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I am submitting herewith a dissertation written by William Henry Wilcox entitled "The Effect of Nitrogen and Phosphorus Enrichment on Salt Marsh Community Structure." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Ecology.

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THE EFFECT OF NITROGEN AND PHOSPHORUS ENRICHMENT ON SALT MARSH COMMUNITY STRUCTURE

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

William Henry Wilcox

August 1979

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ABSTRACT

Fertilization of a *Batis maritima* and *Salicornia virginica* dominated salt marsh in Florida, with a combined nitrogen and phosphorus fertilizer applied at four rates (50:8; 100:16; 150:24 and 200:32 kg/ha/yr N:P) produced the following responses: 1) dominance shifted to *Batis*, 2) *Batis* aerial biomass increased from 428 g/m^2 (control) to 1062 g/m^2 (highest rate) while *Salicornia* showed no positive response to fertilization, 3) highest fertilization plots had a 9% higher decomposition rate than control plots (.00728/day versus .00668/day), 4) no luxury consumption of nutrient was measured, 5) *Batis* stem biomass reached an asymptote of 750 g/m^2 (295 g/m^2 control) after 2 years fertilization at 150:24 and 200:32 kg/ha/yr N:P, 6) *Batis* leaf biomass at 328 g/m^2 (133 g/m^2 control) had not reached an asymptote after two years fertilization. Measurement of initial changes in snail numbers and periphyton biomass and species composition, in response to fertilization could not be repeated, probably due to a drying trend in the marsh and a drastic reduction in snail and periphyton numbers.

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1. INTRODUCTION

1.1 Background

Ecological studies of salt marshes have been summarized by Keefe (1972) and Wentz *et al.* (1974). The significance of tidal influence on the distribution, zonation and production of salt marsh vegetation has been a prominent subject of many studies (Ganong 1903; Harshberger 1911; Johnson and York 1915; Conrad 1935; Taylor 1938; Penfound and Hathaway 1938; Chapman 1940; Clark 1946; Miller and Egler 1950; Jackson 1952; Kurz and Wagner 1957; Adams 1963; Blum 1968; Chapman 1974). Recently researchers have shown the importance of nutrient limitation in determining production (Valiela and Teal 1974) and zonation (Valiela *et al.* 1975) of salt marsh vegetation.

The importance of salt marshes as part of estuarine ecosystems has also been widely described (Davis 1910; Daigh *et al.* 1938; Odum and de la Cruz 1967; Heald 1969; Udell *et al.* 1969; Redfield 1972; Davis 1973; Day *et al.* 1973). Generally salt marshes are thought to trap inorganic nutrients through filtration and sedimentation, converting these nutrients into plant biomass which can be exported to the adjacent estuary as detritus. This detritus may provide an important energy source for estuarine food chains (Teal 1962; Heald 1969).

Natural salt marsh processes of sedimentation, filtration, anaerobic denitrification, organic matter production and nutrient assimilation have resulted in the focus of attention on wetlands as potentially serving as natural waste treatment systems (Odum and Chestnut 1970; Kuenzler and Chestnut 1971; Seidel 1971; Valiela *et al.* 1973; Jong 1975; Nedwell 1975). Most studies have dealt with utilizing salt marshes to treat

wastes high in forms of nitrogen and phosphorus.

Studies of nitrogen and phosphorus enrichment in salt marshes have generally dealt with the biomass response of *Spartina* species. A few studies have investigated the effect of enrichment on other components of saltmarsh communities. Van Raalte *et al.* (1976) reported the effect of fertilization on the species composition of salt marsh diatoms. Valiela *et al.* (1975) investigated the effect of enrichment on a salt marsh community composed of species of *Spartina, Salicornia* and *Distichlis.* Onuf *et al.* (1977) reported on the effect of natural enrichment from bird guano on mangrove production and herbivory. Enrichment in these studies was correlated with increased production and changes in plant species composition and herbivory. Changes in production and species composition in response to nutrient enrichment also have been documented for terrestrial old field ecosystems (Hurd *et al.* 1971; Bakelaar and Odum 1978).

Salt marsh vascular plants growing on fine sediments generally have been found to be nitrogen limited while additions of phosphorus produce no biomass increase (Stewart *et al*, 1972; Sullivan and Daiber 1974; Valiela and Teal 1974; Broome *et al*, 1975). Pigott (1968) found, however, that phosphorus additions to sandy soils caused an increase in the growth of *Salicornia europaea* while additions to muddy sediments did not increase growth. Pigott concludes that there was sufficient phosphorus in the muddy sediments to meet the needs of the plant. Tyler (1967) also found phosphorus limiting in a high Baltic shore meadow, where tidal inundation was infrequent. Pomeroy *et al.* (1969) indicates that fine sediments in salt marshes adsorb phosphorus from tide waters, accumulating

large amounts such that additions produce no biomass response.

Sea water contains sufficient concentrations of micronutrients that tidally washed marshes are not likely to be micronutrient limited. This is especially true for potassium, magnesium and calcium (Tyler 1967). In summary, salt marshes receiving frequent tidal inundation and having fine sediments are not likely to be phosphorus limited. Marshes receiving infrequent tidal inundation or having sandy sediments may be phosphorus limited.

Ideally, nutrient enrichment of salt marshes could increase the amount and quality of organic matter produced and made available to estuarine food chains. At some level of enrichment, however, ecosystems generally show changes in species composition and diversity that are not always desirable (Ryther 1954; Hutchinson 1973).

1.2 Purpose

The purpose of this study was to describe the response of a *Batis maritima* and *Salicornia virginica* dominated salt marsh to five levels of nitrogen and phosphorus fertilization. In addition to vascular plant biomass, sediment invertebrates and algae were measured. However, due to a general drying trend that drastically reduced the populations of the invertebrates and algae, only the first few samplings provided results for these components of the ecosystem.

1.3 Specific Questions Addressed

The following specific questions were successfully addressed in the first year of study:

1) Are *Batis* and *Salicornia* nutrient limited?
2) Do nutrient additions produce changes in vascular plant species composition?

3) How much do nutrient additions increase biomass response?

4) Do the vascular plants demonstrate luxury consumption of nutrients?

5) Is decomposition rate of salt marsh detritus affected by nutrient additions?

6) At what level of nutrient addition does continued increase in nutrients fail to produce continued increase in biomass?

The second and third years of study successfully addressed how 1), 2), 3) and 6) above were affected by discontinuing fertilization after the first year and by continuing fertilization for two and three years.

Data obtained for sediment invertebrates and periphyton permitted no conclusion as to their response to nutrient additions.

2. STUDY AREA DESCRIPTION

2.1 Location

The study area is located in southwest Florida, on the north shore of Charlotte Harbor at latitude 26°58' N and longitude 82°08' W (Figure 1). Charlotte Harbor is a subtropical mangrove-lined estuary, receiving seasonal freshwater inflow from the Peace and Myakka Rivers.

2.2 Plant Communities

The harbor is bordered by extensive mangrove forests that extend inland a distance of 0.4 to 0.8 km (0.25 to 0.50 miles) to approximately the +0.31 m elevation (+1.0 foot). Landward of the mangroves is the study area, a high marsh zone that is infrequently inundated by tides and composed of *Batis maritima* and *Salicornia virginica* as the dominant vascular plant species.

Landward of the high marsh, sand flats or salinas occur and are devoid of vegetation. Salinas are sandy depressions where tide water is retained from occasional inundations. The water evaporates leaving a salt residue on the sand surface. Seaward of the salina, tidal inundation is apparently frequent enough to keep sediment salinities low enough for plant growth. *Batis* marsh and sand flat zones are described by Craighead (1971) and Harper (1927). Landward of the sand flats are pine and palmetto flatwoods. The geomorphology and species composition of this area is discussed by Craighead (1971).

2.3 *Batis* and *Salicornia*

The *Batis* marsh at the study site is comprised almost entirely of *Batis maritima* L. and *Salicornia virginica* L. *Batis maritima* L. is a succulent leafed shrub. Leaves are half-cylindrical, linear, curved and

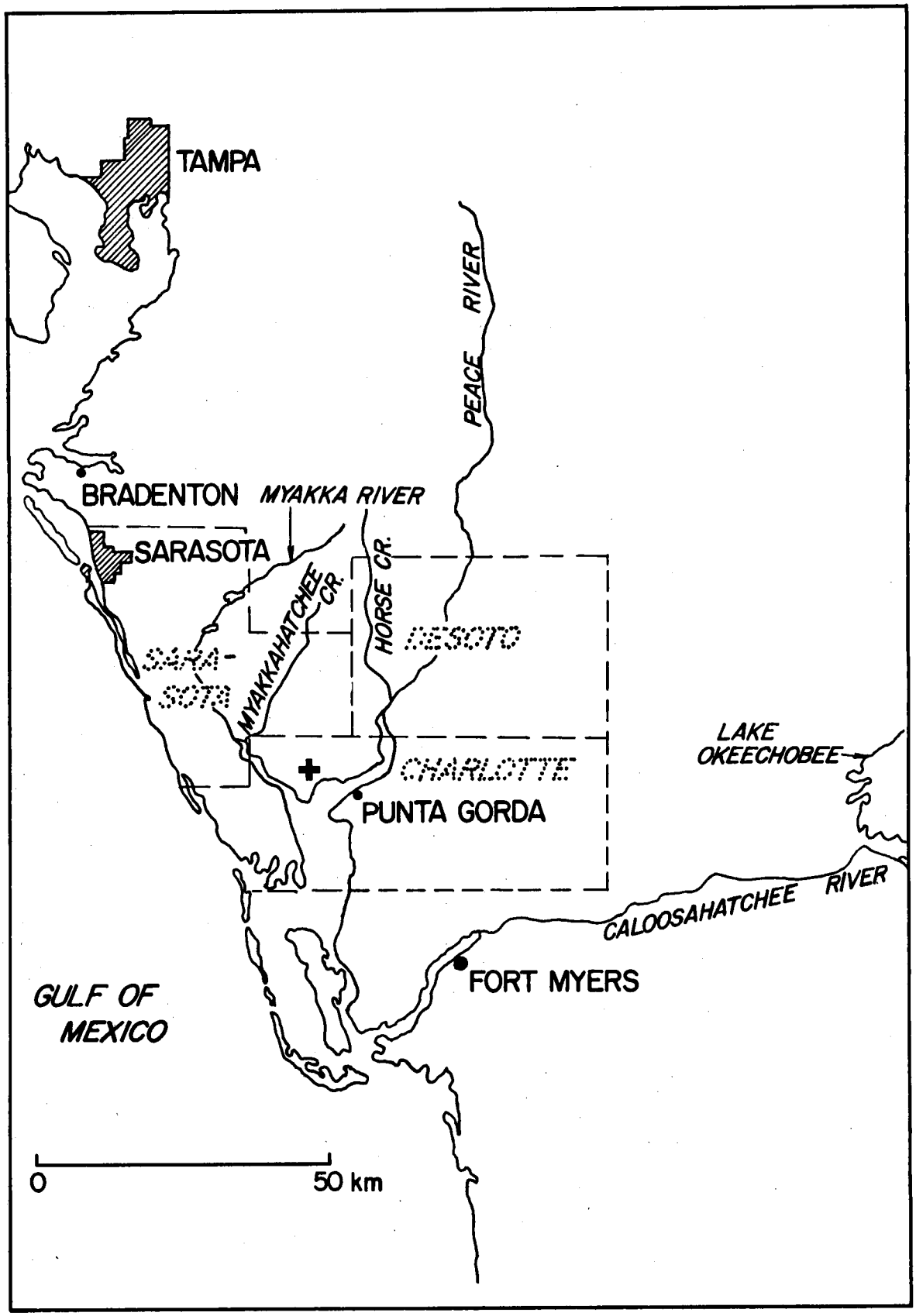

Figure 1. Location of the study site (✚).

1-3 cm long. The species occurs in salt marshes throughout Florida, north to the Carolinas, west along the Gulf coast states and Mexico, and in the West Indies, tropical America and Pacific Islands (Long and Lakela 1971; Radford *et al.* 1968). In the study area, *Batis* shrubs are about 20 to 30 cm tall, forming a continuous ground cover with *Salicornia virginica* L. In the Everglades, plants can approach 1 m in height (Craig 1971). The Batacea is a monotypic family of questionable taxonomic position, presently maintained in its own order, Batales (Cronquist 1968).

Salicornia virginica L. is a perennial plant with a woody, prostrate stem supporting erect, succulent, flowering stems. Leaves are opposite and reduced to a sheath around the stem. There are about fifty species of *Salicornia* in moist saline habitats of temperate and subtropical regions (Waisel 1972). *S. virginica* occurs in salt marshes from Massachusetts to Texas, Alaska to California, and in the West Indies, Europe and North Africa (Gleason and Cronquist 1963). In the study area *S. virginica* is 20 to 30 cm tall. *Salicornia* is in the Chenopodiaceae.

Both *Batis* and *Salicornia* are succulent halophytes which can tolerate high concentrations of chloride in their cell sap. Nonsucculent halophytes either desalinate their tissue and secrete excess salt through glands (e.g., *Spartina alternaflora*) or have no special mechanism for salt removal and concentrations in the plant tissue increase until that portion of the plant dies and is shed (e.g., *Juncus gerardii*, Waisel 1972). Throughout the text and appendices *Batis* will refer to *Batis maritima* and *Salicornia* will refer to *Salicornia virginica* when the generic name is used without the specific epithet.

2.4 Snails

Snails are often abundant on the sediment surface. Densities average 30 snails per 0.1 m^2 when the sediment surface is consistently wetted. *Cerithidea scalariformis* (Say 1825) and *Melampus bidentatus* (Say 1822) are the most abundant snail species. *Melampus coffeus* Linné 1758), *Neritina reclivata* (Say 1822) and *Detracia floridana* (Pfeiffer 1856) are also occasionally found in high marsh. *Cerithidea scalariformis*, Ladder Horn Shell, is 2 to 3 cm long and occurs in salt marshes from South Carolina to the Florida Keys and the West Indies (Abbott 1974). *Melampus bidentatus*, Eastern *Melampus*, is 10 to 15 mm long and occurs in salt marshes from southern Quebec to Texas and the West Indies (Abbott 1974).

2.5 Sediments

Sediments in the *Batis* marsh zone are thin, generally less than 130 cm, sandy and underlain by the coquinoid limestone, sand and clay (Vernon and Puri 1964). The upper 10 cm contains substantial black organics and fibrous roots. Roots extend to a depth of 40 cm with most occurring in the top 10 cm. Sediment pH ranges from 5.4 to 6.0 in the upper 20 cm to 6.0 to 6.7 from 20 cm to 40 cm, during November at the end of the rainy season.

2.6 Climate

The climate is typified by warm humid summers and short, mild winters with occasional invasions of cool northern air (Bradley, 1972). Trewartha (1961) classified this climatic type as humid mesothermal, humid subtropical subgroup and Thornthwaite and Mather (1955) classified it as moist, subhumid with a moisture surplus of 0-20 percent. Latitude

and proximity to the Atlantic Ocean and Gulf of Mexico are the dominant factors controlling the climate (Bradley 1972).

The mean annual temperature at Fort Myers, Florida, for the period 1937-1976 was 23.3°C; the mean January temperature for that period was 18.1°C and mean July temperature, 27.9°C. Relative humidity is usually 80-90 percent at night and decreases to 50-60 percent in the early afternoon year round. The mean summer wind speed is 11.6 km hr^{-1}, and mean winter wind speed is 13.9 km hr^{-1}. From October through December, the direction of the prevailing wind is from the northeast, and for the remainder of the year from the east (NOAA, 1976). The mean annual precipitation at Fort Myers, Florida from 1937-1976 was 135.5 cm, 65 percent of which fell during the summer months (June through September). An average of 95 thunderstorms occurred each year with 78 percent of these in the summer months (NOAA, 1976).

3. METHODS

3.1 First Year

The first year study was conducted in 1976-77 and repeated in 1977-78. The first year study was designed to measure changes in above-ground vascular plant biomass, plant species composition, plant tissue nitrogen and phosphorus concentration, total litter weight, litter decomposition rate, and snail biomass (undecalcified), other invertebrate numbers, periphyton biomass and species composition, caused by the following phosphorus and nitrogen fertilization levels, expressed in kg/ha: 0 P with 0 N, 8 P with 50 N, 16 P with 100 N, 24 P with 150 N, and 32 P with 200 N.

Thirty-five plots were treated the first year, allowing the full complement of treatment to be replicated seven times in a randomized complete block design (Figures 2 and 3). The probability of Type II error, β, was set to be $<.15$ to detect a 30 percent change in total above-ground vascular plant biomass across the range of treatment with a Type I error, α, of .05. The number of replicates needed to meet these error criteria was based on variance estimates from pre-study vascular plant harvest data. The number of blocks or plots per treatment was plotted against increasing statistical sensitivity using this variance estimate (Figure 4). An optimum number of plots per treatment was chosen by selecting the point where increasing the sampling effort provided little increase in sensitivity. Statistical analyses and curve fitting were done using SAS (Barr *et al.* 1976).

N and P were applied to plots as a mixture of ammonium nitrate (33.5 percent N by wt) and superphosphate fertilizer (19.0 percent P by wt). The

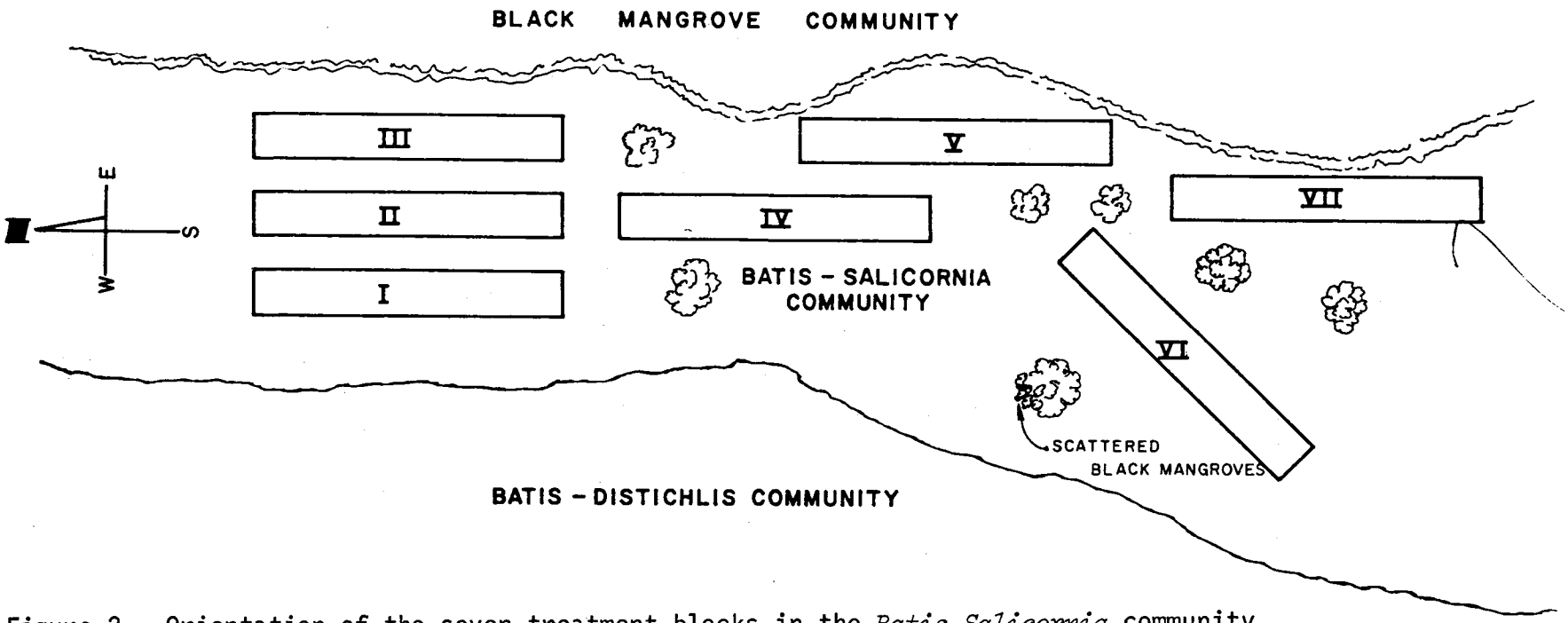

Figure 2. Orientation of the seven treatment blocks in the *Batis-Salicornia* community.

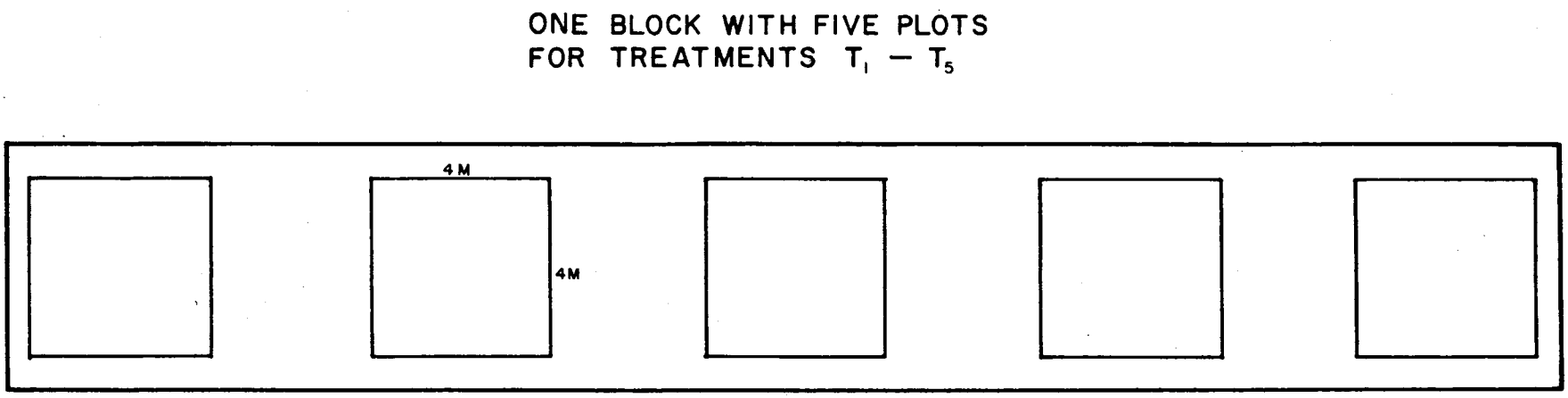

Figure 3. Orientation of the five fertilization plots in a block.

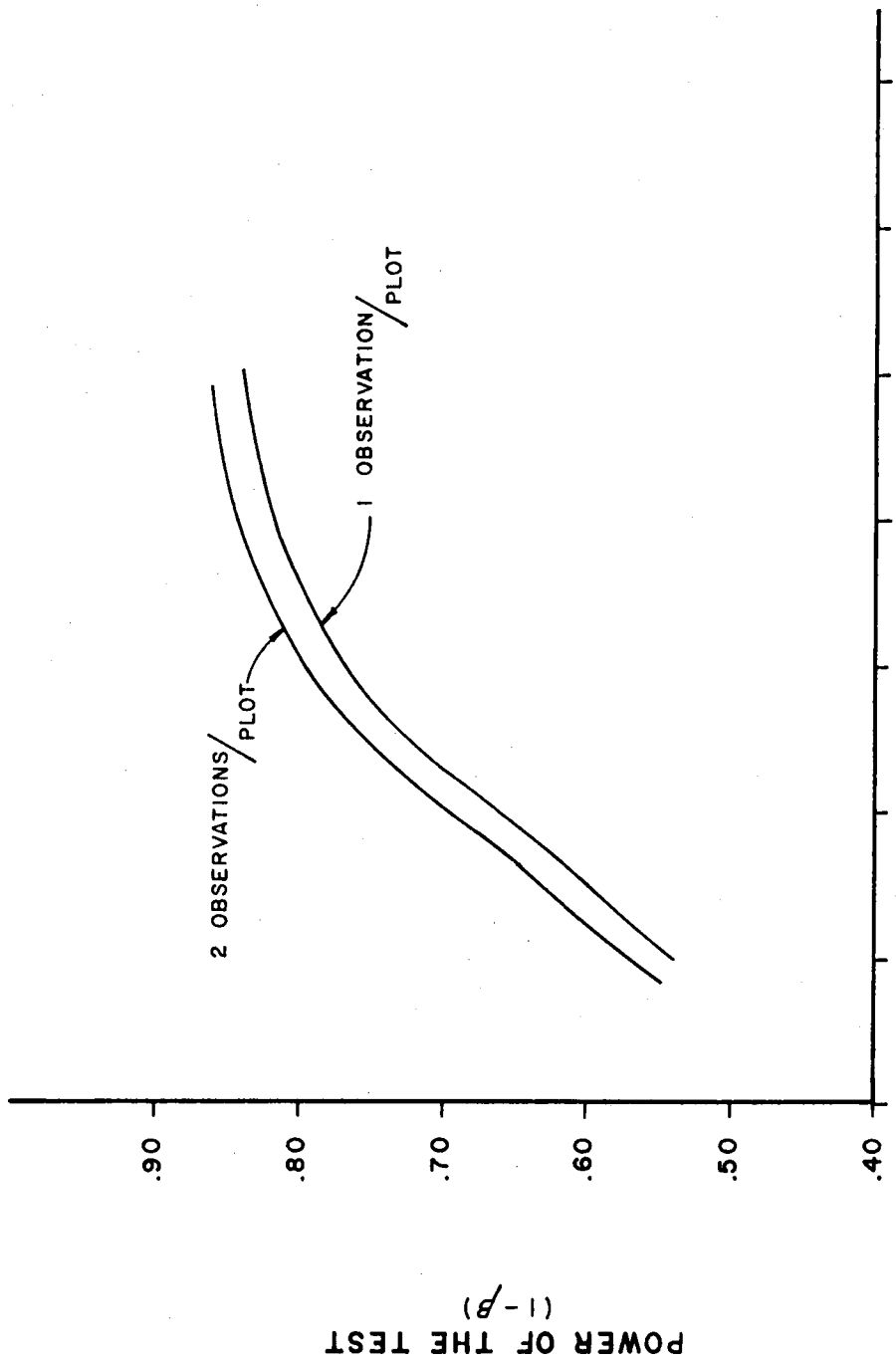

Figure 4. A plot of power of the test against number of plots per treatment considering the effect of one versus two observations per plot.

total treatment was applied in two equal applications spread about one month apart in August and September during the summer wet season. Fertilizers for each plot were mixed and applied evenly to the plot with a cyclone seeder.

Biomass estimates were made by harvesting a 0.1 m^2 quadrat randomly placed in each plot at four times (October, January, March and May) during the first year after nutrient application. Vascular plants were clipped as close to the ground as possible, sorted by species, dried (105^oC) and weighed. Litter weight was estimated in the fourth harvest only. It was removed from the harvested quadrat, then divided into roughly equal fractions. One part was weighed wet, dried (105^oC) and weighed again. The rest was weighed wet and returned to the original plot in mesh bags to estimate the litter decomposition rate. At the end of a 75-day period the mesh bag was removed from the plot, and the remaining litter was dried (105^oC) and weighed. Snails were removed from the harvested quadrat, sorted by genus, counted and weighed.

Below-ground biomass samples were taken from the quadrat after the above-ground plant material was harvested. From each quadrat I took a 4.7 cm diameter core to a depth of 40 cm. These samples were washed through 0.25 mm sieves, dried at 105^oC, and weighed.

Macro-invertebrate samples were taken from the quadrat before the plant material was harvested to minimize avoidance by mobile species. Gastropods were included in these samples even though they were collected from the entire plot after the plant material was harvested. From each quadrat I took an 11.5 cm diameter core to a depth of about 5 cm. The core was removed so that mobile species could not escape and placed in a

plastic bag. The cores were later washed with alcohol and water to remove invertebrates from the surface area. The samples were then preserved in alcohol and sorted.

Tissue nutrient samples were collected from healthy plants throughout the plot. The sample material was sorted into four categories: woody and green *B. maritima* and woody and green *S. virginica*. This material was dried at 105°C and ground in a Wiley mill with a #40 screen. Analyses were made of the dry plant material for nitrogen and phosphorus. Nitrogen was analyzed on a Perkins-Elmer C-H-N analyzer. Phosphorus was analyzed by acid digestion and measurement by a Technicon(R) Autoanalyzer using a colorimetric ascorbic acid reduction method.

Glass slides were placed on the sediment surface in the marsh plots to provide a substrate for periphyton to attach and grow during a 3-week incubation period in September 1976. In Block 3, three slides were placed on each plot for cell density by species estimates, five for biomass estimates and five for chlorophyll a estimates. In Blocks 4 and 5 slides were placed on plots for biomass and chlorophyll a estimates only. In July 1977, five slides were placed on each plot in all seven blocks for chlorophyll a estimates.

Cell density was determined for each species by examining 7.92 mm^2 of each slide under a microscope. Biomass was determined by weighing the glass slide before and after ashing. Chlorophyll a was determined by extracting the chlorophyll on each slide with acetone and measuring spectrophotometrically.

3.2 Second Year

The second year of study was designed to repeat the first year study for vascular plant response and to answer two new questions generated by the first year's results:

1) How would the responses change if the nutrient applications were discontinued for the second year?
2) How would the response change if the nutrient applications were continued for the second year?

To repeat the first year study, 15 new plots (3 new blocks) were created for the second year and, along with six of the seven original control plots were all treated for the first time. Levels of nutrient application were the same as the first year. To answer the two new questions, half of the 28 original plots that received nutrient applications the first year received none the second year, i.e., discontinued treatment. The other half received the same level of nutrient application the second year as they had the first, i.e., continued treatment. Above-ground vascular plant biomass, litter weight, and snail biomass were estimated three times (November, February, and April) using the same techniques as the first year. Other sampling done the first year was not done the second. Nutrient applications and harvest periods lagged about one month behind that of the first year because of the delayed onset of the summer wet season.

An incomplete block design was used in the second year in that no one block had the full complement of treatments (Table 1). Because there was not an equal number of each treatment, this was an unbalanced case of the incomplete block design. Initial analysis of the two years'

Table 1. Assignment of year 1, year 2 and year 3 fertilization levels applied to each plot within each block.

	Continued Treatment				Discontinued Treatment				Repeat of First Year Experiment[b]				
YEAR 1	2	3	4	5	2	3	4	5	1	1	1	1	1
YEAR 2	2	3	4	5	1	1	1	1	2	3	4	5	1
YEAR 3	2	3	4	5	1	1	1	1	1	1	1	1	1
BLOCK 1	X	X	X	X					X				
2					X	X	X	X		X			
3	X	X					X	X			X		
4			X	X	X	X						X	
5	X		X			X							X
6		X		X	X[a]		X		X				
7	X			X		X	X			X			
8									X	X	X	X	X
9									X	X	X	X	X
10									X	X	X	X	X

[a]This particular "X" denotes that this plot in Block 6 received fertilization level 2 the first year and level 1, or no fertilizer the second year.

[b]In the third year these plots were not fertilized. The third year response serves as a replicate of the second year discontinued treatment response.

data revealed that no interaction existed between the effects of fertilizer treatments and those of either year or harvest; i.e., the slopes of the biomass response curves were not significantly different from harvest to harvest or year to year. The year effect was estimated using data from plots fertilized for the first time in 1976 and 1977. Year effect is the difference in variable response between plots treated exactly the same, but in two different years. Since no interaction existed between the effects of fertilizer treatments and the year of harvest for plots for which the year effect could be estimated, it was assumed that no interaction existed between treatment and year effect for the rest of the plots. The harvest effect is the difference in variable response between harvests. Harvest effect was estimated within each year. The interaction between the effects attributed to harvest and those attributed to fertilizer treatments was insignificant.

Lack of interaction between the effects of year or harvest and those of treatment allowed the data to be reanalyzed after the deletion of the interaction classes of effect associated with treatment. The sum of squares among treatments was partitioned into components associated with the effects of continued treatment and the effects of discontinued treatment. Also, both years' data were combined to estimate the plant biomass responses during the first year following fertilization. Data from the three harvests conducted during the second year were combined to estimate plant biomass response to continued treatment and discontinued treatment.

Response curves were compared using polynomial equations to estimate the response curves. The polynomials were also used to test the

null hypothesis that the average slope of the response curve was zero. Because the response curves for the first year treatment, continued treatment, and discontinued treatment had common control plots, which caused all of these curves to converge at treatment level 1 (control), this treatment level was omitted from these analyses. Thus, each curve was tested for a non-zero slope only over the range of actual fertilizer application. Similarly, tests of the null hypotheses that curves were not different from each other also were done with treatment level 1 omitted.

After these analyses were completed, asymptotic curves were fitted to the least square means for each treatment level. In most cases asymptotic curves seem to be a better representation of plant response to increasing nutrient levels than polynomials. However, *B. maritima* leaf biomass responses to the first year treatment and the discontinued treatment are best represented by a straight line.

3.3 Third Year

Fertilizer was applied in July and August of 1978 and above-ground vascular plant biomass was harvested twice in the third year (February and May 1979). The unbalanced incomplete block design was continued.

4. RESULTS

4.1 First Year

The standing crop response curves for the aerial portions of total vascular plant biomass are illustrated in Figure 5. The data for this and other figures and the tables are contained in the Appendices. Each response curve is made up of five points corresponding to the five fertilization levels. Each point is the mean response value for one fertilization level measured in seven blocks, i.e., N-7. The April and July response curves illustrate prefertilization biomass levels and thus no response to fertilization is evident. The response curves for October, January, March and May show increasing biomass with increasing fertilization levels and little difference in response at levels 4 and 5.

The four post-fertilization response curves were combined after analysis determined that there was no time treatment interaction, i.e., that their slopes were not significantly different. The combined response curve for total aerial vascular plant biomass is shown in Figure 6. Each point is a mean of four harvests, seven replicates or blocks per harvest. In both Figures 5 and 6 a somewhat sigmoid response is seen for total biomass. When total biomass is separated into *Batis* and *Salicornia*, *Batis* shows a response to treatment while *Salicornia* does not (Figure 7). The leveling off at higher fertilization levels, seen in the total biomass response curve, is less apparent when the two species are graphed separately.

For *Batis* leaf and stem, the combined response curves for the four post-fertilization harvests are illustrated in Figure 8. Both leaves and stems show a significant response to treatment.

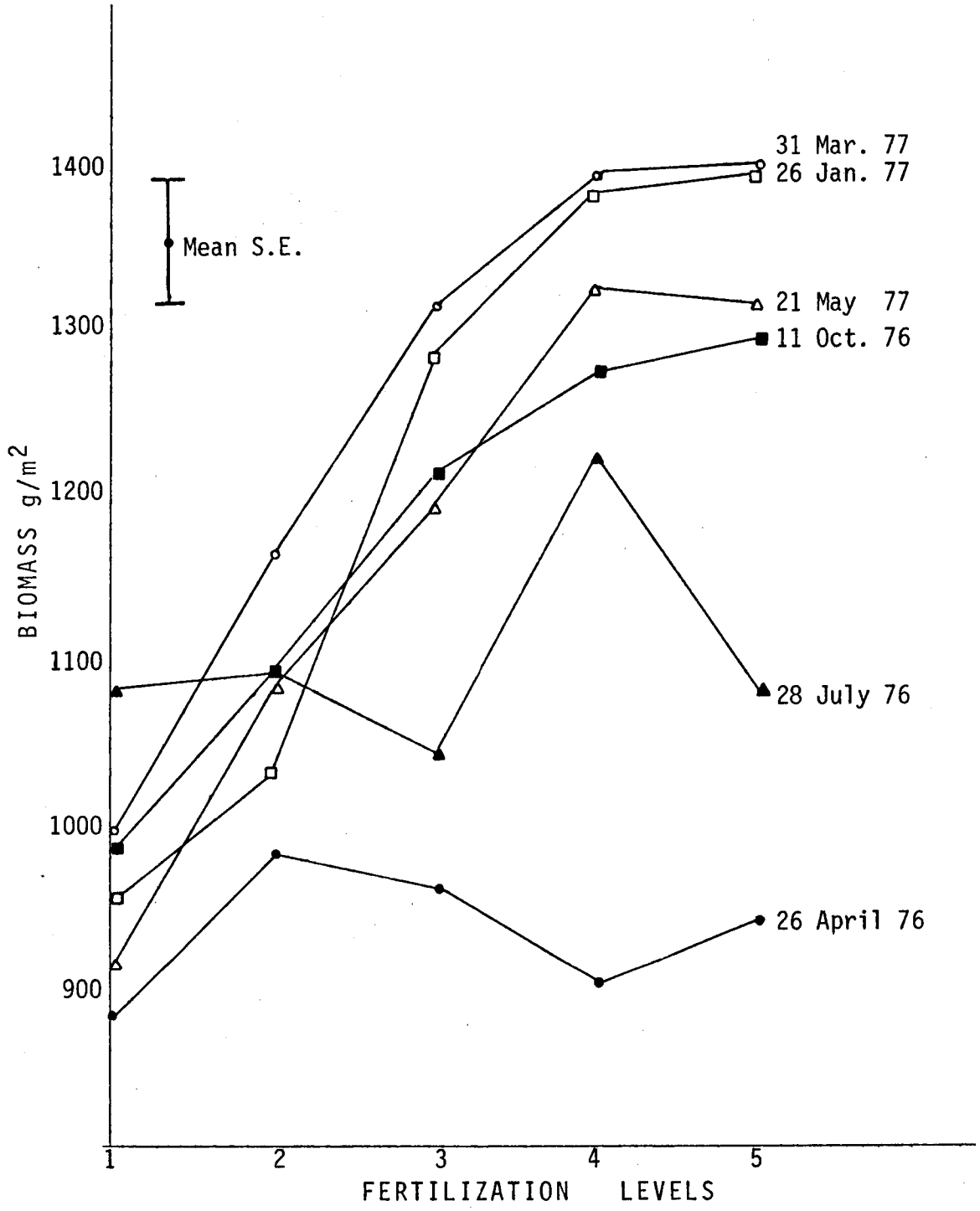

Figure 5. Total aerial vascular plant biomass for each harvest in study year one.

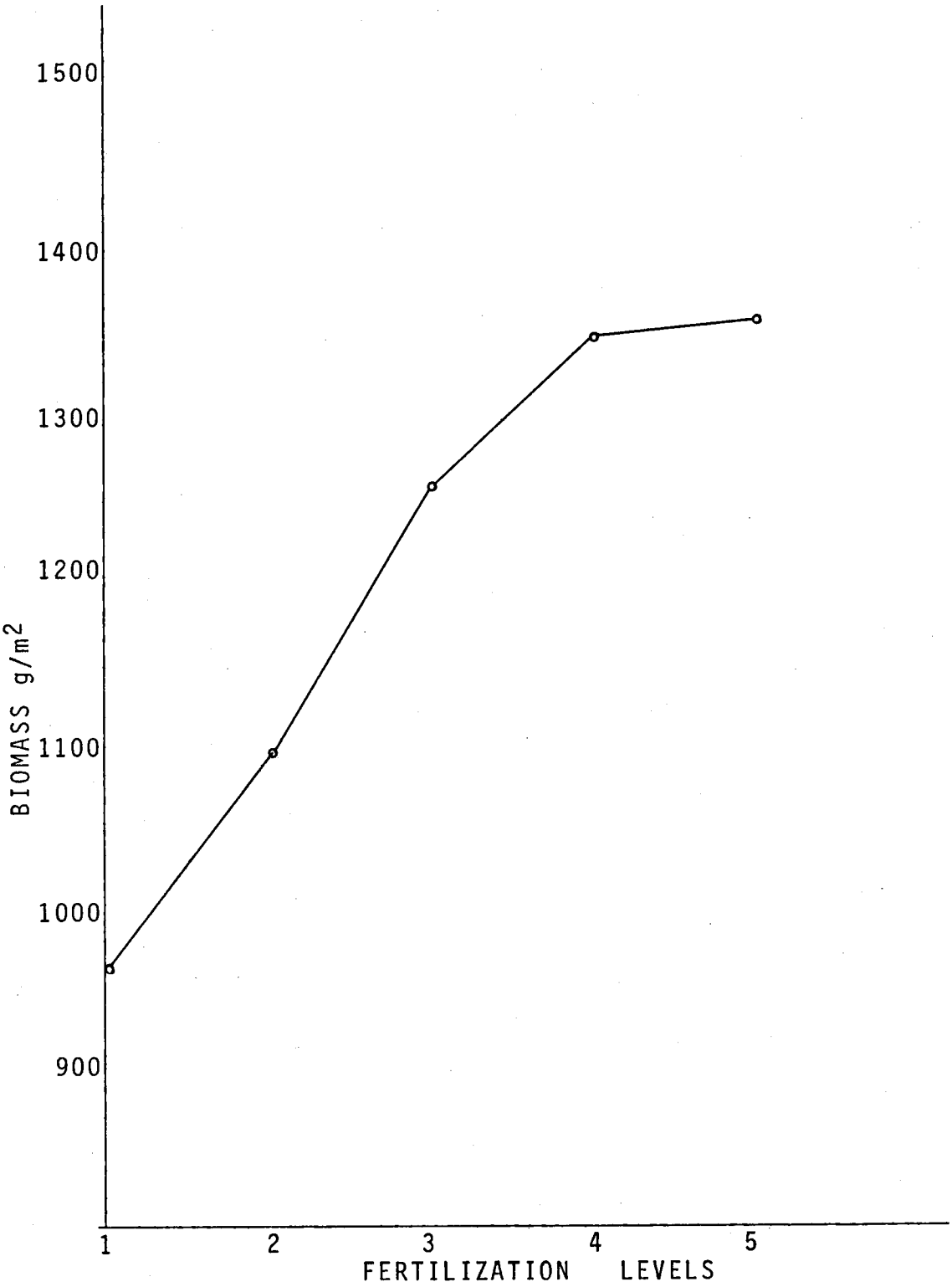

Figure 6. Total aerial vascular plant biomass for October, January, March and May of study year one, combined into one response curve.

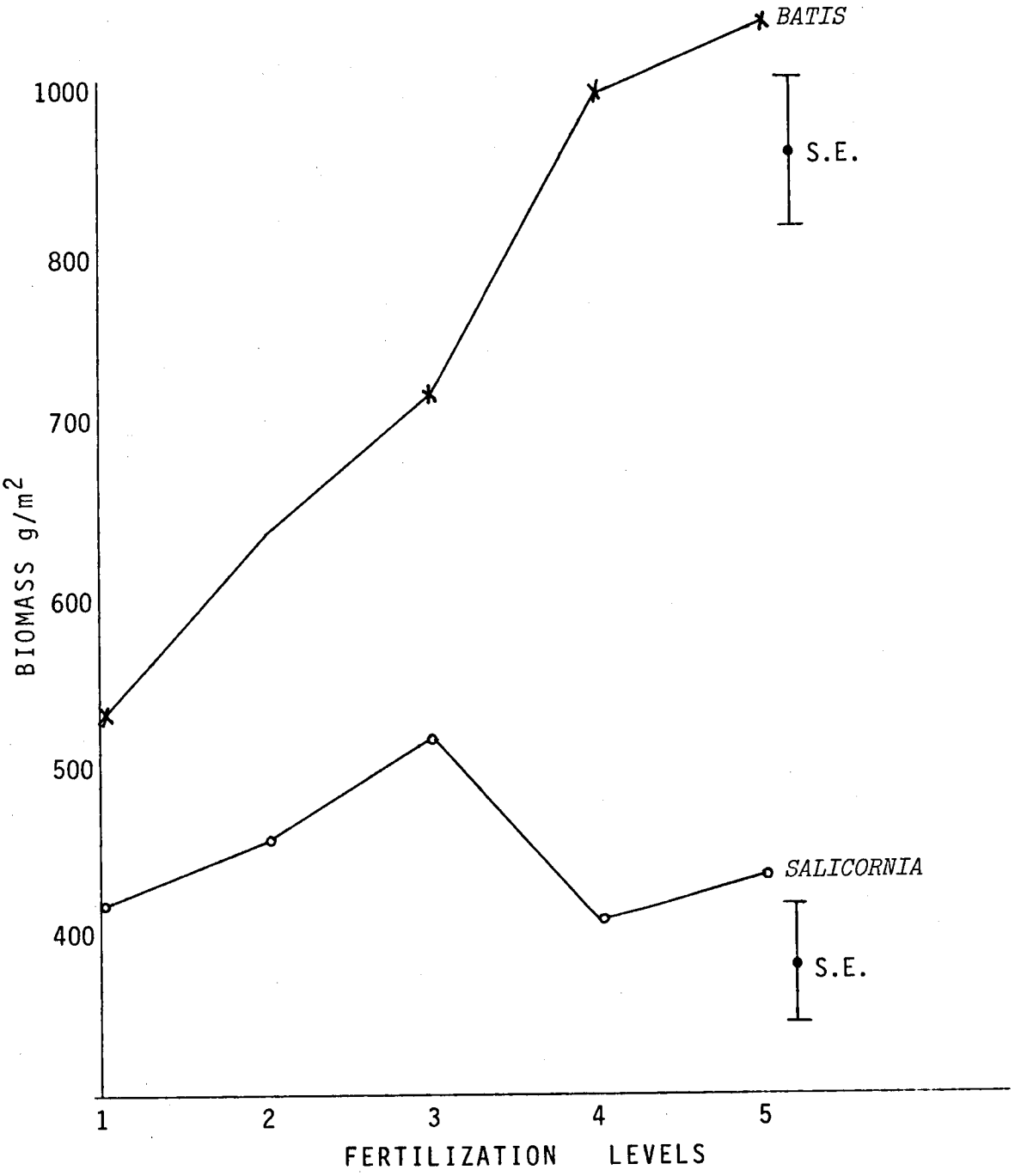

Figure 7. Aerial *Batis* and *Salicornia* biomass for October, January, March and May of study year one, combined into one response curve.

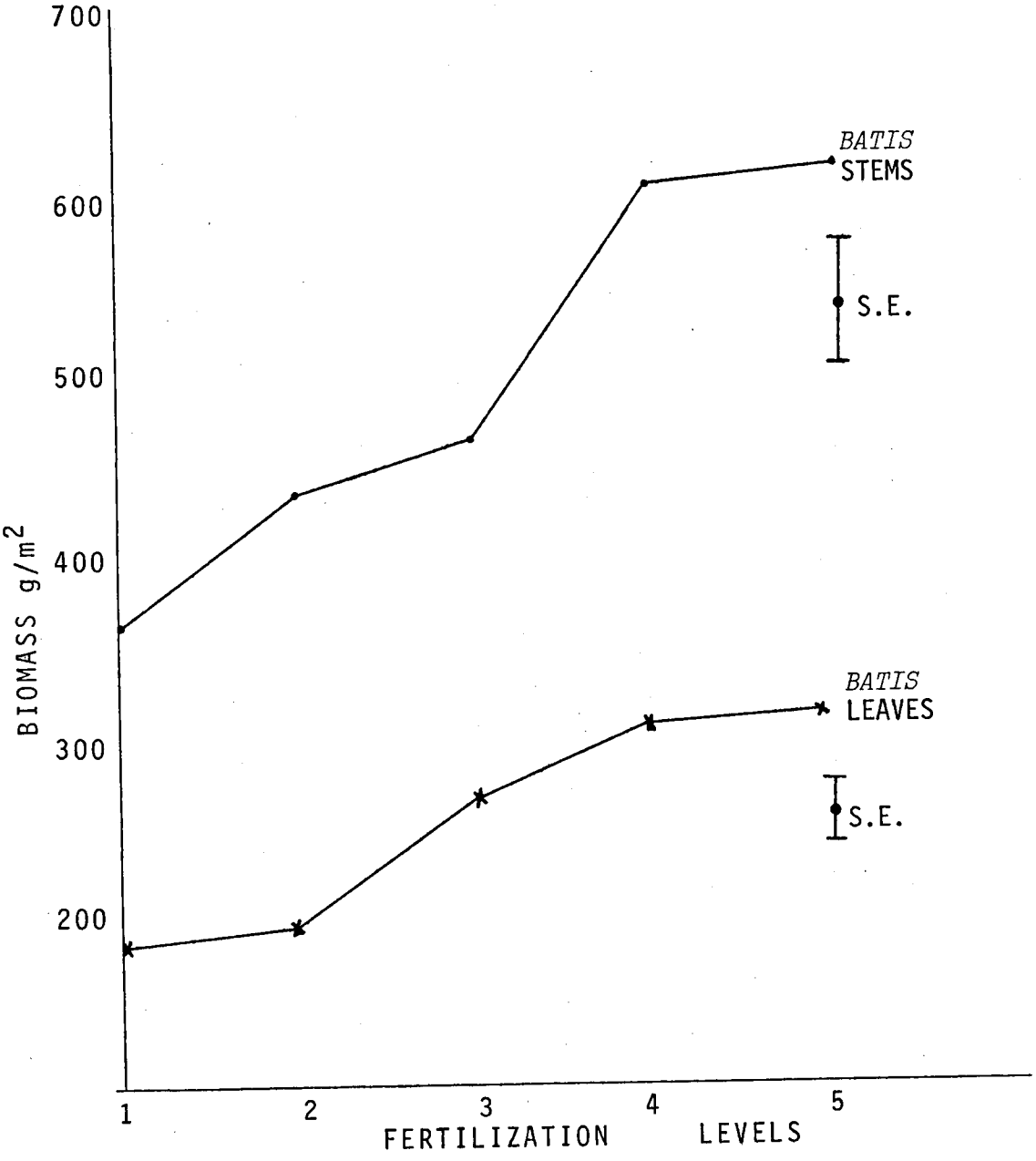

Figure 8. *Batis* leaf and stem biomass for October, January, March and May of study year one, combined into one response curve.

The shape of the response curves for *Batis* and *Salicornia* measured the first year were confirmed in a repeat experiment the second year. The two years' data are combined and fit with curves, as discussed in the "Methods" section, to estimate a first-year response to fertilization. The curve fit response for total *Batis* and *Salicornia* is illustrated in Figure 9. The response curves for *Batis* leaf and stem are illustrated in Figure 10. Both *Batis* stem and leaf biomass show increases across the five levels of increasing nutrient additions while *Salicornia* does not respond. The combined effect of these responses is to shift the community composition from that which originally had slightly more *Salicornia* to that which is clearly dominated by *Batis*. Figure 11 shows the relative change in community composition from before fertilization to 10 months after.

Tissue nitrogen and phosphorus concentrations for prefertilization and post-fertilization are shown in Tables 2 and 3 respectively. No luxury consumption was measured. Plots receiving higher fertilization rates do not show tissue nitrogen and phosphorus concentrations higher than control plots. The lack of luxury consumption measured the first year was confirmed in the repeat study the second year.

Below-ground vascular plant biomass was sampled for three harvests (Table 4). The root material extends to a depth of 30 cm with over 50% occurring in the top 10 cm. Below-ground biomass constitutes approximately two-thirds of the total plot biomass and shows no response to fertilization levels. No attempt to separate live from dead, or *Batis* from *Salicornia*, was made as the effort to do this was well beyond that available. Also, differentiation between live and dead and between species by visual inspection was difficult and unreliable. Since no differentiation

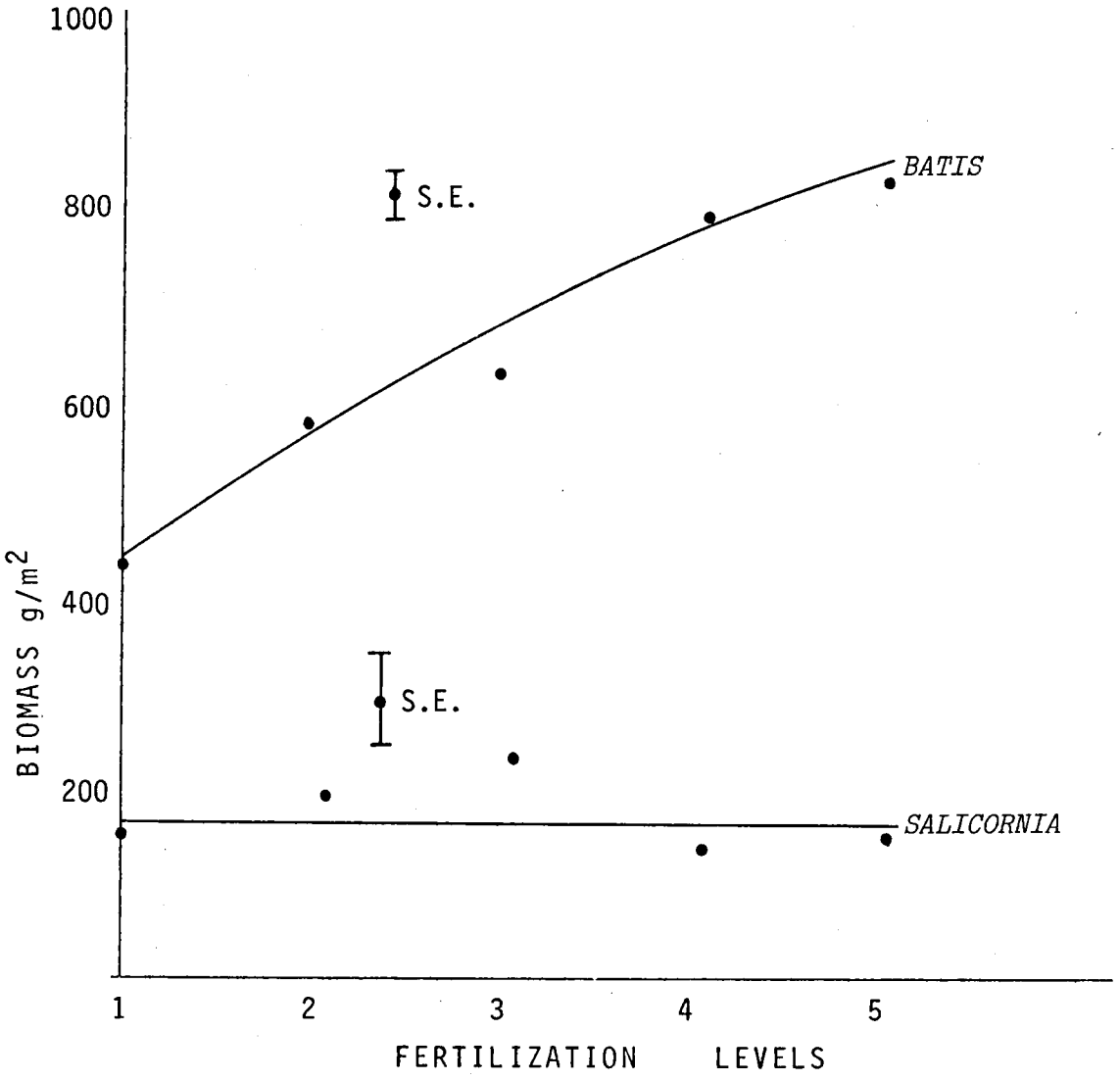

Figure 9. Curve fit response of aerial *Batis* and *Salicornia* in study year one.

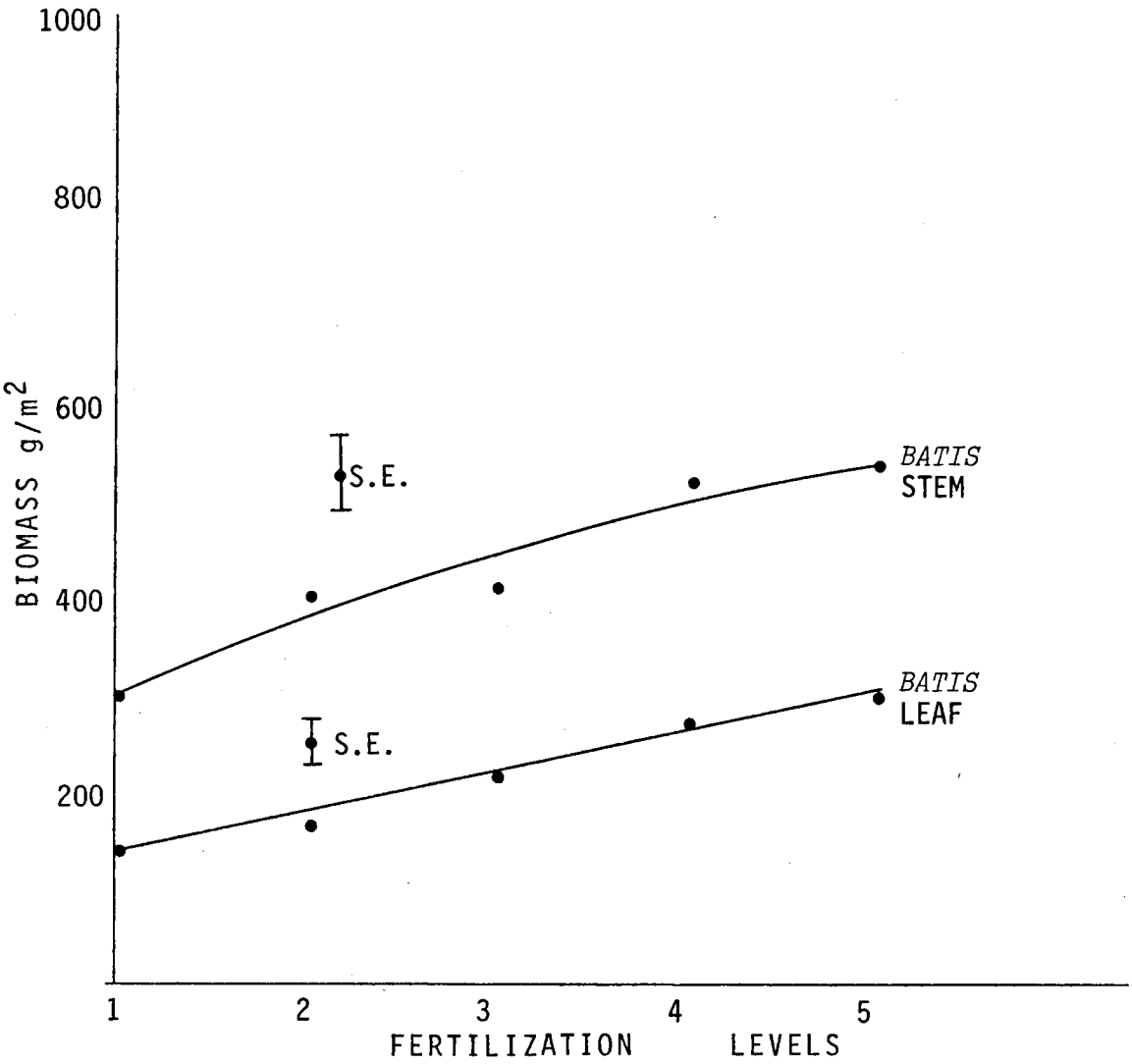

Figure 10. Curve fit response of total aerial *Batis* stem and leaf biomass to one year's fertilization.

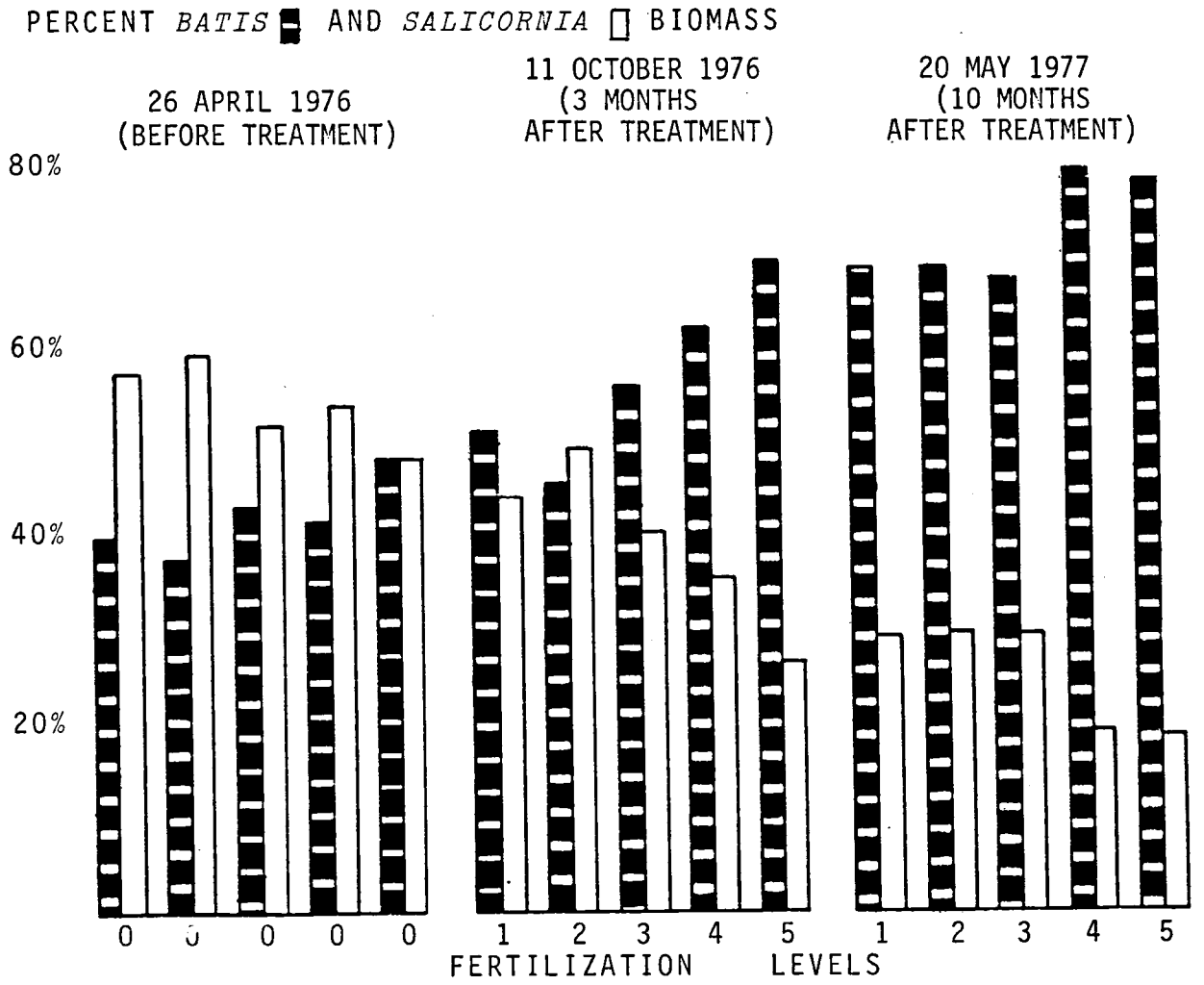

Figure 11. Percent *Batis* and *Salicornia* aerial biomass at three times during study year one.

Table 2. Nutrient concentration in percent dry weight for various vascular plant tissues at each fertilization level; 13 July 1976, prefertilization.

% Phosphorus

	FERTILIZATION LEVELS 1		2		3		4		5	
	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.
Green *Batis*	0.13	- 0.02	0.14	- 0.03	0.14	- 0.02	0.15	- 0.03	0.15	- 0.02
Woody *Batis*	0.18	- 0.01	0.17	- 0.03	0.20	- 0.03	0.18	- 0.02	0.22	- 0.03
Green *Salicornia*	0.14	- 0	0.15	- 0.03	0.16	- 0.01	0.20	- 0.08	0.15	- 0.02
Woody *Salicornia*	0.20	- 0.02	0.21	- 0.01	0.19	- 0.01	0.21	- 0.03	0.21	- 0.02

% Nitrogen

	FERTILIZATION LEVELS 1		2		3		4		5	
	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.
Green *Batis*	1.44	- 0.14	1.42	- 0.23	1.40	- 0.12	1.47	- 0.28	1.42	- 0.10
Woody *Batis*	1.14	- 0.13	1.42	- 0.15	1.19	- 0.03	1.12	- 0.11	1.25	- 0.06
Green *Salicornia*	1.14	- 0.17	1.82	- 0.33	1.68	- 0.19	1.66	- 0.27	1.66	- 0.25
Woody *Salicornia*	1.38	- 0.15	1.38	- 0.25	1.27	- 0.20	1.28	- 0.21	1.31	- 0.20

Table 3. Nutrient concentration in percent dry weight for various vascular plant tissues at each fertilization level; 10 October 1976, post-fertilization.

% Phosphorus

	FERTILIZATION LEVELS 1		2		3		4		5	
	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.
Green *Batis*	0.13	- 0.01	0.14	- 0.03	0.15	- 0.06	0.13	- 0.02	0.13	- 0.01
Woody *Batis*	0.20	- 0.02	0.23	- 0.03	0.30	- 0.12	0.22	- 0.02	0.30	- 0.07
Green *Salicornia*	0.16	- 0.01	0.21	- 0.05	0.21	- 0.04	0.18	- 0.03	0.19	- 0.02
Woody *Salicornia*	0.24	- 0.02	0.25	- 0.02	0.20	- 0.01	0.24	- 0.03	0.27	- 0.03

% Nitrogen

	FERTILIZATION LEVELS 1	2	3	4	5
Green *Batis*	1.28 - 0.13	1.30 - 0.12	1.28 - 0.08	1.39 - 0.35	1.27 - 0.07
Woody *Batis*	1.01 - 0.10	1.20 - 0.21	1.13 - 0.16	1.09 - 0.13	1.14 - 0.10
Green *Salicornia*	1.80 - 0.08	1.70 - 0.11	1.73 - 0.10	1.73 - 0.07	1.40 - 0.58
Woody *Salicornia*	1.40 - 0.16	1.33 - 0.31	1.44 - 0.05	1.49 - 0.11	1.38 - 0.07

Table 4. Below-ground biomass means (N=7) in g/m^2 for each fertilization level.

Fertilization Level	$\bar{x}$	S.E.
	11 October 1976	
1	5,073	577
2	5,027	577
3	5,131	577
4	4,560	577
5	4,543	577
	31 March 1977	
1	5,292	438
2	4,825	438
3	5,401	438
4	5,217	438
5	4,393	438
	20 May 1977	
1	4,560	323
2	4,312	323
3	4,496	323
4	4,393	323
5	3,666	323

between live and dead was made, and the samples may have contained substantial dead root material produced in previous years, this estimate of below-ground biomass should be considered a maximum when compared to aerial biomass. The literature concerning problems in accurately estimating below-ground biomass in salt marshes is briefly reviewed by Valiela *et al.* (1976).

By the ninth month after the fertilizer was first applied to the plots, the amount of litter had increased with increased fertilization. The litter decomposition rate, measured during a 75-day period extending between the ninth and eleventh months (May - July 1977) after treatment, also increased with increased fertilization (Fig. 12 and Table 5).

Snail biomass (undecalcified) showed a weak response to treatment during the first year of the study. *Melampus* showed no response, however. As the marsh dried out during the winter, individuals occurred in clusters and the 0.1 m^2 sampling quadrats were inadequate. Individuals of *Cerithidea* were more evenly distributed and the sampling technique was more adequate to estimate differences in numbers between treatment plots. By six to twelve months after treatment, *Cerithidea* biomass had decreased with increased fertilization (Figure 13). This response is only marginally significant in a statistical sense ($\alpha<0.1$), and it is difficult to interpret because the effects of block, harvest, and the interaction between harvest and treatment were all as significant, or more so, than the effect of treatment. Thus, it appears that factors associated with the location of the plot in the marsh and time of sampling were more important than the direct or indirect effects of nutrients. By the second year of the study, many fewer snails were found throughout the marsh. The overall decline of the snail populations prevented

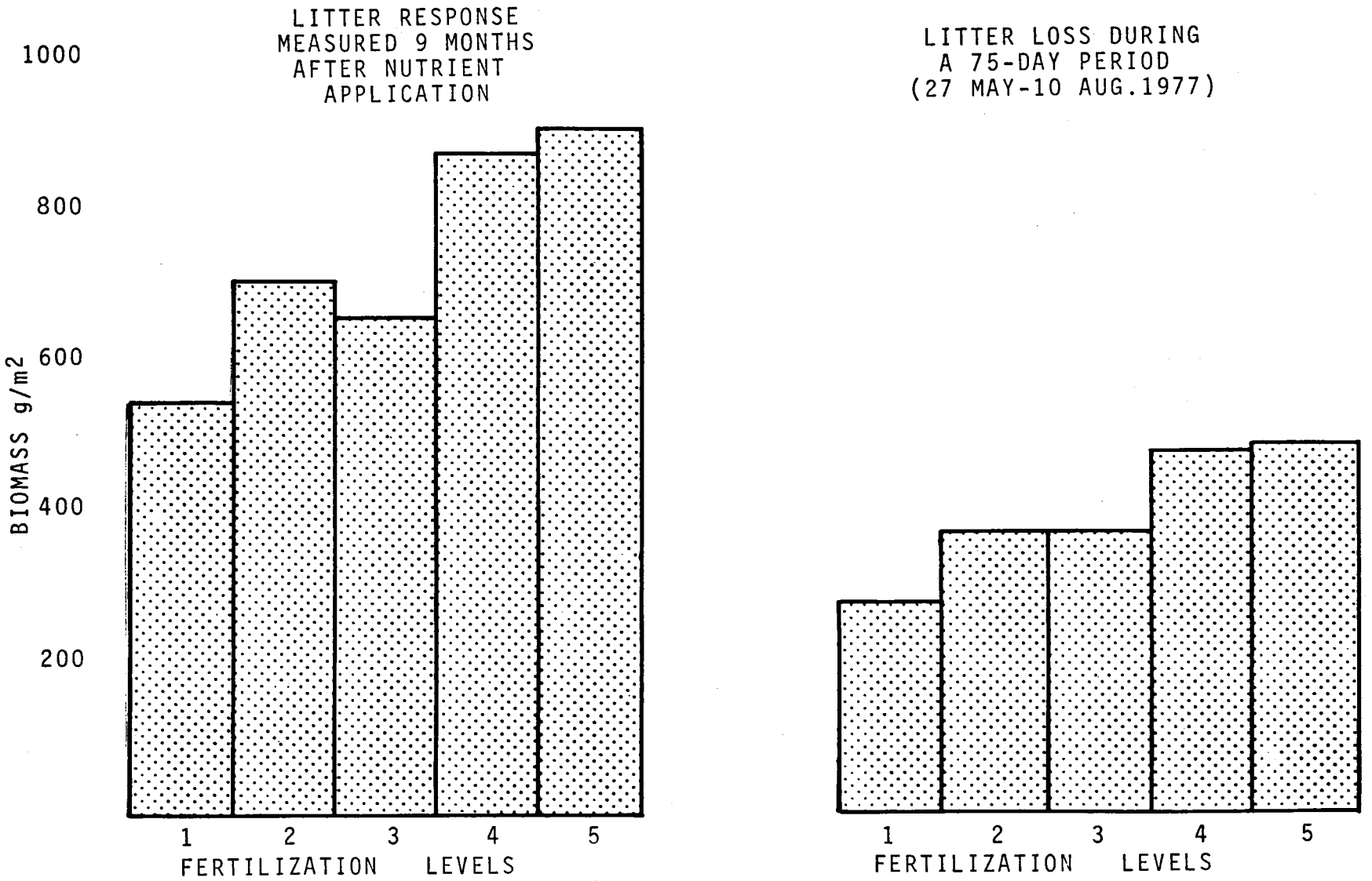

Figure 12. Litter and litter decomposition rate.

Table 5. Grams litter lost during 75-day period (27 May - 10 Aug. 1977) and percent litter lost across treatment.

	FERTILIZATION LEVELS				
	1	2	3	4	5
Mean weight loss	2.780	3.697	3.686	4.776	4.971
Mean initial weight	5.544	7.131	6.596	8.801	9.110
% weight loss/ 75 days	50.1	51.8	55.9	54.3	54.6
% loss/day	.668	.691	.745	.724	.728

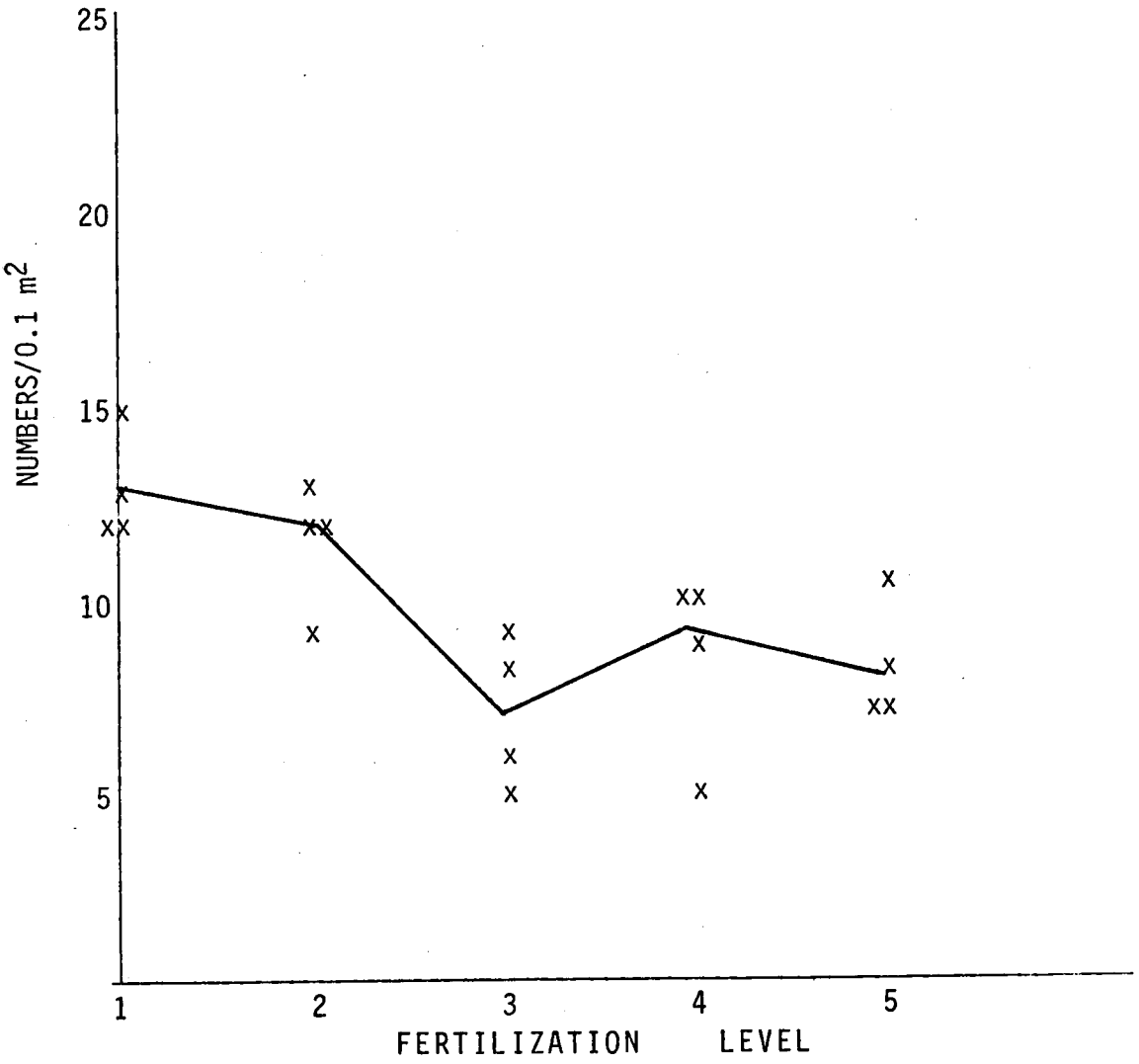

Figure 13. Mean number of *Cerithidea* for the four post-fertilization samplings in study year one. The mean value (N = 7) for each harvest is indicated by an "x".

continuing the snail sampling in the second year without greatly increasing sampling effort, but substantiates the idea that factors other than nutrients, e.g., surface wetness, may control the size of snail populations.

The non-gastropod, sediment invertebrates measured in the control and highest fertilization plots in seven blocks are listed in Table 6 Amphipods are the most numerous and the only organism found consistently in samples. No significant differences were measured between the control and highest treatment. Sampling for these organisms was discontinued because of a drastic reduction in numbers probably due to the drying trend discussed above.

The periphyton response measured in October 1976 is illustrated in Figures 14 and 15. The variances in diatom cell density and periphyton biomass and chlorophyll were so large that no significance response to treatment could be measured. Unfortunately, the drying trend precluded continued sampling for this response component of the salt marsh community. The results reported permit no conclusion as to treatment response. The periphyton data, including species composition, are listed in the Appendix.

In summary, *Batis* increased in biomass during the first year in response to fertilization with increasing levels of nitrogen and phosphorus. *Salicornia* biomass did not respond to the nutrient additions, and the community composition, therefore, shifted to favor *Batis*. The amount of litter had increased with increasing levels of nutrient application by the last quarter of the first year of the study. Also, at this time, the rate of litter decomposition had increased with increasing fertilization. *Cerithidea* population numbers showed a tendency to decline with increasing

Table 6. Numbers of non-gastropod invertebrates per 0.1 m^2, measured 26 January 1977 in seven blocks.

Taxa	Control		Highest Fertilization	
	$\bar{x}$	s.d.	$\bar{x}$	s.d.
Foraminifera - benthic	8.67	13.28	7.50	7.78
Nematoda	0.0	-	1.00	-
Oligochaeta	1.00	0	1.00	0
Pelecypoda	2.83	2.04	1.00	0
Amphipoda	75.14	18.99	89.14	25.52
Insecta-larvae	2.50	1.38	6.40	7.09
Insecta	6.00	4.30	5.00	4.47
Arachnida	2.00	0	1.50	1.0

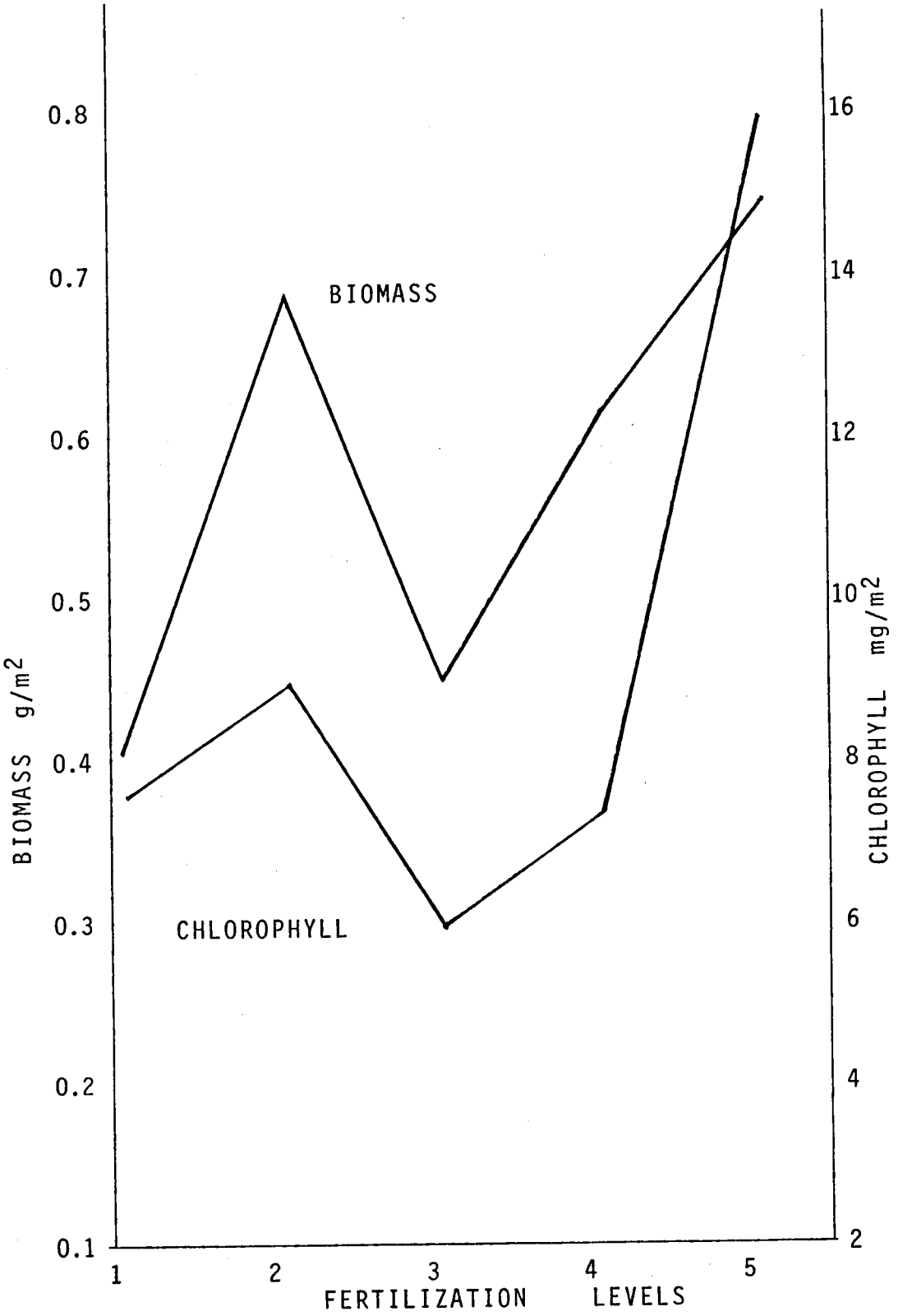

Figure 14. Periphyton biomass and chlorophyll a values for October 1976.

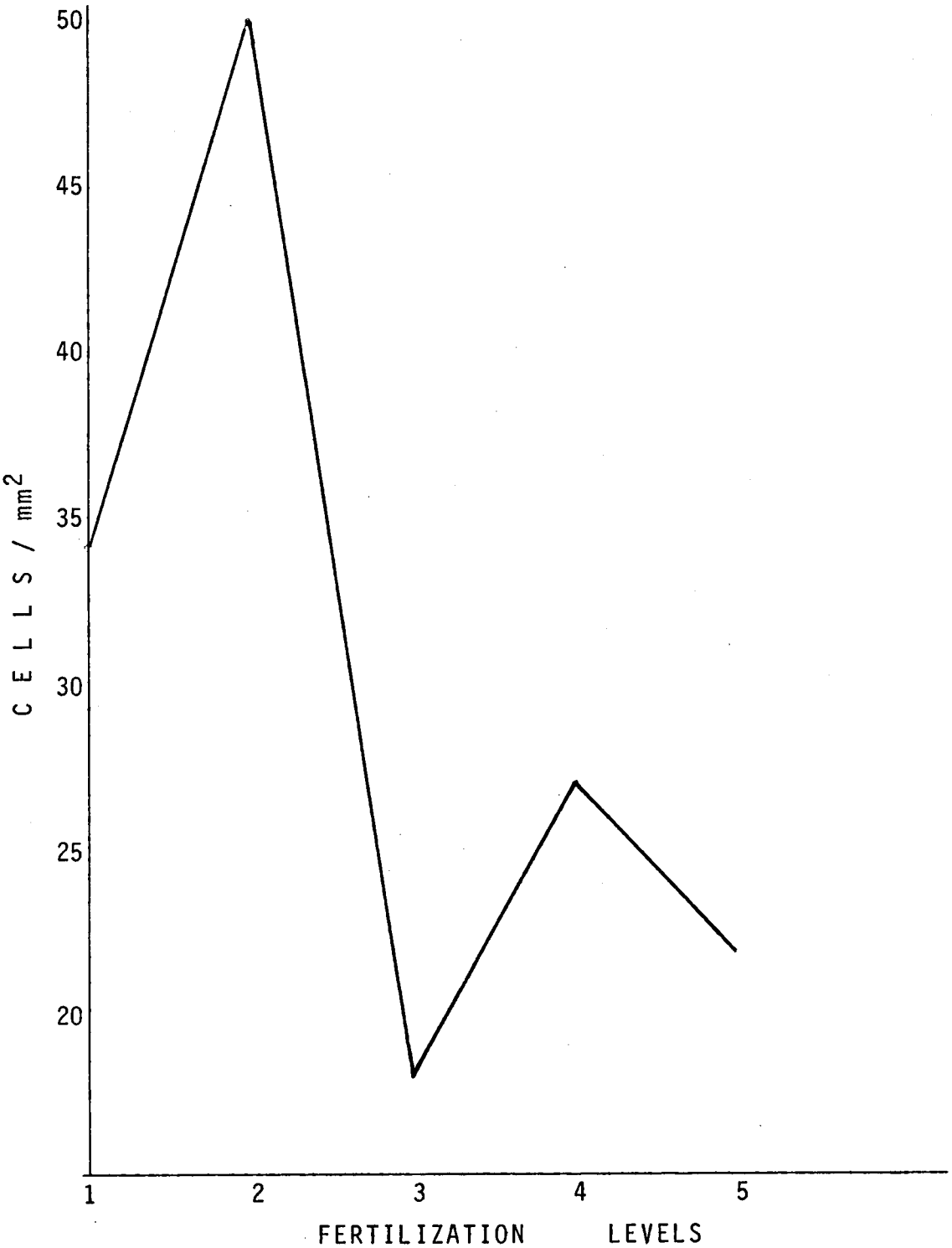

Figure 15. Diatom cell density for October 1976.

nutrient application levels during the first year; however, unestimated factors such as wetness appeared to have more control over the snail population than nitrogen and phosphorus additions. Below-ground biomass and aerial tissue N and P concentrations showed no response to treatment. The variances in the limited data obtained for periphyton and non-gastropod invertebrates permit no conclusion as to treatment response.

4.2 Second Year

Data collected during the second year of study from plots receiving discontinued treatment showed responses similar to the first year response, but with some notable differences. *Batis* biomass showed increases over first-year levels even though treatment was discontinued (Fig. 16). The response of *Batis* to continued treatment showed an increase over the first-year response and appears to be reacing an asymptote near 1000 g/m^2. *Salicornia* showed no response to treatment.

Batis leaf biomass decreased during the second year on all plots for which the fertilizer application was discontinued the second year (Fig. 17). The highest treatment levels lost the most. Conversely, *Batis* biomass from stems continued to increase during the second year. This opposite movement of the two components of overall *Batis* biomass changed their relative proportions. During the first year, leaf biomass on plots given the higher fertilizer applications was 33-35 percent of the overall *B. maritima* biomass, but during the second year following fertilization, leaf biomass on these plots dropped to 21-22 percent of overall biomass. This result may be an artifact of sampling and is addressed in the "Discussion."

Plots receiving continued treatment had the greatest amount of *Batis* biomass (Fig. 17). Plots fertilized two years consecutively at the

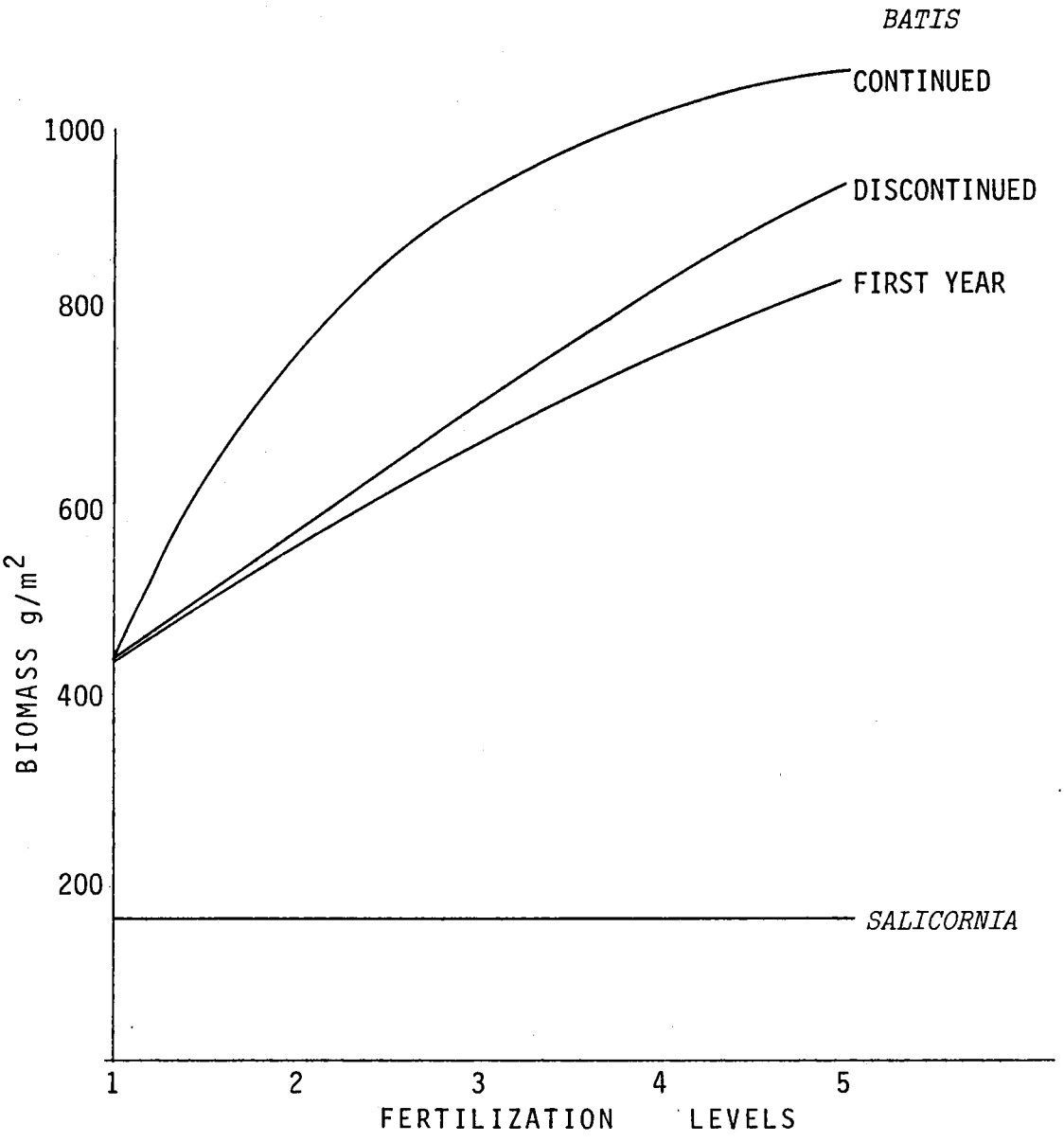

Figure 16. *Batis* and *Salicornia* curve fit biomass responses to first year, discontinued and continued treatments.

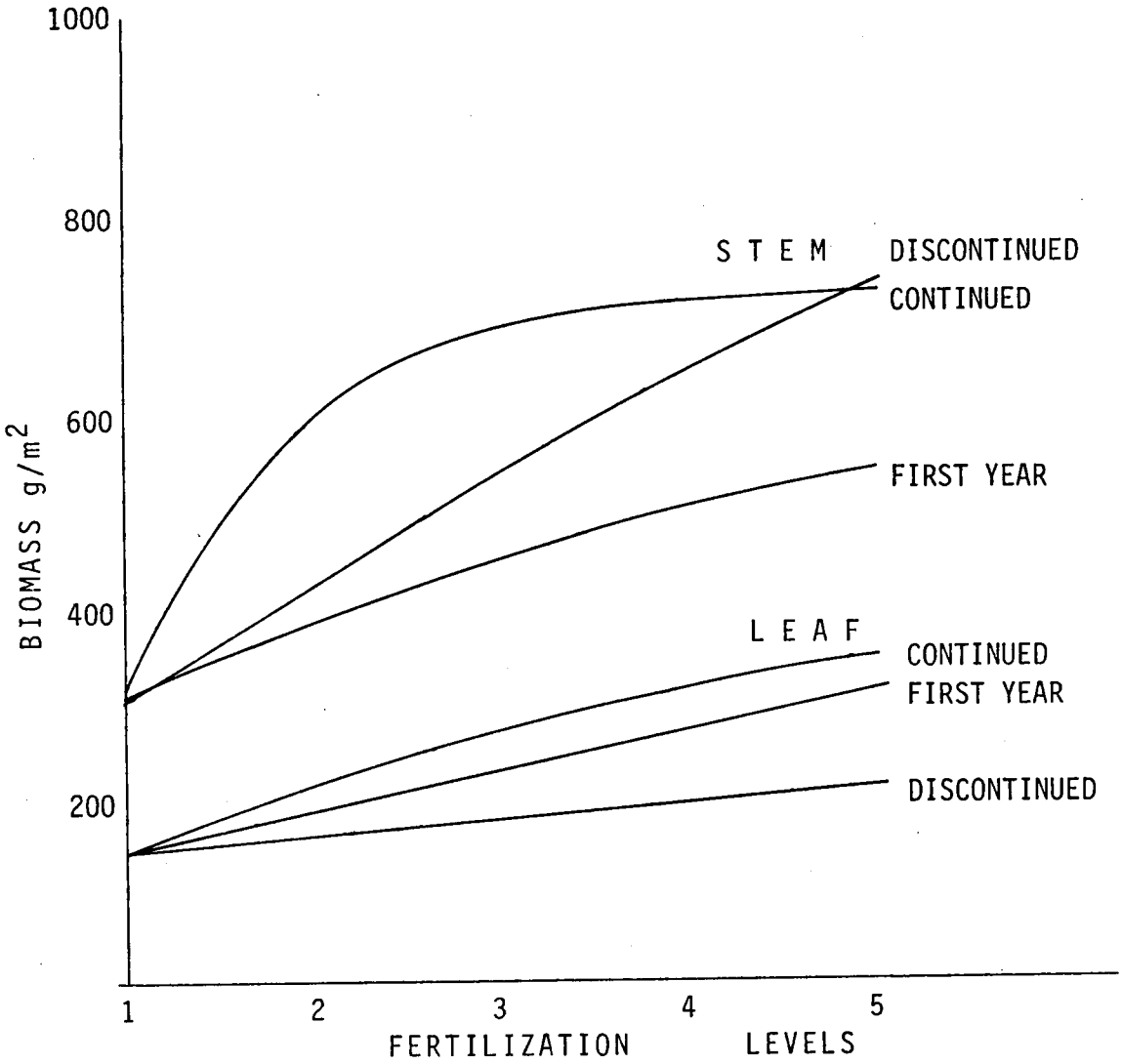

Figure 17. *Batis* leaf and stem curve fit biomass response to first year, discontinued and continued treatment.

three highest levels showed little difference in biomass, indicating that a limit to the response to increased nutrients was approached. This limit was roughly 2.5 times the biomass of the control plots. The biomass data for Fig. 17 are listed in Table 7. The calculated treatment responses generated from equations fit to Table 7 values are listed in Table 8.

In summary, *Salicornia* continued to show no biomass response during the second year of discontinued treatment. There was a gradual overall decrease in *Salicornia* biomass during the end of the first year and through the second year; however, this decline was not associated with treatment levels. It may be associated with increased droughtiness of the site. *Batis* stems showed a continued increase in biomass over the first-year response for both continued and discontinued treatment. *Batis* leaves on plots receiving discontinued treatment showed a decrease in biomass compared to first-year levels, dropping back to about 20% over control biomass. The leaf response to continued treatment showed an increase over the first-year response with slightly higher biomass being maintained at each fertilization level.

4.3 Third Year

Two harvests were made in the third year to measure the third-year response of *Batis* stems and leaves to continued and discontinued treatment. These data are shown in Figure 18 along with the mean biomass measured in years 1 and 2. Stem biomass appears to be approaching an asymptote of 800 g/m^2. Even the second fertilization level shows stem biomass at 750 g/m^2 on plots receiving continued treatment. The stem response to discontinued treatment is still above control biomass at all fertilization levels.

Table 7. Least square means (g/0.1 m^2) and standard errors for biomass responses to first year, discontinued and continued treatment.

		Batis		*Batis* Stem		*Batis* Leaves		*Salicornia* Biomass	
		$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.
FIRST YEAR TREATMENT									
Fertilization Level	1	42.82	3.54	29.45	2.70	13.27	1.42	15.55	2.67
	2	56.80	3.41	40.35	2.57	16.26	1.35	19.20	2.58
	3	62.18	3.41	40.43	2.57	21.53	1.35	22.30	2.68
	4	77.85	3.54	51.67	2.70	26.04	1.42	13.82	2.68
	5	82.46	3.54	53.52	2.70	29.33	1.42	14.96	2.68
DISCONTINUED TREATMENT									
Fertilization Level	1	42.82	3.54	29.45	2.70	13.27	1.42	15.55	2.67
	2	50.77	8.80	36.13	5.98	14.04	3.15	6.83	6.66
	3	77.64	7.91	60.19	5.34	17.45	2.81	9.95	5.99
	4	77.52	7.91	60.41	5.35	17.37	2.82	9.80	5.99
	5	94.86	8.80	74.74	5.98	20.17	3.15	10.22	6.66
CONTINUED TREATMENT									
Fertilization Level	1	42.82	3.54	29.45	2.70	13.27	1.42	15.55	2.67
	2	75.70	7.91	58.20	5.34	17.91	2.81	13.29	5.99
	3	96.45	8.80	70.89	5.98	25.52	3.15	10.53	6.66
	4	99.91	8.80	66.29	5.98	33.23	3.15	9.88	6.66
	5	106.19	7.91	73.34	5.35	32.78	2.82	6.07	5.99

Table 8. Calculated treatment responses (g/0.1 m^2) generated from equations fit to measured treatment responses.

Batis Leaves

TMT	9.12+4.09(t) 1st Year	a) 52.48-48.13$e^{-.195(t)}$ b) 8.64+5.334(t) Continued a)	b)	11.72 + 1.61(t) Discontinued
1	13.21	12.88	13.97	13.33
2	17.30	19.89	19.31	14.94
3	21.39	25.67	24.64	16.55
4	25.48	30.42	29.98	18.16
5	29.57	34.33	35.31	19.77

Batis Stems

TMT	77.68-56.59$e^{-.17(t)}$ 1st Year	71.64-142.08$e^{-1.21(t)}$ Continued	165.43-152.15$e^{-.10(t)}$ Discontinued
1	29.94	29.27	27.76 (29.94)*
2	37.40	59.01	40.86
3	43.70	67.87	52.71
4	49.01	70.52	63.44
5	53.49	71.30	73.15

*Curve forced through control.

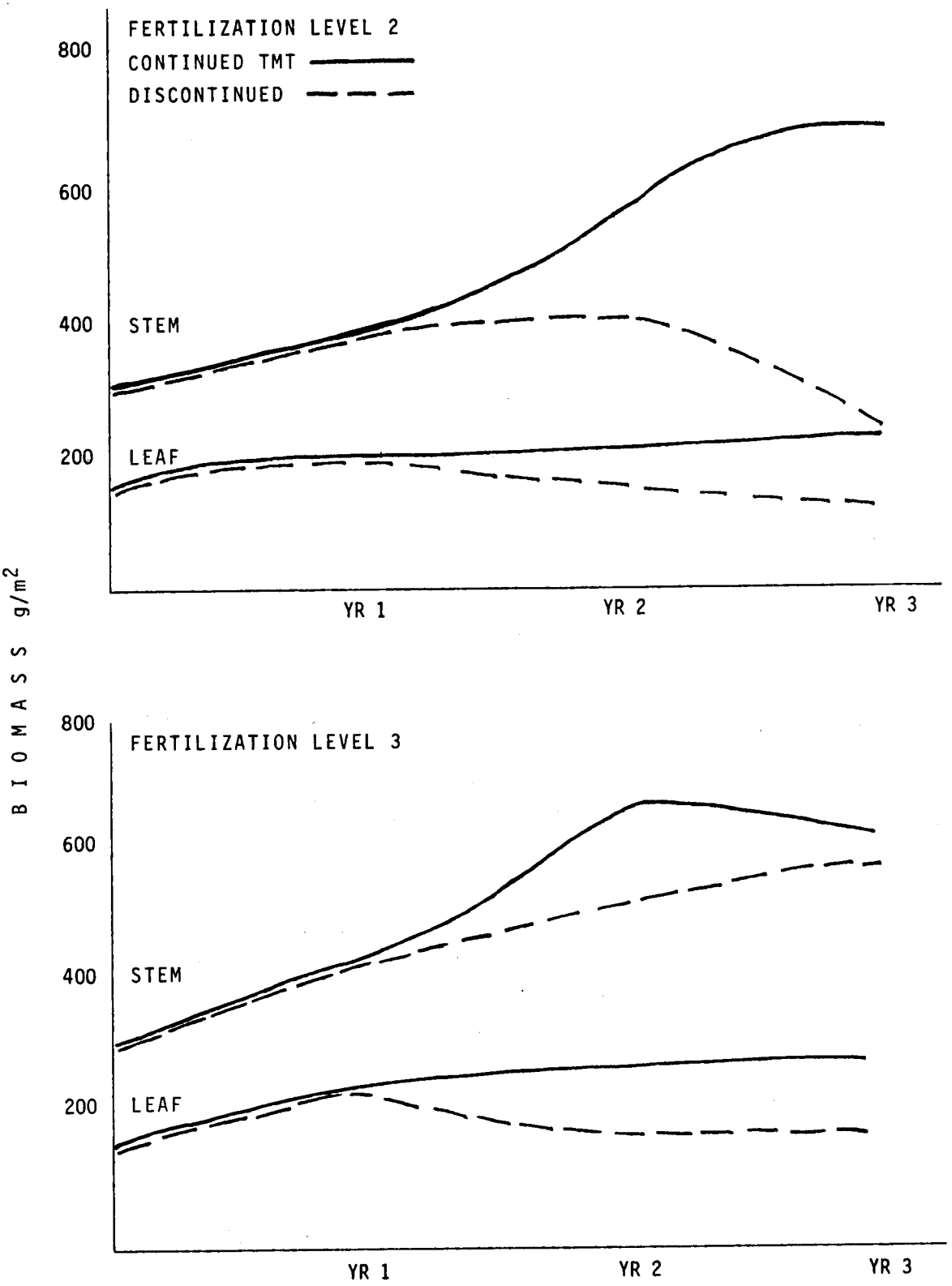

Figure 18. *Batis* leaf and stem biomass for study years 1, 2 and 3.

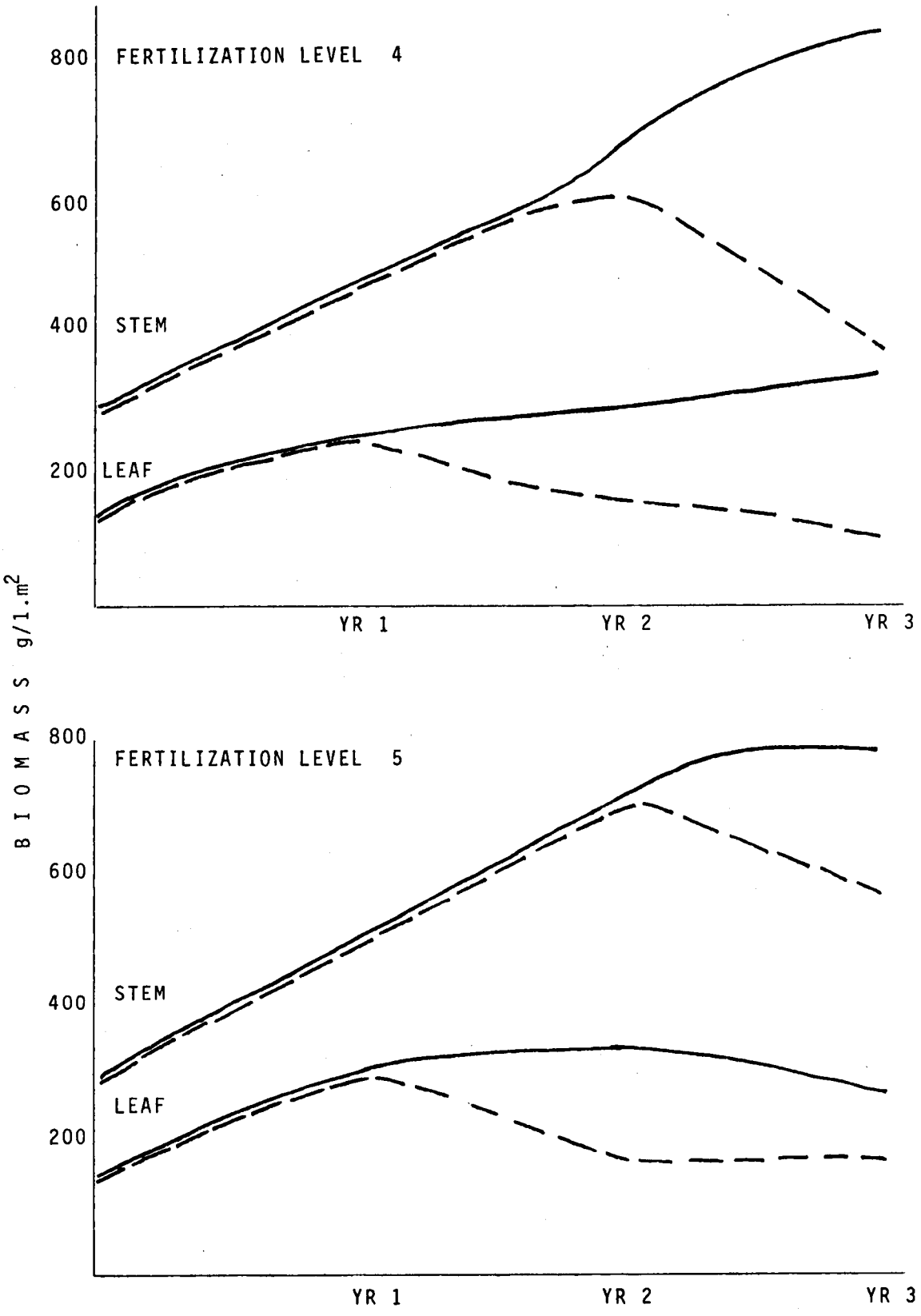

Figure 18 (continued)

Batis leaves on plots receiving continued treatment reach a steady state biomass level in the second year and continued treatment maintains this level. Leaf response to discontinued treatment is back to near control levels by the third year.

5. DISCUSSION

5.1 Aerial Vascular Plant Biomass

Mean aerial standing crop biomass on plots receiving continued treatment increased 92 percent over control levels in two years, from 584 to 1123 g/m^2 (Figure 16). Chalmers *et al.* (1976) found aerial biomass of short form *spartina alternaflora* in Georgia increased to 25 percent over controls by the peak of the growing season, about 500 g/m^2 over 400 g/m^2 respectively. Chalmers applied sewage sludge at one rate of 5 kg/ha nitrogen every two weeks. Valiela *et al.* (1975) reported for the highest fertilization dosage a 370 percent increase over controls in peak biomass of plots containing *Spartina alternaflora* and *Salicornia* spp. in Massachusetts, about 1180 over 320 g/m^2. The plots received 2.5 kg/ha nitrogen, applied each week April to early November as sewage sludge. However, the Massachusetts plots did not show a response until the second year of study. Valiela *et al*, (1975) and Chalmers (1976) used two and one fertilization levels respectively and it cannot be determined if the biomass values they report represent a maximum potential response to fertilization. The percent increase for total plot biomass of 92 percent reported in this study is much less than the increase of 370 percent reported by Valiela *et al.* (1975) and is greater than the range of 30 to 50 percent reported by Chalmers (1976).

The difference between the *Spartina* marsh response in Georgia and Massachusetts may be due to differencesin growth forms, prefertilization levels of available nutrients in the sediments, or latidunal variation.

5.2 *Batis* and *Salicornia*

Batis increased almost 148 percent over control biomass in the second year of continued treatment, from 428 to 1062 g/m^2 (Figure 16). *Spartina*

alone increased from 200 g/m^2 to 600 g/m^2, about a 300 percent increase (Valiela *et al.* 1975). Valiela's *Spartina* increase is not likely a maximum potential biomass response to enrichment because his two fertilization levels do not appear to have covered the response range. As a result, rigorous estimate of the relative abilities of the plants to respond to nitrogen enrichment cannot be made. It does appear that *Batis maritima* in Florida and *Spartina alternaflora* in Massachusetts show roughly similar response in biomass as well as similar percent increase over controls when supplied with limiting nutrients.

The lack of any positive *Salicornia* response to fertilization causes the relative community composition to shift to a *Batis* dominated community (Figure 11, p. 28). Prior to treatment the plots were dominated by *Salicornia*. Although there was a general decrease in *Salicornia* biomass through time, this was not correlated with treatment, as it occurred equally on control plots. *Batis* responded, *Salicornia* did not, and the relative composition shifted toward more *Batis*. The general decline of *Salicornia* may be due to the general drying of the marsh.

The *Salicornia* response after two-year fertilizations shows a decrease in mean biomass with treatment (Table 7). Although this decrease was not significant, it should be noted as a potential negative response.

Valiela *et al.* (1975), however, reported an initial positive, then negative response of *Salicornia* spp. to fertilization on plots also containing *Spartina alternaflora*. *Salicornia* spp. was essentially excluded from the plots by the third year of treatment. Valiela reported a similar exclusion of *Distichlis spicata* on fertilized plots also containing *Spartina patens*. In Valiela's study the change in community composition appears to have involved competitive exclusion of *Salicornia* spp. and

Distichlis spicata by *Spartina*.

5.3 *Batis* Leaves

The *Batis* biomass response involves both leaves and stems. These tissues have greatly different turnover times and are thus discussed separately.

The three leaf response curves in Figure 17 are essentially straight lines. Thus, a discussion of the relative response of the three curves at the highest fertilization level approximates the relative situation for all treatment levels. The highest treatment level produced a first-year leaf response 2.20 times higher than control levels. Discontinued treatment plots measured the second year show resiliency, dropping back toward control levels by about 60% in one year.

This biomass response to discontinued treatment is probably a second-year response to nutrients retained on the plot rather than residual first-year leaf production. This assumes that leaf turnover is on the order of several months, although no direct estimates are available. However, an indirect estimate of leaf turnover rate can be made by calculating the percent change in leaf standing crop from one harvest to the next. This approach indicates that leaf biomass can increase or decrease by about one gram per meter square per day. This estimate is a minimum leaf turnover rate since it measures a change in standing crop. Actually, leaf production and leaf fall could result in a much more rapid turnover rate (Williams and Murdoch 1972). For control levels of leaf biomass, 133 grams per meter square, this estimate provides a maximum turnover time of 133 days or .0075/day. This magnitude of a turnover rate supports the assumption that the response to the discontinued treatment is a response to retained nutrients rather than residual first-year

leaf production.

Retained nutrient may be in the form of inorganic fertilizers still in the sediments (Valiela *et al.* 1973), remineralized nutrients from litter decomposition (Maye 1972) or even some translocated photosynthate from below-ground portions of the plant (Puckridge 1968; Huntjens 1971).

Continued fertilization in the second year produced 2.46 times control leaf biomass at the highest fertilization level. Leaf response to continued treatment can be assumed to have three components: 1) control response levels, 2) response to nutrients applied the second year and 3) response to retained nutrient (i.e., discontinued treatment). By adding 1), 2) and 3) one should be able to predict the leaf response to continued treatment. The first-year response produced 2.20 times the control leaf biomass, or approximately 163 grams over control levels. This can be used as an estimate of 2). The leaf response to discontinued treatment was about 65 grams over control levels. Adding the response to first-year fertilization to the response to discontinued fertilization, to control levels gives 361 grams per meter square as a predicted response to continued treatment at the highest fertilizer level. Predicted leaf responses to continued treatment at each fertilization level are compared to measured responses in Table 9 and illustrated in Figure 19. The predicted responses are in close agreement with the responses measured in the field.

The largest discrepancy is at the highest treatment level where the measured biomass is less than that predicted. Although the cubic and quartic components of the response curve for continued treatment are not statistically significant, biomass for level 5 may be showing the first signs of approach to a leaf asymptote. This could explain why measured

Table 9. Predicted and measured[(a)] leaf biomass response to continued treatment and other response components in g/m^2.

Fertilization Level	Control Response C	Response to Nutrients Applied Yr 2 R_1 -C	Response to Retained Nutrient R_2^d-C	Response of leaf biomass to continued treatment Predicted R_2^c	Measured R_2^c
1	133	-	-	-	-
2	133	40	17	190	199
3	133	81	33	247	257
4	133	122	49	304	304
5	133	163	65	361	343

R_1 = Response year 1

R_2^d = Response year 2 to discontinued treatment

R_2^c = Response year 2 to continued treatment

C = Response to control treatment

(a) Biomass values taken off curves in Figure 17.

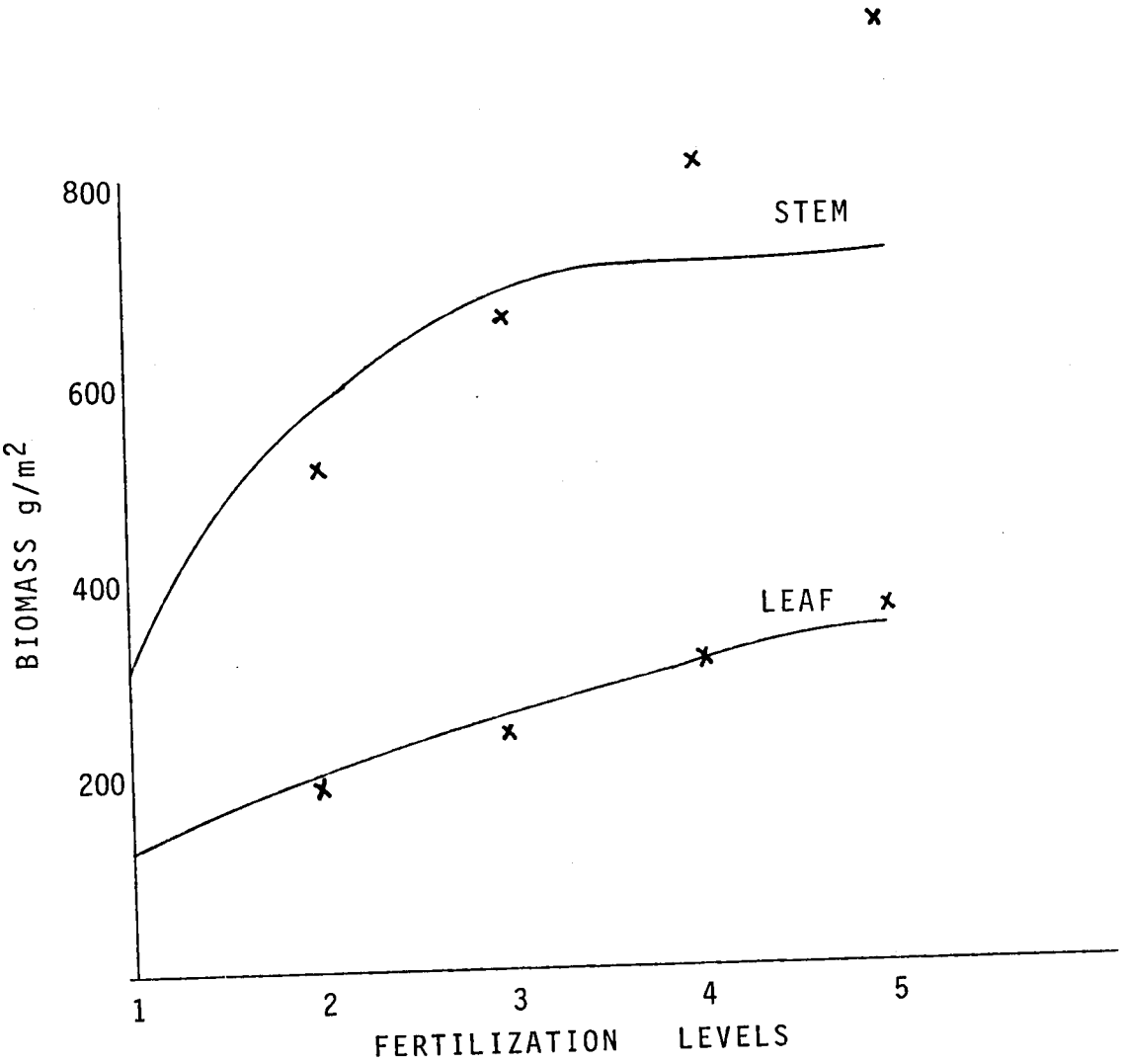

Figure 19. Predicted (x) *Batis* stem and leaf response to continued fertilization compared to measured curves taken from Figure 17.

biomass is less than predicted only at the highest treatment level.

Figure 18, p. 46 shows the response curves for each fertilization level through the three years of study. A steady-state leaf biomass response appears to be maintained at each treatment level by continued fertilization. The steady-state biomass level increases with increasing fertilization level, indicating the biomass response is a function of the rate of leaf turnover and nutrient availability. Thus, given a set leaf turnover rate and increasing nutrient inputs, successively higher steady-states can be reached at each fertilization level. This mechanism is equivalent to increasing the inputs to a response compartment while maintaining a constant outflow rate and producing higher steady state compartment sizes with higher inputs.

5.4 *Batis* Stems

The highest fertilization level produced a first-year stem response 1.80 times control stem biomass (Figure 17, p. 42). Discontinued treatment measured the second year did not produce a stem response less than the first year response as was seen for leaves. Stem biomass continued to increase during the second year even though fertilization was discontinued on these plots. Explanation of this difference between stem and leaf responses to discontinued treatment involves the longer turnover rate of stems, allowing much of the first-year stem production to be measured again in the second year. Stem response to discontinued treatment can be assumed to have three components: 1) residual first year stem biomass above control levels, 2) control stem biomass and 3) the component of second year stem biomass produced by the leaf response to discontinued treatment. Assuming that all stem measured the first year is present in the second year, one can convert the leaf response into a

predicted stem response using a stem leaf ratio of 2.25 (control ratio). If we add the leaf biomass response of year one to the leaf response in year two to discontinued treatment, and multiply this total leaf by 2.25, we predict slightly more stem (3 to 10 percent) than was measured on discontinued plots (Table 10). These predicted stem responses are compared with measured responses in Figure 20.

The over-estimate of stem biomass probably represents turnover of the first year response component of stem biomass (i.e., first year biomass response less control biomass). With this as an assumption, an indirect estimate of annual stem turnover rate can be made by dividing this missing increment of stem biomass by the first year stem biomass response less control stem biomass. This is done in Table 11 and gives rates of .18 to .32 per year (or a mean of .00065 per day), increasing with increasing fertilization. The increasing turnover rate with increasing fertilization level, may be due to the energetic inefficiency of maintaining the increased stem biomass, produced in response to enrichment, once the enrichment is discontinued. Plants with greater increases in stem biomass and thus greater energy demands in this regard could be expected to lose stem biomass more rapidly until some optimum stem leaf ratio is reached.

There is probably some stem to leaf biomass ratio where the energy costs to maintain nonphotosynthetic stem is optimized with respect to the ability of leaves to fix carbon.

To illustrate how fertilization may affect this ratio, the ratios of stem to leaf for various response components are listed in Table 12. The first-year response across treatment showed a consistent decrease in the ratio with a mean of 1.7. Thus, it appears that with increasing

Table 10. Predicted stem biomass for discontinued treatment, assuming no disappearance of measured first year stem biomass.

Fertilization Level	R_1-C lvs.	+	R_2^d-C lvs.	=	Total lvs. measured	X	Mean stem leaf ratio for 1st year response	+	Control stem biomass	=	Predicted stem biomass R_2^d	Measured stem biomass R_2^d
2	40		17		57		2.25		295		423	409
3	81		33		114		2.25		295		552	527
4	122		49		171		2.25		295		680	634
5	163		65		228		2.25		295		808	732

R_1 = Response year 1

R_2^d = Response year 2 to discontinued treatment

C = Response to control treatment.

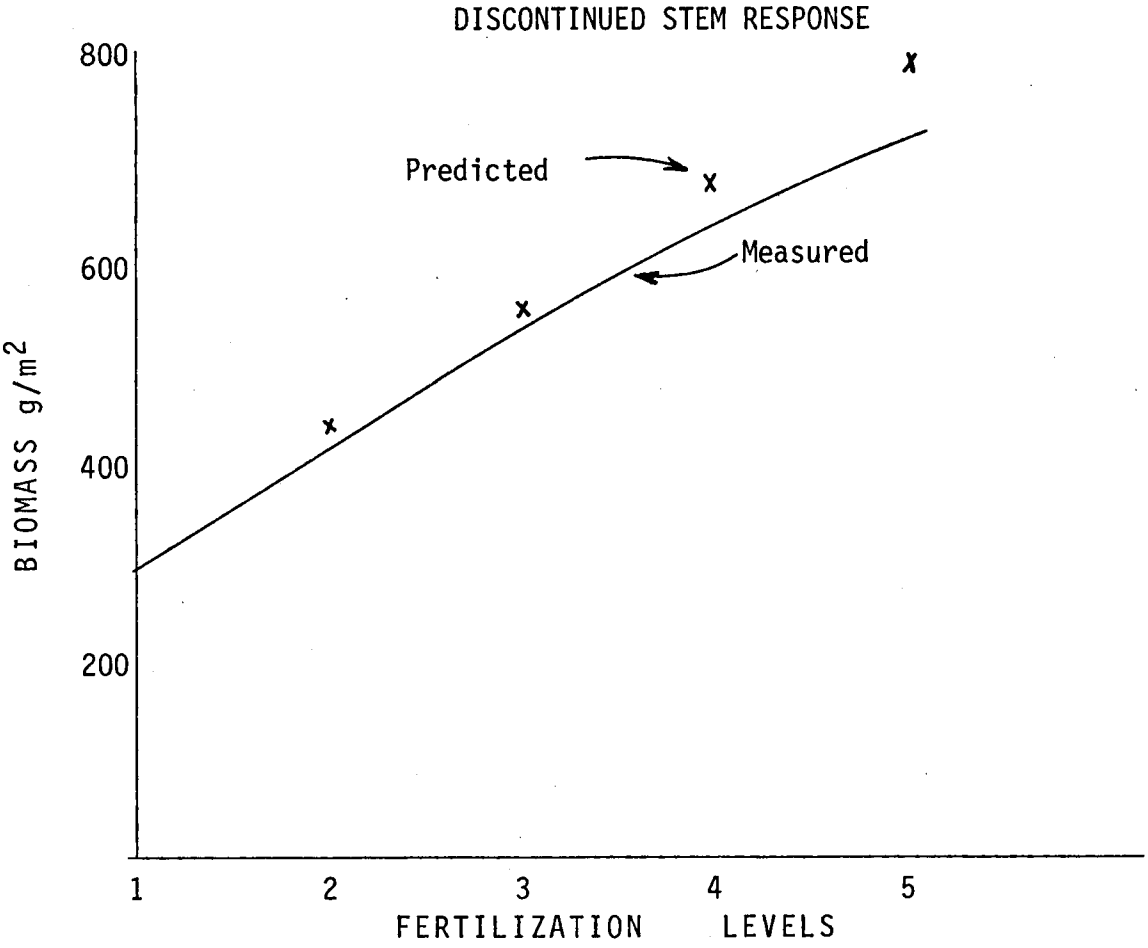

Figure 20. Predicted (x) *Batis* stem response to discontinued treatment.

Table 11. Estimated stem turnover rates calculated by dividing the difference between predicted and measured stem response to discontinued treatment (from Table 10) by the component of 1st year stem production less control stem biomass.

R_2^d Predicted	-	R_2^d Measured	=	Difference	÷	R_1-C Measured	=	Annual turnover rate
423		409		14		79		.177
552		527		25		142		.176
680		634		46		195		.236
808		732		76		240		.317

C = Control response

R_2^d = Response year 2 to discontinued treatment.

Table 12. Stem leaf ratios for various components of response curves illustrated in Figure 17.

Fertilization Level	$\frac{C}{C}$	$\frac{R_1-C}{R_1-C}$	$\frac{R_2^d-R_1}{R_2^d-R_1}$	$\frac{(R_1-C)+(R_2^d-R_1)}{(R_1-C)+(R_2^d-R_1)}$
1	2.25	-	-	-
2		1.98	2.19	2.09
3		1.75	2.73	2.24
4		1.60	2.94	2.27
5		1.47	3.03	2.25
		$\bar{x}$ 1.7	$\bar{x}$ 2.7	$\bar{x}$ 2.21

C = Control

R_1 = Response year 1

R_2^d = Response year 2 to discontinued treatment

R_2^c = Response year 2 to continued treatment

treatment less stem is produced per gram of leaf during the first year. The ratios for discontinued treatment in the second year, show an increase with treatment in contrast with the decrease seen the first year. This increase is illustrated in Figure 17 by the increasing stem response slope from the first-year treatment response to the second-year response to discontinued treatment while the leaf response slopes for the same treatments show a relative decrease. The mean ratio of stem to leaf also increases from 1.7 the first year to 2.7 for the second year. These stem-leaf ratios are illustrated in Figure 21. The absolute values of the slopes are about the same. Thus, if we total all of the stem and leaf produced in response to enrichment through first year and discontinued treatment, we calculate a ratio of 2.21 which is essentially the same as the control ratio of 2.25. When both years' stem and leaf biomass are combined, the ratios are at control levels indicating that treatment did not influence stem-leaf ratios when looked at over a two-year period.

The apparent differences in stem to leaf ratio are primarily due to differential lags in response and differences in turnover rate between the two tissues. Also, stem production occurred between May 1977 (when our interval of observation for year one ended) and November 1977 (when our observations for year two began). Stem produced in this interval was harvested in November and attributed to year two.

Stem response to continued treatment appears to level off at fertilizer levels four and five, indicating the plant's ability to produce stem is limited by something other than fertilizer treatment (Figure 17). Predicted stem biomass response values to continued treatment were calculated in the same fashion as was done for leaves (Figure 19 and

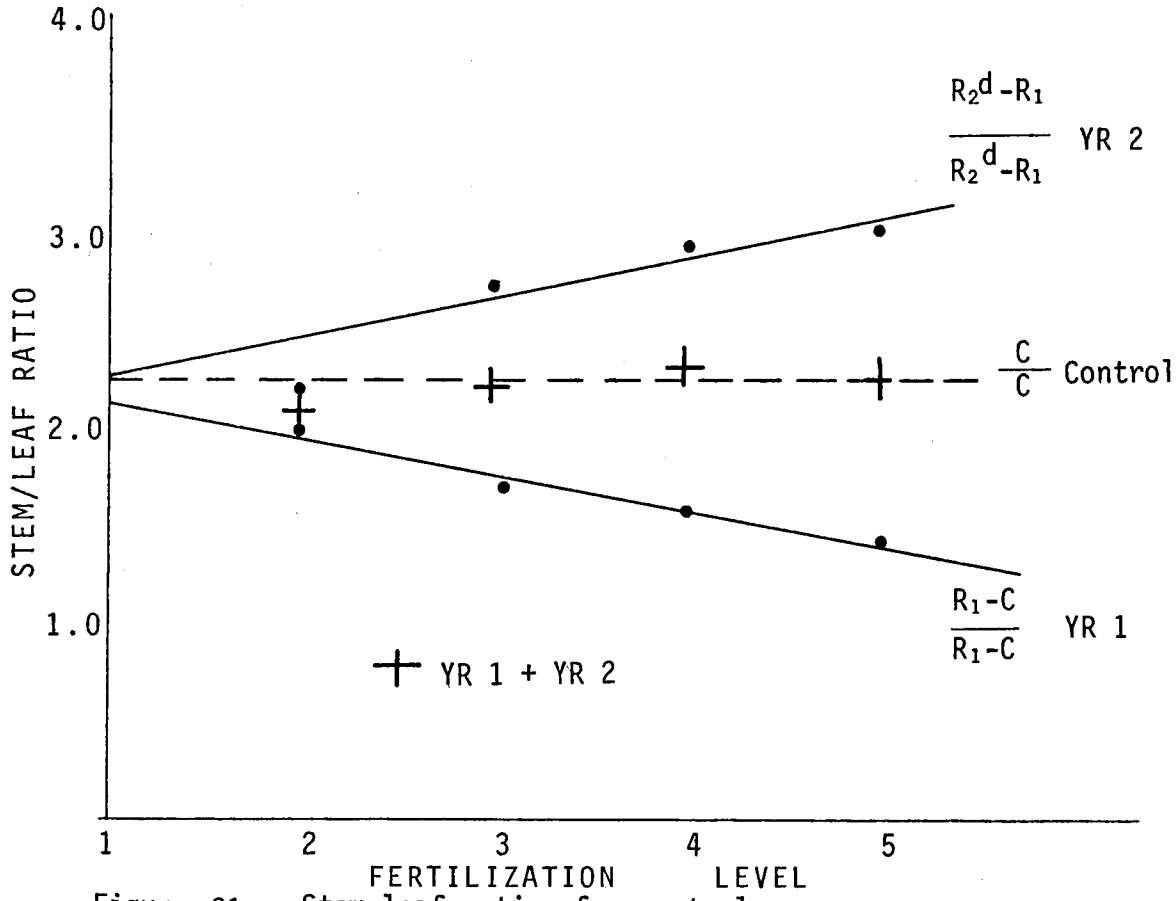

Figure 21. Stem leaf ratios for control response, year one response and year two response to discontinued treatment.
a) R_2^d - R_1 stem/leaf, see Table 12.
b) R_1 - C stem/leaf, see Table 12.

Table 13). Much higher values were predicted for levels four and five than were actually measured. The measured leveling off of response is probably real and an estimated stem asymptote of 750 grams per meter^2 for *Batis* stems, 2.54 times control levels, appears reasonable.

Continuous fertilization at or above level four would probably maintain the stem asymptote. Fertilizer applied above this level, however, would not go unused by the plant because leaf biomass has not demonstrated an asymptote and continues to respond to increasing fertilization. Standing crop biomass obviously does not accurately reflect production or the relative potential of leaf and stem to convert inorganic N and P into plant tissue. *Batis* leaves are thought to turn over much faster than stem thus most of the plot production and most of the nitrogen conversion may be due to leaf production. I have roughly estimated leaf turnover to be a gram per day for control plots or .0075/day. A similar indirect estimate for stem turnover rate is .00065/day. If we apply these estimated turnover rates to control levels of leaf biomass and stem biomass, 133 g/m^2 and 295 g/m^2 respectively, we see that in a year 365 grams of leaf biomass are produced compared to only 70 grams of stem. This difference in turnover rate between stem and leaf, along with the lack of a leaf asymptote, support the conclusion that higher rates of fertilization than applied in this study are required to saturate the ability of *Batis* to convert inorganic N into tissue. Application rates of 200 kg/ha/year of N and 32 kg/ha/year of P are not sufficient to produce a leaf asymptote.

A hypothetical leaf asymptote could be calculated using the stem/leaf ratio of 2.25 which, with admittedly limited testing, has been shown to be conservative for *Batis* viewed in steady state. If the 2.25 ratio is

Table 13. Predicted and measured stem response to continued treatment and other response components.

Fertilization Level	Predicted R_2^c	Measured[a] R_2^c	Measured[a] Control	Measured[a] (R_2^d-C)	Measured[a] (R_1-C)
1	-	-	295	-	-
2	518	590	295	144	79
3	669	679	295	232	142
4	829	705	295	339	195
5	972	713	295	437	240

C = Control

R_1 = Response year 1

R_2^d = Response year 2 to discontinued treatment

R_2^c = Response year 2 to continued treatment.

[a]Treatment values from curves in Figure 17.

an energetic optimum, then we would expect the leaf biomass to approach an asymptote of 333 g/m^2 (i.e., 750 ÷ 2.25). This value is essentially the same as the leaf biomass at the fifth fertilization level.

Another possible mechanism at work in establishing a growth asymptote for *Batis* involves increasing sediment salinities due to increased transpiration at higher treatment levels due to increased leaf biomass. As sediment salinities increase above some optimum, plant yield decreases for some salt marsh plants like *Salicornia herbacea* (Larcher 1975, p. 122). Nutrient enrichment studies on *Spartina alternaflora* have measured increases in sediment salinity that were attributed to increased transpiration resulting from increased leaf biomass (Chalmers 1979). If this is true for *Batis*, then applying nutrients in volumes of fresh water may increase the plant's biomass response to fertilization.

5.5 Litter

Litter decomposition rate increased with increased fertilization (Table 14 and Figure 12, p. 33). Several studies have shown similar increases when nitrogen was applied to decomposing grain plants (Parker 1962; Brown and Dickey 1970; and Black and Reitz 1972). Boyd and Goodyear (1971) and Hart and Howmiller (1975) reported that leaves containing high nitrogen concentrations decomposed more rapidly than low nitrogen leaves. Since fertilization in this study produced no luxury consumption, it is assumed that the higher decomposition rates were not due to nutrient enriched leaves.

The importance of the carbon to nitrogen (C/N) ratio to microbial activity has been demonstrated (Waksman and Tenney 1928; Allison *et al.* 1963; Witkamp 1966). Microbial activity is increased by lowering the C/N

Table 14. Grams of litter lost per day calculated using litter and decomposition rates measured across fertilizer application levels.

Fertilization Level	Litter Present	Litter Loss Rate/Day	Litter Lost/Day
1	550	.00668	3.67
2	710	.00691	4.91
3	630	.00745	4.69
4	880	.00724	6.37
5	910	.00728	6.63

ratio. Thus, nitrogen fertilization would lower the C/N ratio, increase microbial activity and increase rates of litter decomposition. This may be a factor affecting decomposition rates measured in this study.

Kelly and Henderson (1970) reported that urea fertilization in East Tennessee increased soil invertebrate populations by 30 percent and caused a four-fold increase in bacterial populations. This increase in microbial activity was accompanied by a 1 to 3 percent increase in decomposition rates at 550 and 1,100 kg/ha N fertilization levels. This compares to about a 9 percent increase in decomposition rate, measured in this study at the highest fertilization level, 200 kg/ha N and 32 kg/ha P. Kelly's study applied fertilizer to forest floor plots. Litter decomposition was compared at one site for two levels of nutrient enrichment. This study essentially compared decomposition rates at five sites of different nutrient enrichment, as the biomass response of the plants was so rapid that higher treatment plots had 42 percent more standing crop biomass than control plots by the time decomposition rates were measured. The taller more dense biomass probably protected the sediment from desiccation more than control levels of biomass. This assumed higher sediment moisture may account for the higher rates of decomposition measured by this study than measured by Kelly and Henderson (1978).

Kelly and Henderson (1978) also reported a decrease in decomposition rate of 4 and 6 percent with phosphorus additions of 275 and 550 kg/ha P respectively. The phosphorus levels used in this study were about an order of magnitude lower than Kelly applied. Also, salt marsh sediments are known to be very high in phosphorus, and such small additions of phosphorus to phosphorus-rich sediments may not significantly alter the plot phosphorus over control levels.

Litter production and decomposition are probably important in recycling nutrients in the marsh. Higher decomposition rates on higher fertilization plots would, over a given interval of time, supply the sediments of enriched plots with a greater proportion of nutrients per gram of litter produced than control plots. This, combined with greater litter production on enriched plots (Figure 12, p. 33), could be an important factor in determining the second year biomass response to discontinued treatment.

5.6 Snails

The initial and marginally significant decrease in *Cerithidea* and increase in *Melampus* gave rise to initial speculation that trophic relationships may be important as a factor influencing snail dominance. Unfortunately, the snail responses could not be adequately measured as the study progressed.

Since litter production and litter decomposition were increased, it can be assumed that microbial activity also increased. The snails would thus have a greater food supply on enriched plots (this assumes that the snails graze on detritus and the microbial community on the detritus surface). An increased food supply would then stimulate snail production if the organisms were limited by food supply.

It is difficult to speculate on possible shifts in snail dominance resulting from enrichment. Nicotrie (1977) reported that four species of intertidal gastropods feeding on periphyton had remarkably similar diets, apparently using the same food resource in the same way. Changes in dominance of snail populations due solely to increased food supply would occur if the snails were competing for a food resource. Other competitive interactions indirectly related to enrichment,

such as sediment moisture or degree of shading, may cause shifts in snail dominance.

Also, temporary increases in ammonia concentration due to fertilization with ammonium nitrate could be toxic to snails and other organisms. Thus, a toxic response may be incorrectly interpreted as an enrichment response. Studies of mobile organisms on 4 m^2 plots may result in gradient responses that also could be misinterpreted as trophic responses. Mobile organisms such as snails may decide to remain longer on more dense plots due to increased moisture or some other non-food related factor. If the entire marsh was "more dense," the snail would not have this gradient to respond to. The change in *Cerithidia* density was marginally significant and not verified in the second year, due to a drastic reduction in snail numbers. As a result, the evidence for changes in snail populations in response to fertilization treatment is weak and inconclusive.

The data for periphyton response are similarly weak and inconclusive. The apparent initial trend toward decreasing diatom densities and increasing periphyton biomass and chlorophyll could not be confirmed. This sort of shift might be expected if fertilization favored blue-green or green algae over diatoms. Van Raalte *et al.* (1976) reported changes in the species composition of salt marsh diatoms resulting from nitrogen enrichment of *Spartina* plots and Ryther (1954) has documented a shift to blue-green algae in an enriched estuarine area of Long Island, New York.

Another factor in periphyton response to fertilization in *Batis* marshes is increased shading at higher treatment levels. Light may limit potential algae production, especially at higher fertilization levels. Unfortunately, the drying trend precluded continued sampling for this

response component of the salt marsh community. The results reported permit no conclusion as to treatment response.

6. CONCLUSIONS

The conclusions of this study are listed below as answers to six specific questions that were listed in the "Introduction."

1) Is the *Batis* marsh nutrient limited?

   Fertilization with a mixture of ammonium nitrate and superphosphate produced an increase in aerial vascular plant biomass indicating that the primary production of the marsh is nutrient limited.

2) How much do nutrient additions increase plant biomass response?

   Total aerial biomass increased from 584 to 974 g/m^2, about 67 percent, after one year of fertilization at 32 kg/ha P and 100 kg/ha N.

   After two years fertilization, plot biomass reached 1123 g/m^2 or 92 percent over control levels. *Batis* alone increased from 428 to 1062 g/m^2, 148 percent, while *Salicornia* showed no significant response to fertilization.

3) Do nutrient additions produce changes in vascular plant species composition?

   The first year response to fertilization produced a *Batis* increase of 93 percent while *Salicornia* did not respond. After the second year, *Batis*, receiving continued treatment, increased 148 percent over controls. *Salicornia* showed no significant response and the relative community composition shifted from a *Salicornia* dominated community prior to fertilization, to a *Batis* dominated community after fertilization.

4) Do the vascular plants demonstrate luxury consumption?

   Comparing prefertilization tissue concentrations with post-

fertilization concentrations, no increase in tissue N and P concentration is found with increasing fertilization levels.

5) Is decomposition rate of salt marsh detritus affected by nutrient additions?

   Higher fertilization plots had more detritus and a 9 percent higher decomposition rate than control plots.

6) At what level of nutrient addition does continued increase in nutrients fail to produce continued increase in biomass?

   At 32 kg/ha/yr P and 100 kg/ha/yr N, applied for two years, *Batis* stems appear to be at a biomass asymptote whereas *Batis* leaves do not. Thus, the level required to produce a *Batis* biomass asymptote after two years fertilization is at or above the 32 and 100 kg/ha/yr N and P respectively.

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APPENDICES

APPENDIX A

AERIAL VASCULAR PLANT BIOMASS AND SNAIL NUMBERS

Table 15. Aerial vascular plant biomass and snail numbers.

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=1
FIRST YEAR

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	1	16.28	38.50	60.70
1	2	21.66	45.57	81.27
1	3	35.65	46.09	75.25
1	4	39.48	72.79	87.71
1	5	35.39	52.87	98.49
2	1	22.75	44.47	56.57
2	2	12.77	42.37	53.05
2	3	57.50	55.14	94.80
2	4	28.34	52.03	87.79
2	5	68.15	70.06	142.22
3	1	32.33	38.59	70.64
3	2	16.46	23.74	48.67
3	3	40.32	59.37	113.20
3	4	48.69	86.26	130.36
3	5	43.09	67.98	116.09
4	1	7.40	27.94	39.06
4	2	11.60	24.05	35.03
4	3	21.15	33.59	47.01
4	4	26.25	41.06	85.52
4	5	39.23	86.44	102.64
5	1	7.47	24.26	36.11
5	2	13.76	28.81	47.53
5	3	19.22	24.20	63.20
5	4	35.86	39.19	66.83
5	5	34.32	52.65	79.13
6	1	16.82	39.93	39.35
6	2	20.43	52.09	49.04
6	3	4.13	15.49	31.11
6	4	10.85	21.09	52.23
6	5	18.01	36.45	35.20
7	1	15.40	37.64	55.00
7	2	8.63	11.70	37.74
7	3	21.37	35.66	59.92
7	4	15.08	27.64	45.79
7	5	28.23	44.44	60.11

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=1

BLOCK	TREATMENT LEVEL	FIRST YEAR SALICORNIA BIOMASS	TOTAL BIOMASS	LITTER WEIGHT
1	1	42.84	103.87	0.00
1	2	24.65	105.92	0.00
1	3	49.58	125.98	0.00
1	4	30.41	118.35	0.00
1	5	38.74	144.82	0.00
2	1	59.54	117.56	0.00
2	2	37.83	91.51	0.00
2	3	41.36	136.15	0.00
2	4	43.68	131.46	0.00
2	5	16.72	164.94	0.00
3	1	28.72	102.86	0.00
3	2	76.24	126.52	0.00
3	3	17.88	134.14	0.00
3	4	33.15	165.17	0.00
3	5	25.26	141.54	0.00
4	1	70.39	114.46	0.00
4	2	69.90	107.66	0.00
4	3	73.90	124.08	0.00
4	4	72.06	158.51	0.00
4	5	42.64	149.14	0.00
5	1	25.08	66.10	0.00
5	2	54.66	105.77	0.00
5	3	58.02	127.62	0.00
5	4	43.04	113.46	0.00
5	5	39.13	121.99	0.00
6	1	58.31	101.01	0.00
6	2	68.93	119.28	0.00
6	3	69.26	102.58	0.00
6	4	45.74	103.60	0.00
6	5	46.63	86.47	0.00
7	1	22.09	81.18	0.00
7	2	62.26	108.03	0.00
7	3	32.95	95.79	0.00
7	4	46.77	94.12	0.00
7	5	33.56	93.94	0.00

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=1
FIRST YEAR

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	1	4	0.48	10	2.55
1	2	5	0.44	11	3.43
1	3	9	1.33	6	1.81
1	4	7	0.54	8	2.18
1	5	11	0.91	5	1.54
2	1	13	1.37	11	3.53
2	2	7	0.90	18	5.44
2	3	15	1.76	7	2.21
2	4	9	1.14	14	4.24
2	5	10	1.13	9	3.07
3	1	14	1.64	14	3.46
3	2	31	4.26	10	2.95
3	3	13	1.50	5	1.39
3	4	30	4.02	13	3.70
3	5	17	1.90	11	1.69
4	1	44	5.72	10	2.65
4	2	36	2.30	13	3.97
4	3	25	3.14	8	2.27
4	4	6	0.76	8	2.43
4	5	28	3.39	5	1.47
5	1	31	2.84	20	5.40
5	2	30	3.35	8	2.15
5	3	17	1.58	15	4.04
5	4	8	0.98	12	2.89
5	5	90	9.90	5	1.57
6	1	15	1.27	8	1.84
6	2	24	2.55	15	4.68
6	3	56	6.01	5	1.56
6	4	37	4.51	8	2.10
6	5	13	1.07	12	2.63
7	1	11	1.01	11	3.43
7	2	40	5.47	9	2.62
7	3	5	0.47	8	2.50
7	4	43	4.49	7	2.16
7	5	86	9.27	6	1.80

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=2
FIRST YEAR

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	1	0.00	0.00	91.87
1	2	0.00	0.00	93.56
1	3	0.00	0.00	82.53
1	4	0.00	0.00	95.95
1	5	0.00	0.00	103.22
2	1	0.00	0.00	49.99
2	2	0.00	0.00	35.55
2	3	0.00	0.00	155.55
2	4	0.00	0.00	98.00
2	5	0.00	0.00	187.60
3	1	0.00	0.00	66.78
3	2	0.00	0.00	39.11
3	3	0.00	0.00	93.81
3	4	0.00	0.00	127.13
3	5	0.00	0.00	71.78
4	1	0.00	0.00	50.63
4	2	0.00	0.00	49.11
4	3	0.00	0.00	17.53
4	4	0.00	0.00	68.24
4	5	0.00	0.00	110.27
5	1	0.00	0.00	20.80
5	2	0.00	0.00	89.04
5	3	0.00	0.00	54.64
5	4	0.00	0.00	27.42
5	5	0.00	0.00	40.86
6	1	0.00	0.00	2.21
6	2	0.00	0.00	43.84
6	3	0.00	0.00	39.62
6	4	0.00	0.00	72.57
6	5	0.00	0.00	52.98
7	1	0.00	0.00	48.57
7	2	0.00	0.00	73.81
7	3	0.00	0.00	33.94
7	4	0.00	0.00	89.45
7	5	0.00	0.00	77.16

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=2

BLOCK	TREATMENT LEVEL	FIRST YEAR SALICORNIA BIOMASS	TOTAL BIOMASS	LITTER WEIGHT
1	1	9.79	101.66	0.00
1	2	0.00	93.56	0.00
1	3	82.49	168.18	0.00
1	4	51.94	149.37	0.00
1	5	33.08	137.76	0.00
2	1	52.46	102.97	0.00
2	2	62.07	97.62	0.00
2	3	0.00	155.55	0.00
2	4	39.50	146.92	0.00
2	5	22.61	210.21	0.00
3	1	13.09	82.87	0.00
3	2	57.33	98.03	0.00
3	3	9.79	104.98	0.00
3	4	26.22	155.73	0.00
3	5	64.09	135.87	0.00
4	1	67.57	122.42	0.00
4	2	70.08	120.35	0.00
4	3	91.65	111.33	0.00
4	4	66.73	136.08	0.00
4	5	41.58	155.54	0.00
5	1	64.32	85.66	0.00
5	2	44.80	136.04	0.00
5	3	76.75	134.64	0.00
5	4	51.61	84.23	0.00
5	5	66.48	110.05	0.00
6	1	88.09	97.14	0.00
6	2	38.49	87.60	0.00
6	3	55.32	104.92	0.00
6	4	75.95	150.75	0.00
6	5	56.60	118.15	0.00
7	1	12.30	64.96	0.00
7	2	7.39	90.10	0.00
7	3	82.40	119.23	0.00
7	4	57.36	146.81	0.00
7	5	30.65	107.81	0.00

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=2
FIRST YEAR

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	1	0	0.00	0	0.00
1	2	0	0.00	0	0.00
1	3	0	0.00	0	0.00
1	4	0	0.00	0	0.00
1	5	0	0.00	0	0.00
2	1	0	0.00	0	0.00
2	2	0	0.00	0	0.00
2	3	0	0.00	0	0.00
2	4	0	0.00	0	0.00
2	5	0	0.00	0	0.00
3	1	0	0.00	0	0.00
3	2	0	0.00	0	0.00
3	3	0	0.00	0	0.00
3	4	0	0.00	0	0.00
3	5	0	0.00	0	0.00
4	1	0	0.00	0	0.00
4	2	0	0.00	0	0.00
4	3	0	0.00	0	0.00
4	4	0	0.00	0	0.00
4	5	0	0.00	0	0.00
5	1	0	0.00	0	0.00
5	2	0	0.00	0	0.00
5	3	0	0.00	0	0.00
5	4	0	0.00	0	0.00
5	5	0	0.00	0	0.00
6	1	0	0.00	0	0.00
6	2	0	0.00	0	0.00
6	3	0	0.00	0	0.00
6	4	0	0.00	0	0.00
6	5	0	0.00	0	0.00
7	1	0	0.00	0	0.00
7	2	0	0.00	0	0.00
7	3	0	0.00	0	0.00
7	4	0	0.00	0	0.00
7	5	0	0.00	0	0.00

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=3
FIRST YEAR

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	1	13.01	53.40	66.41
1	2	23.21	59.60	82.81
1	3	14.43	48.11	62.54
1	4	19.85	56.42	76.27
1	5	29.74	74.45	104.19
2	1	12.31	36.93	49.24
2	2	14.51	52.10	66.61
2	3	34.06	84.37	118.43
2	4	40.21	82.04	122.25
2	5	31.99	125.28	157.27
3	1	18.55	64.85	83.40
3	2	9.44	33.84	43.28
3	3	17.50	61.64	79.14
3	4	31.03	95.08	126.11
3	5	16.91	57.62	74.53
4	1	10.10	30.00	40.10
4	2	14.17	50.47	64.64
4	3	9.88	26.10	35.98
4	4	12.61	41.53	54.14
4	5	18.13	54.21	72.34
5	1	12.62	33.45	46.07
5	2	9.18	34.40	43.58
5	3	26.09	64.56	90.65
5	4	32.52	83.11	115.63
5	5	27.17	48.12	75.29
6	1	5.37	11.46	16.83
6	2	17.29	42.70	59.99
6	3	12.40	21.69	34.09
6	4	21.75	48.39	70.14
6	5	18.35	26.71	45.06
7	1	10.69	20.70	31.39
7	2	18.23	74.93	93.16
7	3	17.90	31.45	49.35
7	4	25.91	41.33	67.24
7	5	22.94	40.60	63.54

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=3

BLOCK	TREATMENT LEVEL	FIRST YEAR SALICORNIA BIOMASS	TOTAL BIOMASS	LITTER WEIGHT
1	1	29.47	96.79	0.00
1	2	0.44	83.25	0.00
1	3	61.66	124.83	0.00
1	4	32.54	109.53	0.00
1	5	44.35	151.14	0.00
2	1	77.20	126.44	0.00
2	2	46.53	113.14	0.00
2	3	4.34	123.67	0.00
2	4	16.83	139.08	0.00
2	5	44.50	201.77	0.00
3	1	10.89	95.49	0.00
3	2	84.02	127.30	0.00
3	3	69.85	150.34	0.00
3	4	0.63	129.88	0.00
3	5	114	188.55	0.00
4	1	78.49	123.42	0.00
4	2	51.22	115.86	0.00
4	3	111.7	148.81	0.00
4	4	82.39	136.53	0.00
4	5	91.55	163.99	0.00
5	1	36.22	85.90	0.00
5	2	50.87	96.13	0.00
5	3	47.44	142.01	0.00
5	4	15.83	134.14	0.00
5	5	42.23	121.14	0.00
6	1	82.36	104.22	0.00
6	2	61.53	123.58	0.00
6	3	67.38	108.94	0.00
6	4	82.17	155.49	0.00
6	5	75.54	121.11	0.00
7	1	26.80	65.98	0.00
7	2	59.49	155.12	0.00
7	3	64.02	115.23	0.00
7	4	38.36	106.78	0.00
7	5	50.96	114.50	0.00

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=3
FIRST YEAR

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	1	0	0.00	0	0.00
1	2	0	0.00	0	0.00
1	3	0	0.00	0	0.00
1	4	0	0.00	0	0.00
1	5	0	0.00	0	0.00
2	1	0	0.00	0	0.00
2	2	0	0.00	0	0.00
2	3	0	0.00	0	0.00
2	4	0	0.00	0	0.00
2	5	0	0.00	0	0.00
3	1	0	0.00	0	0.00
3	2	0	0.00	0	0.00
3	3	0	0.00	0	0.00
3	4	0	0.00	0	0.00
3	5	0	0.00	0	0.00
4	1	0	0.00	0	0.00
4	2	0	0.00	0	0.00
4	3	0	0.00	0	0.00
4	4	0	0.00	0	0.00
4	5	0	0.00	0	0.00
5	1	0	0.00	0	0.00
5	2	0	0.00	0	0.00
5	3	0	0.00	0	0.00
5	4	0	0.00	0	0.00
5	5	0	0.00	0	0.00
6	1	0	0.00	0	0.00
6	2	0	0.00	0	0.00
6	3	0	0.00	0	0.00
6	4	0	0.00	0	0.00
6	5	0	0.00	0	0.00
7	1	0	0.00	0	0.00
7	2	0	0.00	0	0.00
7	3	0	0.00	0	0.00
7	4	0	0.00	0	0.00
7	5	0	0.00	0	0.00

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=4
FIRST YEAR

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	1	24.79	43.83	68.62
1	2	44.91	71.77	116.68
1	3	25.16	45.49	70.65
1	4	53.09	89.86	142.95
1	5	41.30	61.82	103.12
2	1	26.32	32.67	58.99
2	2	19.04	37.87	56.91
2	3	45.22	83.37	128.59
2	4	29.79	64.66	94.45
2	5	47.34	73.85	121.19
3	1	30.73	54.81	85.54
3	2	23.39	39.29	62.68
3	3	31.56	55.19	86.75
3	4	46.27	73.90	120.17
3	5	41.10	74.31	115.41
4	1	22.89	34.63	57.52
4	2	21.82	45.75	67.57
4	3	20.59	38.70	59.29
4	4	33.39	72.13	105.52
4	5	21.06	47.33	68.39
5	1	21.37	35.52	56.89
5	2	30.89	53.05	83.94
5	3	33.85	50.92	84.77
5	4	25.55	37.91	63.46
5	5	55.57	85.24	140.81
6	1	18.22	24.06	42.28
6	2	23.05	37.58	60.63
6	3	44.06	59.17	103.23
6	4	39.53	58.66	98.19
6	5	49.80	76.23	126.03
7	1	33.94	33.20	67.14
7	2	32.21	42.78	74.99
7	3	14.10	17.18	31.28
7	4	45.03	67.04	112.07
7	5	24.99	30.05	55.04

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=4

BLOCK	TREATMENT LEVEL	FIRST YEAR SALICORNIA BIOMASS	TOTAL BIOMASS	LITTER WEIGHT
1	1	18.86	88.48	14.52
1	2	2.77	119.45	11.11
1	3	16.05	86.70	14.85
1	4	11.74	155.24	27.75
1	5	21.47	126.88	28.66
2	1	26.79	85.78	9.48
2	2	19.84	76.75	16.77
2	3	7.03	136.50	19.92
2	4	14.09	108.54	27.16
2	5	5.97	127.16	20.38
3	1	17.06	103.42	16.28
3	2	32.54	95.22	11.11
3	3	7.64	97.69	10.13
3	4	5.66	127.07	7.63
3	5	19.60	135.01	19.57
4	1	34.07	91.59	3.28
4	2	36.59	105.82	19.94
4	3	49.71	113.93	10.09
4	4	22.29	129.81	22.38
4	5	50.61	121.67	17.36
5	1	28.40	85.96	11.56
5	2	56.29	142.85	23.64
5	3	51.99	141.09	22.30
5	4	27.15	93.49	13.90
5	5	19.95	161.83	18.04
6	1	52.36	99.19	11.79
6	2	35.10	97.23	9.01
6	3	34.91	143.77	5.74
6	4	50.38	150.18	6.68
6	5	6.80	138.72	12.51
7	1	10.48	82.89	5.68
7	2	43.26	124.55	7.54
7	3	82.93	116.89	9.35
7	4	40.80	156.64	14.67
7	5	51.12	108.03	14.08

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=4
FIRST YEAR

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	1	0	0.00	0	0.00
1	2	0	0.00	0	0.00
1	3	0	0.00	0	0.00
1	4	0	0.00	0	0.00
1	5	0	0.00	0	0.00
2	1	0	0.00	0	0.00
2	2	0	0.00	0	0.00
2	3	0	0.00	0	0.00
2	4	0	0.00	0	0.00
2	5	0	0.00	0	0.00
3	1	0	0.00	0	0.00
3	2	0	0.00	0	0.00
3	3	0	0.00	0	0.00
3	4	0	0.00	0	0.00
3	5	0	0.00	0	0.00
4	1	0	0.00	0	0.00
4	2	0	0.00	0	0.00
4	3	0	0.00	0	0.00
4	4	0	0.00	0	0.00
4	5	0	0.00	0	0.00
5	1	0	0.00	0	0.00
5	2	0	0.00	0	0.00
5	3	0	0.00	0	0.00
5	4	0	0.00	0	0.00
5	5	0	0.00	0	0.00
6	1	0	0.00	0	0.00
6	2	0	0.00	0	0.00
6	3	0	0.00	0	0.00
6	4	0	0.00	0	0.00
6	5	0	0.00	0	0.00
7	1	0	0.00	0	0.00
7	2	0	0.00	0	0.00
7	3	0	0.00	0	0.00
7	4	0	0.00	0	0.00
7	5	0	0.00	0	0.00

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=5
FIRST YEAR

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	1	23.56	67.63	91.19
1	2	46.75	82.60	129.35
1	3	58.41	107.86	166.27
1	4	36.35	99.17	135.52
1	5	26.12	81.29	107.41
2	1	19.30	36.62	55.92
2	2	19.49	38.37	57.86
2	3	92.23	56.44	148.67
2	4	31.76	76.89	108.65
2	5	37.53	103.31	140.84
3	1	28.57	54.85	83.42
3	2	33.65	55.38	89.03
3	3	22.37	66.02	88.39
3	4	24.35	80.63	104.98
3	5	36.39	74.09	110.48
4	1	0.00	0.00	42.73
4	2	0.00	0.00	76.49
4	3	0.00	0.00	43.20
4	4	0.00	0.00	92.10
4	5	0.00	0.00	43.70
5	1	0.00	0.00	31.78
5	2	0.00	0.00	82.13
5	3	0.00	0.00	35.24
5	4	0.00	0.00	94.88
5	5	0.00	0.00	97.45
6	1	0.00	0.00	47.57
6	2	0.00	0.00	70.33
6	3	0.00	0.00	57.06
6	4	0.00	0.00	79.43
6	5	0.00	0.00	78.95
7	1	0.00	0.00	50.06
7	2	0.00	0.00	70.85
7	3	0.00	0.00	48.35
7	4	0.00	0.00	50.86
7	5	0.00	0.00	82.69

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=5

BLOCK	TREATMENT LEVEL	FIRST YEAR SALICORNIA BIOMASS	TOTAL BIOMASS	LITTER WEIGHT
1	1	10.95	103.77	0.00
1	2	12.47	141.82	0.00
1	3	14.33	180.60	0.00
1	4	22.48	158.00	0.00
1	5	18.84	126.25	0.00
2	1	40.23	96.15	0.00
2	2	25.47	83.33	0.00
2	3	7.43	158.95	0.00
2	4	19.02	127.67	0.00
2	5	17.51	158.35	0.00
3	1	5.32	93.01	0.00
3	2	26.56	115.59	0.00
3	3	1.74	93.74	0.00
3	4	4.97	110.62	0.00
3	5	25.36	135.84	0.00
4	1	62.84	106.34	0.00
4	2	29.85	107.87	0.00
4	3	46.82	91.17	0.00
4	4	44.62	138.27	0.00
4	5	59.74	107.16	0.00
5	1	25.64	59.63	0.00
5	2	28.71	112.01	0.00
5	3	41.44	84.15	0.00
5	4	43.58	140.67	0.00
5	5	10.98	112.03	0.00
6	1	24.50	72.07	0.00
6	2	28.26	99.32	0.00
6	3	27.74	88.90	0.00
6	4	43.78	130.69	0.00
6	5	39.21	121.88	0.00
7	1	20.60	78.07	0.00
7	2	36.47	111.82	0.00
7	3	31.14	81.71	0.00
7	4	26.67	78.67	0.00
7	5	26.46	109.15	0.00

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=1 HARVEST=5
FIRST YEAR

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	1	2	0.18	7	2.20
1	2	19	1.34	13	4.42
1	3	2	0.20	14	5.35
1	4	4	0.24	12	4.36
1	5	3	0.20	4	1.33
2	1	4	0.18	16	4.79
2	2	3	0.29	13	4.52
2	3	6	0.39	13	4.18
2	4	2	0.10	12	3.69
2	5	11	1.46	3	0.92
3	1	3	0.14	3	0.75
3	2	3	0.40	5	1.35
3	3	7	0.87	6	1.80
3	4	3	0.24	10	2.90
3	5	1	0.04	5	1.40
4	1	8	1.04	4	1.46
4	2	1	0.06	8	2.37
4	3	12	1.37	9	2.73
4	4	2	0.33	3	0.50
4	5	47	5.42	7	2.38
5	1	19	1.46	6	1.83
5	2	24	2.67	4	1.28
5	3	15	1.38	3	0.86
5	4	10	1.39	4	1.44
5	5	5	0.55	0	0.00
6	1	11	1.36	6	1.66
6	2	1	0.01	4	1.22
6	3	9	1.21	4	1.17
6	4	5	0.57	1	0.19
6	5	4	0.52	1	0.19
7	1	18	2.17	6	1.75
7	2	39	5.66	3	0.83
7	3	18	2.30	4	1.21
7	4	20	1.91	2	0.54
7	5	28	3.63	3	1.06

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=1

FIRST YEAR

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	2	16.00	44.06	60.06
2	3	24.86	55.62	80.48
3	4	24.07	55.09	79.16
4	5	39.38	59.23	98.61
5	1	9.94	23.79	33.73
6	2	16.13	54.06	70.19
7	3	24.23	36.13	60.36
8	1	9.83	19.72	29.55
8	2	14.18	26.14	40.32
8	3	18.61	24.50	43.11
8	4	20.90	18.92	39.82
8	5	28.36	33.33	61.69
9	1	5.29	9.78	15.07
9	2	10.78	36.44	47.22
9	3	10.66	18.25	28.91
9	4	22.45	45.98	68.43
9	5	20.75	29.15	49.90
10	1	11.80	16.89	28.69
10	2	15.94	32.77	48.71
10	3	27.74	47.28	75.02
10	4	20.56	39.18	59.74
10	5	28.66	33.31	61.97

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	2	22.52	85.66	108.18
1	3	20.05	47.78	67.83
1	4	41.19	86.03	127.22
1	5	38.40	98.16	136.56
3	2	13.24	63.26	76.50
3	3	19.79	103.62	123.41
4	4	30.55	62.09	92.64
4	5	16.73	67.26	83.99
5	1	9.94	23.79	33.73
5	2	33.59	58.66	92.25
5	4	36.22	59.30	95.52
6	3	36.96	78.78	115.74
6	5	20.54	45.51	66.05
7	2	18.06	42.44	60.50
7	5	36.15	80.95	117.10
8	1	9.83	19.72	29.55
9	1	5.29	9.78	15.07
10	1	11.80	16.89	28.69

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=1
DISCONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
2	2	10.60	31.84	42.44
2	3	13.58	77.24	90.82
2	4	14.83	65.69	80.52
2	5	21.82	112.50	134.32
3	4	23.94	86.65	110.59
3	5	21.85	47.85	69.70
4	2	19.61	49.58	69.19
4	3	17.31	61.55	78.86
5	1	9.94	23.79	33.73
5	3	13.70	52.56	66.26
5	5	25.44	84.29	109.73
6	2	15.31	37.83	53.14
6	4	23.28	67.87	91.15
7	3	11.92	37.06	48.98
7	4	11.60	54.50	66.10
8	1	9.83	19.72	29.55
9	1	5.29	9.78	15.07
10	1	11.80	16.89	28.69

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=1

FIRST YEAR

BLOCK	TREATMENT LEVEL	SALICORNIA BIOMASS	TOTAL BIOMASS	LITTER WEIGHT
1	2	33.23	98.19	15.64
2	3	37.48	118.85	13.96
3	4	15.85	100.58	11.37
4	5	29.30	131.31	6.25
5	1	32.42	71.94	6.57
6	2	9.14	84.84	4.59
7	3	5.10	66.92	3.04
8	1	0.70	30.25	1.43
8	2	21.22	61.54	6.84
8	3	8.65	51.76	3.23
8	4	0.48	40.30	1.65
8	5	4.67	66.36	3.59
9	1	20.86	39.02	3.05
9	2	50.33	99.01	16.64
9	3	31.96	62.86	8.52
9	4	10.89	80.86	17.25
9	5	18.32	69.66	2.08
10	1	10.48	40.67	11.05
10	2	2.23	52.57	3.18
10	3	5.49	83.36	9.14
10	4	11.48	74.97	18.46
10	5	1.47	64.28	5.98

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	SALICORNIA SALICORNIA	TOTAL BIOMASS	LITTER WEIGHT
1	2	0.00	108.18	26.22
1	3	7.90	76.68	20.94
1	4	21.55	148.77	29.11
1	5	8.17	144.73	43.41
3	2	7.24	83.74	11.48
3	3	5.02	133.19	18.90
4	4	1.14	95.68	4.26
4	5	18.61	104.56	15.58
5	1	32.42	71.94	6.57
5	2	20.08	114.77	5.32
5	4	17.16	113.73	14.36
6	3	3.44	121.04	4.85
6	5	24.55	98.03	3.81
7	2	10.43	77.36	1.86
7	5	9.42	126.83	9.09
8	1	0.70	30.25	1.43
9	1	20.86	39.02	3.05
10	1	10.48	40.67	11.05

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=1
DISCONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	SALICORNIA SALICORNIA	TOTAL BIOMASS	LITTER WEIGHT
2	2	12.93	57.32	8.65
2	3	1.92	92.74	16.55
2	4	7.10	87.62	18.76
2	5	4.73	139.05	28.81
3	4	6.08	119.57	12.27
3	5	12.51	88.24	28.95
4	2	4.51	73.70	13.54
4	3	10.24	95.69	19.71
5	1	32.42	71.94	6.57
5	3	25.26	93.37	9.19
5	5	15.78	128.53	3.95
6	2	10.76	63.90	8.46
6	4	13.10	111.09	6.32
7	3	13.58	62.56	8.04
7	4	22.69	88.79	7.48
8	1	0.70	30.25	1.43
9	1	20.86	39.02	3.05
10	1	10.48	40.67	11.05

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=1

FIRST YEAR

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	2	0	0.00	7	2.70
2	3	2	4.06	10	4.13
3	4	0	0.00	6	2.33
4	5	0	0.00	0	0.00
5	1	5	0.52	22	8.54
6	2	33	1.84	13	5.06
7	3	2	0.26	6	2.12
8	1	0	0.00	1	0.37
8	2	0	0.00	22	9.14
8	3	0	0.00	14	6.00
8	4	0	0.00	5	1.40
8	5	0	0.00	9	3.30
9	1	0	0.00	2	0.68
9	2	94	16.85	0	0.00
9	3	0	0.00	8	3.45
9	4	0	0.00	3	1.07
9	5	0	0.00	19	6.58
10	1	0	0.00	0	0.00
10	2	0	0.00	13	5.51
10	3	0	0.00	0	0.00
10	4	0	0.00	3	1.00
10	5	0	0.00	1	0.36

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	2	0	0.00	4	1.56
1	3	0	0.00	9	3.45
1	4	0	0.00	0	0.00
1	5	0	0.00	3	1.11
3	2	0	0.00	11	3.70
3	3	0	0.00	0	0.00
4	4	8	1.06	4	1.37
4	5	0	0.00	2	0.79
5	1	5	0.52	22	8.54
5	2	68	9.10	5	1.71
5	4	8	1.27	0	0.00
6	3	0	0.00	0	0.00
6	5	47	5.28	5	2.00
7	2	3	0.40	4	1.54
7	5	72	9.40	0	0.00
8	1	0	0.00	1	0.37
9	1	0	0.00	2	0.68
10	1	0	0.00	0	0.00

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=1
DISCONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
2	2	0	0.00	5	1.61
2	3	0	0.00	4	1.46
2	4	0	0.00	9	3.73
2	5	314	46.14	4	1.67
3	4	41	5.84	1	0.35
3	5	2	0.19	1	0.29
4	2	0	0.00	6	2.28
4	3	73	10.33	3	1.00
5	1	5	0.52	22	8.54
5	3	3	0.40	4	1.38
5	5	129	20.06	1	0.29
6	2	5	0.65	8	2.37
6	4	43	5.23	5	1.51
7	3	1	0.13	13	4.67
7	4	0	0.00	0	0.00
8	1	0	0.00	1	0.37
9	1	0	0.00	2	0.68
10	1	0	0.00	0	0.00

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=2
FIRST YEAR

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	2	15.30	46.36	61.66
2	3	19.77	47.21	66.98
3	4	35.84	76.04	111.88
4	5	25.84	64.63	90.47
5	1	12.87	12.89	25.76
6	2	14.30	27.12	41.42
7	3	20.03	33.38	53.41
8	1	6.28	8.10	14.38
8	2	13.53	24.89	38.42
8	3	12.97	27.08	40.05
8	4	23.46	24.39	47.85
8	5	21.80	31.15	52.95
9	1	8.94	11.00	19.94
9	2	15.38	42.95	58.33
9	3	11.68	20.28	31.96
9	4	17.56	41.32	58.88
9	5	22.71	44.88	67.59
10	1	16.43	34.58	51.01
10	2	15.15	32.60	47.75
10	3	18.82	44.29	63.11
10	4	24.52	61.89	86.41
10	5	32.26	39.18	71.44

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	2	12.68	63.55	76.23
1	3	12.69	57.20	69.89
1	4	29.66	69.22	98.88
1	5	23.18	73.85	97.03
3	2	11.66	53.50	65.16
3	3	40.87	95.09	135.96
4	4	35.40	86.80	122.20
4	5	41.39	81.47	122.86
5	1	12.87	12.89	25.76
5	2	20.76	55.30	76.06
5	4	29.74	43.67	73.41
6	3	18.95	36.58	55.53
6	5	32.06	47.51	79.57
7	2	17.48	43.80	61.28
7	5	29.97	48.88	78.85
8	1	6.28	8.10	14.38
9	1	8.94	11.00	19.94
10	1	16.43	34.58	51.01

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=2

BLOCK	TREATMENT LEVEL	DISCONTINUED TREATMENT BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
2	2	5.48	32.30	37.78
2	3	16.65	96.92	113.57
2	4	12.15	73.60	85.75
2	5	23.14	90.92	114.06
3	4	14.65	85.37	100.02
3	5	21.60	87.61	109.21
4	2	10.97	41.20	52.17
4	3	8.55	31.84	40.39
5	1	12.87	12.89	25.76
5	3	16.78	50.92	67.70
5	5	14.35	43.48	57.83
6	2	12.93	25.89	38.82
6	4	19.78	43.42	63.20
7	3	23.75	55.39	79.14
7	4	21.18	43.58	64.76
8	1	6.28	8.10	14.38
9	1	8.94	11.00	19.94
10	1	16.43	34.58	51.01

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=2

FIRST YEAR

BLOCK	TREATMENT LEVEL	SALICORNIA BIOMASS	TOTAL BIOMASS	LITTER WEIGHT
1	2	26.67	88.67	25.65
2	3	18.29	86.44	23.34
3	4	0.62	114.69	14.30
4	5	15.26	106.42	24.21
5	1	14.25	43.74	17.22
6	2	8.52	53.34	13.53
7	3	1.43	64.12	8.95
8	1	5.64	21.22	2.95
8	2	3.00	41.42	5.60
8	3	4.14	44.39	4.07
8	4	0.87	48.72	7.36
8	5	0.90	53.85	2.76
9	1	4.85	28.98	8.67
9	2	4.16	69.68	14.71
9	3	10.54	43.49	15.53
9	4	1.12	61.43	9.55
9	5	9.04	78.32	4.33
10	1	11.95	63.76	15.81
10	2	0.00	47.75	6.19
10	3	0.57	63.68	14.84
10	4	0.00	88.68	7.73
10	5	0.63	73.21	7.82

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	SALICORNIA SALICORNIA	TOTAL BIOMASS	LITTER WEIGHT
1	2	0.25	76.48	13.69
1	3	13.86	84.66	42.68
1	4	14.19	113.07	40.75
1	5	0.62	98.34	47.22
3	2	20.57	86.90	20.55
3	3	5.51	146.01	13.13
4	4	18.84	144.42	20.14
4	5	1.66	124.52	30.34
5	1	14.25	43.74	17.22
5	2	6.38	86.58	17.08
5	4	14.46	90.96	6.45
6	3	22.46	85.43	26.11
6	5	2.94	83.34	10.40
7	2	3.42	73.35	6.74
7	5	4.95	84.28	16.67
8	1	5.64	21.22	2.95
9	1	4.85	28.98	8.67
10	1	11.95	63.76	15.81

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=2
DISCONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	SALICORNIA SALICORNIA	TOTAL BIOMASS	LITTER WEIGHT
2	2	11.44	49.69	.
2	3	3.86	117.43	19.74
2	4	1.20	86.95	27.26
2	5	0.00	114.06	11.65
3	4	1.04	101.06	15.24
3	5	2.10	111.98	5.65
4	2	8.78	60.96	16.54
4	3	45.86	87.88	26.44
5	1	14.25	43.74	17.22
5	3	6.65	79.48	8.80
5	5	10.51	70.88	11.41
6	2	5.25	44.07	4.93
6	4	12.48	78.82	6.08
7	3	0.58	80.94	6.96
7	4	6.52	71.28	12.69
8	1	5.64	21.22	2.95
9	1	4.85	28.98	8.67
10	1	11.95	63.76	15.81

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=2

FIRST YEAR

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	2	0	0.00	18	7.42
2	3	0	0.00	7	2.50
3	4	0	0.00	12	5.20
4	5	5	0.00	0	0.00
5	1	1	0.17	9	1.42
6	2	0	0.00	9	2.90
7	3	0	0.00	4	1.34
8	1	0	0.00	4	0.40
8	2	0	0.00	4	0.31
8	3	0	0.00	11	3.92
8	4	0	0.00	0	0.00
8	5	0	0.00	1	0.48
9	1	0	0.00	1	0.26
9	2	0	0.00	0	0.00
9	3	0	0.00	13	5.50
9	4	0	0.00	13	3.81
9	5	1	0.16	2	0.80
10	1	0	0.00	2	0.78
10	2	0	0.00	5	1.88
10	3	0	0.00	0	0.00
10	4	0	0.00	1	0.40
10	5	0	0.00	2	0.67

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	2	4	0.13	4	1.82
1	3	2	0.39	7	2.83
1	4	0	0.00	5	1.83
1	5	0	0.00	2	0.73
3	2	0	0.00	20	7.65
3	3	0	0.00	5	2.00
4	4	1	0.28	5	1.99
4	5	0	0.00	0	0.00
5	1	1	0.17	9	1.42
5	2	0	0.00	7	2.69
5	4	0	0.00	14	5.60
6	3	0	0.00	7	2.79
6	5	0	0.00	11	4.13
7	2	45	6.88	8	3.07
7	5	105	15.53	2	0.65
8	1	0	0.00	4	0.40
9	1	0	0.00	1	0.26
10	1	0	0.00	2	0.78

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=2
DISCONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
2	2	0	0.00	3	1.09
2	3	0	0.00	5	1.85
2	4	0	0.00	5	2.45
2	5	0	0.00	10	3.80
3	4	0	0.00	4	1.55
3	5	4	0.77	9	3.17
4	2	0	0.00	11	4.00
4	3	2	0.34	6	2.60
5	1	1	0.17	9	1.42
5	3	0	0.00	8	3.00
5	5	0	0.00	5	2.17
6	2	0	0.00	1	0.31
6	4	0	0.00	3	1.25
7	3	101	13.47	4	1.63
7	4	48	6.50	5	1.62
8	1	0	0.00	4	0.40
9	1	0	0.00	1	0.26
10	1	0	0.00	2	0.78

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=3

FIRST YEAR

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	2	18.32	46.37	64.69
2	3	14.31	49.65	63.96
3	4	22.46	51.92	74.38
4	5	23.69	57.41	81.10
5	1	4.56	13.45	18.01
6	2	30.40	37.02	67.42
7	3	26.08	46.40	72.48
8	1	13.15	11.58	24.73
8	2	11.20	26.70	37.90
8	3	22.42	18.55	40.97
8	4	17.57	22.95	40.52
8	5	24.63	33.65	58.28
9	1	26.92	39.66	66.58
9	2	10.53	41.39	51.92
9	3	10.62	12.40	23.02
9	4	20.14	25.64	45.78
9	5	17.17	23.78	40.95
10	1	11.00	17.47	28.47
10	2	18.86	38.07	56.93
10	3	33.76	48.34	82.10
10	4	17.77	37.35	55.12
10	5	18.61	45.97	64.58

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	2	20.82	76.27	97.09
1	3	28.06	69.12	97.18
1	4	21.87	68.75	90.62
1	5	29.44	79.63	109.07
3	2	19.82	50.06	69.88
3	3	36.15	121.75	157.90
4	4	17.45	53.70	71.15
4	5	40.97	101.10	142.07
5	1	4.56	13.45	18.01
5	2	18.62	92.69	111.31
5	4	50.49	90.02	140.51
6	3	22.12	59.70	81.82
6	5	18.99	29.35	48.34
7	2	18.18	40.58	58.76
7	5	50.25	99.43	149.68
8	1	13.15	11.58	24.73
9	1	26.92	39.66	66.58
10	1	11.00	17.47	28.47

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=3
DISCONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
2	2	8.27	29.75	38.02
2	3	20.71	72.90	93.61
2	4	13.10	76.75	89.85
2	5	31.50	127.72	159.22
3	4	15.67	64.19	79.86
3	5	23.92	75.25	99.17
4	2	18.72	53.92	72.64
4	3	14.64	82.67	97.31
5	1	4.56	13.45	18.01
5	3	21.63	62.05	83.68
5	5	17.37	79.28	96.65
6	2	16.20	44.64	60.84
6	4	27.27	58.70	85.97
7	3	28.43	58.67	87.10
7	4	21.65	30.80	52.45
8	1	13.15	11.58	24.73
9	1	26.92	39.66	66.58
10	1	11.00	17.47	28.47

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=3

FIRST YEAR

BLOCK	TREATMENT LEVEL	SALICORNIA BIOMASS	TOTAL BIOMASS	LITTER WEIGHT
1	2	23.16	88.49	15.16
2	3	30.65	94.61	12.13
3	4	12.86	88.47	5.64
4	5	27.33	111.66	13.14
5	1	38.22	56.23	11.50
6	2	14.69	84.45	15.57
7	3	1.68	78.16	3.45
8	1	2.72	28.10	2.87
8	2	10.05	48.71	7.27
8	3	7.00	48.22	1.46
8	4	2.49	43.01	3.74
8	5	6.14	64.42	5.81
9	1	14.44	81.02	9.62
9	2	72.26	124.18	18.82
9	3	32.69	57.91	11.06
9	4	9.94	60.67	8.26
9	5	12.43	56.04	4.78
10	1	15.32	51.48	8.20
10	2	3.25	60.18	2.80
10	3	0.28	82.38	9.81
10	4	28.06	87.33	30.85
10	5	1.85	67.14	6.95

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	SALICORNIA SALICORNIA	TOTAL BIOMASS	LITTER WEIGHT
1	2	6.93	104.02	31.36
1	3	10.77	108.65	20.82
1	4	10.92	101.54	15.28
1	5	6.69	116.11	16.80
3	2	19.55	89.43	22.10
3	3	0.00	166.36	38.26
4	4	14.83	85.98	11.46
4	5	0.90	146.44	15.09
5	1	38.22	56.23	11.50
5	2	25.82	138.91	4.22
5	4	5.18	145.69	12.83
6	3	14.50	98.85	28.60
6	5	31.77	80.11	25.32
7	2	1.07	67.92	7.73
7	5	1.09	150.77	24.53
8	1	2.72	28.10	2.87
9	1	14.44	81.02	9.62
10	1	15.32	51.48	8.20

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=3
DISCONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	SALICORNIA SALICORNIA	TOTAL BIOMASS	LITTER WEIGHT
2	2	25.54	63.56	9.18
2	3	1.90	96.15	21.64
2	4	9.64	99.49	21.11
2	5	0.75	159.97	22.79
3	4	7.46	88.98	5.19
3	5	9.43	108.60	16.42
4	2	11.65	84.92	14.99
4	3	8.20	105.51	30.12
5	1	38.22	56.23	11.50
5	3	18.68	104.60	28.49
5	5	8.76	111.83	42.84
6	2	19.46	81.29	9.57
6	4	4.80	97.07	16.31
7	3	5.14	94.72	5.43
7	4	7.21	62.37	1.02
8	1	2.72	28.10	2.87
9	1	14.44	81.02	9.62
10	1	15.32	51.48	8.20

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=3

FIRST YEAR

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	2	0	0.00	3	0.88
2	3	0	0.00	27	10.55
3	4	0	0.00	10	3.68
4	5	0	0.00	1	0.38
5	1	0	0.00	5	1.28
6	2	0	0.00	12	3.60
7	3	0	0.00	1	0.02
8	1	0	0.00	0	0.00
8	2	0	0.00	2	0.93
8	3	0	0.00	1	0.03
8	4	0	0.00	0	0.00
8	5	0	0.00	5	1.90
9	1	0	0.00	18	6.54
9	2	0	0.00	5	1.87
9	3	0	0.00	9	2.43
9	4	0	0.00	7	1.34
9	5	0	0.00	4	1.38
10	1	0	0.00	0	0.00
10	2	0	0.00	8	2.46
10	3	0	0.00	4	1.51
10	4	0	0.00	7	2.65
10	5	0	0.00	5	1.85

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	2	0	0.00	12	4.75
1	3	0	0.00	16	5.47
1	4	0	0.00	6	1.81
1	5	0	0.00	7	2.55
3	2	0	0.00	18	6.59
3	3	3	0.39	9	3.47
4	4	0	0.00	0	0.00
4	5	0	0.00	10	3.78
5	1	0	0.00	5	1.28
5	2	0	0.00	9	3.56
5	4	0	0.00	17	6.80
6	3	0	0.00	8	3.06
6	5	0	0.00	7	2.46
7	2	0	0.00	12	2.86
7	5	0	0.00	3	0.80
8	1	0	0.00	0	0.00
9	1	0	0.00	18	6.54
10	1	0	0.00	0	0.00

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=2 HARVEST=3

		DISCONTINUED TREATMENT			
BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
2	2	0	0.00	8	3.03
2	3	0	0.00	9	3.39
2	4	0	0.00	14	5.30
2	5	0	0.00	12	4.77
3	4	0	0.00	3	1.20
3	5	7	0.40	16	6.42
4	2	0	0.00	3	0.85
4	3	0	0.00	12	4.57
5	1	0	0.00	5	1.28
5	3	0	0.00	16	6.53
5	5	0	0.00	12	4.10
6	2	0	0.00	5	1.12
6	4	0	0.00	1	0.31
7	3	0	0.00	5	0.73
7	4	0	0.00	1	0.23
8	1	0	0.00	0	0.00
9	1	0	0.00	18	6.54
10	1	0	0.00	0	0.00

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=1

FIRST YEAR

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	2	12.96	48.90	61.86
2	3	8.63	40.55	49.18
3	4	17.97	52.46	70.43
4	5	17.96	38.21	56.17
5	1	12.80	28.02	40.82
6	2	21.10	43.66	64.76
7	3	16.54	32.14	48.68
8	1	4.22	7.75	11.97
8	2	0.75	2.50	3.25
8	3	2.77	10.93	13.70
8	4	8.29	13.83	22.12
8	5	24.30	74.43	98.73
9	1	14.83	29.84	44.67
9	2	19.31	56.46	75.77
9	3	2.90	4.19	7.09
9	4	20.00	58.05	78.05
9	5	16.87	48.47	65.34
10	1	13.55	37.23	50.78
10	2	10.62	22.16	32.78
10	3	24.24	79.70	103.94
10	4	13.89	67.28	81.17
10	5	20.42	41.57	61.99

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	2	15.86	73.04	88.90
1	3	13.82	87.10	100.92
1	4	20.72	85.58	106.30
1	5	21.90	98.75	120.65
3	2	17.34	69.72	87.06
3	3	21.67	49.60	71.27
4	4	13.49	42.02	55.51
4	5	32.91	84.50	117.41
5	1	12.80	28.02	40.82
5	2	14.55	50.84	65.39
5	4	32.95	100.35	133.30
6	3	28.98	45.78	74.76
6	5	26.66	32.82	59.48
7	2	32.84	84.10	116.94
7	5	34.44	104.78	139.22
8	1	4.22	7.75	11.97
9	1	14.83	29.84	44.67
10	1	13.55	37.23	50.78

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=1

BLOCK	TREATMENT LEVEL	DISCONTINUED TREATMENT BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
2	2	4.21	19.31	23.52
2	3	12.62	80.84	93.46
2	4	21.33	54.72	76.05
2	5	19.05	88.33	107.38
3	4	16.36	44.43	60.79
3	5	19.00	45.37	64.37
4	2	14.68	42.80	57.48
4	3	19.46	65.09	84.55
5	1	12.80	28.02	40.82
5	3	5.64	47.88	53.52
5	5	19.00	46.60	65.60
6	2	11.20	22.50	33.70
6	4	20.95	50.95	71.90
7	3	26.51	57.08	83.59
7	4	6.86	13.90	20.76
8	1	4.22	7.75	11.97
9	1	14.83	29.84	44.67
10	1	13.55	37.23	50.78

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=1

BLOCK	TREATMENT LEVEL	FIRST YEAR SALICORNIA BIOMASS	TOTAL BIOMASS	LITTER WEIGHT
1	2	35.85	101.76	6.60
2	3	41.98	92.96	3.61
3	4	16.49	86.92	8.48
4	5	36.55	98.82	3.58
5	1	43.52	84.34	1.81
6	2	18.00	90.78	2.68
7	3	8.80	68.11	4.53
8	1	20.40	32.37	1.90
8	2	46.08	49.33	0.29
8	3	32.57	46.67	2.43
8	4	8.16	30.28	3.74
8	5	0.03	98.76	3.12
9	1	9.72	56.57	1.16
9	2	0.02	76.36	4.13
9	3	38.57	45.66	1.35
9	4	1.81	87.28	6.19
9	5	17.00	83.64	6.45
10	1	16.48	70.26	12.67
10	2	10.54	51.49	3.11
10	3	1.18	105.12	3.60
10	4	4.66	90.80	7.71
10	5	1.50	63.73	0.35

BLOCK	TREATMENT LEVEL	CONTINUED TREATMENT SALICORNIA SALICORNIA	TOTAL BIOMASS	LITTER WEIGHT
1	2	8.54	97.44	11.92
1	3	24.35	125.27	16.55
1	4	59.00	170.90	13.23
1	5	37.48	158.13	35.49
3	2	15.92	102.98	6.54
3	3	20.38	98.95	6.60
4	4	32.27	90.74	11.85
4	5	0.53	117.94	7.40
5	1	43.52	84.34	1.81
5	2	17.21	85.84	6.74
5	4	2.68	138.76	3.25
6	3	1.75	77.84	3.59
6	5	8.10	71.25	3.65
7	2	23.00	149.74	8.20
7	5	5.19	145.21	0.45
8	1	20.40	32.37	1.90
9	1	9.72	56.57	1.16
10	1	16.48	70.26	12.67

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=1
DISCONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	SALICORNIA SALICORNIA	TOTAL BIOMASS	LITTER WEIGHT
2	2	68.68	93.06	2.42
2	3	20.60	116.72	5.66
2	4	29.86	107.01	2.50
2	5	1.79	109.17	3.49
3	4	0.00	60.79	10.86
3	5	25.30	92.51	11.22
4	2	24.17	82.19	4.30
4	3	38.21	125.61	4.80
5	1	43.52	84.34	1.81
5	3	53.97	111.01	2.16
5	5	4.00	71.30	6.44
6	2	31.30	69.10	8.63
6	4	0.53	78.05	8.40
7	3	3.66	89.01	3.56
7	4	18.30	40.16	1.50
8	1	20.40	32.37	1.90
9	1	9.72	56.57	1.16
10	1	16.48	70.26	12.67

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=1

FIRST YEAR

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	2	2	0.52	20	3.60
2	3	0	0.00	6	0.76
3	4	5	0.81	17	4.26
4	5	14	2.97	11	2.90
5	1	7	0.87	5	1.67
6	2	6	0.60	14	3.70
7	3	19	3.02	15	5.73
8	1	0	0.00	9	2.20
8	2	0	0.00	11	3.43
8	3	0	0.00	20	6.12
8	4	0	0.00	1	0.10
8	5	1	0.01	2	0.34
9	1	0	0.00	14	3.70
9	2	2	0.01	2	0.55
9	3	2	0.01	11	3.24
9	4	2	0.12	12	3.14
9	5	2	0.02	7	1.78
10	1	0	0.00	3	0.68
10	2	0	0.00	8	2.36
10	3	2	0.08	5	1.20
10	4	5	1.07	2	0.57
10	5	0	0.00	9	3.20

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	2	0	0.00	1	0.25
1	3	4	0.76	5	1.70
1	4	1	0.14	7	2.56
1	5	1	0.19	3	1.02
3	2	17	3.37	8	2.90
3	3	6	1.11	13	1.49
4	4	15	2.62	19	5.70
4	5	15	3.23	18	5.90
5	1	7	0.87	5	1.67
5	2	6	1.37	4	1.46
5	4	7	1.07	14	5.15
6	3	5	0.52	15	5.30
6	5	1	0.17	6	2.08
7	2	8	1.20	10	3.44
7	5	21	3.66	14	5.63
8	1	0	0.00	9	2.20
9	1	0	0.00	14	3.70
10	1	0	0.00	3	0.68

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=1
DISCONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
2	2	1	0.05	12	2.80
2	3	1	0.19	13	2.79
2	4	2	0.37	8	1.57
2	5	1	0.05	7	2.34
3	4	2	0.41	3	0.89
3	5	6	1.40	4	1.70
4	2	7	1.57	10	3.14
4	3	36	5.65	9	3.27
5	1	7	0.87	5	1.67
5	3	46	8.05	7	2.36
5	5	4	0.06	12	4.02
6	2	5	0.99	15	4.95
6	4	2	0.04	4	1.21
7	3	15	3.08	10	3.25
7	4	6	0.90	14	4.74
8	1	0	0.00	9	2.20
9	1	0	0.00	14	3.70
10	1	0	0.00	3	0.68

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=2

FIRST YEAR

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	2	12.40	46.19	58.59
2	3	15.30	55.00	70.30
3	4	38.50	97.36	135.86
4	5	21.50	60.20	81.70
5	1	9.80	33.80	43.60
6	2	25.58	68.27	93.85
7	3	41.57	52.46	94.03
8	1	15.40	21.90	37.30
8	2	16.80	26.80	43.60
8	3	16.39	16.75	33.14
8	4	16.20	30.70	46.90
8	5	28.16	60.07	88.23
9	1	13.30	24.00	37.30
9	2	7.70	34.39	42.09
9	3	18.20	48.07	66.27
9	4	25.40	50.20	75.60
9	5	30.80	41.80	72.60
10	1	12.09	23.66	35.75
10	2	17.90	35.00	52.90
10	3	25.50	48.10	73.60
10	4	14.10	81.17	95.27
10	5	24.58	50.73	75.31

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
1	2	22.04	90.76	112.80
1	3	25.85	76.99	102.84
1	4	15.97	120.89	136.86
1	5	19.40	66.54	85.94
3	2	19.30	76.70	96.00
3	3	41.70	81.40	123.10
4	4	69.00	141.80	210.80
4	5	24.30	102.00	126.30
5	1	9.80	33.80	43.60
5	2	21.10	69.80	90.90
5	4	44.60	77.70	122.30
6	3	35.22	67.39	102.61
6	5	30.90	81.10	112.00
7	2	55.60	77.60	133.20
7	5	49.07	94.66	143.73
8	1	15.40	21.90	37.30
9	1	13.30	24.00	37.30
10	1	12.09	23.66	35.75

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=2

BLOCK	TREATMENT LEVEL	DISCONTINUED TREATMENT BATIS LEAF BIOMASS	BATIS STEM BIOMASS	BATIS BIOMASS
2	2	9.99	29.17	39.16
2	3	12.30	71.80	84.10
2	4	15.50	50.50	66.00
2	5	13.00	83.60	96.60
3	4	13.50	64.20	77.70
3	5	21.80	70.00	91.80
4	2	17.40	53.70	71.10
4	3	14.80	43.30	58.10
5	1	9.80	33.80	43.60
5	3	17.65	54.61	72.26
5	5	8.86	28.55	37.41
6	2	22.90	25.70	48.60
6	4	20.80	44.00	64.80
7	3	48.00	75.00	123.00
7	4	7.50	21.60	29.10
8	1	15.40	21.90	37.30
9	1	13.30	24.00	37.30
10	1	12.09	23.66	35.75

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=2

FIRST YEAR

BLOCK	TREATMENT LEVEL	SALICORNIA BIOMASS	TOTAL BIOMASS	LITTER WEIGHT
1	2	33.30	104.69	6.76
2	3	23.20	94.40	4.80
3	4	0.40	137.66	6.58
4	5	28.30	112.00	8.10
5	1	39.30	84.40	3.70
6	2	0.52	98.57	4.15
7	3	11.71	107.61	1.50
8	1	12.60	51.00	3.16
8	2	17.90	61.50	2.36
8	3	16.65	49.79	3.17
8	4	2.30	51.10	9.44
8	5	42.50	92.88	5.18
9	1	26.60	65.20	5.79
9	2	49.89	94.78	5.20
9	3	23.80	92.70	2.16
9	4	3.00	83.70	6.20
9	5	3.40	82.40	2.40
10	1	43.40	81.63	7.50
10	2	0.60	60.00	1.80
10	3	9.50	84.10	2.10
10	4	15.35	114.04	9.13
10	5	0.46	75.87	8.45

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	SALICORNIA SALICORNIA	TOTAL BIOMASS	LITTER WEIGHT
1	2	15.95	128.75	1.90
1	3	12.66	118.69	3.20
1	4	29.66	166.52	8.40
1	5	26.70	112.64	5.23
3	2	27.40	123.40	1.90
3	3	14.90	141.00	2.70
4	4	3.50	217.30	5.20
4	5	23.90	152.30	2.50
5	1	39.30	84.40	3.70
5	2	39.80	138.10	1.40
5	4	16.70	139.00	0.70
6	3	14.85	118.79	5.80
6	5	1.30	117.20	7.50
7	2	3.22	141.10	6.50
7	5	8.66	155.72	1.06
8	1	12.60	51.00	3.16
9	1	26.60	65.20	5.79
10	1	43.40	81.63	7.50

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS: GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=2

BLOCK	TREATMENT LEVEL	DISCONTINUED TREATMENT SALICORNIA SALICORNIA	TOTAL BIOMASS	LITTER WEIGHT
2	2	51.40	95.24	3.71
2	3	20.90	107.80	2.60
2	4	42.60	108.90	6.90
2	5	3.10	99.70	2.50
3	4	35.20	113.60	4.90
3	5	26.60	118.40	6.10
4	2	3.60	74.70	4.30
4	3	52.50	115.30	5.60
5	1	39.30	84.40	3.70
5	3	40.15	113.22	5.40
5	5	38.82	80.26	2.38
6	2	20.60	69.90	1.70
6	4	2.10	69.30	4.00
7	3	9.10	136.20	1.40
7	4	48.60	79.20	6.30
8	1	12.60	51.00	3.16
9	1	26.60	65.20	5.79
10	1	43.40	81.63	7.50

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=2

FIRST YEAR

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	2	1	0.13	16	2.68
2	3	0	0.00	4	0.25
3	4	5	1.00	14	4.88
4	5	0	0.00	7	1.02
5	1	0	0.00	12	3.20
6	2	0	0.00	6	1.39
7	3	0	0.00	10	3.23
8	1	0	0.00	0	0.00
8	2	0	0.00	3	1.18
8	3	0	0.00	4	1.36
8	4	0	0.00	1	0.03
8	5	0	0.00	2	1.00
9	1	0	0.00	4	1.00
9	2	0	0.00	3	1.06
9	3	0	0.00	0	0.00
9	4	1	0.24	8	2.47
9	5	0	0.00	24	7.58
10	1	0	0.00	2	0.41
10	2	0	0.00	9	2.88
10	3	0	0.00	2	0.56
10	4	0	0.00	7	2.46
10	5	0	0.00	0	0.00

CONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
1	2	6	1.21	4	0.89
1	3	0	0.00	2	1.53
1	4	2	0.27	3	0.87
1	5	4	0.80	9	3.20
3	2	1	0.06	3	0.46
3	3	7	1.61	3	1.10
4	4	8	1.32	16	5.37
4	5	2	5.38	5	1.62
5	1	0	0.00	12	3.20
5	2	82	16.23	23	8.02
5	4	13	2.35	20	7.20
6	3	8	1.65	5	1.82
6	5	12	2.12	9	3.12
7	2	45	7.79	8	3.22
7	5	6	1.13	13	5.08
8	1	0	0.00	0	0.00
9	1	0	0.00	4	1.00
10	1	0	0.00	2	0.41

Table 15 (continued)

MANCHESTER MARSH DATA (BIOMASS:GRAMS PER TENTH SQUARE METER)
YEAR=3 HARVEST=2
DISCONTINUED TREATMENT

BLOCK	TREATMENT LEVEL	NUMBER OF MELAMPUS	MELAMPUS BIOMASS	NUMBER OF CERTHIDEA	CERTHIDEA BIOMASS
2	2	0	0.00	19	5.51
2	3	0	0.00	6	0.92
2	4	0	0.00	18	4.22
2	5	0	0.00	19	3.89
3	4	2	0.19	34	5.00
3	5	6	1.20	27	4.03
4	2	0	0.00	3	0.24
4	3	0	0.00	23	5.17
5	1	0	0.00	12	3.20
5	3	24	4.44	9	2.77
5	5	0	0.00	1	0.39
6	2	0	0.00	2	0.43
6	4	0	0.00	2	0.73
7	3	0	0.00	15	4.82
7	4	1	0.08	42	13.59
8	1	0	0.00	0	0.00
9	1	0	0.00	4	1.00
10	1	0	0.00	2	0.41

APPENDIX B

BELOW GROUND BIOMASS

Table 16. Below ground biomass in grams per 694 cm^3 sample.

Treatment Level	BLOCKS 1	2	3	4	5	6	7	$\bar{x}$
				October 11, 1976				
1	6.952	6.050	7.910	7.320	10.967	9.272	13.130	8.800
2	5.155	5.787	7.125	6.682	8.157	12.867	15.295	8.724
3	7.352	5.907	7.832	7.690	9.307	12.175	12.075	8.905
4	6.487	6.125	7.150	7.255	9.785	12.370	6.175	7.906
5	6.252	7.010	7.280	8.157	10.182	7.732	8.555	7.881
$\bar{x}$	6.440	6.176	7.459	7.421	9.680	10.883	11.046	
				March 31, 1976				
1	8.740	5.750	8.480	7.440	9.420	10.190	14.250	9.181
2	6.270	5.910	8.290	6.950	8.050	9.070	14.090	8.375
3	8.970	6.370	7.410	7.750	8.490	11.600	15.020	9.372
4	8.290	8.210	9.510	8.680	8.820	12.720	7.120	9.050
5	7.680	8.600	7.470	6.120	10.110	6.280	7.120	7.625
$\bar{x}$	7.990	6.968	8.232	7.388	8.978	9.972	11.520	
				May 20, 1977				
1	5.320	4.940	6.540	7.050	8.790	8.650	14.070	7.908
2	4.180	5.530	6.230	8.420	7.830	8.030	12.180	7.485
3	6.870	5.970	7.030	5.890	8.100	10.420	10.360	7.805
4	5.730	5.740	6.990	7.320	10.330	8.800	8.460	7.624
5	5.770	4.840	6.830	5.900	9.450	4.360	7.340	6.355
$\bar{x}$	5.574	5.404	6.724	6.916	8.900	8.052	10.482	

APPENDIX C

PLANT TISSUE NUTRIENT CONCENTRATIONS

Table 17. Plant tissue nutrient concentrations in percent by weight. GB = Green *Batis*; WB = Woody *Batis*; GS = Green *Salicornia*; WS = Woody *Salicornia*

			June 17, 1976			
Block	Treatment Level	Tissue	%P	%N	%C	%H
1	1	GB	0.12	1.30	25.48	3.60
		WB	0.18	1.30	41.10	5.61
		GS	0.12	1.47	29.13	4.10
		WS	0.18	1.30	45.00	6.27
1	2	GB	0.12	1.44	25.71	3.52
		WB	0.20	1.46	41.33	5.37
		GS	0.12	1.23	26.09	3.44
		WS	0.17	1.28	43.89	5.80
1	3	GB	0.11	1.43	23.79	3.62
		WB	0.18	1.50	39.88	5.63
		GS	0.12	1.43	29.60	4.32
		WS	0.18	1.27	44.62	6.08
1	4	GB	0.14	1.58	25.64	3.69
		WB	0.18	1.44	41.95	5.50
		GS	0.12	1.26	26.02	3.77
		WS	0.18	1.46	43.72	6.07
1	5	GB	0.12	1.44	24.65	3.31
		WB	0.19	1.20	41.25	5.72
		GS	0.12	1.41	27.86	3.81
		WS	0.17	1.10	45.21	6.06
4	1	GB	0.13	1.08	22.97	3.32
		WB	0.20	1.05	41.31	5.56
		GS	0.12	1.48	31.22	4.31
		WS	0.18	1.06	45.32	6.05
4	2	GB	0.12	1.21	23.86	3.24
		WB	0.20	1.05	41.45	5.40
		GS	0.13	1.31	29.26	3.98
		WS	0.20	1.18	45.47	6.16
4	3	GB	0.13	1.16	24.65	3.48
		WB	0.21	1.09	40.01	5.29
		GS	0.14	1.41	32.81	4.53
		WS	0.19	1.01	44.89	5.78
4	4	GB	0.12	1.23	24.36	3.56
		WB	0.18	1.06	41.71	5.30
		GS	0.13	1.27	27.98	3.66
		WS	0.18	1.14	44.86	5.90

Table 17 (continued)

Block	Treatment Level	Tissue	%P	%N	%C	%H
			June 17, 1976 (*Cont'd*)			
4	5	GB	0.14	1.17	23.65	3.44
		WB	0.20	1.02	41.06	5.32
		GS	0.12	1.21	28.70	4.06
		WS	0.19	1.13	43.75	5.87
7	1	GB	0.11	1.09	23.53	3.28
		WB	0.17	1.06	39.92	5.28
		GS	0.14	1.27	28.35	3.85
		WS	0.18	1.02	43.86	5.66
7	2	GB	0.12	1.19	23.44	3.31
		WB	0.14	1.03	40.30	5.42
		GS	0.13	1.20	28.31	3.91
		WS	0.17	1.01	43.75	5.77
7	3	GB	0.11	1.17	23.29	3.42
		WB	0.19	1.03	39.42	5.18
		GS	0.15	1.13	30.07	4.14
		WS	0.18	0.98	43.63	5.92
7	4	GB	0.12	1.22	24.03	3.42
		WB	0.20	1.03	40.76	5.32
		GS	0.14	1.14	30.07	4.16
		WS	0.18	0.90	44.66	5.94
7	5	GB	0.11	1.08	22.27	3.51
		WB	0.17	1.00	40.99	5.33
		GS	0.11	1.14	27.30	3.76
		WS	0.18	0.96	43.13	5.76

Table 17 (continued)

July 13, 1976

Block	Treatment Level	Tissue	%P	%N	%C	%H
1	1	GB	0.15	1.60	24.93	3.78
		WB	0.18	1.26	40.76	5.67
		GS	0.14	1.74	31.93	4.36
		WS	0.19	1.49	46.01	6.17
1	2	GB	0.14	1.63	26.38	3.60
		WB	0.17	1.30	42.09	5.45
		GS	0.18	2.05	31.73	4.21
		WS	0.22	1.62	45.42	6.03
1	3	GB	0.14	1.53	25.28	3.73
		WB	0.19	1.21	40.63	5.35
		GS	0.15	1.87	33.01	4.58
		WS	0.20	1.50	45.72	5.99
1	4	GB	0.18	1.78	26.42	3.85
		WB	0.19	1.25	40.80	5.50
		GS	0.18	1.85	33.05	4.52
		WS	0.24	1.51	45.67	6.06
1	5	GB	0.14	1.36	24.71	3.49
		WB	0.21	1.25	41.15	5.50
		GS	0.16	1.82	33.75	4.75
		WS	0.18	1.52	45.77	6.07
4	1	GB	0.13	1.39	24.61	3.36
		WB	0.18	1.00	40.12	5.54
		GS	0.14	1.74	32.20	4.38
		WS	0.22	1.44	44.99	6.00
4	2	GB	0.17	1.46	25.91	3.74
		WB	0.20	1.00	39.96	5.52
		GS	0.14	1.59	31.86	4.36
		WS	0.21	1.40	45.30	6.02
4	3	GB	0.15	1.29	24.83	3.51
		WB	0.23	1.15	40.17	5.39
		GS	0.17	1.69	32.35	4.44
		WS	0.19	1.16	45.07	5.94
4	4	GB	0.15	1.41	26.37	3.69
		WB	0.19	1.07	39.99	5.47
		GS	0.16	1.78	32.02	4.31
		WS	0.21	1.24	44.97	6.04

Table 17 (continued)

July 13, 1976 (*Cont'd*)

Block	Treatment Level	Tissue	%P	%N	%C	%H
4	5	GB	0.17	1.53	24.90	3.46
		WB	0.26	1.30	40.92	5.38
		GS	0.16	1.77	31.68	4.38
		WS	0.22	1.29	44.97	6.04
7	1	GB	0.11	1.34	23.66	3.35
		WB	0.19	1.17	39.82	5.32
		GS	0.14	1.45	30.38	4.21
		WS	0.20	1.21	45.03	5.95
7	2	GB	0.12	1.17	22.93	3.38
		WB	0.15	1.11	41.21	5.44
		GS	0.13	1.37	29.29	4.23
		WS	0.20	1.13	45.73	6.36
7	3	GB	0.12	1.38	25.11	3.71
		WB	0.17	1.21	40.81	5.60
		GS	0.16	1.49	31.62	4.40
		WS	0.19	1.16	45.39	5.95
7	4	GB	0.13	1.23	25.18	3.36
		WB	0.20	1.04	41.35	5.18
		GS	0.13	1.36	31.80	4.31
		WS	0.19	1.10	45.65	6.33
7	5	GB	0.13	1.36	25.88	3.41
		WB	0.20	1.19	40.18	5.26
		GS	0.13	1.38	31.53	4.21
		WS	0.21	1.13	45.12	5.94

Table 17 (continued)

October 1, 1976

Block	Treatment Level	Tissue	%P	%N	%C	%H
1	1	GB	0.125	1.20	23.51	3.40
		WB	0.189	1.06	40.65	5.52
		GS	0.167	1.87	32.30	4.45
		WS	0.268	1.48	47.11	6.20
1	2	GB	0.171	1.33	25.97	3.70
		WB	0.267	1.26	41.89	5.53
		GS	0.259	1.74	31.50	4.35
		WS	0.240	1.60	46.31	6.27
1	3	GB	0.108	1.29	24.58	3.71
		WB	0.244	1.30	40.94	5.41
		GS	0.231	1.75	32.06	4.43
		WS	0.313	1.39	46.14	6.29
1	4	GB	0.108	1.20	22.06	3.18
		WB	0.210	1.13	41.29	5.66
		GS	0.212	1.76	31.71	4.29
		WS	0.226	1.47	46.80	6.44
1	5	GB	0.132	1.21	22.48	3.30
		WB	0.385	1.07	42.10	5.71
		GS	0.210	1.73	31.94	4.34
		WS	0.308	1.42	46.82	6.24
2	1	GB	0.117	1.21	23.89	3.43
		WB	0.186	0.90	41.79	5.38
		GS	0.151	1.81	30.56	4.27
		WS	0.227	1.56	46.72	6.04
2	2	GB	0.113	1.40	23.35	3.34
		WB	0.210	1.38	40.25	5.30
		GS	0.200	1.78	31.47	4.19
		WS	0.267	1.45	46.42	6.07
2	3	GB	0.212	1.35	25.40	3.65
		WB	0.434	1.11	40.59	5.41
		GS	0.228	1.87	30.64	4.25
		WS	0.286	1.50	47.72	6.31
2	4	GB	0.137	1.79	24.58	3.46
		WB	0.244	1.20	41.28	5.41
		GS	0.179	1.79	31.05	4.11
		WS	0.268	1.60	46.34	6.05

Table 17 (continued)

October 1, 1976 *(Cont'd)*

Block	Treatment Level	Tissue	%P	%N	%C	%H
2	5	GB	0.120	1.34	24.92	3.63
		WB	0.261	1.26	41.41	5.62
		GS	0.176	1.78	32.26	4.57
		WS	0.247	1.30	46.06	5.99
3	1	GB	0.142	1.43	27.91	3.90
		WB	0.255	1.08	41.97	5.38
		GS	0.152	1.72	28.58	4.28
		WS	0.234	1.25	47.05	6.00
3	2	GB	0.138	1.16	24.29	3.50
		WB	0.217	0.97	42.22	5.30
		GS	0.162	1.57	29.02	3.95
		WS	0.267	1.30	46.69	6.12
3	3	GB	0.119	1.20	23.88	3.49
		WB	0.219	0.98	42.35	5.70
		GS	0.165	1.69	27.55	3.91
		WS	0.300	1.42	46.48	6.01
3	4	GB	0.151	1.18	24.24	3.71
		WB	0.196	0.95	43.94	5.86
		GS	0.141	1.65	28.75	4.00
		WS	0.213	1.39	46.67	5.97
3	5	GB	0.136	1.25	23.58	3.25
		WB	0.252	1.09	42.16	5.65
		GS	0.169	1.69	31.79	4.20
		WS	0.256	1.41	46.14	6.02

Table 17 (continued)

BATLVS = *Batis* leaves
BATSTM = *Batis* stems
SAL = *Salicornia*

October 14, 1977

Block	Treatment Level	Tissue	%P	%N	%C
8	1	BATLVS	0.129	1.50	24.68
		BATSTM	0.150	1.01	36.65
		SAL	0.226	1.70	42.13
8	2	BATLVS	0.142	1.48	24.44
		BATSTM	0.195	1.16	39.84
		SAL	0.230	1.63	40.85
8	3	BATLVS	0.150	1.39	25.14
		BATSTM	0.192	2.17	37.25
		SAL	0.180	1.44	36.75
8	4	BATLVS	0.165	1.85	24.76
		BATSTM	0.218	1.60	37.35
		SAL	0.235	1.84	39.87
8	5	BATLVS	0.162	1.79	24.48
		BATSTM	0.182	2.01	41.95
		SAL	0.226	1.69	39.10
9	1	BATLVS	0.126	1.50	25.08
		BATSTM	0.209	1.67	41.52
		SAL	0.226	2.38	45.01
9	2	BATLVS	0.124	1.36	24.08
		BATSTM	0.214	1.84	39.97
		SAL	0.201	1.52	38.60
9	3	BATLVS	0.143	1.73	27.24
		BATSTM	0.188	1.67	39.66
		SAL	0.245	2.04	41.45
9	4	BATLVS	0.145	1.78	25.43
		BATSTM	0.179	1.58	40.30
		SAL	0.220	1.40	37.83
9	5	BATLVS	0.178	1.71	25.76
		BATSTM	0.203	1.58	38.91
		SAL	0.242	1.93	39.33

Table 17 (continued)

October 14, 1977 *(Cont'd)*

Block	Treatment Level	Tissue	%P	%N	%C
10	1	BATLVS	0.126	1.30	23.91
		BATSTM	0.173	1.38	39.79
		SAL	0.198	1.52	39.92
10	2	BATLVS	0.125	1.75	26.86
		BATSTM	0.184	1.98	39.95
		SAL	0.241	2.14	45.37
10	3	BATLVS	0.177	2.03	26.33
		BATSTM	0.242	1.70	39.68
		SAL	0.277	2.12	42.69
10	4	BATLVS	0.145	1.79	26.00
		BATSTM	0.184	1.72	40.79
		SAL	0.242	1.82	38.50
10	5	BATLVS	0.159	2.10	25.47
		BATSTM	0.199	2.06	39.71
		SAL	0.251	2.05	42.12

APPENDIX D

PERIPHYTON SPECIES LIST, DENSITY, DIVERSITY, CHLOROPHYLL AND BIOMASS

Table 18. Summary of diatom data from Block 3.

Fertilization Level Replicate No.	Cell Densities (Cells/mm^2)	Total No. of Species	Species Diversity Index
1-1	28.4	13	2.06
2	34.5	10	2.05
3	40.2	11	1.94
2-1	29.5	9	1.65
2	36.7	10	1.54
3	87.2	10	1.68
3-1	17.4	9	1.74
2	5.8	10	1.95
3	30.9	11	1.81
4-1	25.7	13	1.94
2	31.7	11	1.95
3	26.9	12	1.62
5-1	44.6	12	1.84
2	10.6	11	1.99
3	11.8	10	1.77

Table 19. Summary of filamentous algae data from Block 3.

Fertilization Level Replicate No.	Sample No.	Cell Densities (cells/mm^2)	Total No. of Species
1-1	PB-199	0.4	3
-2	PB-392	0.2	2
2-1	PB-314	10.8	3
-2	PB-608	13.4	2
3-1	PB-281	0.1	1
-2	PB-533	0.1	1
4-1	PB-247	1.7	2
-2	PB-222	0.5	2
5-1	PB-567	3.8	3
-2	PB-236	12.7	3

Table 20. Species list and cell densities of filamentous algae populations collected from glass slides incubated in Block 3.

Species	Fertilization Levels and Replicate Nos.									
	1-1	1-2	2-1	2-2	3-1	3-2	4-1	4-2	5-1	5-2
Filamentous Blue-Green Algae*										
Oscillatoria c.f. *lutea* Ag.	0.1	0.1	10.5	13.3		--	1.6	0.4	3.6	12.4
Microcoleus sp.	0.1	--	0.1	0.1	--	--	--	0.1	0.1	0.2
Schizothrix calcicola (Ag.) Gom.	0.2	0.1	0.2	--	0.1	--	0.1	--	0.1	0.1
Total (cells/mm^2	0.4	0.2	10.8	13.4	0.1	0.1	1.7	0.5	3.8	12.7

*No filamentous chlorophyceae (green algae) were observed.

Table 21. Chlorophyll and biomass results from Blocks 3, 4 and 5.

Fertilization Level - Replicate No. Plot	Block 3 Chlorophyll a (mg/m^2)	Block 3 Biomass (gm/m^2)	Block 4 Chlorophyll a (mg/m^2)	Block 4 Biomass (gm/m^2)	Block 5 Chlorophyll a (mg/m^2)	Block 5 Biomass (gm/m^2)
1-1	9.1	0.17	2.8	0.83	2.8	0.23
2	7.7	0.44	22.4	<0.01	1.5	0.09
3	6.7	0.55	5.8	0.44	4.1	0.48
4	2.9	0.39	15.5	0.15	10.3	0.71
5	1.5	0.69	2.9	<0.01	7.7	<0.01
2-1	13.8	<0.01	8.5	<0.01	21.1	0.55
2	33.3	0.99	8.1	1.43	8.6	0.40
3	24.8	1.35	6.4	0.67	32.7	0.73
4	14.3	0.69	5.9	0.99	9.2	0.35
5	10.0	0.64	8.6	2.19	7.9	1.01
3-1	11.5	0.41	20.6	0.15	7.8	0.23
2	8.1	0.15	3.7	0.21	4.5	0.72
3	11.9	0.01	8.2	0.68	7.0	0.11
4	2.6	0.41	12.6	0.03	10.4	0.39
5	3.8	0.21	27.8	0.24	7.8	0.33
4-1	12.8	0.19	5.0	0.36	1.4	0.28
2	2.2	0.41	6.5	0.28	0.8	<0.01
3	8.1	0.21	31.6	0.25	4.9	0.57
4	4.9	0.31		0.04	2.6	0.47
5	12.8	0.29		0.93	13.6	0.32
5-1	31.1	0.59	10.8	<0.01	15.3	0.33
2	9.6	0.53	20.1	0.51	16.3	0.24
3	23.3	0.75	9.4	0.53	22.0	1.20
4	20.4	1.29	14.0	0.24	19.9	0.67
5	26.1	0.55	16.4	0.55	21.4	0.28

Table 22. Species list, cell densities and species diversity indices of diatom populations collected from glass slides incubated in Block No. 3.

Species	Fertilization Level and Replicate Nos.														
	1-1	1-2	1-3	2-1	2-2	2-3	3-1	3-2	3-3	4-1	4-2	4-3	5-1	5-2	5-3
Achnanthes brevipes	0.5	0.9	0.4	0.3	1.0	-	2.1	0.8	1.3	0.5	1.0	0.5	0.3	0.8	0.1
Achnanthes hauckiana	3.4	3.4	1.9	-	0.5	6.5	-	0.3	1.3	0.8	1.8	1.3	-	0.3	0.1
Amphora angusta v. *ventricosa*	0.1	-	-	-	-	0.3	-	-	-	-	-	-	-	0.1	-
Amphora coffeiformis	7.6	10.0	13.1	6.2	18.7	40.1									
Cyclotella cf. *ocellata*	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-
Melosira sp.	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-
Navicula cf. *cari**	0.6	1.4	1.0	0.6	0.8	0.3	0.4	0.3	0.6	1.3	3.8	0.3	3.0	0.3	0.6
Navicula cryptocephala v. *intermedia*	1.9	1.9	1.8	1.1	0.8	3.8	0.9	0.6	1.5	1.8	0.5	1.0	3.5	0.3	0.9
Navicula cf. *heufleri**	3.0	4.3	3.3	2.6	1.9	6.8	1.4	0.5	3.0	2.5	3.8	3.3	4.5	0.9	1.9
Navicula pygmaea	0.3	0.6	1.6	-	-	-	0.1	-	0.6	0.5	0.3	0.3	0.1	-	-
Navicula sp. 3	-	-	-	-	-	-	-	0.1	-	-	-	-	0.1	-	-
Nitzschia closterium	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-
Nitzschia microcephala	4.5	3.7	4.4	11.7	7.3	13.4	1.4	0.6	4.5	2.5	4.8	2.0	4.9	1.8	0.9
Nitzschia pseudohybrida	0.1	4.8	0.1		0.1	0.8	-	-	0.3	0.3	-	0.3		0.4	0.6
Nitzschia proxima	3.7	-	4.0	1.9	1.9	6.1	2.4	0.1	2.5	2.8	2.8	2.5	4.0	1.0	1.9
Nitzschia sp. 1	2.6	3.5	8.6	5.0	3.7	9.1	1.1	0.4	1.3	1.0	1.3	0.5	7.1	1.0	0.1
Nitzschia sp. 2	0.1	-	-	0.1	-	-	-	-	-	0.3	0.5	-	0.3	-	-
Total No. cells/mm^2**	28.4	34.5	40.2	29.5	36.7	87.2	17.4	5.8	30.9	25.7	31.7	26.9	44.6	10.6	11.8
Total No. Species	13	10	11	9	10	10	9	10	11	13	11	12	12	11	10
Species Diversity Index***	2.06	2.05	1.94	1.65	1.54	1.68	1.74	1.95	1.81	1.94	1.95	1.62	1.84	1.99	1.77

*Tentative identification.
**Total area examined per slide = 7.92 mm^2.
***Shannon-Weaver Index (1949) to the base e.

VITA

William Henry Wilcox was born in Memphis, Tennessee on February 4, 1945. He attended elementary school in that city and was graduated from Christian Brothers High School in 1963. The following year he entered Memphis State University, and in 1968 he received a Bachelor of Science degree in biology and in 1970 a Master of Science degree in biology.

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