An ecological study of gordon moss, Berwickshire, a spring mire

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AN ECOLOGICAL STUDY OF GORDON MOSS, BERWICKSHIRE, A SPRING MIRE.

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INTRODUCTION

For more than a century, Gordon Moss, Berwickshire, grid reference : NT 6342, has been famous for its wild life, and thus as a hunting ground for naturalists. The area has been regularly visited by the Berwickshire Naturalists Club, and various reports of its fauna and flora occur in the Annals of this Society. Apart from an early description of this site by Stobbs in 1879, (relevant details of which are given in Appendix I) no detailed study of the area has been published.

Stobbs, in his account, refers to the mire at Gordon as a "moss" and records ancient rights of turbary on this land. Coupled with this the local names for areas of the "Moss":- Feuars Bog and Laird's Bog, imply an area of vegetation dominated by Sphagna growing in a habitat with acidic ground water producing peat of the ombrophilous type. However, Sphagna are far from the most typical plants on Gordon Moss and in fact a list of species found on the "Moss" includes, or rather is predominated by those plants more typical of Fen vegetation (Rheophilous Mire). Some examples of the rarer species recorded from the Moss area over a long period of time are:-

e.g. Stellaria palustris
Catabrosa aquatica
Carex aquatilis
Lythrum salicaria etc.

(see Appendix 2 for full floral lists)

Such vegetation is very much dependant on flowing ground water bringing fresh nutrient supplies to the plants growing in the area, and so the origin and development of Gordon Moss needed to be established.

The "Moss" has recently been acquired as a local Nature Reserve and one of the objects of the study undertaken was to make a basic ecological description of the site and also classify it prior to the preparation of a management plan for the Reserve.

Work started along these lines, but very soon a number of rather interesting facts emerged, namely that -

1. Gordon Moss sensu stricto, today only occupies a very minor part of the lake basin originally filled by the moss and therefore formerly covered with peat. The bulk of the original area has been drained - see Appendix I for the account by Stobbs, to produce very poor Juncus infested pasture land, and also the peat has been cut and removed from large tracts of the moss over many centuries, to provide fuel.

2. The remnant of the moss left in a semi-natural but highly disturbed state is a forested spring mire - the Quellemoore of Bulow (1918), a mire type as yet undescribed in Britain. Although very atypical Gordon Moss must be referred to a Spring Mire type as it owes its continued existance to springs along its Eastern and Northern boundaries.

3. Carex paniculata appears to be an indicator species for flowing ground water and springs in the mire area, growing by the ditches and pools in the wooded areas. This species, however, forms large tussocks, and this growth form seems to tend to isolate the growing part of the plant from the effects of ground water movement.

4. Large areas of the mire surface are dominated by dense stands of certain species, which in the past would probably have been mown and harvested to provide animal litter and winter fodder. Such species are:-

Phragmites communis	Carex rostrata
Filipendula ulmaria	Eriophorum angustifolium
Carex paniculata	

Comparing the productivity of such species as these with that of the drained pastureland nearby can give an approximate index of the economic usefulness of the two forms of agricultural use of peat, mowing the natural vegetation and drainage to "reclaim" agricultural land, and such land's subsequent upkeep.

Modifications were therefore made of the original programme of research, to include and attempt to explain and solve these various problems. The study relating to each factor will be described and discussed separately, namely:-

1. An attempt has been made to describe and classify the site according to the hydrology of the area.

2. An investigation of the growth form of _Carex paniculata_ was made, using a radioactive tracer.

3. Production studies were carried out on three species:- _Phragmites communis_, _Filipendula ulmaria_ and _Carex paniculata_.

4. Another Production study was carried out on a mixed Fen sward with _Eriophorum angustifolium_ and _Carex rostrata_ as dominant species.

Survey and Classification

A survey of Gordon Moss was carried out using both small (1"=1 mile) and large (6¼"=1 mile) scale maps of the area, also photographs from the hills overlooking the Moss.

The area seems to be bounded by the 475' contour to the north, and by Tower Burn to the east, the south and west boundaries being given by Hareford Burn and one of its tributaries. The Moss no longer occupies the lowest part of the drainage basin, which extends considerably to the south of Hareford Burn, the present boundary between the Moss and the poor pasture land produced by drainage of the Moss. See maps figs. 4, 5 & 6. In fact the geological map (fig. 4) shows what must have been the original extent of the mire as fresh water deposits of sand and silt which probably underlay the peat of the Moss itself. Fig. 4 shows that probably the Moss originally filled this basin bounded by the 500' contour and that Hareford Burn was cut as a drain across the middle of the Moss and given outflow into the Eden water by blasting through the basalt dyke along the eastern edge of the Moss. An account of this attempt at drainage is given by Stobbs (1879) - see Appendix I. The stank or drain referred to by Stobbs appears to be Hareford Burn. Mention in his account is made of the Moss being divided by a stank, indicating that in the 1880's the Moss extended south of Hareford Burn for some distance towards Lightfield & Fans.The tract of moss left is in a far from natural state, having been disturbed by ancient peat cuts, pools, and also by the cutting of a network of drainage ditches running across the moss surface.

A number of causeways and paths also run across and round the Moss - see map fig. 5, the largest of these being the embankment which once carried the Berwickshire Railway from Kelso and Earlston to Greenlaw, Duns and eventually Edinburgh. All the embankments and causeways across the Moss are composed of dried peat, and may even represent the original peat level on the Moss.

The Moss is maintained with its transition mire type flora by the effect of not very mineral rich water from springs flowing from the edge of the basalt dyke along the western margin of the Moss, see figs. 4 & 5. More springs feed the streams running across the north wood area from the field boundary to the north-west of the Moss, and the course of all the streams across the Moss are marked by tussocks of Carex paniculata. The water from these springs is high in CaH CO_3 Calcuim bicarbonate, and has a pH value approaching neutrality. pH values for water samples taken at various sites across the Moss are given in Table 2. All the streams or ditches across Gordon Moss tend to drain into Hareford Burn and thence into the Eden Water - see fig. 4. The surface of Gordon Moss tends to be rather wet, especially near Hareford Burn. This is in part due to the pools remaining from old peat cuts and in part to the nature of the highly humified peat produced by Phragmites and Filipendula which form major constituents of the vegetation in this sector of the Moss. The area known as Laird's Bog - see fig. 4, is extremely wet underfoot and is dominated by a grass-type vegetation including species like Phalaris.

Stratigraphy

The Moss lies on freshwater deposits over Upper Devonian Old Red Sandstone. The bed of the basin now consists of stratified clays, silts and sands, a greyish sand lying between layers of pinkish silty clay, which are overlaid by varying depths of peat of different types. The stratigraphy of the Moss was studied using a random profile and a levelled series of boreings taken with a Russian pattern open chamber borer. The sediment below the peat in the area of the Moss near the springs tended to be a sandy gravel, and in the south this was replaced by pinkish silty clay. Peat depths vary greatly across the Moss area, one part of the open regenerating Moss having no peat cover at all only mineral soil, while the deepest peat found on the modern Moss area was 135 cm. only 60 metres north of the area lacking peat on the transect. Along the railway embankment to the west of the Moss greater depths of peat were found - 425 to 525 cms. of peat were found by Hareford Burn, and a depth of about 1,000 cms. was found to the south of the embankment. In the deepest boreing the peat was highly humified (on Von Post scale value 10) Carex sp. and Phragmites peat, whereas across the transect the greatest depth of peat at the base of the profile was well structured Sphagnum peat, with fibrous Carex or Eriophorum peat above it. See maps - figs. 6 and 7 and also Table I.

Vegetation

Most of the remaining moss area is covered by Betula sp. and Salix sp. dominated transition mire "forest" or scrub woodland. See figs. 1 to 3, also Fig. 8. Fig. 3 shows that the trees in the south half of the Moss are apparently taller than those in the north. This may possibly be explained by the denser canopy found north of the railway causeway than to the south.

The ground flora of the Moss is varied and is an admixture of various species of Sphagnum, with Deschampsia flexuosa and Deschampsia caespitosa under the tree canopy. The spring-fed pools and streamlets, all of which probably represent old peat cuts, are dominated by Salices rather than species of Betula, and Carex paniculata tussocks which follow the lines of the streamlets. Along the banks of Hareford Burn and the banks and flood plains of the other main drainage ditches sometimes extensive areas of "Fen meadow" are found, dominated by such species as: Phragmites communis and Filipendula ulmaria and with an almost complete carpet of Chrysosplenium alternifolium in a few places.

The effects of canalization of ground water flow on the vegetation can be seen in a number of places, e.g. towards the north margin of the mire where a spring supplies a rapidly flowing streamlet a marked zonation of vegetation has developed parallel to this stream.

Zone 1 nearest stream - Carex rostrata, Acrocladium giganteum

Zone 2 Carex rostrata, Eriophorum angustifolium, Acrocladium cuspidatum

Zone 3 Eriophorum angustifolium, Acrocladium stramineum, Sphagnum palustre

Zonw 4 Sphagnum palustre, Erica tetralix, Calluna vulgaris.

see Fig. 7 - area labelled Eriophorum/Carex rostrata.

In the centre of the north woodland (see Fig. 7) there is an area of open "wet heath" vegetation, dominated by Eriophorum angustifolium, Eriophorum vaginatum and Sphagna, which is being rapidly re-colonized by young birch trees. This is an area of extremely shallow peat and it is probable that near the ditch and path all the plants are rooting into a coarse gravelly mineral soil and not peat. Water flow from springs has been channelled around this area, so that it has effectively been isolated to a greater or lesser degree from moving mineral rich ground water. Consequently there is an abrupt transition from rheophilus mire type plants, e.g. carices to transition and ombrophilous mire-typical species at the ground water flow/non-flow boundary.

The floras of all these areas were studied in as much detail as time allowed and the plant lists compiled can be found in Appendix 2.

Water Analyses

Water samples were collected from sites in different vegetational areas spread randomly across the Moss. These were stored for the minimum possible time and then analysed for major ions. For the methods of water analysis see Appendix 3, also Mackereth.* A second series of samples were collected and analysed for pH or pH and bicarbonate content alone - the methods are again given in Appendix 2. The results of the analyses are given in Table 2.

* Freshwater Biological Association's publication : Some Methods of Water Analysis for Limnologists, Mackereth 1963.

Discussion

Gordon Moss is rather an anomaly, not only in its continual existence after drastic methods have been used to attempt to drain it, but also in its flora, which contains a surprising number of rare and interesting species. Its continued existance is dependant upon the springs arising along the basalt dyke to the east of the Moss, and to those on its northern edge. The Moss surface is flat, in contrast to the domed profile of the classical spring mire (Kukla 1960). While the springs continue to flow the mire area is undrainable, so in spite of its atypical flora it is feasible therefore to classify the site as a spring mire, the Quellemoore described by Bulow 1918. Classically (see Kukla - Zeszyty Problemowe Postepow nauk Rolniczych - Zeszyt 57) spring mires are:-

1. Developed over a single large spring and show a marked convexity of surface, the ultimate degree of convexity is determined by the hydrostatic pressure of the spring below the peat.
2. The stratigraphy of spring mires usually consists of thin layers of marl alternating with varying depths of highly humified peat.
3. The typical vegetational climax of a spring mire is usually alder woodland.

Gordon Moss, however, probably originated as indicated by Stobbs (1879), as a peat filled basin, which passed over to ombrophilous mire, This is substantiated by the occurrence of Sphagnum peat lying at the base of the peat profile on the remaining part of the Moss area. After drainage the regeneration of peat in the cutaways became wholly dependant on the influence of flowing water from the springs along the basalt dyke on the eastern edge of the peat covered area. Thus Gordon Moss can now be referred to as a spring mire although lacking the usual typical features. The springs rise from the basalt dyke and percolate through the gravel which underlies the peat in the north section of the moss area.. The maintenance of Gordon Moss depends on the continued flow of this unpolluted spring water through the mire, and conservational management must see this is maintained. Further canalization of ground water flow would probably harm or destroy the birch woodland and its interesting and rare flora, so conservation must again see that the habitat for birch woodland is maintained.

The paths of the ditches and flowing ground water seem to be marked by Carex paniculata tussocks, although this plant apparently paradoxically shuts itself off from the affect of the ground water by its tussock growth form. It was necessary to study the uptake of water by individual Carex paniculata shoots in detail, to ascertain whether the shoots do in fact take up their minerals from the ground water or whether they depend for nutrients on water percolating through the fibrous body of the tussock by capillary action, which would be very poor in minerals due to the filtering effect of the body of the tussock. A complete tussock of Carex paniculata was removed to the laboratory and studied.

Part 2

The Uptake of Mineral Rich Ground Water by Carex paniculata

A large tussock of Carex paniculata was studied - firstly a number of intact plants of Carex paniculata - shoot + root system - were dissected out of the tussock. It was found that the current year's shoots had long root systems stretching down to the base of the tussock (see photograph fig.16) passing through the zones of leaf bases and fibrous roots into the ground water. These dissected plants were supported with their root systems in a water based solution with radioactive Caesium as a trace in it, to see whether the root system would pick up the radioactive material and transport it throughout the plant. The plants were left in this solution for 60 hours, during which time their radioactivity was monitored using a Geiger-Muller counter. The plants were then removed from the radioactive source, allowed to dry for a few days and then the individual plant which had taken up the most radioactive was used to take an autoradiograph. The plant was placed between sheets of ordinary paper and photographic paper and left in the dark for about a 48 hour exposure. The resulting autoradiograph was photographed - see fig. 17. The original autoradiograph showed that radioactive tracer had been transported throughout the plant, from its roots, up the stem and into the leaves to the apical meristems, but the photograph fig. 17 does not show the radioactivity in the root very well, probably due to the size of the negative. Fig. 16 shows the whole Carex paniculata tussock, or rather half of it, with one plant fully dissected to show its own root system.

It can be seen that each individual Carex paniculata 'plant' roots into the flowing ground water below the tussock and that such plants can pick up ions from this ground water as is shown by the autoradiograph and these ions will be transported throughout the plant. For the purposes of this study a plant of Carex paniculata is taken to be the one or two shoots bound together by the same leaf bases and dependent on the same root system. Usually single shoots are involved, in fact the Carex paniculata tussock is produced by tillering and this consists of a large number of genetically identical shoots which can either all be considered as separate plants or as representative of one plant or clone.

For further studies of the Carex paniculata tussock see Section 3.

Production Studies on Gordon Moss

Production studies of various species growing on the Moss were undertaken partly as an exercise to learn the techniques involved in this type of ecological study, and partly in an attempt to solve a conservational problem.

To the agriculturalist and general layman Gordon Moss in its present state appears to be a tract of apparently useless waste land, only fit for reclaimation by being filled in while in use as a rubbish tip. The west end of the Moss near Noble's Well has already suffered this fate. Before this, or the remaining part of the Moss could be used for agriculture, it would have to be drained, ploughed and fertilized to a high degree before any grass or hay crop could be grown, or alternatively the natural vegetation of the area could be mown and harvested to provide "winter bite" or litter for stock. This latter method represents one of the most ancient techniques of Fen farming.

A large scale attempt to drain Gordon Moss was made in the early 1800's, and this is reported in Appendix 1. A large drain or stank was cut through the mire area to drain the basin, outflow to the Eden Water being given by blasting through the basalt dyke at the eastern boundary of the Moss. This attempt was only partly successful, draining the area to the south of the main stank - Hareford Burn - and that west of the remaining moss area - see figs. 3, 6 & 8, converting both areas into poor Juncus infested pasture land. These areas of reclaimed mire are frequently waterlogged, and require the continuous upkeep of drainage ditches and addition of fertilizer to keep them from reverting to mire. The maintenance of such land is expensive, and often the yield given by reclaimed peat land is poor.

The undrained area of the Moss was probably mown regularly at one time, and only when this practice ceased had the vegetation reverted to Betula dominated woodland.

After considering these factors it was decided to study the productivity of certain species of the open area of the Moss, which formerly would have been mown to provide animal litter and fodder, and compare the results obtained with yield data published for poor pasturage of the type occurring on the drained area of the Moss. It was hoped that this comparison would give an indication of the efficiency of both of these types of land management. As time available for this study was limited, that of the actual productivity of the pastureland was not attempted, but data published for similar vegetational areas is presented for comparison.

Full results for annual, or rather seasonal production of the following species were obtained:-

Phragmites communis
Filipendula ulmaria
Carex paniculata
and also for a mixed fen vegetation dominated by *Eriophorum angustifolium* and *Carex rostrata*.

These were found to be of considerable interest. Only study of the aerial production of the species was attempted due to limitations of time and also to the intrinsic problems of growth form and micro-habitat of the species.

Root production is always difficult to estimate, and in a species like *Carex paniculata* with its tussock growth - form the distinction between root growth of one year and another is practically impossible. Both *Filipendula ulmaria* and *Phragmites* communis have perennial rhizome systems, deep in Phragmites and shallow in Filipendula, which would further confuse the estimation of annual root production, although possibly making the excavation of the plants whole root system simpler than would otherwise be the case in such a waterlogged habitat, which makes identification between living roots and dead ones about to be incorporated in peat very difficult.

Problems in the Methods used for the Production Studies

The cropping of a large plant like Phragmites communis presents several difficulties. In the area studied the density of this species per metre^2 was never very great, also the maximum height reached by Phragmites plants is 5ft. to 6ft. at the end of the growing season, and the combined effect of these two factors would make the technique normally used of cropping a number of random $\frac{1}{2}$ x $\frac{1}{2}$ metre quadrats or 1 metre^2 quadrats not applicable in this study. Filipendula ulmaria did not present so many difficulties in the use of a quadratting technique, forming denser stands and being a shorter plant than Phragmites, but, as the plants of this species tend to be rather fragile the use of quadrats was again discounted. Carex paniculata, with its peculiar growth form also represents a species where the technique of cropping randon quadrats of unit area was not applicable, therefore, a different cropping technique had to be employed. Further, it is difficult to know whether to relate the production of Carex paniculata to the unit crown area of the tussock formed, or the area of ground covered by the tussock. As the crown of the tussock tends to be hemispherical these two areas differ substantially and consequently so would production values related to the two different areas.

The problem of cropping technique to be used was solved by cutting at ground level individual shoots of the plant species studied. The data thus obtained for mean shoot weight and variation throughout the population can subsequently be related to unit ground area by counting the number of plants of the species being studied in a number of random unit area quadrats - ($\frac{1}{4}$metre x $\frac{1}{4}$metre, $\frac{1}{2}$metre x $\frac{1}{2}$metre or 1 metre square), at intervals throughout the season to find density per unit area. For Carex paniculata two techniques can be used, either counting the number of shoots per 10cm x 10cm quadrat on the crown of the tussock or counting the total number of shoots produced by the tussock, and then calculating its surface area from its girth or diameter, and again from this the number of plants per unit area can be found relative to crown area or base area of the tussock.

Methods

The general pattern of cropping was to cut or pull a given number of shoots of each species, frequently in two samples taken by two observers to show up an individual's cropping errors, in areas dominated by each of the species being studied, at regular intervals during the growing season. Cropping was commenced in February for Carex paniculata and the mixed Fen vegetation, and in March for the other two species studied. Collections were first made monthly, and them from May 11th until June 15th croppings of Phragmites communis and Filipendula ulmaria were taken weekly and subsequently fortnightly to July 20th, with one final cropping on August 17th. Croppings of the mixed fen vegetation were taken monthly, and those of Carex paniculata were taken roughly fortnightly after May 11th. Shoots were cut at ground level, or plucked from the leaf bases on the tussock in the case of Carex paniculata, and stored in polythene bags in a deep freeze until their fresh weight was taken. After this original weighing the plants were divided into live material/shoot and dead material/shoot, these fractions were then weighed for fresh weight, dried to constant weight at 105°C and then re-weighed separately.

The major weights and results obtained for each species are:-

1. Individual fresh weights of:-
a) A number of individual shoots of each species
b) Live material of a given number of individual shoots
c) Dead material " " " " " " "
and from these can be found the mean fresh weights of
a) Total shoot material
b) Live shoot material
c) Dead shoot material

2. Individual dry weights of:-
a) Live material of a number of individual shoots
b) Dead " " " " " " "
c) Total " " " " " " "
and from these the mean dry weight of shoots in each category can be found.

3. Fresh weights of lumped collections of shoots split up into fractions of:-
a) Live material
b) Dead material
c) Total fresh material
and again mean values are found.

4. Dry weights of lumped collections of
a) Live material
b) Dead material

c) Total live + dead shoot material
and similarly mean values are again found.

Various other results were calculated from these weighings and these are recorded later. Care was taken to see that croppings were not made from areas which might have been affected by a previous cropping. The actual methods used varied slightly from species to species, and were as follows:-

Phragmites communis

The first cropping of new shoots of this plant was made on March 17th 1967 when very few new shoots were visible above ground. Most of the sample taken were found as axilary buds on old stems, growing almost entirely below ground at this stage, and cropped by pulling up the old stems and cutting the shoots off at the base. In the early collections there is a tendency to crop only the largest plants in the population at this time, as the smaller shoots are frequently not visible above ground, or insignificant. In March and April shoots were cropped from the dead stems below ground level, but by May 25th the shoots were large enough above ground to be representative of the whole shoot population, and so these were then cut at ground level rather than being pulled as before. This would explain the apparent drop in mean weight of Phragmites for May 25th in figs. 18 and 19. The first collections were made from an area of Phragmites growing in an apron-shaped area by the wood just north of Hareford Burn - figs. 6 and 12, but later it was observed that plants were growing less well here than on the stream bank itself or in the ditch bounding the apron and draining into the stream, or those plants actually growing in the stream - figs. 6 and 13. In all but the first collection

50 or 100 shoots were cut, usually in two samples from the area being sampled, smaller collections being made at the end of the season and in two further cropping areas. Fresh weights were found for all but the first and last croppings, although the validity of their use in production studies is very dubious, as fresh weights tend to be greatly influenced by whether there has been recent rainfall, humidity, and the efficiency with which the polythene bags used for collecting are sealed, and thus are extremely variable. Phragmites communis shoots seem to produce very little dead material through the growing season, making sorting of the shoots into live and dead fractions unnecessary before weighing.

Four areas of Phragmites communis were sampled:-

1) By the wood near Hareford Burn - fig. 12
2) On the banks of Hareford Burn - fig. 13
3) Growing in Hareford Burn
4) In a ditch feeding Hareford Burn - see fig. 6

The density of plants per unit area varied considerably between these areas.

Area 1 - By Wood - Here the plants were forming a mixed stand with Filipendula ulmaria forming a lower storey with Phragmites communis shoots protruding through it. Here plants tended, at the end of the season, to be shorter than in Area 2 but rather taller than those in the ditch or Hareford Burn, but rather well dispersed.

Area 2 - On the North Bank of Hareford Burn - here Phragmites shoots are forming a denser stand containing plants of Urtica dioica and Filipendula ulmaria as an understorey. Plants here were taller and on average heavier than those found in the other areas, and so production was higher than those found in the other areas cropped for this species.

Area 3 - Plants growing in Hareford Burn - a few plants of Phragmites grow in the stank. Early in the season these are much further advanced than those shoots in other areas, but by the end of the growing season these plants tend to be smaller than those growing on the stream bank.

Area 4 - Plants growing in the ditch - again a few dispersed plants grow in the ditch and early in the season these again were much larger than plants growing on the stream bank, although this advantage had been lost by the end of the season - see figs. 18 and 19 for production results.

Filipendula ulmaria

The same basic technique of cropping about 100 plants in two separate samples were used. The same area near the stream was used for all cropping, see fig. 6, and near the end of the season a distinct difference in the height of plants in two parts of this area was noted, so separate collections was made from each of these. The smaller plants cropped tended in June to be heavily infected with a downy mildew (Peronosporaceae) covering the upper leaves and this may have contributed to their small size. The first cropping was made in March and the final crop of Filipendula was taken in August. Through the season the density of the stand was established using $\frac{1}{4}$m x $\frac{1}{4}$m square quadrats and this was used to determine the productivity of this species per square metre.

It was found that Filipendula tends to fragment very easily with storage and also lose moisture rapidly. Fresh weights were found to be extremely variable and so were largely discounted. The plants were divided up into live, dead and rhizome fractions before being dried and were weighed in these fractions. A large amount of dead material tends to remain attached to the young

Filipendula plant, consisting mainly of dead leaves. These leaves may stay attached to the plant for up to a month and thus were cropped with the living plant to give an approximate index of dead material turn-over during the season, and thus a better idea of the production/metre^2 of this species. The rhizome weights were not used in calculating production as these only represent a small fraction of the stored nutrient of the plants and also varied greatly in size due to cropping.

Carex paniculata

Individual shoots of this species were again cropped. About 100 shoots were taken from each of 2 or 3 tussocks in both the North Spring influenced area of the wood on Gordon Moss and from the wood south of the railway line - see fig. 6. The first cropping was made on 24th February when the complete tussock of Carex paniculata was also removed from the North Spring area of Feuars Bog, and the final collection weighed was made on 20th July. A further cropping was made on 17th August but this unfortunately was lost. The shoots cropped were weighed for fresh weight in some of the early collections, but later this was abandoned due to the inaccuracy of fresh weights. The shoots were then sorted into living material and dead material fractions which were weighed, dried to constant weight at 105°C and then re-weighed. For the first few collections all the plants of Carex paniculata collected were sorted into 5 arbitrary size classes and these size classed samples were then lumped together and weighed for fresh weight and dry weight of the entire plant, live + dead material. From this the mean weight/shoot of each size class could be found, the size class spread giving a rough index of the variability throughout the population. This was later abandoned and plants were then weighed individually.

A Single Tussock of Carex paniculata

This was removed wholesale from the ditch south of Noble's

Spring - figs. 6 & 7 and fig. 16. The base of the tussock was dug out of the bed of the stream to remove all the roots and litter belonging to it. Litter was collected from the plant before its removal, to show the extent of the 'trunk' of the tussock, which was composed of roots and leaf bases of long dead Carex shoots which had accumulated over the years. The tussock was removed to the laboratory and there divided up into various fractions; all the current shoots were plucked off the crown of the tussock and sorted into live and dead material, and then the rest of the tussock was sawn up into three regions, comprising :- (i) dead leaf bases, (ii) a mixture of fibrous leaves, leaf bases and roots, and (iii) the region of current roots permeated by mineral rich ground water. Each of these categories was dried to constant weight 105°C and then re-weighed, as was the loose litter of dead leaves collected from round the plant. The number of living shoots on the crown of the plant was counted. This value would, in fact, have been an underestimation of the number of plants on the tussock, as the 'litter' forming a 'skirt' around the tussock in fact consisted of dead plants occupying a given space on the surface of the tussock, as well as loose leaves from dead Carex plants. A few complete plants had been dissected out of the tussock before weighing, to be used in radioactive tracer experiment.

Transition Mire dominated by Eriophorum angustifolium & Carex rostrata.

Unlike the other areas studied, this was not even an approximation of a pure stand of one species, being a mixed vegetation containing Eriphorum angustifolium, Carex rostrata, Potentilla palustris and a few small willow trees. The area was isolated from the influence of any springs - see figs. 6 & 7, and in one part was represented by a large patch of Sphagnum, The area has at some time been drained, as two rather inefficient drainage ditches run across it, while others run at right angles to these below the field boundary and below the mound (see fig. 15) by the main path. A different cropping technique was employed in the study of this vegetation. Initially an attempt was made to follow Wiegert's paired plot techniques and crop from fixed quadrats at monthly intervals for both living and dead material. However, the area was too waterlogged for the disappearance of dead material to be accurately recorded, as it became difficult to distinguish between recently dead material and dead material on its way to forming peat which partly formed the rooting medium for this vegetation. Croppings were taken monthly from two separate randomly selected quadrants $\frac{1}{2}$m x $\frac{1}{2}$m square. These two areas were then marked, so that they could be found again and not re-cropped, and the herbage was cut off them at ground level. This had to be an arbitrary level as the area was completely waterlogged and solid ground probably would not have occurred for more than 1ft. below the water level, and thus below the rooting level of most of this vegetation. Therefore, an arbitrary ground level, approximating to the base of the herbage and to the water level, was used. Starting in February the vegetation was collected monthly until August. The collections were sorted to species and to live and dead material per species, the mosses were also sorted to species. All these fractions were then dried to constant weight at 105^{O}C and weighed. This data was used to obtain a series of values for standing crop/species/unit area throughout the season.

RESULTS

The following data was obtained from weighings taken:-

1. The mean fresh weight of living and dead material per shoot of each species on a given area for each cropping.
2. The mean dry weight of living and dead material per shoot of each species on a given area for each cropping.
3. Standard deviations from the mean size per shoot per collection per area, giving the variability of the population.
4. The size class of plants contributing most of the production for each collection.
5. The standing crop for each species per square metre throughout the season.
6. The actual production per metre squared can be found.

Histograms were plotted for each species studied, *Carex paniculata*, *Filipendula ulmaria* and *Phragmites communis*, all based on a percentage of the population of the samples rather than on the actual numbers of the sample taken to bring them all to a uniform scale. These showed the numbers of plants in each size class against size by weight, and product or (number of plants/ size class x mean weight of that size class) against the weight in size classes. These full results are given in Appendix 4. A summary of the main results is given below for each species, and in figs. 18 - 22.

Phragmites

The main results for this species are summarized in the graph fig. 18, which shows the mean weight of plants per collection, against time. This curve shows a clear rise in mean dry weight of the individual shoots from March until July, with small drops in May, due to sampling error caused by a tendency to crop only the larger shoots which were more obvious before that time, and in August, due again to a large degree of variability in the population. If the graph were plotted for values of mean weight of phragmites shoots + 1 standard deviation for each collection, the curve would be seen to rise still in August, indicating that the drop shown in fig. 18 is simply an artefact.

The densities of Phragmites per square metre are given in Table 3 for the two main areas sampled. From these and the mean shoot weights the standing crop of Phragmites throughout the season can be found, and also the annual production/m^2 of this species. The standing crop per metre square was found from the data of the August collection, and as the death rate for Phragmites plants through the season seemed to be very low, this was taken as the annual production figure. At the beginning of the growing season the Phragmites shoots were very small and, therefore, were assumed to be entirely part of the season's growth studied, although they probably started growing during the previous season.

The annual production of Phragmites communis per $metre^2$ was found to be:-

on stream bank = $372g/m^2$
by wood = $162g/m^2$

Filipendula ulmaria

The full results for the production of Filipendula by Hareford Burn are given in histogram form in Appendix 4. These are summarized in figs. 19 & 22 and again the numbers of plants per $metre^2$ are given in Table 4.

There is a tendency in Filipendula for the old leaves on the plant to die and at first remain attached to the plant and finally drop off throughout the season. It is thought likely that leaves remain attached to the plant for 2-3 weeks after their death and by one month most of the dead leaves are detached or rotting. This one month is taken as the duration of these dead leaves on the plant for production purposes. The chances of a dead leaf remaining attached to the plant for more than one month are slight as full cropping of these attached leaves is difficult. Annual production of Filipendula was calculated from the standing crop in August plus the approximate amount of dead material that has been produced and disappeared as well as that still existing during the season from March to August. From the density of the plant stand the production per metre^2 can be calculated:-

Total standing crop for August -					Filipendula	$=876g/m^2$ tall
"	"	"	"	"	"	$=746g/m^2$ short
live	"	"	"	"	"	$=797.5g/m^2$ tall
"	"	"	"	"	"	$=687g/m^2$ short

Annual production/m^2 Filipendula = $947g/m^2$ in shorter area
= $1074g/m^2$ in taller area

Carex paniculata

In the course of the study of a tussock of Carex paniculata to establish whether this was a valid indicator plant for flowing ground water, it was observed that the living shoots on it could be classed on height into five size categories. This structure was first observed in February and was maintained to a greater or lesser degree throughout the season by maturation of the young shoots and recruitment of new shoots throughout the season replacing any large shoots which had died. Dead shoots tended to remain on the plant for quite some time and thus were thought to endure throughout the season without rotting or falling off the tussock.

Subsequent study of the development and production of the living Carex paniculata plant and tussock in two distinct areas of the Moss, following the same single plant cropping method used for

Phragmites and Filipendula, produced interesting results. These are summarized in figs. 20 & 21. The full results expressed as histograms based on percentage of the sample rather than actual numbers are to be found in Appendix 4. Fig. 23 shows two histograms giving the size class structure at the beginning of the growth season, and the second showing structure at the end of the season.

It can be seen that there is little change in actual size class structure through out of season, apart from a shift of numbers so that more occur in the categories of heavier plants at the end of the season, indicating continuous recruitment of new shoots during the season.

If a Carex paniculata tussock is actually in dynamic equilibrium it would seem that the first recruitment of shoots must take place in Autumn, rather than in Spring, to allow shoots to be of a viable age at the beginning of the following season.

The inherent difficulties present in measuring or estimating the annual production of such a system are immediately obvious as the population being studied is one containing individuals of different sizes and with different growth rates which will show peak production and peak standing crops at slightly different times of year for different tussocks. It is however, suggested, that an indication of the annual production of Carex paniculata may be obtained as follows:
The mean number of plants/m^2 was found by counting all the shoots in a number of 1/100th m^2 quadrats (10 cm. x 10 cm.square) on several tussocks in both areas of the wood investigated. The following results were obtained:

Mean number of plants per metre^2 in N. wood area = 467.6
Mean number of plants per metre^2 in S. wood area = 462

The resulting standing crops for July are:
in North wood - spring influenced area = 585.5g/m^2
South wood area = 516 g/m^2

Using this data it is possible to further investigate the estimation of production. Since the smallest shoots present in February will grow during the season, they are assumed to reach a size coincident with the maximum weight size class by July, similarly all larger plants present in February will have reached the maximum size class and ceased to grow but not started decaying. Production can then be calculated by the addition of increment growth weights calculated from the difference between the mean live plant weights in February and July to the July standing crop. A similar death rate occurs throughout the season, although the dead material remains attached to the tussock as recruitment continues through the season. If actual weights of dead material are ignored then the production during the growing season approximates to :-

the living standing crop at the end of the growing season + increment weight put on by the average plant of each of 5 arbitrary size classes to reach the size to be included in the maximum size category.
Production in the North area of the wood = 978 grm/m^2
Production in the South area of the wood = 903 grm/m^2

Eriophorum angustifolium and Carex rostrata dominated transition mire. The full results of production studies in this area of vegetation are given in table 5. Total product per metre^2 varied little throughout the season - see table 5 .

As with Carex paniculata a certain amount of perenial standing crop is present throughout the season, making the estimation of annual production of this mixed vegetation rather difficult. A continuous death rate occurs throughout the season and data has been obtained to give an indication of this - again see *table 5*. The total standing crop per metre square was found for this vegetation in August.

$$\text{Standing crop} = 398 \times 4 \text{ grm/m}^2$$
$$= 1592 \text{ grm/m}^2$$

As can be seen, this figure for standing crop is considerably higher than that for standing crop in either Filipendula or Carex paniculata. This can be attributed to the cropping of all the components of the vegetation rather than just simply the major species found, as in the former two cases. The Bryophyte component of the vegetation makes in some croppings an extremely high contribution to the production per metre^2. In the August cropping for example, out of a standing crop of 331 grms/$\frac{1}{4}$metre^2 90.8 grms. represents the production of moss, i.e. just under 1/3 of the total production per unit area. This fraction of course has not been taken into account in any of the other production studies on Carex paniculata, Phragmites and Filipendula. Again in the August collection dead material accounts for 160 grms. out of a total of 308 grms/quarter metre^2 quadrat, or just under $\frac{1}{2}$ of the total production in that quadrat. The ratio of live material to dead seems to change a little during the season, as the February cropping showed 171grm. of dead material to 105grm. live material, so that dead material represents 62% of the total production in February compared with 43% of total production in August at the end of the season.

As would be expected the main part of angiosperm production in this region is represented by living and dead Eriophorum angustifolium and Carex rostrata, e.g. living Carex rostrata produces 7.55% of total standing crop in August and dead material from this species represents 32.8%.

The total live material per $metre^2$ does not vary very greatly through the season, the lowest value found was in April - 367 g/m^2 - the greatest in May 764.5 g/m^2, but this apparently great variation is probably due in part to the variation in density of the vegetation in this region, and in part to individual cropping errors. The most abundant moss in the area was Acrocladium cuspidatum, and this formed a complete carpet understorey to the Carex/Eriophorum stand. A number of leafy liverworts were found but their contribution to the production of the area was negligible.

DISCUSSION

The results obtained using the increment single plant cropping technique employed in this investigation of production in Carex paniculata, Filipendula ulmaria and Phragmites communis show a distinct and continuous rise in mean plant weight per collection until August, indicating a distinct seasonal growth rate for each plant. The growth rate of plants of the same species growing under slightly different conditions of water or mineral supply in different parts of Gordon Moss have been investigated. In fig. 18 this difference is clearly shown for Phragmites in two areas near Hareford Burn, and in the burn itself. The plants growing on the stream bank are seen to have a faster growth rate than those by the wood, especially in the earlier collections, and also reach a higher maximum weight than those by the wood. The plants collected from the ditch and stream itself on two occasions start with a higher growth rate than either the streambank plants or those by the wood, but tend to be overtaken by the stream bank plants and have a final mean weight considerably less than that of the streambank population but more than that of the wood edge population. Full analyses of water samples were only made for the stream bank community but pH was determined in the field for the two main areas of Phragmites. It was found that ground water in the wood edge area tended to be more acidic, i.e. have a lower pH than that in the stream bank, pH 6.57 being found by the stream and a pH as low as pH 4.8 occurring in the woodside area. This may indicate a lower mineral content in the wood side ground water although the analysis of samples for Magnesium which was commenced showed very little difference between the samples. It is probable that an ion other than Mg^{++} is involved in determining both growth rate and ultimate maximum weight of Phragmites plants in these two areas, or even it may be that the drainage is so impeded in the wood side area, which tends to be very wet under foot, that the excess of water present may in some way hinder growth. The poorer growth of Phragmites in the wood side area is also influenced by competition with Filipendula - see fig. 12 - which here forms a fairly dense understorey through which eventually the taller Phragmites plants protrude. Early in the season Filipendula starts to develop, produces moderate amount of foliage while the majority of the Phragmites shoots in the community are still underground. In fact, Phragmites does not produce leaves ~~to~~ until quite late in the season. The majority of plants found on May 31st had not yet produced a leaf and were just elongated leaf 'buds' which had not opened out. At this time, however, Filipendula ulmaria forms a carpet of moderately dense foliage up to 30cm. high, and this obviously will have an effect in shading out some of the weaker Phragmites shoots. Thus the Phragmites population in the wood edge area tends to be less dense than that on the stream bank and also the plants tend to be smaller, perhaps again an effect of competition or perhaps of non-optimal mineral supply. On the stream bank Phragmites grows mixed with Filipendula ulmaria again and also with Urtica dioica which tends to grow only in areas of soil with a high phosphate content. Here the understorey of Filipendula is much less dense - see fig. 13 - so competition would not be such an important factor. Also the mineral supply in the ground water in this area is high - see table 2 for water analysis pH here, and this generally is linked with fairly eutrophic water conditions. Table 2 shows that compared with other areas of the Moss, the ground water in the stream bank Phragmites community is both high in anions and cations, notably for $SO_4^=$, Ca^+, Mg^{++} and also to a lesser extent Na^+, k^+ & Cl^-. The value obtained for bicarbonate content of this water ia also high, and so would probably encourage good growth of Phragmites.

The two areas of Filipendula are so close together that a drastic change in mineral content of the ground water with the other is not envisaged. The latter plants, however, do grow on a slightly higher area of peat, and the smaller ones occur in a lower more waterlogged region. Perhaps the puddling effect of the wetter area somewhat inhibits the growth of Filipendula after a certain stage. The distinction between an area of taller and one of shorter plants was not observed until July 6th, although some differentiation must have taken place earlier in the season, probably some time during June, when all the plants cropped were infected to a greater or lesser degree by a downy mildew, and a few were also infected with rust. These fungal parasites seemed to infect more of the plants in the low lying patch, and to infect them more heavily than those on the slightly higher and drier peat. This heavy fungal infection, may, therefore have contributed to stunting the plants seen later in the season as small, or may have been one of many factors in combination with a possible slight mineral deficiency. In both stands of Filipendula there is no other species of plant with which it would be in direct competition to any great degree. Urtica dioica occurs with Filipendula in both areas, and would tend to indicate that the area has fairly phosphate-rich ground water. Table 2 shows the results of water analysis in the area of Filipendula sampled. It can be seen that, as for Phragmites, the water is fairly rich in bicarbonate, and also fairly rich in cations, but with considerably lower values for anions than were found for Phragmites. The pH of the ground water was slightly higher here than in the Phragmites area by Hareford Burn, but apart from this and the bicarbonate content, the ground water in the Filipendula area tends to be less ion-rich than that in the Phragmites area. It cannot, however, be directly assumed that Filipendula grows in areas of lower ion-content ground water, because it either cannot tolerate very high concentrations of certain ions, or because it does not have such a high ion requirement. Competition with Phragmites does play quite a large part, the Filipendula tending to colonize the less ion-rich sites than Phragmites. It is possible that Filipendula has a higher bicarbonate requirement or something similar. In the wood side area it is uncertain whether Phragmites is invading and taking over the site from Filipendula or vice-versa. It is more likely here in fact that Filipendula is replacing Phragmites.

The production of Carex paniculata differs somewhat between tussocks, and more greatly between tussocks sampled in the areas of the wood north and south of the railway line. The tussocks in the north generally produced more and larger shoots per tussock than were found in the south - see figs. 20 & 21.

The final production figures obtained for Carex paniculata were:-

North wood - spring influenced area	978grms/m^2
South wood area	903grms/m^2

The difference is attributed to the fact that Carex in the north area occurs along spring water fed ditches which would carry water with a fairly high mineral content. In the south area, however, the ditches are fed by water which has drained through the Moss and is thus likely to have lost some mineral content, and also by rainwater which would have a low ion content - see table 2 for water analysis from the spring influenced area. Carex paniculata has been shown to be a good indicator plant for flowing ground water, and thus is a species indicative of a rheophilousmire type. The pH of water in the north and south wood areas differs little - pH 6.69 in the north spring area, compared with pH 6.4 in the south wood area, but Magnesium, in the analysis which was not completed because of lack of time, showed a larger value in the north spring area than that found in ground water of the south, showing a clear difference between these two ground waters for this particular ion. Although Carex paniculata tussocks are a little smaller in the south than the north, the casual observer would see there is very little apparent difference in the performance of Carex paniculata in the two areas - see figs. 9, 10 and 11. The water analysis for the Carex paniculata dominated area in the north wood showed that here water had a high pH 6.73 - in line with those for Filipendula and Phragmites, and with similar high values for all ions, especially K, for which this area has a higher content than the ground waters for either Filipendula or Phragmites. Correspondingly high values are seen for cations, but all these are slightly lower than those found in the Phragmites area. The value for bicarbonate is lower here in the spring water than that for either Phragmites or Filipendula.

Phragmites and Filipendula tend to grow in a similar open habitat, not shaded by trees and thus come into competition in a few areas. Mainly, however, they tend to form distinct stands, and this may possibly be related to their mineral and water requirements - for water analysis see table 2 again. As discussed above, it is thought possible that Phragmites has a higher general mineral requirement than Filipendula, or alternatively it may, as a species, be more tolerant of high concentrations of certain ions, e.g. $SO_4^=$. It is, however, possible that Filipendula and Phragmites have the same basic mineral requirements but that one may oust the other by competition in certain circumstances.

As Carex paniculata grows mainly in the woodland area there is little chance of direct competition occurring between it and the two former species, although a few patches of Filipendula do occur in the ditches alongside of the Carex paniculata tussocks, but these never reach the same proportions as the large expanse of Filipendula growing on the open banks of Hareford Burn.

Water analyses from these three areas are basically fairly similar and show that all these three species seem to grow preferentially in fairly wet areas of high pH, moderately high bicarbonate values, moderately high K^+, Na^+, Mg^{++} & Ca^{++} and variable anion contents - see table 2.

These three rheophilous mire areas can be compared for water analysis with three transition mire areas, dominated by Eriophorum angustifolium, Calluna and Spahgnum spp. The latter three areas show ground water with lower pH values, pH 4.64 for Eriophorum angustifolium area, pH 3.36 for the Sphagnum dominated area and pH 5.2 by the wood on the edge of the clearing in the north area - see fig. 7. Values for anions are lower in these samples than in the first three, whereas cation values are very much the same for these latter three and they are below the values found in ground water for Carex paniculata and Phragmites - again see table 2.

The weight results obtained by the method used are accurate enough to allow the calculation of production figures given above and these can now be compared for each species and vegetation.

Phragmites has a much lower value for production/metre^2 than any of the other species investigated - see results section and table 7. This may be due to its low density/m^2, and its therefore rather dispersed distribution. Table 3 shows that generally speaking there are about four times as many Filipendula plants per square metre as Phragmites plants. Since the mean dry weights in August of both Filipendula and Phragmites plants are of the same order, the low production in comparison with Filipendula is to be expected. Again, as would be expected the highest production per metre^2 was found for the mixed vegetation dominated by Eriophorum angustifolium as this included all the components of the vegetation, some of which or most of which were omitted in the other studies, which did not include weights and production of mosses/metre^2. The production values obtained for Carex paniculata and Filipendula ulmaria are very much the same 978g/m^2 for Carex in north wood. 903g/m^2 for Carex in the south wood and 886g/m^2 for Filipendula.

The results obtained for Phragmites for mean dry shoot weight compare with those obtained by Pearsall for Kinrara and Esthwaite Fen etc.

Pearsall's results		Gordon Moss			
Kinrara	5.3 ± 0.4g	Wood	5.8 ± SD = 4.2	max.	17.04
				min.	0.88
	21.7 ± 2.6g				
Esthwaite Fen	10.7g.	Streambank	8.3 SD = 4.8	max.	20.47
				min.	1.62

In this study of Gordon Moss care has been taken to sample as near as possible a section through the complete population, so that most sizes of plants present are represented. Thus the mean weights obtained for Gordon Moss are, for the most part, lower than the mean weights/Phragmites shoot found by Pearsall - 1960.

A similar technique of cropping single shoots was used by Pearsall at a number of sites, but only one standing crop was taken in September, and this was used as an index of annual production.

Due to lack of time the present study had to rely on final cropping data collected for August, when the plants may or may not have reached maximal size and so the production figures obtained may be perhaps a little low.

The standing crop found for the Eriophorum angustifolium/Carex rostrata dominated transition mire is much higher than that for any of the other species studied, and this is due to two factors. Firstly, not all of the material dealt with in the mixed vegetation is annual and so the standing crop value obtained cannot be directly related to seasonal or annual production. Secondly, this mixed vegetation includes mosses, Carices, angiosperms representative of all the layers of the vegetation, whereas in the other studies one species only has been investigated.

Wiegert 1961 gives production data for an old field system in Michigan and quotes a maximum standing crop of 340^{+} grm/m^2 for the upland field by summation of peak standing crops, + dead material disappearing at a rate of 8.4 mg/day. This production value still appears to be below that found above for Filipendula and Carex paniculata, and thus it can be assumed that the production of the drained area of the Moss, now turned over to poor pasture is in fact considerably less than that of the Moss in it's natural state, or rather less than that of certain species on the Moss.

The methods used in this study, especially the techniques of single shoot cropping have a number of advantages and disadvantages. The method of single shoot cropping is useful in that it gives a clear idea not only of the mean weight per plant or per unit area of the population being studied, but also it gives an idea of the spread of the population and standard deviations from the mean weight can be found. The process of sorting a mixed community cropped to species is eliminated, but every plant has to be weighed individually and then divided into living and dead fractions which again were weighed individually. This part of the method tends to be tedious. The accuracy of this method is fairly good, although it still depends to a certain extent on personal cropping error, in not collecting a strictly random sample, or unconsciously selecting only the large plants, as happened in the early collections of Phragmites - see earlier.

Further investigation and application of this method is needed.

CONCLUSIONS:

1. Gordon Moss is an atypical Spring Mire, and any Conservation policy for the area must take this into consideration.

2. Carex paniculata is an indicator species for flowing ground water in a mire ecosystem. The current year's growth on the tussocks derive nutrients from the ground water flowing below the tussock itself, via roots which develop and grow down through the whole height of the tussock itself into the mineral soil or ground water. Water in the tussock does not supply any nutrient to the current year's plants.

3. The method by which individual shoots or plants are cropped which was largely used in this survey is a simple, rapid and valuable technique for obtaining productivity data.

SUMMARY

An area of atypical Spring Mire - Gordon Moss in Berwickshire was studied for its flora, water relations, topography etc., and a general description was prepared. It was noted that springs fed drainage channels in parts of the Moss and these drains continued throughout the mire area, in all places marked by tussocks of Carex paniculata. This tussock growth form was then investigated and so was the plant of Carex paniculata, to establish whether it could be used as an indicator plant for flowing ground water by seeing if it was in fact dependant on flowing mineral-rich ground water for growth. This was proved. The Moss had largely been drained and a study was commenced to see if the production of certain natural species on the remaining Moss area compared favourably or unfavourably with that of the reclaimed Moss, now Juncus spp. infested pastureland. The method of cropping used was one of single shoot increment cropping, and crops were harvested weekly to monthly depending on the time of year and species. The species studied by this method were: Carex paniculata, Phragmites communis, and Filipendula ulmaria. A further production study was carried out on an Eriophorum angustifolium dominated transition mire area, using a quadrat technique.

The results for production for each species and area were compared and discussed.

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Tables.

List of Tables.

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Table I. Depths of peat on Transect crossing Gordon Moss.

Profile Number	Distance From Datum.	Depth of Profile.	Depth of Peat.	Nature of Profile.
I	17.7 m. from causeway.	120 cm.	120 cm.	All Carex peat.
2	100 m.	110 cm.	110 cm.	Top 70 cm Eriophorum peat over Sphagnum.
3	140 m.	135 cm.	135 cm.	Top 30 cm. Carex fibrous gold-brown peat over 105 cm. Sphagnum peat.
4	200 m.	70 cm.	0 cm.	No peat, gravelly soil found only.
5	260 m. (by hut.)	100 cm.	70 cm.	30 cm. soil over 40 cm. peat containing Betula twigs and Carex.
6	300 m.	110 cm.	70 cm.	70 cm. wood peat over 10 cm mixed peat & gravel, 10 cm. coarse grey sand, & 10 cm. finer red sand.
7	330 m.	90 cm.	60 cm.	60 cm. peat over 30 cm. grit.

Table I cont.

Profile Number.	Distance from Datum.	Depth of Profile.	Depth of Peat.	Nature of Profile.
8	360 m.	130 cm.	130 cm.	50 cm Eriophorum peat over Sphagnum Menyanthes seed found at 70 cm down.
9	390 m.	150 cm.	150 cm.	Carex peat cont. Betula twigs & Menyanthes seeds.
10	430 m.	110 cm.	90 cm.	Moss peat not Sphagnum for top 40 cm, over 15 cm Sphagnum peat, Carex peat above moss peat, 20 cm compressed clay & roots at base of profile.
11	460 m.	120 cm.		Carex peat.
12	500 m.	75 cm.		Carex & wood peat.
13	550 m.	100 cm.	80 cm.	60 cm Carex & wood peat over 20 cm. fine grey sand.
14	about 20 m from stream in field	100 cm.	100 cm.	100 cm peat over Old Red Sandstone, thin soil above.

Table 2. Results of Water Analyses from Gordon Moss.

1) Analysis for major ions in water samples from different areas of Gordon Moss.

	HCO_3^-	Cl^-	NO_3^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+	pH.
Eriophorum /	0	19.53		66.72	16.1	7.69	7.66	6.0	4.64±
Carex rostrata	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	0.022
area.	0	0.55	0.02	1.39	0.81	0.81	0.63	0.153	
	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	
Spring area		23.79		81.6	29.75	13.27	14.9	12.18	6.69
with Carex	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	
paniculata.	1.12	0.67	0.02	1.70	1.49	1.09	0.65	0.31	
	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	
Phragmites		31.42	2.48	124.8	56.5	26.84	20.0	8.20	6.57
by stream.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	
	2.53	0.89	0.04	2.60	2.83	2.20	0.87	0.21	
	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	
Filipendula		10.12	5.58	19.39	43.5	19.83	9.61	6.75	6.73
by stream.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	
	3.62	0.29	0.09	0.94	2.18	1.63	0.42	0.17	
	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	
Edge of open		15.62		54.24	19.60	3.54	8.59	3.21	5.20±
heath area.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	0.006
	0.195	0.44	0.04	1.13	0.98	0.29	0.37	0.08	
	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	
Sphagnum	0	15,98		49.44	6.26	3.75	7.49	3.36	3.36±
dominated	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	0.437
area.	0	0.45	0.02	1.03	0.31	0.31	0.33	0.09	
	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	

Table 2 cont.

2) Water samples collected on May 31st, 1967, and analysed for Bicarbonate and pH only. From open Eriophorum heath in North wood area.

Sample Number	pH.	Bicarbonate meq/L	Flora.
1	6.05	0.50	Acrocladium cuspidatum, Sphagnum palustre, S. fimbriatum, S.papillosum.
2	6.5	0.11	Acrocladium cuspidatum, Juncus effusus, Stellaria palustris.
3	6.2	0.63	Sphagnum squarrosum, S. palustre, Carex rostrata.
4	4.45	0.06	Polytrichum commune, Eriophorum vaginatum, Calluna vulgaris.
5	5.7	0.24	Sphagnum palustre, Molinia caerulea, Eriophorum vaginatum.
6	4.5	0.10	Aulocomium palustre, Sphagnum palustre.
7	4.5	0.06	Sphagnum fimbriatum, S. palustre, Eriophorum vaginatum.
8	5.9	0.32	Sphagnum palustre, S. squarrosum, Potentilla palustre.
9	4.65	0.06	Sphagnum cuspidatum, S. rubellum, Eriophorum angustifolium, E. vaginatum.

Table 2, (2) cont.

Sample Number.	pH.	Bicarbonate meq/L.	Flora.
10	4.0		Sphagnum fimbriatum, S. palustre, S. recurvum, Polytrichum commune.
11	6.1	0.55	Sphagnum palustre, Carex rostrata, Molinia caerulea.
12	5.8	0.34	Acrocladium cuspidatum, Sphagnum squarrosum, Carex rostrata.
13	4.1		Sphagnum palustre, S. rubellum, Eriophorum angustifolium, E. vaginatum.
14	6.9	1.24	Carex paniculata, Filipendula ulmaria.
15	7.1	1.74	Sample taken from Hareford Burn.

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3) Water samples from North wood, analysed for pH and Bicarbonate.

Sample Number	pH.	Bicarbonate meq/L.	Site from which sample was taken.
1	5.10	0.33	Mid-stream of Hareford Burn.
2	7.3	1.60	Pool by drain in South wood.
3	6.5	1.30	Closed pool.
4	6.7	1.40	Pool in drain just North of Railway.
5	6.25	0.80	Isolated pool.
6	5.6	0.24	In 'moss' area.
7	4.7	0.12	In regenerating Sphagnum 'moss' area

Table 2. cont.

4) Water samples from Eriophorum sp. / Carex rostrata vegetation, analysed for pH only.

Sample Number.	pH.	Flora.
1	6.65 ± 0.05	Acrocladium cuspidatum, Carex rostrata, Eriophorum angustifolium, Potentilla palustris.
2	4.65 ± 0.025	Carex panicea, Eriophorum angustifolium, Anthoxanthum odoratum, Pedicularis palustris. (Edge of Sphagneteum.)
3	4.40 ± 0.15	Sphagnum papillosum, S. rubellum, Dicranum scoparium, Eriophorum angustifolium, Molinia caerulea, Succisa pratensis, Potentilla palustris.
4	4.375 ± 0.75	Sphagnum cuspidatum, S. papillosum, S. recurvum, Calluna vulgaris, Erica tetralix.

****

Table 3.

Data obtained from one large Carex paniculata tussock.

Site	Ditch running N - S from Noble's Well (South end of the rubbish tip) through the wood to Hareford Burn.
Size of Tussock :	
Height	75 cm.
Girth	180 cm.
No. shoots	907.

Dry weight of litter on tussock :	4477.8 grms.
Dry weight of leaf bases :	2745.35 grms.
Dry weight of zone of mixed leaf bases and roots :	4299.55 grms.
Dry weight roots :	2887.88 grms.
Dry weight live shoots on tussock :	1014.5051, grms.
Total live material on tussock :	1014.5051 grms.
Total dead material on tussock :	14410.58 grms.
Total weight of tussock :	15425.09 grms.
Ratio live : dead material :	0.093422988
	9.34%

Weights of 20 shoots of each of the 5 size classes.

Size class	Fresh weight 20 shoots.	Mean fresh wt. per shoot.	Total no. shoots in that size class.	Total no. shoots.
i	73.72 g.	3.686 g.	329	
ii	106.31 g.	5.3165 g.	240	
iii	125.22 g.	6.261 g.	183	907.
iv	115.25 g.	5.7625 g.	107	
v	99.4 g.	4.97 g.	48	

Table 3 cont.

Dry weights of live and dead material in 20 shoots of each size class from one large Carex paniculata tussock.

Size Class	Live	Dead	Ratio Live / Dead	Mean Dry Weight / Shoot. Live.	Dead.	Total.
i	7.8 g.	3.67 g.	2.125	0.39 g.	0.1835 g.	0.5735 g.
ii	16.24 g.	5.46 g.	2.975	0.813 g.	0.273 g.	1.085 g.
iii	24.67 g.	8.19 g.	3.0	1.233 g.	0.4095 g.	1.643 g.
iv	27.1 g.	11.3 g.	2.4	1.355 g.	0.565 g.	1.92 g.
v	26.12 g.	12.3 g.	2.12	1.306 g.	o.615 g.	1.921 g.

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Table 4.

i) Density of Phragmites plants per metre^2 quadrat.

a) on stream bank.

May 31st.	Small	Large	Dead	Total
	7	4	0	11
	3	4	0	7
	0	6	0	6
	1	4	0	5
	1	8	0	9
	1	9	0	10
	2	12	0	14
	1	7	0	8
	1	0	0	1
	1	4	0	5
Total for 10 Quadrats :	18	58	0	76
Mean :	1.8	5.8	0	7.6 plants per metre^2.
June 22nd.	2	8	0	10
	0	4	1	5
	1	4	1	6
	3	5	0	8
	2	6	0	8
	0	10	0	10
	0	8	0	8
	1	9	1	11
	0	3	0	3
	0	2	0	2
Total for 10 Quadrats :	9	59	3	71
Mean :	0.9	5.9	0.3	7.1 plants per metre^2.

Table 4 cont.

Aug. 17th. Total no. Phragmites plants per $1m^2$ quadrat.

	20
	7
	8
	15
	18
	4
	12
	19
	4
	5
Total for 10 quadrats :	112
Mean :	11.2 plants per $metre^2$.

b) By wood.

May 31st.	Small	Large	Dead	Total.
	6	0	0	6
	6	0	0	6
	2	3	0	5
	6	3	0	9
	10	7	0	17
	3	5	0	8
	0	2	0	2
	2	3	0	5
	2	6	0	8
	3	1	0	4
Total :	40	30	0	70
Mean :	4.0	3.0	0	7.0 plants per $metre^2$.

Table 4 cont.

b) Phragmites plants by wood cont.

August 17 th.	Total no. Phragmites plants per 1 m^2 quadrat.
	8
	6
	11
	9
	10
	9
	6
	1
	6
	3
Total for 10 quadrats :	69
Mean :	6.9 plants per $metre^2$.

Table 4 cont.

ii) Density of Filipendula plants per ¼ metre^2 quadrat.

May 31st.	Total.
	22
	11
	7
	13
Mean no. plants per metre^2.	13.25

August 17th.	Mature plants	New shoots.
	6	
	7	
	8	1
	11	1
	4	
	8	
	4	
	4	
	2	
	7	
Mean no. plants per metre^2.	6.1	

N.B. The new shoots are omitted from the mean number of plants per metre^2 because it is thought that they represent overwintering shoots for next season's growth which have developed after the death of a mature plant which otherwise would have shaded the new shoot out.

Table 5.

Production in the mixed Carex rostrata - Eriophorum angustifolium vegetation.

Species.		Sample.					
a) live material.	Feb.	March.	April.	May.	June.	July.	August.
Eriophorum angustifolium	7.1g.	7.1g.	7.7g.	16.9g.	12.9g.	16.9g.	9.59g.
E. vaginatum	0	9.5g.	3.2g.	1.15g	1.4g.	4.85g.	8.5g.
Carex rostrata	78.8g.	54.0g.	62.2g.	100g.	44.6g.	40.6g.	29.7g.
Anthoxanthum odoratum.		2.0g.			0.2g.	0.07g	1.33g.
Holcus lanatus.		0.8g.	0.96g.		0.5g.	0.33g.	
Erica tetralix.		7.5g.					
Filipendula vulgaris.					0.6g.	2.0g.	8.49g.
Potentilla erecta.					0.3g.	0.14g.	0.84g.
P. palustris.		11.4g		1.5g	2.4g.	7.5g.	20.2g.
Polygala vulgaris.						0.04g.	0.07g.
Hypochaeris radicata.						0.19g.	
Succisa pratensis.			1.66g.			0.68g.	1.65g.
Viola palustris.	0.01g.		0.03g.		0.3g.	0.11g.	0.04g.
Acrocladium cordifolium			0.59g.			0.16g.	
A. cuspidatum.	12.7g.		8.7g.	71.45g		53.3g.	90.0g.
A. stramineum			0.93g.				
Brachythecium velutinum.						0.01g.	
Hylocomium splendens.			6.1g.			1.12g	0.32g.
Lophocolea bidentata			0.25g.				
Mylia anomala						0.01g.	
Mnium affine						0.19g.	
M. hornum			0.02g.			0.01g.	
M. punctatum.			1.19g.			0.01g.	
M. undulatum.			0.74g.			0.01g.	0.44g.
Rhytidiadelphus loreus.				0.13g.		3.56g.	
Sphagnum palustre.						0.05g.	
b) dead material.							
Eriophorum angustifolium	7.7g.	25.4g.	12.9g.	12.0g.	24.4g.	21.4g.	12.9g.
E. vaginatum		2.0g.	3.0g.	1.1g.		8.7g.	4.2g.

Table 5 cont. Carex rostrata / Eriophorum vaginatum production.

Species.							
b) dead material cont.	Feb.	March.	April.	May.	June.	July.	August.
Carex rostrata	163.2g	24.0g.		30.8g.	55.3g.	19.8g.	130.5g.
Anthoxanthum odoratum.							
Holcus lanatus,			1.41g.				
Filipendula ulmaria		1.1g.	1.7g.	9.0g.	3.2g.	0.22g.	
Unallocated litter.			28.06g	1.1g		4.3g.	12.6g.
Total live product :	98.61g	202.11g	94.27g	191.13	63.2g	131.84	171.17g.
Total dead :	170.9g	52.5g.	46.44g	54.0g.	82.9g	54.42g	160.2g.
Total product i)	269.51g	254.61	140.71	245.13	146.1	186.66	331.37g.
Total weight of second sample set :	276.0g	271.3g.	301.g.	272g.	219g.	220g.	397.5g.

Figures 1 to 23.

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fig.1. View of Gordon Moss from field above railway line. to E.N.E. of Laird's Bog

fig. 2. View from road to North of Gordon Moss.

Fig. 3. Panoramic view of Gordon Moss from remains of railway bridge over the Gordon to Earlston road, A. 6105.

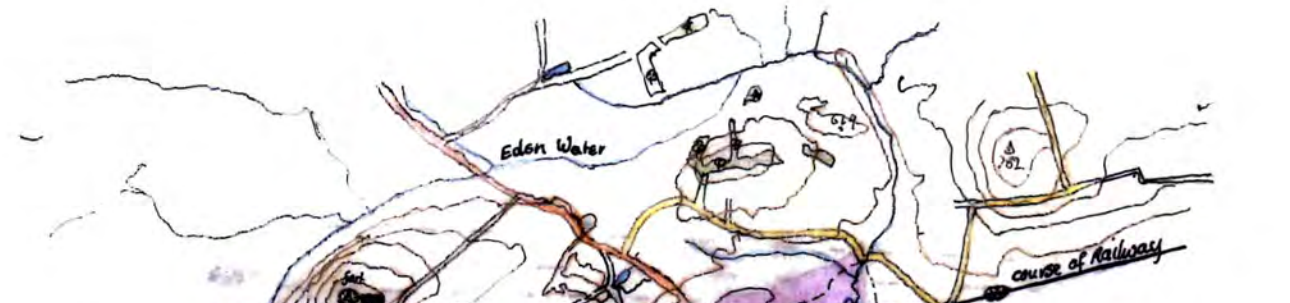
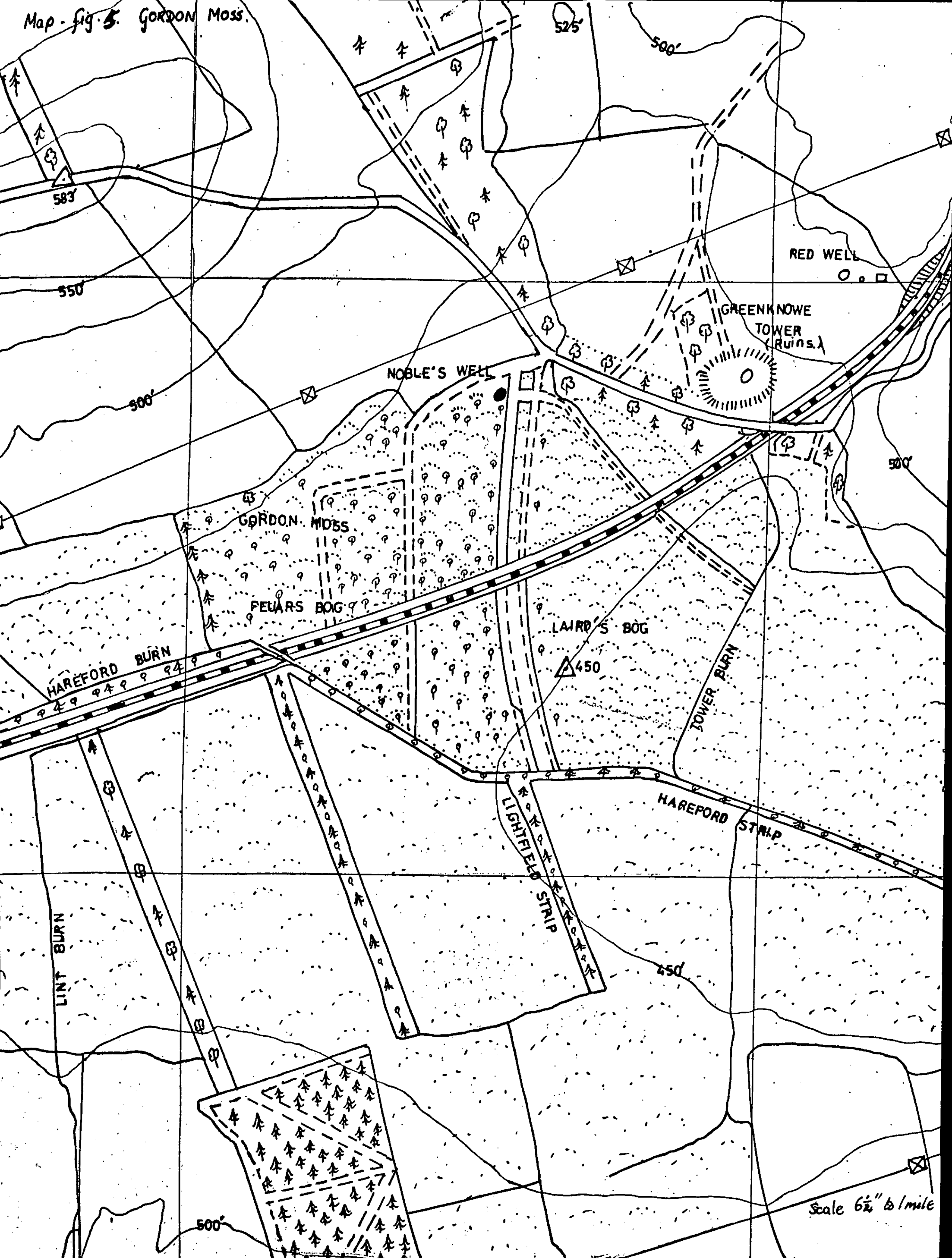


Fig 4. Geological & General Map of the Area round Gordon Moss to show drainage etc.

Scale 1" ≡ 1 mile

from Ordnance Survey Map sheet 63 Seventh series



Map - fig 5. GORDON MOSS.
525'
500'
583'
550'
500'
RED WELL
GREENKNOWE
TOWER
(Ruins.)
NOBLE'S WELL
GORDON MOSS
FEUARS BOG
LAIRD'S BOG
450
500'
HAREFORD BURN
TOWER BURN
HAREFORD STRIP
LIGHTFIELD STRIP
LINT BURN
450'
500'
Scale 6¼" to 1 mile

Map - fig 6. GORDON MOSS

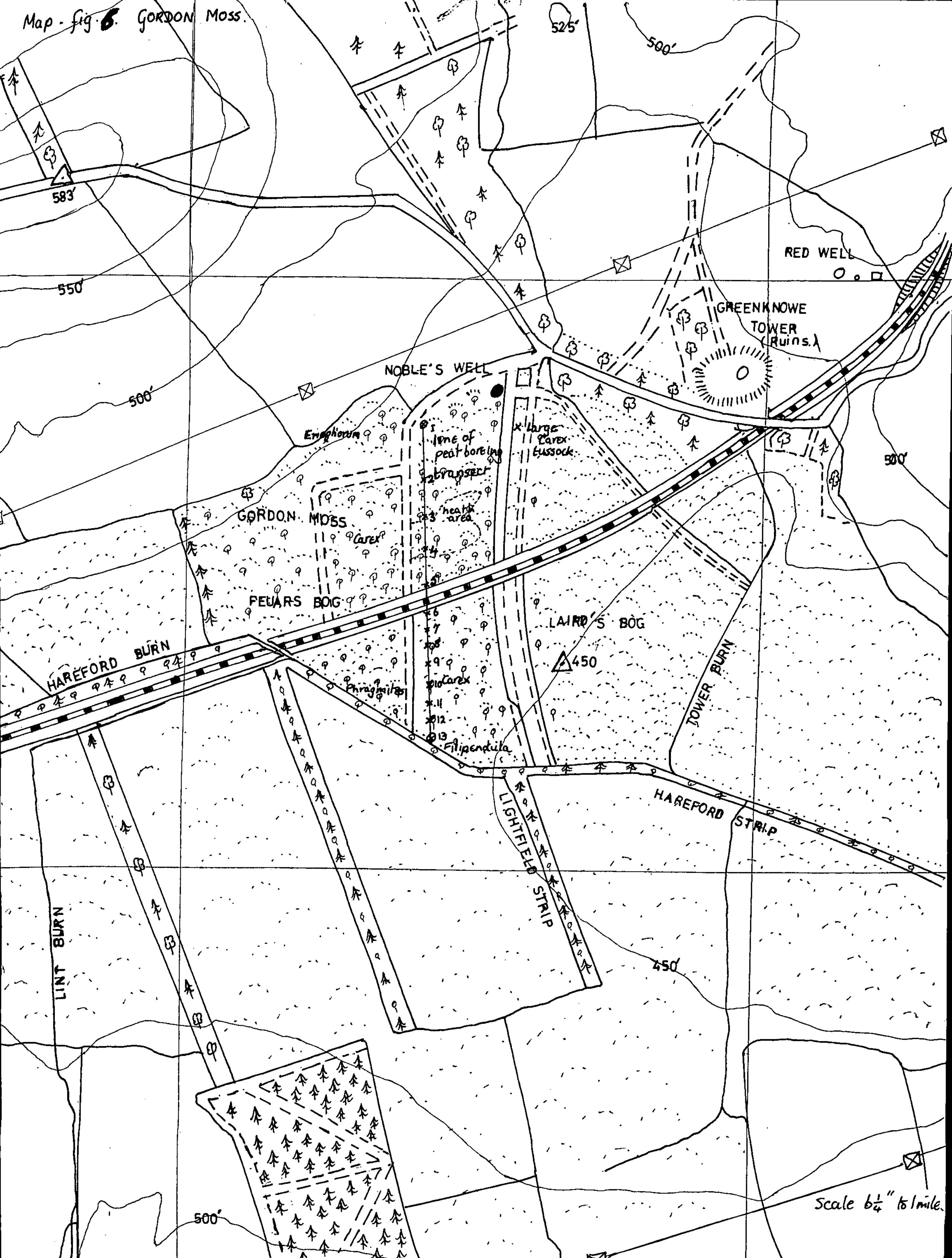
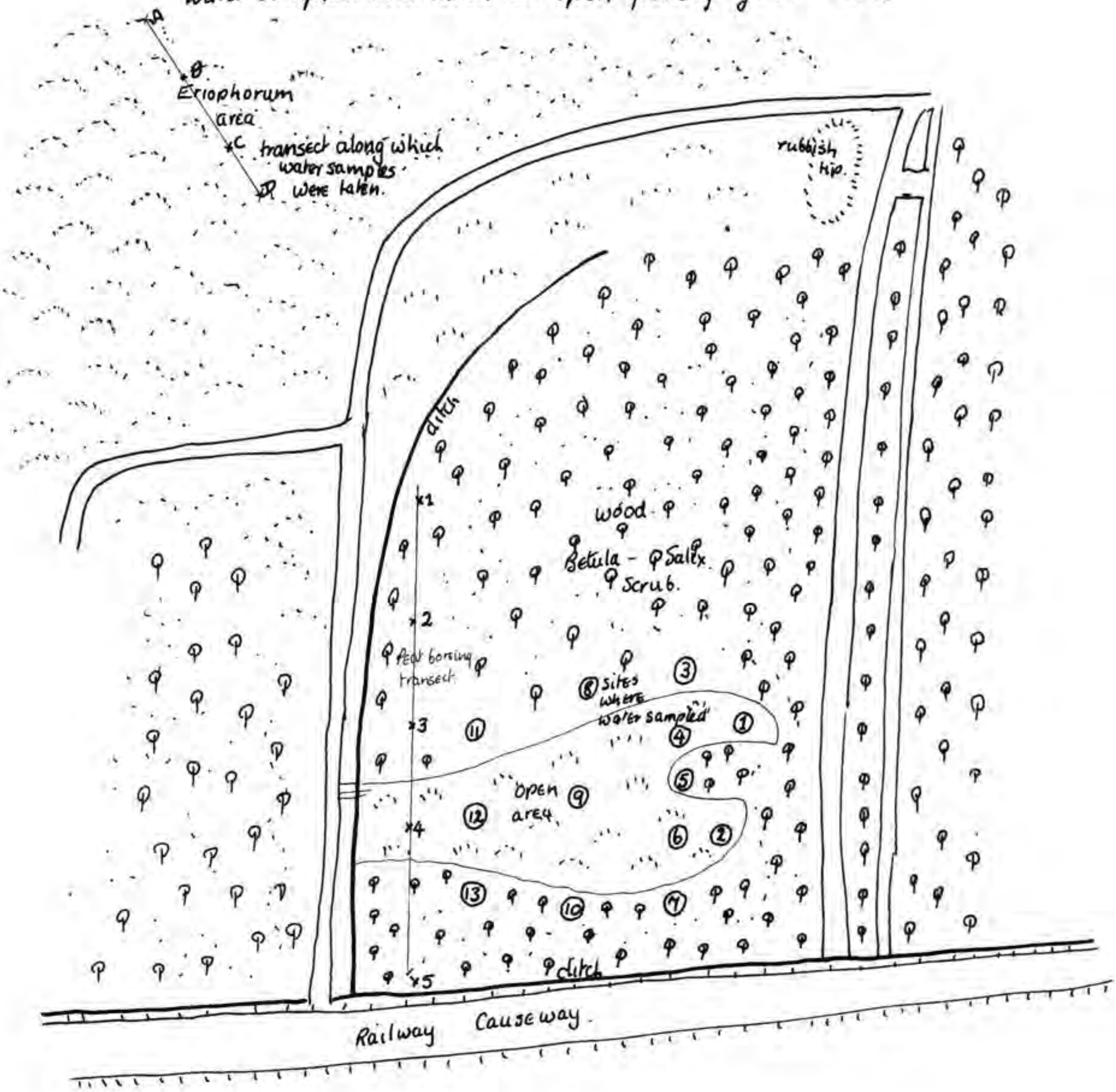


Fig. 7.

Sketch Map to show the approximate location of areas where Water samples were taken on open parts of Gordon Moss.



approximate Scale 20·5 inches ≡ 1 mile.

Fig. 8. Panoramic view of Gordon Moss from the Gordon to Earlston road A.6105.

Fig. 9. The South wood area where Carex paniculata was cropped
Tree canopy made up of Betula verrucosa & Salix Sp.

Fig 10. North wood area, Showing Carex paniculata, Betula sp & Salix sp.

Fig 11. Carex paniculata in North wood area.

Fig 12. Phragmites communis
in area by wood, where it is mixed with Filipendula ulmaria

Fig 13. Phragmites communis on the bank of Hareford Burn.

Fig. 14. Filipendula ulmaria
by Hareford Burn.

Fig. 15. Eriophorum angustifolium dominated vegetation in open area North of Salix/Betula woodland.

Fig. 16. A large Carex paniculata tussock, cut in half to show zonation of leaf bases, roots, etc, with one plant fully dissected to show that its root system reaches to the very base of the tussock.

Fig. 17.

Photograph of an autoradiograph taken with a Carex paniculata plant placed in radioactive Caesium salt solution for 60hrs, showing that the radioactive salt has been transported throughout the plants from the roots to the apical meristems.

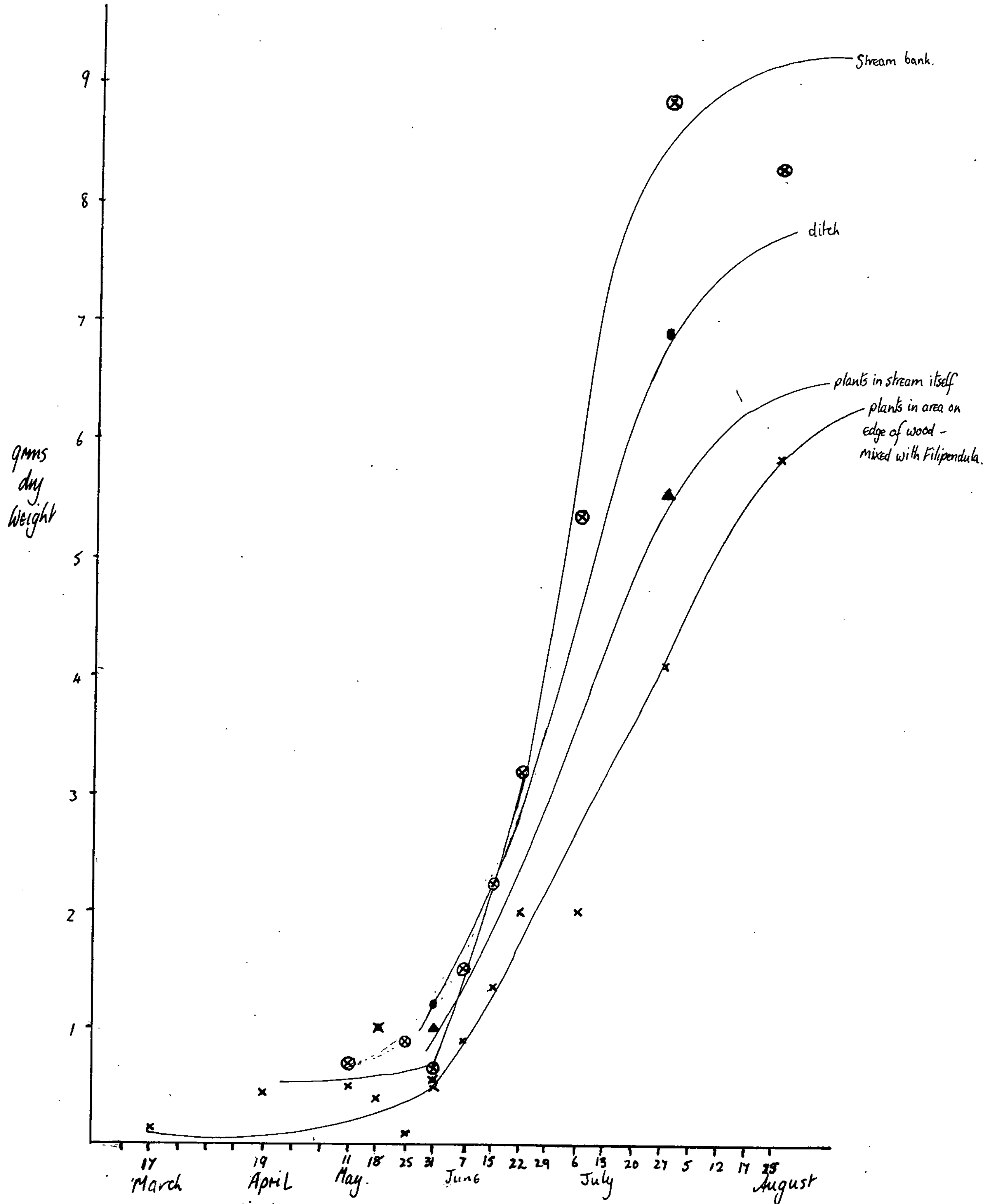


Fig 18.

Comparative standing crops for Phragmites in four areas through out growing season

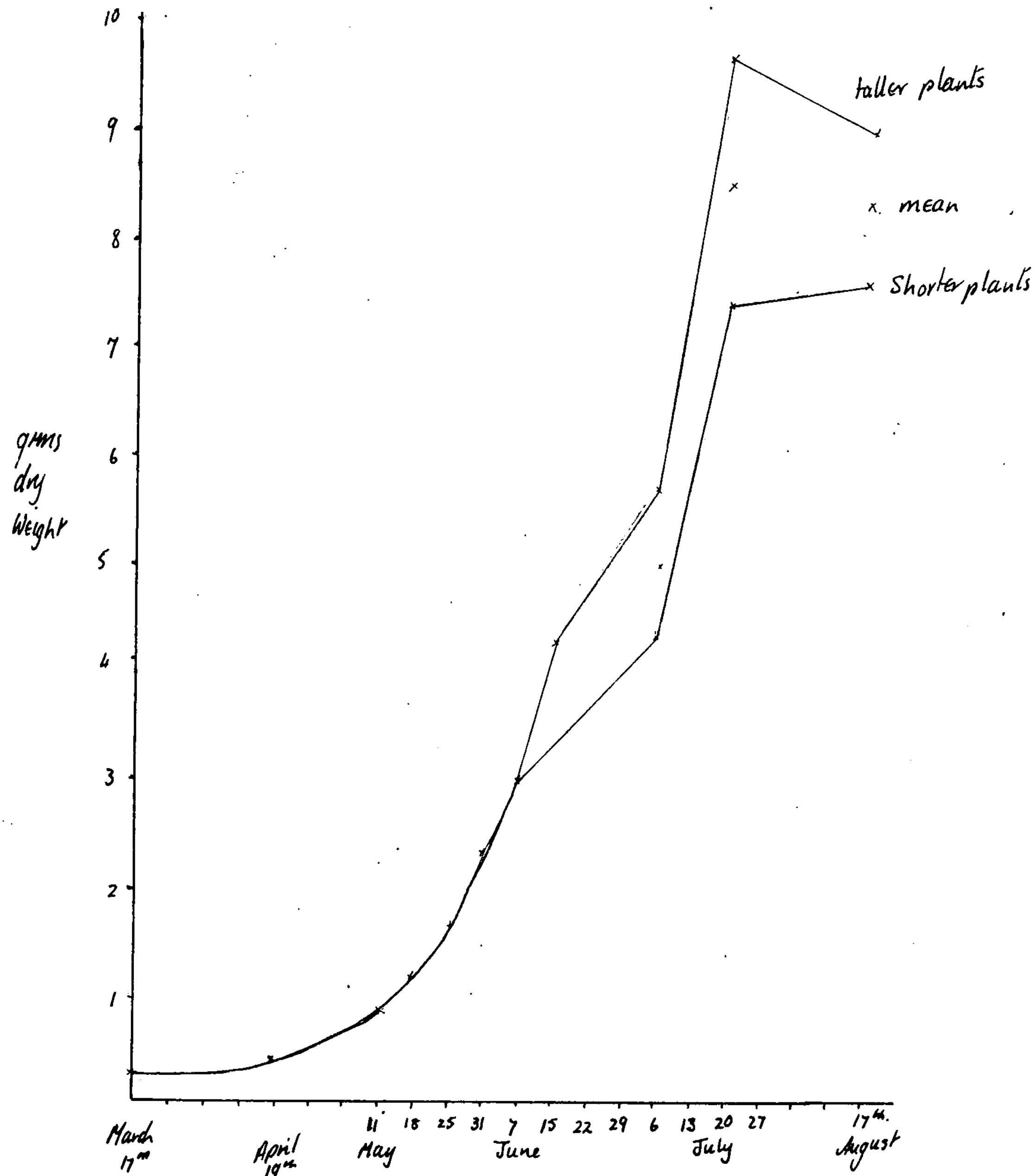


Fig 19. Comparative Standing crops for Filipendula ulmaria throughout growing season.

fig. 20. Meanweights of Carex paniculata showing live and dead components from Aliquots, in which each plant was weighed.

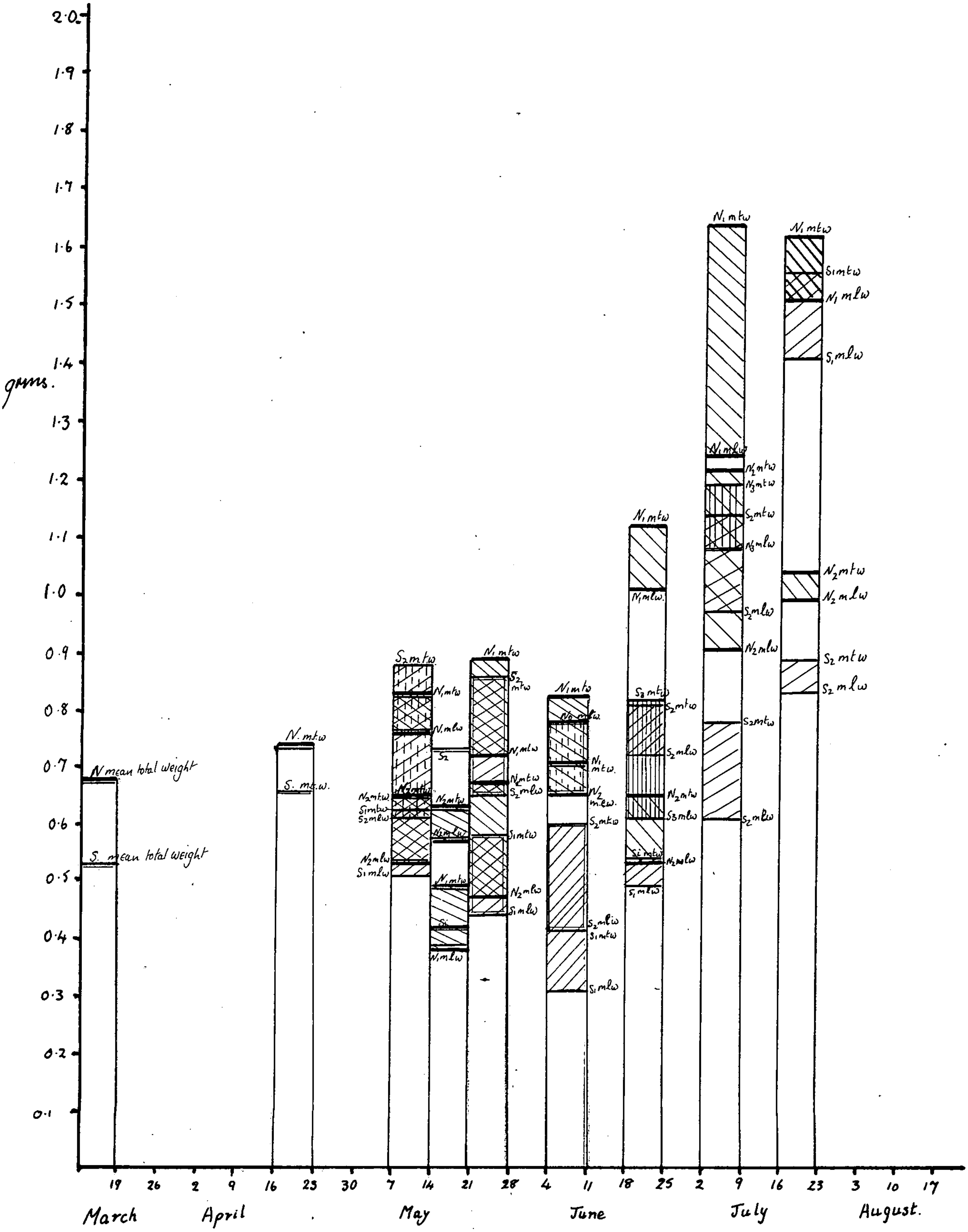


fig 21. Mean weights of Carex paniculata showing total and live product from Aliquots and also from 'lumped' samples.

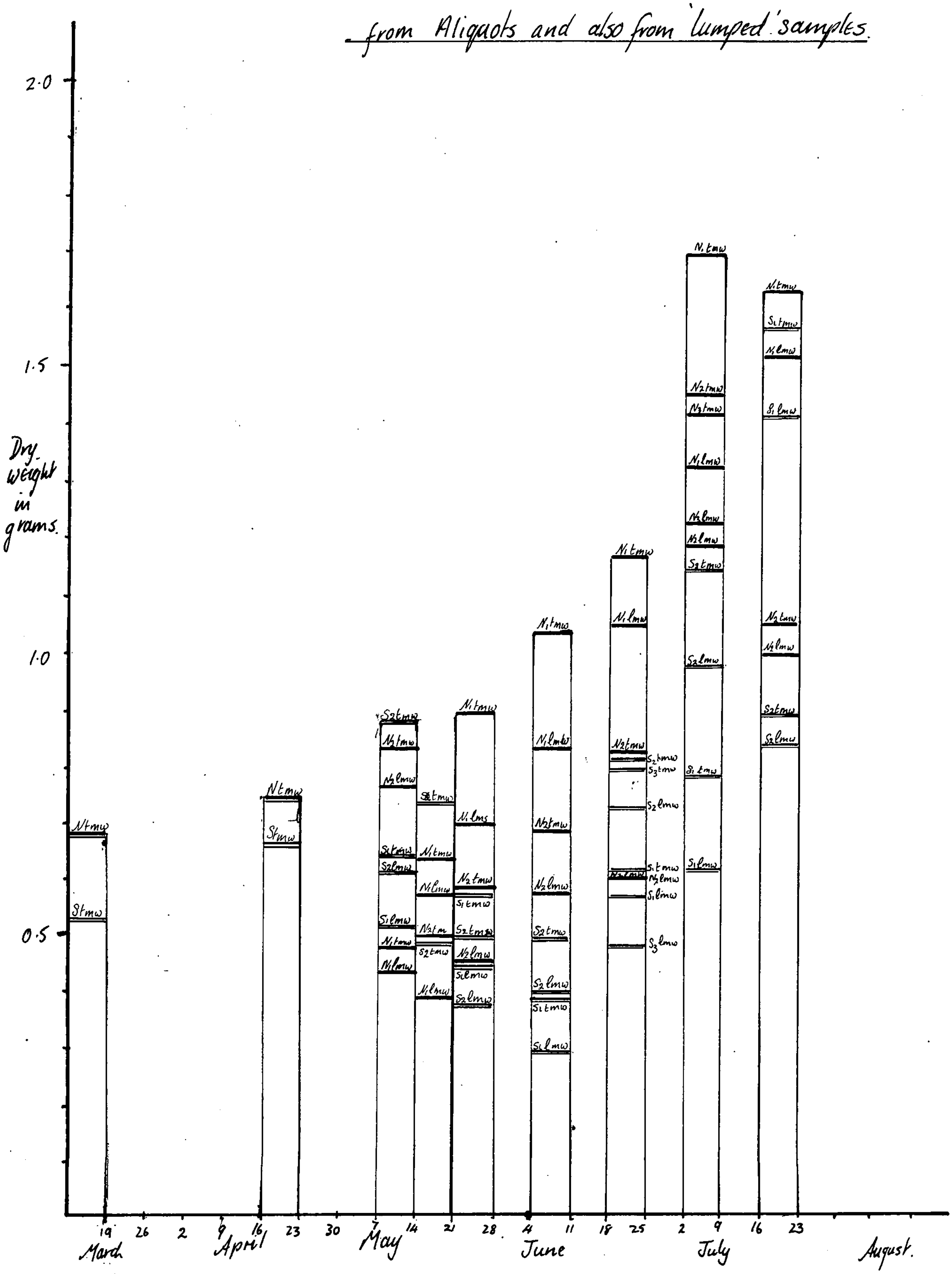


Fig. 22. Mean weights of Filipendula ulmaria plants from Aliquots & lumped collections

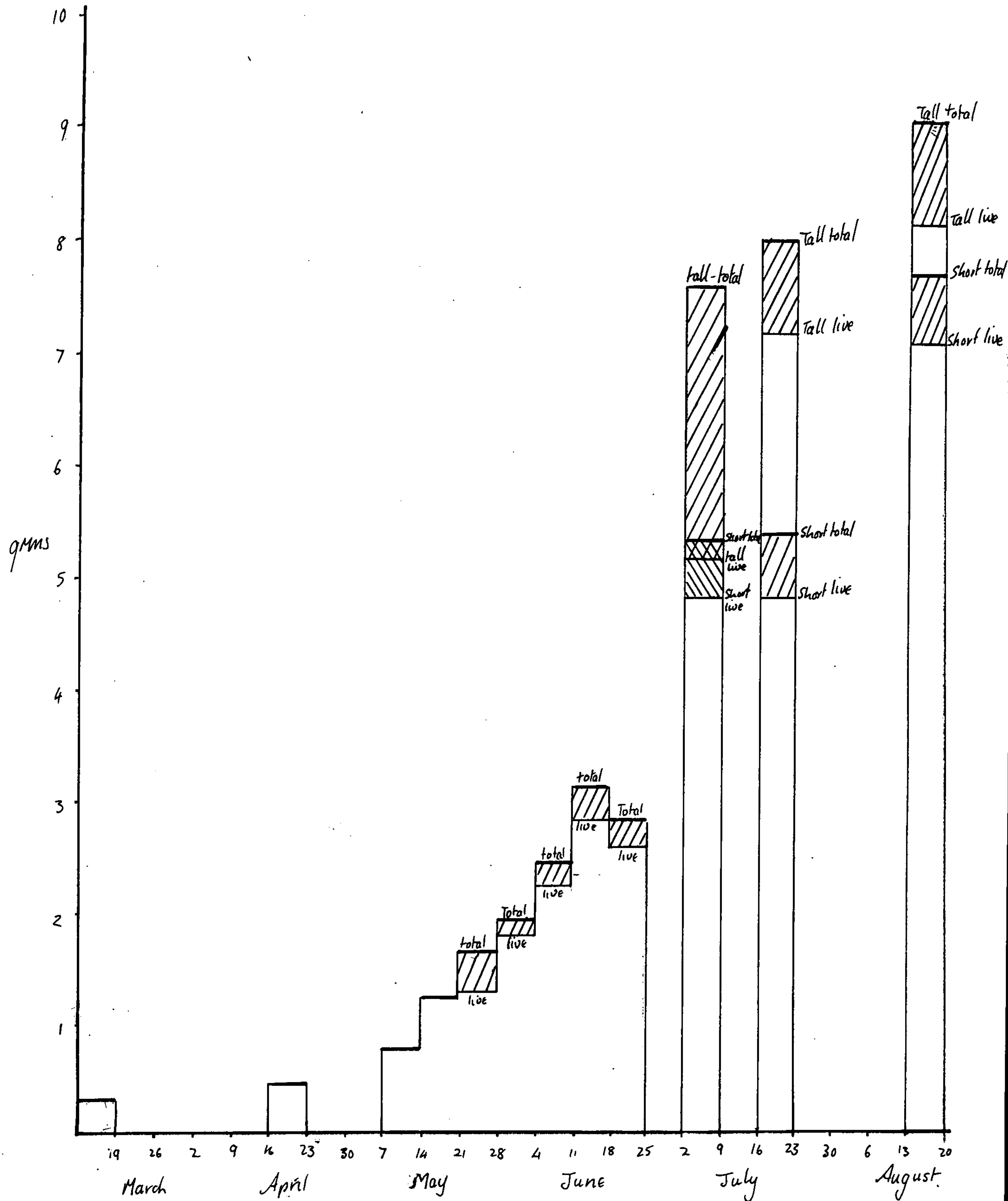
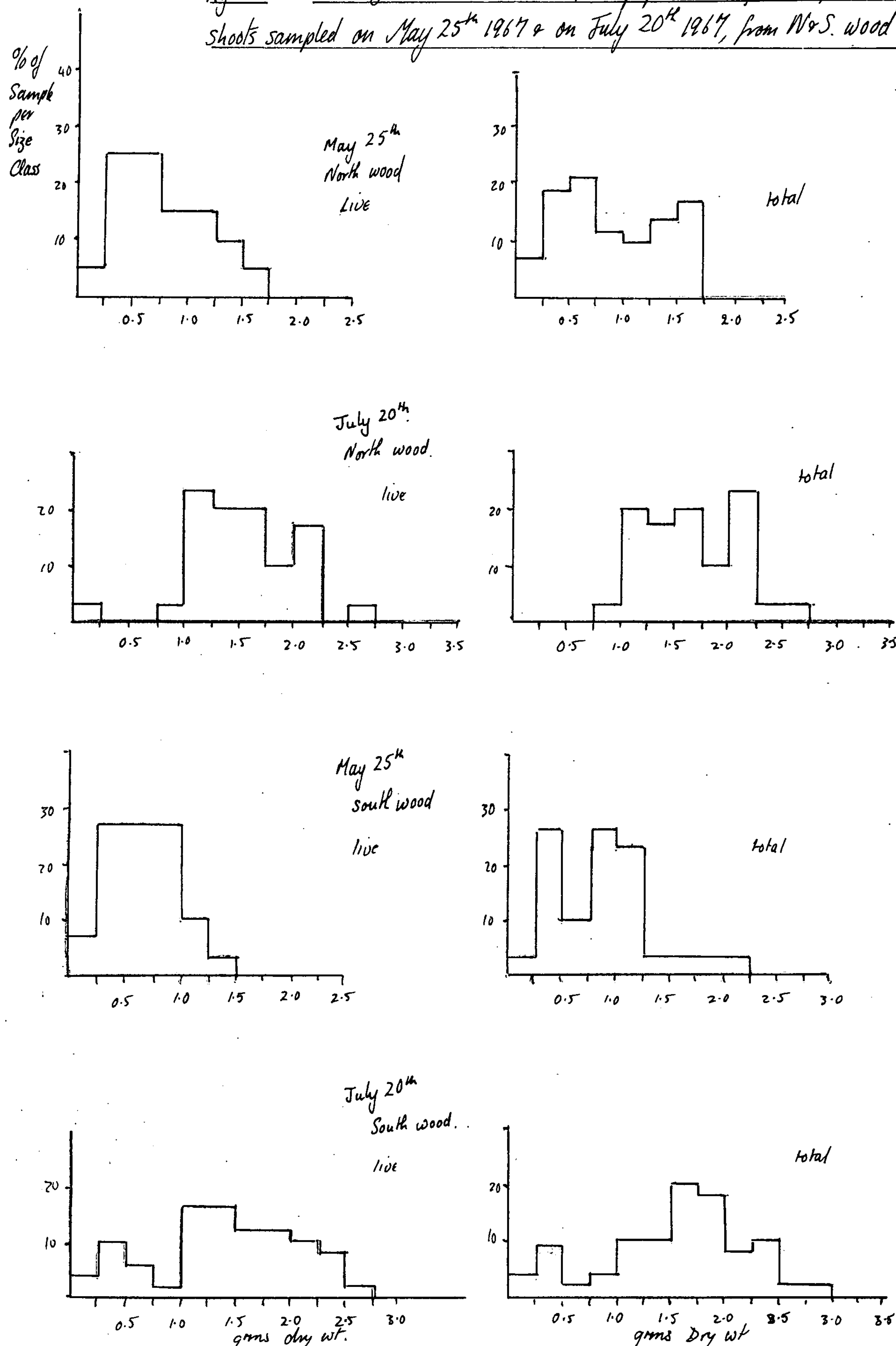


Fig. 23. The Size Class structure of the populations of Carex paniculata shoots sampled on May 25th 1967 & on July 20th 1967, from N & S. wood areas.



APPENDICES I to IV.

Appendix I.

Appendix I.

The description of Gordon Moss given by a Mr. Stobbs in the Annals of the Berwickshire Naturalists Club, Vol. 9, for 1879 - 1881.

" The Moss is one by nature, but belongs to four proprietors. It is divided by a stank, which helps to drain it. The moss has been a lake unable to drain itself, by its outlet deepening its bed in the course of ages. A dyke of basalt that crosses the country at its eastern extremity proved too tough to be so easily worn down as the rest of the land. This dyke of basalt had to be blasted with gunpowder when the stank was made and the moss drained about 60 years ago. There is a succession of very fine springs down the course of the trap or basalt dyke that breaks through the red sandstone from the railway station to the moss. In the moss there is a well known 'verter' i.e. virtue well, which has a strong tincture of iron. Hazel and birch are the chief ligneous constituents dug up in the moss. The monks of Kelso Abbey had two petaries here, and six cottages of which each of the tenants was bound to deliver annually thirty wain loads of dry peats at the cloister. Each husbandman of the 28 husbandlands of Bolden or Bowden, Roxburghshire, was also obliged to furnish a wain to carry peats from the moss at Gordon to the Abbey. These amounted to 208 wain-loads per annum. "

Unfortunately this early description gives no indication of how wet the moss was during the last century, to enable a comparison to be made with present- day conditions, or to give an indication of the amount of regeneration of peat which has occurred during the last century. So much peat has been cut from the moss since the Middle Ages, that the remaining layer in the basin is rather shallow, and represents Zone VI, Boreal peat deposits, and later deposits, where the peat is deeper. Peat regeneration is taking place, and Sphagna dominate the vegetation of these actively regenerating areas.

Appendix II.

The Flora of Gordon Moss, Berwickshire.

Contents : page.

Appendix II.

The Flora of Gordon Moss.

Gordon Moss has long been locally famous for its unusual fauna and flora. The following record of species occurring on the moss at the end of the last century, is taken from Vol. 9. of the Annals of the Berwickshire Naturalists Club, 1879 - 1881.

Catabrosa aquatica
Stellaria glauca
Orchis incarnata
Utricularia minor
Several species of Potomageton.
Botrychium lunaria.

Also in this volume is found:-

"A List of Plants from the neighbourhood of Gordon Moss.

Vicia angustifolia   on edge of right-hand bog from Gordon.
Drosera rotundifolia
Hydrocotyle vulgaris
Pedicularis palustris
Orchis latifolia   colours from pure white to lilac and deep purple.
O. latifolia var. incarnata   (bogs.)
Comarum palustre
Menyanthes trifoliata
Myosotis caespitosa
M. repens
M. versicolor
Ranunculus flammula
Triglochin palustre
Valeriana officinale

Montia fontana
Lythrum salicaria
Genista anglica
Mentha aquatilis
Eriophorum vaginatum
E. polystachion
Sparganium natans
Habenaria bifolia
Hippuris vulgaris
Callitriche platycarpa
Carex ovalis
C. paniculata
C. pulicularis
C. panicea
C. aquatilis
C. glauca
C. ampullacea
C. stellulata
C. teretiusulca (rare)
C. curta
C. pallescens

Catabrosa aquatica	in ditch running North from left-hand bog.
Utricularia minor	in water holes at West end of right-hand bog from Gordon.

Stellaria glauca
Botrychium lunularia
Lemna trisulca
L. minor
Potomageton natans
P. praelongus
P. polygonifolius
P. pulsillus
Galium uliginosum
Juncus acutifolius

Salix repens var. argentia

S. repens var. fusca

Hypnum crista castrensis

Sphagnum cymbifolium

Bryum ? "

Most of these species are still to be found in various areas of the moss. Only the flora in the vicinity of the cropping areas was studied and consequently certain species which grow in parts of the moss away from the cropping areas may not be recorded here. Cover / abundance values were estimated on the Braun-Blanquet scale.

A list of species now found on the moss is given in the following pages.

A List of Plant Species found on Gordon Moss.

1) Species found growing by Hareford Burn.

a) Associated with the stand of Filipendula ulmaria :

	Cover / Abundance.
Filipendula ulmaria	5
Cirsium palustre	+
Galium aparine	+
Heracleum sphondylium	+
Rubus idaeus	+
Rumex acetosa	+
Valeriana officinalis	+

b) Associated with the stand of Phragmites communis :

i) on the stream bank.

Phragmites communis	3
Filipendula ulmaria	2
Urtica dioica	1
Galium aparine	+
Holcus mollis	+
Lysimachia vulgaris	+

ii) by the wood area.

Phragmites communis	3
Filipendula ulmaria	3
Urtica dioica	1
Angelica sylvestris	+
Valeriana officinalis	+

2) Species found in the areas of woodland vegetation on Gordon Moss :

a) South of the railway :

	Cover / Abundance.	
Betula pubescens	3	
B. verrucosa	3	
B. pubescens / verrucosa hybrids	3	
Salix aurita	1	
S. cinerea var. atrocinerea	1	
S. nigricans	+	
Potentilla erecta	+	
P. palustris	3	
Filipendula ulmaria	1	
Rubus idaeus	+	
Caltha palustris	+	
Chamaenarion angustifolium	+	
Epilobium hirsutum	+	
Lythrum salicaria	+	
Lysimachia vulgaris	+	
Calluna vulgaris	1	
Erica tetralix	1	
Potamogeton polygonifolius	+	
Succisa pratensis	+	
Carex paniculata	3	
C. dioica	+	
C. flacca	+	
C. nigra	+	
C. pseudocyperus	+	
C. pulicularis	+	
Eriophorum angustifolium	1	(by pools.)
Luzula sylvatica	+	
Juncus effusus	+	
Agrostis stolonifera	+	

2a) continued.

	Cover / Abundance.
Anthoxanthum odoratum	1
Deschampsia caespitosa	1
Holcus lanatus	+
Molinia caerulea	1
Festuca ovina	+
Equisetum fluviatile	+
E. palustre	1
Dryopteris dilatata	+
D. felix-mas	+
Acrocladium cuspidatum	2
A. cordifolium	+
Aulocomium palustre	+
Brachythecium velutinum	+
Ctenidium molluscum	+
Dicranum scoparium	+
Dicranella heteromalla	+
Mnium hornum	+
M. punctatum	+
M. undulatum	+
Polytrichum commune	1
Sphagnum cuspidatum	1
S. fimbriatum	1
S. palustre	1
S. plumulosum	1
S. umbricatum	+

By pools and the drain :

Carex paniculata	4
Eriophorum angustifolium	+
Equisetum fluviatile	+
Acrocladium cuspidatum	+
A. cordifolium	+

2a) continued.

	Cover / Abundance.
Sphagnum fimbriatum	+
S. recurvum	+

2b.) North of the railway.

	Cover / Abundance.
Betula pubescens	3
B. verrucosa	3
Salix aurita	1
S. cinerea var. atrocinerea	1
Sorbus acuparia	+
Salix nigricans	+
Filipendula ulmaria	+
Potentilla palustre	2
P. erecta	2
Geum rivale	+
Erica tetralix	+
Calluna vulgaris	1
Menyanthes trifoliata	+
Epilobium palustre	+
Rumex acetosa	+
Viola palustris	+
Galium saxatile	+
G. uliginosum	+
Angelica sylvatica	+
Heracleum sphondylium	+
Valeriana officinalis	+
Succisa pratensis	+
Chrysosplenium alternifolium	+
C. oppositifolium	+
Stellaria palustris	+
Potamogeton polygonifolius	+

2b) continued.

	Cover / Abundance.
Potamogeton lutescens	+
Corallorrhiza trifida	+
Dactylorchis fuchsii	+
D. fuchsii var. erioceteum	+
Dactylorrhiza purpurella	+
Dactylorchis / Dactylorrhiza hybrids	+
Plantanthera bifolia	+
Myosotis caespitosa	+
M. discolor	+
M. secunda	+
Anthoxanthum odoratum	+
Agrostis tenuis	+
A. stolonifera / canina hybrids	+
Holcus lanatus	+
Juncus effusus	+
Luzula sylvatica	+
Eriophorum angustifolium	2
E. vaginatum	1
Carex diandrea	+
C. dioica	+
C. paniculata	3
Dryopteris dilatata	+
D. felix-mas	+
Equisetum palustris	+
E. varigatum	+
Acrocladium cuspidatum	2
A. cordifolium	+
A. stramineum	+
Aulacomium palustre	1
Hylocomium splendens	1
Hypnum cupressiforme	+

2b) continued.

Species	Cover / Abundance.
Mnium hornum	+
M. punctatum	+
M. undulatum	+
Polytrichum commune	+
P. piliferum	+
Ptilidium ciliare	+
Sphagnum palustre	+
S. cuspidatum	+
S. fimbriatum	+
S. plumulosum	+
Lophocolea bidentata	+
Mylia anomala	+

Lichens on Birch and Willow trees :-

Parmelia sp.	+
Usnia sp.	+

3) Species found in the open heath area North of the Railway :

	Cover / Abundance
Carex rostrata	2
C. paniculata	1
Eriophorum angustifolium	2
E. vaginatum	3
Juncus effusus	+
Agrostis stolonifera	+
Molinia caerulea	1
Betula pubescens	+
B. verrucosa	+
Calluna vulgaris	3
Erica tetralix	3
Angelica sylvestris	+
Cirsium palustre	+
Potentilla palustris	+
P. erecta	+
Geum rivale	+
Menyanthes trifoliatus	1
Stellaria palustris	+
Succisa pratensis	+
Potamogeton polygonifolius	+
Equisetum fluviatile	+
E. limosum	+
Acrocladium cordifolium	+
A. cuspidatum	3
Aulacomium palustre	+
Polytrichum commune	+
P. strictum	+
Rhytidiadelphus squarrosus	+
Sphagnum cuspidatum	2
S. fimbriatum	+
S. palustre	1

3) continued.

	Cover / Abundance.
Sphagnum papillosum	+
S. recurvum	+
S. rubellum	+
S. squarrosum	1

4) Species found with Eriophorum sp. in open mire at the North end of Gordon Moss:

Eriophorum angustifolium	3
E. vaginatum	2
Carex flacca	1
C. nigra	+
C. panicea	+
C. rostrata	3
Juncus effusus	1
Anthoxanthum odoratum	1
Deschampsia caespitosa	+
D. flexuosa	+
Festuca ovina	+
Holcus lanatus	+
Betula pubescens	+
B. verrucosa	+
Salix sp.	+
Calluna vulgaris	1
Erica tetralix	+
Potentilla erecta	+
P. palustre	+
Heracleum sphondylium	+
Valeriana officinalis	+
Hieracium sp.	+
Taraxacum officinale	+
Cirsium palustre	+
Succisa pratensis	+
Acrocladium cuspidatum	2

4) continued.

	Cover / Abundance.
Acrocladium stramineum	+
Aulacomium palustre	+
Brachythecium velutinum	+
Dicranum scoparium	+
Mnium affine	+
M. hornum	+
M. punctatum	+
M. undulatum	+
Pleurozium schreberi	+
Sphagnum cuspidatum	1
S. fimbriatum	+
S. papillosum	+
S. palustre	1
S. recurvum	+
S. rubellum	+

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The orchids on Gordon Moss were particularly interesting for the diversity of hybrids between Dactylorchis fuchsii and Dactylorhiza purpurella or D. incarnata. The colours of these hybrids as remarked on in Stobbs' 1879 account varied from deep purple to white and a salmon pink colour. One of the hybrids found resembled very closely Dactylorchis transteineri both in colour and shape of the flowers, but this species has not been recorded from this area of the Border previously. Similarly a plant which must by the distribution of the species be Dactylorhiza purpurella had the broader labellum, deep purple colour and unspotted leaves of the Southern species of Marsh Orchis, D. praetermissa. A study of the genetic variation within the Dactylorchis - Dactylorhiza hybrid population on Gordon Moss would be most interesting and illuminating.

Other rare species found in different areas of Gordon Moss are :-

Corallorhiza trifida

Pyrola rotundifolia

P. media

Chrysosplenium alternifolium

C. oppositifolium

Stellaria palustris.

Appendix III.

Methods Used for Analysis of Water Samples from Gordon Moss.

Appendix III.

Methods used for the analyses of water samples taken from Gordon Moss.
(See also Mackereth : Some Methods of Water Analysis for Limnologists. published by the Freshwater Biological Association, 1963.)

1) pH.

This was measured electrometrically using a glass electrode.

2) Concentration of weak acid radicals, mainly bicarbonate - $HCO_3^=$.

This was measured by titrating the sample with Standard acid...N / IOO HCl to an end point at pH 4.5, when all bicarbonate in the sample is present as undissociated Carbonic acid ...H_2CO_3, or as CO_2 in aqueous solution. The indicator used for this was B.D.H. standard pH 4.5 indicator, which contains 0.02% methyl red and 0.1% bromocresol green in neutral 95% alcohol.

3) Concentration of strong acid salts, mainly sulphate, $SO_4^=$, chloride, Cl^- and nitrate, NO_3^-.

Measured by an ion exchange method, using hydrogen charged synthetic resin as an exchange surface. The concentration of the free acids thus produced in equivalent concentration to the salts present in the sample is obtained by back titration with Standard potassium hydroxide (KOH) to pH 4.5. It is assumed that all weak acids are undissociated at this pH value.

Sulphate and Nitrate alone.

An ion exchange column with the upper in the silver form, and the lower half in the hydrogen form was used. Halides are held back on the upper half as insoluble silver salts, in practice mainly silver chloride, the ionic content of the eluent being that of sulphate and nitrate alone.

Nitrate alone.

The phenol-disulphonic acid method was used, comparing the colouration produced spectophotometrically.

By subtraction the concentrations of all three major anions in each sample may be found.

4) Sodium, Na^+, and Potassium, K^+,

These comcentrations were estimated by Flame Photometry.

5) Calcium, Ca^{++}, and Magnesium, Mg^{++}.

These concentrations were estimated Spectophotometrically.

Appendix IV.

Full Results of Production Studies of Phragmites communis, Filipendula ulmaria, and Carex paniculata on Gordon Moss.

November 1966 to August 1967.

Contents of Appendix IV.

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Histograms.

These show the size class structure of the populations of Phragmites communis, Filipendula ulmaria and Carex paniculata, and also the production , or rather the standing crop for each collection , as the mean product per size class, which was obtained by the product of the number of plants in a size class, expressed as a percentage of the total sample, and the mean weight of plants in each size class.

The weight of plants, as dry weight usually, in grams, is given on the abscissa, and the number or percentage of the sample found in that size class, or the product of this percentage and the mean weight of the size class, is given on the ordinate.

Histograms 1 to 7.	Size class structure of the population of Phragmites communis cropped through the season, based on dry weight data.
8 to 11.	Size class structure of Phragmites communis samples through the season , based on fresh weight data.
12 to 20.	Production of Phragmites communis per size class in samples taken through the season, based on dry weights.
21 & 22.	Size class structure of Filipendula ulmaria population through the season , on dry weights.

Contents of Appendix IV. cont.

Table 1.

Live Dry weight production of Phragmites communis on Gordon Moss, 1967.

Date	Cropping Area.	No. plants in sample.	Mean weight per plant.	Standard Deviation	Standard Error.
March 17th	'wood'	18	0.165g	0.0646	0.0152
April 19.	'wood'	25	0.4528g.	0.1647	0.03294
May 11.	'wood'	107	0.5144g.	0.2987	0.02888
May 18	'wood' I	62	0.43597g.	0.2148	
	'wood' ii	15	1.0313g.	0.9541	
May 18	'stream'	26	0.706g.	0.9503	0.1864
May 25	'wood'	42	0.2419g.	0.1389	0.02078
	'stream'	39	0.629g.	0.9359	0.14986
May 31	'wood' i	30	0.565g.	0.1952	
	'wood' ii	36	0.495g.	0.2802	
	'stream'	49	0.63837g.	1.1655	0.1665
	ditch	35	1.2226g.	0.7658	0.1294
	in stream	30	0.9843g.	0.4873	0.08897
June 7	'wood'	30	0.8823g;	0.4116	0.07515
	'stream'	30	1.514g.	0.5780	0.1055
June 15	'wood'	50	1.3664g.	0.9222	0.1304
	'stream'	53	2.255g.	1.3927	0.1913
June 22	'wood'	33	2.0133g.	1.5518	0.2701
	'stream'	57	3.208g.	2.0929	0.2772
July 6	'wood'	30	2.0066g.	1.5321	0.2797
	'stream'	30	5.379g.	2.8835	0.5265
July 20	'wood'	30	4.1327g.	3.6757	0.6711
	'stream'	25	8.8704g.	4.1727	0.8345
	ditch	20	6.931g.	3.0993	0.6930
	in stream	25	5.6324g.	3.7377	0.7475

Samples were taken from the area of Phragmites plants near the wood..'wood', from the stream bank...'stream', from the ditch running from the wood area to Hareford Burn...ditch, and from the Burn itself...in stream.

Table 1 cont.

Date	Cropping Area	No. plants in sample.	Mean weight per plant.	Standard Deviation	Standard Error.
Aug. 17	'wood'	44	5.7852g.	4.3154	
	'stream'	38	8.2737g.	4.1903	

Table 2.

Dry weight production of Filipendula ulmeria on Gordon Moss, 1967.

a) Results from samples in which individual plants were weighed.

Cropping Date	Mean weight of live material per plant	S.D.	Mean weight of Dead material per plant.	S.D.	Mean above-ground weight per plant.	S.D.
May 25th	1.56g.	0.602	0.098g.	0.335	1.6804g.	0.65
May 31st	2.225g.	0.949	0.188g.	0.218	2.354g.	0.997
June 7th	2.699g.	0.971	0.274g.	0.224	3.014g.	1.101
June 15th	3.935g.	2.39	0.343g.	0.224	4.278g.	2.515
July 6th tall	5.233g.	3.085	0.431g	0.388	4.278g	3.442
short	3.73g.	3.29	0.628g	0.437	4.3575g.	3.5815
July 20th tall	8.691g.	3.759	1.047g.	0.232	9.738g.	3.859
short	6.787g.	4.3012	0.624g.	0.540	7.411g.	4.373
mean	7.739g.	4.1499				
Aug. 17th tall	8.172g.	4.25	0.792g.	0.512	8.975g.	4.64
short	7.040g.	3.729	0.624g.	0.310	7.6640g.	3.94

b) Results for total collection including both samples in which individual plants were weighed, and those in which all the plants cropped were lumped and weighed together.

Cropping Date	Mean weight of live material per plant	Mean weight of dead material per plant.	Mean weight of above-ground product per plant.
March 17th	-	-	0.267g.
April 19th	-	-	0.417g
May 11th	-	-	0.756g.
May 18th	-	-	1.212g.
May 25th	1.522g.	1.13g	1.633g.
May 31st	1.77g.	1.59g.	1.929g.
June 7th	2.197g	0.252g.	2.42g.
June 15th	2.819g.	0.28g.	3.099g.

Table 2 b) cont.

Cropping Date	Mean weight live material per plant.	Mean weight dead material per plant.	Mean total above-ground weight.
June 22nd.	2.556g.	0.230g.	2.786g.
July 6th tall	5.139g.	0.686g.	7.563g.
short	4.826g.	0.512g.	5.337g.
July 20th tall	7.137g.	0.813g.	7.95g.
short	4.821g.	0.512g.	5.337g.
Aug. 17th tall	8.172g	0.792g.	8.975g.
short	7.040g.	0.624g.	7.664g.

Rhizome weights were taken, but these varied irregularly during the season, depending only on how the plant had been cut. Some specimens had virtually no rhizome while others might have a rhizome of 3 cms or more.

Table 3.

Dry weight production of Carex paniculata on Gordon Moss, 1967.
Live weight fractions used with dead and total weights.

Date	Cropping Area	No. plants in sample.	Mean weight per plant.	Standard Deviation.
May 11.	North wood.	94.	* T. 0.7637g.	0.2957
	i		D. 0.06628g.	
			L. 0.6975g.	
	ii	140	T. 0.6459g.	0.4483
			D. 0.1204g.	0.1961
			L. 0.5255g.	0.3231
	South wood.	40	T. 0.6353g.	0.4615
	i		D. 0.1235g.	0.2109
			L. 0.51175g.	0.3269
	ii	50	T. 0.7332g.	0.5043
			D. 0.3678g.	0.4461
	iii	66	T. 0.8774g.	0.5532
			D. 0.2694g.	0.4709
			L. 0.6080g	0.2255
May 18.	North wood.	136	D. 0.1071g.	0.3614
	i		L. 0.3793g.	0.3847
	ii	117	D. 0.0577g.	
			L. 0.5684g.	0.6314
	South wood.i.	70	T. 0.4164g.	0.2378
	ii	112	T. 0.7299g.	0.4752
May 25.	North wood.	42	T. 0.8936g.	0.5017
	i		D. 0.1729g.	0.2697
			L. 0.7207g.	0.4346
	ii	55	T. 0.6658g.	0.4406
			D. 0.2002g.	0.2945
			L. 0.4656g.	0.2787

* T. =mean total plant weight
L. = mean live plant weight
D. = Mean dead plant weight

Table 3 cont.

Date	Cropping Area.	No. plants in sample.	Mean weight per plant.	Standard Deviation.
June 7.	North wood.	50	T. 0.8898g.	0.5262
	i		D. 0.177g.	0.4310
	ii	50	L. 0.7128g.	0.3851
	ii	50	D. 0.135g.	0.2128
			L. 0.6542g.	0.2791
			T. 0.7772g.	0.4583
	South wood.	40	T. 0.407g.	0.2281
	i		D. 0.097g.	0.2105
			L. 0.310g.	0.1825
	ii	40	T. 0.596g.	0.338
			D. 0.186g.	0.2806
			L. 0.410g.	0.2485
June 15.	North wood. i	57	L. 0.6958g.	0.3925
			D. 0.1386g.	
	ii	51	L. 0.7235g.	0.4198
			D. 0.1118g.	
June 22.	North wood.	75	T. 1.1804g.	0.5344
	i		D. 0.10067g.	0.1911
			L. 1.07973g.	0.4644
	ii	61	T. 0.6528g.	0.3296
			D. 0.0931g.	0.2053
			L. 0.5327g.	0.1773
	South wood.	40	T.0.54g.	0.3135
	i		D. 0.04975g.	0.08705
			L. 0.49025g.	0.27169
	ii	40	T. 0.8125g.	0.4038
			D. 0.095g.	0.1933
			L. 0.7175g.	0.33125
	iii	29	T.0.8179g.	0.4604
			D. 0.2031g.	0.3466
			L. 0.6148g.	0.3063

Table 3 cont.

Date.	Cropping Area.	No. plants in sample.	Mean weight per plant.	Standard Deviation.
July 6.	North wood.	25	L. 1.2372g.	0.4637
	i		D. 0.400g.	0.4395
			T. 1.6372g.	0.6040
	ii	40	T. 1.22125g.	0.6844
			D. 0.31375g.	0.3108
			L. 0.905g.	0.5561
	iii	40	T. 1.19525g.	0.4725
			D. 0.11225g.	0.1695
			L. 1.083g	0.3850
	South wood.	55	T. 0.7842g.	0.4686
	i		D. 0.17727g.	0.2411
			L. 0.60691g.	0.3568
	ii	54	T. 1.14259g.	0.5308
			D. 0.6185g.	0.2257
			L. 0.97407g.	0.4762.
July 20	North wood.	30	T. 1.6236g.	0.4259.
	i		D. 0.1167g.	0.2422
			L. 1.512g.	0.4564
	ii	28	T. 1.04036g.	0.8252
			D. 0.0489g.	0.1597
			L. 0.9921g.	0.7958
	South wood.	49	T. 1.55776g.	0.6377
	i		D. 0.1520g.	0.2689
			L. 1.4057g.	0.6571
	ii	55	T. 1.037g.	0.4987
			D. 0.0616g.	0.1922
			L. 0.828g.	0.5052.

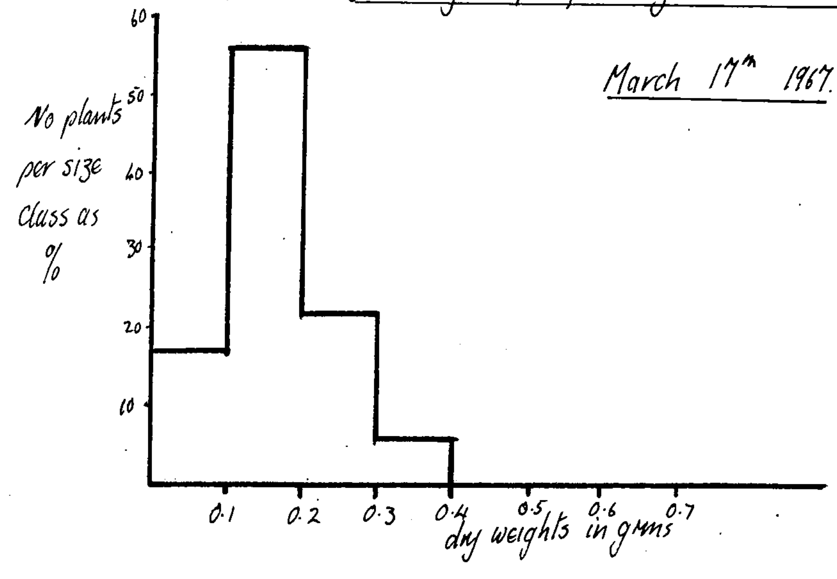
Table 4.

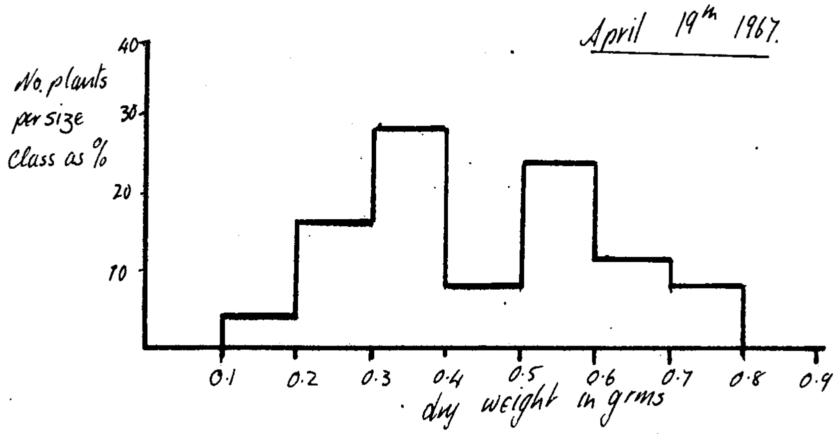
Fresh weight production of Carex paniculata on Gordon Moss, 1967

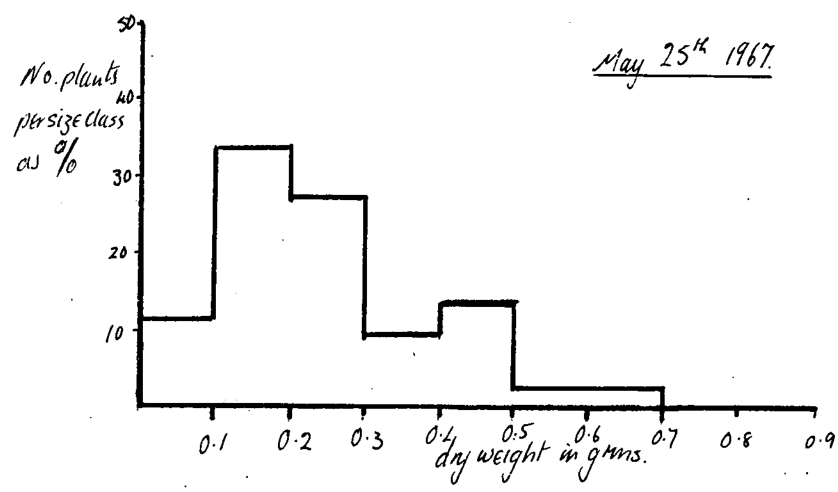
Date	Cropping Area.	No. plants in sample.	Mean weight per plant.	Standard Deviation.
May 11.	North wood.	94	T. 4.286g.	2.164
	i		D. 0.437g.	0.6215
			L. 3.849g.	1.687
May 18.	North wood.	134	T. 2.18g.	1.1883
	i		D. 0.3497g.	0.4031
			L. 1.8338g.	1.1587
	ii	108	T. 2.3828g.	1.4703
			D. 0.2333'g.	0.2593
			L. 2.1494g.	1.2876
	South wood i.	70	T. 1.50586g.	0.6111
	ii	112	T. 3.1006g.	1.5471
June 15th	North wood i	57	L. 3.4811g.	1.5028
			D. 1.4511g.	2.2134
			T. 4.9321g.	3.4919
	ii	51	L. 3.7239g.	1.8372
			D. 1.6492g.	2.3156
			T..5.3731g.	3.9654
July 6.	North wood	25	L. 5.0188g.	1.7892
	i		D. 0.878g.	0.8729
	ii	40	T. 5.858g.	2.9496
			D. 1.261g.	1.068
			L. 4.597g.	2.5843
	iii	40	T. 5.198g.	1.7048
			D. 0.2285g.	0.3824
			L. 4.884g.	1.5408
	South wood	55	T. 2.954g.	1.5494
	i		D. 0.5033g.	0.6011
			L. 2.4516g.	1.4076
	ii	54	T. 4.6066g.	2.0971
			D. 0.4546 g.	0.6438
			L. 4.1517g.	2.0219

Standing Crop of Phragmites in wood side area.

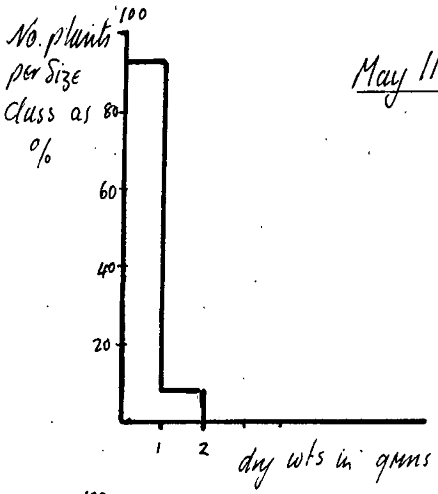
I.

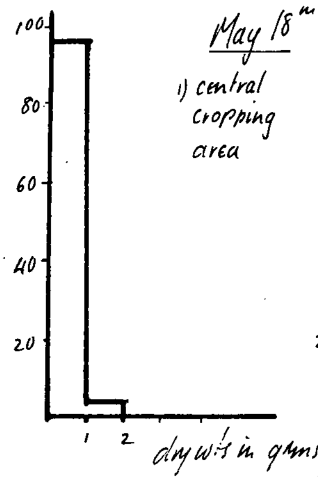


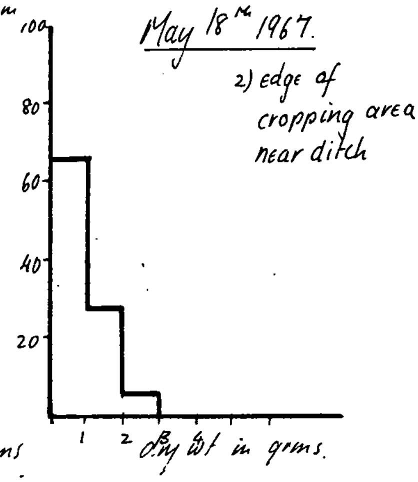


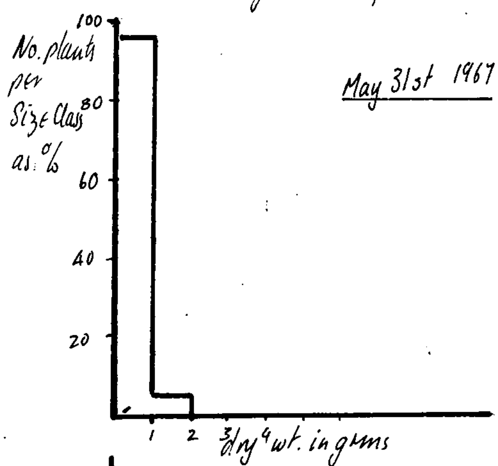


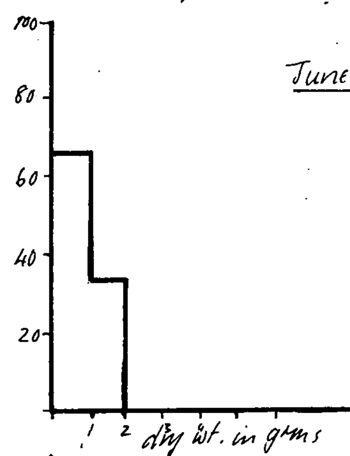
Standing Crops of Phragmites in wood side area.

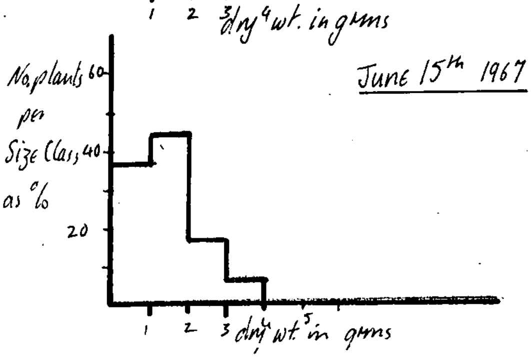


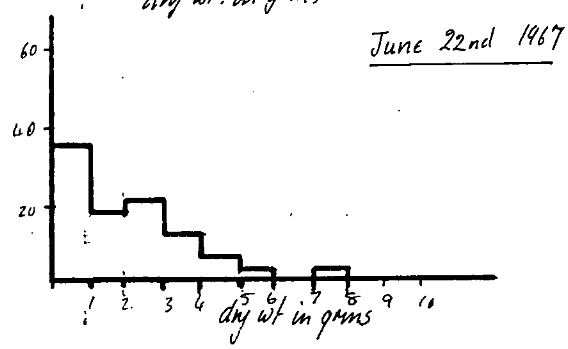


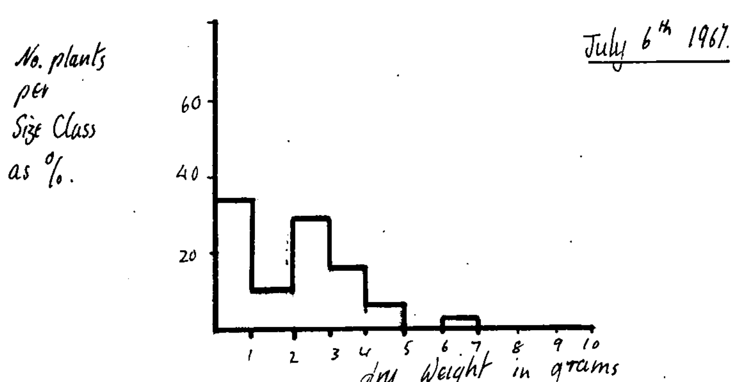




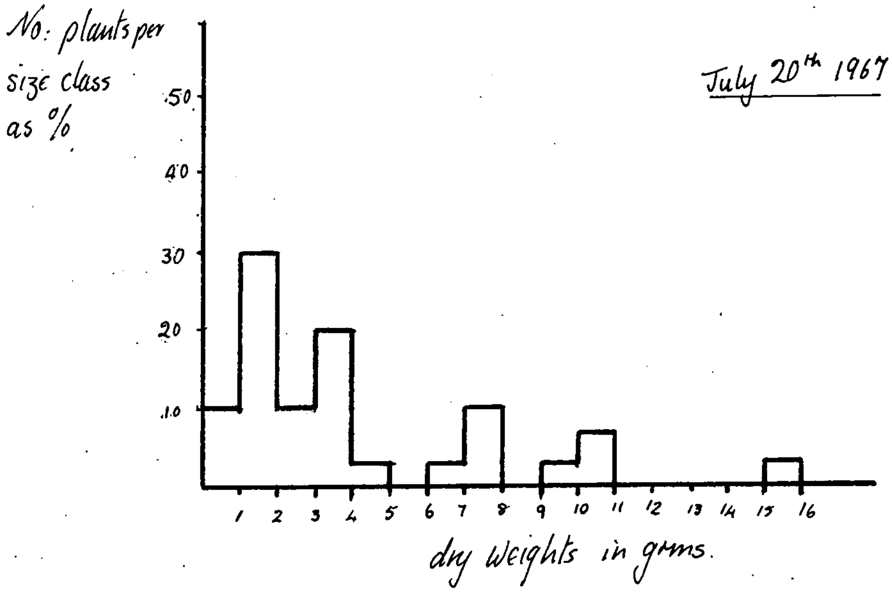


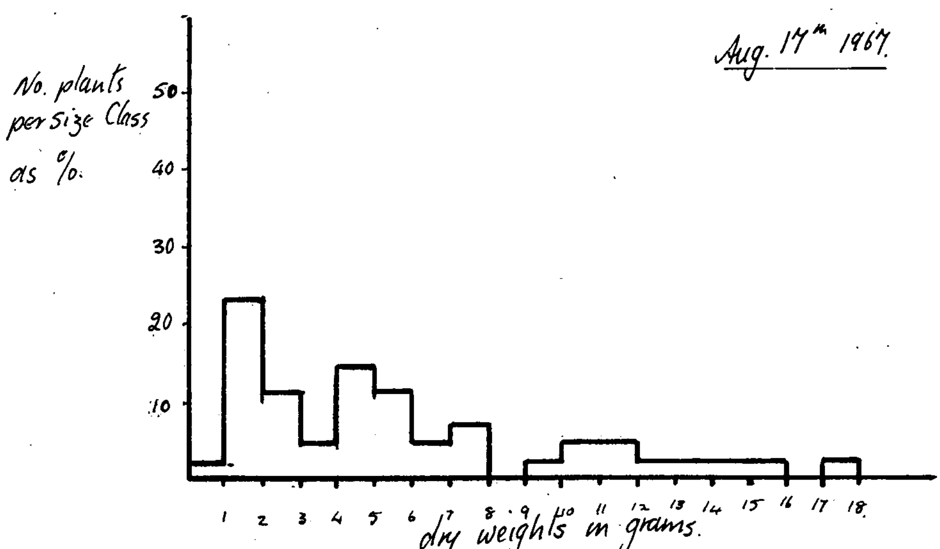




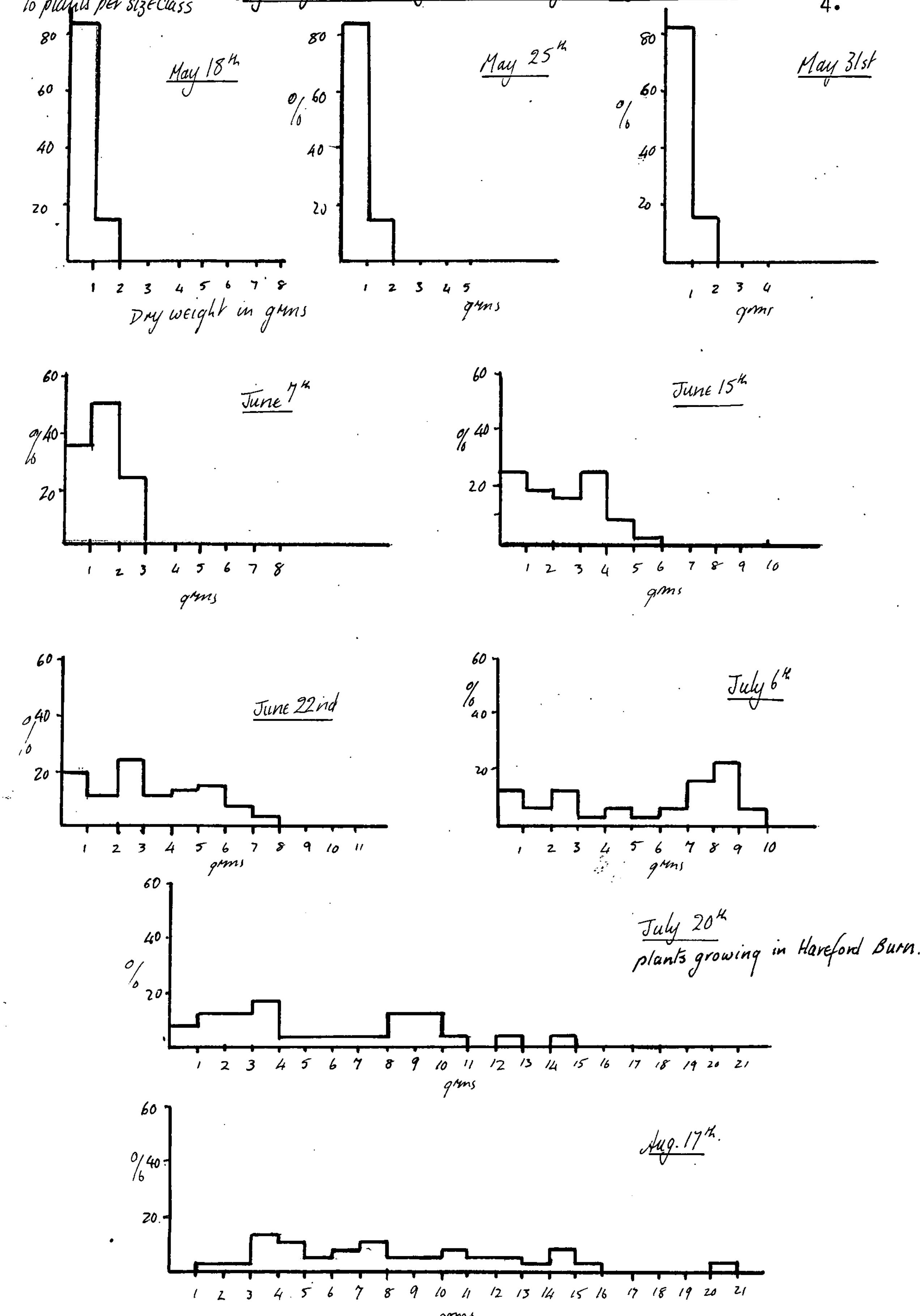


Standing Crop of Phragmites in wood side area.

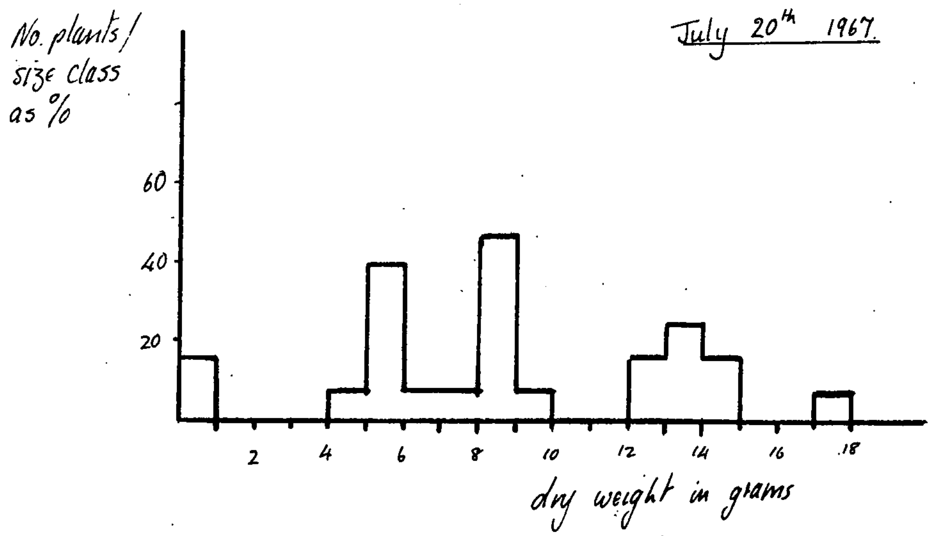


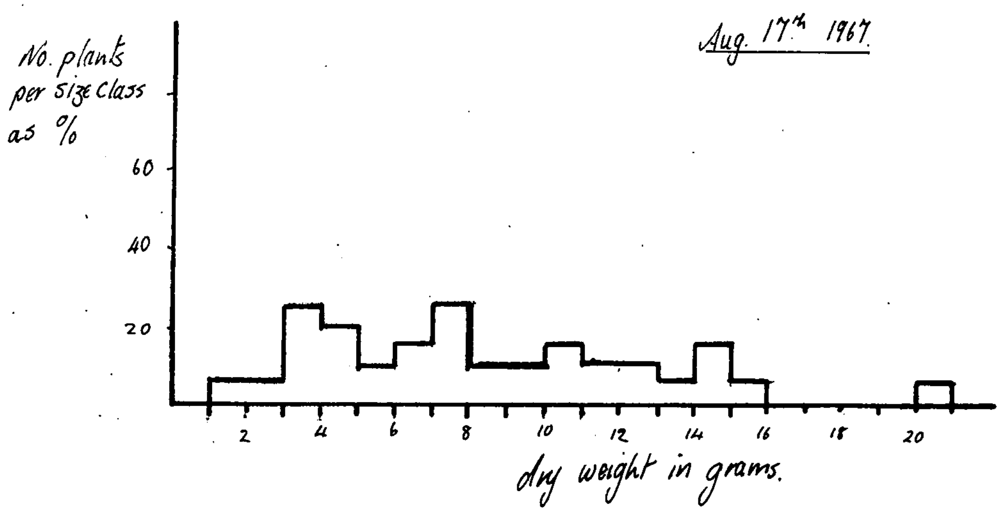


Dry weight Standing Crop of Phragmites by Stream bank

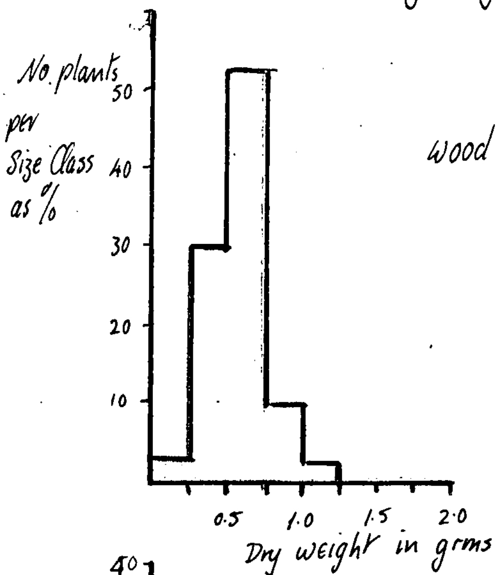


Standing Crop of Phragmites in Stream bank area.

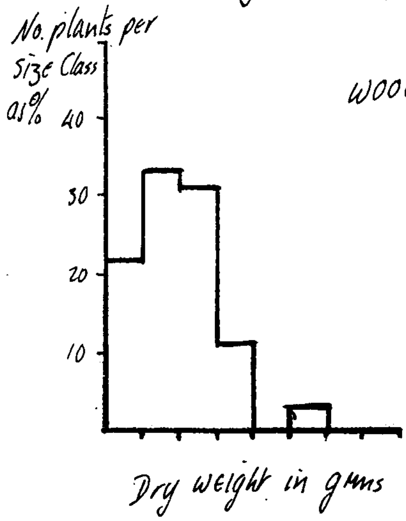




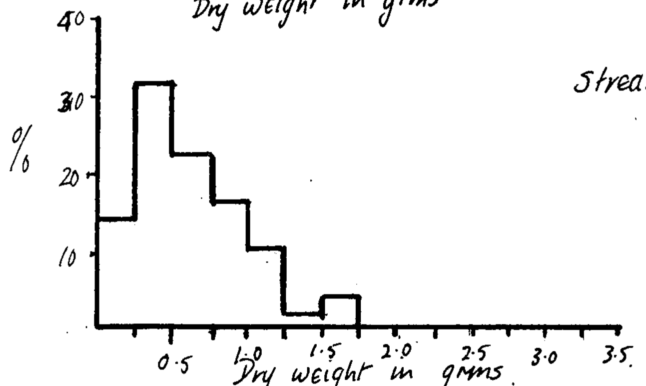
Dry Weight Standing Crop of Phragmites - from Sampling on May 31st.



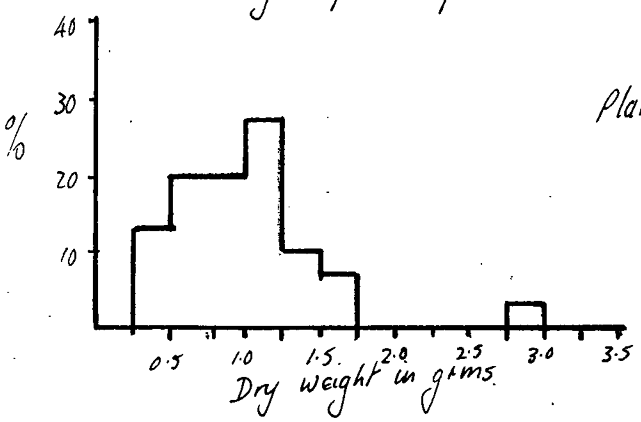
wood I



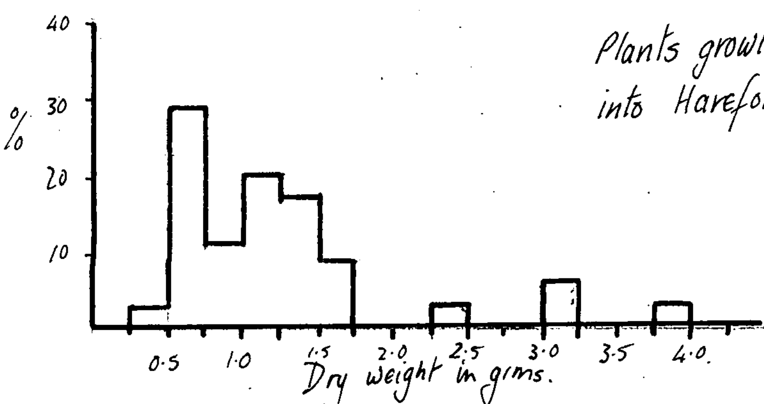
wood II



Stream bank



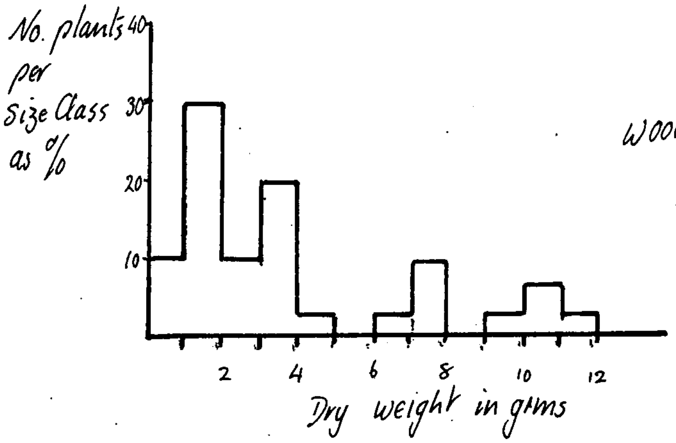
Plants growing in Hareford Burn.



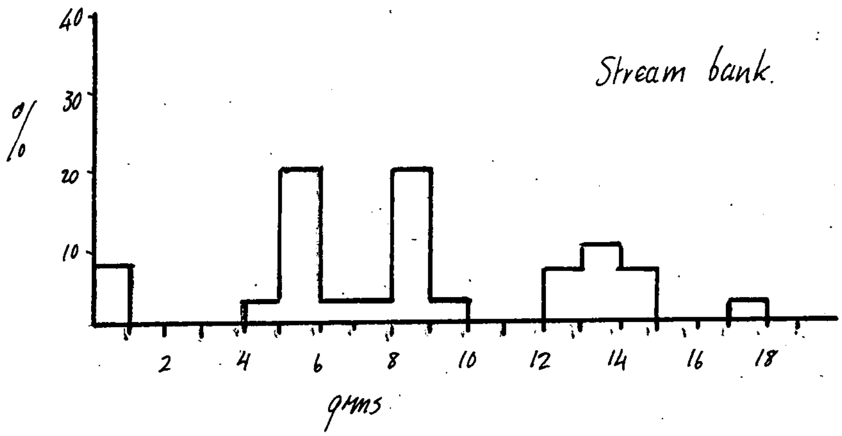
Plants growing in Ditch draining into Hareford Burn.

Dry weight Standing Crop of Phragmites Samples Collected on July 20th

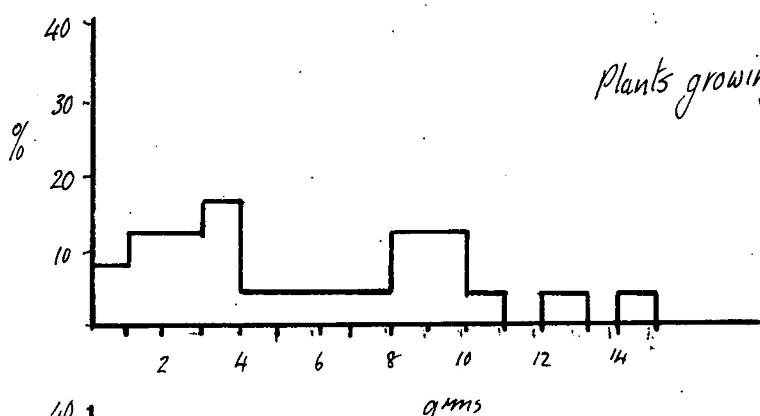
wood side area.



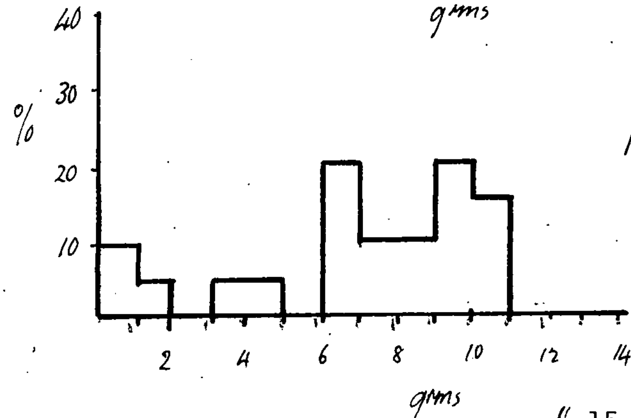
Stream bank.



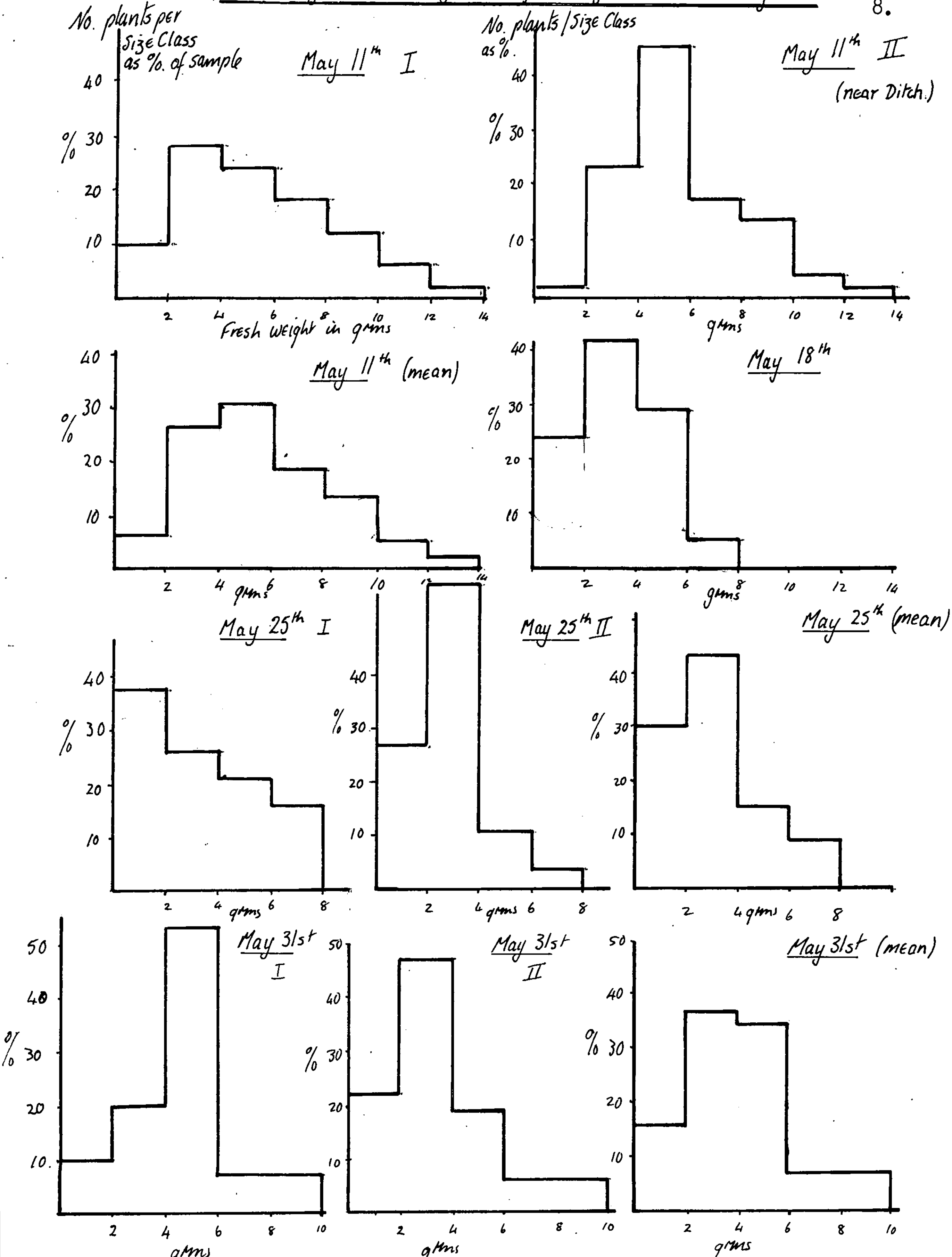
Plants growing in Hareford Burn.



Plants growing in ditch.

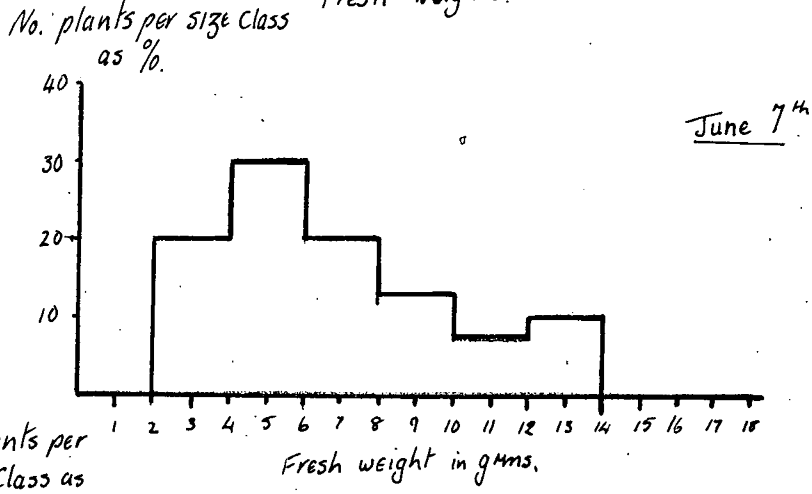


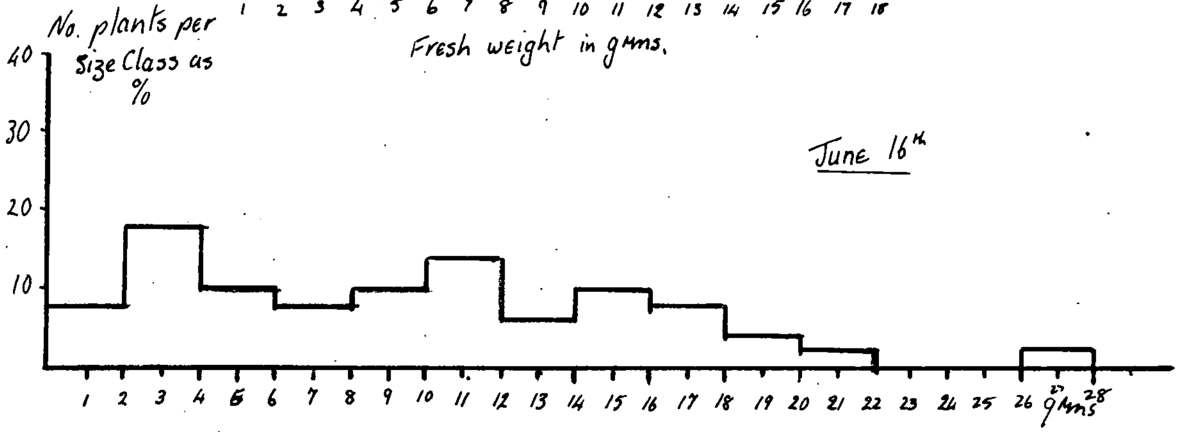
Fresh Weight Standing Crop of Phragmites in area by wood.

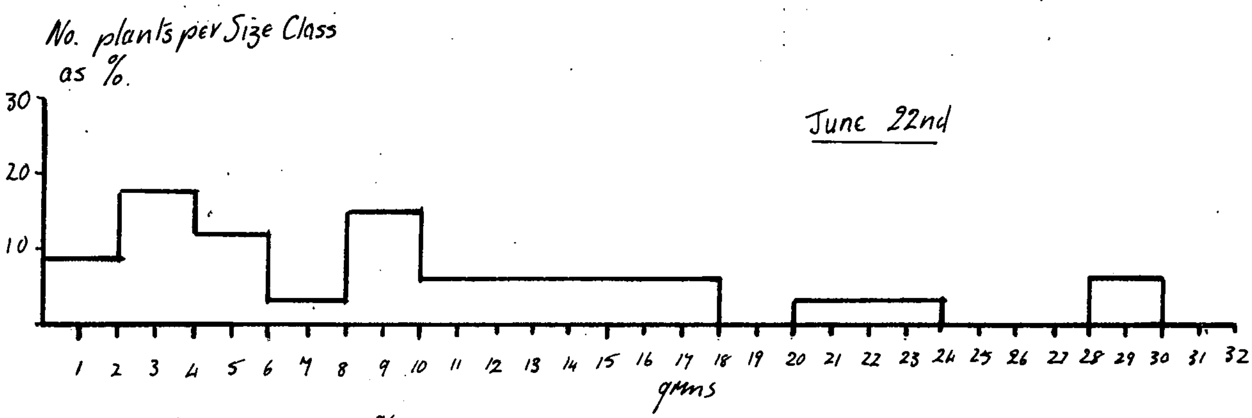


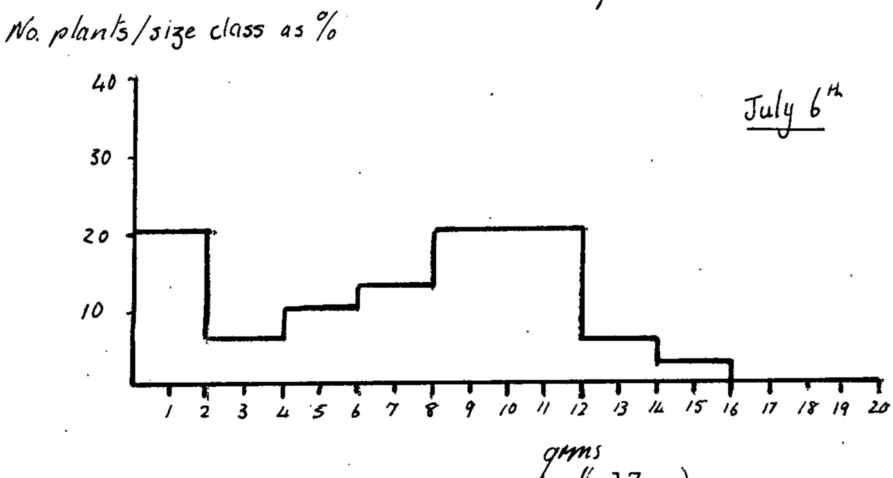
Standing Crop of Phragmites plants in area by wood

Fresh Weights.

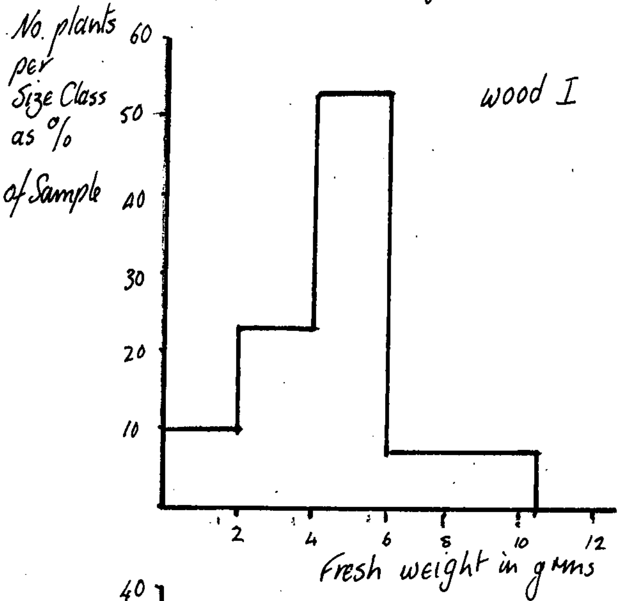


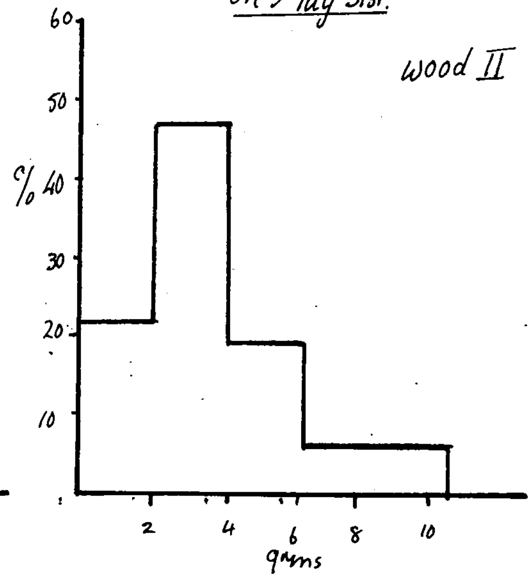


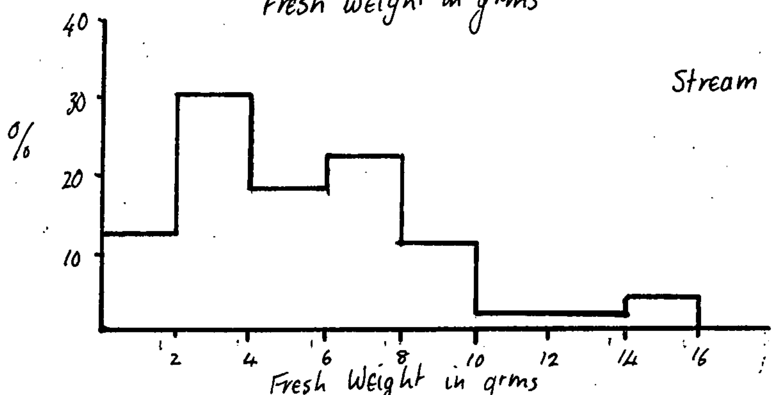


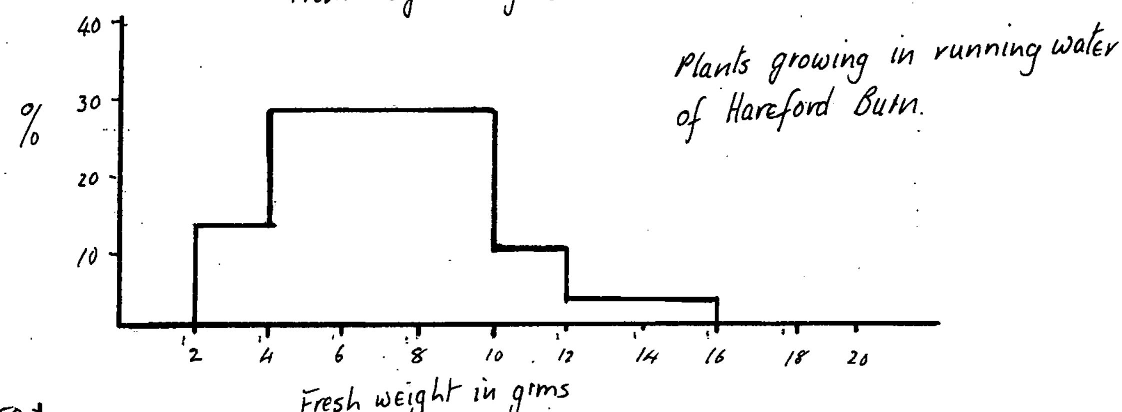


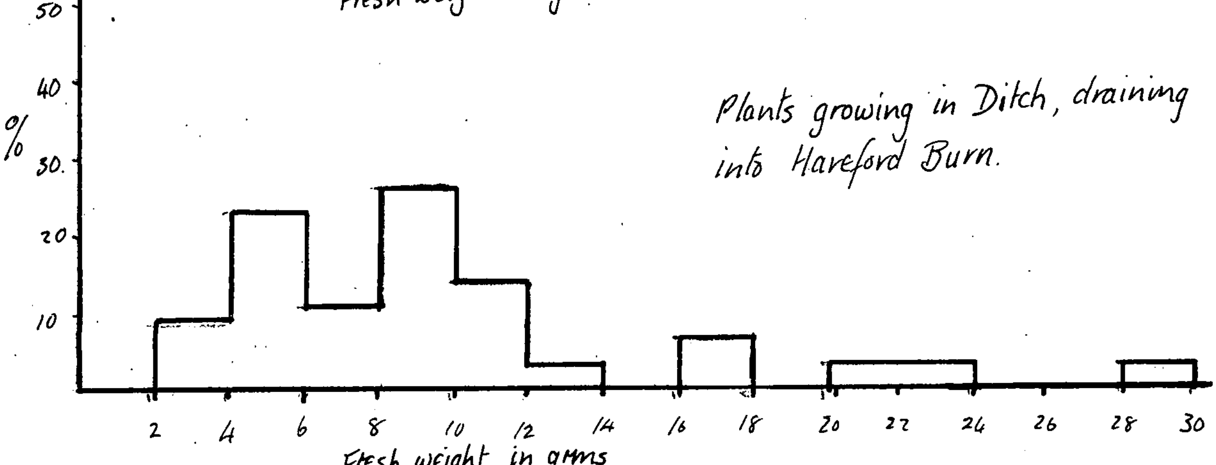
Fresh Weight Standing Crop of Phragmites from Samples collected on May 31st.





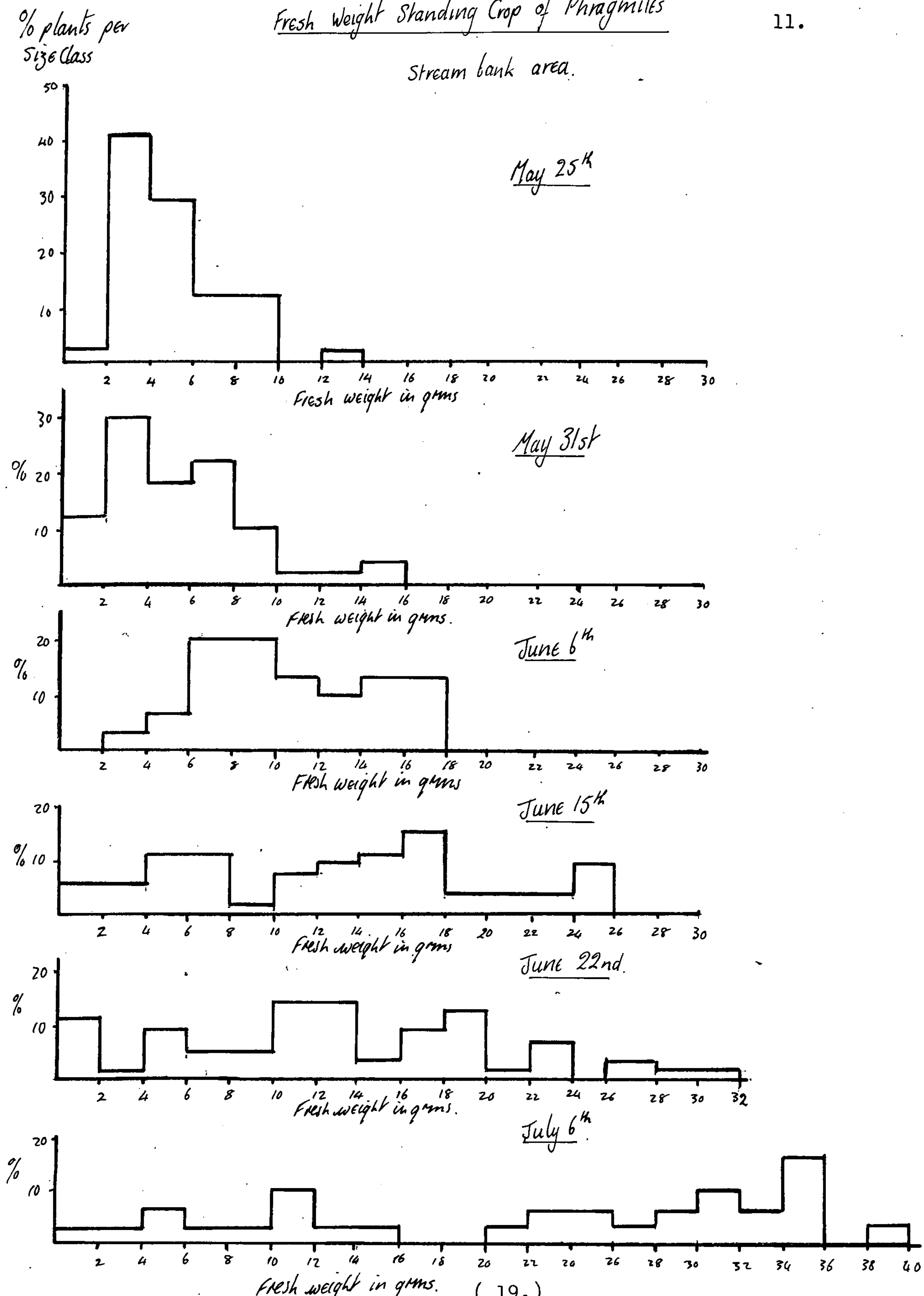




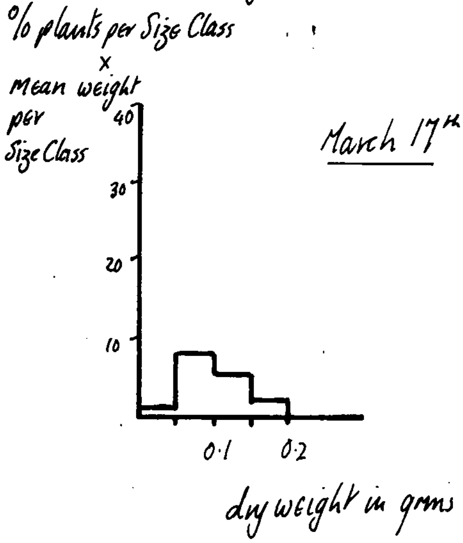


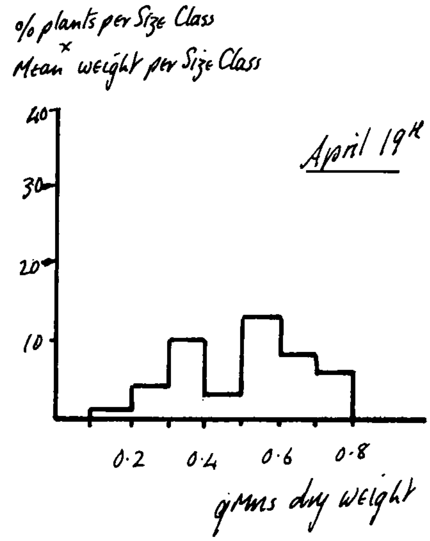
Fresh Weight Standing Crop of Phragmites

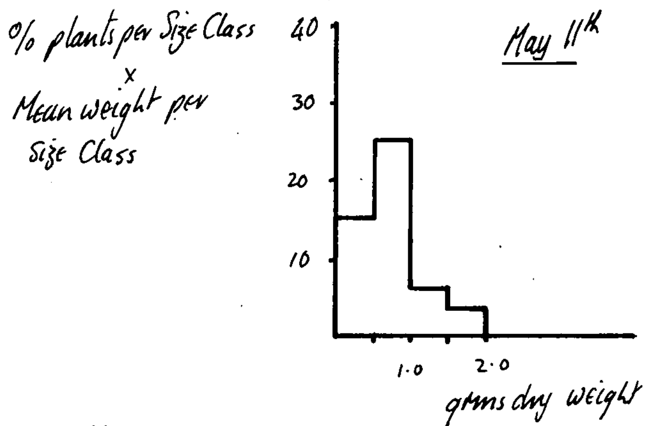
Stream bank area.

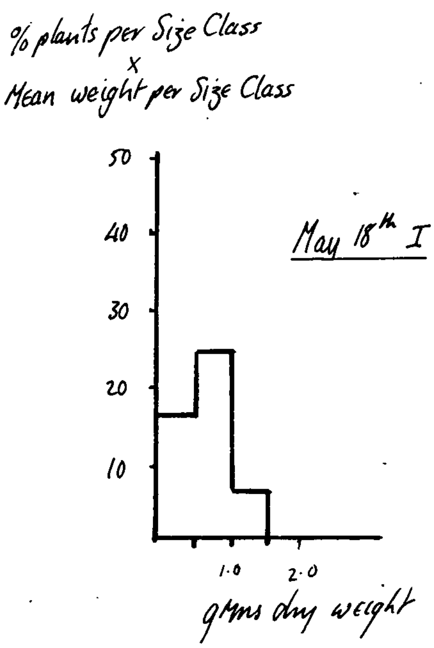


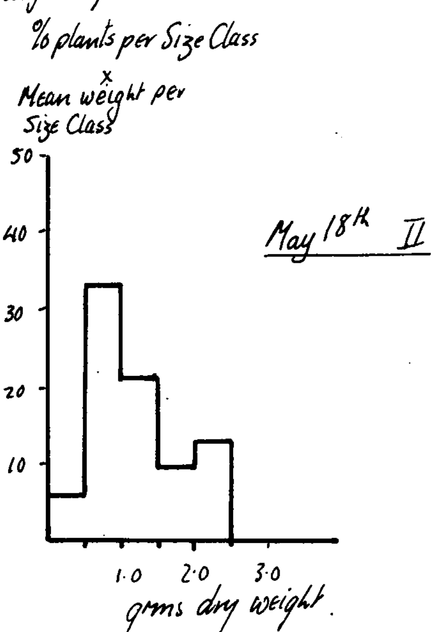
Dry Weight Product of Phragmites Area by wood.





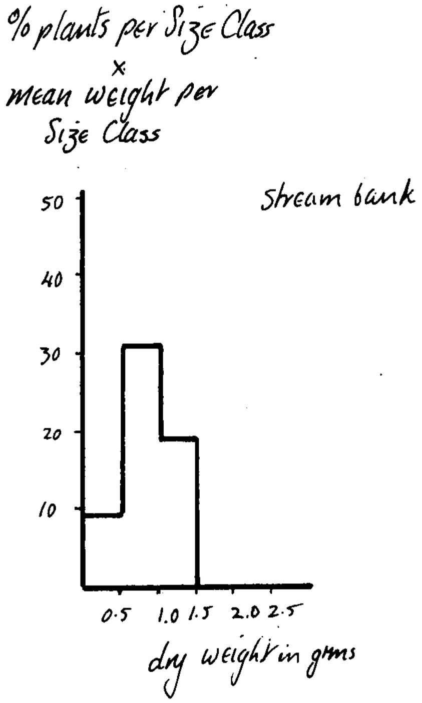


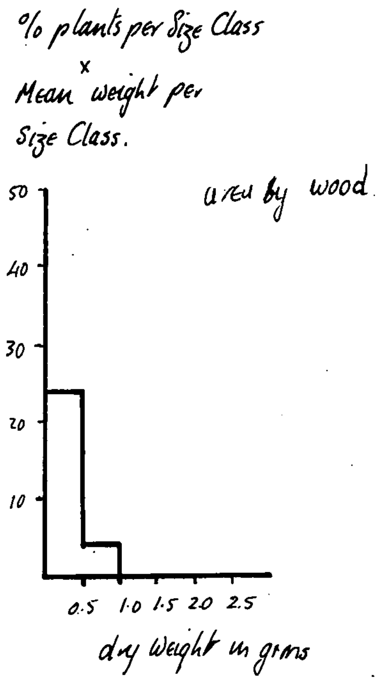




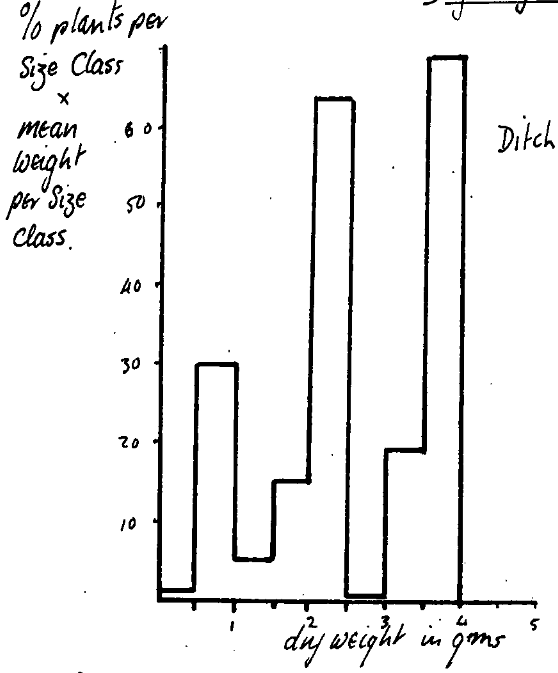
Dry Weight Product of Phragmites

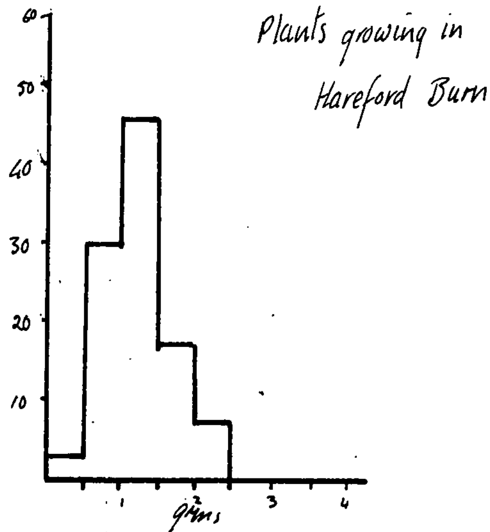
May 25th

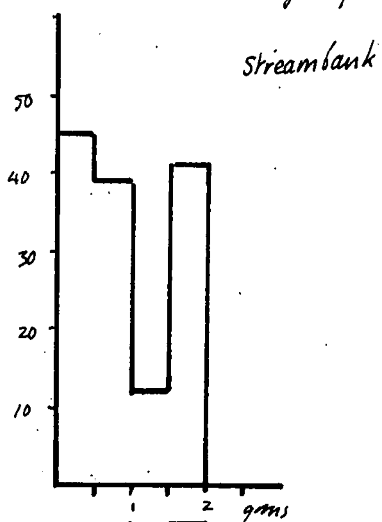


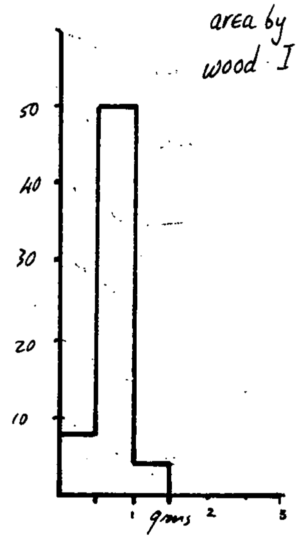


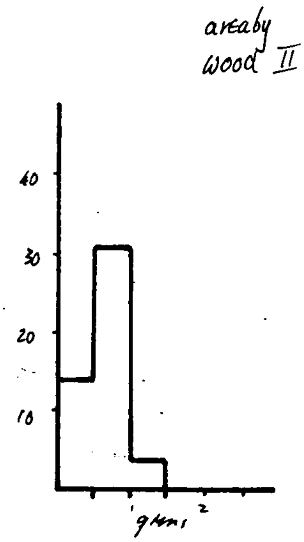
Dry weight Product of Phragmites May 31st.



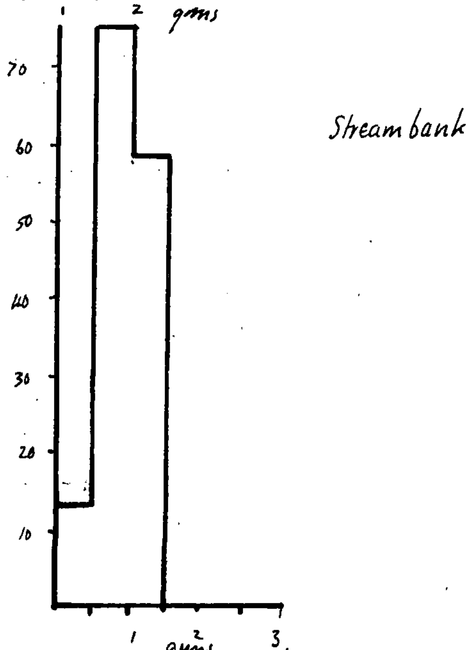


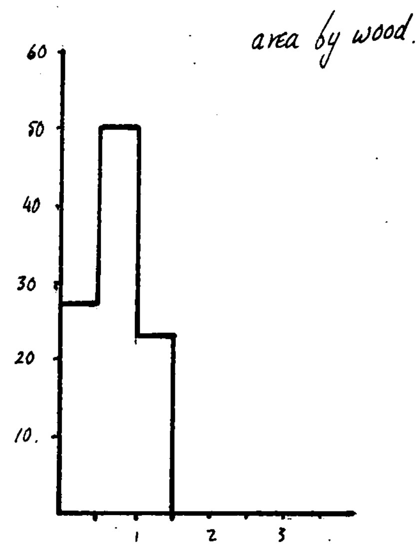






June 7th.

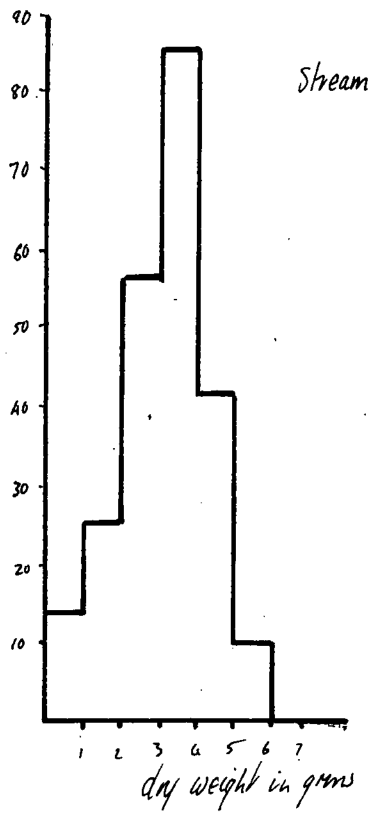




Dry Weight Product of Phragmites. June 15th

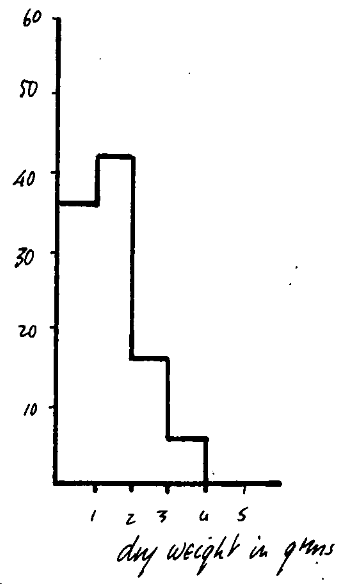
% plants per sizeclass
x
Mean weight per size Class

Stream bank



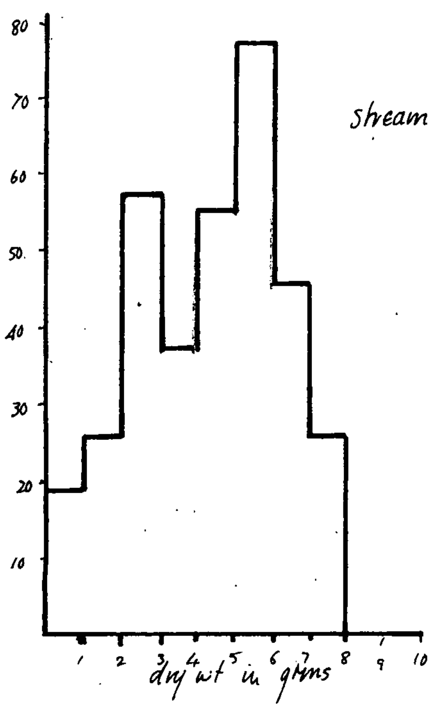
area by wood

% plants per size class
x
Mean weight per sizeclass



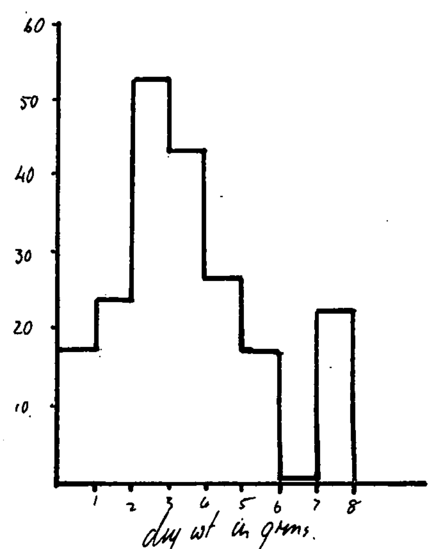
June 22nd

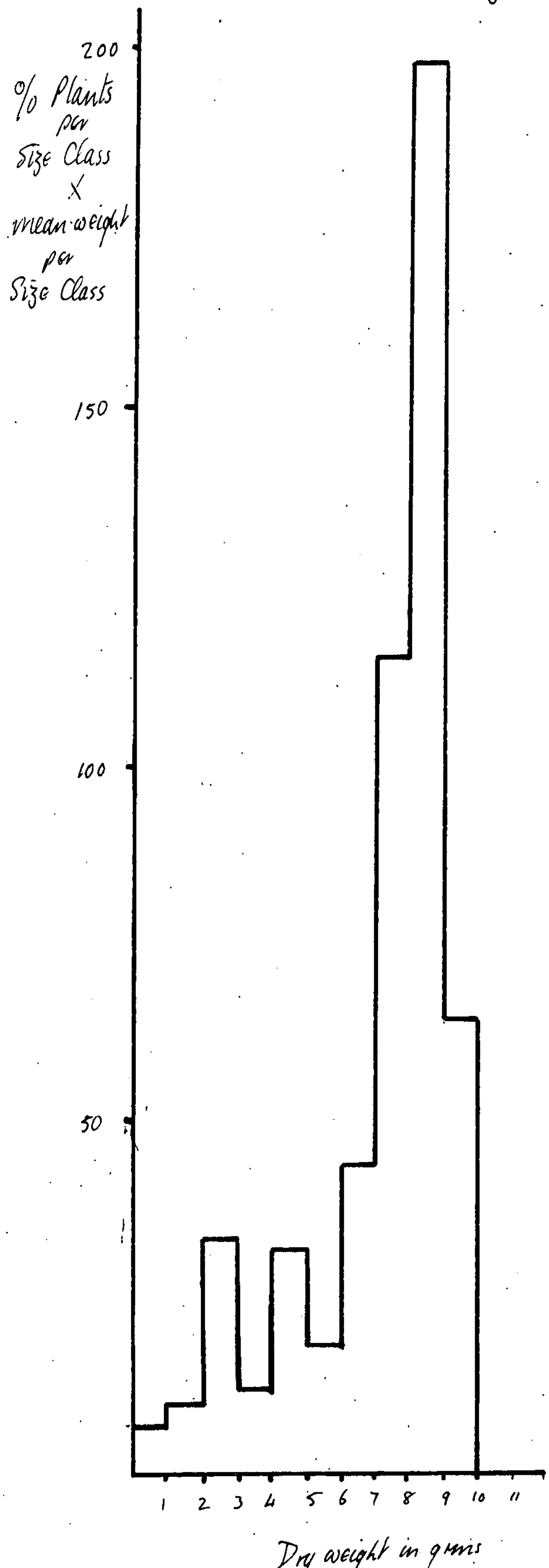
stream bank

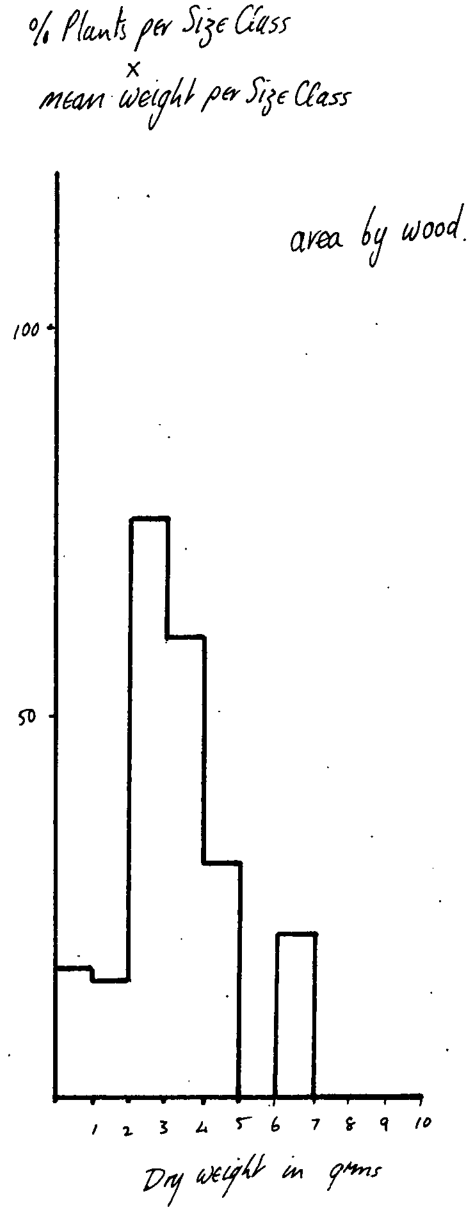


June 22nd.

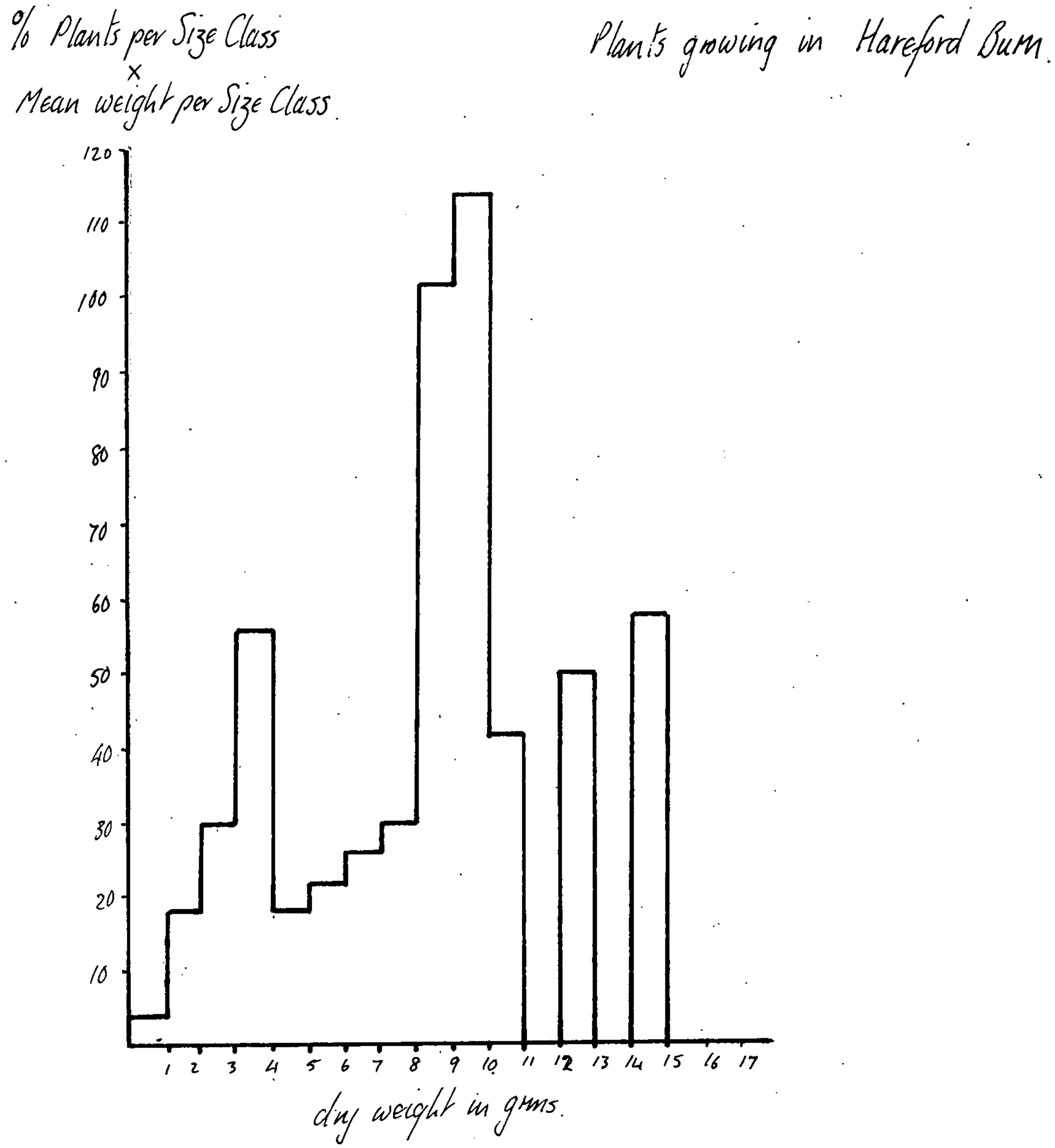
area by wood.



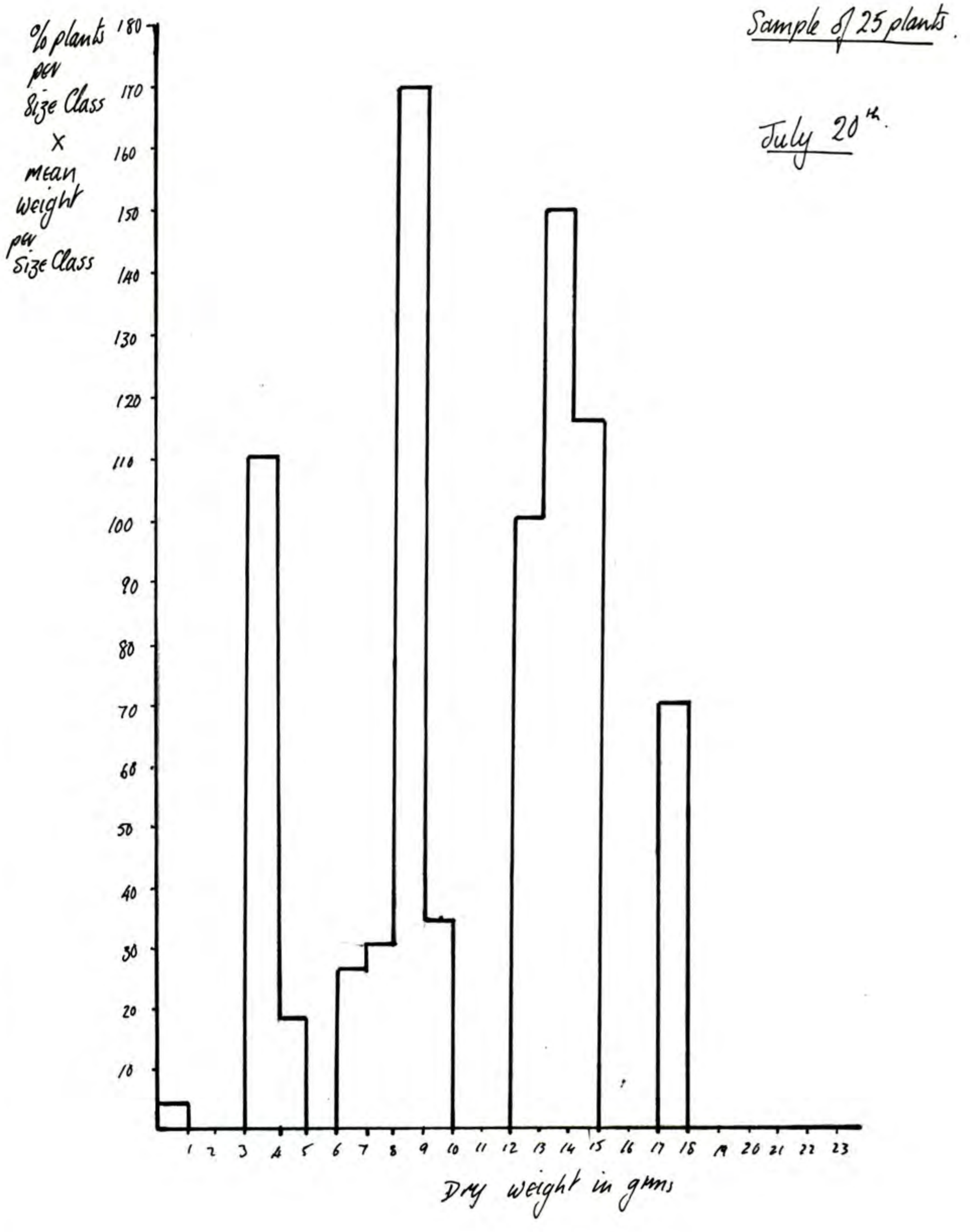

200
150
100
50
% Plants per Size Class X mean weight per Size Class
Stream bank
1 2 3 4 5 6 7 8 9 10 11
Dry weight in grams


% Plants per Size Class x mean weight per Size Class
area by wood.
100
50
1 2 3 4 5 6 7 8 9 10
Dry weight in grams

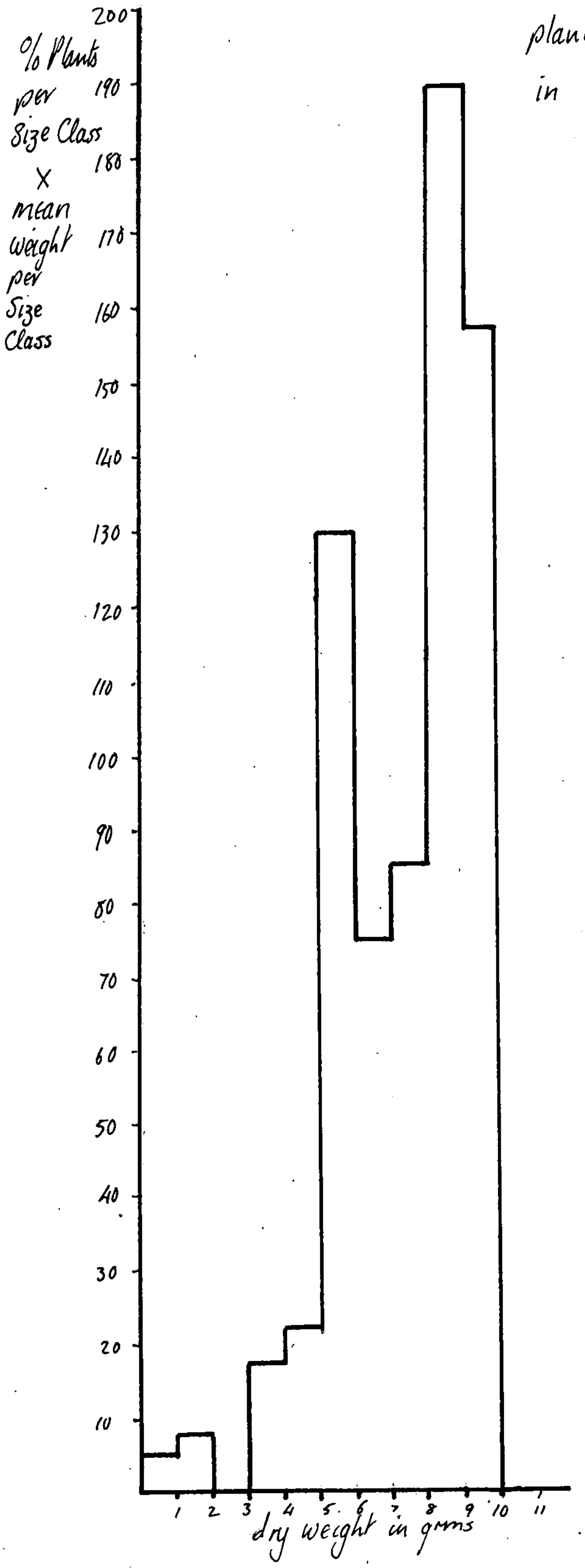
Dry Weight Product of Phragmites July 20th.

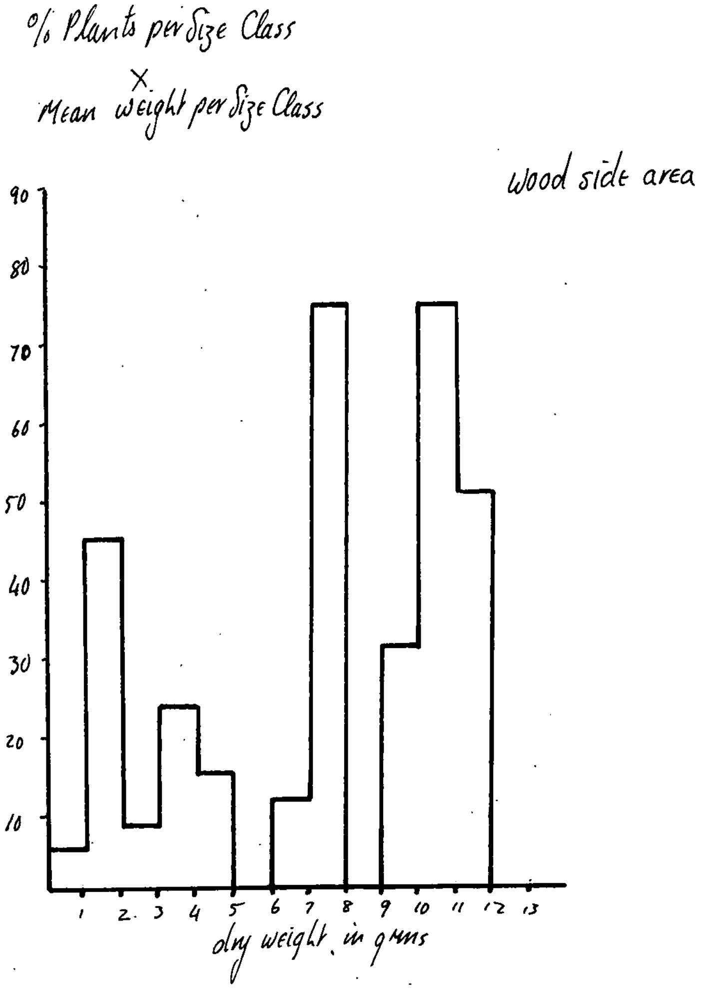


Dry Weight Product of Phragmites from Stream Bank area.

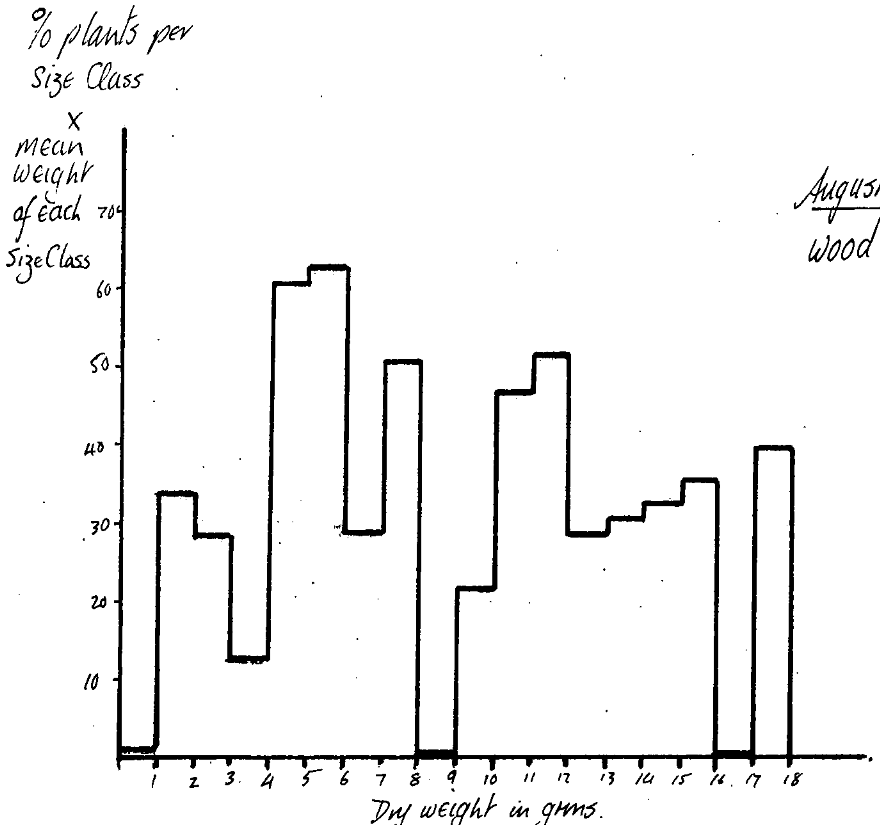


Dry Weight Product of Phragmites July 20th

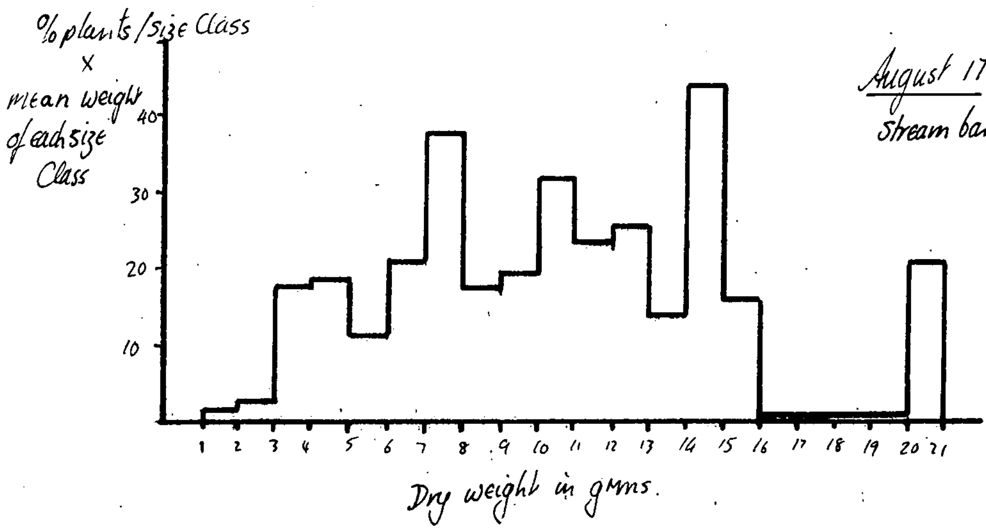




Dry weight Production of Phragmites



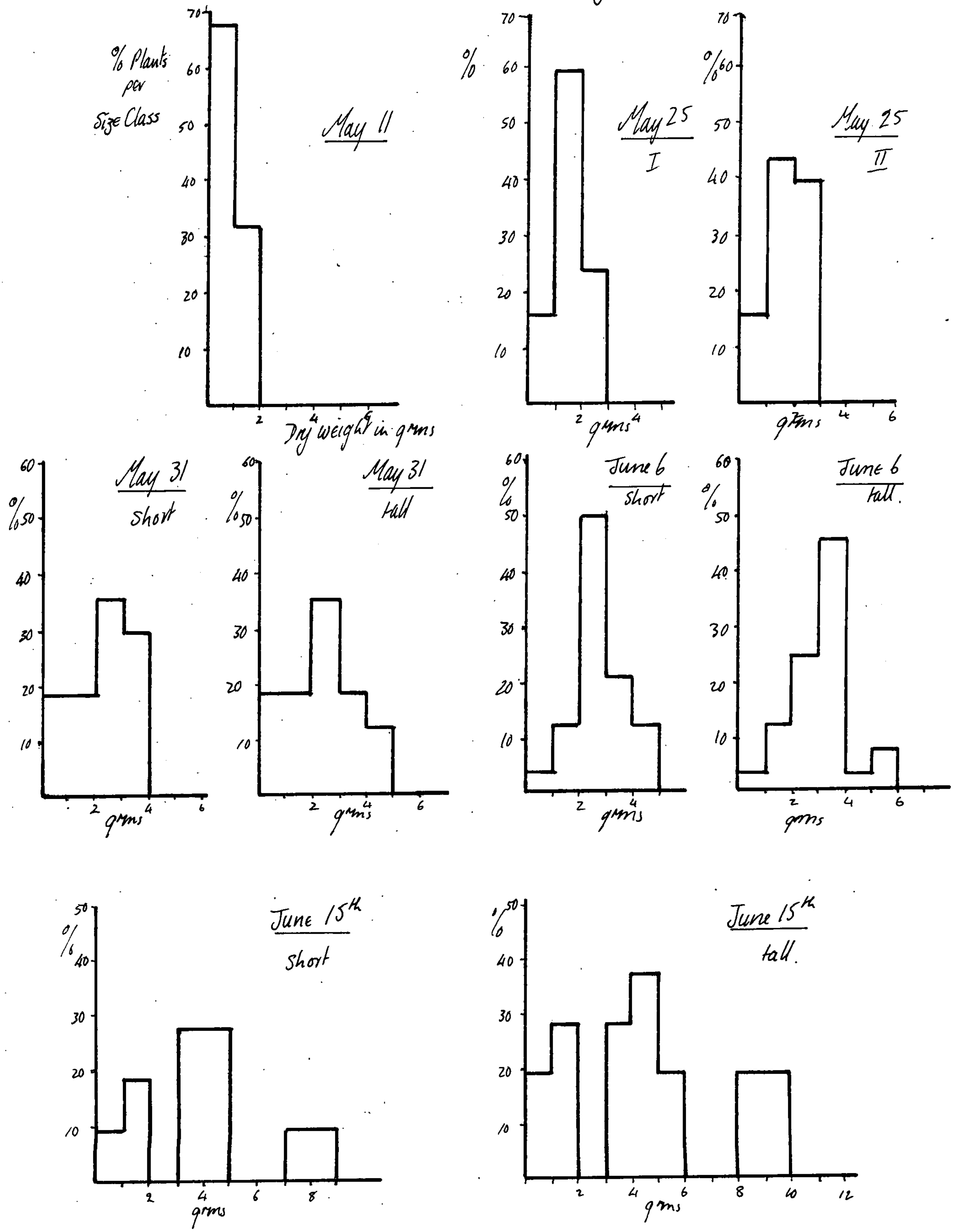
August 17th
wood area - 44 plants in sample.



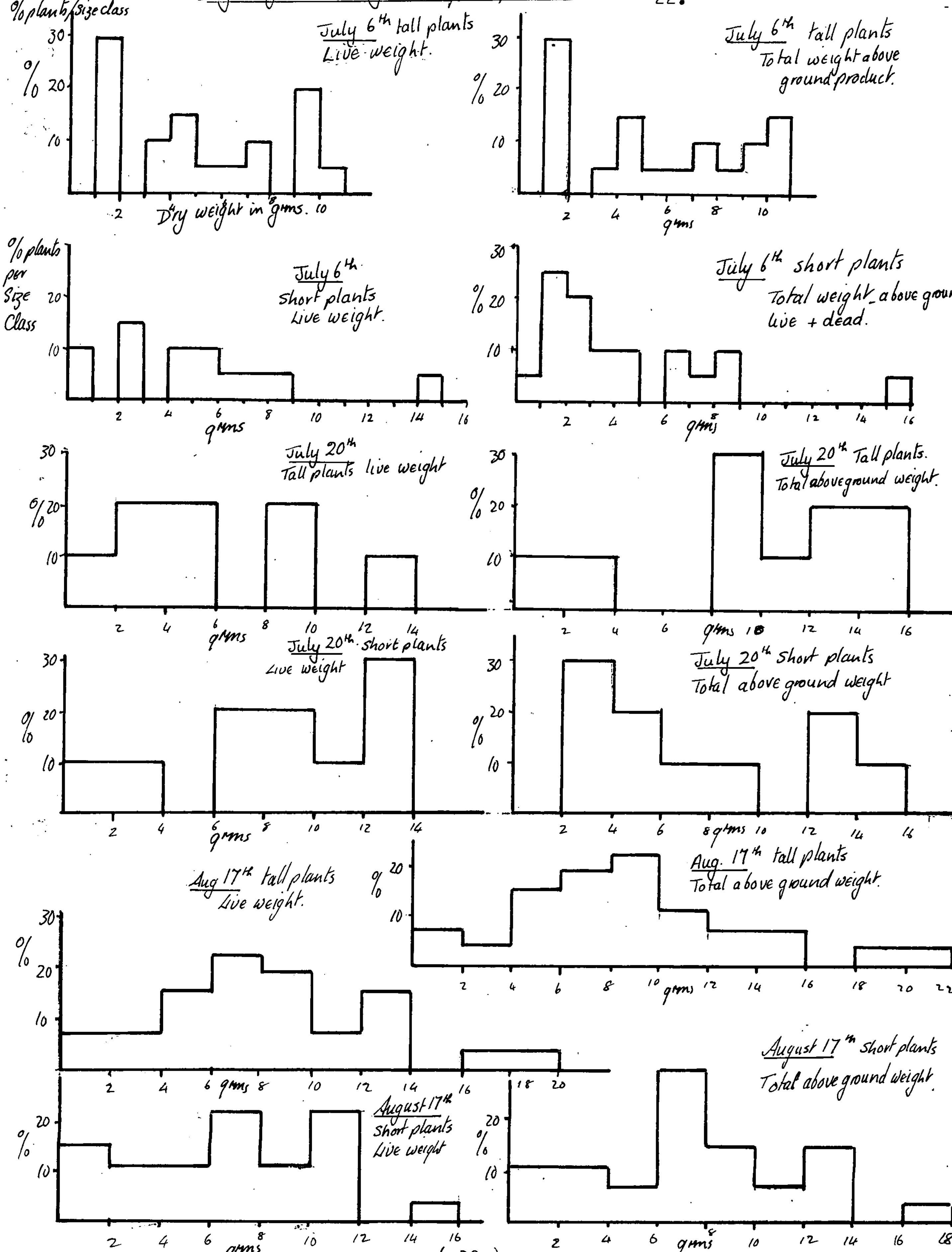
August 17th
Stream bank - 38 plants in sample.

Dry weight Standing Crop of Filipendula

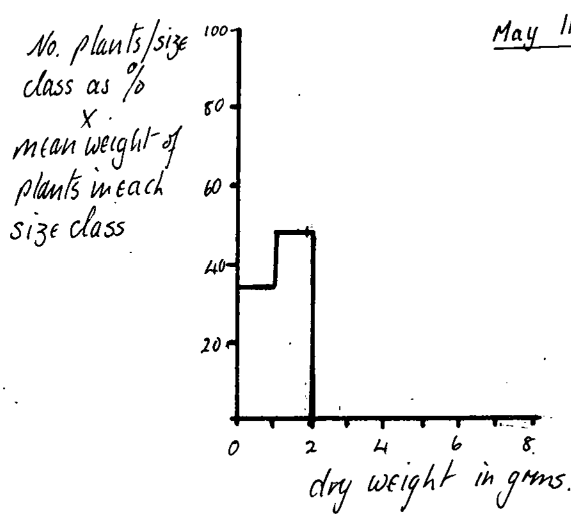
Live material only.

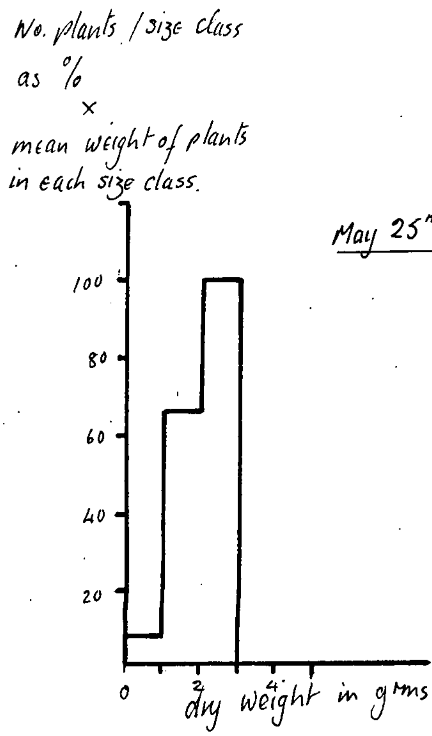


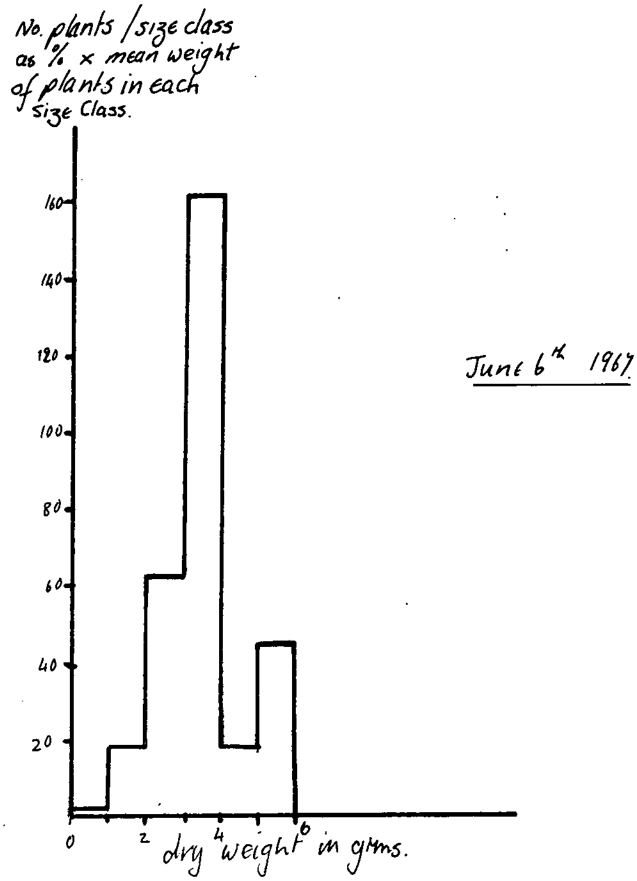
Dry Weight Standing Crop of Filipendula.



Production from Standing Crop of Filipendula - live.





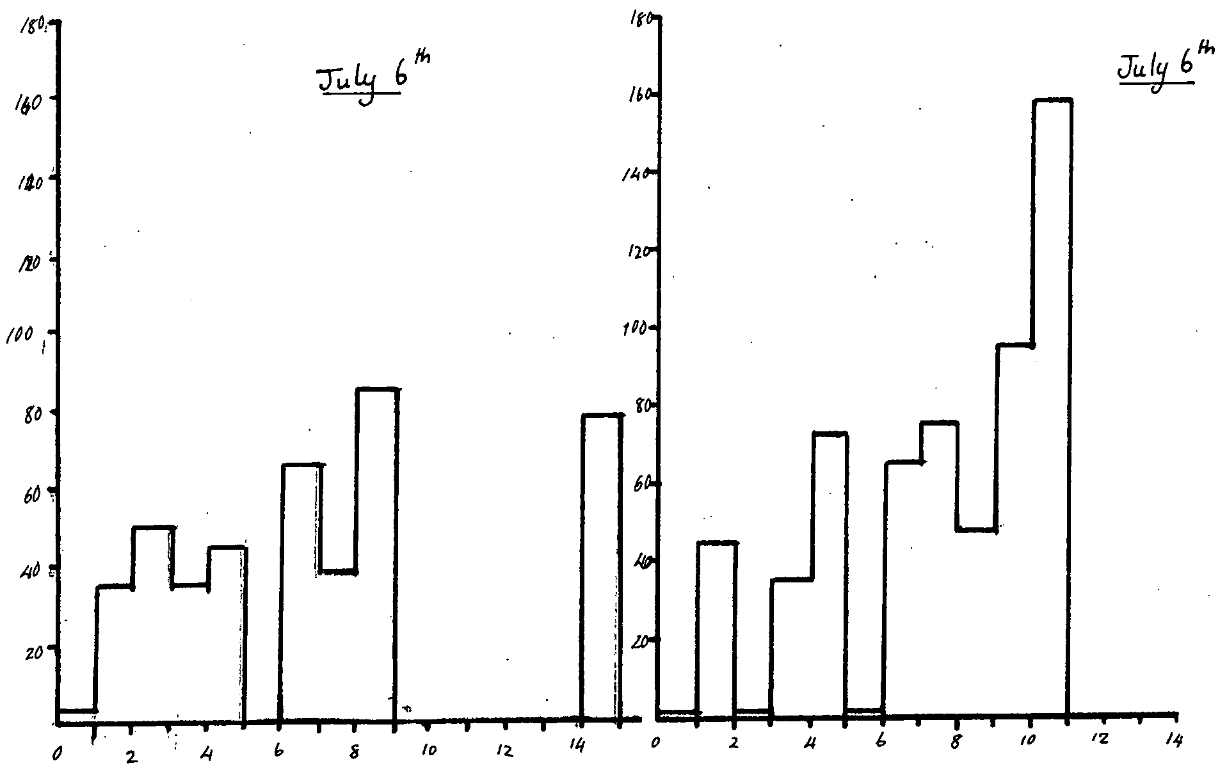


Production from standing Crops of Filipendula

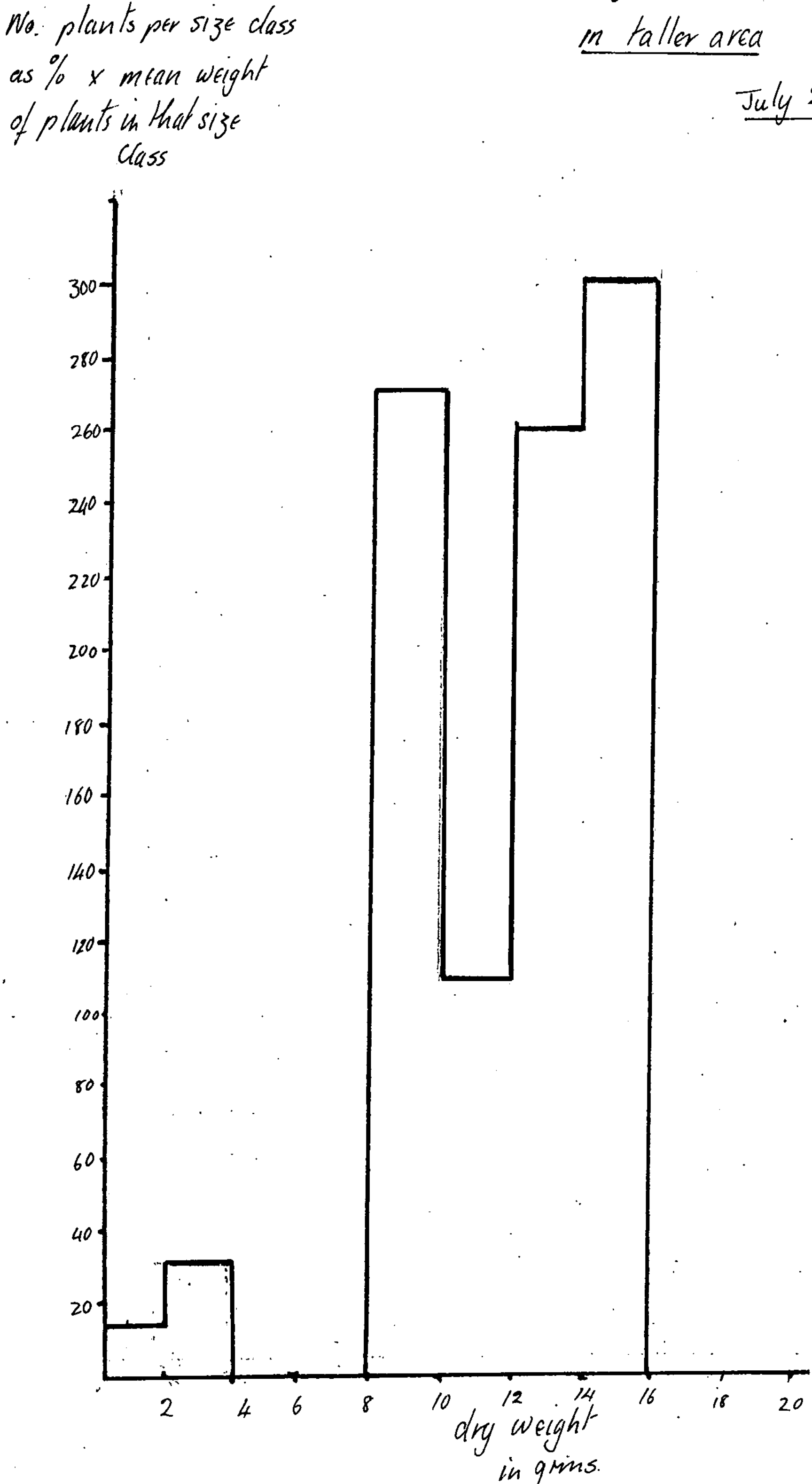
No. plants/size class as % x mean weight of plants in that size class

1) area of short plants

2) area of taller plants.

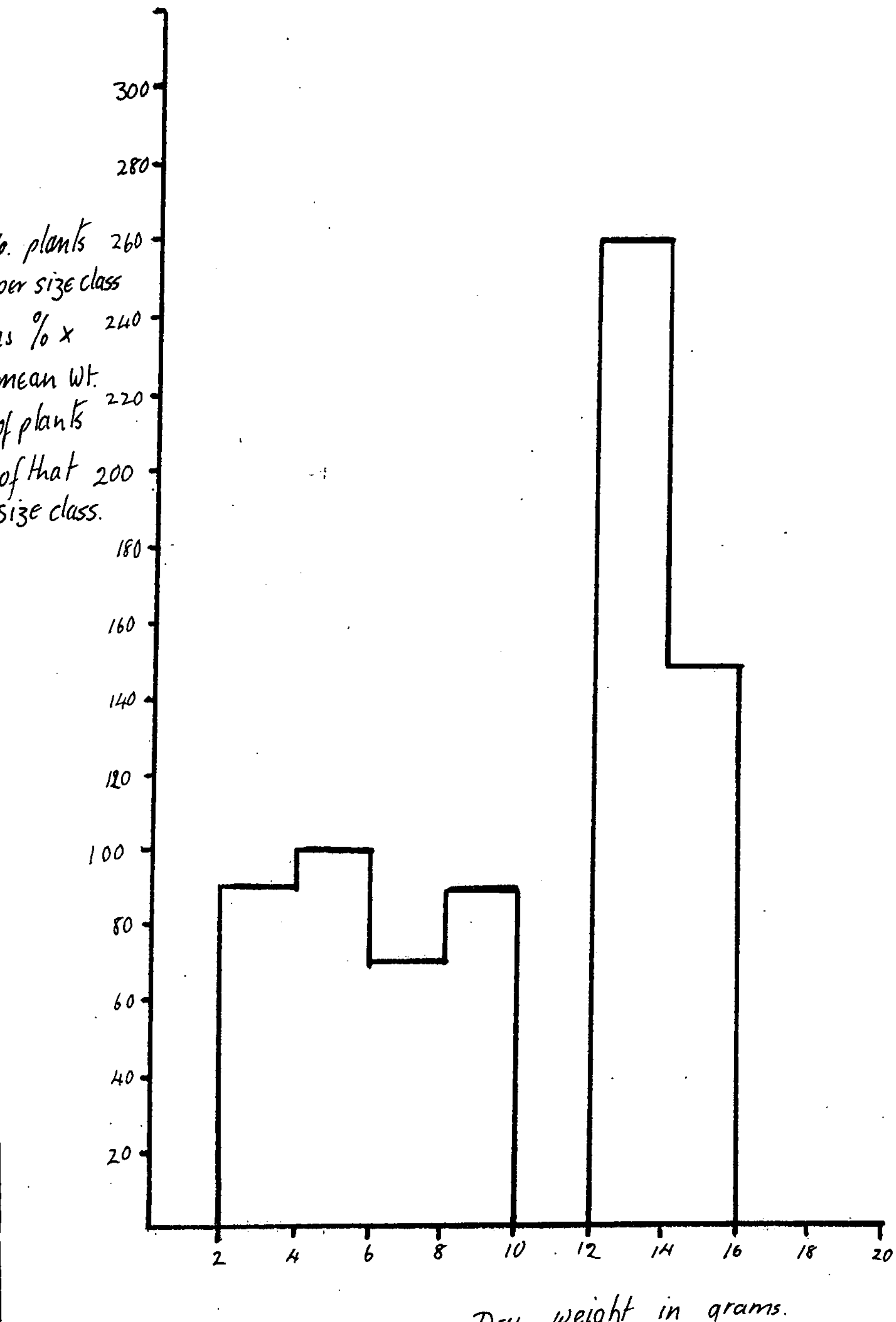


Standing Crop of Filipendula
in taller area
July 20th 1967

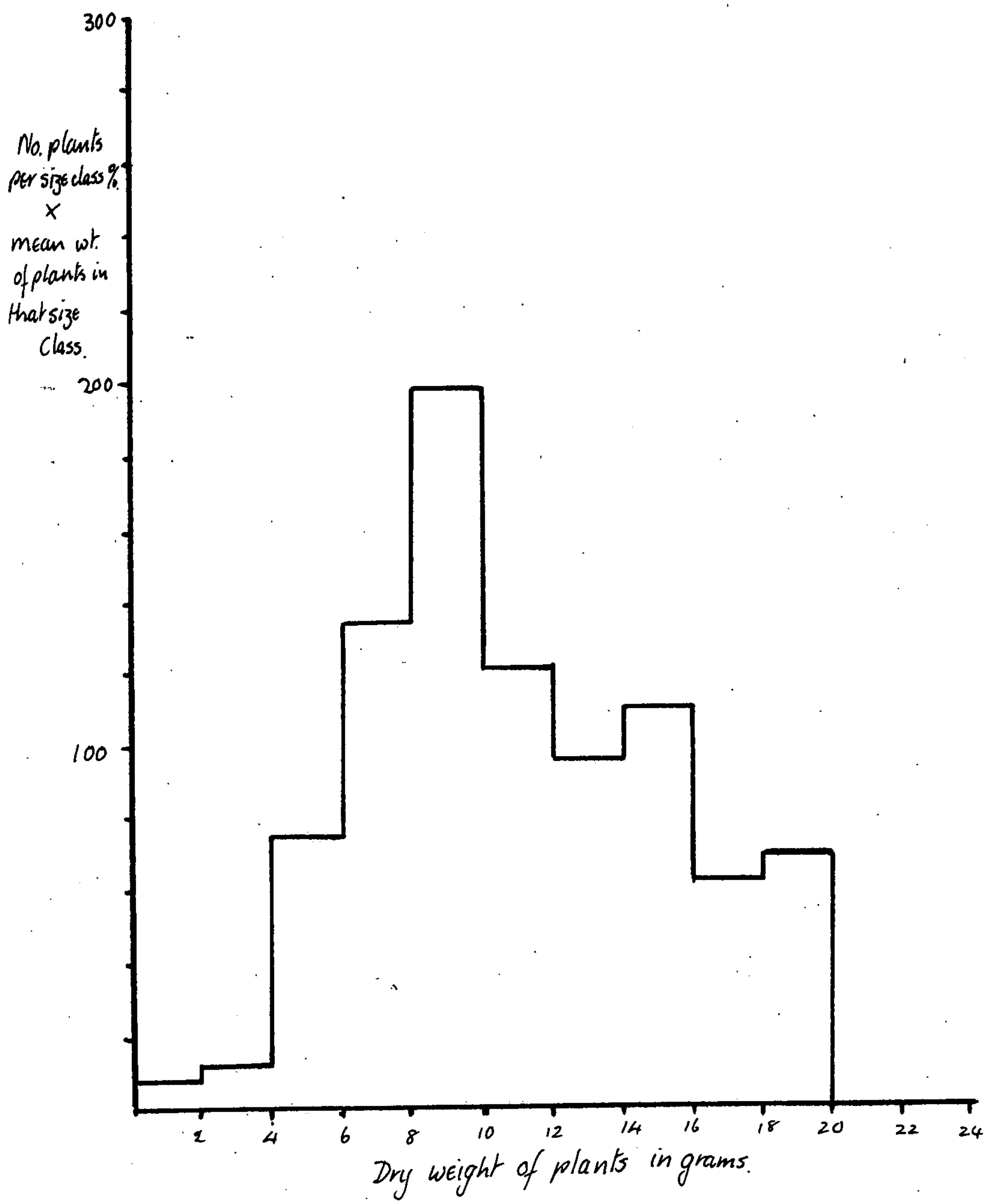


Production from Standing Crop of Filipendula in area of Shorter plants

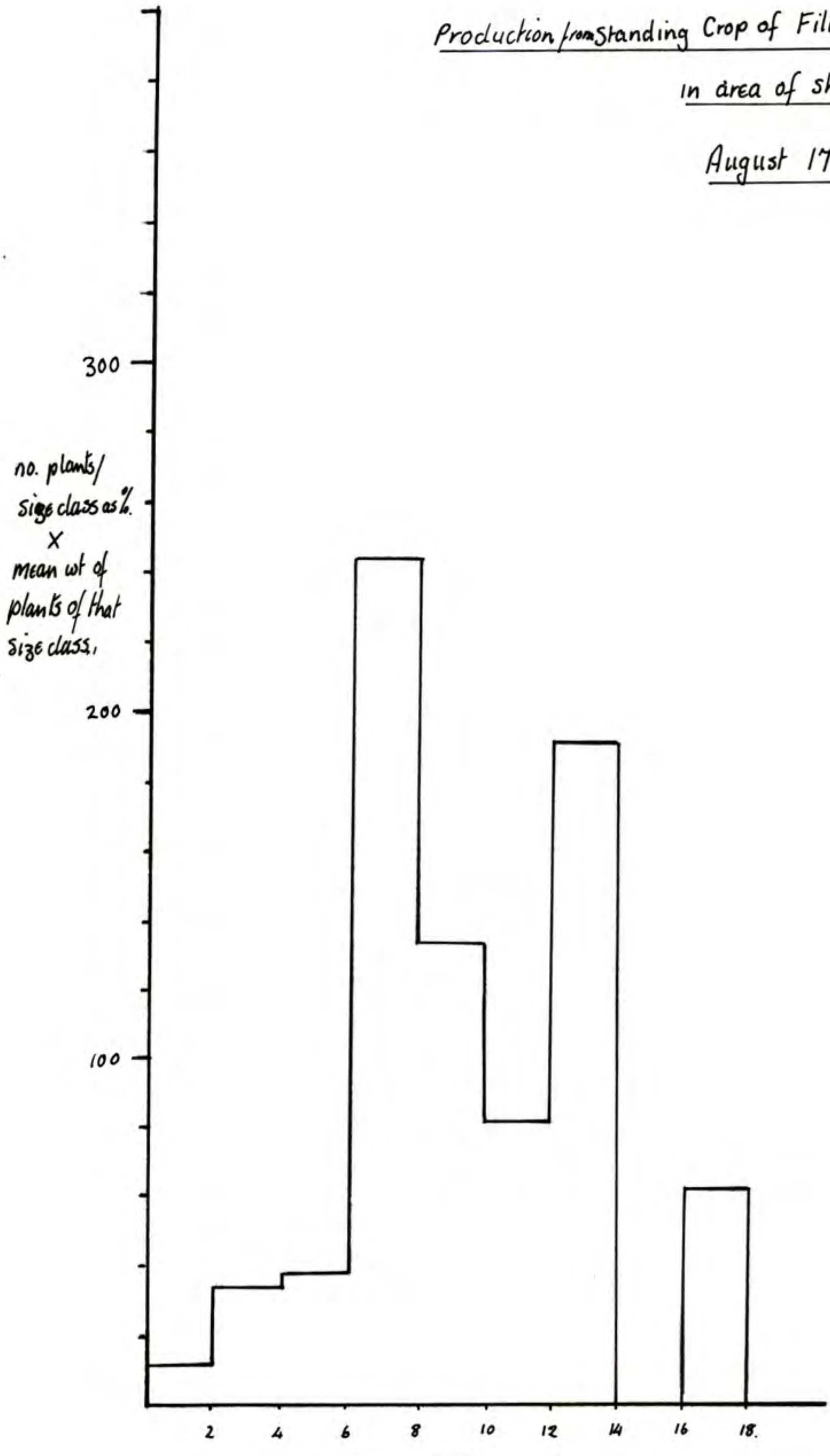
July 20th 1967



Production from Standing Crop of Filipendula ulmaria
in area of taller plants.
August 17th 1967.

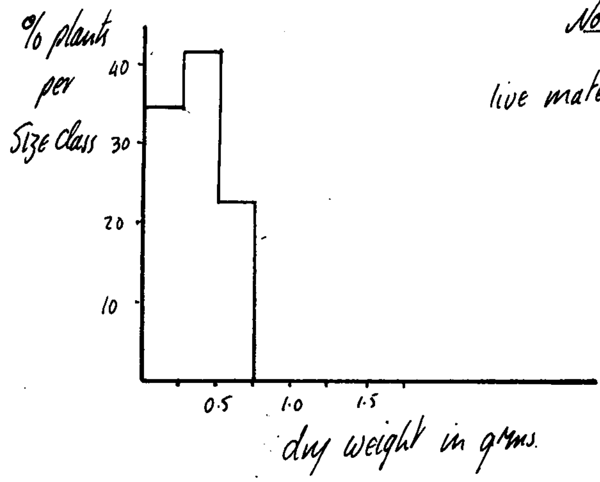


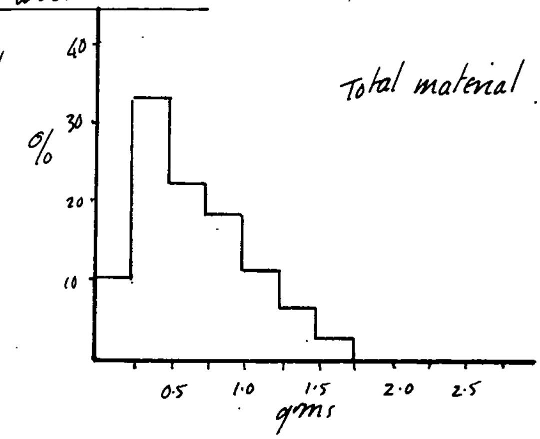
Production from Standing Crop of Filipendula
in area of shorter plants.
August 17th 1967.



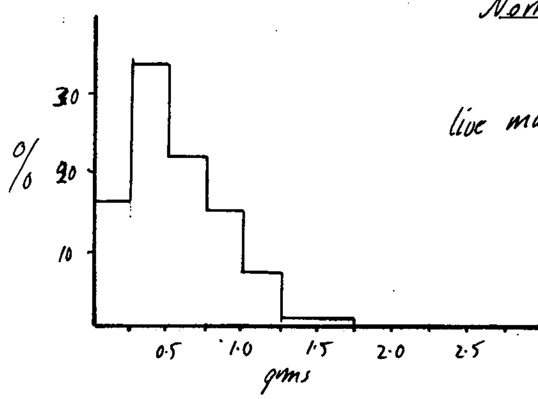
Standing Crop. Dry weight Production of Carex Paniculata May 11th.

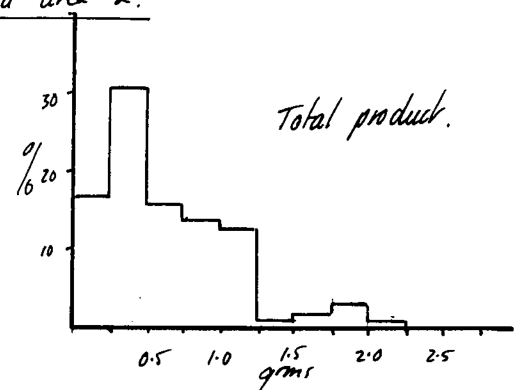
North wood area. I



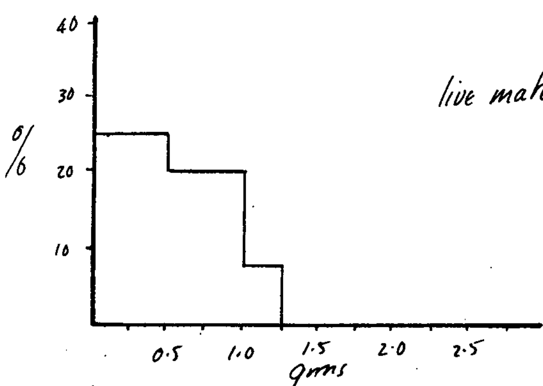


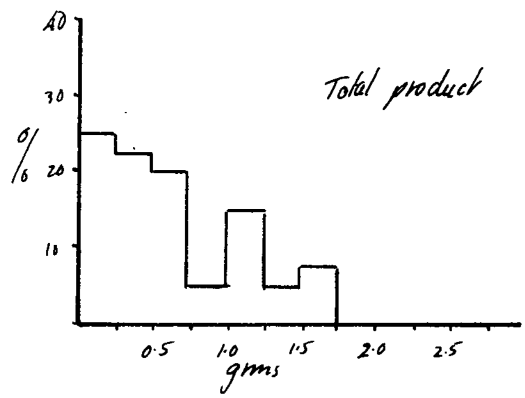
North wood area 2.



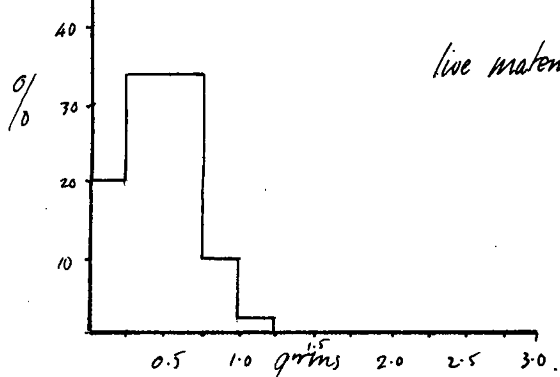


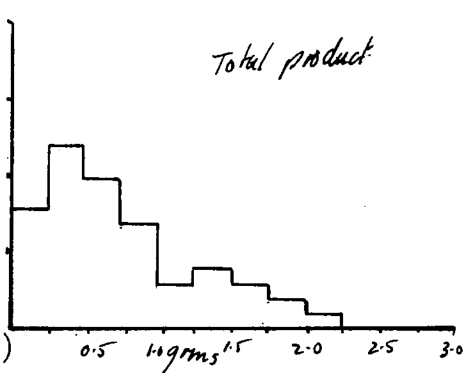
South wood area I





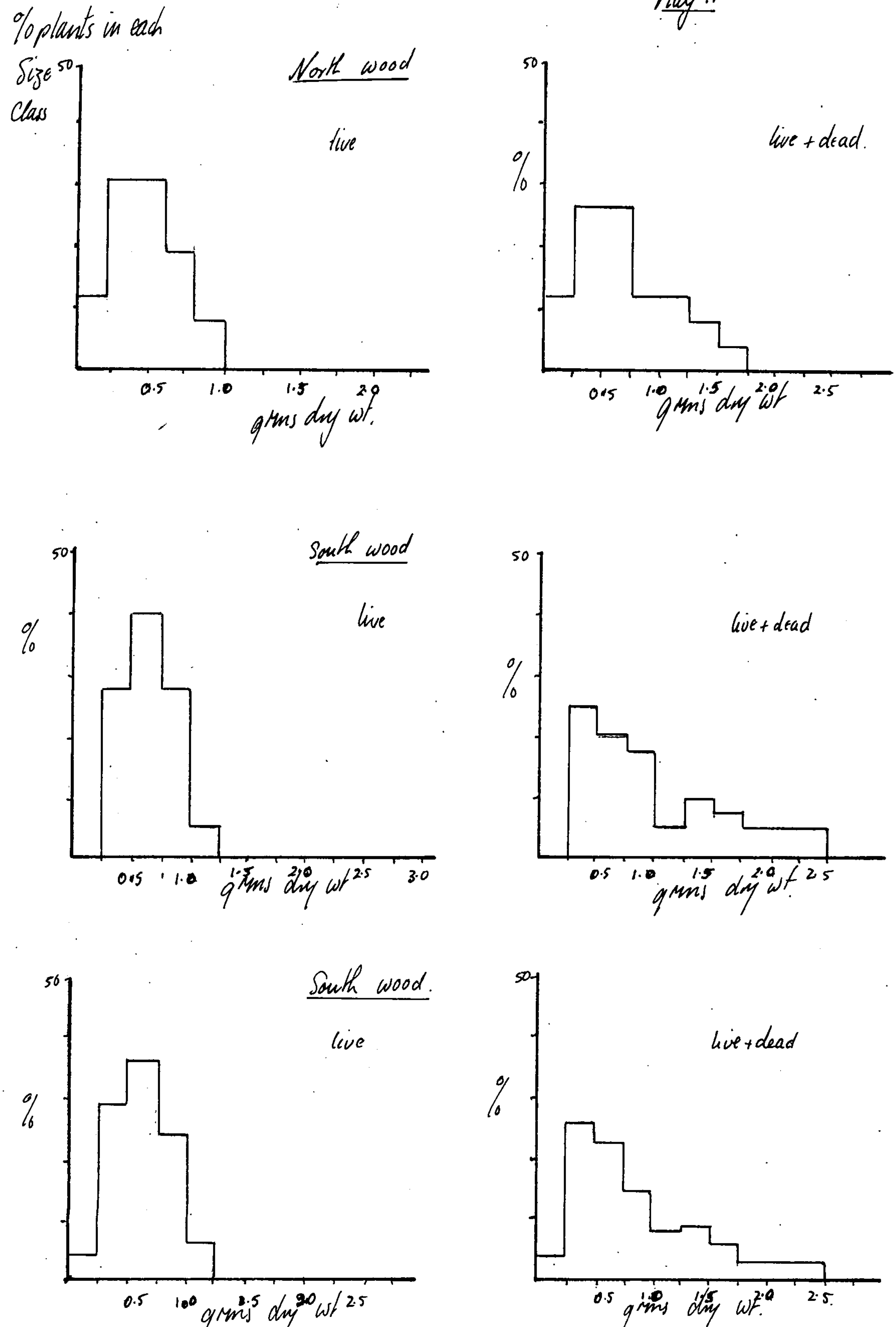
South wood area 2.



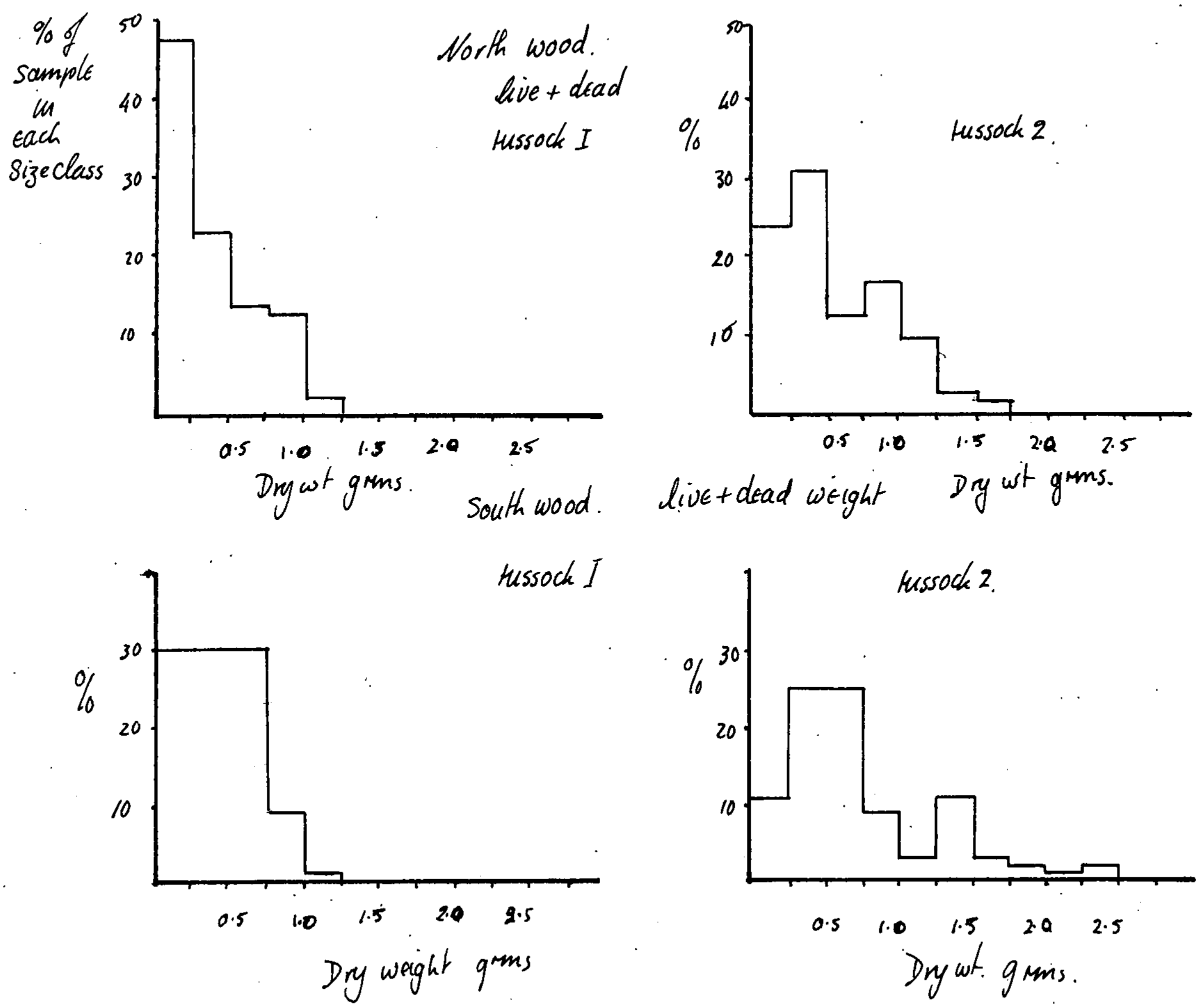


Dry Weight Production of Carex Paniculata as Standing Crop.

May 11th.

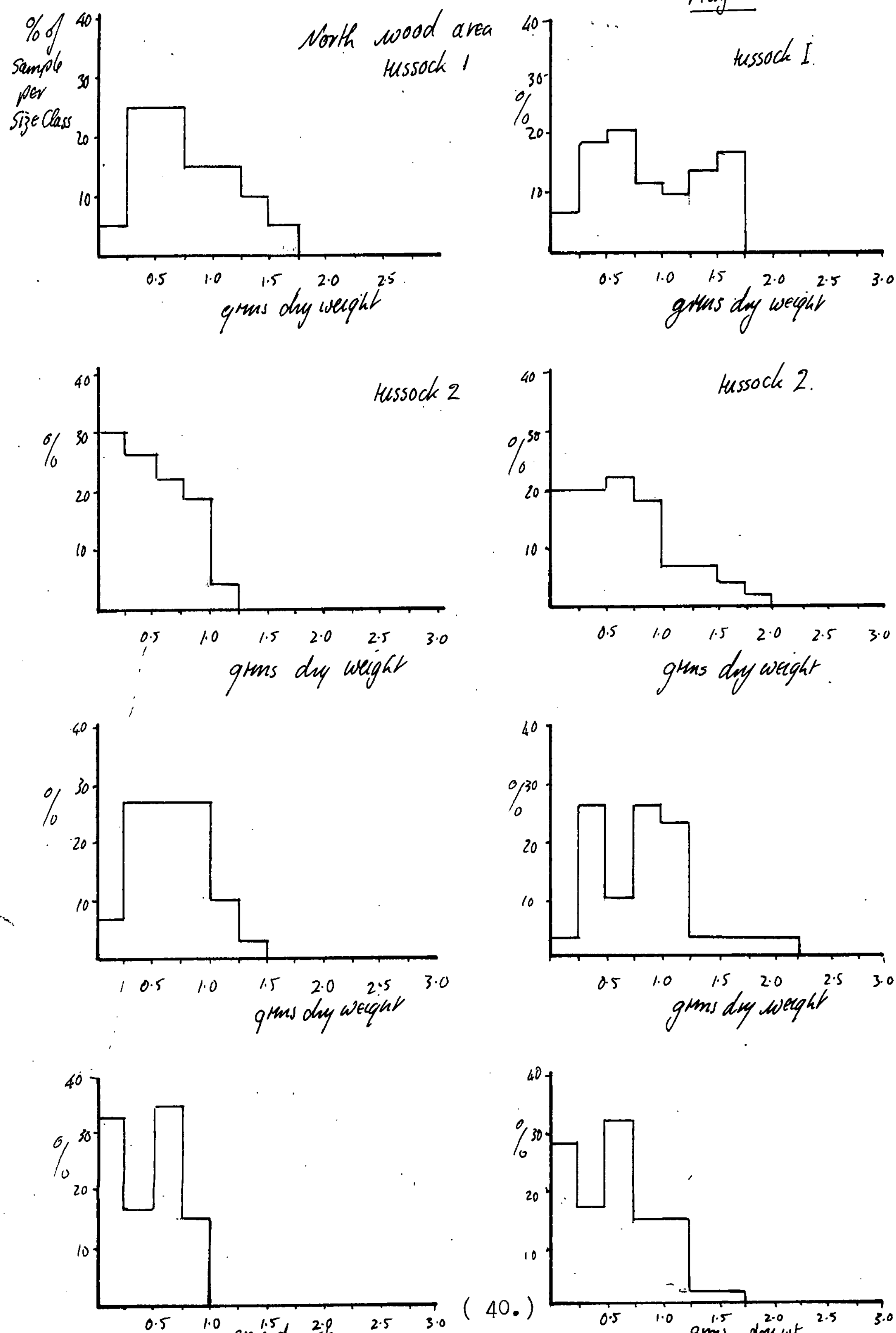


Dry Weight Standing Crop of Carex paniculata. May 18th.

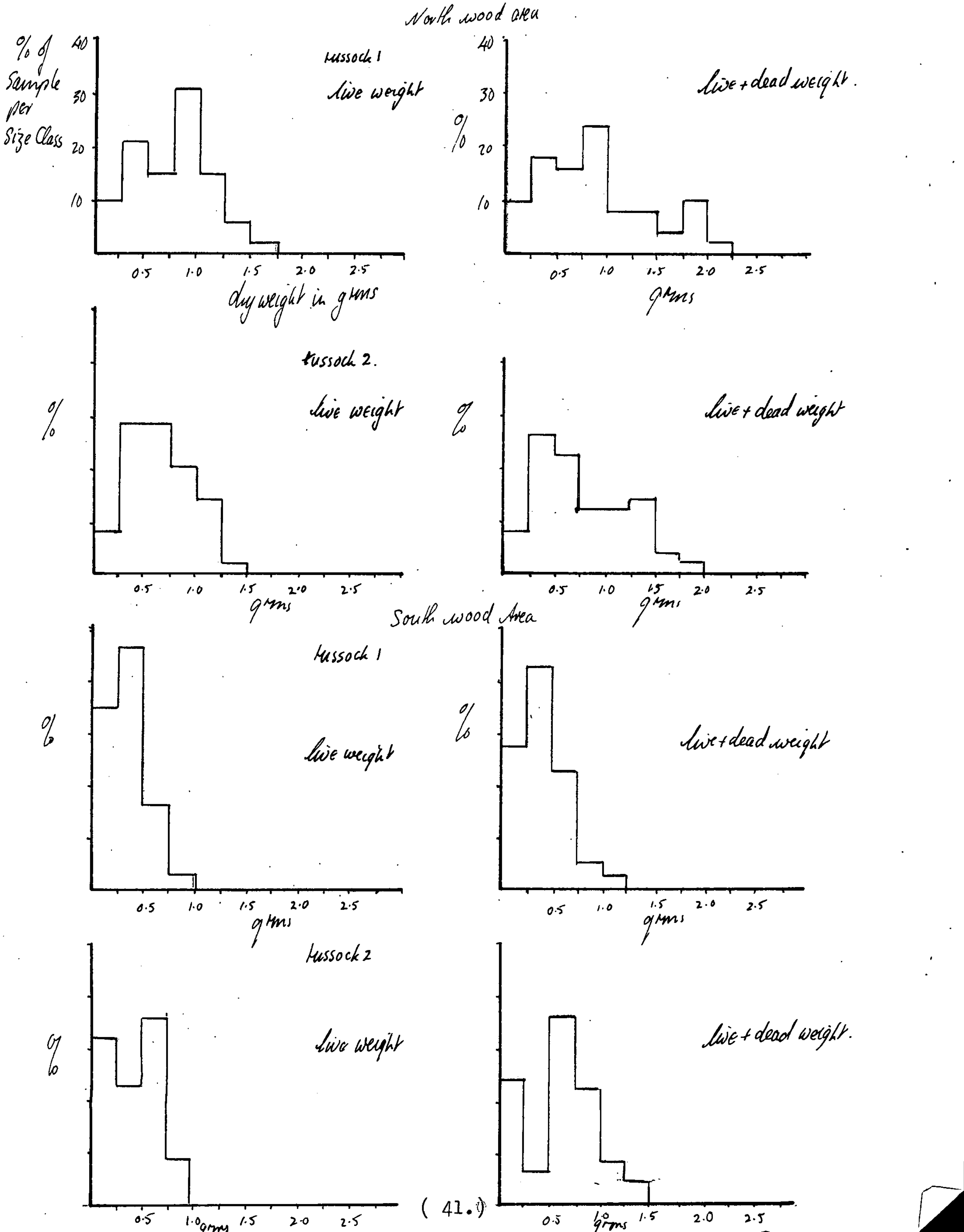


Dry weight Standing Crop of Carex paniculata

May 25th

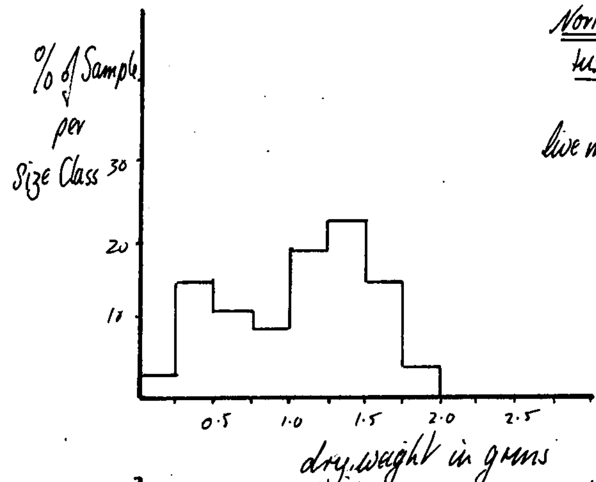


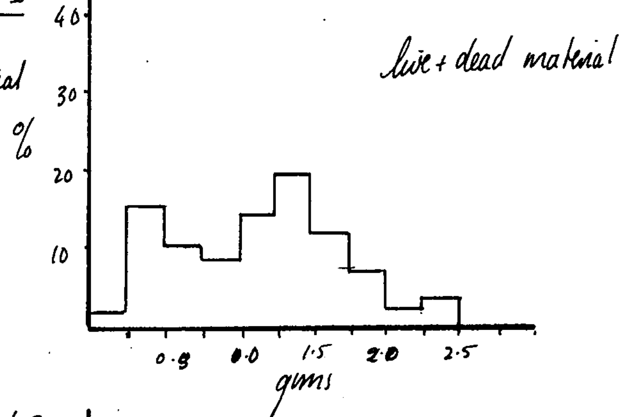
Dry weight Standing Crop of Carex paniculata June 7th.



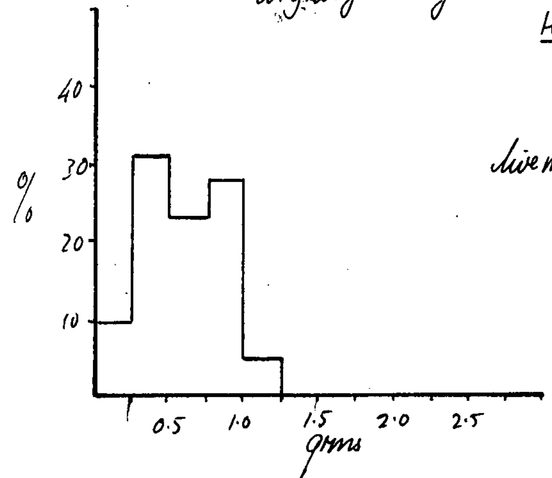
North wood Area.

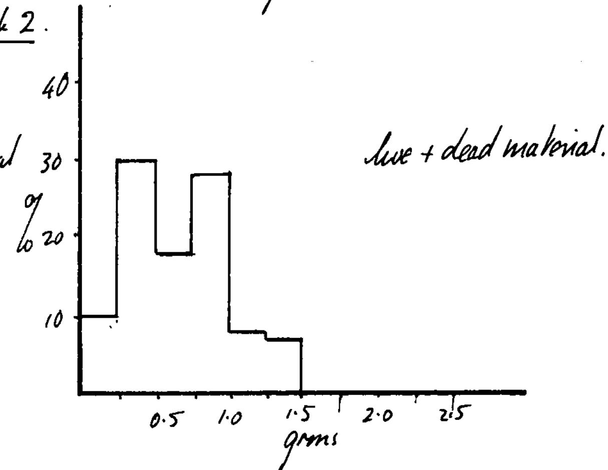
tussock I





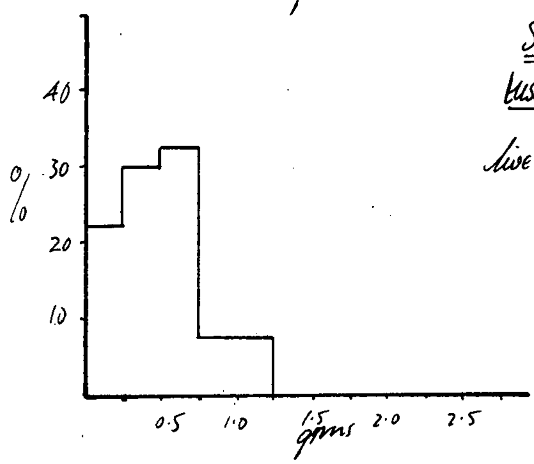
tussock 2.



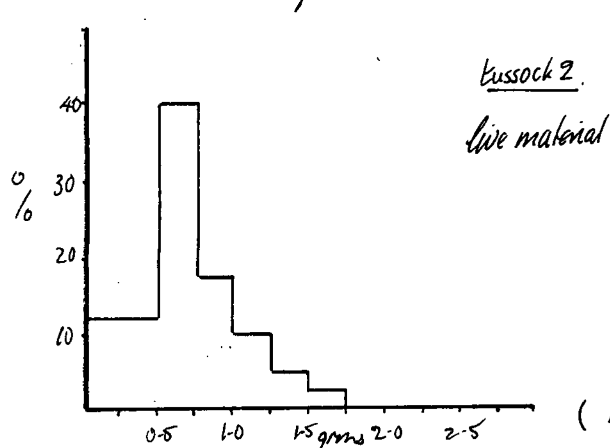


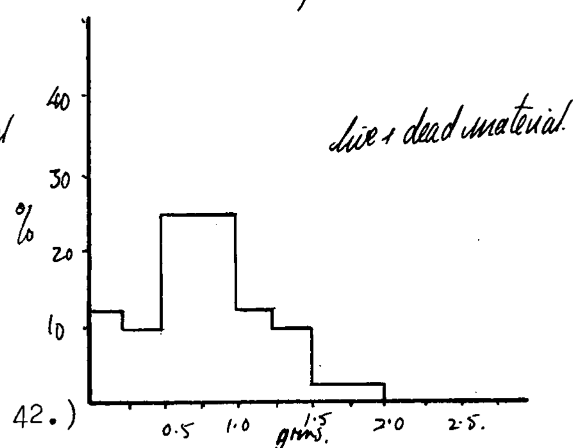
South wood Area.

tussock 1.



tussock 2.



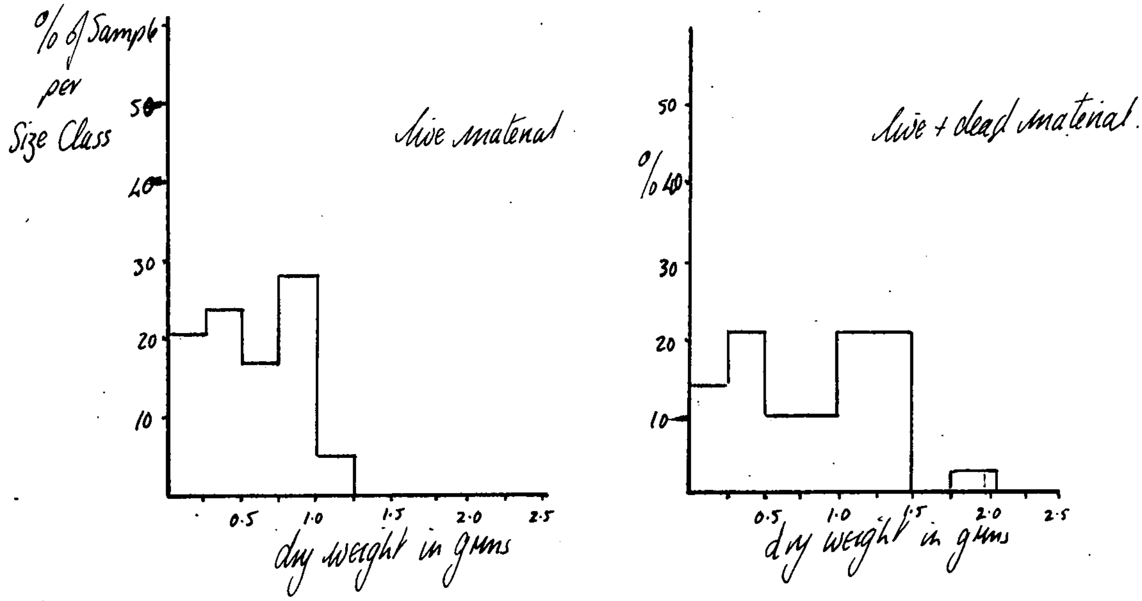


Dry weight Standing Crop of Carex paniculata

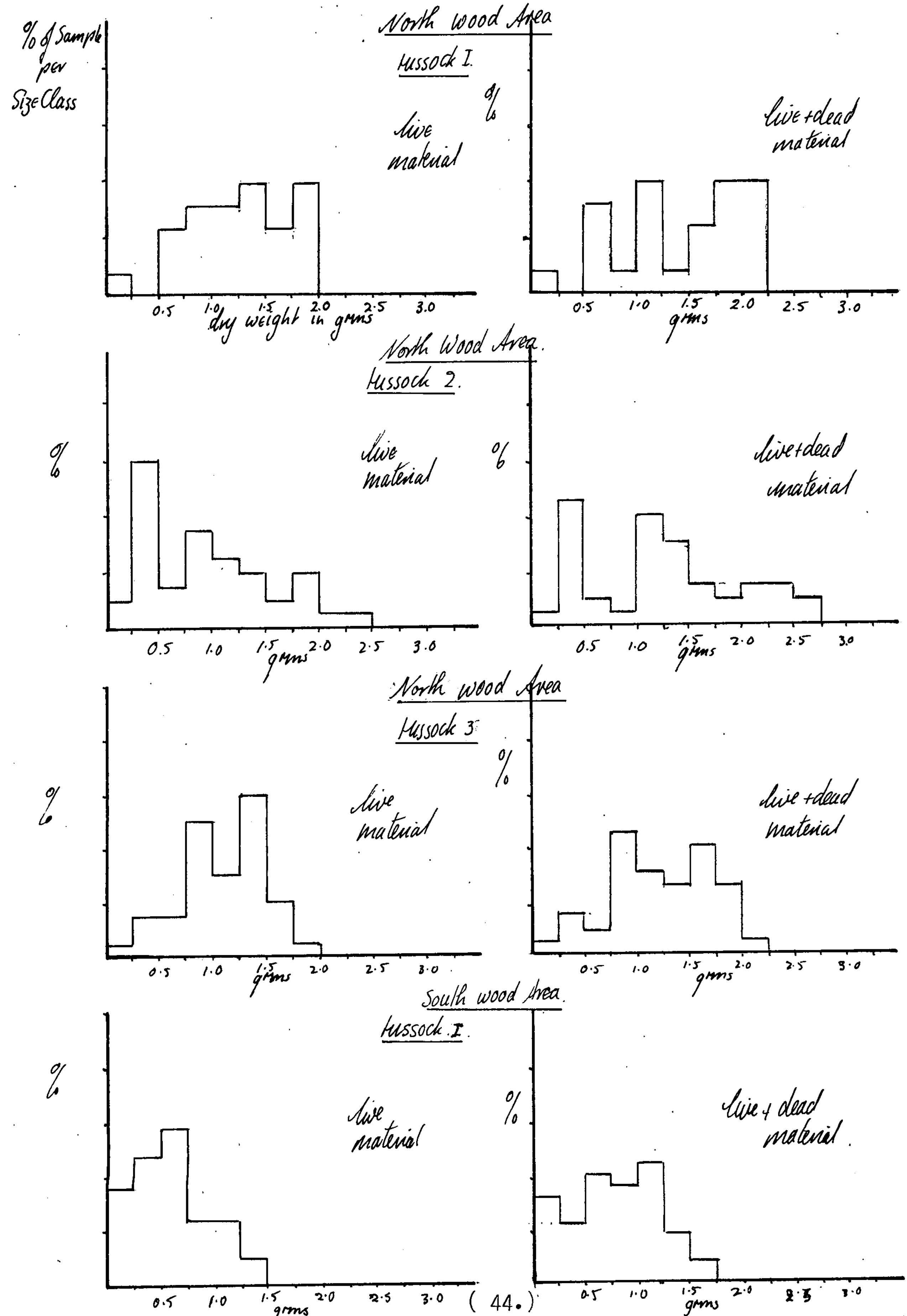
June 22nd

South wood Area

Tussock 3.



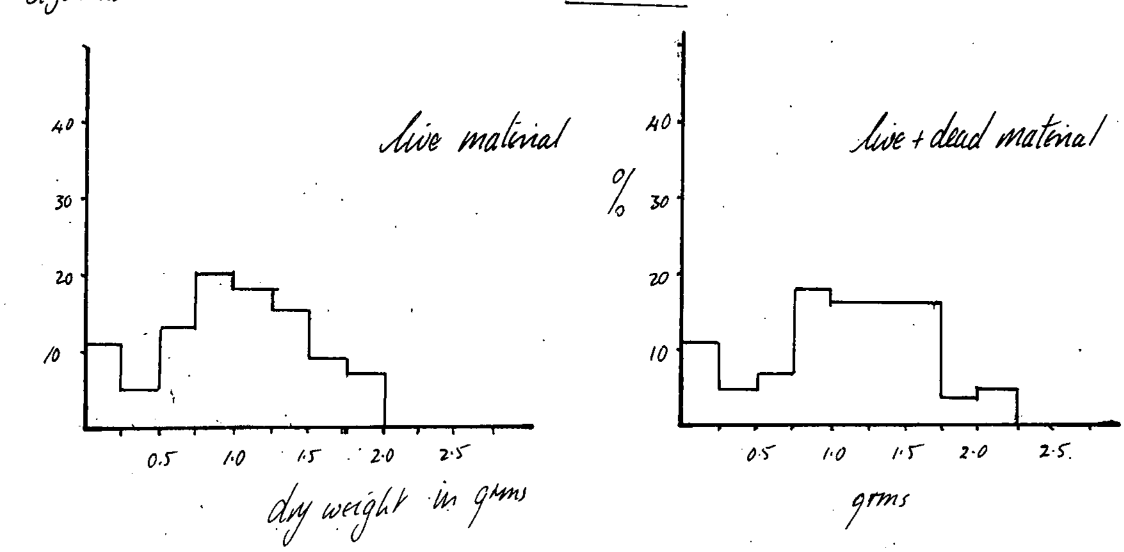
Dry weight Standing Crop of Carex paniculata July 6th.



Dry Weight Standing Crop of Carex paniculata

July 6th.

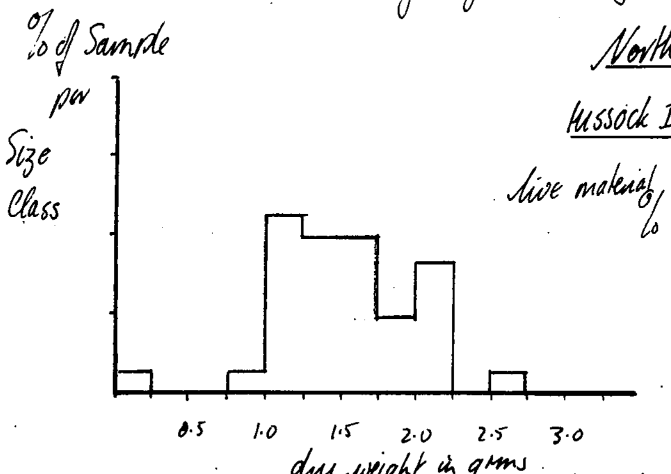
South wood Area
Tussock 2.

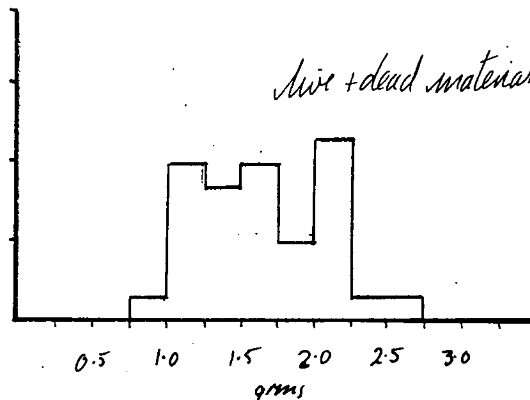


Dry weight Standing Crop of Carex paniculata. July 20th

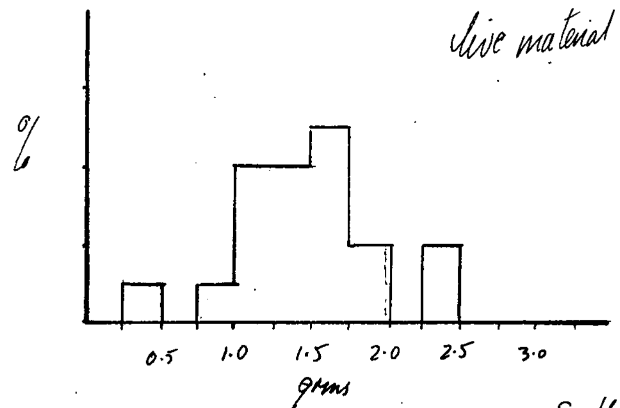
North Wood Area

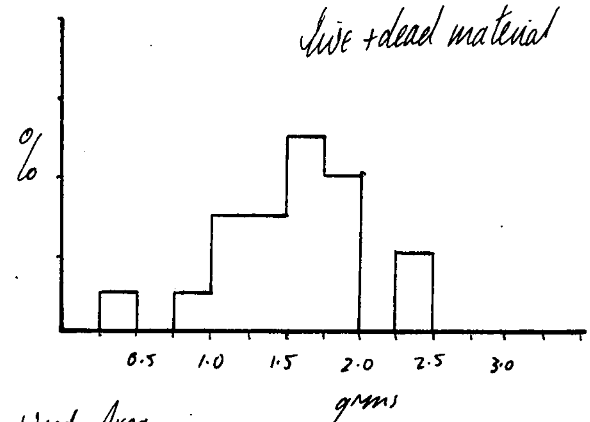
Tussock I





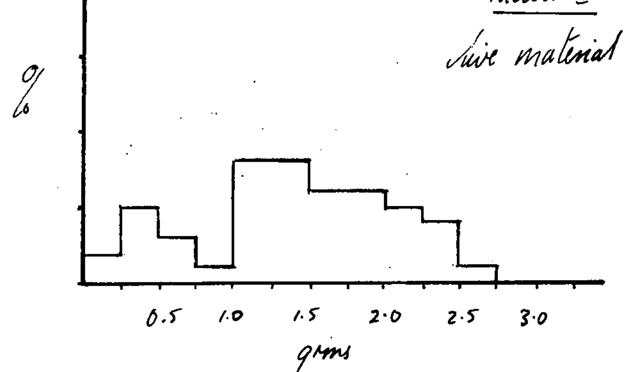
Tussock 2

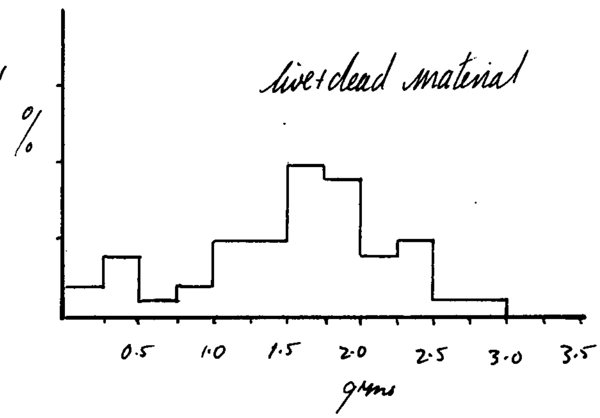




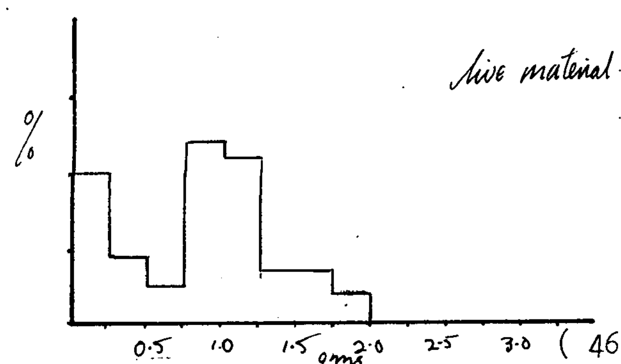
South Wood Area

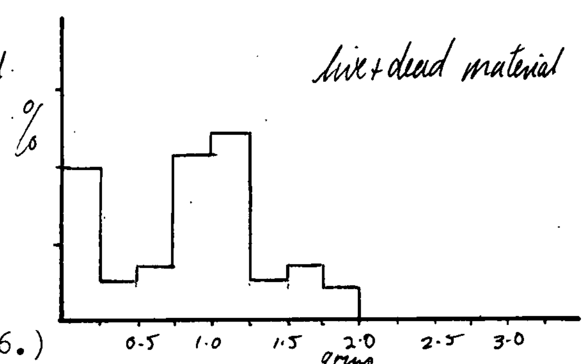
Tussock I





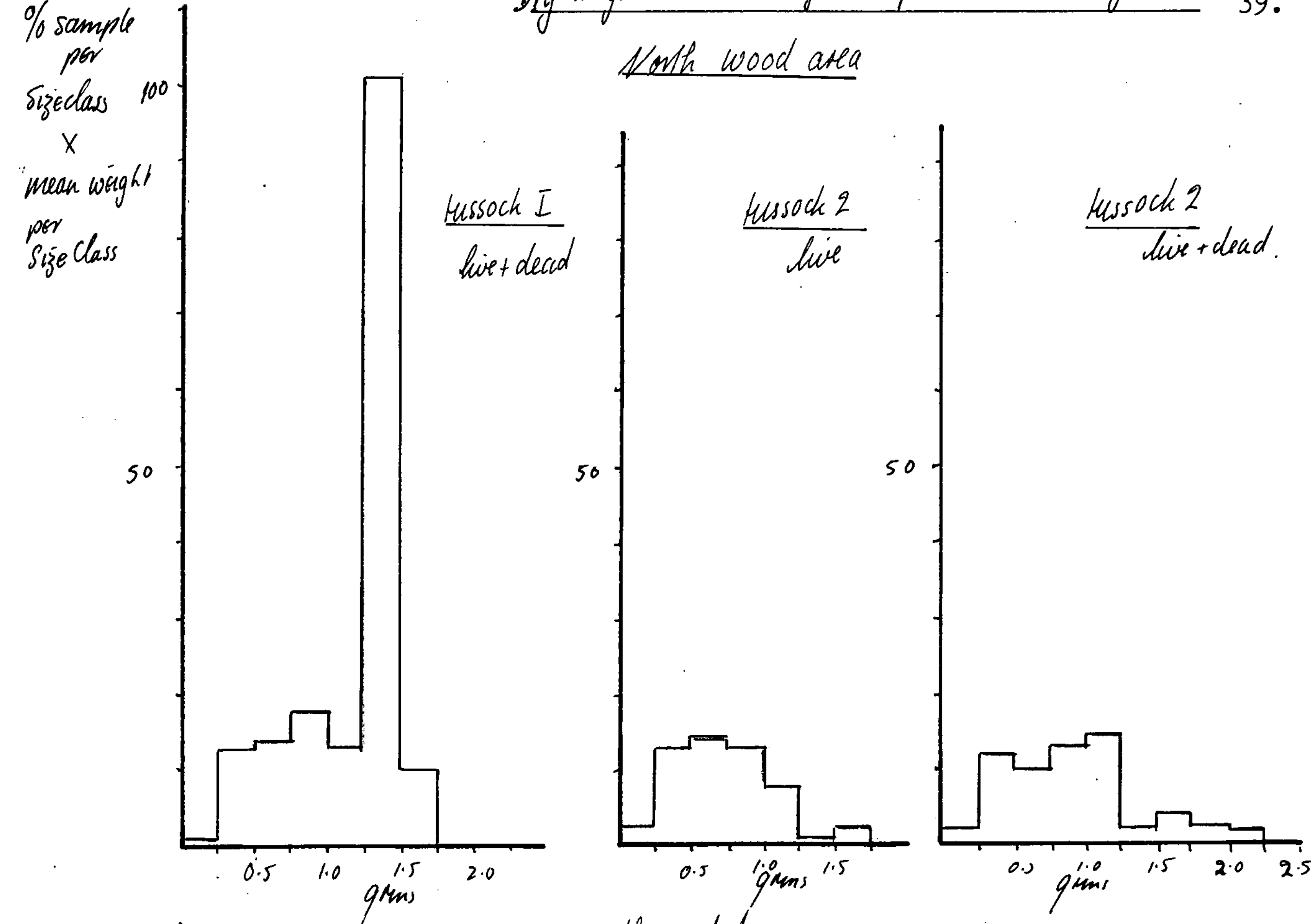
Tussock 2



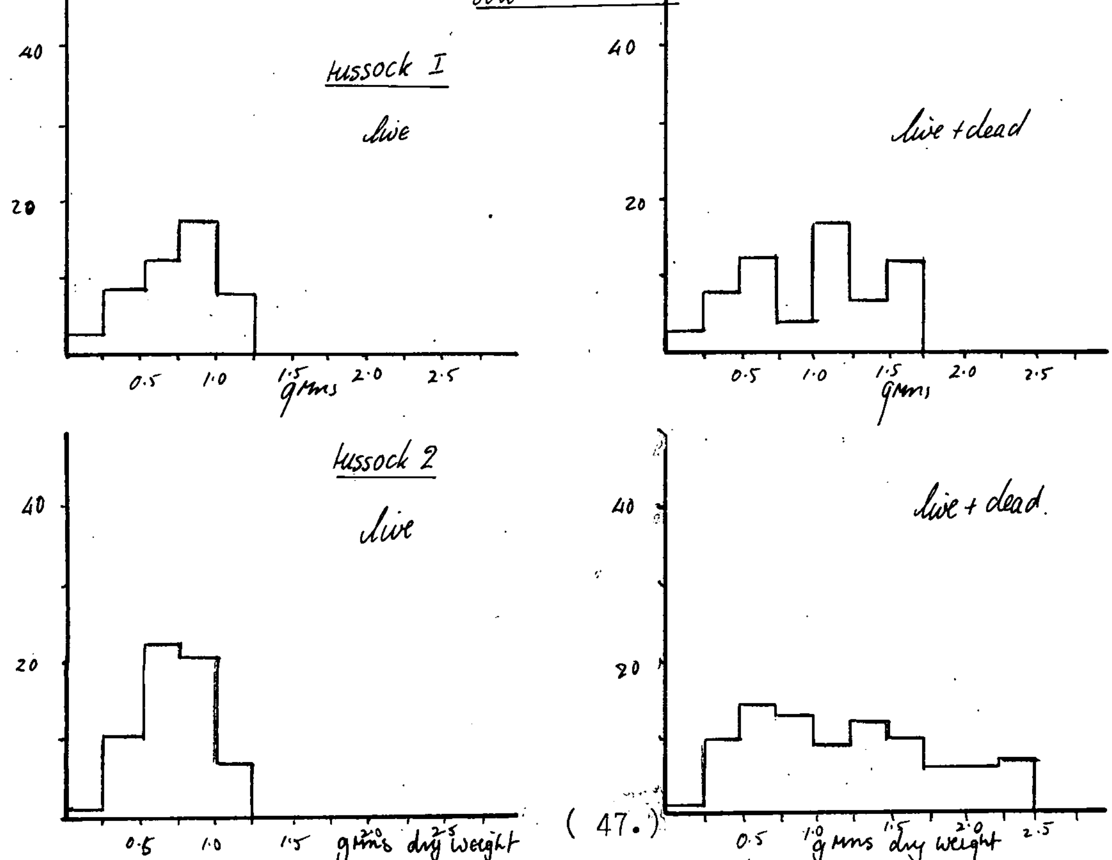


Dry weight Production of Carex paniculata May 11th.

North wood area



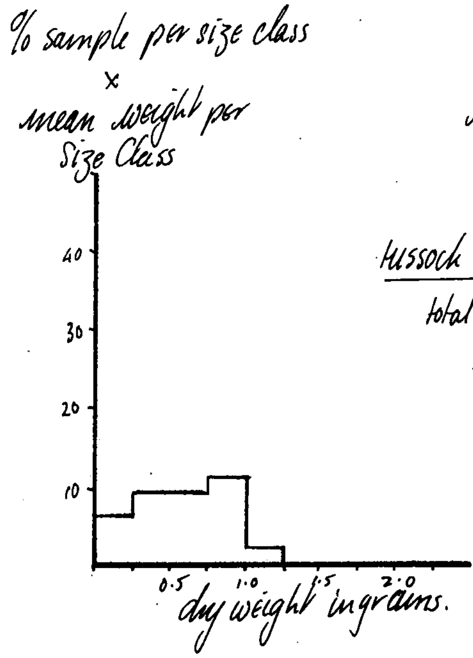
South wood Area.

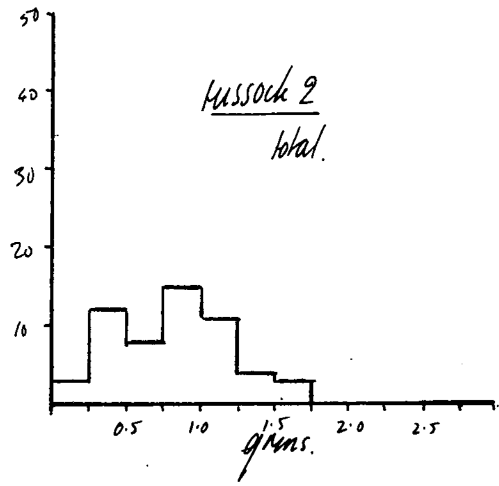


Dry weight Production of Carex paniculata

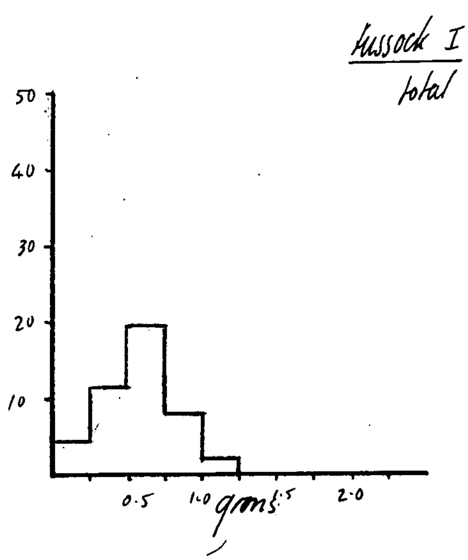
May 18th

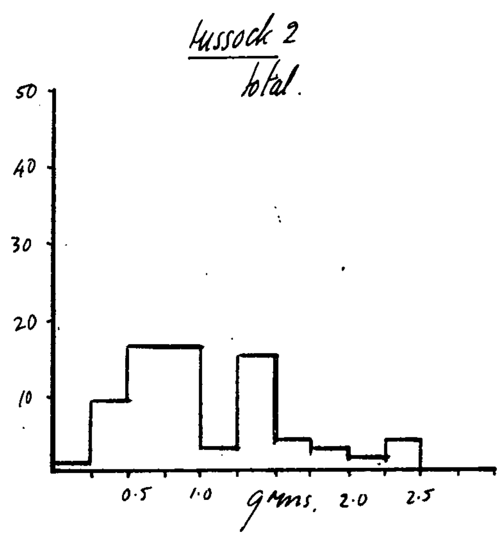
North wood Area





South wood Area

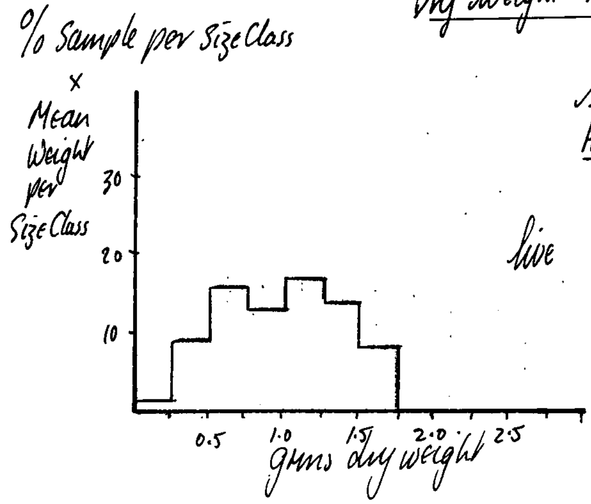


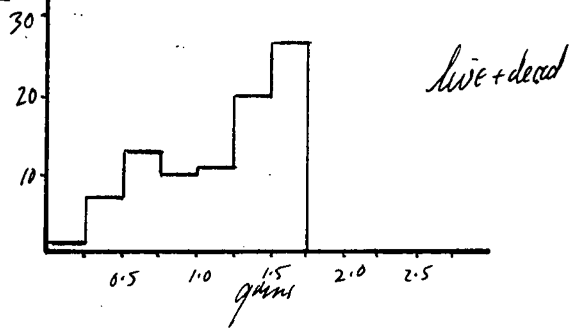


Dry weight Production of Carex paniculata May 25th

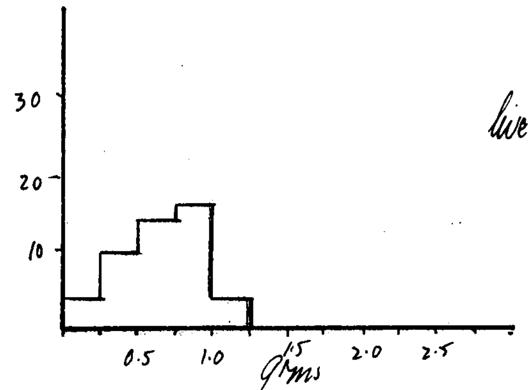
North wood Area

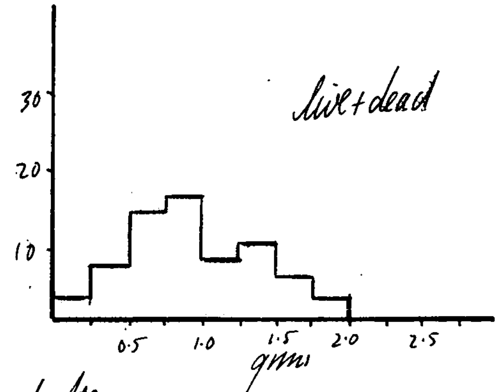
Tussock I





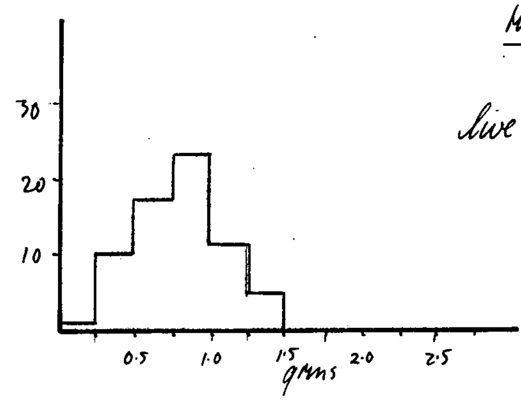
Tussock 2.

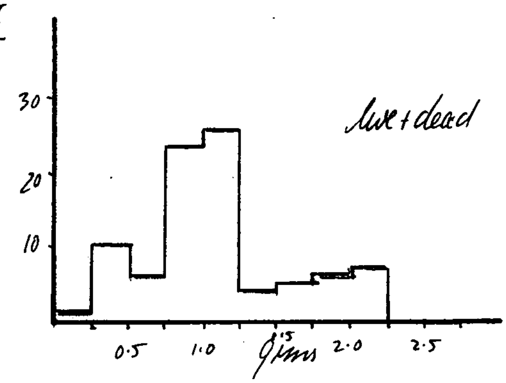




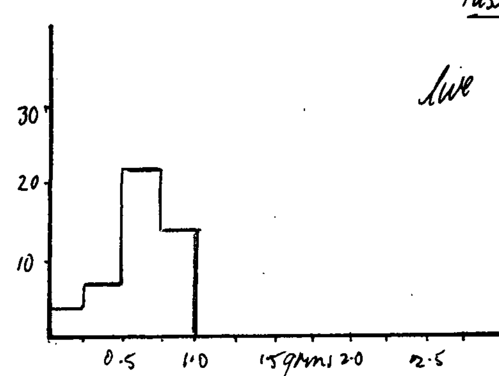
South wood Area

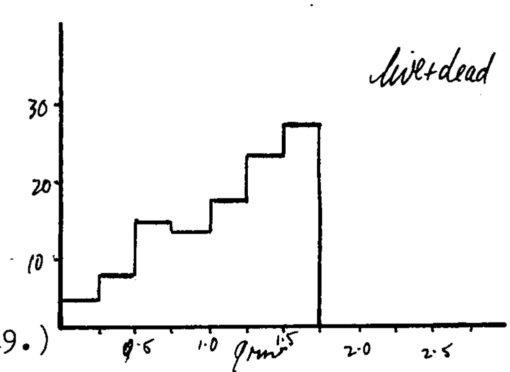
Tussock I





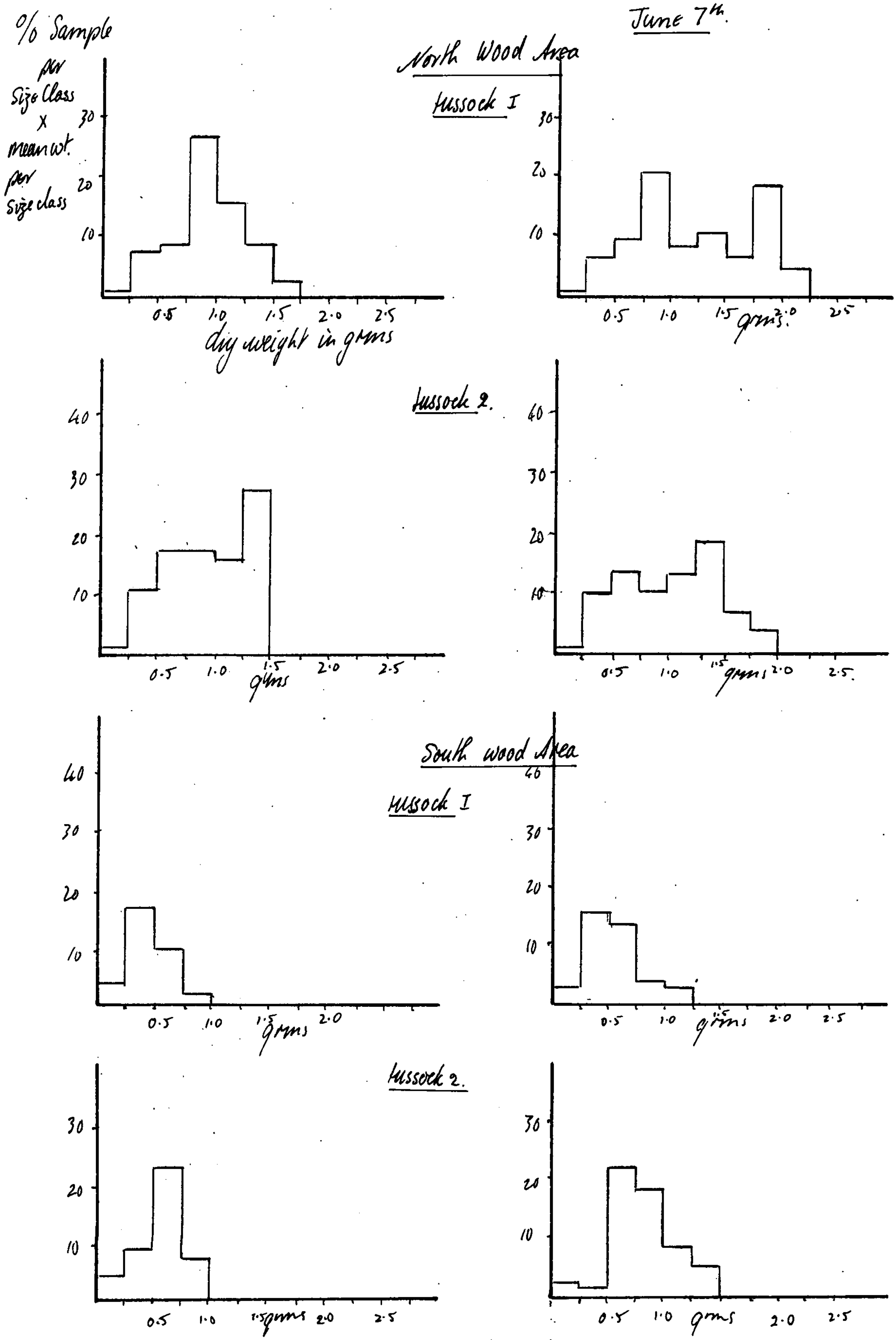
Tussock 2





Dry Weight Production of Carex Paniculata

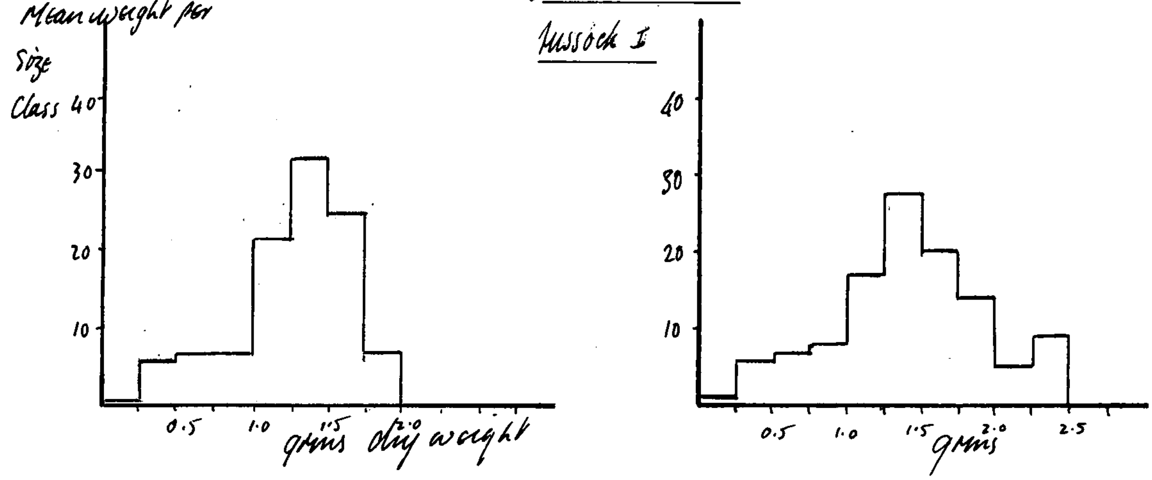
June 7th.



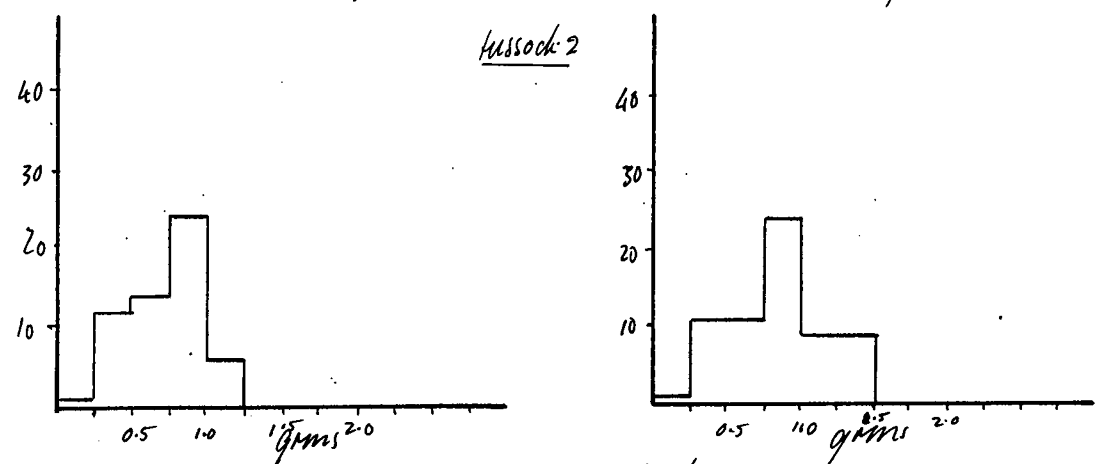
Dry Weight Production of Carex paniculata June 22nd

North wood Area

Tussock I

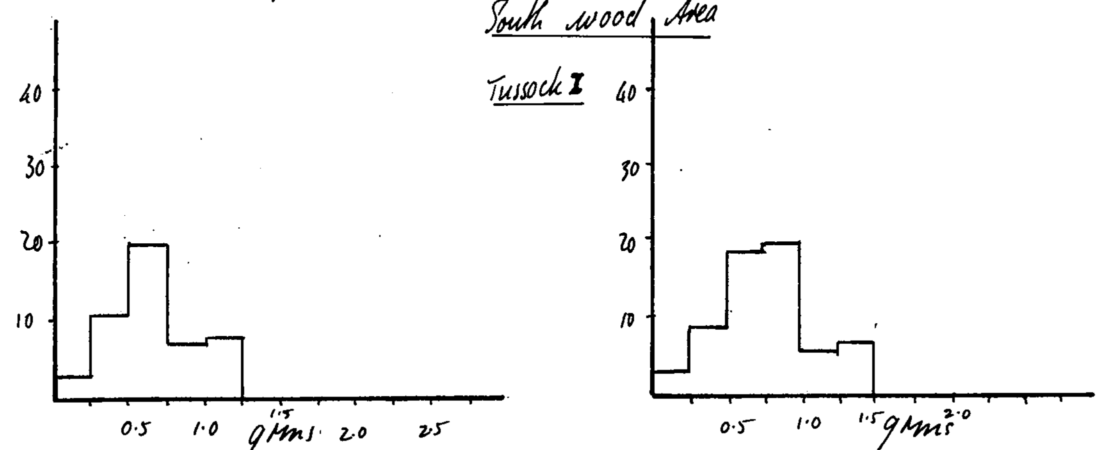


Tussock 2

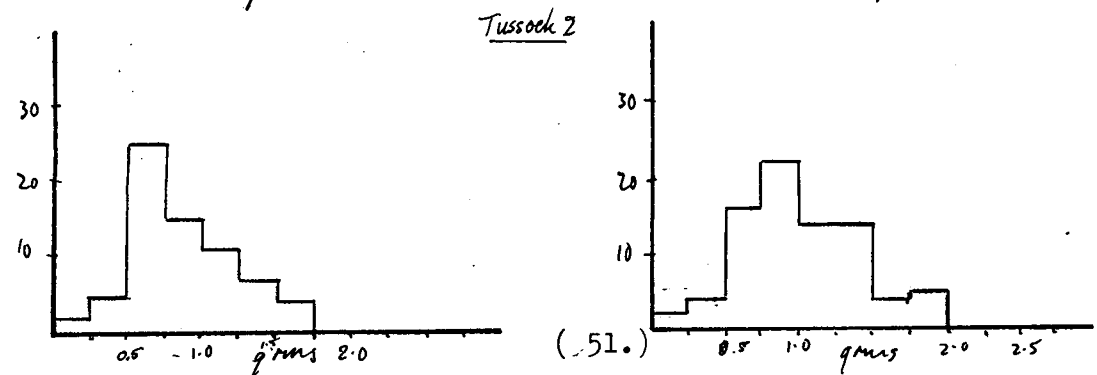


South wood Area

Tussock I

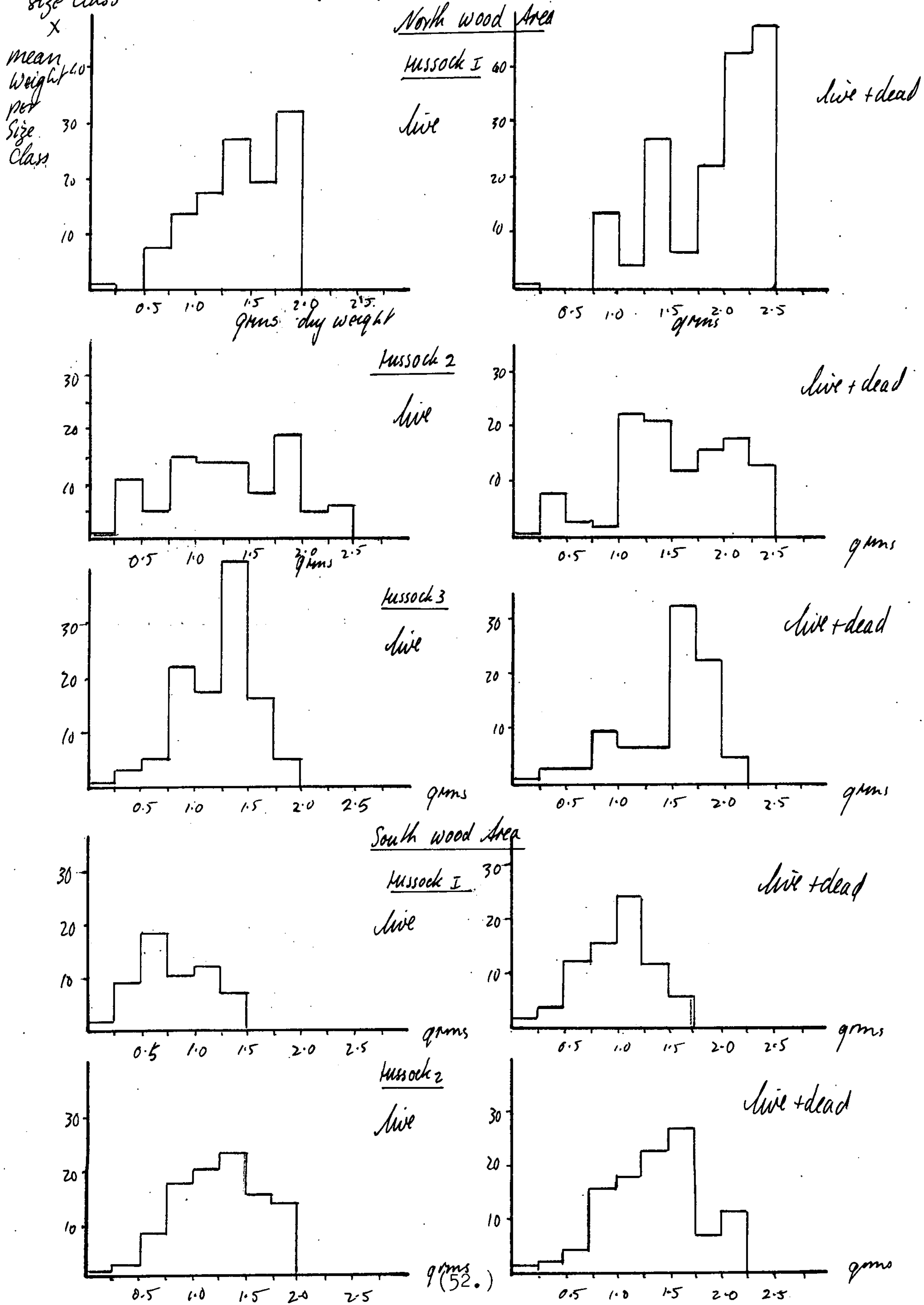


Tussock 2



Dry Weight Production of Carex paniculata July 6th

% sample per size class x mean weight per size class

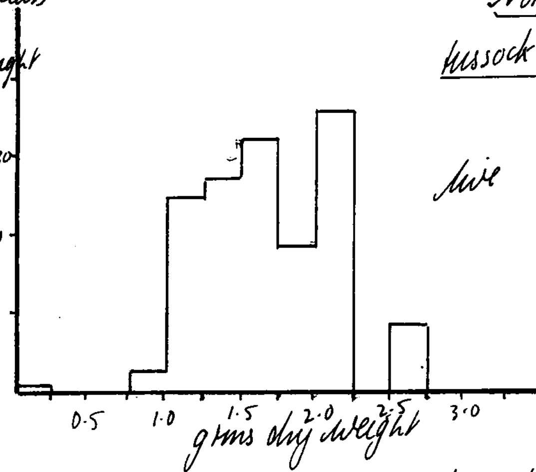


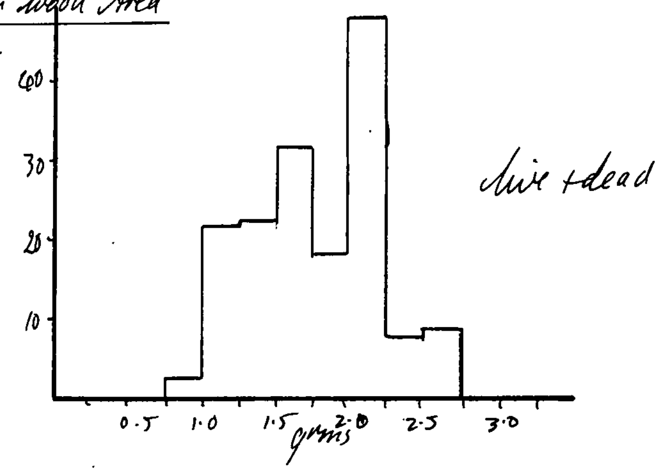
Dry weight Production of Carex Paniculata July 20.

North wood Area

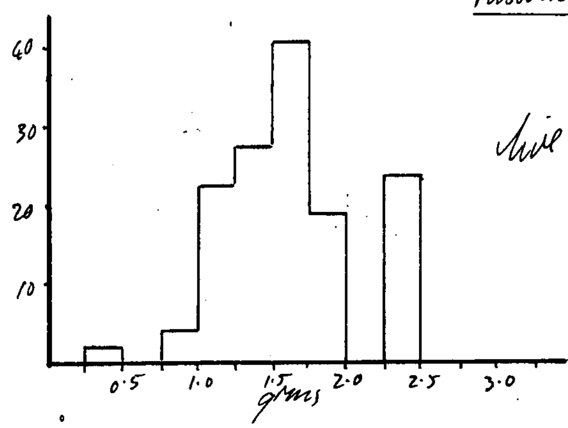
% Sample per size class x mean weight per size class

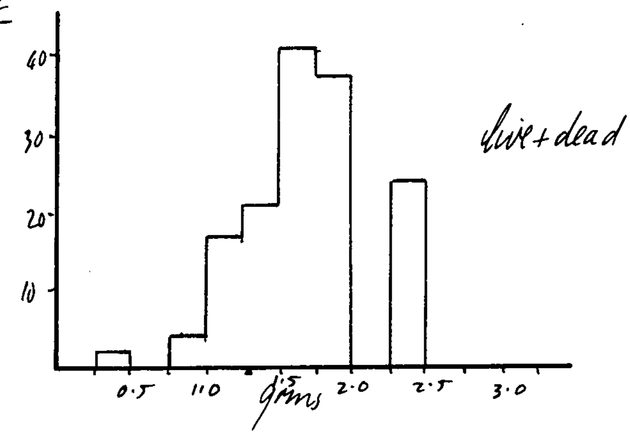
Tussock I





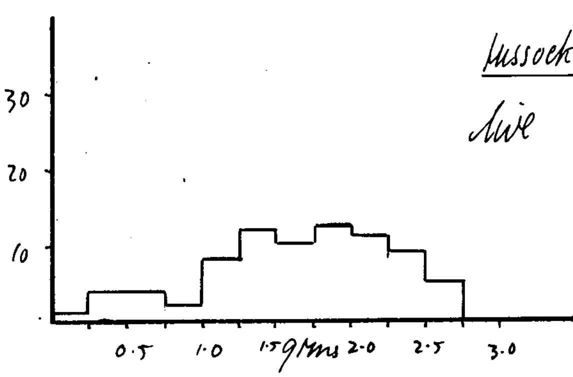
Tussock 2

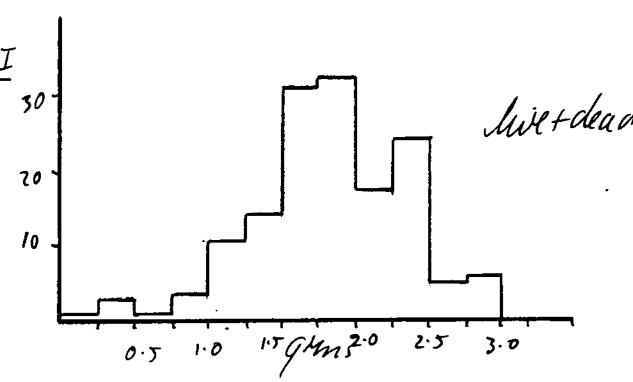




South wood Area

Tussock I





Tussock 2