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Interpreting Relative Productivity of South Boulder Creek by Systematic Stonefly (plecoptera) and Mayfly (ephemeroptera) Nymph Counts

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Abstract

Stonefly (plecoptera) and mayfly (ephemeroptera) nymph counts were taken during the spring of 1970 at selected sites along lower South Boulder Creek near Boulder, Colorado. Sites chosen were upstream from the town of Marshall and at several points further downstream between Marshall and Arapahoe Road. The optimum productivity was found between Marshall and South Boulder Road. Upstream from Marshall productivity was lower due to a lack of nutrient input. Downstream from South Boulder Road productivity decreased sharply. There were many nymphs but few were large enough to be counted. Productivity continued to decrease further down the stream until no nymphs could be found. This decrease was attributed to an above-optimum nutrient input, chemical input, and increased siltation. A strong correlation is noted between the size and quantity of trout in the stream and the results of the nymph count study.

Introduction

Stonefly (plecoptera) and mayfly (ephemeroptera) nymphs require relatively clean and well oxygenated water to live. Though the water must be relatively clean, nutrient inputs into a stream will increase its mayfly

and stonefly producing capability. Small amounts of raw sewage and phosphates are among the nutrients which increase productivity (Ryther, 1956). Heavy siltation will hamper reproduction of stoneflies and mayflies. Nymph counts provide a bases for interpreting why a stretch of stream is or is not at optimum productivity. In many cases an input of harmful pollution can be detected by nymph counts. Accurate stonefly and mayfly nymph counts show a strong correlation between the number of nymphs present and the quality and quantity of trout present in a stream. (This is due to the fact that) in many streams stoneflies and mayflies are a very important food of trout (Hoopes, 1960). South Boulder Creek is assumed to be an example of such a stream (due to) the predominance of these insects observed in the samples taken.

Methods and Materials

Nymphs were systematically collected from an 8-mile section of lower South Boulder Creek near Boulder, Colorado. Points for sampling were chosen which best suited the purpose of interpreting the productivity of lower South Boulder Creek (fig. 1). The points chosen were; a) 2 miles upstream from the town of Marshall, b) 1/4 mile downstream from Marshall, c) 1/2 mile downstream from Marshall, d) 1/4 mile upstream from South Boulder Road, e) 1/8 mile downstream from South Boulder Road, f) 1/8 mile upstream from Baseline Road, g) 1/2 mile downstream from Baseline Road, and h) 1/4 mile upstream from Arapahoe Road.

A Surber stream sampler (fig. 2) was used for the systematic collection of stonefly and mayfly nymphs. The sampler's base is open and is one tenth of a square meter in area. The sampler is open at the front, and the sides

are constructed from aluminum. The back is square and opens into a net which retains the debris and insects washed downstream into it. Tupperware containers 3 1/2 inches by 3 inches by 3 inches were used to carry the samples collected. A large shallow pan with a light-colored bottom was used for sorting the nymphs from the debris. Forceps were used to pick the nymphs out of the debris. A 70% alcohol solution was used to preserve some of the nymphs.

The samples were taken in early May of 1970 when the stream was still low and clear. For this kind of sampling it is important to do the field work before runoff from spring snowmelt has started. During runoff the water level is too high to obtain accurate results and the water is too murky to see the bottom. Late summer sampling does not give accurate results because many of the nymphs have molted to their adult stage by then.

All samples were taken from the faster sections of the stream where nymph life is most abundant. The samples were taken from a water depth of nine to eleven inches. Uniformity was sought in the size of rocks inside the boundary of the sampler. The rocks were generally about fist size.

The sampler was placed in the stream facing into the current while the investigator stood behind (downstream from) the sampler. The rocks in the boundary created by the sampler were picked up and washed in the current inside the sampler. Anything washed from the rocks was picked up by the current and washed into the net. Rocks toward the back ~~to~~ of the sampler were washed first and those toward the front were washed last. After the rocks were washed they were placed to the side of the sampler.

After the bottom within the boundary of the sampler had been cleared

the sampler was removed from the stream. The net was then carefully emptied into a container. Ten samples were taken from each sample location and yielded a bottom area of one square meter. Three containers were used to retain the samples from each location.

~~Upon gathering the samples from a location, sorting the~~ were ~~immediately~~ sorted nymphs from the accumulated debris ~~began. This was done~~ immediately after collection because the nymphs soon die, making sorting very difficult.

The samples were sorted one container at a time to avoid complication of sorting by having too much debris to look through. The contents of a container were spread out on the bottom of the pan and water was added to a depth of about 1/2 inch. The nymphs were then picked out of the pan with forceps and placed in a clean container for counting. The light bottom of the pan aided greatly in making the nymphs easier to see. Only those nymphs which had attained a certain size were counted due to ~~in~~ impracticality of counting all of the nymphs in the sample. ~~I did not count~~ mayfly nymphs less than 1/4 inch long and stonefly nymphs less than 1/2 inch long were not counted (measurement does not include tails or antennae). Relative ~~estimates of~~ numbers of smaller nymphs were ~~made~~ estimated. The data ~~was~~ were recorded and those nymphs not saved for preservation were released. This procedure was followed at all eight of the sample locations.

From several prior years of fly fishing on lower South Boulder Creek, during which several hundred trout were caught and released, estimates were made pertaining to the trout species dominance, quantity, and quality of the stream.

Results and Discussion

The results showed that nymph productivity was at an optimum between Marshall and South Boulder Road. Upstream from Marshall there was less then the optimum amount of nutrient material in the stream. Downstream from South Boulder Road the nutrient content exceeded optimum amounts and production dropped. A point was reached where production ceased entirely due to the high level of input of nutrients and other substanses into the stream. (fig. 3, Table 1). Nymph production can be interpreted as an index to the total productivity of the stream, and is particulary relevent to trout production.

The sample location 2 miles above Marshall (sample site "a") showed less than optimum productivity. This was interpreted as being due to a lack of nutrient sources above Marshall. Fourteen stonefly nymphs and 64 mayfly nymphs were counted at this sample location. There were only a few small uncountable nymphs observed here. The stream in this section is fast, with many boulders and fist-sized rocks. The bottom is generally gravel with little siltation noticable.

One quarter mile downstream from Marshall (sample site "b") the number of stonefly and mayfly nymphs increased greatly. Twenty-one stonefly nymphs and 103 mayfly nymphs were counted. There were also a few small uncountable nymphs. Nutrients are apparently gained as the stream flows through Marshall. At this location the stream takes on the form of a meandering pasture stream. Cattle graze in the pastures on both sides of the stream downstream from this point. The stream is fast, but curves and slows at large deep pools and runs. The bottom is gravel with fist-sized rocks. There is

little evidence of siltation. The bottom is more slippery here, indicating an increased nutrient availability in the stream. The increased nutrients available stimulate growth of algae and make the rocks more slippery (Ellis, 1937).

One half mile below Marshall (sample site"c") 29 stonefly nymphs and 119 mayfly nymphs were counted. This was the highest count found at any location. This increase was interpreted as being due to the added nutrients from the wastes of the cattle that graze on both sides of the stream. The stream conditions are the same as they are at sample site "b".

One quarter mile above South Boulder Road (sample site "d") the number of nymphs counted dropped slightly. Twenty-six stonefly nymphs and 107 mayfly nymphs were counted at this location. There were again a few small nymphs that were not counted. This small decrease could be due to a slight increase in nutrients to above an optimum level from cattle wastes accumulated from the last location 1 1/4 miles upstream. The optimum level was assumed to have been reached between sample site "c" and sample site "d". Stream conditions were the same ~~with the exception of the fact~~ that the stream had straightened somewhat.

One eighth mile below South Boulder Road (sample site "e") nymph production dropped drastically. Three stonefly nymphs were large encugh to be counted and 27 mayfly nymphs were counted. There were many small stonefly and mayfly nymphs at this location, yet the biomass of the nymphs was considerably less. Upstream a few feet a ditch that ran through Boulder entered South Boulder Creek. A great deal of silt was added from this ditch. Apparently the ditch also added a chemical to the stream that either retarded nymph growth or made the stream less inhabitable to the larger strains

of plecoptera and ephemeroptera, giving the smaller strains the edge in competition (Cook and Moore, 1969). The ~~only~~ conclusion ~~I can defend~~ is that the ditch added a chemical which was harmful to nymph biomass production.

One eighth mile upstream from Baseline Road (sample site "f") no stonefly nymphs of a countable size were found and 23 mayfly nymphs were counted. There were a great many small stonefly and mayfly nymphs. Stream conditions were the same here as at the last sample site ("e") 1 1/4 miles upstream except for a greater accumulation of silt.

One half mile downstream from Baseline Road (sample site "g") production had continued to decrease. ~~There were~~ no stonefly nymphs ~~counted~~ and only 17 mayfly nymphs were counted. At this site ~~there were~~ only a few small stonefly and mayfly nymphs were observed. Here the water was slower and there were less rocks ~~found~~ on the bottom. Silt and black mud were present in great quantities. Little gravel could be found, making reproduction nearly impossible for nymphs. Houses had replaced the pastures that had been along the creek.

One quarter mile upstream from Arapahoe Road (sample site "h") no nymphs were present in the stream. Production had ceased completely. At this final site there were few rocks and no gravel. The bottom was almost entirely black mud and silt.

A strong correlation between nymph production and the size and quantity of trout was noted on lower South Boulder Creek. Trout above Marshall ranged from 4 inches to 12 inches and averaged about 8 inches. A relatively good population of rainbow trout (Salmo gairdneri) existed upstream from Marshall. Between Marshall and South Boulder Road both rainbow trout and

brown trout (Salmo trutta) were numerous and ranged from 4 inches to 20 inches. The average trout was about 12 inches.in this section of the stream. Trout were rarely caught downstream from South Boulder Road, and those caught never exceeded 10 inches in lenght. These findings correlate strongly with the nymph count study.

Acknowledgments

I wish to extend special thanks to David Mann of Boulder, Colorado, who introduced me to the Surber stream sampling method and gave me valuable assistance in initiating my field work.

Literature Cited

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Ellis, M. M. 1937. Detection and Measurement of Stream Pollution. Bull. U. S. Bur. Fish., Vol 48: 363-365

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Ryther, John H. 1956 The Measurement of Primary Production. Limnol. and Oceanogr., 1: 72-84

Tables and figures need descriptive labels. Mechanics and interpretation are generally improved. There is still room for improvement but I rate this an A-

Figure 1 LOWER SOUTH BOULDER CREEK

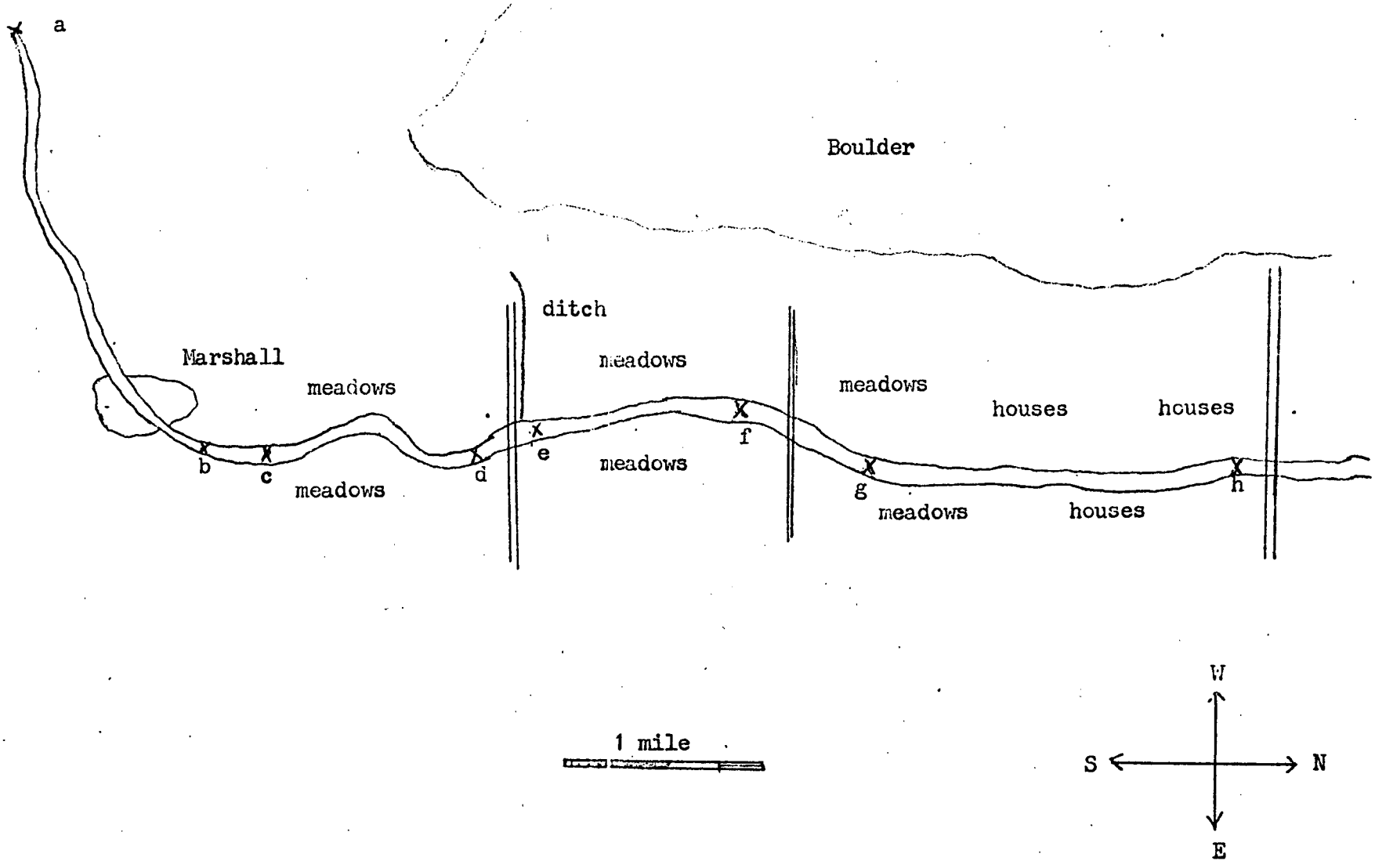
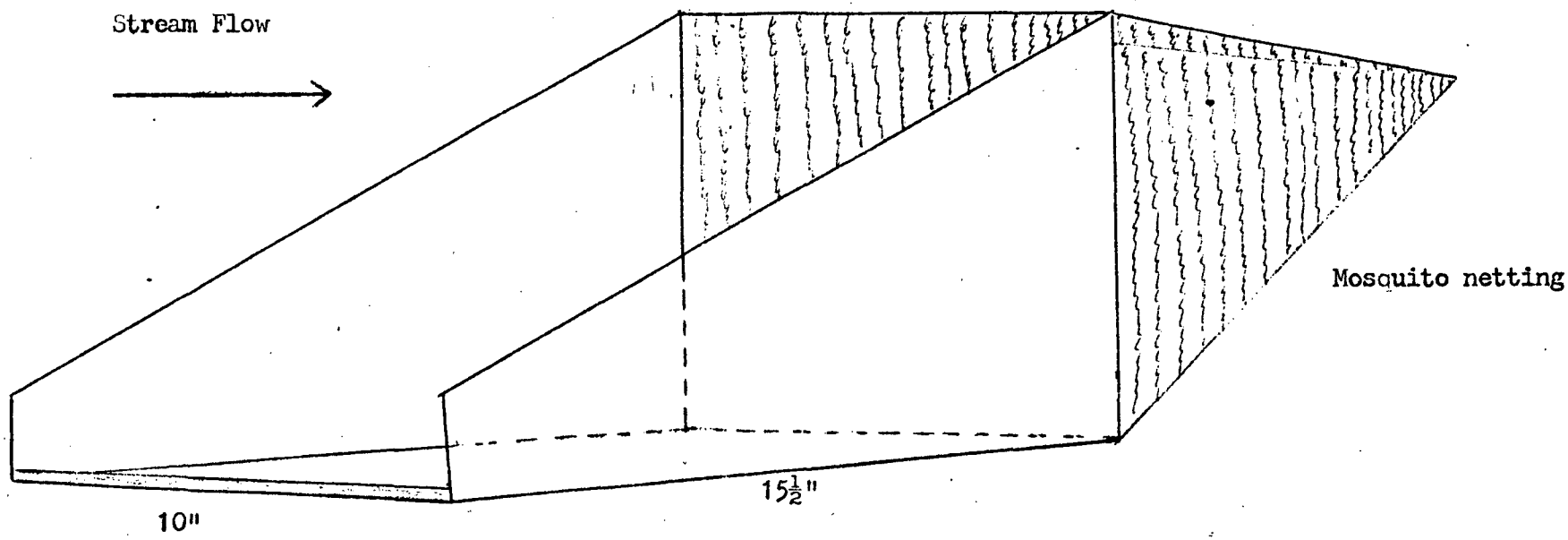


Figure 2

SURBER STREAM SAMPLER



Bottom is open.

Sides are aluminum.

Area of bottom of stream sampled is 1/10 square meter.

Table 1 Data and Observations

Location	~~# of~~ stonefly nymphs*	# of mayfly nymphs*	Observations
a) 2 miles upstream from Marshall	14 Large / Small uncountable few a few ~~small~~ uncountable	64 a few small uncountable	~~the~~ stream is fast ~~with~~ lots of boulders, many fist-size rocks, gravel bottom
b) 1/4 mile downstream from Marshall	21 few a few ~~small~~ uncountable	103 a few small uncountable	stream fast with deep pools, gravel bottom, fist-size rocks.
c) 1/2 mile downstream from Marshall	29 few a few ~~small~~ uncountable	119 a few small uncountable	stream fast with deep pools, gravel bottom, fist size rocks, ~~meadows on sides~~
d) 1/4 mile upstream from S. Boulder Road	26 few a few ~~small~~ uncountable	107 a few small uncountable	stream fast with deep pools, gravel bottom, fist size rocks, meadows on sides
e) 1/8 mile downstream from S. Boulder Road	3 many many ~~small~~ uncountable	27 many small uncountable	stream slower, fist size rocks spaced more black silt, meadows on sides
f) 1/8 mile upstream from Baseline Road	0 very many many ~~many~~ small uncountable	23 many small uncountable	stream slower, fewer rocks, more silt
g) 1/2 mile downstream from Baseline Road	0 few a few ~~small~~ uncountable	17 a few small uncountable	stream slow, less rocks and more silt
h) 1/4 mile upstream from Arapahoe Road	0 none present	0 none present	very muddy and silty, very few rocks

* number of nymphs which have reached a certain size in a square meter of stream bottom

Figure 3

GRAPHIC RESULTS OF NYMPH COUNTS