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ECOLOGICAL STUDIES ON THE EFFECTS OF REGULATION ON THE MACROINVERTEBRATES IN THE FLATHEAD RIVER

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In the first year of our study we have been collecting base-line data on the composition and biomass of invertebrates in control and regulated areas of the Flathead River. We are just starting fish food habit studies and work on the effects of regulation on insect habitat and insect growth and emergence. We are still in the early stages of data analysis, so today I will mainly address the subject of compositional changes in regulated areas of the Flathead River.

The presence of Hungry Horse Dam greatly alters the downstream aquatic environment (Graham et al 1980). There are the obvious changes in flow; we often have daily fluctuations of seven vertical feet in the South Fork. Water is released from the hypolimnion of the Reservoir, so there are marked changes in the temperature regime. South Fork temperatures are very constant, varying only from 3° to 7° C year around. Temperatures are thus colder in the summer and warmer in the winter in the South Fork. Many insects need a certain number of degree days for growth and emergence. Temperatures (Stanford 1975) are probably too low on a yearly basis for many species in the South Fork; therefore, you have a limited fauna. During the summer, temperatures are lower in partially regulated areas than in control areas when they are generating at Hungry Horse Dam. We are finding differences in insect emergence times in the control and partially regulated areas which may be largely due to temperature differences. There are also changes in water chemistry, in the substrate and increased growth of peri-phyton, all of which affect the zoobenthos.

Our regulated sampling site is seven and one-half kilometers from the dam, near the mouth of the South Fork. The South Fork is joined by the combined North and Middle Forks which ameliorates the effects of the hypolimnial discharge. Our control site is one kilometer north of the mouth of the South Fork and our par-tially regulated site is 11 kilometers south of the mouth of the South Fork. We sample during conditions of minimum flows from the dam of 150 cfs.

We use a circular sampler and a kick net which have been modified for use in the large substrate of the Flathead River. They both sample one-third m^2 and have a 150 um mesh size.

The percent of the total number of invertebrates represented by insect order varies considerably at the three sites (Figures 1 and 2). The South Fork is dominated by the midge family, Chironomidae. There are also oligochaetes, nematodes, and a few species of the other orders which can adapt metabolically to the constant temperatures (e.g., *Baetis tricaudatus*, *Zapada columbiana*).

Both the control and partially regulated sites have high species diversity, but you find species shifts in regulated areas. There are more dipterans at both of these sites in July than in October. Numbers of dipterans are reduced in October, because there was an early fall emergence of midges.

There were more mayflies at the control site in both months. Heptageniid mayflies are reduced in numbers in regulated areas. These species have their gills arranged to form a suction cup which assists in maintaining their position on rock surfaces. Rapid water fluctuations and increased algal growth probably impair the efficiency with which these species can maintain their positions in the boundary layer on the surface of rocks.

Stoneflies are found in greater numbers at the partially regulated site. *Pteronarcella badia* and the capniid and chloroperlid stoneflies are abundant in the main stem Flathead River. Stoneflies generally do not do well in regulated rivers (Radford and Hartland-Rowe 1971, Trotsky and Gregory 1974; Ward and Short 1978; Henricson and Miller 1979). The key here is probably the fact that the main stem Flathead River is only partially regulated. The addition of waters from the North and Middle Forks maintain the substrate by the flushing and redeposition of sediments during spring runoff. In the main stem Flathead River, insects can escape fluctuating flows by going down in the substrate. We have an extensive hyporheic (subterranean) habitat in the Flathead. The area was once a lake bed and there are deep deposits of cobble which apparently have a good flow of water through them. Certain stoneflies (e.g., *Isocapnia grandis*, *Isocapnia crinita*) live only in this subterranean habitat and we collect them only when they are getting ready to emerge and as adults.

Caddisflies show compositional differences in control and partially regulated areas. The hydropsychid caddisflies are a good example; *Symphitopsyche cockerelli* and *Symphitopsyche oslari* are much more abundant in control areas and *Arctopsyche grandis* is more abundant in partially regulated areas. These compositional differences may reflect changes in temperature or in the size of available food particles in partially regulated areas (Hauer 1980). These species are filter feeders and collect seston in the nets they spin. *Arctopsyche* is a large particle feeder; their net openings generally vary from 400-500 um, and the other two species

have nets with a smaller mesh size. It may also be related to the fact that the larger mesh nets are stronger and more able to withstand current fluctuations. We are size-fractionating carbon to determine if there are differences in the size of the available food particles in control and partially regulated areas.

We started fish food habits studies in April,1980. We are sampling the drift and the benthos when the fish we collect are feeding, so we will be able to use electivity indices. The food items in whitefish stomachs show a similar percent composition to that in the benthic samples at these sites, indicating that the whitefish are feeding mostly on the bottom (Figure 3). Two species of stoneflies (*Capnia confusa, Taenionema pacificum*) were abundant in the drift in regulated areas in April but were not common in whitefish stomachs. The whitefish appear to be selecting for certain caddisflies. Two species (*Glossosoma sp.* and *Ochrotrichia sp.*) were more abundant in the whitefish stomachs than in the benthic samples.

SUMMARY

We found the faunal composition to be markedly changed in the South Fork downstream from Hungry Horse Dam. Due to the addition of waters from the North and Middle Forks, the changes were much less marked in the partially regulated areas. The temperature and flow fluctuations were modified, the flushing and redeposition of sediments occurred during spring runoff and drifting insects could be supplied from upstream. However, there were still compositional changes in the benthic invertebrates in the partially regulated portion of the river.

The delineation of the factors responsible for these compositional differences requires further study. We need to know the environmental requirements of certain species or insect groups. This will enable us to manage regulated rivers to prevent further loss of species diversity and to enhance the food base for the fishery.

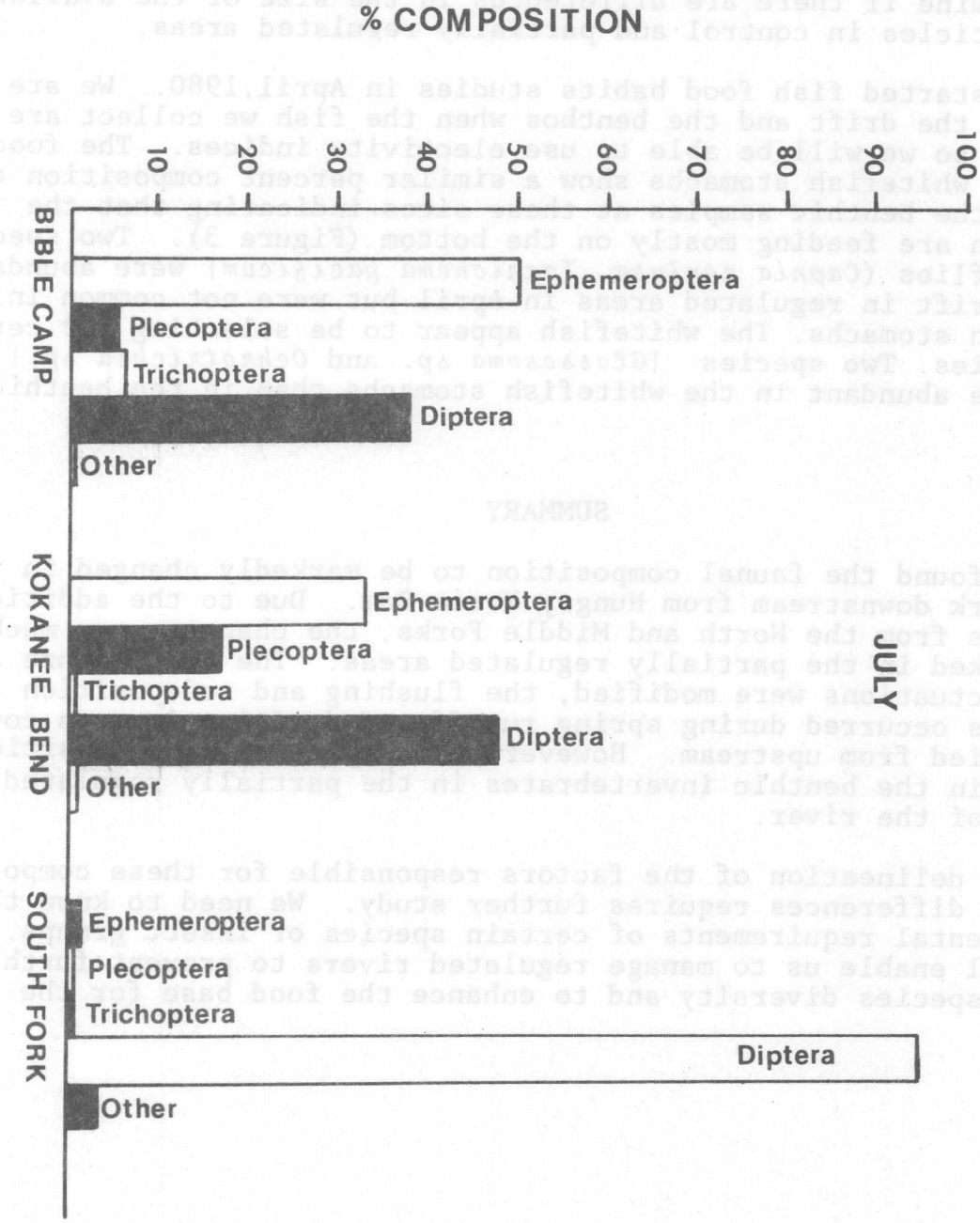

Figure 1. Percent of total number of insects represented by insect order(July, 1979) South Fork-regulated site, Bible Camp - control site, Kokanee Bend - partially regulated site.

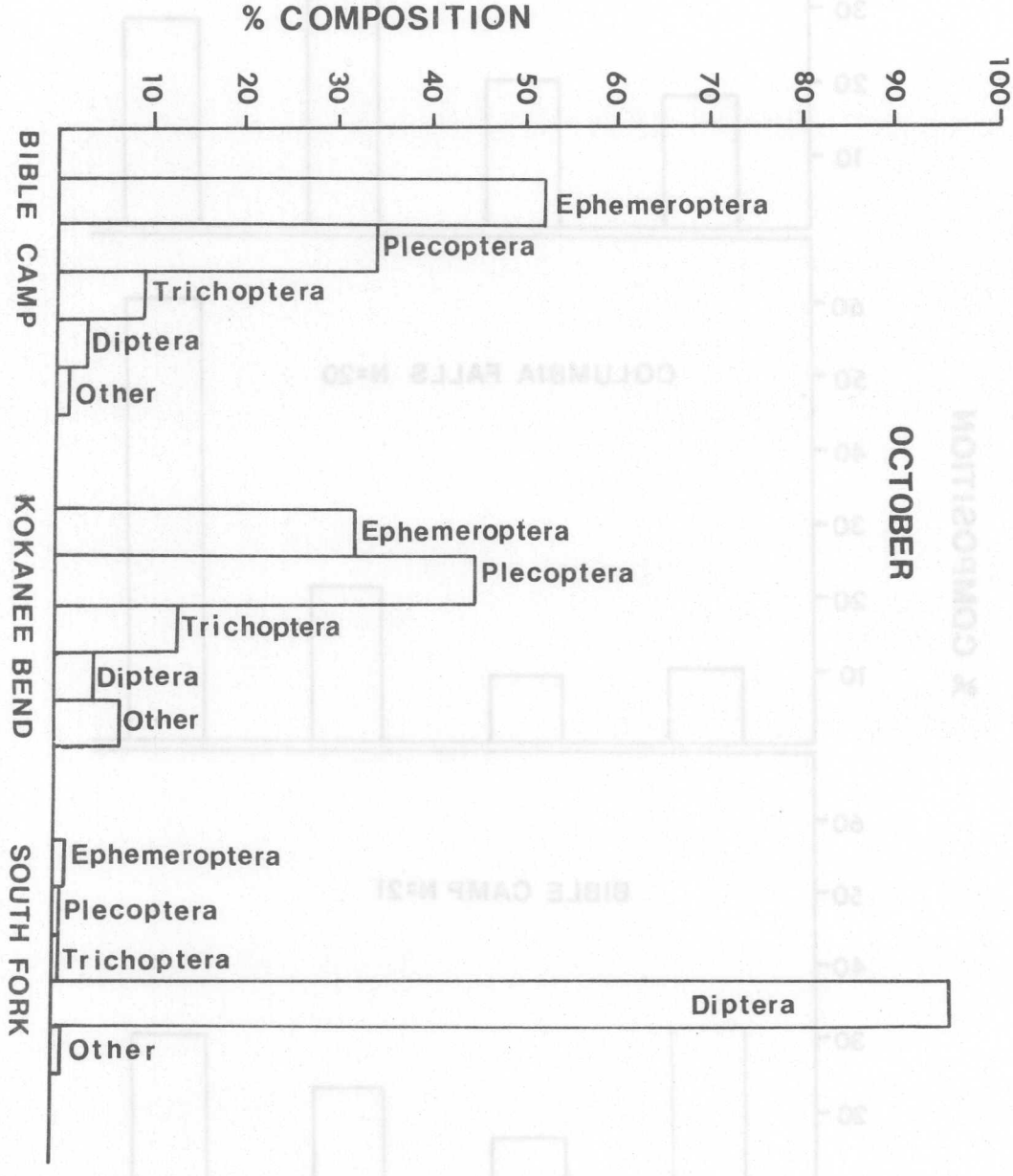

Figure 2. Percent of total number of insects represented by insect order (October, 1979). South Fork - regulated site; Bible Camp - control site; Kokanee Bend - partially regulated site.

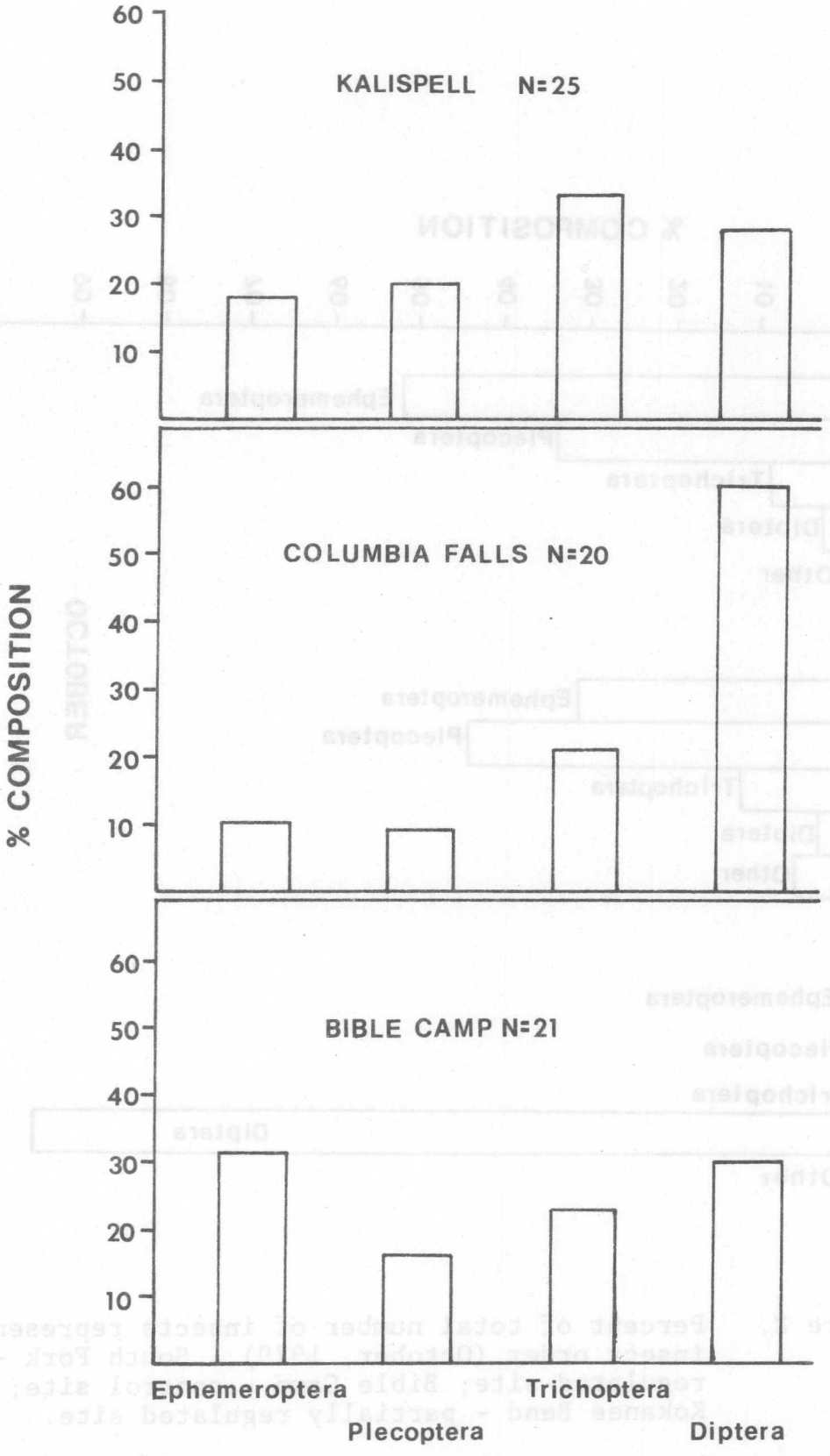

Figure 3. Percent composition of food items in mountain whitefish stomachs - April, 1980. Bible Camp - control site; Columbia Falls - most regulated site; Kalispell - farthest from influence of regulation.

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