

1992 DYKE MARSH HERBACEOUS PLANT STUDY by

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conjunction with
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I. Introduction.

In 1991 Dr. Zhaoran Xu, through George Mason University, published *Final Report on Inventories of Plant Species and Communities in Dyke Marsh, Alexandria, Virginia*. That study established eight east to west transects across the marsh with sampling points on marshland at (normally) twenty meter intervals. During the Fall of 1991 both wooded and herbaceous (open marsh) sites were sampled, determining sp. present, individual sp. count, coverage, height, and circumference, as well as noting surrounding flora. This study augments and complements the herbaceous part of that work. Contrary to the Fall 1991 transect sampling, this sampling took place in the early summer. It covered 53 open marsh points on transects 2,3,4 and the permanent transect. The small portions of transects 1, 5, 6, and 7 that are not wooded were not sampled in 1992. This study further includes a search for Spring sp. not found earlier, conducting a separate elevation survey of plants at their lower marsh elevations, and comparing 1992 data to the elevations which were taken for 33 of the 53 sampling quadrats.

II. Methods.

Spring Species Survey. The Spring sp. survey involved checking infrequently travelled areas of Dyke marsh for specific Spring-flowering sp. It was successful in adding dozens of sp. to the Dyke marsh inventory and will be published under separate cover.

Transect Quadrat Survey. Methods followed those of the Fall 1991 herbaceous survey. Considerable effort was expended to find the small wooden stakes marking the 1991 sampling points, and a one meter square quadrat (starting one meter away from each stake and extending one meter into the NW quadrat) was marked with pieces of wood. The same forms were used that were used in 1991 to record the transect and point number, who did the inventory, individual and "other" sp., height, % cover, and circumference at 8 cm. above the marsh surface. The height measurement was the average upper height for each sp. within or hanging over the quadrat; % cover was visually estimated as that % of the quadrat that was covered by each sp. (so could be and usually was greater than 100% for the combined sp.); and the circumference of each specimen rooted within the quadrat was physically measured and recorded with a cm. tape. Normally the inventory was conducted by two persons, occasionally three, with the codicil in place that for accuracy,

each inventory team always consisted of at least one of the three individuals with extensive previous Dyke marsh experience (S. Getlein, E. Haug, D. Lindholm). Inventory teams worked immediately adjacent to each other to answer questions - and to assist in finding points. The inventory began on June 15, 1992 with transect 2 and continued south through transect 3, the permanent transect, and transect 4 respectively, finishing on July 17, 1992.

Elevation Study. On July 31 and August 1, 1992 this study was able to assist and gain data from the hydrology study being conducted by Dr. J. Harper (also of George Mason University). For approximately five hours on each of these days during high tide, elevation measurements of individual plant sp. were taken and recorded in the vicinity of Hog Island Gut (crossed by transect 3, 4 and the permanent transect). Hand measurements of the deeper plant specimens of each sp. were taken, measuring the distance from the marsh floor to the water level (quite a bit above the marsh floor). This distance was immediately radioed to an individual at a benchmark of known elevation, water levels were compared, and the specimen elevation was calculated and recorded. The low points of ten microhabitats (low points in the marsh, high points on islands, guts, unusual areas) were checked, resulting in a survey of the elevations of 151 specimens of 21 sp.

Further elevation study was conducted of some of the points on transect 3 and on the permanent transect. As a result, the 21 points on transect 3 and the 12 permanent transect points for which elevation measurements were taken were compared with density and cover measurements (for these same points).

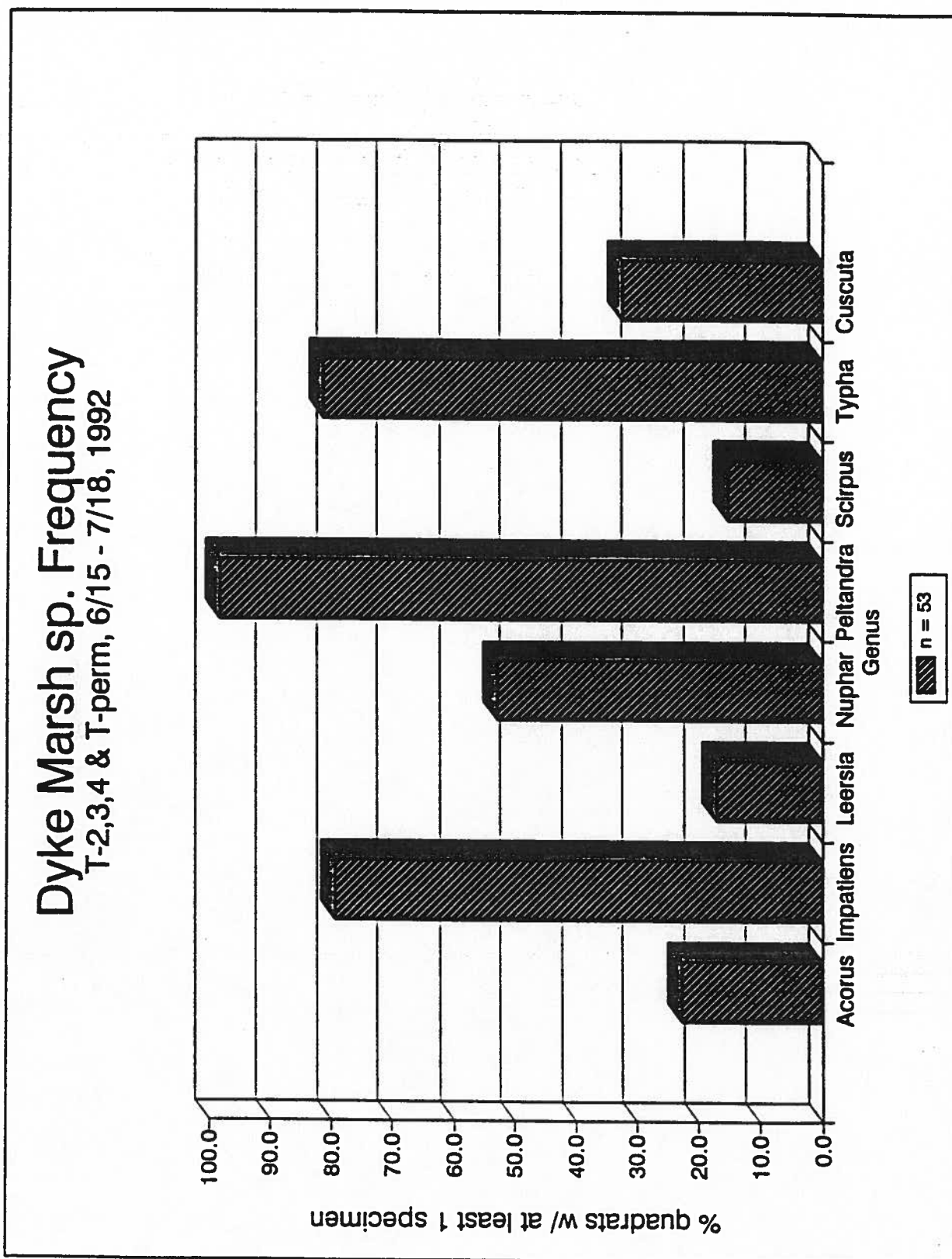
III. Results and Discussion.

Species Diversity. Considering that over the last two years this survey has identified approximately 400 species of plants at Dyke Marsh, it is surprising to find that greater than 98% of the open marsh consists of the eight sp. shown in figure 1. Thus sp. richness is generally low in the open marsh, especially in comparison to Dyke marsh as a whole. Species evenness is better, as is reflected by the high frequencies in figure 1. The open marsh points (n=53) sampled result in a Shannon-Wiener diversity index (Shannon and Weaver 1949) of:

$$H' = - \sum_{i=1}^s (p_i) (\ln p_i) = \underline{1.668}$$

where s is the number of sp. in the sample, and p_i is the proportion of all individuals in the sample that belong to sp. i . H' is thought to represent the "uncertainty" or "information" of a

FIGURE 1



community, varying from 0, in communities of one species only, to as much as 7 or more in rich forests between climes in such areas as the Siskiyou Mountains of Oregon and Northern California (DeJong 1975). It is not really useful to compare the 1.668 value from this study to the mountains of Oregon; this value should be used against nearby tidal freshwater marshes or Dyke marsh in the future at the same time of year.

As an indicator of dominance because it weighs the most abundant species more heavily, Simpson's diversity index (Simpson 1949) for these 53 sampled quadrats is:

$$C = \frac{S}{\sum_{i=1}^S (p_i)^2} = \underline{0.251}$$

where C is the index number. Although the Shannon-Wiener index reflects diversity in the more traditional sense of the word (more evenness), the Simpson's index value should not vary as much from sample to sample because the rare sp. vary more from place to place than the common ones. Simpson's diversity index is thus probably more accurate within a single type of ecosystem (with less rare sp. represented) like this riverine emergent freshwater tidal marsh.

It is difficult to attribute a diversity / dominance number to some ecological values within a community. Diversity generally increases as one goes from the poles toward the equator and from higher elevations to lower, but diversity indices are usually treated as one of the descriptive attributes of a community. Given the limited nature of this study, that is certainly the case with the Shannon-Wiener index of 1.668 and the Simpson's index of 0.251. They should be considered as only one part of the Dyke Marsh of June / July 1992. Because high diversity apparently requires periodic random disturbance (Barbour et al. 1987), these values can be compared to future values as indicators of the open marsh ecosystem change. Whether this change is progression or regression is a determination that will have to be made in the future based on man-made definitions of the two terms in relation to the marsh.

Species Density / Cover / Frequency. Figures 2, 4, and 5 show sp. density for Dyke marsh. Figs. 4 and 5 show sp. density for each of the transects surveyed, and fig. 2 reflects not actual total density, but percentage density - the portion of 100% that the sum of the four transects for each sp. represents. This survey found that for the period June 15 - July 17 1992 seven sp. made up 98% of the 53 open marsh quadrats surveyed (fig. 2). There are only seven sp. shown (vs. eight in fig. 1) because *Cuscuta gronovii* (Common Dodder), is a parasitic vine that will not show up on a density survey. At 41.2% of the marsh, *Impatiens capensis* (Spotted Touch-me-not) exists at almost double the density of the nearest competitor, *Peltandra virginica* (Arrow Arum). Fig. 3 illustrates that part of the reason this is possible is that *I. capensis* is at

FIGURE 2

Dyke Marsh Open Marsh Density

T-2,3,4 & perm., 6/15 - 7/18, 1992.

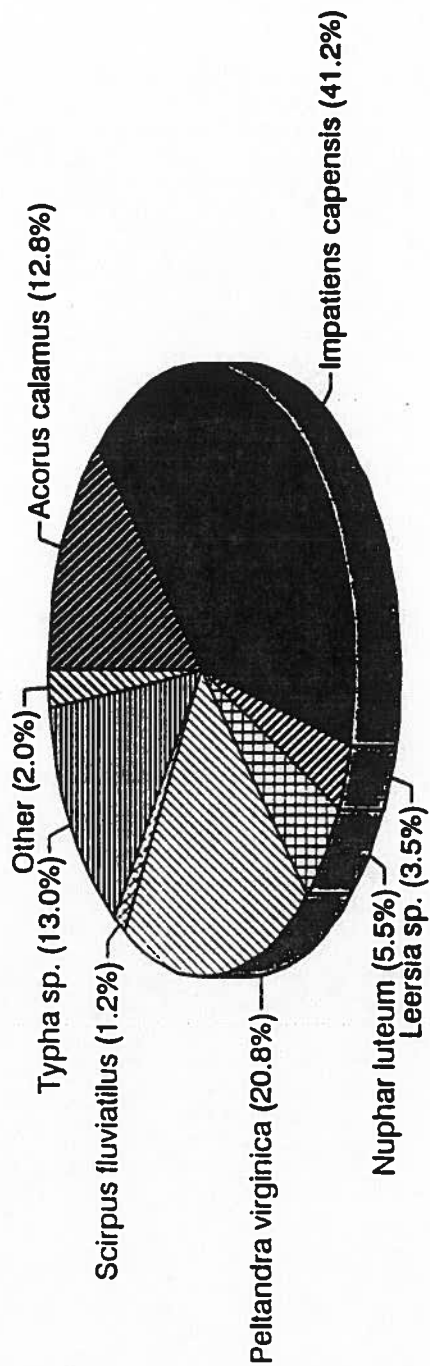


FIGURE 3

Dyke Marsh average cover / sp.
T-2,3,4 & T-perm., 6/15 - 7/18, 1992

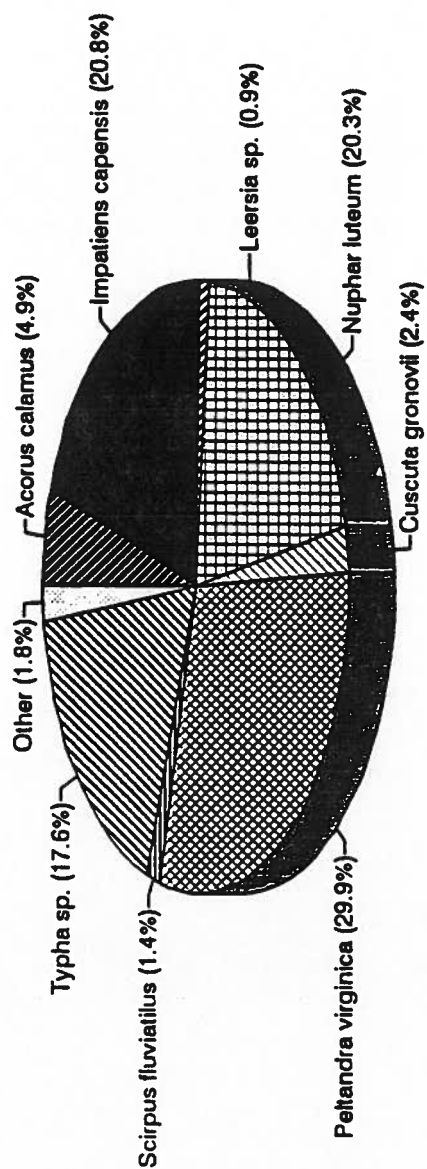


FIGURE 4

Dyke Marsh sp. Density (#1) June 15 - July 18, 1992

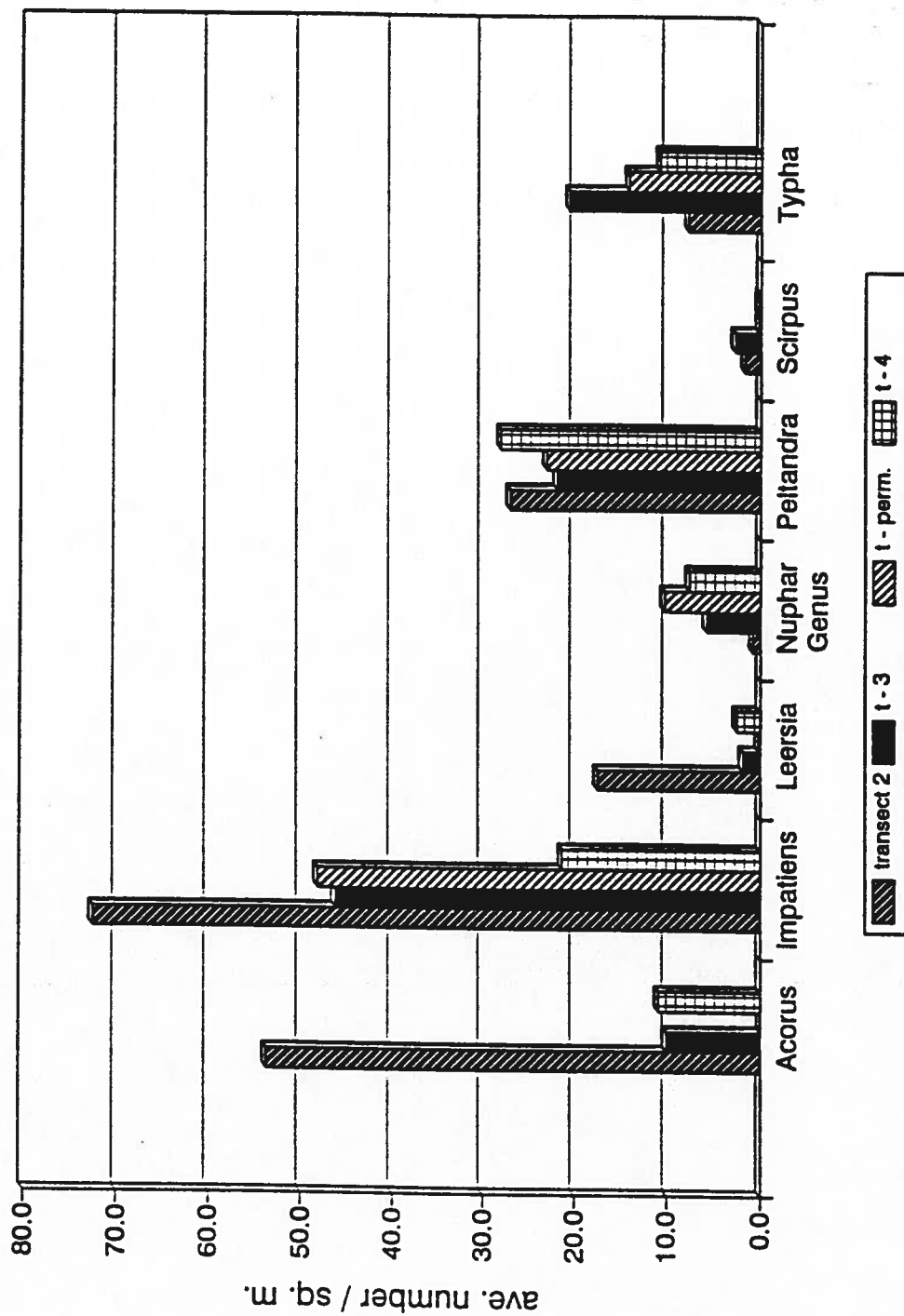
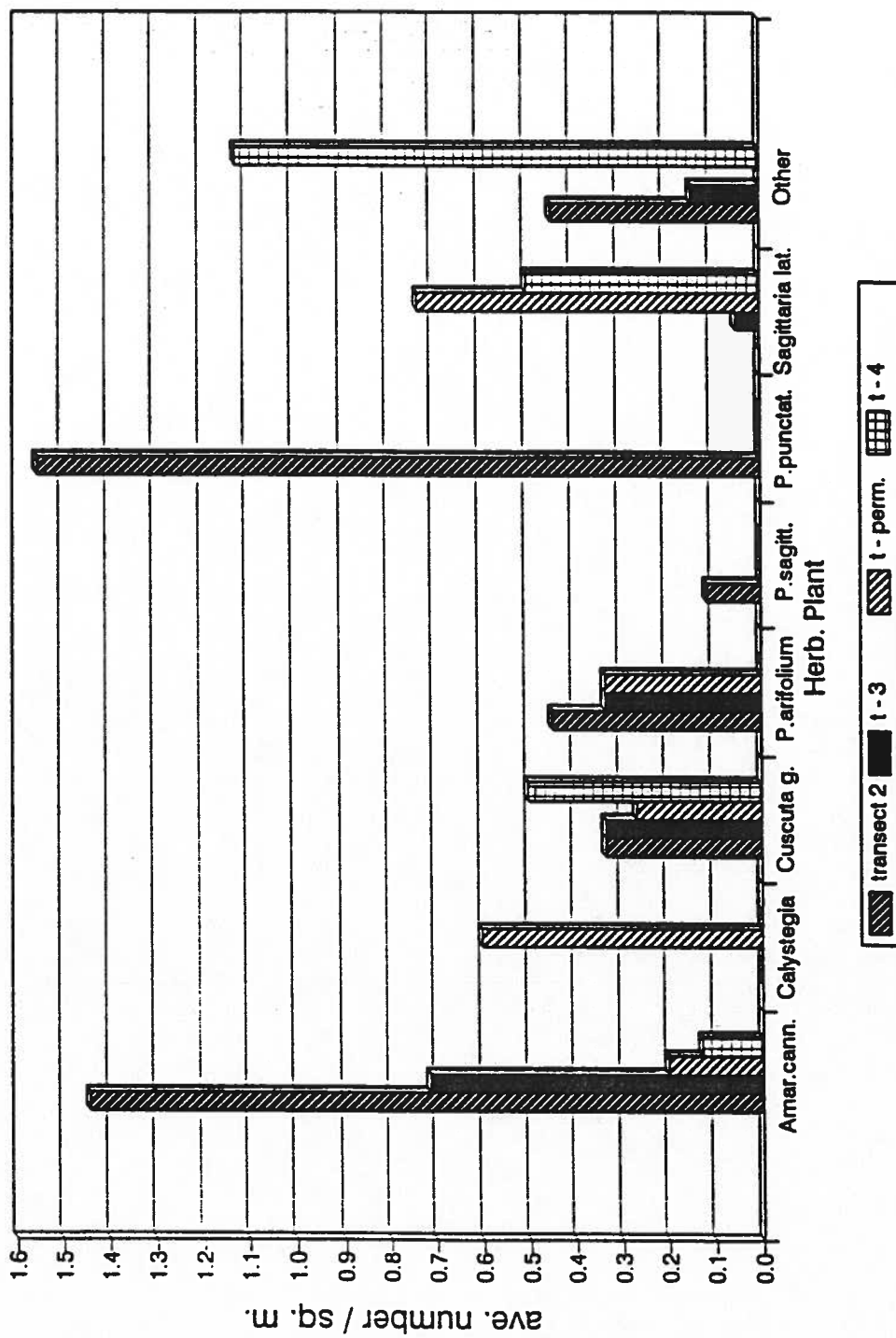


FIGURE 5

Dyke Marsh sp. Density (#2) June 15 - July 18, 1992



a growing stage in which there are an enormous amount of small-stemmed plants (402 *I. capensis* individuals in quadrat 132C of the permanent transect and 394 individual plants in quadrat 22 of transect 2) competing for limited resources not only with their own sp., but with others as well. The result is that many *I. capensis* plants annually die very soon after this survey was taken, and others still will not make it to the Fall as they are replaced by later sp. Because the survey was conducted in the transect order shown at the bottom of fig. 4, it is possible that the considerably fewer *I. capensis* plants found on T-4 than the other three transects, and the fewer on T-3 and T-perm than on T-2) could partially reflect their later sampling.

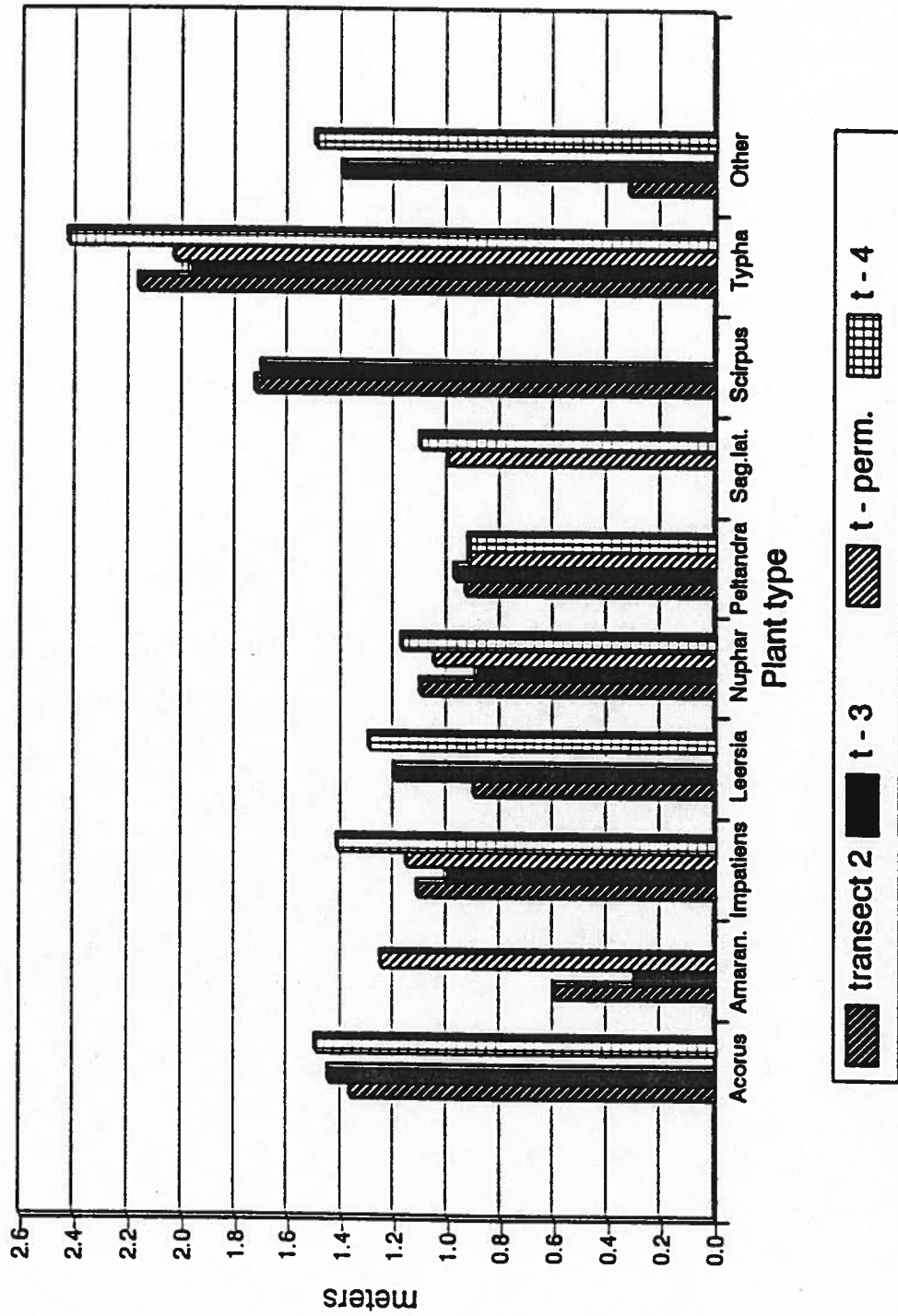
In fig. 2, *Peltandra virginica*, *Typha* sp., and *Acorus calamus* make up 20.8%, 13.0%, and 12.8% of the remainder of the open marsh density, respectively. The distichous, linear leaves of *Typha* (cattail) and *Acorus calamus* (Sweetflag) are not reflected in measuring density, but show up in fig. 3, cover. The area of marsh covered by the nonlinear (hastate) *P. virginica* leaves is almost twice that of *Typha* sp. and six times that of *A. calamus* (fig. 3). Despite leaf similarities, *Typha* sp. covers more marsh than *A. calamus* simply because it occupies much more of the area than *A. calamus* (fig. 1), and also because of its greater height (fig. 6).

As the second most densely populated species in the open marsh at this time of year, *P. virginica* is also more evenly distributed than any other sp. (figs. 4,5). This could be critically important for marsh stability given the extensive - and two meter deep - root network of *Peltandra*. This sp. has been found to have a root to shoot ratio of 8.42 ± 5.05 (mean $\pm$ S.D., $n=13$) vs. most wetland perennials with a mean in the vicinity of 1.00, and annuals < 1.00 (Whigham and Simpson 1978). Given that most plants do not extend their roots below the root zone, and the extensive seasonal flooding of the tidal Potomac, the regular distribution of *P. virginica* should remain near the top of the list for future monitoring. Finally, *P. virginica* is an early season sp., almost disappearing in the Fall, so its significance is much better represented by this (early summer) survey.

The final three sp. making up the seven most densely populated sp. are *Nuphar luteum*, *Leersia* sp. (either *L. oryzoides* or *L. virginica*), and *Scirpus fluviatilis*. *Nuphar luteum* (Spatterdock, Yellow pond-lily) is by far the most far-ranging of the three (fig 1), being found at almost all of the elevations surveyed, but becoming monospecific at lower elevations. This is reflected in fig. 4 because much of the permanent transect is at a slightly lower elevation than the others. Further, when the transect points were set up in 1990 there were a few points along transects that ended up in sloughs - and hence were skipped. Because of their lower elevations, *N. luteum* was represented if any plants were. So despite forming only 5.5% of the plants found in the open marsh (fig 2), *N. luteum* is more significant than both this figure

FIGURE 6

Dyke Marsh sp. Heights (ave.) June 15 - July 18, 1992



represents, and than the final two sp. This is better reflected in fig. 3 where *N. luteum* is well ahead in the percentage cover it forms of all but *P. virginica* and *Impatiens capensis*.

Leersia (Rice Cutgrass) was still early in its season and often obscure to the point that it was not noticed until the actual counting / stem-measuring began (note fig. 3). *Scirpus fluviatilis* (River Bullrush) had the least numbers per square meter of the seven sp. represented in fig. 2, at 1.2% of the total. It was included because it is rare, found in only five or so other locations within the state of Virginia (personal conversation with Al Belden, Virginia Heritage Division). Notice from fig. 4 that it was found only along the two Northern transects, yet it was found in fully 15% of the total quadrats sampled (fig. 1).

S. fluviatilis has also been found in the open areas around transect 7 (unsampled) in May 1992 (personal experience), so appears to exist in most or all of the large open marsh areas. Finally, the "other" sp. which make up the final 2.0% of the open marsh density percentage are represented in fig. 5. Despite the single transect location for *Polygonum punctatum* (Knotweed), it is another lower elevation sp. that is probably more common than it appears due to its colonizing deeper areas along channel borders.

Figures 3, 7, and 8 are plant cover figures. As noted, fig. 3 is a summation which divides the actual total cover values into percentages; figs. 7 and 8 illustrate the actual cover values for each of the transects. Fig. 7 again supports the evenness of the Dyke marsh open marsh. The top several sp. providing cover for each of the transects, and the average cover per sp. (fig. 7) is:

Table 1. Top Three Species per Transect, Average Percent Quadrat Cover.

T-2:	<i>Peltandra virginica</i> , 43.9%, <i>Impatiens capensis</i> , 32.1%, <i>Acorus calamus</i> , 27.8%.
T-3:	<i>P. virginica</i> , 40.1%, <i>Typha</i> sp., 38.3%, <i>I. capensis</i> , 25.1%.
T-perm.:	<i>Nuphar luteum</i> , 49.9%, <i>P. virginica</i> , 37.3%, <i>I.</i> <i>capensis</i> , 28.0%.
T-4:	<i>N. luteum</i> , 36.8%, <i>P. virginica</i> , 36.2%, <i>I. capensis</i> , 27.5%.

It appears that *I. capensis* and *P. virginica* are among the dominant sp. at this time of year throughout the open marsh, with *A. calamus*, *Typha* sp., and *N. luteum* sharing cover (and hence dominance) as one moves from North to South in the open marsh.

Although *N. luteum* makes up only 5.5% of total marsh density, it leads two of the four transects in the average percent quadrat

FIGURE 7

Dyke Marsh average cover / sp. June 15 - July 18, 1992

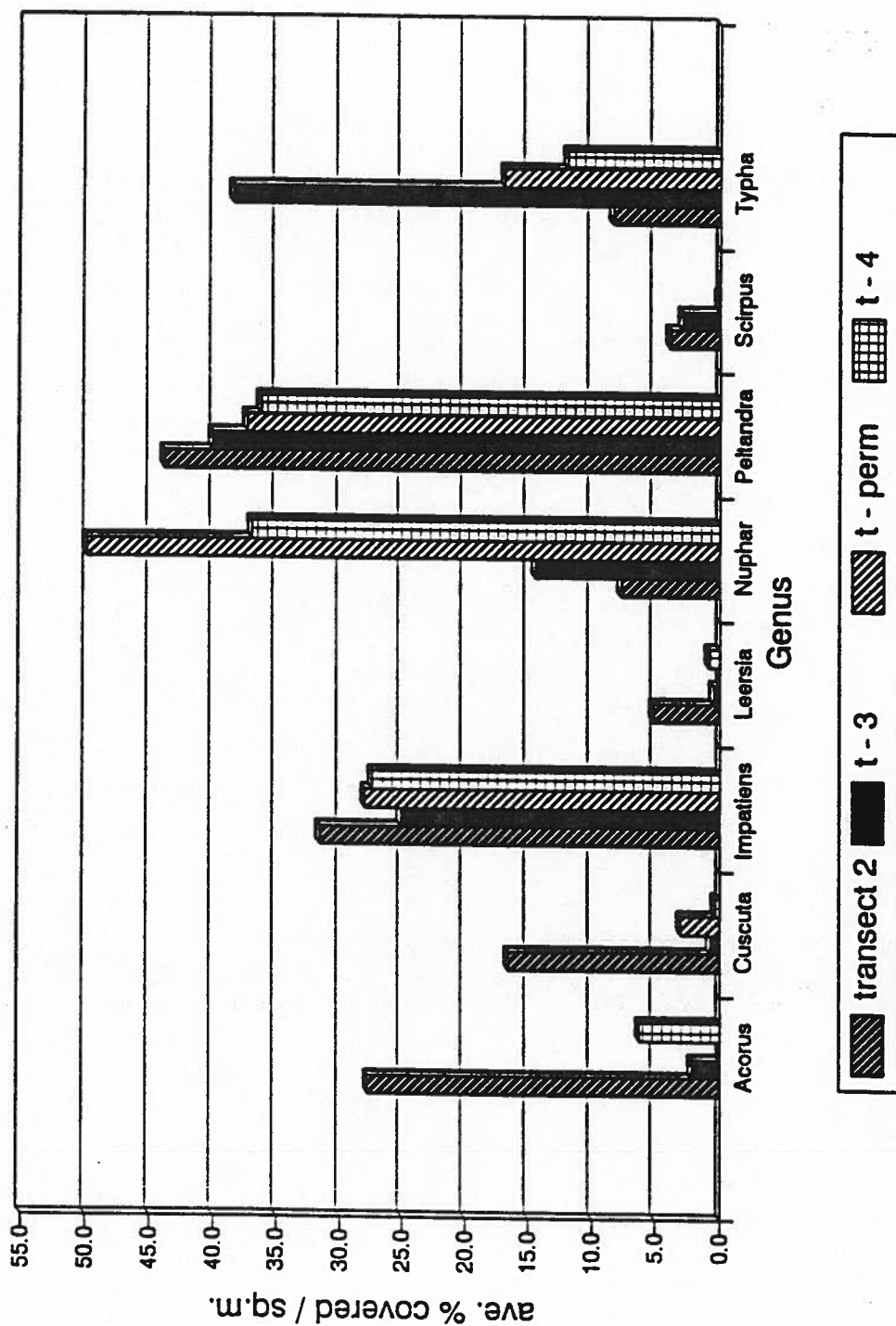


FIGURE 8

Dyke Marsh average cover / sp. June 15 - July 18, 1992

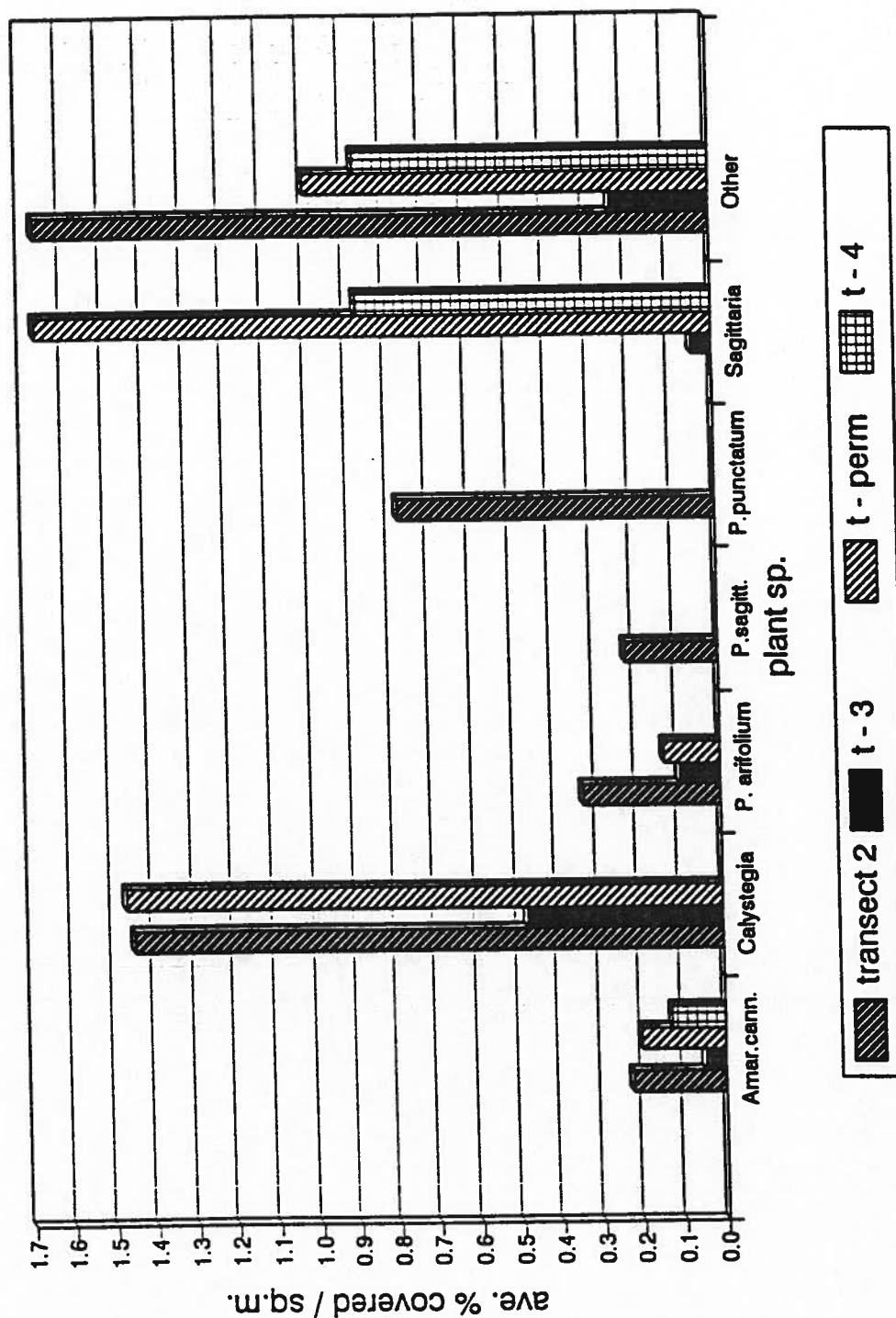
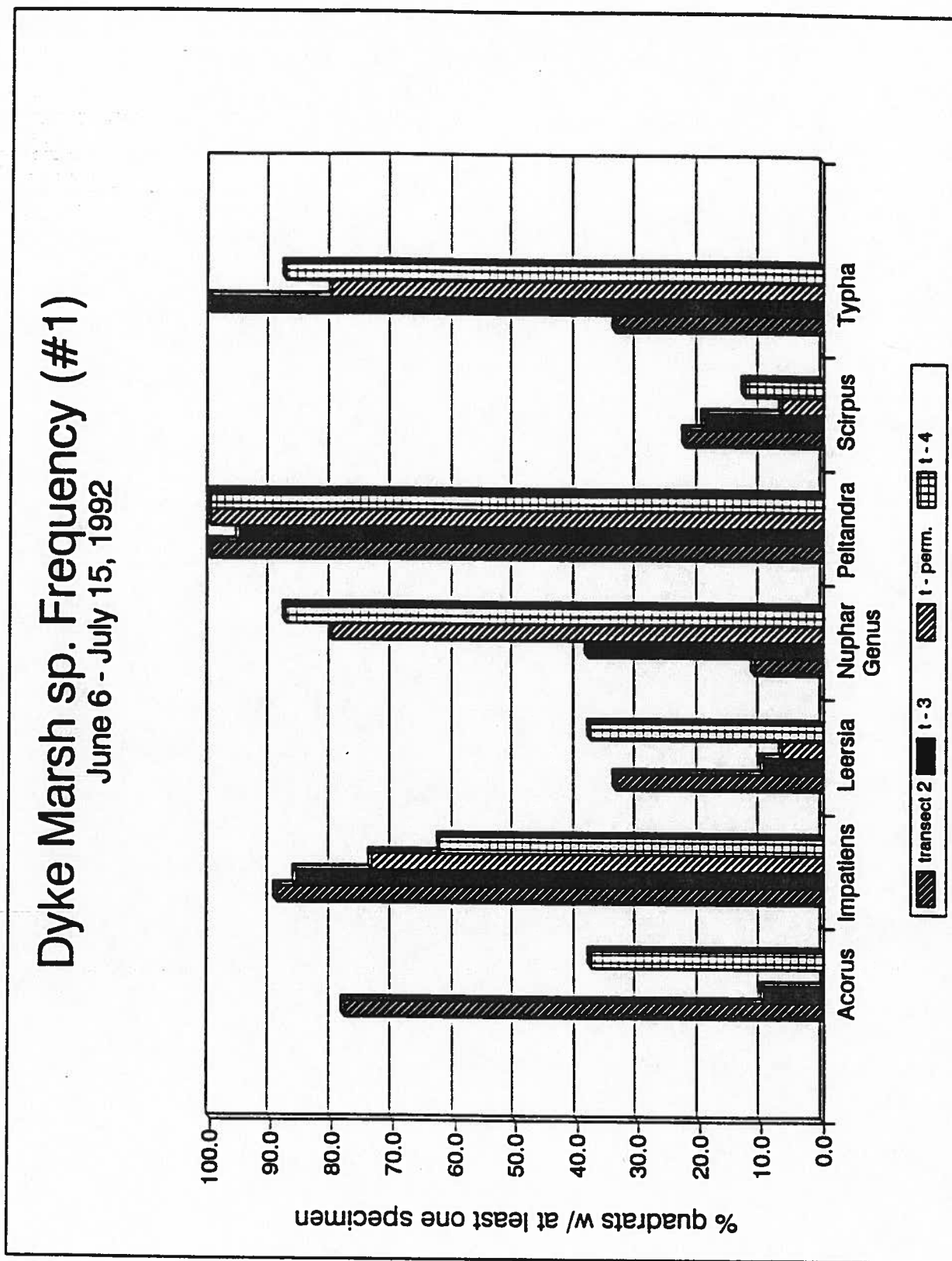


FIGURE 9



covered. This anomaly can be explained by a high frequency within those two transects (fig. 9), its large leaf area per specimen, and the season. Although the *N. luteum* found at lower elevations in the channels does well throughout the growing season, the plants at most of the transect points are probably near their peak early in the growing season because the late-season sp. outcompete them (note *N. luteum* height in fig. 6 - this does not increase much). In contrast to the large *N. luteum* leaf area, that *A. calamus* and *Typha* sp. even make the table 1 list is amazing considering the already-discussed small surface area of their leaves. Frequency per transect (Fig. 9) clarifies how this happens. *A. calamus*, *Typha* sp. and *N. luteum* are present in at least 75% of the quadrats on the transect in which they are one of the top three cover sp. (fig. 9). These three sp. (*Acorus*, *Typha*, *Nuphar*) are reasonably reflected in the total cover also (fig. 3), with the exception of *A. calamus* due to its single-transect representation. Finally, note that *Cuscuta gronovii*, represented on fig. 1 but not fig. 2, was found consistently in all of the transects (fig. 10) but at this time of the year appeared significant only in transect 2 (fig. 7).

Elevation.

Table 2 lists the sp. encountered, number sampled, and elevation during the July 31 - Aug. 1 elevation measurements at Hog Island Gut in the vicinity of T-3, T-perm, and T-4. The deeper (lower in elevation) sp. and the elevations at which they were found are illustrated in fig. 11. This elevation survey concentrated on finding specimens at the lower limits of their range, so the arrows denote those sp. for which it is known unequivocally that their ranges extend upward (to greater elevations as well). Of particular interest in fig. 11 are *Nuphar luteum*, *Peltandra virginica*, and *Typha* sp. from the previous discussion. The incredibly low range of *Fraxinus* sp. (Ash tree) does not concern this study because it is not an open marsh sp., but warrants further research because of the importance of these trees as frontline erosion defenders at Dyke marsh. *Zizania aquatica* (Wild Rice) was probably much more populous in the past than today (whole rice marshes used to exist just upriver), and was studied because of its values, particularly as a food source. Finally, note the *Bidens* sp. (Beggar Ticks) elevation range. *Bidens* sp. are a late season sp. and will play a much more important role in Fall surveys.

Fig. 12 is a further illustration of the living elevations of the sp. in table 2. Notice the considerably higher elevation ranges of these sp. in comparison to fig. 11 and to the mean high and low tides shown. *Acorus calamus*, *Impatiens capensis*, *Leersia* sp., and *Scirpus fluviatilis* are important in relation to this survey. As long as tidal levels are provided, these data can be compared to elevation figures from other freshwater tidal marshes, and may prove valuable in marsh restoration.

FIGURE 10

Dyke Marsh sp. Frequency (#2)

June 15 - July 18, 1992

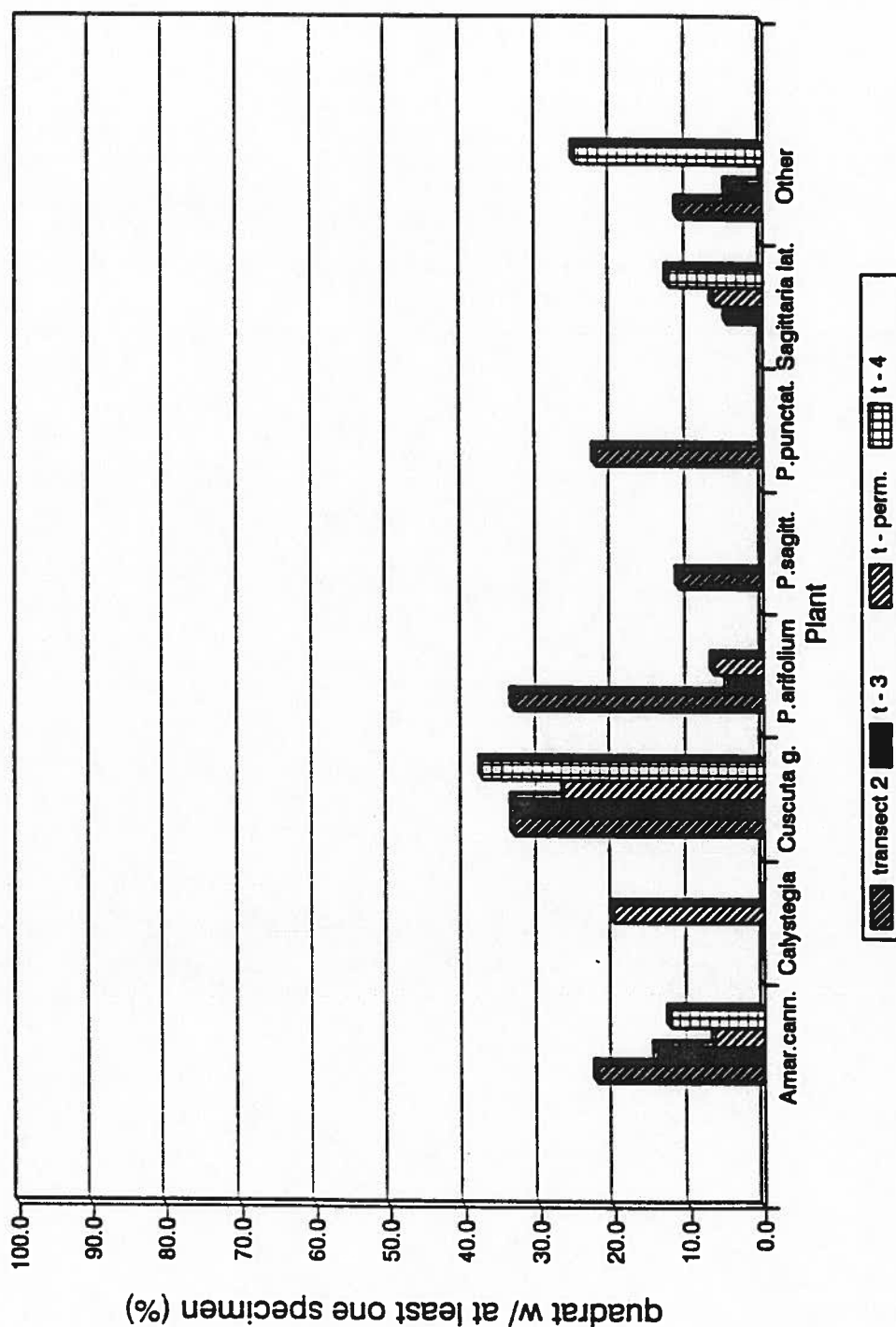


TABLE 2

DYKE MARSH SUMMER 1992 ELEVATION SURVEY

SPECIES	COMMON NAME, SAMPLE	ELEVATION RANGE, ft.
<i>Acorus calamus</i> L	Sweetflag, 217	1.6-2.6
<i>Amaranthus cannabinus</i> (L.)	Waterhemp, 23	1.7-2.5
<i>Asclepias incarnata</i> L	Swamp milkweed, 1	2.3
<i>Bidens</i> sp.	Beggar Tick, 9	1.4-2.7
<i>Calystegia sepium</i> (L.)	Hedge Bindweed, 8	2.3-2.7
<i>Cephalanthus occidentalis</i> L	Button Bush, 1	2.0
<i>Fraxinus</i> sp. (either <i>F. pennsylvanicum</i> or <i>F. tomentosa</i>)	Ash, 14	-0.2-2.4
<i>Impatiens capensis</i> Meerb.	Spotted Touch-me-not, Jewelweed, 1693	1.7-2.8
<i>Leersia</i> sp. (<i>L. oryzoides</i> or <i>L. virginica</i>)	Rice Cutgrass, 41	1.7-2.7
<i>Lobelia cardinalis</i> L	Cardinal Flower, 2	2.5-2.6
<i>Nuphar luteum</i> (L.)	Spatter-dock, Yellow Pond-lily, 231	-0.5-2.7
<i>Peltandra virginica</i> (L.) Kunth	Arrow Arum, 725	0.3-2.8
<i>Phragmites communis</i> Trinius	Common Reed, 6	1.2-2.1
<i>Polygonum arifolium</i> L	Halberd-leaved Tearthumb, 19	1.5-2.7
<i>Polygonum punctatum</i> Ell. ~~<i>segitatum</i>~~	Arrow-leaved Tearthumb, 10	1.4-2.1
<i>Pontedaria cordata</i> L	Pickereelweed, 3	1.2-1.7
<i>Sagittaria latifolia</i> Willd.	Duck-potato, 19	2.0-2.7
<i>Scirpus fluviatilis</i>	River Bulrush, 66	2.1-2.7
<i>Sparganium americanum</i> Nuttall	Bur-reed, 1	2.7
<i>Thalictrum polygamum</i> Muhl.	Meadow Rue, 3	2.1
<i>Typha</i> sp.	Cattail, 639	1.2-2.8
<i>Zizania aquatica</i>	Wild Rice, 19	0.6-3.3

FIGURE 11

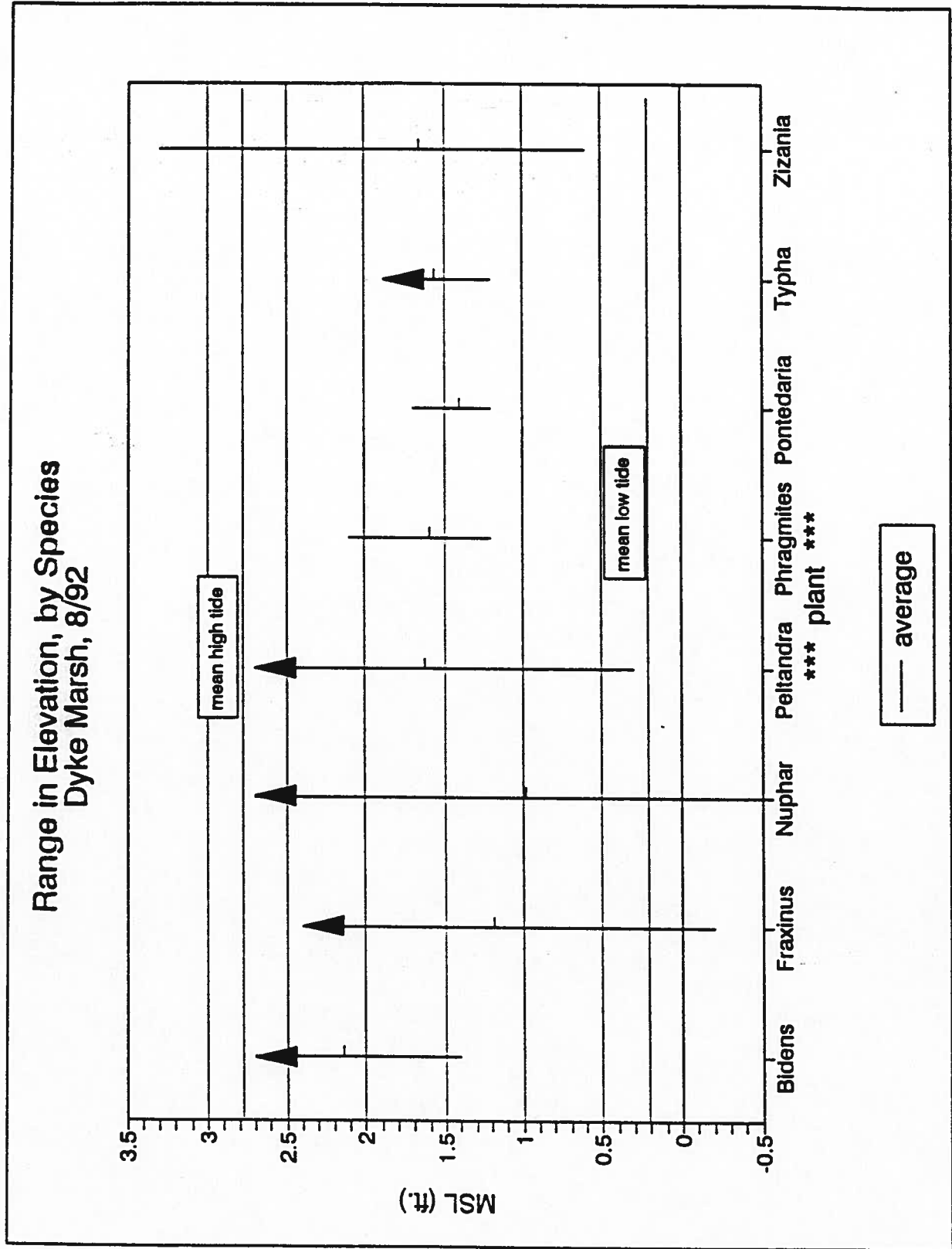


FIGURE 12

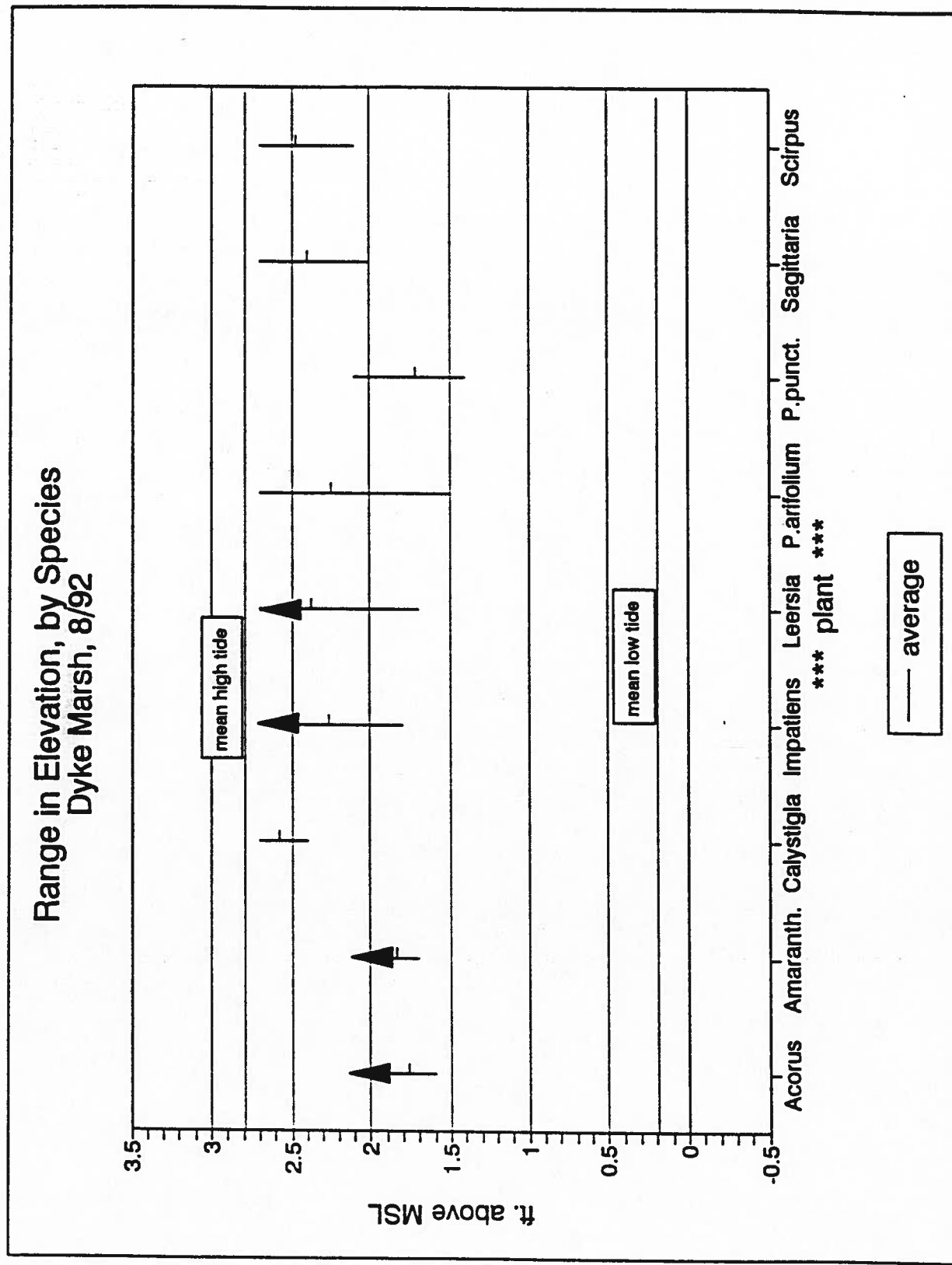


FIGURE 13

Dyke Marsh sp. Density / elevation T-3 & t-perm, 6/15 - 7/18, 1992.

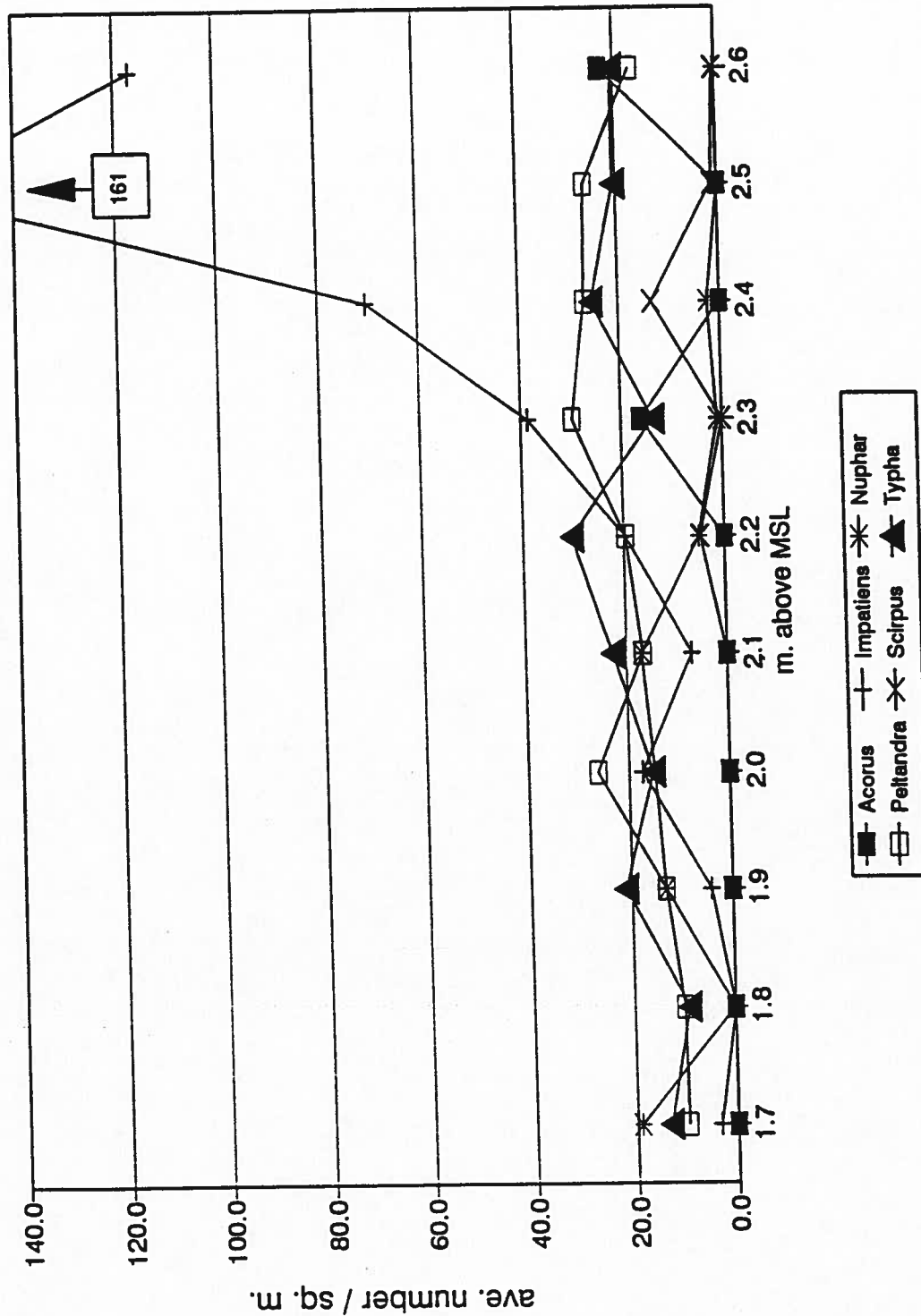


FIGURE 14

Density / elev. w/o Peltandra & Typha T-3 & t-perm, 6/15 - 7/18, 1992.

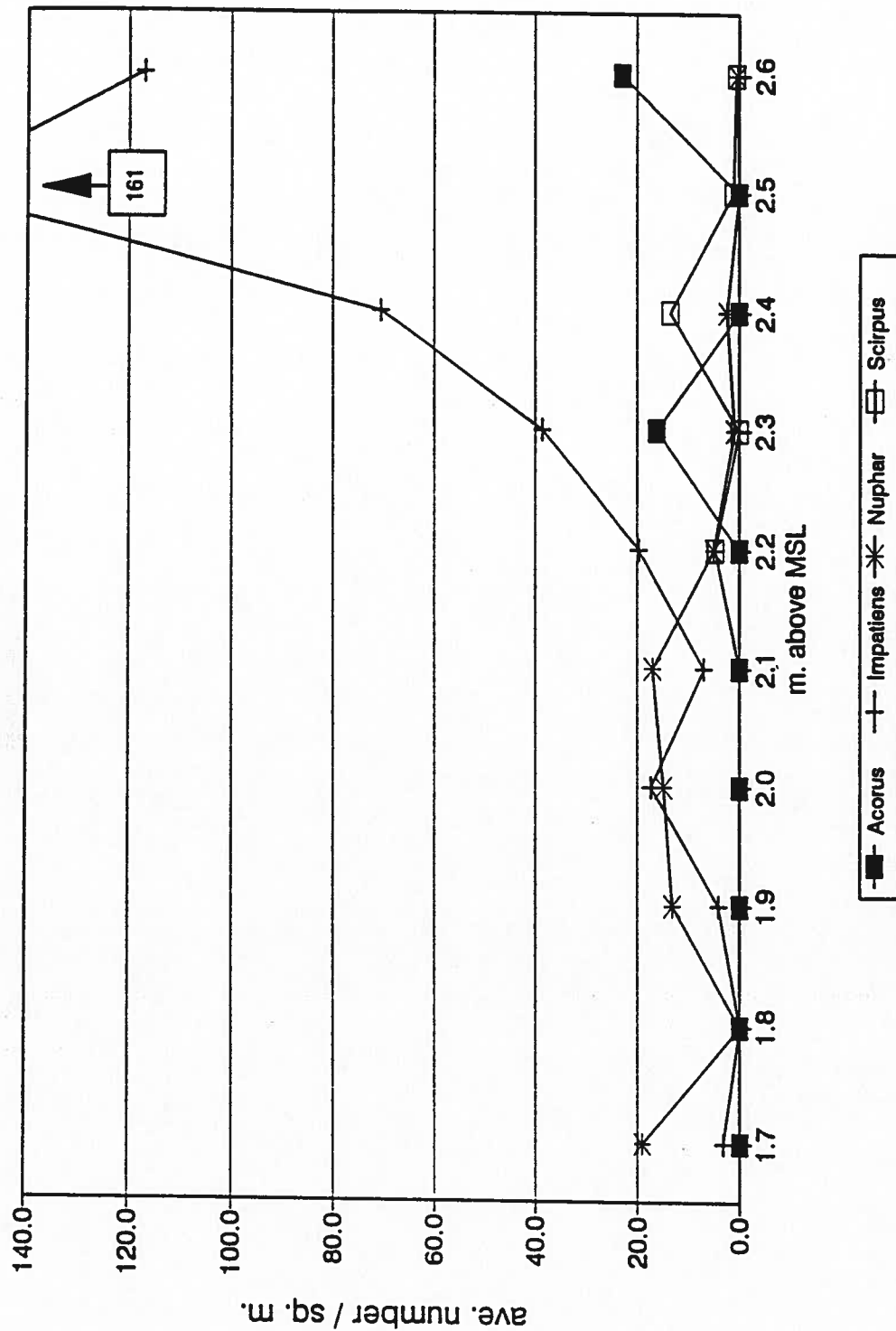
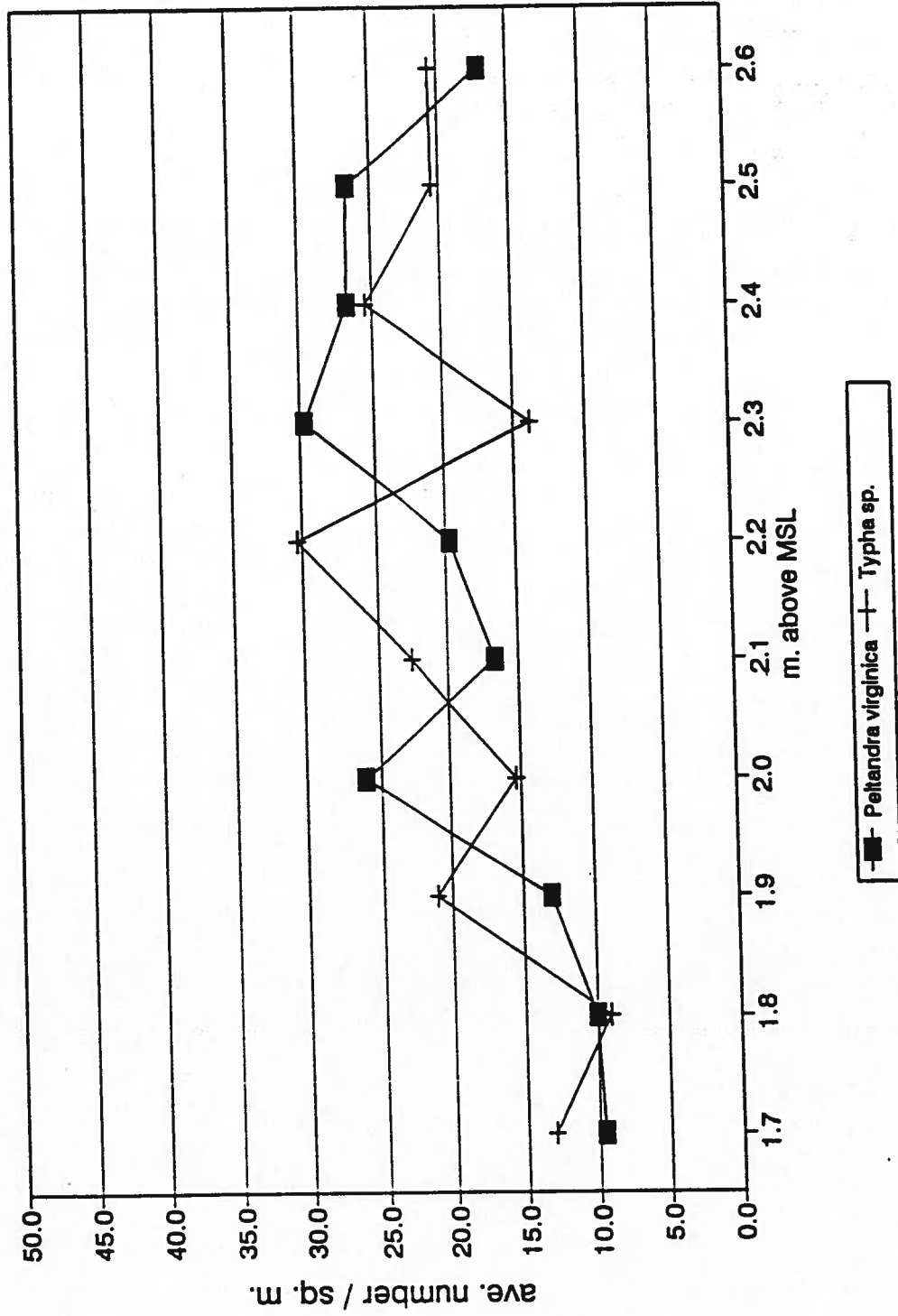


FIGURE 15

Density / elevation Peltandra vs. Typha T-3 & t-perm, 6/15 - 7/18, 1992.



In taking the 33 quadrats (transect points) for which elevation measurements were taken, it was possible to compare sp. density and cover to elevation. These graphs are limited by the restricted elevation ranges on the transects and by the limited number of points sampled. The result of such a comparison for the six sp. with the highest density in the open marsh is shown at fig. 13. Except for the spike of *Impatiens capensis* up to 161 specimens per sq. m. at 2.5 ft. above sea level, this is a confusing graph. Figs. 14 and 15 are meant to clarify this. Fig. 14 removes the two upper density sp., and shows a somewhat clearer picture of the remaining sp. Notice the higher elevation limitations of *Acorus calamus* and *Scirpus fluviatilis*, and how one rises in number per sq. m. at the elevation at which the other falls. This is possibly coincidence; similarly the depression of the other sp. at 2.5 ft. above sea level just at the enormous *Impatiens capensis* peak is also worthy of further investigation.

Figure 15 displays the remaining two sp., showing their shared dominance at the elevations sampled (even considering the *I. capensis* peak at 2.5 ft. above MSL). The evenness between the two despite a greater total density (fig. 2) for *Peltandra* is explained by their virtually equal density on T-3 (fig. 4), because elevation measurements came only from T-3 and T-perm. Note the scale differences between figs. 14 and 15.

A comparison of quadrat elevation and cover is shown in figs. 16-18. Just as with density, removing *Peltandra* and *Typha* from the graph results in the clearer fig. 17. The lack of a similar huge peak at 2.5 ft. above MSL for *I. capensis* is the result of the many small plants discussed earlier. It is again interesting to note that the *I. capensis* curve dips at 2.4 ft. above MSL just as that of *Nuphar luteum* and *Scirpus fluviatilis* rise. As expected, *N. luteum* covers much more of the lower elevations; the extreme drop in coverage at 1.8 ft. above MSL is an aberration that is the result of too few sampling points. *Typha* sp. is again a surprise over *Peltandra virginica* in fig. 18 when you consider the difference in leaf area. Again, the much greater *Typha* coverage on T-3 than on the other three transects offers one explanation (fig. 7).

IV. Conclusions.

This survey is limited in that it encompasses only one season during one year. It would be more significant if it was combined with last year's and future data where possible, particularly future elevation data. Nevertheless, it provides an accurate and complete data set of the Dyke marsh open marsh as it was in June and July 1992. This is a starting point for monitoring the marsh health and direction in future years as well as a data set that will be valuable for future marsh restorations.

FIGURE 16

Dyke Marsh sp. Cover / Elevation T-3 & T-perm., 6/15 - 7/18, 1992

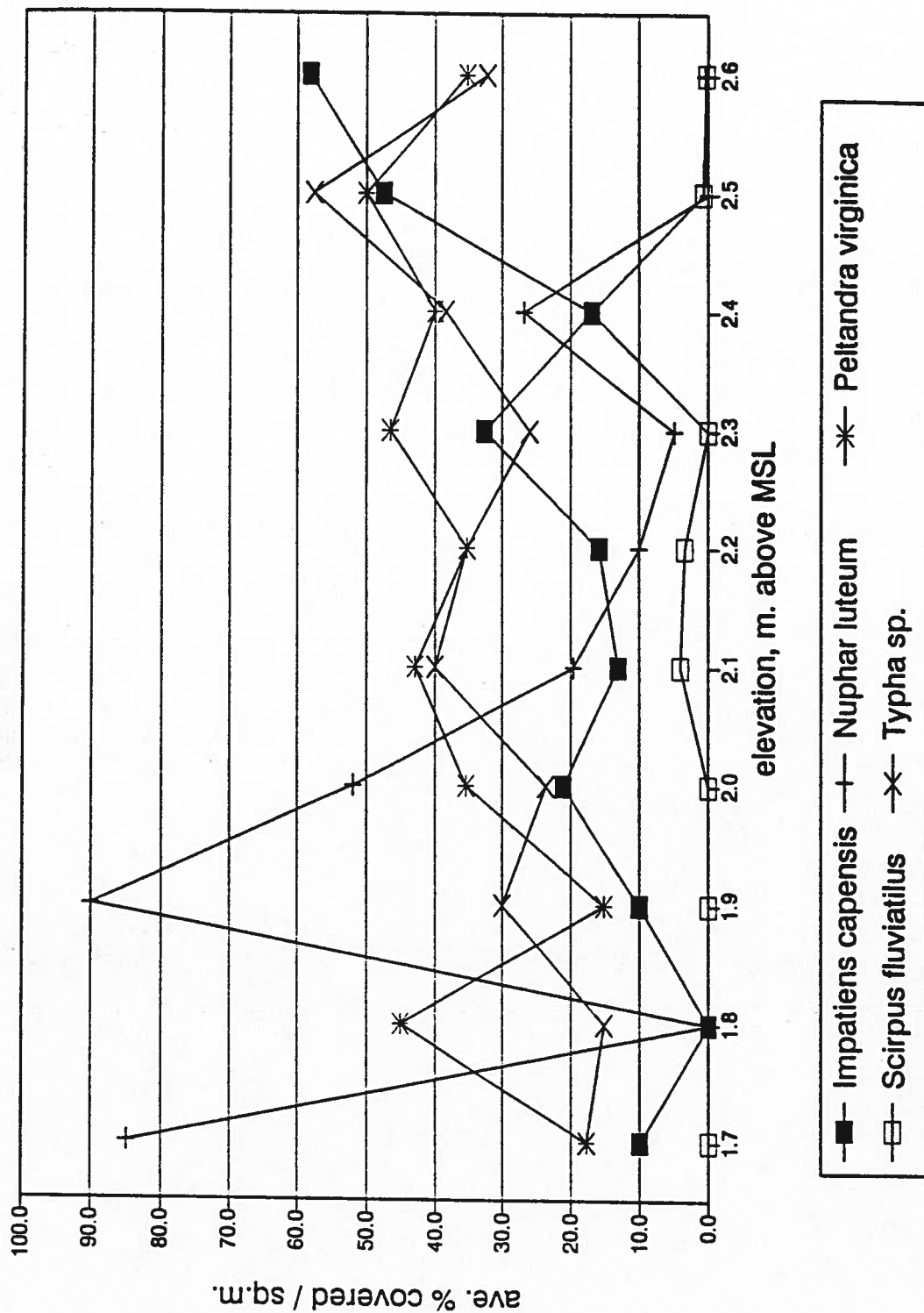


FIGURE 17

Cover / Elevation w/o Peltandra & Typha T-3 & T-perm., 6/15 - 7/18, 1992

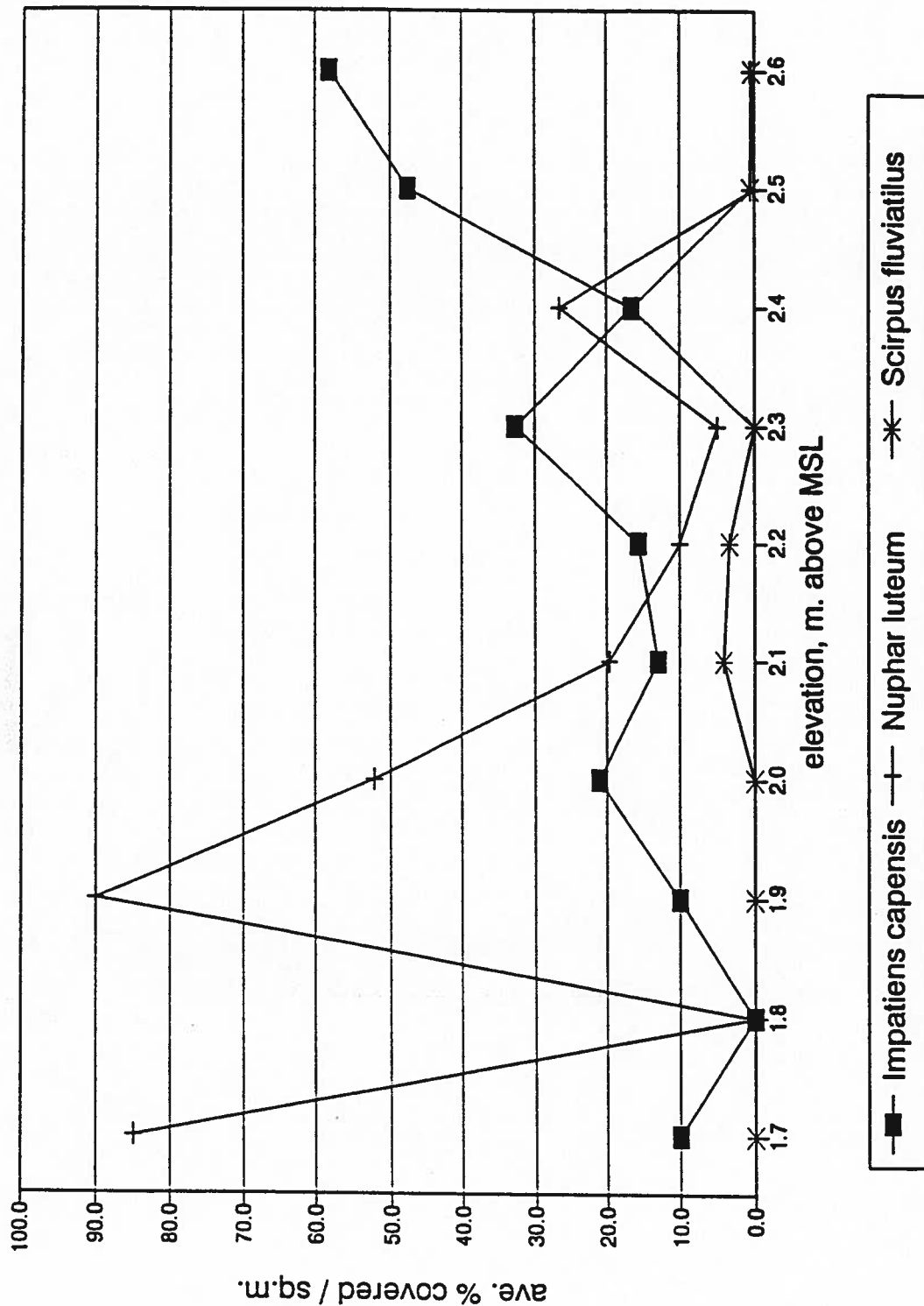
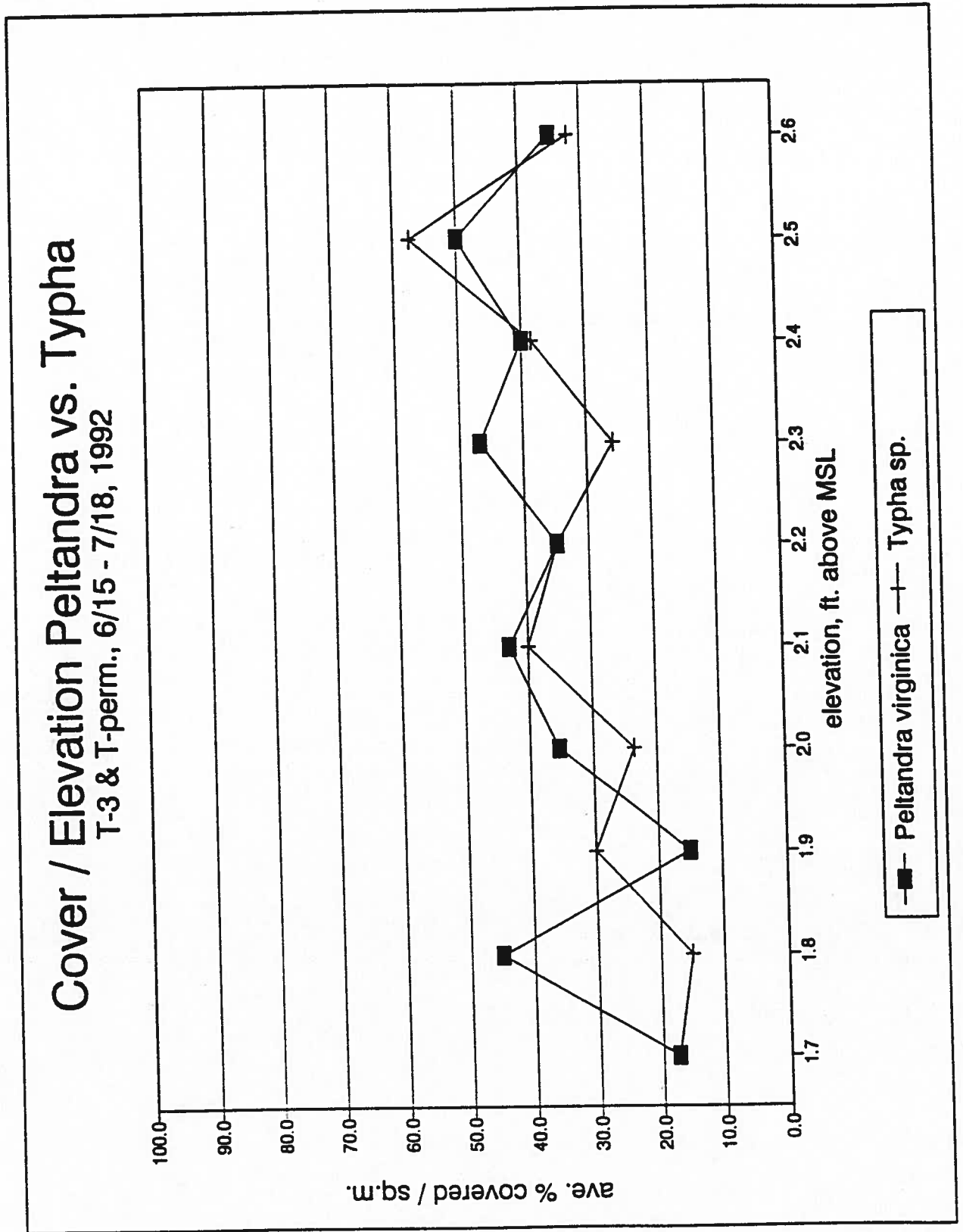


FIGURE 18



References

- Barbour, M.G., J. Burk and W. Pitts. 1987. *Terrestrial Plant Ecology 2nd Edition*. Menlo Park, CA: Benjamin/Cummings Publishing Co., Inc.
- DeJong, T.M. 1975. A comparison of three diversity indices based on their components of richness and evenness. *Oikos* 26:222-227.
- Harper, J.L. 1977. *Population biology of plants*. London: Academic Press.
- Shannon, C.E. and W. Weaver. 1949. *The mathematical theory of communication*. Urbana, IL: Univ. of Illinois Press.
- Simpson, E.H. 1949. Measurement of diversity. *Nature* 163:688.
- Whigham, D.F. and R. Simpson. 1978. The relationship between aboveground and belowground biomass of freshwater tidal wetland macrophytes. *Aquat. Bot.* 5:355-364.
- Xu, Zhaoran. 1991. Final report on inventories of plant species and communities in Dyke marsh, Alexandria, Virginia. Unpublished report, 67 pp.