Effects of Overwinter Drawdown on Bushy Pondweed

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INTRODUCTION

Kahle Lake, in Clarion and Venango Counties, Pennsylvania, was created in 1974 under the jurisdiction of the Pennsylvania Fish Commission by impounding Mill Creek. The lake has a surface area of 102 hectares with a normal depth of 12 meters at the dam and a relatively uniform bottom consisting mostly of clay with scattered stumps and boulders. Few aquatic vascular plants were present until early autumn, 1976, at which time they appeared in the shallow regions of the lake. Subsequently, the submergent vegetation has impeded fishing activities. For a detailed description of the lake and surrounding area, see Kaufman (3).

The submersed macrophyte community in Kahle Lake was comprised primarily of bushy pondweed *Najas flexilis* (Wild.) R&S which constituted 80-90% of the submersed vegetation in Kahle Lake. Several other submergents present were: floating pondweed, *Potamogeton natans* L.; *P. confervoides*; Vasey's pondweed, *P. vaseyi* Robbins; and ribbonleaf pondweed, *P. epihydries* Raf. These other species constituted a very small proportion of the total aquatic vegetation. Prior to and after drawdown, the sample site contained only bushy pondweed. Bushy pondweed is considered one of the most common species in the genus *Najas* and in suitable environments is known to develop highly homogeneous stands (5, 8).

Abundant growth of aquatic vascular plants at Kahle Lake has created a weed problem which is especially apparent in the areas of shallow water. In September, 1977, prior to drawdown, 7% of the entire lake and 74% of the shoreline was covered with vegetation leaving approximately 19% of the available shoreline free of vegetation.

MATERIALS AND METHODS

Plant sampling done before and after drawdown of the water level (2 meters) was accomplished with a 0.25 m^2 quadrat sampler with a metal base surrounded by wood supports and 6 mm hardware cloth that extends 1 m in height. A small rake was used to gather the plants from within the sampler. This technique has been used by other investigators in obtaining quantitative samples (2, 6).

A research site 100 m^2 was established parallel to the shoreline and sectioned into 1 m^2 plots. At each sampling period, ten 1 m^2 plots were randomly chosen (7), the sampler was placed within the plot, and the vegetation removed.

In the laboratory, each sample was washed in tap water to remove debris and dried at 105 C for 24 hours (1, 10). Dried plant material was then weighed to determine standing crop biomass ($gm/^2$ dry weight) and productivity was calculated as $gm/m^2/$ day. Productivity calculations were done between each successive sample period. Ranges in productivity were obtained from high and low values.

The non-parametric Kruskal-Wallis test was applied to the plant biomass data for the analysis of differences in standing crop between dates. The appropriate *a posteriori* test is the nonparametric Range Simultaneous Test Procedure (STP) and this was used to determine the location of the differences (9).

RESULTS AND DISCUSSION

Drawdown proved to be ineffective in controlling the abundant growth of the bushy pondweed in Kahle Lake. The data show that the amount of rooted vegetation was considerably less in September, 1978 than September, 1977. But because of the production that took place earlier in the growing season, the problems of mobility in the shoreline areas were as great in September, 1978 as they were in September, 1977.

Quadrats sampled early in September 1978 contained thick mats of algae (*Spirogyra* sp. and *Volvox* spp.) which were inseparable from the vascular plants. The samples taken on September 30, 1978, consisted primarily of dead plants and the algal bloom that covered the study area during the previous sampling was greatly reduced.

In April, 1978, no plants were observed either in the study areas or in other shallow water areas of the lake. The water had attained its normal level about 2 weeks prior to the April sampling date. By June, plants about 7.6 cm high were growing throughout the shallow water regions of the lake and the clumped distribution of bushy pondweed was easily detected. By July the macrophytes had reached nuisance levels by completely clogging the sample site.

The non-parametric Kruskal-Wallis test (9) was used to analyze the biomass data because of the lack of homogeneity of variances as revealed by Bartlett's test (9). The Kruskal-Wallis test showed that the biomass differed markedly from one date to another. The Range Simultaneous Test Procedure (STP) revealed differences between all dates except the following pairs: September, 1977 and July 1978; June, 1978 and September 2, 1978; June, 1978 and September 30, 1978.

Non-parametric statistical analyses were necessary due to the lack of homogeneity of variances of the data. When the April, 1978 sample period was removed and the other variances analyzed, homogeneity resulted. Lack of homogeneity can therefore be attributed to the April, 1978 sample period. Variances of growth data are often heterogeneous. The Kruskal Wallis test showed that standing crop biomass differed markedly between dates and an *a posteriori* test (Range STP) reveals where the differences lie. There was no difference between September, 1977 and July, 1978 samples. Those samples were the largest overall. The other pairs that were not different according to the Range STP test were those with small samples, June, 1978 and two samples of September, 1978.

Differences between sample 1 and 6 could be attributed to several causes; the most probable being the very extensive algal bloom present in the lake in late summer, early fall 1978 which was pronounced by September 2 and persisted through September. The algal growth blocks out much of the light necessary for photosynthesis by aquatic vasculars. Early death and decomposition of plants in those areas may have resulted from the algae bloom. In areas not plagued by the bloom, bushy pondweed seemed to be doing well until the September 30 sampling.

Bushy pondweed has been found to be not only resistant to drawdown, but actually enhanced by it (4). Our observations supported this concept or at best indicated bushy pondweed was affected very little by drawdown. Insufficient data are available from 1977 samples to indicate whether the macrophyte thrived on drawdown or not. The luxuriant growth during the 1978 growing season indicates that the problem certainly was not alleviated. *Najas* reproduces primarily from seeds rather than from rhizomes which may be one reason that reproduction is not hindered by drawdown. Those species reproducing vegetatively from rhizomes may be more likely to be affected by drawdown, giving *Najas* a selective advantage in this circumstance.

The standing crop biomass for each of the dates sampled was divided by the number of days that had elapsed since the last sample. Turnover rates are not accounted for in these calculations. The high and low values of each sample involved were used to calculate the range of productivity. Standing crop data were not normally distributed, therefore confidence intervals were not utilized. A positive net productivity occurred between April and June, 1978 and between June and July, 1978. Negative net productivities resulted between July and September 2, 1978 and between September 2 and 30, 1978. The peak standing crop appeared in the July sampling. No calculations could be made for samples 1 and 2. (Table 1.)

Although productivity was calculated between each sampling period rather than over the entire growing season, the ranges were large. The productivity calculation showed that there was a positive productivity from April to July, 1978, with the height of production occurring in July. From July, 1978 to September 30, 1978, negative net productivities resulted, the greatest occurring between July and September 2, 1978. Negative net productivity may have been the result of utilization of more products than were being produced or the result of intensive grazing; the former being more likely. Even though harvest methods provide accurate information on the amount of plant life potentially available for use by higher trophic levels, turnover rates are not reflected. Therefore, these productivity calculations are

TABLE 1. PRODUCTIVITY CALCULATIONS.

	Sample #1 September 30, 1977	Sample #2 April 28, 1978	Sample #3 June 16, 1978	Sample #4 July 28, 1978	Sample #5 September 2, 1978	Sample #6 September 30, 1978
n	10	10	10	10	10	10
Number of days since last sample	*	211	48	42	36	28
High value (gm/m² dry weight)	351.8	0	37.2	205.6	94.8	48.4
Low value (gm/m² dry weight)	57.3	0	4.4	46.8	6.8	04.
Productivity Range	NC	0	0.775 to 0.092	4.120 to 1.022	−0.833 to −1.487	−0.242 to −0.819

*First sample.
NC = no calculation.

not accurate estimates of net production over time for this community.

All limnological characteristics measured served only to descriptively characterize the environment of study organism and due to the infrequency of sampling periods and limited number of samples the standard error, variability and confidence intervals were too great to make reliable statements concerning water quality. Any pulses observed in these data are coincidental and cannot be used to exemplify a described pattern. Since water samples were taken from the surface water in the sample area some of the variability in the measurements may be attributed to local differences resulting from the dense vegetation.

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