1.4
TOTAL	73	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.53	1.37
MAXIMUM DIVERSITY	2.81	2.58
MINIMUM DIVERSITY	0.62	0.50
REDUNDANCY	0.59	0.58
EVENNESS	0.54	0.53
EQUITABILITY	0.25	0.28
SPECIES RICHNESS	1.28	1.09

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	23	69.7
2	4	12.1
3	3	9.1
4	2	6.1
5	1	3.0
TOTAL	33	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.44	1.21
MAXIMUM DIVERSITY	2.32	2.03
MINIMUM DIVERSITY	0.78	0.60
REDUNDANCY	0.57	0.57
EVENNESS	0.62	0.60
EQUITABILITY	0.29	0.33
SPECIES RICHNESS	1.16	0.89

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	47	43.1
2	40	36.7
3	9	8.3
4	5	4.6
5	4	3.7
6	2	1.8
7	1	0.9
8	1	0.9
TOTAL	109	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.96	1.81
MAXIMUM DIVERSITY	3.00	2.81
MINIMUM DIVERSITY	0.52	0.43
REDUNDANCY	0.42	0.42
EVENNESS	0.65	0.65
EQUITABILITY	0.29	0.34
SPECIES RICHNESS	1.67	1.48

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	32	71.1
2	7	15.6
3	2	4.4
4	2	4.4
5	1	2.2
6	1	2.2
TOTAL	45	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.41	1.21
MAXIMUM DIVERSITY	2.58	2.30
MINIMUM DIVERSITY	0.76	0.60
REDUNDANCY	0.64	0.64
EVENNESS	0.55	0.52
EQUITABILITY	0.26	0.29
SPECIES RICHNESS	1.15	0.92

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	29	46.0
2	17	27.0
3	5	7.9
4	4	6.3
5	4	6.3
6	4	6.3
TOTAL	63	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.07	1.88
MAXIMUM DIVERSITY	2.58	2.36
MINIMUM DIVERSITY	0.58	0.47
REDUNDANCY	0.26	0.26
EVENNESS	0.80	0.79
EQUITABILITY	0.35	0.41
SPECIES RICHNESS	1.73	1.47

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: MILES CITY

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	225	54.0
2	98	23.5
3	38	9.1
4	26	6.2
5	10	2.4
6	6	1.4
7	4	1.0
8	4	1.0
9	2	0.5
10	1	0.2
11	1	0.2
12	1	0.2
13	1	0.2
TOTAL	417	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.00	1.93
MAXIMUM DIVERSITY	3.70	3.59
MINIMUM DIVERSITY	0.29	0.25
REDUNDANCY	0.50	0.50
EVENNESS	0.54	0.54
EQUITABILITY	0.23	0.27
SPECIES RICHNESS	1.77	1.67

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2220.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	36	65.5
2	14	25.5
3	2	3.6
4	1	1.8
5	1	1.8
6	1	1.8
TOTAL	55	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.39	1.23
MAXIMUM DIVERSITY	2.58	2.34
MINIMUM DIVERSITY	0.65	0.52
REDUNDANCY	0.62	0.61
EVENNESS	0.54	0.52
EQUITABILITY	0.24	0.28
SPECIES RICHNESS	1.15	0.95

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	39	67.2
2	16	27.6
3	1	1.7
4	1	1.7
5	1	1.7
TOTAL	58	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.20	1.07
MAXIMUM DIVERSITY	2.32	2.13
MINIMUM DIVERSITY	0.50	0.40
REDUNDANCY	0.62	0.61
EVENNESS	0.52	0.50
EQUITABILITY	0.20	0.24
SPECIES RICHNESS	1.00	0.83

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	33	31.1
2	32	30.2
3	16	15.1
4	12	11.3
5	5	4.7
6	4	3.8
7	1	0.9
8	1	0.9
9	1	0.9
10	1	0.9
TOTAL	106	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.45	2.26
MAXIMUM DIVERSITY	3.32	3.08
MINIMUM DIVERSITY	0.69	0.57
REDUNDANCY	0.33	0.32
EVENNESS	0.74	0.74
EQUITABILITY	0.36	0.42
SPECIES RICHNESS	2.09	1.84

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	50	69.4
2	15	20.8
3	3	4.2
4	2	2.8
5	1	1.4
6	1	1.4
TOTAL	72	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.34	1.20
MAXIMUM DIVERSITY	2.58	2.39
MINIMUM DIVERSITY	0.53	0.43
REDUNDANCY	0.60	0.60
EVENNESS	0.52	0.50
EQUITABILITY	0.22	0.25
SPECIES RICHNESS	1.13	0.95

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1

SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	73	85.9
2	7	8.2
3	2	2.4
4	1	1.2
5	1	1.2
6	1	1.2
TOTAL	85	100.0

	SHANNON	BRILLOUIN
DIVERSITY	0.84	0.73
MAXIMUM DIVERSITY	2.58	2.41
MINIMUM DIVERSITY	0.46	0.37
REDUNDANCY	0.82	0.82
EVENNESS	0.32	0.30
EQUITABILITY	0.13	0.15
SPECIES RICHNESS	0.71	0.59

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	78	41.5
2	43	22.9
3	41	21.8
4	10	5.3
5	7	3.7
6	6	3.2
7	1	0.5
8	1	0.5
9	1	0.5
TOTAL	188	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.17	2.07
MAXIMUM DIVERSITY	3.17	3.03
MINIMUM DIVERSITY	0.38	0.32
REDUNDANCY	0.36	0.36
EVENNESS	0.69	0.68
EQUITABILITY	0.29	0.34
SPECIES RICHNESS	1.89	1.73

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: GLENDIVE

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: XI-10-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	271	48.0
2	116	20.6
3	111	19.7
4	20	3.5
5	17	3.0
6	15	2.7
7	3	0.5
8	2	0.4
9	2	0.4
10	1	0.2
11	1	0.2
12	1	0.2
13	1	0.2
14	1	0.2
15	1	0.2
16	1	0.2
TOTAL	564	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.11	2.05
MAXIMUM DIVERSITY	4.00	3.90
MINIMUM DIVERSITY	0.28	0.24
REDUNDANCY	0.51	0.51
EVENNESS	0.53	0.53
EQUITABILITY	0.23	0.27
SPECIES RICHNESS	1.88	1.78

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	21	55.3
2	6	15.8
3	4	10.5
4	3	7.9
5	2	5.3
6	1	2.6
7	1	2.6
TOTAL	38	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.02	1.72
MAXIMUM DIVERSITY	2.81	2.43
MINIMUM DIVERSITY	1.04	0.81
REDUNDANCY	0.44	0.44
EVENNESS	0.72	0.71
EQUITABILITY	0.39	0.44
SPECIES RICHNESS	1.64	1.28

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	39	58.2
2	13	19.4
3	4	6.0
4	3	4.5
5	2	3.0
6	2	3.0
7	1	1.5
8	1	1.5
9	1	1.5
10	1	1.5
TOTAL	67	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.02	1.77
MAXIMUM DIVERSITY	3.32	2.98
MINIMUM DIVERSITY	1.02	0.80
REDUNDANCY	0.56	0.56
EVENNESS	0.61	0.59
EQUITABILITY	0.33	0.38
SPECIES RICHNESS	1.69	1.39

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	20	64.5
2	7	22.6
3	3	9.7
4	1	3.2
TOTAL	31	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.38	1.18
MAXIMUM DIVERSITY	2.00	1.76
MINIMUM DIVERSITY	0.61	0.47
REDUNDANCY	0.45	0.45
EVENNESS	0.69	0.67
EQUITABILITY	0.28	0.33
SPECIES RICHNESS	1.10	0.86

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	23	50.0
2	12	26.1
3	5	10.9
4	3	6.5
5	1	2.2
6	1	2.2
7	1	2.2
TOTAL	46	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.97	1.72
MAXIMUM DIVERSITY	2.81	2.48
MINIMUM DIVERSITY	0.90	0.71
REDUNDANCY	0.44	0.43
EVENNESS	0.70	0.69
EQUITABILITY	0.36	0.41
SPECIES RICHNESS	1.61	1.31

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	6	75.0
2	1	12.5
3	1	12.5
TOTAL	8	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.06	0.73
MAXIMUM DIVERSITY	1.58	1.14
MINIMUM DIVERSITY	1.06	0.73
REDUNDANCY	1.00	1.00
EVENNESS	0.67	0.64
EQUITABILITY	0.35	0.38
SPECIES RICHNESS	0.71	0.35

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	24	43.6
2	12	21.8
3	8	14.5
4	6	10.9
5	2	3.6
6	1	1.8
7	1	1.8
8	1	1.8
TOTAL	55	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.24	1.99
MAXIMUM DIVERSITY	3.00	2.68
MINIMUM DIVERSITY	0.91	0.73
REDUNDANCY	0.36	0.35
EVENNESS	0.75	0.74
EQUITABILITY	0.39	0.45
SPECIES RICHNESS	1.86	1.54

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: INTAKE

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	87	35.5
2	72	29.4
3	26	10.6
4	21	8.6
5	20	8.2
6	6	2.4
7	5	2.0
8	3	1.2
9	3	1.2
10	1	0.4
11	1	0.4
TOTAL	245	100.0

	SHANNON	BRILLOUIN
DIVERSITY	2.46	2.35
MAXIMUM DIVERSITY	3.46	3.32
MINIMUM DIVERSITY	0.38	0.32
REDUNDANCY	0.33	0.32
EVENNESS	0.71	0.71
EQUITABILITY	0.31	0.36
SPECIES RICHNESS	2.15	1.99

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 1

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	167	96.5
2	5	2.9
3	1	0.6
TOTAL	173	100.0

	SHANNON	BRILLOUIN
DIVERSITY	0.24	0.22
MAXIMUM DIVERSITY	1.58	1.54
MINIMUM DIVERSITY	0.10	0.09
REDUNDANCY	0.91	0.91
EVENNESS	0.15	0.14
EQUITABILITY	0.03	0.04
SPECIES RICHNESS	0.21	0.18

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 2

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	43	60.6
2	11	15.5
3	6	8.5
4	5	7.0
5	3	4.2
6	2	2.8
7	1	1.4
TOTAL	71	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.85	1.66
MAXIMUM DIVERSITY	2.81	2.57
MINIMUM DIVERSITY	0.64	0.52
REDUNDANCY	0.44	0.44
EVENNESS	0.66	0.65
EQUITABILITY	0.39	0.35
SPECIES RICHNESS	1.55	1.31

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 3

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	80	82.5
2	10	10.3
3	4	4.1
4	3	3.1
TOTAL	97	100.0

	SHANNON	BRILLOUIN
DIVERSITY	0.91	0.84
MAXIMUM DIVERSITY	2.00	1.90
MINIMUM DIVERSITY	0.25	0.20
REDUNDANCY	0.62	0.63
EVENNESS	0.46	0.44
EQUITABILITY	0.14	0.16
SPECIES RICHNESS	0.77	0.68

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 4

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	17	38.6
2	17	38.6
3	4	9.1
4	3	6.8
5	2	4.5
6	1	2.3
TOTAL	44	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.97	1.73
MAXIMUM DIVERSITY	2.58	2.30
MINIMUM DIVERSITY	0.77	0.61
REDUNDANCY	0.34	0.34
EVENNESS	0.76	0.75
EQUITABILITY	0.36	0.42
SPECIES RICHNESS	1.61	1.31

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 5

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	37	67.3
2	14	25.5
3	4	7.3
TOTAL	55	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.16	1.07
MAXIMUM DIVERSITY	1.58	1.47
MINIMUM DIVERSITY	0.26	0.21
REDUNDANCY	0.32	0.32
EVENNESS	0.73	0.72
EQUITABILITY	0.29	0.24
SPECIES RICHNESS	0.96	0.82

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 6

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	24	47.1
2	17	33.3
3	7	13.7
4	2	3.9
5	1	2.0
TOTAL	51	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.73	1.55
MAXIMUM DIVERSITY	2.32	2.11
MINIMUM DIVERSITY	0.55	0.44
REDUNDANCY	0.34	0.33
EVENNESS	0.74	0.74
EQUITABILITY	0.39	0.36
SPECIES RICHNESS	1.42	1.19

MONTANA DEPARTMENT OF FISH AND GAME

RPT 2200.1 SPECIES DIVERSITY ANALYSIS

JULY 2, 1976

STATION: SIDNEY

NUMBER OF SAMPLERS: 7

SAMPLING PERIOD: XI-11-75

RANK	ABUNDANCE	PERCENT OF TOTAL
1	368	74.9
2	53	10.8
3	42	8.6
4	14	2.9
5	7	1.4
6	5	1.0
7	2	0.4
TOTAL	491	100.0

	SHANNON	BRILLOUIN
DIVERSITY	1.30	1.26
MAXIMUM DIVERSITY	2.81	2.76
MINIMUM DIVERSITY	0.13	0.11
REDUNDANCY	0.56	0.57
EVENNESS	0.46	0.46
EQUITABILITY	0.14	0.17
SPECIES RICHNESS	1.15	1.09

APPENDIX G

SPI 271B.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 16, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: AUG 7, 1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.3	0.0	2	4
	0.3	0.185	6	9
	1.0	0.605	4	11
	0.8	0.674	2	2
	1.4	0.746	5	8
	1.4	0.837	6	21
	1.1	0.867	2	3
	0.9	0.947	5	6
	1.5	0.947	4	37
	1.0	1.110	5	20
	1.4	1.110	2	4
	2.0	1.110	4	11
	1.8	1.160	4	9
	3.3	1.320	3	7
	2.8	1.330	6	13
	3.1	1.410	3	5
	2.0	1.470	7	20
	1.9	1.540	2	2
	1.7	1.650	5	7
	2.2	1.650	5	7
	2.5	1.730	3	3
	2.7	1.760	3	3
	3.0	2.190	4	5
	3.3	2.490	1	2
MEAN	1.8	1.202	3.9	9.1
ST DEV	0.9	0.575	1.6	8.2

RPT 2716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 16, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: AUG 7, 1975

REGRESSION OF Y1 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	4.3429	A =	4.3882	A =	4.4106
B =	-0.2588	B =	-0.4266	B =	-0.1044
				C =	-0.2885
R =	-0.1467	R =	-0.1538	R =	0.1570
F =	0.4638	F =	0.5327	F =	0.2655
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	1.4052	A =	1.4569	A =	1.4517
B =	-0.0822	B =	-0.1665	B =	0.0239
				C =	-0.1982
R =	-0.1548	R =	-0.1994	R =	0.2009
F =	0.5401	F =	0.9110	F =	0.4415
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	1.2761	A =	1.2697	A =	1.3982
B =	-0.0502	B =	0.0355	B =	-0.2596
				C =	0.0832
R =	-0.0686	R =	0.1794	R =	0.3161
F =	0.1041	F =	0.7318	F =	1.1655
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 2716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 16, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: AUG 7, 1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	11.7768	A =	12.5628	A =	12.5164
B =	-1.4664	B =	-2.8599	B =	0.2202
				C =	-3.1517
R =	-0.1615	R =	-0.2002	R =	0.2006
F =	0.5894	F =	0.9188	F =	0.4405
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	2.1631	A =	2.3445	A =	2.3062
B =	-0.1463	B =	-0.3739	B =	0.1778
				C =	-0.6095
R =	-0.1674	R =	-0.2681	R =	0.2892
F =	0.6341	F =	1.7043	F =	0.9581
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	1.9307	A =	1.9040	A =	2.0384
B =	-0.0837	B =	0.0247	B =	-0.2715
				C =	0.0746
R =	-0.0665	R =	0.0748	R =	0.1793
F =	0.1039	F =	0.1238	F =	0.3489
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 271r.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 16, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: SEPT 17, 1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.1	0.0	12	40
	0.2	0.0	6	27
	0.2	0.0	7	25
	0.2	0.0	13	46
	0.3	0.0	6	28
	0.3	0.0	8	35
	0.3	0.060	5	25
	0.5	0.100	8	24
	0.6	0.200	2	5
	0.9	0.687	7	14
	0.9	0.837	6	18
	1.0	0.947	3	6
	1.6	0.947	5	11
	1.1	1.010	7	23
	1.8	1.010	6	18
	1.8	1.030	5	9
	1.4	1.060	5	28
	1.5	1.110	7	24
	1.9	1.160	6	13
	1.9	1.320	5	24
	2.3	1.350	5	6
	2.0	1.380	7	39
	2.6	1.760	5	16
	3.3	1.880	4	17
MEAN	1.2	0.744	6.5	21.7
ST DEV	0.9	0.613	2.4	11.1

WPI 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: SEPT 17, 1975

REGRESSION OF Y1 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	7.5291	A =	7.4390	A =	7.4721
B =	-0.6954	B =	-1.3187	B =	-0.1963
				C =	-1.0443
R =	-0.3326	R =	-0.3402	R =	0.3408
F =	2.7360	F =	2.8799	F =	1.3801
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	1.9092	A =	1.9011	A =	1.9022
B =	-0.0917	B =	-0.1367	B =	-0.0064
				C =	-0.1279
R =	-0.2110	R =	-0.2164	R =	0.2164
F =	1.0248	F =	1.1017	F =	0.5260
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	1.7720	A =	1.6945	A =	1.6696
B =	-0.1401	B =	-0.0341	B =	0.0714
				C =	-0.0467
R =	-0.3633	R =	-0.4473	R =	0.4549
F =	3.3456	F =	5.5024	F =	2.7393
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 2716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: SEPT 17, 1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	28.1597	A =	27.3794	A =	28.0442
B =	-5.3949	B =	-7.6259	B =	-3.9809
				C =	-2.1185
R =	-0.4307	R =	-0.4229	R =	0.4319
F =	5.0109	F =	4.7912	F =	2.4083
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	3.2138	A =	3.1735	A =	3.2136
B =	-0.2421	B =	-0.3352	B =	-0.2396
				C =	-0.0037
R =	-0.3501	R =	-0.3367	R =	0.3501
F =	3.0726	F =	2.8127	F =	1.4665
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	2.6678	A =	2.7229	A =	2.7084
B =	-0.2874	B =	-0.0653	B =	0.0418
				C =	-0.0727
R =	-0.4686	R =	-0.5369	R =	0.5398
F =	6.1904	F =	9.0037	F =	4.3166
DF =	1, 22	DF =	1, 22	DF =	2, 21

REI 0716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 16, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: OCT 9, 1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.1	0.0	6	32
	0.2	0.0	9	44
	0.2	0.0	11	55
	0.5	0.0	7	57
	0.1	0.050	11	41
	0.2	0.100	11	66
	0.5	0.250	10	102
	0.4	0.300	17	205
	1.2	0.565	11	66
	1.8	0.674	8	27
	1.0	0.817	9	23
	1.2	0.856	12	101
	2.0	0.927	11	110
	2.1	1.030	13	45
	1.0	1.060	14	115
	1.4	1.060	12	167
	2.5	1.130	10	151
	2.0	1.260	11	304
	1.5	1.290	12	141
	2.9	1.440	10	268
	2.5	1.470	10	193
	2.5	1.470	13	253
	3.0	1.470	8	147
	3.4	1.650	10	290
MEAN	1.4	0.786	10.9	126.9
ST DEV	1.0	0.570	2.2	80.6

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: OCT 9, 1975

REGRESSION OF Y1 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	10.7426	A =	10.1926	A =	10.4542
B =	0.0928	B =	0.8679	B =	-2.3689
				C =	4.8284
R =	0.0429	R =	0.2217	R =	0.4758
F =	0.0406	F =	1.1372	F =	3.0731
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	2.3462	A =	2.2930	A =	2.3183
B =	0.0143	B =	0.0928	B =	-0.2233
				C =	0.4662
R =	0.0725	R =	0.2594	R =	0.5061
F =	0.1164	F =	1.5875	F =	3.6160
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	2.3685	A =	2.4134	A =	2.4407
B =	0.0255	B =	0.0214	B =	-0.0798
				C =	0.0365
R =	0.1395	R =	0.4556	R =	0.5420
F =	0.4369	F =	5.7617	F =	4.3670
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT C716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: OCT 9, 1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I: Y = A + B*X1

A =	49.9123
B =	54.0090
R =	0.6436
F =	15.5768
DF =	1, 22

Y = A + B*X2

A =	44.6186
B =	104.6133
R =	0.6887
F =	19.6468
DF =	1, 22

Y = A + B*X1 + C*X2

A =	44.1146
B =	4.5643
C =	96.9823
R =	0.6890
F =	9.4889
DF =	2, 21

MODEL II: LN(Y) = A + B*X1

A =	3.9659
B =	0.4352
R =	0.5804
F =	11.1733
DF =	1, 22

LN(Y) = A + B*X2

A =	3.8960
B =	0.8750
R =	0.6444
F =	15.6238
DF =	1, 22

LN(Y) = A + B*X1 + C*X2

A =	3.9062
B =	-0.0741
C =	0.9989
R =	0.6455
F =	7.5012
DF =	2, 21

MODEL III: LN(Y) = A + B*LN(X1)

A =	4.6139
B =	0.3761
R =	0.5417
F =	9.1364
DF =	1, 22

LN(Y) = A + B*LN(X2)

A =	4.7597
B =	0.0793
R =	0.4451
F =	5.4368
DF =	1, 22

LN(Y) = A + B*LN(X1) + C*LN(X2)

A =	4.6484
B =	0.3258
C =	0.0175
R =	0.5457
F =	4.4526
DF =	2, 21

RPI 2716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 16, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: NOV 7, 1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.2	0.0	6	43
	0.3	0.0	4	91
	0.4	0.0	5	26
	0.5	0.0	6	46
	1.1	0.397	7	46
	0.6	0.440	6	44
	1.2	0.465	6	36
	0.7	0.661	4	19
	1.0	0.701	4	47
	1.0	0.755	10	68
	1.7	1.080	14	149
	1.6	1.110	7	100
	1.5	1.200	10	103
	1.5	1.230	7	26
	2.0	1.260	11	183
	1.9	1.500	11	206
	2.2	1.500	9	193
	2.4	1.500	15	263
	2.5	1.540	14	271
	2.2	1.610	13	303
	2.5	1.720	13	551
	3.0	1.800	12	118
	3.1	1.850	11	369
	3.2	2.380	14	274
MEAN	1.6	1.029	9.0	149.0
ST DEV	0.9	0.676	3.8	133.9

RPT 2716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: NOV 7, 1975

REGRESSION OF Y1 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	3.5921	A =	4.3860	A =	3.7237
B =	3.4149	B =	4.5220	B =	2.5471
				C =	1.2178
R =	0.8316	R =	0.8161	R =	0.8338
F =	49.3168	F =	43.6881	F =	23.9449
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	1.4257	A =	1.5218	A =	1.4463
B =	0.4251	B =	0.5658	B =	0.2893
				C =	0.1906
R =	0.6213	R =	0.8103	R =	0.8248
F =	45.6064	F =	42.0682	F =	22.3346
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	1.9848	A =	2.2262	A =	1.9198
B =	0.4926	B =	0.0665	B =	0.5981
				C =	-0.0215
R =	0.6007	R =	0.6242	R =	0.8077
F =	39.2979	F =	14.0445	F =	19.7087
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 2710.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: NOV 7, 1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I:

	Y = A + B*X1	Y = A + B*X2	Y = A + B*X1 + C*X2
A =	-27.2074	1.0625	-26.4642
B =	110.4434	143.7915	105.5454
C =			6.8729
R =	0.7550	0.7286	0.7551
F =	29.1678	24.8883	13.9261
DF =	1, 22	1, 22	2, 21

MODEL II:

	LN(Y) = A + B*X1	LN(Y) = A + B*X2	LN(Y) = A + B*X1 + C*X2
A =	3.2551	3.4799	3.2483
B =	0.8433	1.0892	0.8883
C =			-0.0632
R =	0.8089	0.7744	0.8090
F =	41.6461	32.9497	19.8898
DF =	1, 22	1, 22	2, 21

MODEL III:

	LN(Y) = A + B*LN(X1)	LN(Y) = A + B*LN(X2)	LN(Y) = A + B*LN(X1) + C*LN(X2)
A =	4.3852	4.7736	3.9835
B =	0.8902	0.0941	1.5419
C =			-0.1328
R =	0.7184	0.4363	0.7890
F =	23.4575	5.2308	17.3165
DF =	1, 22	1, 22	2, 21

RPT 2716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 16

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: AUG 6, 1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.6	0.0	1	2
	0.5	0.674	4	6
	0.6	0.746	5	13
	0.4	0.837	6	15
	0.8	0.927	5	11
	1.0	1.170	8	27
	0.7	1.210	7	35
	0.6	1.290	6	37
	0.5	1.320	5	84
	1.5	1.360	6	53
	1.1	1.400	3	7
	1.3	1.530	4	15
	1.1	1.570	6	23
	1.5	1.760	3	18
	1.6	1.870	4	33
	1.6	1.980	7	41
	1.8	2.190	4	36
	1.9	2.190	4	49
	2.3	2.190	4	131
	1.9	2.240	6	68
	2.4	2.280	6	110
	1.8	2.390	3	26
	1.6	3.270	3	24
	2.0	3.270	3	46
MEAN	1.3	1.653	4.8	37.9
ST DEV	0.6	0.782	1.8	32.4

RPT 2716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 16, 1976

STATION: 18

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: AUG 6, 1975

REGRESSION OF Y1 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	5.5473	A =	5.4252	A =	5.5584
B =	-0.58[illegible]1	B =	-0.3632	B =	-0.5455
				C =	-0.0362
R =	-0.2017	R =	-0.1695	R =	0.2019
F =	0.9330	F =	0.6507	F =	0.4463
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	1.5593	A =	1.4869	A =	1.5274
B =	-0.0571	B =	-0.0009	B =	-0.1659
				C =	0.1046
R =	-0.0776	R =	-0.0016	R =	0.1312
F =	0.1333	F =	0.0001	F =	0.1839
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	1.4953	A =	1.4899	A =	1.5339
B =	-0.0766	B =	0.1158	B =	-0.3303
				C =	0.1441
R =	-0.0931	R =	0.6385	R =	0.7380
F =	0.1926	F =	15.1406	F =	12.5589
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 18

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: AUG 6, 1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	-2.7647	A =	6.7776	A =	-0.6454
B =	31.3940	B =	17.6227	B =	38.6102
				C =	-6.9369
R =	0.5936	R =	0.4261	R =	0.6015
F =	11.9667	F =	4.6800	F =	5.9531
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	2.0241	A =	2.0083	A =	1.8874
B =	0.9603	B =	0.7621	B =	0.4952
				C =	0.4472
R =	0.6113	R =	0.6205	R =	0.6470
F =	13.1296	F =	13.7704	F =	7.5593
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	3.1437	A =	3.2783	A =	3.1965
B =	0.9599	B =	0.2493	B =	0.6136
				C =	0.1967
R =	0.5466	R =	0.6434	R =	0.7195
F =	9.3726	F =	15.5404	F =	11.2687
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 16

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: SEPT 9, 1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.1	0.0	4	11
	0.2	0.0	6	22
	0.2	0.0	9	29
	0.2	0.100	8	34
	0.3	0.100	3	17
	0.7	0.403	6	11
	0.8	0.516	5	22
	0.9	0.763	4	11
	0.6	0.837	4	16
	1.1	0.837	5	15
	1.2	1.010	7	31
	1.3	1.110	5	32
	1.3	1.110	5	26
	1.4	1.200	7	53
	1.6	1.260	4	40
	1.9	1.260	6	30
	2.0	1.290	7	55
	2.5	1.290	7	29
	1.8	1.360	9	32
	2.3	1.540	9	49
	2.3	1.650	6	30
	2.7	1.650	7	30
	3.0	1.830	5	36
	3.5	2.140	6	31
MEAN	1.4	0.970	6.0	28.9
ST DEV	1.0	0.623	1.7	12.2

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 16

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: SEPT 9, 1975

REGRESSION OF Y1 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	5.4523	A =	5.5683	A =	5.5987
B =	0.3877	B =	0.4451	B =	1.3196
				C =	-1.5081
R =	0.2208	R =	0.1638	R =	0.2740
F =	1.1278	F =	0.6063	F =	0.8522
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	1.6344	A =	1.6526	A =	1.6583
B =	0.0833	B =	0.1024	B =	0.2349
				C =	-0.2454
R =	0.2752	R =	0.2185	R =	0.3149
F =	1.8030	F =	1.1025	F =	1.1561
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	1.7523	A =	1.7523	A =	1.6862
B =	0.0658	B =	0.0002	B =	0.2077
				C =	-0.0433
R =	0.2238	R =	0.0021	R =	0.3961
F =	1.1596	F =	0.0001	F =	1.9538
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 2716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 18

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: SEPT 9, 1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	20.1720	A =	19.0913	A =	19.0728
B =	6.1909	B =	10.1310	B =	-0.8036
				C =	11.3205
R =	0.4901	R =	0.5182	R =	0.5185
F =	6.9546	F =	8.0746	F =	3.8606
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	2.9099	A =	2.8726	A =	2.8730
B =	0.2547	B =	0.4094	B =	0.0198
				C =	0.3801
R =	0.5291	R =	0.5496	R =	0.5497
F =	8.5542	F =	9.5218	F =	4.5476
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	3.2704	A =	3.3300	A =	3.2171
B =	0.2401	B =	0.0393	B =	0.3545
				C =	-0.0349
R =	0.5139	R =	0.3327	R =	0.5399
F =	7.8946	F =	2.7389	F =	4.3205
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 2716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 16, 1976

STATION: 16

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: OCT 15, 1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.1	0.0	3	9
	0.1	0.0	4	11
	0.2	0.0	4	26
	0.2	0.0	9	22
	0.2	0.100	4	31
	0.2	0.150	4	50
	0.3	0.250	8	140
	0.6	0.330	9	66
	0.5	0.400	9	71
	0.7	0.550	9	59
	0.6	0.649	12	65
	1.2	0.637	10	60
	1.0	0.850	12	92
	1.2	1.110	13	112
	1.8	1.110	6	54
	1.6	1.440	11	199
	0.6	1.650	7	34
	1.6	1.790	10	142
	0.9	2.140	11	181
	0.7	2.490	9	98
	1.2	2.550	8	75
	1.2	2.730	13	144
	1.5	2.860	9	131
	1.5	2.960	7	124
MEAN	0.8	1.124	8.5	84.0
ST DEV	0.6	1.031	2.9	53.1

RPT 2716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 16

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: OCT 15, 1975

REGRESSION OF Y1 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	5.9696	A =	7.0687	A =	5.9645
B =	3.0014	B =	1.2190	B =	2.8288
				C =	0.1320
R =	0.5691	R =	0.4264	R =	0.5701
F =	10.5400	F =	4.6901	F =	5.0549
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	1.6822	A =	1.8453	A =	1.6809
B =	0.4566	B =	0.1917	B =	0.4137
				C =	0.0328
R =	0.6048	R =	0.4686	R =	0.6074
F =	12.6880	F =	6.1692	F =	6.1392
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	2.2414	A =	2.1643	A =	2.2411
B =	0.3581	B =	0.0623	B =	0.3383
				C =	0.0049
R =	0.7754	R =	0.6567	R =	0.7759
F =	33.1695	F =	16.6845	F =	15.8874
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 16

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: OCT 15, 1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	34.1316	A =	48.1276	A =	33.4391
B =	60.1426	B =	31.9268	B =	36.9599
				C =	17.7246
R =	0.6329	R =	0.6198	R =	0.6778
F =	14.6983	F =	13.7245	F =	8.9233
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	3.3354	A =	3.5940	A =	3.3256
B =	1.0058	B =	0.5122	B =	0.6754
				C =	0.2526
R =	0.6764	R =	0.6354	R =	0.7116
F =	18.5538	F =	14.8990	F =	10.7715
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	4.5390	A =	4.4781	A =	4.5347
B =	0.7327	B =	0.1556	B =	0.3369
				C =	0.0984
R =	0.8055	R =	0.8328	R =	0.8586
F =	40.6402	F =	49.7742	F =	29.4437
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 2716.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 18

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: NOV 11, 1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.1	0.0	1	2
	0.2	0.150	3	15
	0.3	0.220	5	23
	0.4	0.333	5	20
	0.6	0.510	11	67
	0.9	0.705	4	15
	1.1	0.770	3	19
	1.5	0.967	8	102
	1.3	1.200	7	64
	1.5	1.260	7	95
	1.9	1.410	13	167
	2.0	1.440	7	74
	1.7	1.570	10	68
	2.3	1.610	11	129
	1.1	1.670	7	22
	2.7	1.690	12	92
	2.5	2.000	11	164
	3.0	2.000	9	58
	1.5	2.190	8	51
	2.1	2.190	8	102
	1.8	2.600	5	70
	2.7	2.680	3	51
	2.4	2.730	7	59
	2.4	3.550	4	51
MEAN	1.6	1.477	7.0	65.8
ST DEV	0.9	0.921	3.2	44.8

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 18

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: NOV 11, 1975

REGRESSION OF YI ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	4.2757	A =	6.0950	A =	4.4430
B =	1.7469	B =	0.6410	B =	3.6926
				C =	-2.1992
R =	0.4653	R =	0.1831	R =	0.5853
F =	6.0795	F =	0.7632	F =	5.4726
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	1.2809	A =	1.5520	A =	1.3001
B =	0.3386	B =	0.1795	B =	0.5628
				C =	-0.2535
R =	0.4918	R =	0.2795	R =	0.5400
F =	7.0169	F =	1.8646	F =	4.3225
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	1.7322	A =	1.8651	A =	1.8213
B =	0.4237	B =	0.1627	B =	0.1537
				C =	0.1188
R =	0.6408	R =	0.6939	R =	0.7074
F =	15.3277	F =	20.4304	F =	10.5180
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

FEBRUARY 18, 1976

STATION: 16

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: NOV 11, 1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I:

	Y = A + B*X1	Y = A + B*X2	Y = A + B*X1 + C*X2
A =	17.0509	41.3263	18.7420
B =	30.6100	16.5939	50.4811
C =			-22.2341
R =	0.5904	0.3410	0.6444
F =	11.7725	2.8955	7.4579
DF =	1, 22	1, 22	2, 21

MODEL II:

	LN(Y) = A + B*X1	LN(Y) = A + B*X2	LN(Y) = A + B*X1 + C*X2
A =	2.5952	3.0285	2.6072
B =	0.8017	0.5660	0.9418
C =			-0.1583
R =	0.6977	0.5283	0.7027
F =	20.8697	8.5196	10.2427
DF =	1, 22	1, 22	2, 21

MODEL III:

	LN(Y) = A + B*LN(X1)	LN(Y) = A + B*LN(X2)	LN(Y) = A + B*LN(X1) + C*LN(X2)
A =	3.6845	3.9552	3.7916
B =	0.8997	0.3072	0.5752
C =			0.1428
R =	0.8156	0.7852	0.8436
F =	43.6911	35.3690	25.9200
DF =	1, 22	1, 22	2, 21

APPENDIX H

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

MARCH 12, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: OCT.9,1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.1	0.0	0	1
	0.2	0.0	0	2
	0.2	0.0	0	1
	0.5	0.0	0	5
	0.1	0.050	0	1
	0.2	0.100	0	1
	0.5	0.250	0	8
	0.4	0.300	0	2
	1.2	0.565	0	1
	1.8	0.674	0	2
	1.0	0.817	0	5
	1.2	0.858	0	59
	2.0	0.927	0	67
	2.1	1.030	0	20
	1.0	1.060	0	31
	1.4	1.060	0	91
	2.5	1.130	0	110
	2.0	1.260	0	201
	1.5	1.290	0	73
	2.9	1.440	0	165
	2.5	1.470	0	142
	2.5	1.470	0	180
	3.0	1.470	0	94
	3.4	1.650	0	210
MEAN	1.4	0.786	0.0	61.3
ST DEV	1.0	0.570	0.0	71.6

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

MARCH 12, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: OCT.9.1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I:

	Y = A + B*X1	Y = A + B*X2	Y = A + B*X1 + C*X2
A =	-19.5299	-20.8114	-23.4170
B =	56.7462	104.4713	23.5951
C =			65.0238
R =	0.8180	0.8317	0.8419
F =	44.5017	49.3494	25.5500
DF =	1, 22	1, 22	2, 21

MODEL II:

	LN(Y) = A + B*X1	LN(Y) = A + B*X2	LN(Y) = A + B*X1 + C*X2
A =	0.3615	0.1456	0.1549
B =	1.6773	3.3144	-0.0844
C =			3.4555
R =	0.8302	0.9059	0.9061
F =	48.7969	100.6949	48.1432
DF =	1, 22	1, 22	2, 21

MODEL III:

	LN(Y) = A + B*LN(X1)	LN(Y) = A + B*LN(X2)	LN(Y) = A + B*LN(X1) + C*LN(X2)
A =	2.8666	3.3897	2.8521
B =	1.5518	0.2913	1.5729
C =			-0.0073
R =	0.8294	0.6058	0.8295
F =	48.5088	12.8189	23.1633
DF =	1, 22	1, 22	2, 21

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

MARCH 12, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: NOV.7.1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.2	0.0	0	0
	0.3	0.0	0	0
	0.4	0.0	0	0
	0.5	0.0	0	0
	0.7	0.0	0	2
	1.1	0.397	0	2
	0.6	0.440	0	2
	1.2	0.465	0	1
	1.0	0.701	0	0
	1.0	0.755	0	20
	1.7	1.080	0	70
	1.6	1.110	0	13
	1.5	1.200	0	58
	1.5	1.230	0	1
	2.0	1.260	0	110
	1.9	1.500	0	80
	2.2	1.500	0	89
	2.4	1.500	0	140
	2.5	1.540	0	201
	2.2	1.610	0	135
	2.5	1.720	0	390
	3.0	1.800	0	80
	3.1	1.850	0	301
	3.2	2.380	0	170
MEAN	1.6	1.002	0.0	77.7
ST DEV	0.9	0.707	0.0	103.5

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

MARCH 12, 1976

STATION: 17

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: NOV.7.1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	-60.8812	A =	-28.2292	A =	-67.1428
B =	86.8447	B =	105.7703	B =	112.0479
				C =	-33.9047
R =	0.7677	R =	0.7221	R =	0.7703
F =	31.5821	F =	23.9639	F =	15.3205
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	-8.5077	A =	-6.8370	A =	-7.8640
B =	5.5478	B =	7.1716	B =	2.9570
				C =	3.4854
R =	0.7847	R =	0.7833	R =	0.7914
F =	35.2542	F =	34.9281	F =	17.6035
DF =	1, 22	DF =	1, 22	DF =	2, 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	-1.4100	A =	2.7668	A =	-0.4968
B =	7.2490	B =	1.0530	B =	5.8837
				C =	0.2533
R =	0.8626	R =	0.7892	R =	0.8682
F =	63.9687	F =	36.3389	F =	32.1323
DF =	1, 22	DF =	1, 22	DF =	2, 21

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

MARCH 12, 1976

STATION: 18

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: OCT.15,1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.1	0.0	0	0
	0.1	0.0	0	0
	0.2	0.0	0	2
	0.2	0.0	0	0
	0.2	0.100	0	0
	0.2	0.150	0	0
	0.3	0.250	0	0
	0.6	0.330	0	2
	0.5	0.400	0	1
	0.7	0.550	0	3
	0.5	0.649	0	1
	1.2	0.837	0	10
	1.0	0.850	0	5
	1.2	1.110	0	66
	1.8	1.110	0	18
	1.6	1.440	0	121
	0.6	1.650	0	3
	1.8	1.790	0	101
	0.9	2.140	0	85
	0.7	2.490	0	52
	1.2	2.550	0	34
	1.2	2.730	0	56
	1.5	2.860	0	65
	1.5	2.980	0	40
MEAN	0.8	1.124	0.0	27.7
ST DEV	0.6	1.031	0.C	36.9

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

MARCH 12, 1976

STATION: 18

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: OCT.15.1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I:

Y = A + B*X1		Y = A + B*X2		Y = A + B*X1 + C*X2	
A =	-11.2272	A =	1.1668	A =	-11.6655
B =	46.9574	B =	23.6223	B =	32.2891
				C =	11.2148
R =	0.7117	R =	0.6606	R =	0.7453
F =	22.5856	F =	17.0311	F =	13.1213
DF =	1. 22	DF =	1. 22	DF =	2. 21

MODEL II:

LN(Y) = A + B*X1		LN(Y) = A + B*X2		LN(Y) = A + B*X1 + C*X2	
A =	-8.4027	A =	-5.9088	A =	-8.4802
B =	9.0644	B =	4.4697	B =	6.4702
				C =	1.9835
R =	0.7873	R =	0.7163	R =	0.8186
F =	35.8822	F =	23.1806	F =	21.3349
DF =	1. 22	DF =	1. 22	DF =	2. 21

MODEL III:

LN(Y) = A + B*LN(X1)		LN(Y) = A + B*LN(X2)		LN(Y) = A + B*LN(X1) + C*LN(X2)	
A =	2.2599	A =	1.0216	A =	2.2732
B =	6.2385	B =	0.9518	B =	7.4530
				C =	-0.3020
R =	0.8858	R =	0.6650	R =	0.8936
F =	80.1472	F =	17.4399	F =	41.6094
DF =	1. 22	DF =	1. 22	DF =	2. 21

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

MARCH 12, 1976

STATION: 18

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: NOV.11.1975

	X1 WATER DEPTH	X2 CURRENT VELOCITY	Y1 NUMBER OF SPECIES	Y2 NUMBER OF ORGANISMS
	0.1	0.0	0	0
	0.2	0.150	0	0
	0.3	0.220	0	0
	0.4	0.333	0	0
	0.6	0.510	0	2
	0.9	0.705	0	0
	1.1	0.770	0	0
	1.5	0.967	0	32
	1.3	1.200	0	9
	1.5	1.260	0	26
	1.9	1.410	0	105
	2.0	1.440	0	48
	1.7	1.570	0	38
	2.3	1.610	0	91
	1.1	1.670	0	0
	2.7	1.690	0	65
	2.5	2.000	0	130
	3.0	2.000	0	38
	1.5	2.190	0	34
	2.1	2.190	0	75
	1.8	2.600	0	49
	2.7	2.680	0	39
	2.4	2.730	0	40
	2.4	3.550	0	31
MEAN	1.6	1.477	0.0	35.5
ST DEV	0.9	0.921	0.0	36.4

RPT 2718.1

MONTANA DEPARTMENT OF FISH AND GAME

AQUATIC INSECT REGRESSION ANALYSIS

MARCH 12, 1976

STATION: 18

NUMBER OF SAMPLERS: 24

SAMPLING PERIOD: NOV.11.1975

REGRESSION OF Y2 ON X1 AND X2

MODEL I:

	Y = A + B*X1	Y = A + B*X2	Y = A + B*X1 + C*X2
A =	-11.8690	7.0011	-10.9849
B =	29.9173	19.2968	40.2026
C =			-11.6284
R =	0.7062	0.4885	0.7255
F =	21.8877	6.8963	11.6705
DF =	1. 22	1. 22	2. 21

MODEL II:

	LN(Y) = A + B*X1	LN(Y) = A + B*X2	LN(Y) = A + B*X1 + C*X2
A =	-11.2785	-8.5895	-11.3225
B =	6.6206	5.2771	6.1091
C =			0.5783
R =	0.8038	0.6871	0.8049
F =	40.1620	19.6775	19.3210
DF =	1. 22	1. 22	2. 21

MODEL III:

	LN(Y) = A + B*LN(X1)	LN(Y) = A + B*LN(X2)	LN(Y) = A + B*LN(X1) + C*LN(X2)
A =	-2.0578	-0.3576	-2.7423
B =	6.3077	1.4840	8.3818
C =			-0.9125
R =	0.7976	0.5291	0.8205
F =	38.4592	8.5528	21.6267
DF =	1. 22	1. 22	2. 21