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FARM POND RESTORATION USING CHARA VULGARIS VEGETATION

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Abstract

Four aged Madison County, New York farm ponds were selected to see if various treatments could be used to restore the water quality. One pond was untreated and used as a control; another pond was partially drained and exposed to the drying and oxidizing effects of the air over the fall and winter; the other two ponds were drained and the accumulated sediment removed by bulldozing. In these latter two ponds, *Chara vulgaris* vegetation was inoculated following the restoration process. *C. vulgaris* growth rapidly became the dominant producer where this inoculation was accomplished in the fall of 1976, and it is expected that the other pond will also become a *C. vulgaris* pond in 1978 – after its oogonia have undergone the requisite winter dormancy period.

Early *C. vulgaris* growth was found to be associated with clear water conditions and lessened phytoplankton growth; short, bushy, light-inhibited growth by the algae stabilized the bottom against wind-caused turbidity because of its rhizoidal growth within the substrate. Pioneer *C. vulgaris* growth was also found to be highly productive, significantly lowering the pond's CO_2 readings.

Investigators of aquatic systems are cautioned to be cognizant of the effect of epiphytic growth on successional events in such environments. Such epiphytes are surely important, if not prime, causes of the demise of various aquatic macrophytes.

The partial draining and exposing of a pond over the fall and winter did not yield significantly improved water conditions.

Introduction

Maintaining the water quality of manmade aquatic systems is a constant problem. For example, owners of farm ponds desire clear, well-oxygenated water free from phytoplankton algae blooms in order to satisfy the multiple-uses – swimming, watering, fishing – of these water resources. Many investigators have previously determined that the growth of submerged macrophytes discourages phytoplankton blooms (Boyd, 1971; Goulder, 1969; Hasler, 1949; Myers, 1973). In addition the pond should contain the type of macrophytic vegetation which would also stabilize the substrate from wind-caused turbidity and enhance fish production. For these reasons, the search for a beneficial farm pond macrophyte seems a worthwhile quest.

Authors of articles concerning aquatic vegetation view the presence of the macrophytic alga, *Chara vulgaris*, L. (Smith, 1950; Robinson, 1906) in two completely different ways. One author views the alga as a pest and seeks methods to eradicate the entire *C. vulgaris* population along with all the other submerged macrophytes; another author lists the attributes of the alga and expounds on its beneficial effects in an aquatic environment.

The answer to such conflicting views requires consideration of where the specific *C. vulgaris* population in question fits into the successional events occurring in that aquatic system. Previous research by the author indicated that *C. vulgaris* is initially found as a pioneer species, filling the niche of the submerged macrophyte before higher angiosperms, such as *Potamogeton* sp. or *Najas* sp., replace it in natural successional events or before phytoplankton populations become the dominant producers. As long as *C. vulgaris* is in an early pioneer stage, its beneficial effects on the water quality are apparent; as it becomes replaced by other successional species, it loses its control over the aquatic habitat and becomes

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labelled a pest along with the other producers. This same earlier research found that Chara-dominated ponds had significantly lower free carbon dioxide, alkalinity, and hardness readings. Low phytoplankton productivity and low phosphate were associated with high dissolved oxygen and high Secchi disk readings in these ponds where *Chara vulgaris* was dominant (Crawford, 1977). Crocker (1948) reports a definite decrease in turbidity and the establishment of clear water conditions as *Chara* growth became established. Forsberg (1965) noted that *Chara* growth is light-inhibited; that is, it is short and bushy under conditions of clear water whereas it becomes etiolated with long internodes as water becomes turbid and light penetration decreases. Recent research has isolated a chemical compound produced by *Chara* which inhibits some bloom-causing blue-green algae (van Aller & Pessoney, 1974).

Henricsson (1976) has shown that various species of *Chara* are able to accumulate phosphate from the water in which they are grown; such action would tend to discourage phytoplankton blooms.
This author states:

'The typical *Chara* lake is oligotrophic in character, with low plankton productivity. It is lime rich, with a high pH. The phosphate content of the water is very low. Because of the high pH, phosphate, iron and trace element are not readily available. Organic material which might act as chelates is in short supply. – There is little competition from higher plants with high nutrient requirements in *Chara* lakes. Increased supply of organic material can make nutrients available for phytoplankton and higher plants, which may bring about the exclusion of *Chara* as a result of the increased competition.'

However, it has also been found that certain events tend to forecast the successional replacement of *C. vulgaris.* Grazing by crayfish, overtopping by angiosperms, wind-caused turbidity, and especially epiphytic growth by various phytoplanktonic algae, all worked to the detriment of the *Chara vulgaris* population. The use of Baytex has been advocated by some researchers as a way to eradicate the undesirable crayfish populations. (Ray, 1970). As the *C. vulgaris* population declined, the positive physical and chemical parameters associated with its growth declined also. In the later successional stages, the *C. vulgaris* was replaced by annual angiosperms and/or phytoplankton growth; the ponds became susceptible to the wind-caused turbidity as the stabilizing effect of the perennial *C. vulgaris* growth was lost (Crawford, 1977).

The question then arose as to how an owner of a farm pond might establish and maintain the *C. vulgaris* population in an early successional stage, thereby reaping the desirable benefits and avoiding the deleterious effects which occur with the replacement of the alga. A grant by the State University of New York Research Foundation made this additional research possible.

Four aged Madison County, New York farm ponds whose owners were dissatisfied with their condition were selected for this two year study. The owners estimated that all of the ponds were over twenty years old and they complained of wind-caused turbidity, phytoplankton blooms, and/or excessive macrophyte growth. None of these conditions has been found to be associated with *C. vulgaris* early pioneer populations so it was decided to try to restore as many of these ponds as financially possible within the research grant, to the early successional stage of this alga. In practice, this worked out to the draining and cleaning of accumulated sediment in two of the ponds, the partial draining of one pond, and the use of the last pond as an untreated control.

Methods

The first year (1976) of this two-year research project was spent establishing base-line data in the four ponds. The chemical and physical parameters which were measured biweekly in each pond were temperature, free carbon dioxide, total alkalinity, total hardness, dissolved oxygen, phytoplankton gross productivity, and combined ortho- and acid-hydrolyzable phosphate. These parameters were again measured in 1977 after the ponds had undergone various treatments. The methods used were the same as those employed in previous research on this alga (Crawford, 1977).

The Student's t test was used to detect significant differences in the four ponds for all seven parameters; the ponds were analyzed against each other for the year 1976 and again for the year 1977. Then the paired t test was used to compare each pond to itself, 1976 versus 1977, in order to assess what effect the various treatments had had on all parameters (Zar, 1974).

Towards the end of the growing season of the first year (28 July 1976), the plug on Richard New's 1 acre pond was pulled. The accumulated sediment was then bulldozed out and the pond was left to dry and oxidize over the winter season. Three times before snow covered the bottom of the pond, beginning on 10 October 1976, sexually reproductive *C. vulgaris* growth was 'seeded' along the banks of the pond and across the bottom.

In the late spring of 1977 the 2″ drain pipe on Charles Record's .5 acre pond was cleared and the pond drained. This pond was then bulldozed free of accumulated sediment and 'seeded' with *C. vulgaris* three times – August 10, September 4, and October 29. The valve in the drain line was then closed and the pond quickly refilled.

Karl Leebrick's .25 acre pond was lowered approximately two feet by removing all the boards from its watergate on August 15, 1976. This partial draining exposed approximately 3 feet all around the pond's perimeter to the drying and oxidizing effects of the air. The pond was then left over the winter months and the watergate boards were not replaced until April 5, 1977; the pond then quickly refilled to its original waterline.

Gary Pratt's .25 acre pond was used as a control and allowed to vary its level according to the prevailing water table.

Results and discussion

1976

Record Pond

The Student t tests (Table 1) showed that Record Pond had significantly lower levels of carbon dioxide when compared to any of the other test ponds. Previous research has indicated that this parameter drops as the productivity of a pond increases, thus denoting Record Pond as the most productive pond in 1976. Record Pond also had significantly lower levels of total hardness and total alkalinity when compared to any of the other ponds in either 1976 or 1977. Record Pond was the oldest of all the ponds (approximately 27 years old) and throughout the year much of its littoral zone was covered with *Spirogyra/Rhizoclonium* vegetation, both on the bottom and in floating clumps. This was the only vegetation observed throughout the year.

New Pond

This pond also showed extensive littoral bottom patches and floating clumps of *Spirogyra/Rhizoclonium* populations. However, New Pond was much larger than Record Pond (approximately 1 acre vs. .5 acre) and it might be expected that in New Pond the carbon dioxide level would not fall as rapidly as it did in the smaller pond. A few strands of etiolated *C. vulgaris* were found but they were in isolated, thin patches; New Pond appeared to be in the final successional stage of *C. vulgaris* with phytoplankton being the dominant type of vegetation. In addition, *Typha* sp. invaded from the shoreline and *Lemna* sp. grew near the spring-fed end of the pond.

Pratt Pond

This pond was in the latter stages of *Chara* succession with *Potamogeton foliosus* and *Najas flexilis* overtopping the *C. fragilis* population. *Rhizoclonium/Mougeotia* blooms were prevalent throughout the season also.

Leebrick Pond

This pond was still primarily a *C. vulgaris* pond but blooms of *Mougeotia, Zygnema, Spirogyra, Oscillatoria, Spondylosium,* and/or *Rhizoclonium* occurred thoughout the growing season.

The lack of significant differences in the seven parameters among Pratt, New, and Leebrick ponds tended to indicate that these three ponds were in similar productive states. All were aging ponds highly susceptible to a variety of phytoplankton blooms. As mentioned previously, Record Pond was also noted for extensive phytoplankton populations which caused its productivity measures to be significantly greater than any of the other ponds. The tests conducted in 1976 showed all four ponds to be ex-
9 cellent candidates for restoration efforts.

1977

Record Pond

This pond, having been drained and scraped of accumulated sediment in the late spring of 1977, lost its 1976 significantly higher productivity rating to New Pond during the year of 1977. Although Record Pond was 'seeded' with sexually reproductive *C. vulgaris* during 1977, no growth was expected the same year, as a period of dormancy with exposure to either freezing or drying is required before many of the oogonia will germinate (Migula, 1897). However, the new *Rhizoclonium* sp. growth which was found to precede *C. vulgaris* establishment in previous research, was present on the rocks and bottom of Record Pond by the end of October 1977 (Crawford, 1977).

New Pond

This pond was drained and cleared in the fall of 1976, the plug was replaced on April 30, 1977, and by the middle of May *C. vulgaris* oogonia had germinated across the entire bottom. *C. vulgaris* vegetation quickly dominated this

Table 1

Student t Tests - 1976

Record Pond vs. New Pond H_0: t(.05)(2) ≧ +2.06 or ≧ -2.06

Significant Parameters		Non-Significant Parameters	
CO_2	-2.50	Temperature	-.20
Alkalinity	-2.81	Dissolved Oxygen	-.18
Hardness	-3.37	Phytoplankton Gross Productivity	-1.48
		Phosphate	.50

Record Pond vs. Pratt Pond H_0: t(.05)(2) ≧ +2.04 or ≧ -2.04

Significant Parameters		Non-Significant Parameters	
CO_2	-3.00	Temperature	.25
Alkalinity	-3.13	Dissolved Oxygen	.67
Hardness	-2.94	Phytoplankton Gross Productivity	-.23
		Phosphate	-1.00

Record Pond vs. Leebrick Pond H_0: t(.05)(2) ≧ +2.04 or ≧ -2.04

Significant Parameters		Non-Significant Parameters	
CO_2	-3.00	Temperature	.32
Alkalinity	-3.24	Dissolved Oxygen	-.72
Hardness	-3.14	Phytoplankton Gross Productivity	-.94
		Phosphate	-.88

New Pond vs. Pratt Pond H_0: t(.05)(2) ≧ +2.06 or ≧ -2.06

Significant Parameters		Non-Significant Parameters	
		Temperature	.42
		CO_2	-1.72
		Alkalinity	-.57
		Hardness	1.22
		Dissolved Oxygen	.77
		Phytoplankton Gross Productivity	1.29
		Phosphate	-.90

New Pond vs. Leebrick Pond H_0: $t(.05)(2) \geq +2.06$ or ≥ -2.06

Significant Parameters	Non-Significant Parameters	
	Temperature	.48
	CO_2	-1.82
	Alkalinity	-.85
	Hardness	.73
	Dissolved Oxygen	-.43
	Phytoplankton Gross Productivity	.19
	Phosphate	-.80

Pratt Pond vs. Leebrick Pond H_0: $t(.05)(2) \geq +2.04$ or ≥ -2.04

Significant Parameters	Non-Significant Parameters	
	Temperature	.07
	CO_2	-.40
	Alkalinity	-.37
	Hardness	-.56
	Dissolved Oxygen	-1.33
	Phytoplankton Gross Productivity	-.80
	Phosphate	-.10

pond, stabilized the bottom, and led to the clear water conditions associated with early, pioneer *C. vulgaris* growth. A few isolated patches of floating *Rhizoclonium* sp. and a few strands of *P. foliosus* were the only signs of vegetation other than *C. vulgaris* seen throughout the growing season of 1977. The high productivity of New Pond is demonstrated by its significantly lower CO_2 ratings than any of the other 1977 ponds.

Pratt Pond and Leebrick Pond

These ponds did not vary significantly from each other in any of the parameters, indicating the partial lowering of Leebrick Pond at the end of the 1976 growing season did not change its productivity or aging process to any great extent. Both ponds remained susceptible to phytoplankton blooms similar to those which occurred the previous year. By the end of September 1977, the *C. vulgaris* growth had invaded the 1976 drained and exposed area of Leebrick Pond to the edge of the waterline. These results indicate that partial draining should be considered a temporary means of vegetation control only. *P. foliosus*–a frequent successional replacement species of *C. vulgaris*–was also observed to be growing in among the *C. vulgaris* growth in Leebrick Pond.

Both Pratt Pond and Leebrick Pond supported the hypothesis put forth in a previous article, which stressed the importance that epiphytic growth has on successional events in an aquatic environment (Crawford, 1977). The *Chara* growth in both ponds was highly epiphytized by phytoplanktonic algae such as *Mougeotia, Rhizoclonium, Oedogonium, Gloeocapsa,* desmids, *Anabaena, Gloeocystis,* and *Gloeotrichia* sp. This burden, added to the usual $CaCO_3$ coat of marl which occurs on *Chara,* must greatly inhibit the photosynthetic capability by blocking the transmission of light. In addition, Crocker (1948) reported that the gelatinous cover which occurs on many epiphytes is a good culture medium for larvae, worms, diatoms, rotifers, fungi, and bacteria, adding to the injury of the macrophyte through decay, ingestion, or decreased photosynthesis. In Pratt Pond, especially, the *Chara* was bent over onto the bottom and covered with a grayish brown growth of epiphytes by the time the growing season was over. Although the *N. flexilis* and *P. foliosus* in this pond were also epiphytized, the cover was light

Table 2

Student t Tests - 1977

Record Pond vs. New Pond H_o: t(.05)(2) ≥ +2.05 or ≥ -2.05

Significant Parameters		Non-Significant Parameters	
CO_2	2.10	Temperature	-.14
Alkalinity	-2.08	Dissolved Oxygen	-.76
Hardness	-3.29	Phytoplankton Gross Productivity	1.53
		Phosphate	.68

Record Pond vs. Pratt Pond H_o: t(.05)(2) ≥ +2.04 or ≥ -2.04

Significant Parameters		Non-Significant Parameters	
Alkalinity	-2.73	Temperature	.08
Hardness	-2.36	CO_2	-.03
		Dissolved Oxygen	-.23
		Phytoplankton Gross Productivity	1.09
		Phosphate	-.24

Record Pond vs. Leebrick Pond H_o: t(.05)(2) ≥ +2.04 or ≥ -2.04

Significant Parameters		Non-Significant Parameters	
Alkalinity	-2.83	Temperature	.19
Hardness	-2.61	CO_2	-.27
		Dissolved Oxygen	-.96
		Phytoplankton Gross Productivity	.38
		Phosphate	.24

New Pond vs. Pratt Pond H_o: t(.05)(2) ≥ +2.05 or ≥ -2.05

Significant Parameters		Non-Significant Parameters	
CO_2	-2.22	Temperature	.22
		Alkalinity	-.85
		Hardness	1.90
		Dissolved Oxygen	.73
		Phytoplankton Gross Productivity	-.84
		Phosphate	-.89

New Pond vs. Leebrick Pond H_o: $t(.05)(2) \geq +2.05$ or ≥ -2.05

Significant Parameters		Non-Significant Parameters	
CO_2	-2.22	Temperature	.32
		Alkalinity	-1.09
		Hardness	1.50
		Dissolved Oxygen	-.16
		Phytoplankton Gross Productivity	-1.11
		Phosphate	-.42

Pratt Pond vs. Leebrick Pond H_o: $t(.05)(2) \geq +2.04$ or ≥ -2.04

Significant Parameters	Non-Significant Parameters	
	Temperature	.11
	CO_2	-.24
	Alkalinity	-.29
	Hardness	-.49
	Dissolved Oxygen	-.76
	Phytoplankton Gross Productivity	-.65
	Phosphate	.47

and the plants did not decrease in frequency until their normal annual demise in late October.

The difference in epiphytic growth on submerged aquatics should be taken into consideration by investigators studying successional events in aquatic systems. For example, research on the distribution of aquatic macrophytes in Otsego Lake notes that the biomass of *C. vulgaris* reached a peak in the spring and declined completely by mid-summer; the same report notes the prevalence of epiphytic algae (Vertucci, 1977). Most likely the two events – *C. vulgaris* decline and heavy epiphytic growth – are directly correlated.

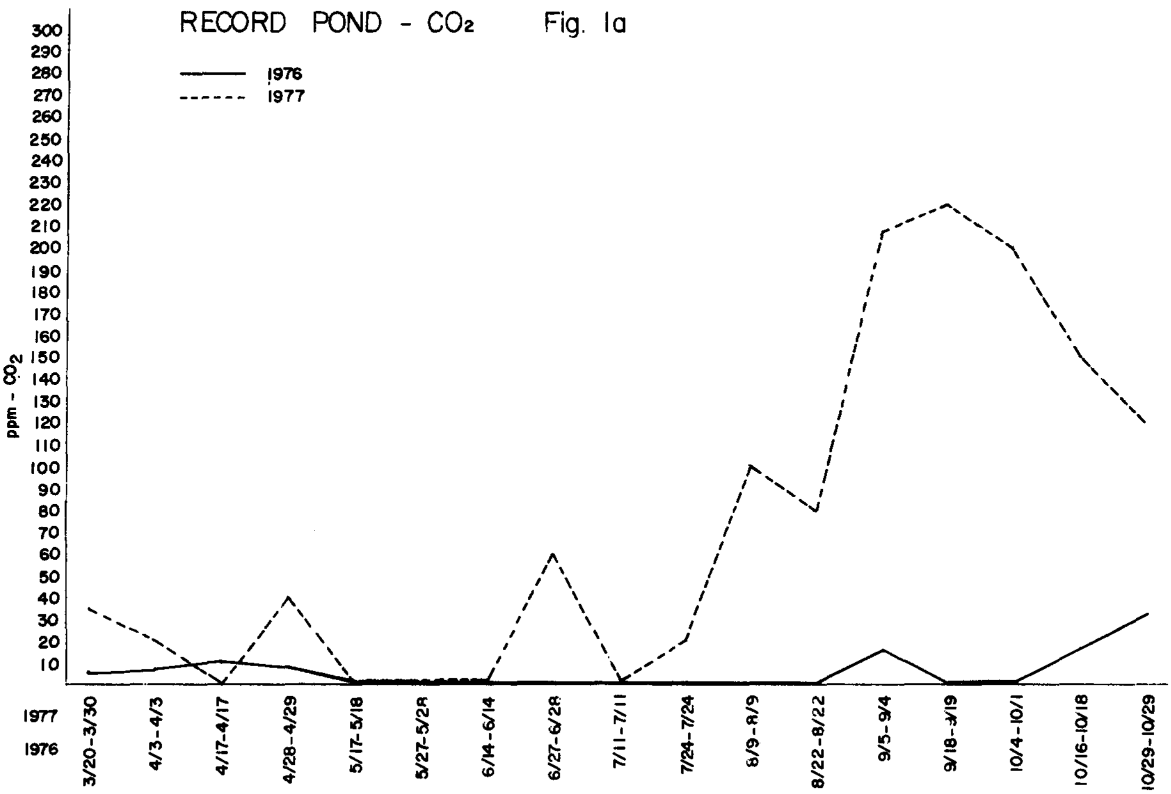
1976 vs. 1977

Record Pond

As previously noted, Record Pond was the most productive of all the ponds in 1976 as shown by its significantly lower CO_2 readings. The decrease in Record Pond's productivity – which in 1976 was due to phytoplankton growth – is evident in the greater CO_2 concentration maintained during 1977. Hardness and alkalinity, also tending to decrease in very productive ponds, increased in 1977. As might be expected with less vegetation, the 1977 dissolved oxygen levels were significantly lower than those obtained in 1976. Figs. 1a, 1b and 1c depict the parameters differing significantly when 1976 measures were compared to 1977 measures. It appears the draining and scraping of Record Pond had the desired effect of greatly lowering the phytoplankton productivity. After its winter dormancy, it is anticipated that the *C. vulgaris* introduced into this pond in the fall of 1977 will germinate and place this pond in the desired pioneer stage of *C. vulgaris* succession.

New Pond

This pond's increased productivity was shown in its significantly lowered CO_2 levels over 1976 measures; New Pond was strongly dominated throughout 1977 by an extensive pioneer growth of *C. vulgaris.* (Figs. 2a and 2b.) New Pond's higher phosphate levels in 1977 are probably due to the fact that this pond, being so large, did not succeed in refilling for most of the growing season. Without any flushing action, it is anticipated that the phosphate level in the pond would remain higher than usual. The disturbance of the bottom substrate during the bulldozing operation might have contributed to this phenomenon also. Although the phytoplankton gross produc-



RECORD POND - CO2 Fig. 1a
1976
1977
ppm - CO2
1977
1976
3/20-3/30
4/3-4/3
4/17-4/17
4/28-4/29
5/17-5/18
5/27-5/28
6/14-6/14
6/27-6/28
7/11-7/11
7/24-7/24
8/9-8/9
8/22-8/22
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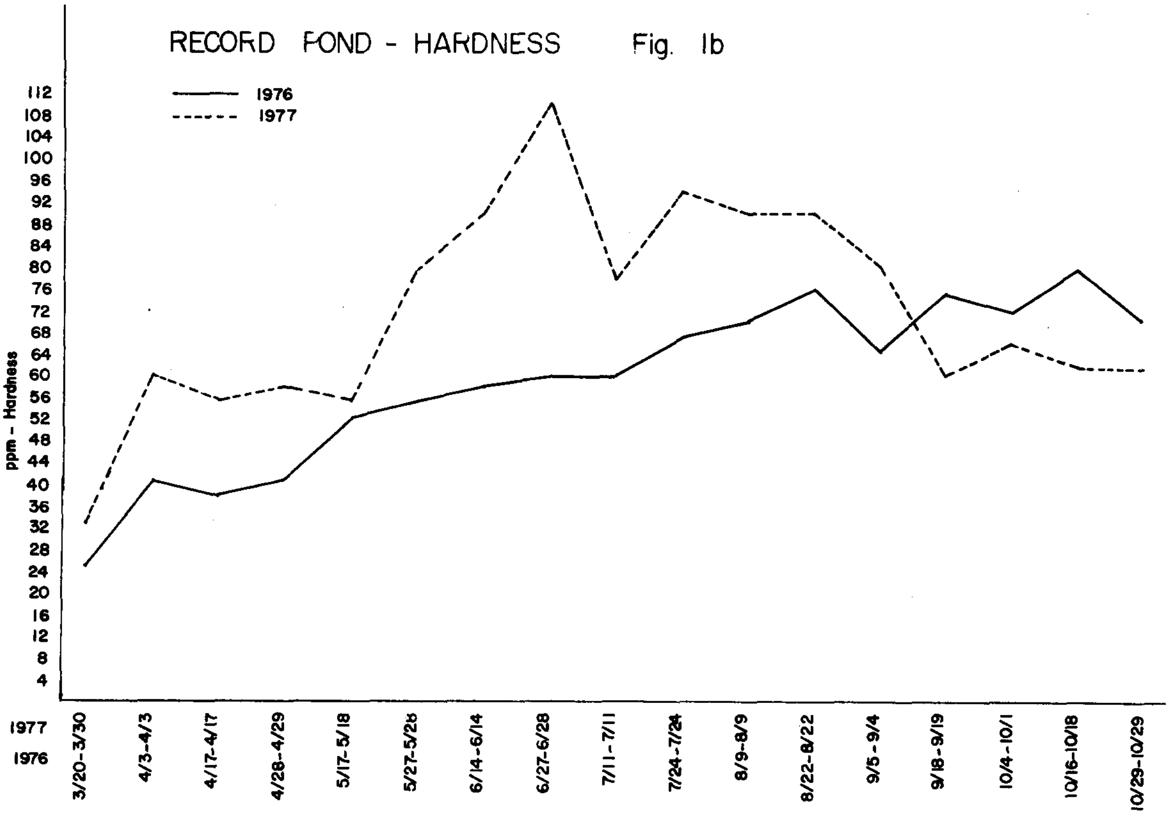
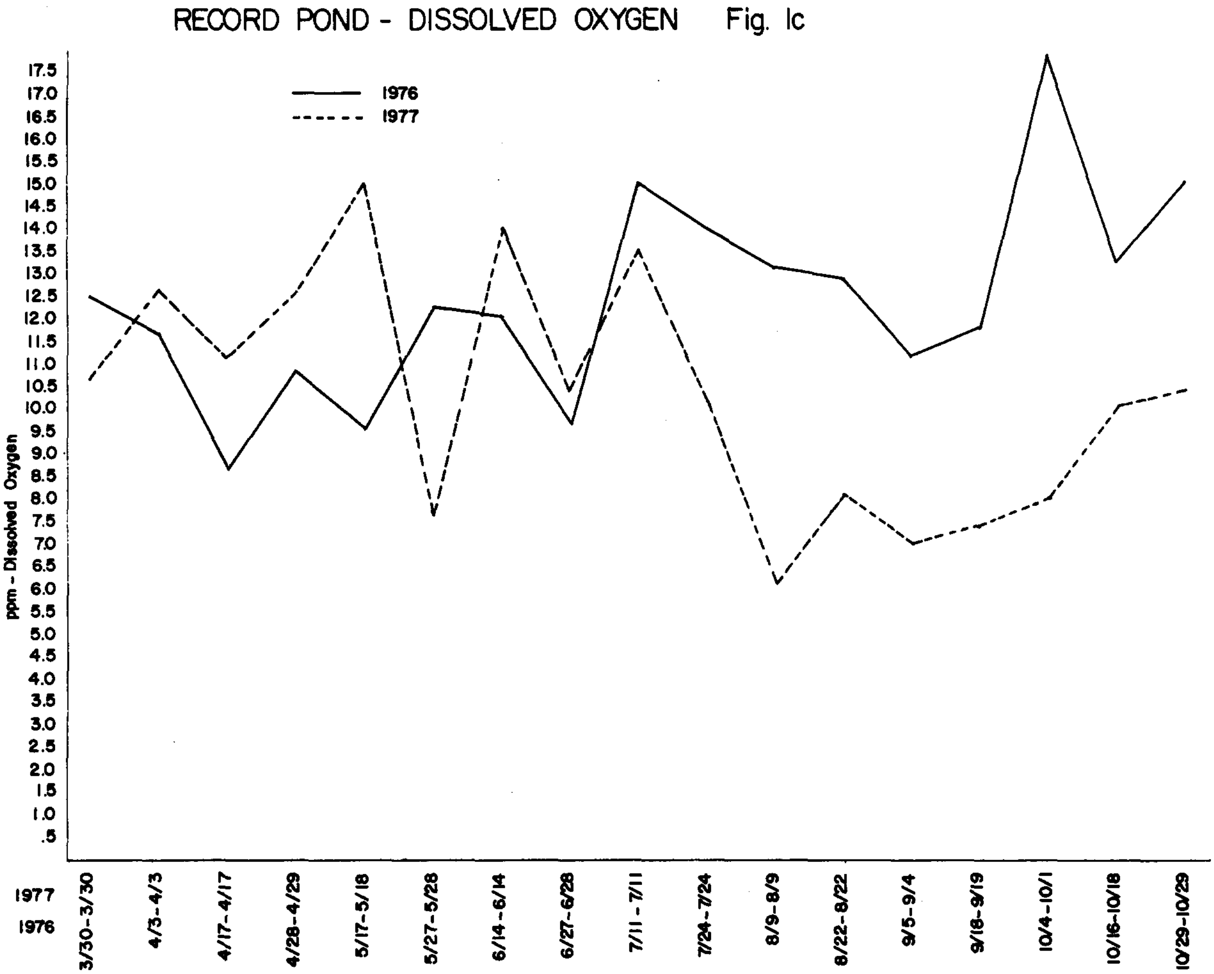
10/16-10/18
10/29-10/29



RECORD POND - HARDNESS Fig. 1b
1976
1977
ppm - Hardness
1977
1976
3/20-3/30
4/3-4/3
4/17-4/17
4/28-4/29
5/17-5/18
5/27-5/28
6/14-6/14
6/27-6/28
7/11-7/11
7/24-7/24
8/9-8/9
8/22-8/22
9/5-9/4
9/18-9/19
10/4-10/1
10/16-10/18
10/29-10/29



tivity did not vary significantly between the years, it was still higher in 1976 than in 1977. The 1977 productivity in this pond was due to the dominant *C. vulgaris* growth, not to phytoplankton growth.

Pratt Pond

The increased aging and productivity of this pond was displayed in its significantly lessened alkalinity and hardness levels along with its increased dissolved oxygen and phosphate levels from 1976 to 1977 (Fig. 3a, 3b, 3c, and 3d). This pond was untreated and it is felt that these results occurred due to the natural aging process.

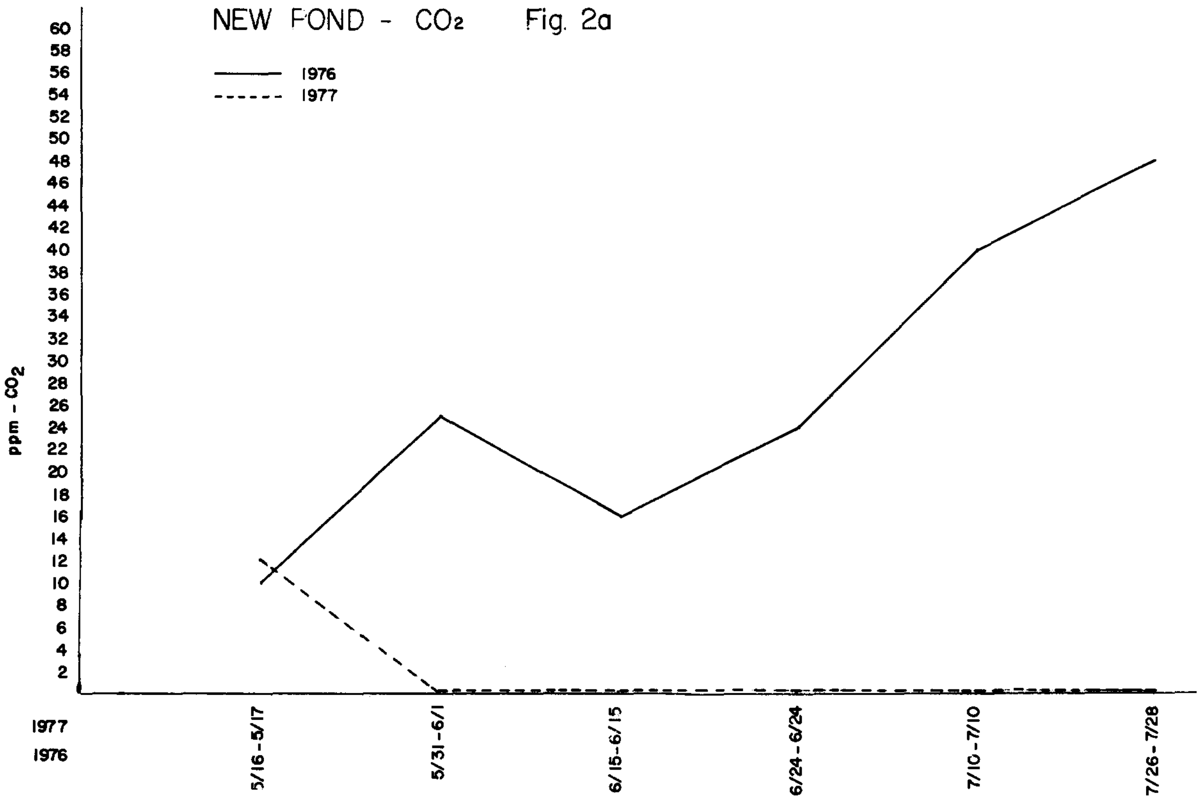
Leebrick Pond

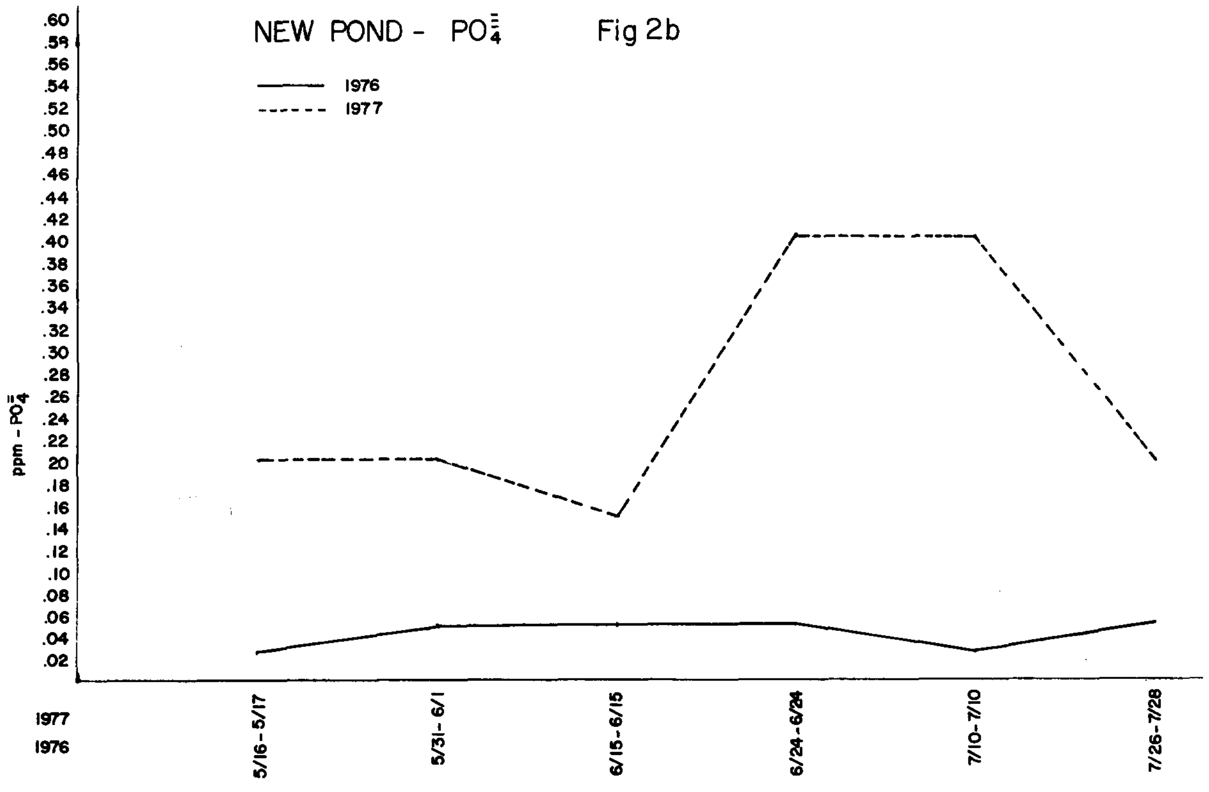
This pond also showed increased aging and productivity as alkalinity and hardness levels fell significantly during 1977. Phosphate levels were significantly higher in 1977. (Fig. 4a, 4b, and 4c). The partial draining and drying of this pond did not have the desired effect of controlling productivity.

Conclusions

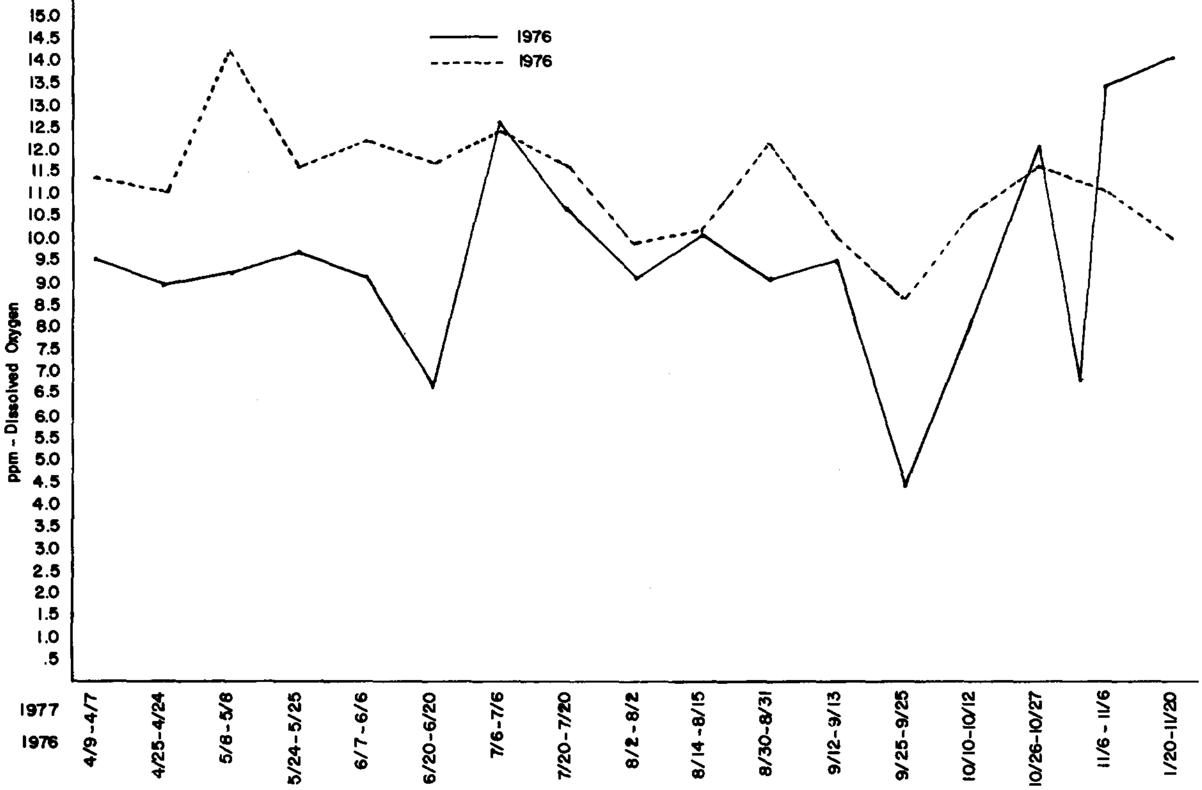
The usual approach for controlling undesirable vegetation in farm ponds is to treat the pond with one or more chemicals. For example, a copper sulfate/aliquat combination has resulted in a 50% control of *Potamogeton* sp. in treated ponds (Archer & Bachman, 1974). However, such treatment is very temporary at best and may lead to oxygen depletion and undesirable effects on other organisms in the aquatic system. When possible, a natural control of undesirable vegetation should be sought.

The idea of draining ponds or lakes to help control

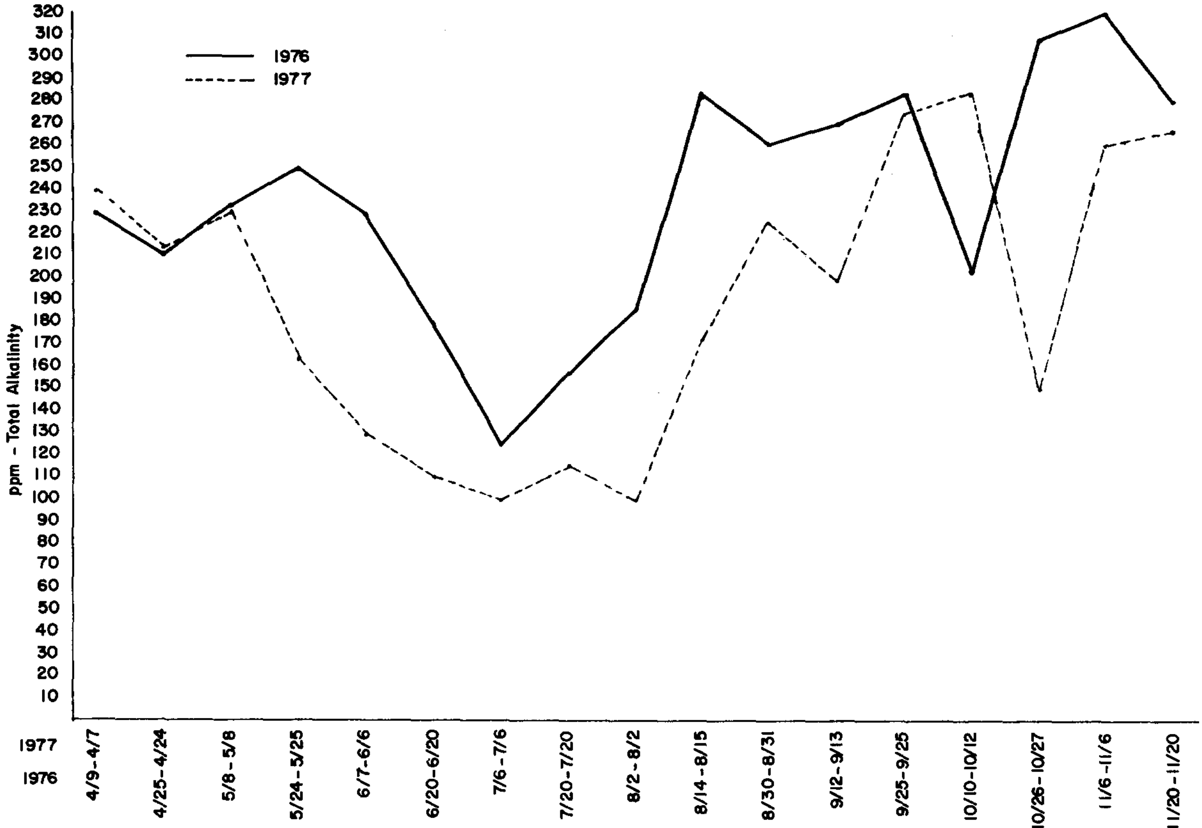

NEW POND - CO2 Fig. 2a
1976
1977
60 58 56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2
ppm - CO2
1977
1976
5/16-5/17
5/31-6/1
6/15-6/15
6/24-6/24
7/10-7/10
7/26-7/28

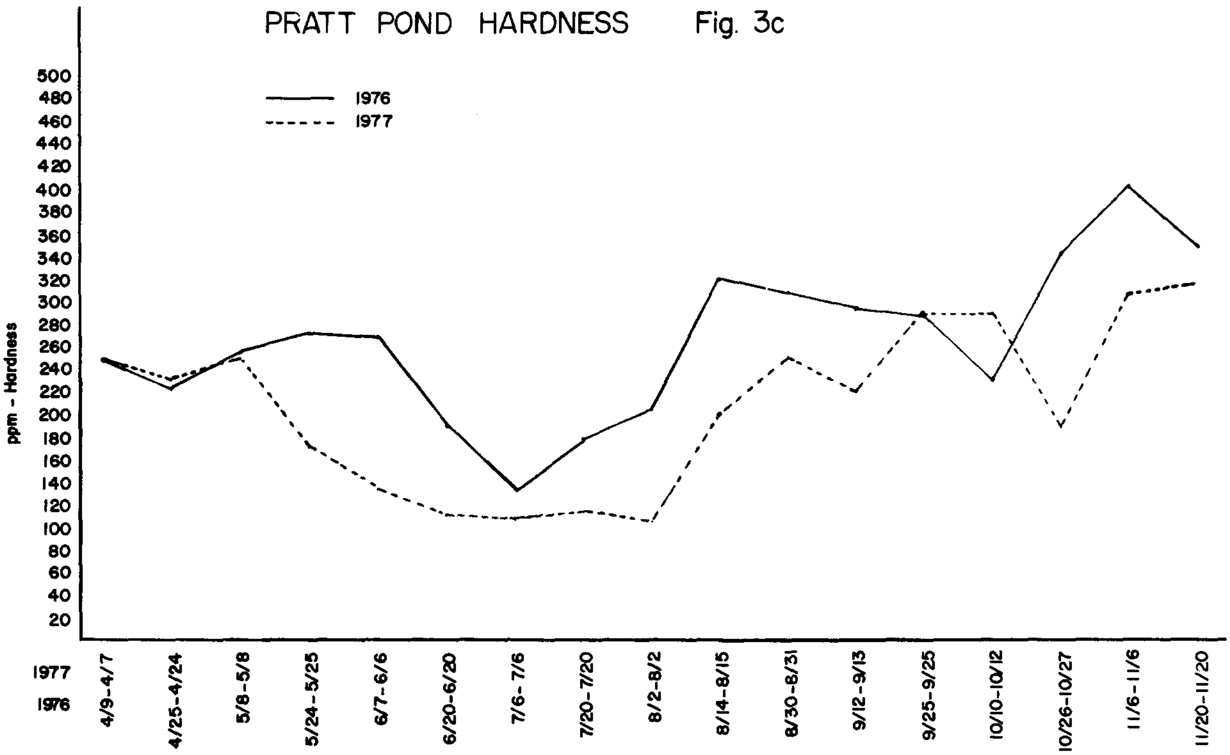

NEW POND - PO4 Fig 2b
1976
1977
.60 .58 .56 .54 .52 .50 .48 .46 .44 .42 .40 .38 .36 .34 .32 .30 .28 .26 .24 .22 .20 .18 .16 .14 .12 .10 .08 .06 .04 .02
ppm - PO4
1977
1976
5/16-5/17
5/31-6/1
6/15-6/15
6/24-6/24
7/10-7/10
7/26-7/28

PRATT POND DISSOLVED OXYGEN Fig. 3a



PRATT POND - TOTAL ALKALINITY Fig. 3b




PRATT POND HARDNESS Fig. 3c
1976
1977
ppm - Hardness
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
1977
1976
4/9-4/7
4/25-4/24
5/8-5/8
5/24-5/25
6/7-6/6
6/20-6/20
7/6-7/6
7/20-7/20
8/2-8/2
8/14-8/15
8/30-8/31
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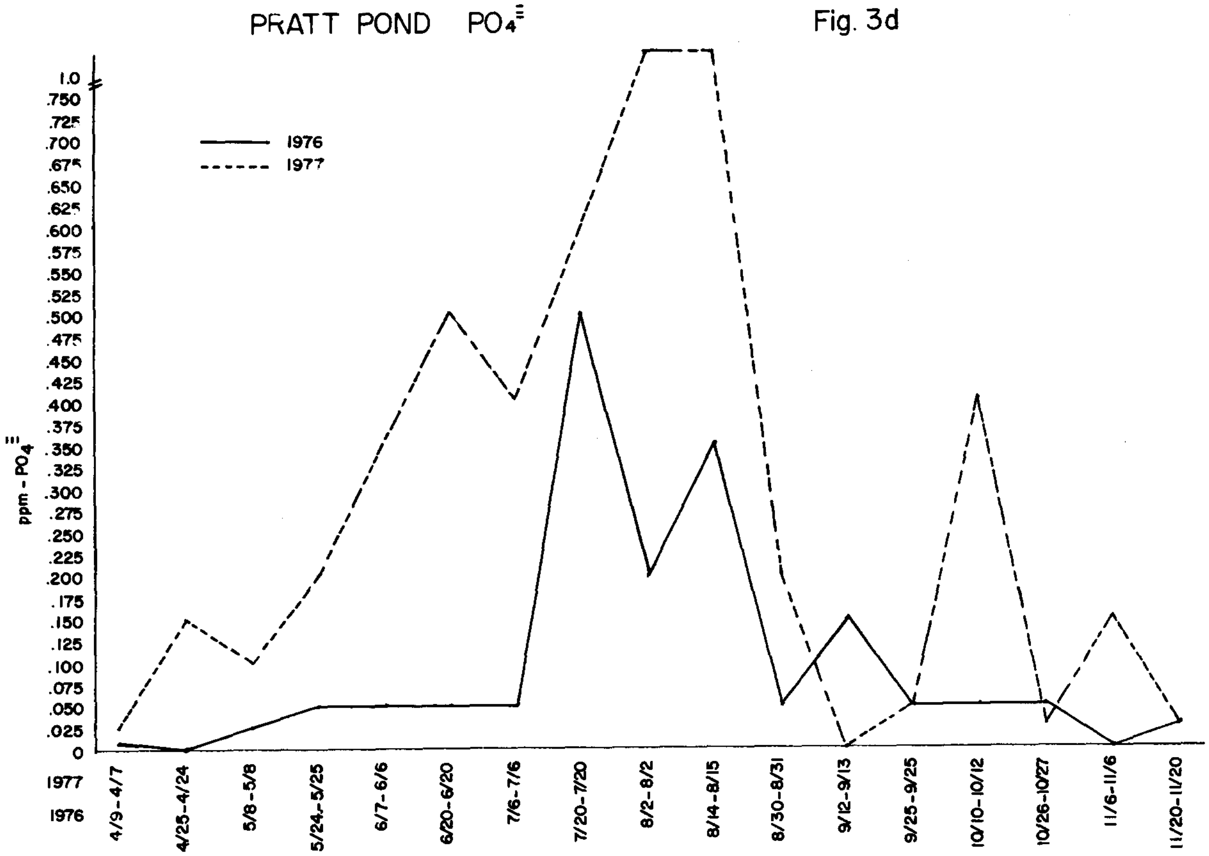
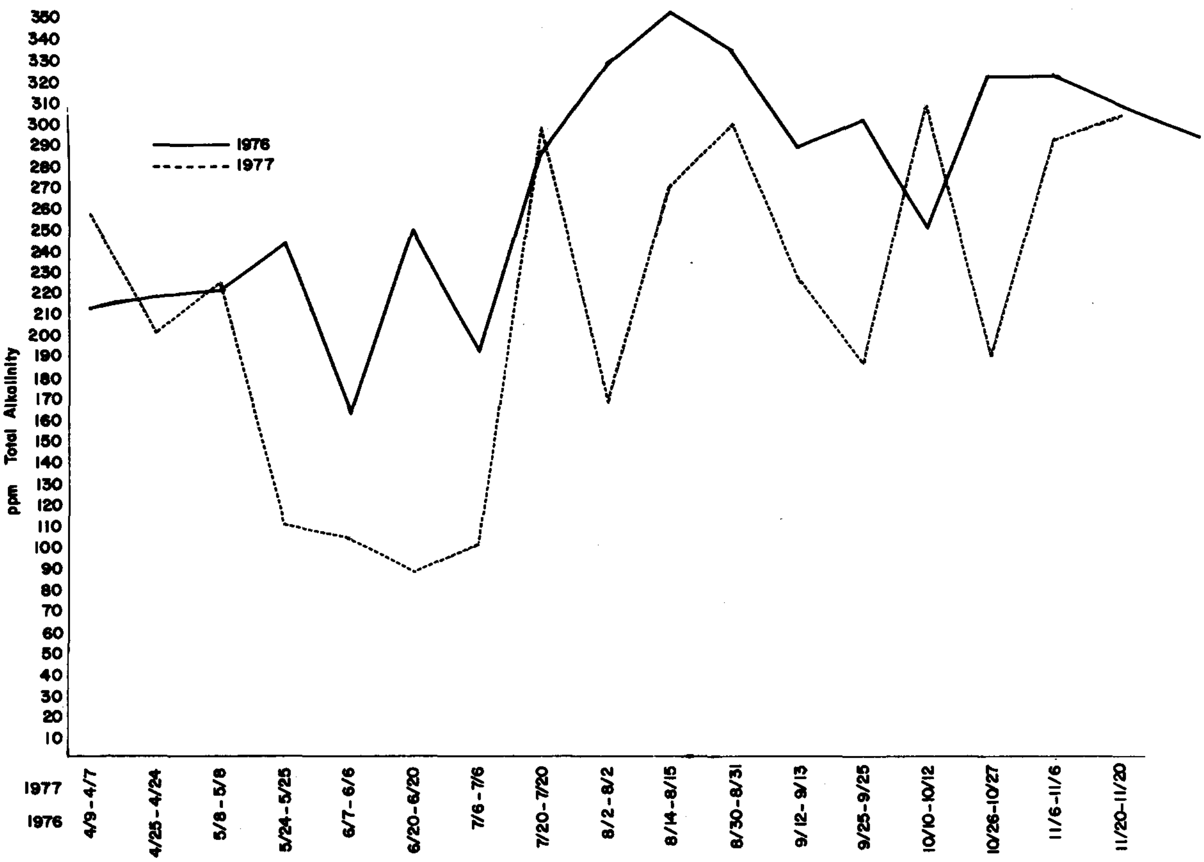
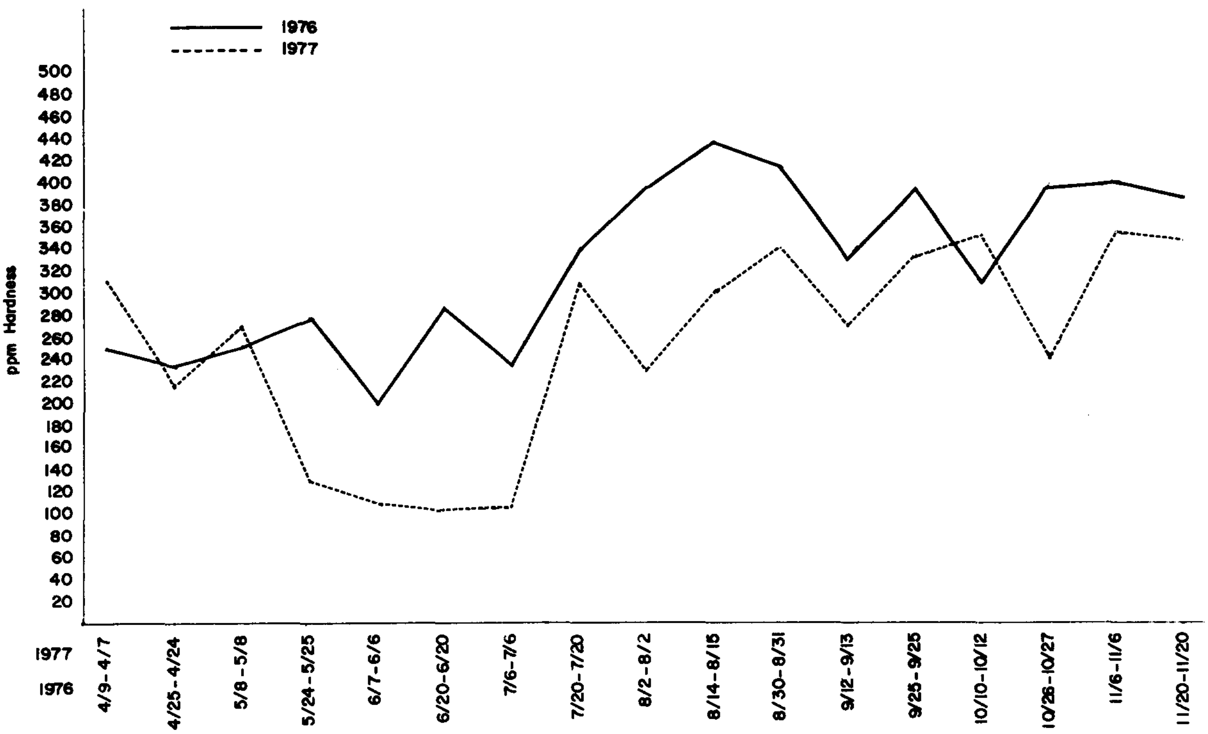
10/26-10/27
11/6-11/6
11/20-11/20

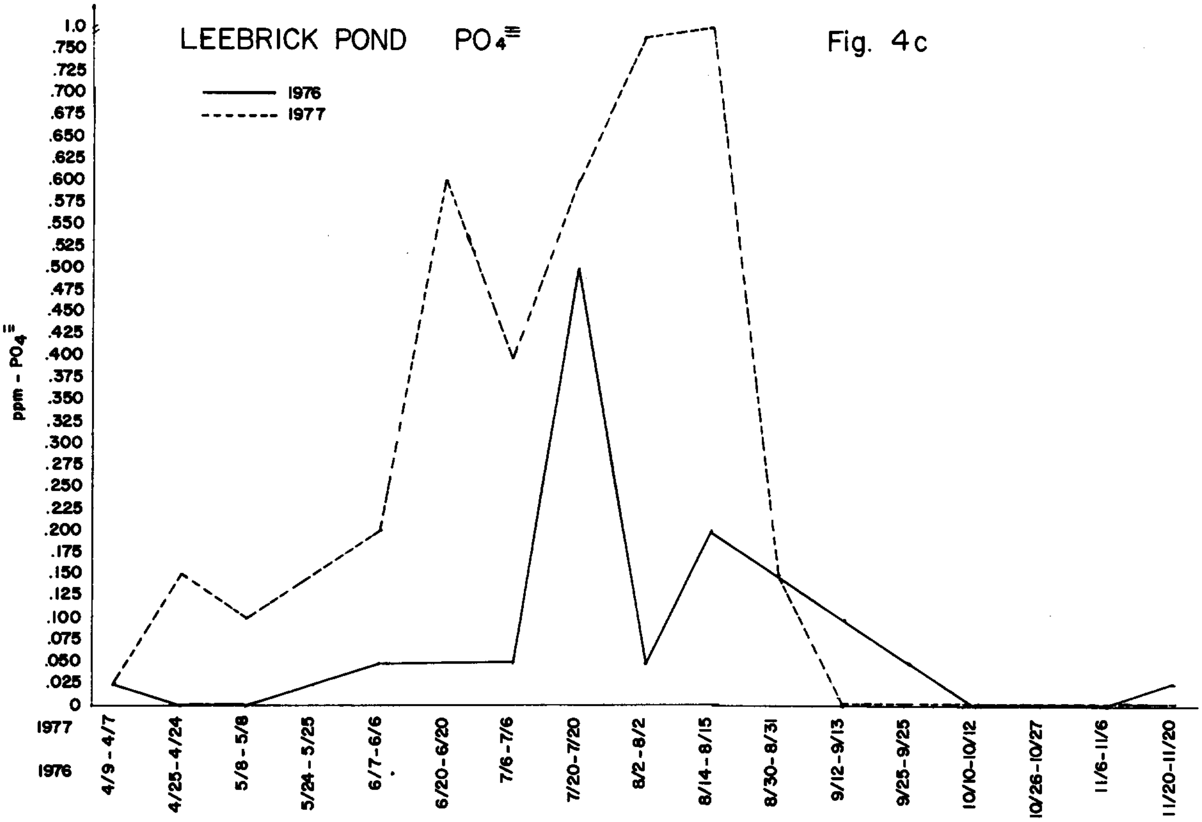

PRATT POND PO4
Fig. 3d
1976
1977
ppm - PO4
1.0
.750
.700
.650
.600
.575
.550
.525
.500
.450
.425
.400
.375
.350
.325
.300
.250
.225
.200
.175
.150
.125
.100
.075
.050
.025
0
1977
1976
4/9-4/7
4/25-4/24
5/8-5/8
5/24-5/25
6/7-6/6
6/20-6/20
7/6-7/6
7/20-7/20
8/2-8/2
8/14-8/15
8/30-8/31
9/12-9/13
9/25-9/25
10/10-10/12
10/26-10/27
11/6-11/6
11/20-11/20

LEEBRICK POND - TOTAL ALKALINITY Fig. 4a



LEEBRICK POND - HARDNESS Fig. 4b





vegetation is not new (Adamec, 1973; Barr & Huner, 1977; Twitty, 1977). However, the following of this process with sediment removal and the inoculation of *C. vulgaris* is a unique approach not attempted by previous researchers.

This research tended to show that farm ponds can be maintained in the pioneer stage of *C. vulgaris* succession in order to gain the beneficial water quality aspects of this stage. The ideal conditions for this type of restoration appear to be a complete draining and scraping of the pond in the fall with an oxidizing and drying period until spring. Inoculation of the pond with sexually reproductive *C. vulgaris* in the fall leads to a *C. vulgaris* pond next spring. This process can be repeated when the pond succeeds to undesirable types of vegetation. Partial draining and drying does not give the same beneficial results of the more complete treatment.

It is also highly recommended that designers of new farm ponds include some device whereby the pond can be completely drained in anticipation of its future restoration needs. Inoculation of drained, dried, and scraped ponds with *C. vulgaris* in the fall should yield a springtime with *C. vulgaris* growth controlling turbidity and phytoplankton growth. Pond owners who desire to stock their *Chara* ponds with fish fingerlings will find that the alga harbors many protozoans, crustaceans, and worms beneficial to fish populations (Gordon, 1943). In addition *Chara* is of direct value as food for waterfowl, being listed as fifth in importance in this regard in the United States and Canada (Kiner, 1944).

It is the author's belief that the beneficial effects of pioneer growth of *C. vulgaris* on aquatic systems has not been fully exploited in farm pond situations. Farm pond owners should not lose the capability of restoring their pond as it ages by neglecting to install a simple draining device at the outset. The maintenance of a pond should be considered at the time of its construction; the establishment of the beneficial macrophytic alga *C. vulgaris* is recommended in this regard.

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