EFFECTS OF TRAMPLING ON STREAM BIOTA IN SILVER CREEK

A Research Report

to

The Nature Conservancy

August 1983

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Introduction

The response of aquatic macroinvertebrates and macrophytes to disturbances such as floods, sedimentation, drought, and toxic wastes has been well documented (Davis and Brinson 1980); however, no research to date has thoroughly assessed the impact of trampling by fishermen on stream biota. Significant fishing pressure on The Nature Conservancy Silver Creek Preserve has prompted this study to evaluate the impacts if any,trampling may have on aquatic macroinvertebrates and vegetation.

The substrate of Silver Creek is colonized by heavy growths of aquatic macrophytes, the primary species being *Chara vulgaris*. *Chara vulgaris* beds support a large macroinvertebrate population which utilizes the plant as a colonizing substrate. Should this substrate be eliminated or significantly altered by physical disturbance, a corresponding response might occur in the macroinvertebrate community due to the decrease in the surface area of aquatic vegetation in Silver Creek. Fishermen walk through these plant beds creating distinct trails or localities where much of the vegetation has been crushed and or eliminated from the stream bottom, exposing fine sediment. The precipitation of calcium carbonate during photosynthesis makes *C. vulgaris* particularly susceptible to trampling. This calcium carbonate layer is readily crushed when *C. vulgaris* is walked upon, resulting in damage or death of the plant. It is the concern of The Nature Conservancy that if fishing pressure on the preserve rises above a certain level the *Chara* beds may be severely affected, resulting in a significant decrease in standing crop of aquatic macroinvertebrates. The implication is a decrease in the food supply of trout species in Silver Creek. There also exists the possibility of a major negative impact on the aesthetic value of the preserve.

The two major objectives of this survey were:

1. To assess the impact of trampling on the standing crop of Chara vulgaris in Silver Creek.

2. To assess changes in the macroinvertebrate community stimulated by trampling of Chara vulgaris beds.

Methods and Materials

The study area was located in the main channel of Silver Creek immediately below The Nature Conservancy cabin. Six exclosures were established on 16 June 1983 to prevent fishermen from walking through the plots. Orange fiberglass posts and orange twine were used to encircle C. vulgaris beds ranging in size from 1 m X 2 m to 2 m X 3 m, to make them as visible as possible. The six plots were selected to maximize physical similarities between plots in terms of current velocity, water depth, and solar insolation.

A single sample from each of the six C. vulgaris plots was taken on 17 June with a Hess net (mesh size 0.39 mm) to assess pre-trampling composition and abundance of aquatic macroinvertebrates and to estimate biomass of C. vulgaris. Samples were preserved in ethyl alcohol in the field and later sorted to separate invertebrates from plants and debris. Macroinvertebrates were identified to order or family. Chara vulgaris was dried in a wet drying oven at 58 C for 24 hours and then weighed to determine biomass.

Trampling was initiated on 17 June and terminated on 20 July . Each of the six plots was randomly assigned a number ranging from one to six.

Plot number one was walked through a single time the first week, as were the other five plots. During the second week, plot number two was walked through a second and final time, while plots three to six received their second trampling of the series. During each successive week, the plots were trampled until plot number six had been walked through a total of six times. Each trampling was superimposed on the former until a noticeable channel began to appear. This was done to simulate as closely as possible the varying conditions of trampling actually present in Silver Creek due to wading by fishermen. On 27 July, Hess samples were taken from the portion of each plot which had been trampled by researchers to assess cumulative impacts on aquatic macroinvertebrates and C. vulgaris.

Results

No significant correlation was found between the number of times C. vulgaris was trampled and plant biomass during the period of study ($r= 0.04$). These weights are found in Table 1. The percentage of live plant material remaining in each sample from the six plots after trampling was estimated (Table 1). There was a proportional increase in the percentage of dead plant material possibly associated with trampling, and this is illustrated in Figure 1. It was estimated that following the fifth and sixth trampling, nearly 50% of the C. vulgaris per sample was dead or dying. Dead or dying plant material was defined as that which apparently had ceased photosynthesizing and was yellow in color. "Control" areas of each plot stayed green.

A significant correlation was also not found between the number of times an area was trampled and total numbers of macroinvertebrates present ($r= 0.21$). These data are found in Table 2. Aquatic macroinvertebrates were separated into three categories according to substrate

Table 1. *Total biomass of *Chara vulgaris* samples taken on 17 June and 27 July 1983. Estimates are in grams/m^2.

Plot Number	17 June	27 July	% live plant material
1	261.92	221.92	95-100
2	1362.88	1002.88	85-95
3	432.80	661.92	75-85
4	289.76	876.00	65-75
5	900.16	1019.68	55-65
6	845.60	362.72	50-55

* The percent live plant material were visual estimates from samples taken on 27 July. The weights presented are total standing crop which included any dead plant material.

Figure 1. Biomass of *Chara vulgaris* samples taken on 17 June and 27 July 1983. The shaded regions are estimates of the percentage of dead plant material per sample taken on 27 July.

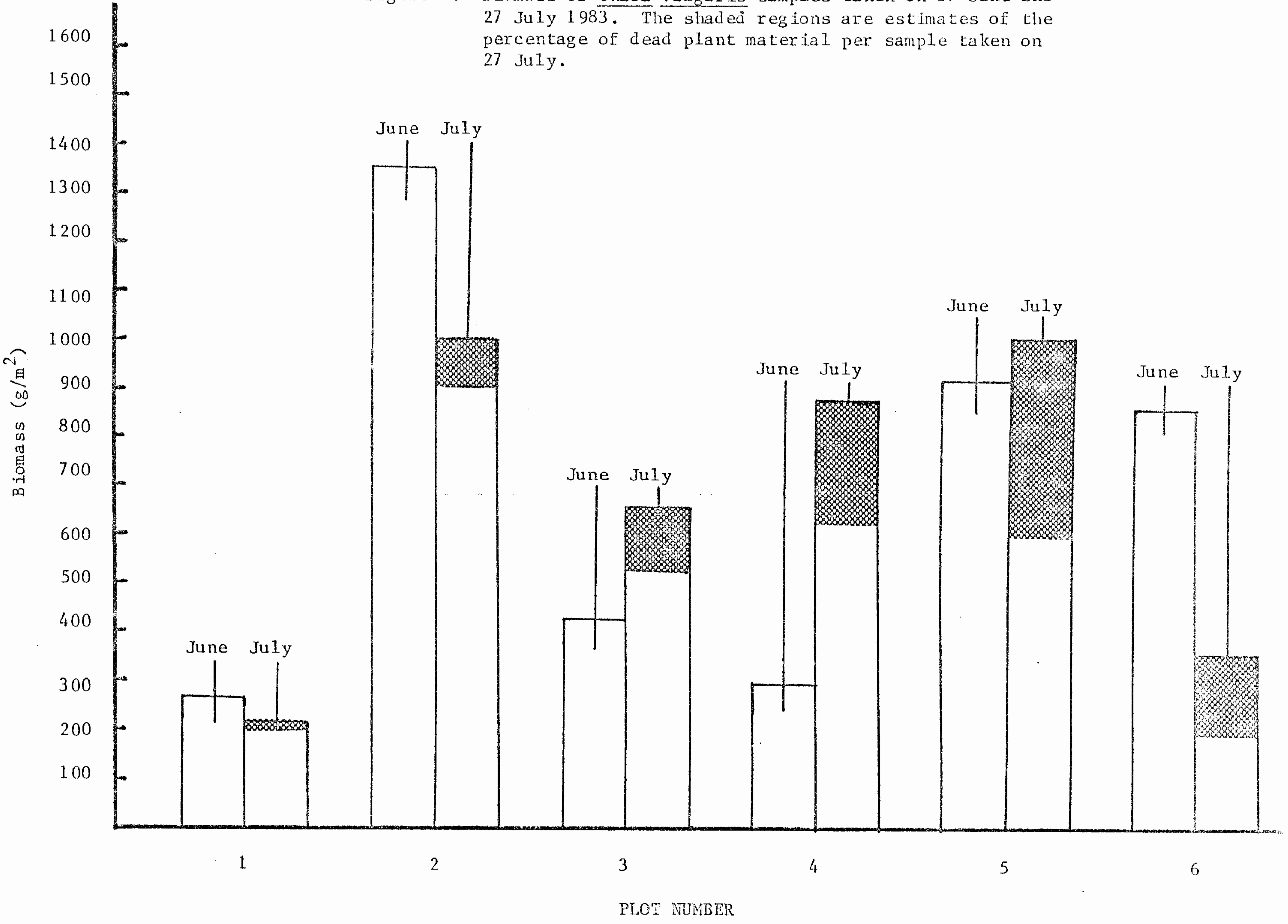


Table 2. Numbers of aquatic macroinvertebrates per m^2 sample taken on 17 June and 27 July 1983 in Silver Creek.

	17 June 1983						27 July 1983					
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
Chironomidae	9840	3648	8448	11136	4640	4944	432	6608	2064	3232	3920	3552
Ephemeroptera	5520	4656	12928	11712	13360	18416	2848	16656	11616	16864	10832	8304
Trichoptera	608	256	288	736	640	2448	48	288	160	288	960	160
Amphipoda	176	464	1152	912	1264	736	32	1392	2448	1184	2368	720
Annelida	1248	224	464	448	448	208	128	6432	1088	4848	4400	1552
Coleoptera	32	16	32	0	0	32	0	16	32	16	80	32
Hirudinea	304	560	240	160	64	0	320	1344	2368	2592	1984	480
Pelecypoda	352	0	16	0	16	0	112	272	96	32	320	304
Gastropoda	0	0	16	0	0	0	0	16	16	16	0	0
Culicidae	0	0	0	0	0	0	0	16	32	0	0	0
Odonata	0	0	48	16	64	112	0	0	0	0	0	0
Plecoptera	0	32	64	32	48	112	0	0	0	0	48	0
Hydracarina	0	0	0	0	0	32	0	0	16	0	0	16
Gerridae	0	0	0	16	0	0	0	0	0	0	0	0
Hemiptera	0	0	0	0	0	0	0	0	0	0	16	16
Diptera	32	0	0	16	48	48	0	112	16	48	0	0
TOTAL	18112	9856	23696	25184	20592	27088	3920	33152	19952	29120	24928	15136

preference in an attempt to discern differences which may not have been detected by correlation analysis. The first category was those invertebrates which preferred sediment [Chironomidae (midges), Annelida (segmented worms), Pelecypoda (clams, mussels)]. The second category was those taxa which were physically attached to C. vulgaris such as trichopterans (caddisflies) and dipterans (flies, excluding immature chironomids). The third group was those macroinvertebrates which were feeding or resting in the plant growth, but not firmly attached to it. These included:

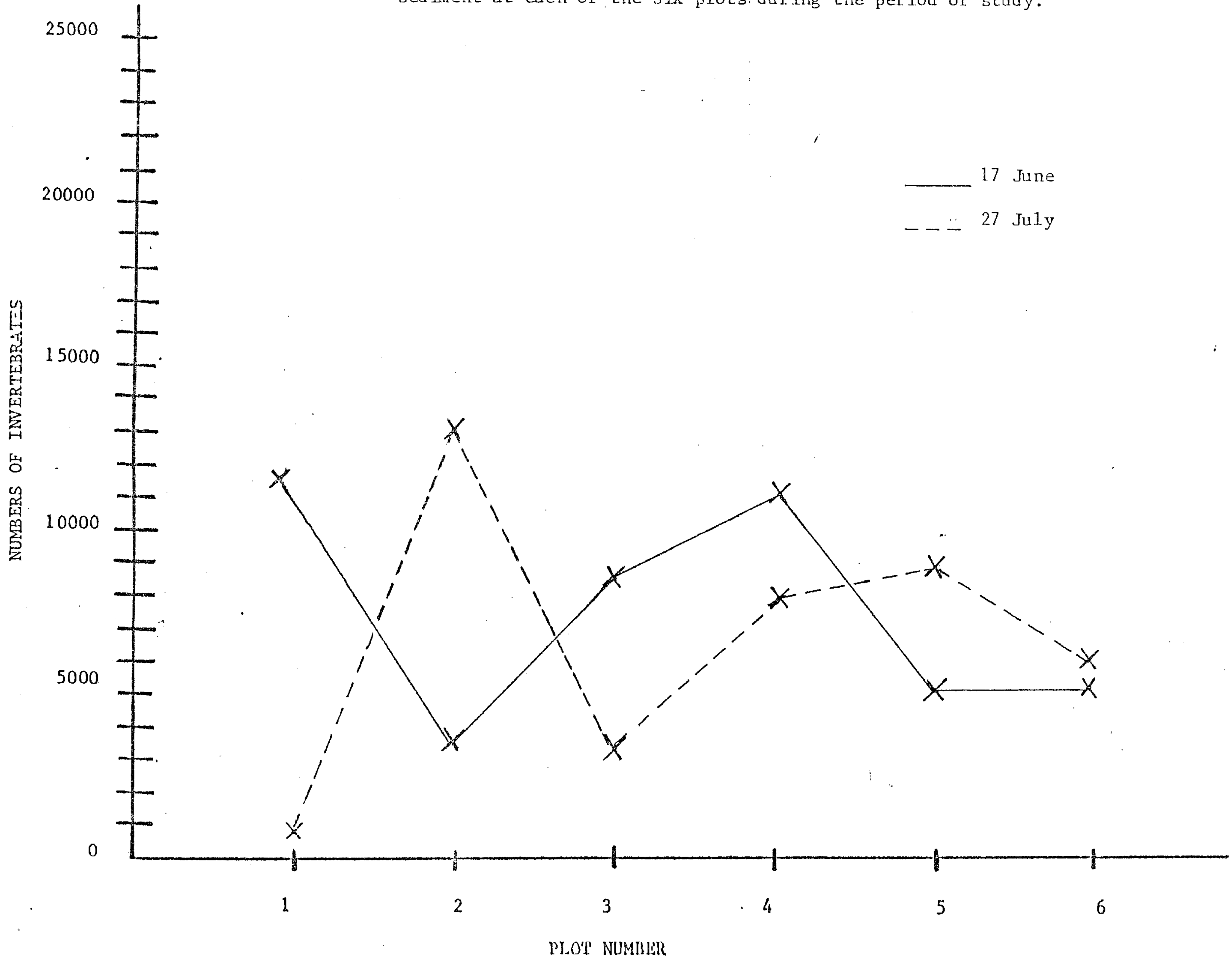
- Ephemeroptera (mayflies)
- Amphipoda (shrimp)
- Coleoptera (beetles)
- Hirudinea (leeches)
- Gastropoda (snails)
- Culicidae (mosquitoes)
- Odonata (dragonflies, damselflies)
- Plecoptera (stoneflies)
- Hydracarina (water mites)
- Gerridae (water striders)
- Hemiptera (true bugs)

Those aquatic macroinvertebrates preferring sediment did not show a noticeable trend to decline as the number of tramplings increased (Figure 2). Numbers of those taxa which were attached to C. vulgaris were lower following trampling at all plots except number five but not significantly as can be seen in Figure 3. The third category of macroinvertebrates also did not show a trend to decline except in plot six where there was approximately a 50% decline in the numbers of these taxa (Figure 4).

Discussion

These results suggest that trampling may not adversely affect stream biota in Silver Creek; however, this may be misleading for several reasons. Firstly, we may not have simulated the degree of trampling actually present on the streambed. Our observations suggest that C. vulgaris begins to die and slough off the substrate after being walked on four to five times. Following the sixth trampling, Chara beds

Figure 2. Number of aquatic macroinvertebrates which are associated with sediment at each of the six plots during the period of study.



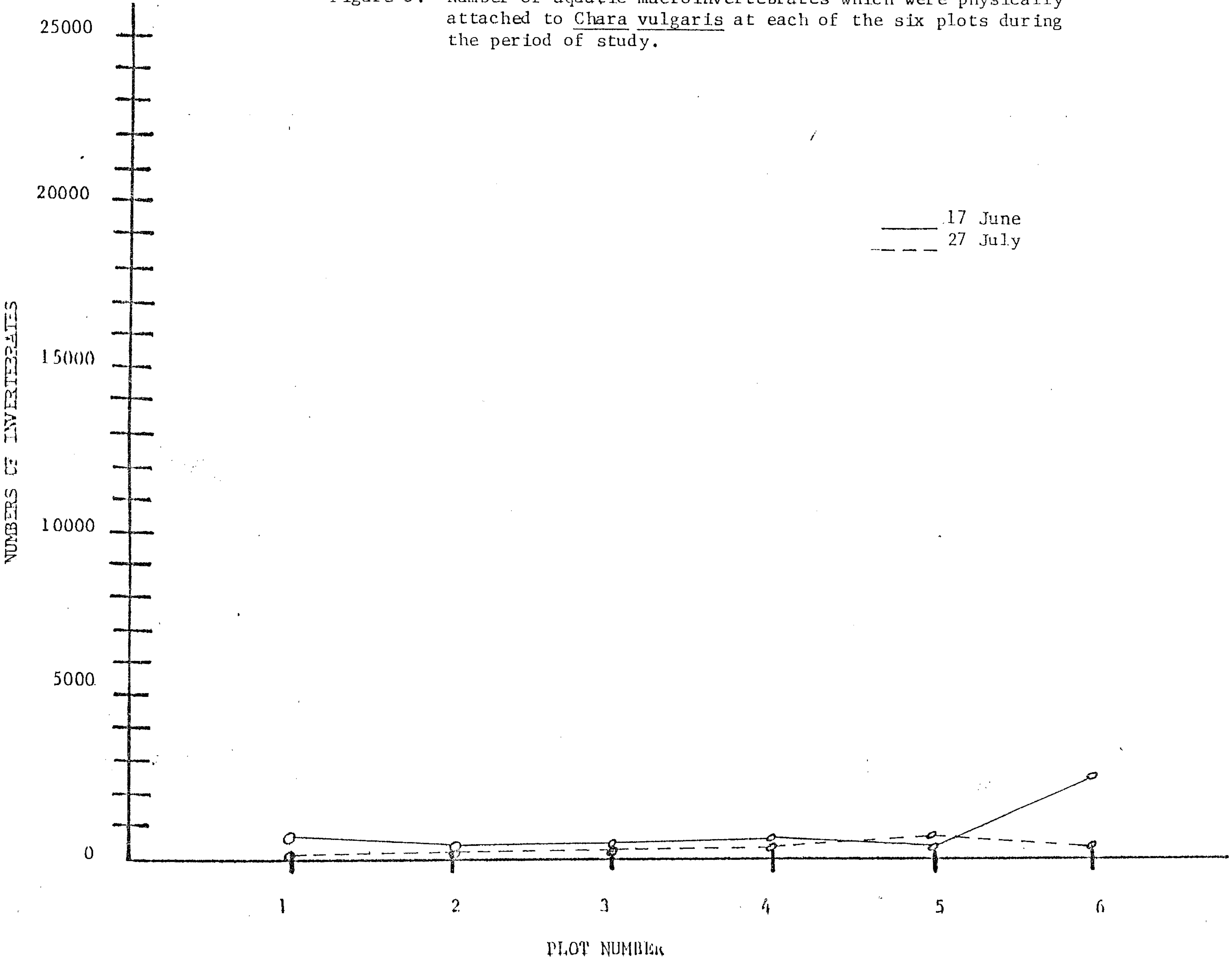


Figure 3. Number of aquatic macroinvertebrates which were physically attached to Chara vulgaris at each of the six plots during the period of study.

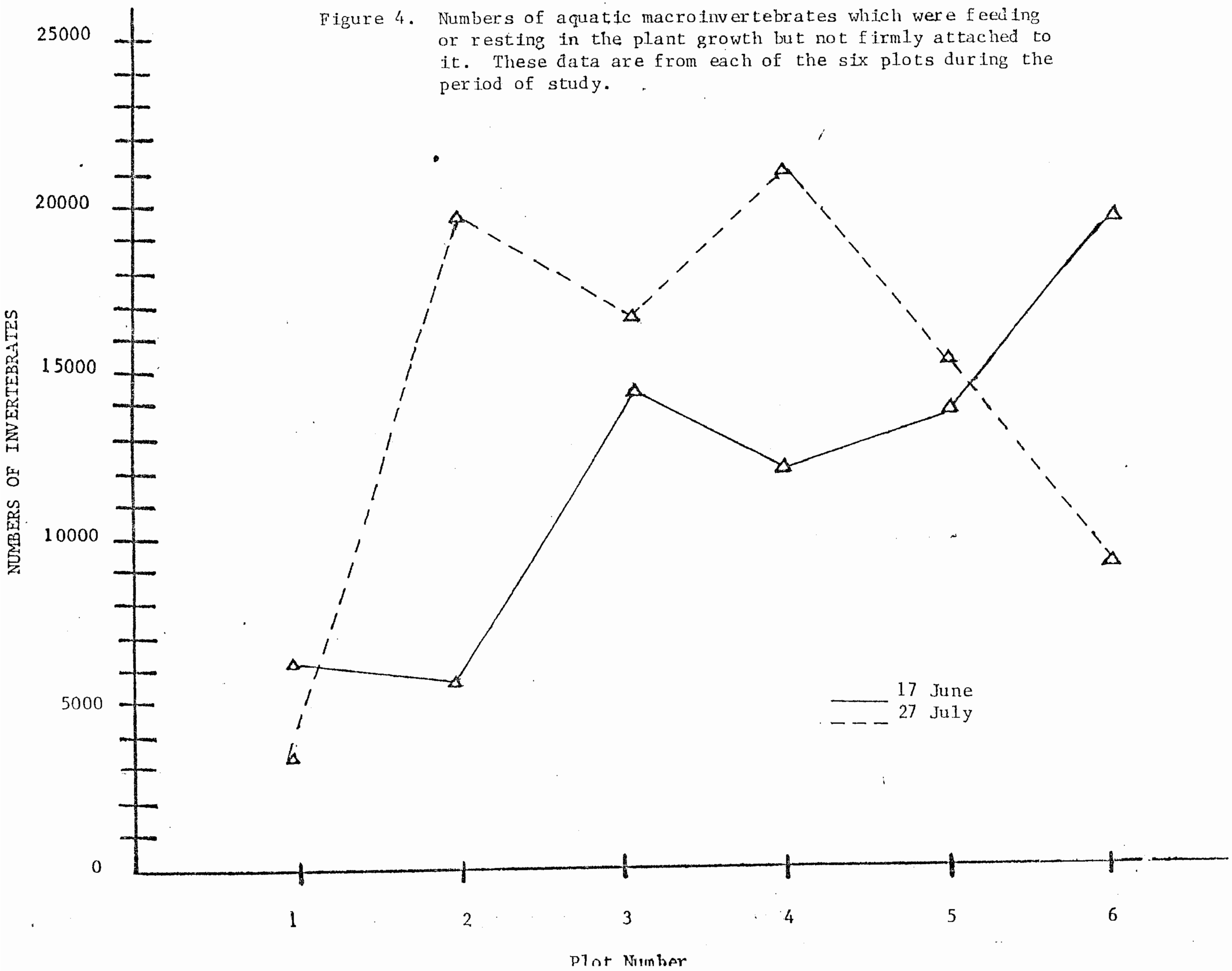


Figure 4. Numbers of aquatic macroinvertebrates which were feeding or resting in the plant growth but not firmly attached to it. These data are from each of the six plots during the period of study.

had distinct trails through them and fine sediment substrate was partially exposed. Certain sections of the stream bottom where fishermen have trampled were totally devoid of aquatic vegetation making it unsuitable for colonization by most species of macroinvertebrates in Silver Creek. We had few areas in our six plots where vegetation was completely absent, and therefore may not have acquired our anticipated end result of simulating the degree of trampling caused by fishermen. Secondly, only one benthic invertebrate sample per plot was taken at each sampling period and this is a small sample size. Thirdly, when C. vulgaris samples were weighed to obtain biomass estimates, it was difficult to separate the live from the dead plant material. This would result in inflated estimates of standing crop of Chara and a masking of differences which may have existed.

The decrease in invertebrate numbers observed in plots one and three cannot be directly correlated to the degree of trampling. In plot number one, plant biomass decreased insignificantly and in plot three Chara biomass was actually greater. It is only in plot six that the decrease in invertebrates may possibly be associated with the degree of trampling. Biomass of C. vulgaris decreased by approximately 50% as did numbers of invertebrates in the sample taken in this exclosure.

No consistent trends were observed in particular groups of invertebrates between sampling periods. Temporal variability of invertebrates may explain some of our results (Minshall et al. 1982). Francis and Bjornn (1979) reported variability in the abundance of aquatic macroinvertebrates in their vegetation benthos samples in Silver Creek. Since they sampled at approximately the same dates as we did, this would lend further support to temporal variation of numbers of invertebrates. Also, macroinvertebrates may not leave the surface of C.

vulgaris and enter the drift until the *Chara* itself is dislodged from the stream bottom and carried downstream. It appears that the viability of the vegetation is not important in determining invertebrate density since it was readily colonized despite being alive or dead. It is not apparent that *Chara* itself is a food source for aquatic macroinvertebrates. It is more probable that because of the calcium carbonate layer, *C. vulgaris* is not a preferred food source, but that instead most nutrition is derived from epiphyton colonizing the plant surface. Thus, *C. vulgaris* indirectly may be a very essential biotic component of the Silver Creek ecosystem.

Recommendations

1. Four of five benthic invertebrate samples per plot should be taken. This would enhance statistical analysis and enable biologists to more readily detect trends should they exist.

2. Trampling effects should be monitored throughout the growing season of *C. vulgaris* to assess temporal variability of aquatic macroinvertebrates.

3. Underwater photography should be continued to establish a visual record of the effects of trampling on aquatic vegetation.

4. Benthic invertebrate samples should be taken from areas which have been trampled by fishermen to draw comparisons.

5. A chemical such as tetrazolium should be used to test for viability of *C. vulgaris* samples in the field. This would improve the accuracy of biomass estimates.

LITERATURE CITED

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