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AN APPROACH TO THE RIPARIAN VEGETATION OF RUPERT BAY, QUE.

THE CANADIAN WILDLIFE SERVICE,
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Introduction

Introduction

Prior to dealing with the main body of the present report, we would like to give a few explanations concerning the interpretation of the various tests used, as well as a vocabulary index and the references underlying the formulas employed.

A- Horizontal structure of the vegetation

Vegetation may be considered as a three-dimensional system containing a certain number of components that occupy a place in space.

The structure of such a system is the position in space of the components relative to each other.

Structure analysis means a study of the relationship between components within the space of a chosen model, as a function of the problem at hand, by means of the most appropriate method of analysis available.

Horizontal structure analysis consists in the application of the above reasoning to the horizontal plane.

Horizontal structure analysis includes a study of the following items:

1- the internal heterogeneity or diversity of a system and its appraisal

2- the relationships between the various components

3- the distribution of the various components

4- heterogeneity variations as a function of different perception scales

5- the location or ordination of component groups.

In order to effect such an analysis, we had to do a special observation of the vegetation: we have used for this purpose the sampling method known as "exhaustive analysis" using lines assembled from adjacent segments.

Lines were located at random in vegetation zones that had the appearance of uniform flora. These zones were defined based on a stratification of the study area by means of helicopter surveys.

As we have stated earlier, the vegetation was examined along lines of adjacent segments. The segment length or the segment mesh were added to the optimum mesh by means of the following formula:

$$\log_e (\text{frequency}) = a - b \log_e (\text{rank}),$$

for each zone. (See GODRON 1971, p. 145).

On each segment we have noted the presence or absence of species. The sum of all presences of a species gives the specific frequency, F for short.

The number of segments to be studied, NS for short, where the length of the line was calculated based on the species vs. area probability curve, was expressed in the following formula: (see GODRON, 1971, p. 158).

$$P_{(DEB = S)} = \frac{C^{F-1}_{NS-S}}{C^{F}_{NS}}$$

We have thus defined the mesh and the length of the line. We have noted the frequencies of the species along the line; they were incorporated in the text as matrices. The matrices were used as basic data for analyzing the horizontal structure of the vegetation of each line.

Let us consider separately each item of the horizontal structure analysis.

Item 1- <u>Heterogeneity</u>

Within the text, we use several names for the general (i.e., average) heterogeneity, the meaning of which is the same as that of the coefficient of heterogeneity; their magnitudes indicate the degree of diversity for the entire set of species of each line and are expressed in bits. Their magnitudes were calculated by means of the following formula:

$$H_m\ (M) = \frac{H_m\ (G)}{E}$$

or $$H_m\ (G) = (\log_2 C_N^A + \log_2 C_N^B + \ldots)$$

We then made a comparison between the average general heterogeneity and the maximum theoretical heterogeneity, expressed in %. The maximum theoretical heterogeneity is an imaginary magnitude that assumes F (frequency) = NS/2 and thus:

$$H_m\ (T) = \log_2 C_{NS}^{NS/2}$$

A comparison between these two magnitudes allows us to evaluate the relative heterogeneity and to specify at the same time the heterogeneity of the various species, as well as the whole, as a function of the scale adopted .

1- $>$ 75% : very heterogeneous
2- $>$ 50% : heterogeneous
3- $>$ 25% : not very heterogeneous
4- $<$ 25% : homogeneous

It is thus possible to obtain certain units suited for vegetation mapping.

Item 2-

Relationships between the various components - in our case, the various species - were examined by means of the values of the point correlation coefficient, the formula of which is the following:

$$r_{j;k} = \frac{ad - bc}{\sqrt{(a+b)(a+c)(c+d)(b+d)}}$$

The positive or negative signifi:ance of the correlation coefficients at the 95% and th: 99% thresholds was determined by the following formula:

$$r_x = \frac{t_x}{\sqrt{t_x^2 + N - 2}}$$

that allowed us to determine groups of related or opposed species, (see DAGNELIE, 1960).

Item 3-

The distribution of species was studied in order to qualify it as contagious, uncertain or regular, on the one hand and to verify the heterogeneity of each species on the other hand. The following formula was used for this purpose:

$$I_G = \log_2 C_{F-1}^{G-1} \times C_{D-F-1}^{G-2}$$

Results were expressed in bits; their values allowed us to estimate the importance of data supplied either by the number of groups, or by the size and location of each group.

In order to specify the distribution, we calculated the probability of the number of groups by means of the following quotient expressed in %:

$$PNG = \frac{C_{F-1}^{G-1} \times C_{D-F-1}^{G-2}}{C_{D-2}^{F-2}} \times 100$$

It can thus be verified whether the number of groups actually recorded diverges significantly from the number that could be logically expected.

Qualifications were selected on the following scale:

PNG: $< 1\%$ contagious distribution
PNG: $> 1\%$ random distribution
PNG: $< 1.$ but $\frac{L}{2} = 2$ regular distribution

See GODRON 1966, ZARNOVICAN 1972 for further details.

Item 4-

Since a model of the vegetation structure may seem homogeneous or heterogeneous, according to the perception scale (or mesh: length of basic segments) used, we have varied the mesh and the number of segments arranged together; this allowed us to detect the changes in general heterogeneity.

We have used for this purpose a polygonal arrangement (ZARNOVICAN, 1972) and the results of the general heterogeneity, expressed in bits, were shown in the double-entry tables, the columns of which contain the various numbers of segments joined together, while the rows correspond to the various meshes.

These operations allowed us to detect the cases of macro and micro-heterogeneity and to specify later the structure in terms of the nature of its components.

Item 5-

Even though we may be able to describe the structure in terms of the nature of its elements, of their prior relationship, of their mode of distribution as well as of their heterogeneity, we still have to locate - or specify the co-ordinates of - the elements, or the groups of elements if applicable, on the presence-absence matrix. We tried to do this by means of the optimum boundary. Its principle is based on detecting the maximum heterogeneity in several sub-matrices of different natures. The formula used for this purpose was the following:

$$LO \doteq \Gamma(H_G - H_{GG} + H_{DD})$$

$$LO = \Gamma\left[\left(\sum_1^F \log_2 C_{NS}^{F}\right) - \left[\left(\sum_1^F \log_2 C_{NSx}^{F_x}\right) + \left(\sum_1^F \log_2 C_{NS - Sx}^{F - Fx}\right)\right]\right]$$

The graphical presentation proved easy to read and to interpret. Let us mention further that the optimum boundary was expressed in bits.

The optimum boundary has thus allowed us to split up the model into groups of species, but in order to find the particular locations of the beginning and the end of certain species, we used their extreme probability. These data permitted us to distinguish species living at the center of the line from those living at its fringes.

The formula used for calculating the extreme start was the following:

$$P_{(DEB = S)} = \sum_{i=1}^{S} \left(\frac{C_{NS-S}^{F-1}}{C_{NS}^{F}} \right)$$

while the following formula was used for calculating the probability of the extreme end:

$$P_{(FIN = S)} = \sum_{i=1}^{S} \left[\frac{C^{F-1}_{S-1}}{C^{F}_{NS}} \right]$$

The results were expressed in percentage points and the 99% level was chosen as the significant probability threshold.

We do not intend to supply, by means of this brief introduction, complete explanations on the theoretical aspect of the report; we ask the reader instead to refer to the references we have quoted.

Our concern is rather with practical applications, since we attempt to show what a wide spectrum of data even the most rigorous statistical methods can supply to further our knowledge of intimate relationships between plants.

B- Work organization

For budgetary reasons, the inventory made during the summer of 1972 was only approved late in the season. There was but one month available to plan and organize the work and to carry it out as well. It was quite obvious that

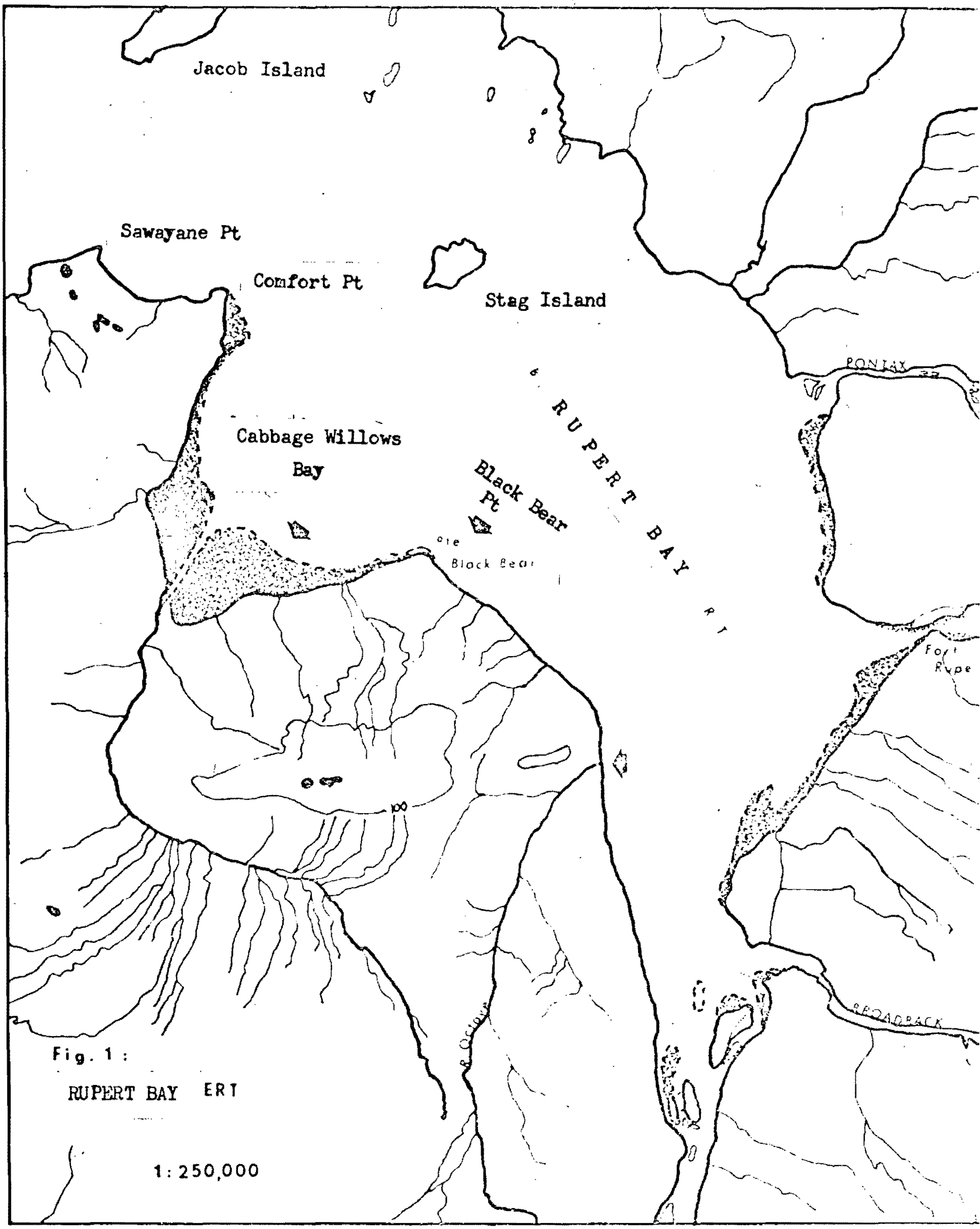


Fig. 1 :

RUPERT BAY ERT

1:250,000

under such circumstances it was unthinkable to do an exhaustive inventory of vegetation and ecological factors.

However, it was predictable that these inventories would be expanded in the years ahead. On the other hand, almost nothing was known about the riparian phytosociology of the Rupert Bay area, as was the case, incidentally, for all the rest of James Bay. One had to work blindly, by making the following assumption at the start: that plants group together into homogeneous associations that correspond to the units which can be identified from the air. The whole sampling was thus based on this assumption which, as we mention hereinafter, turned out to be false. The results obtained in 1972 were intended to give an orientation to all other inventories after having acquired a basic knowledge of the riparian vegetation structure.

From the base camp located in Fort Rupert, the team flew over the area, landing at the center of each unit that seemed homogeneous and suited for mapping. A survey was then made at that location, comprising generally 64 segments. The team then proceeded to another zone. Only the vegetation structure was recorded, since the short time available prevented the team from effecting any readings pertaining to ecological factors.

The present report includes an individual analysis of each line, as well as a synthesis of the conclusions to be drawn and a series of recommendations relative to future inventories.

Individual interpretation of lines

Interpretation: Line 001

Horizontal structure

The predominance of *Carex paleacea* on this line had led the field team to believe that vegetation here was homogeneous. The tests employed have shown this to be totally mistaken.

The coefficient of heterogeneity averaged 39 bits -which was quite high- and was thus equivalent to 64% of the maximum theoretical heterogeneity. Average frequency was 27 per species; on the whole, presences were spread out over 8 groups. Furthermore, the data supplied by the presence or absence of species at the extreme beginnings and ends of the line is absolutely not significant. This is to say, that the distribution of species within this zone seems to be perfectly random. This statement was also confirmed by the group number test.

Furthermore, it can be seen from figure 2 that the optimum boundary has no extreme values, but is represented instead by a series of steps having different heterogeneities, the main step being located in the neighbourhood of 4 bits. The end of the line is also heterogeneous, even if to a slightly smaller degree.

<u>Table 1 : Matrix 001</u>

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Calamagrostis neglecta	1111111100100000111100010000011111110000100110101000011001110111
2-	Triglochin maritima	1100111101110100100011101010111111001010000101111101101001111110
3-	Carex paleacea	1000100000010111111111111111111110101111111001111111011111111111
4-	Festuca rubra	1011100011100111000000011000001001111010111001111101110111010101
5-	Hierochloe odorata	0010001000101000010001011000011111001000100101111111100001011110
6-	Lathyrus palustris	0001111101001101000010000000000100101110001001011010010001101110
7-	Galium trifidum	0000000000001000000000000000000000000001110000000000000000000000
8-	Sphagnum sp.	1111111111111111111111111111111111111111111111111111111111111111
9-	Stellaria longipes	1100000000000000010000000000000000000001011000101111100000000000000
10-	Potentilla anserina	0000000000000000001110000000000000000000000000000000000000000000
11-	Carex salina	0000000000000000001000000000000000000000000000000000000000000000

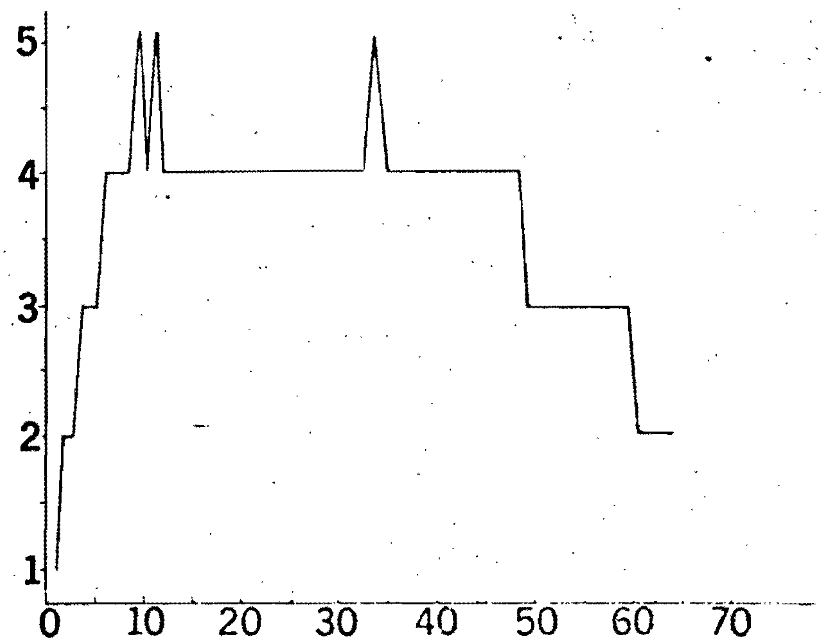


Fig 2 Optimal boundary for line 001

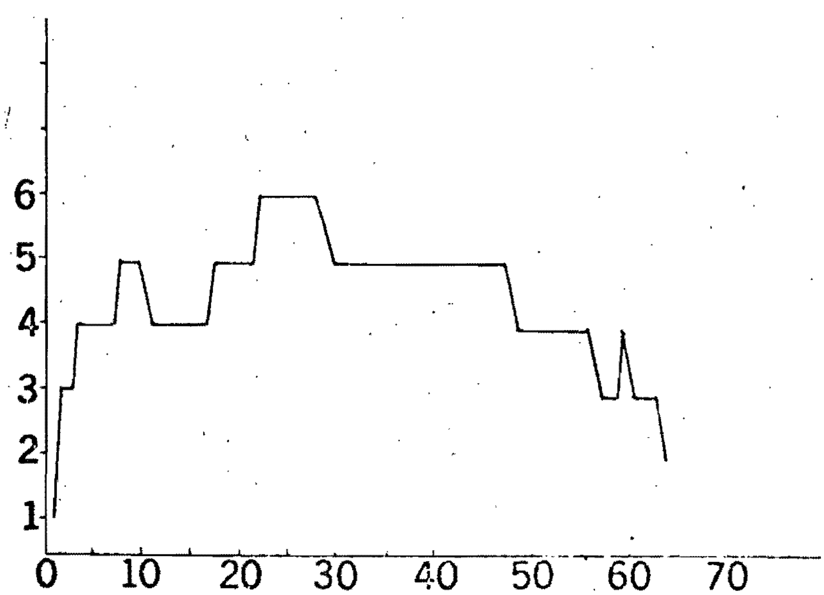


Fig 3 Optimal boundary for line 002

The test of general heterogeneity distribution shows clearly that total heterogeneity increases as the mesh increases. In almost all cases, variations in heterogeneity were exceeded the limits of the confidence interval. Therefore, the structure of this line does not follow any pattern. The overall line is macroheterogeneous.

Links between species

In spite of the overall heterogeneity of the line, certain affinities were observed: thus Potentilla anserina and Carex salina are interlinked (99%), as well as Triglochin maritima and Hierochloe odorata (95%) on the one hand and Galium trifidum and Stellaria longipes (95%) on the other hand.

On the other hand, divergences between species appear only from the 95% threshold on. Opposite species are Carex paleacea and Lathyrus palustris on the one hand and Festuca rubra and Potentilla anserina on the other.

Phenology and stratification

It is interesting to note that analysis of the line shows, at first, that Carex paleacea, which covers 70% of stratum 4, seems to completely dominate the morphology of the vegetation. This same stratum contains moreover a relatively large quantity of Calamagrostis neglecta (covering 30%). These two species are responsible for the general physiognomy of the line. Triglochin maritima, a species easy to identify, is present in stratum 5, but it only affects physiognomy to a limited extent, since the area it covers does not exceed 2%. The same goes for Festuca rubra (5% coverage) and Lathyrus palustris . (3% coverage) in stratum 3.

The eleven species present on line 001 belong mainly to 2 phenological stages: the vegetative and the reproductive stages. At the time when the line was studied in August 1972, 90% of the species were still vegetative, o ,at most, in bloom or fructifying.

Testing of the coefficients of correlation showed that of all these species, Lathyrus palustris alone had a phenological succession; this occurred between stages 4 and 5. The stages of the other species seemed to be mutually independent.

Conclusion:

Line 001 ran through the midst of heterogeneous vegetation, even though, as we have mentioned earlier, the general physiognomy may at first lead to the opposite assumption.

This peculiarity should be taken into account when certain studies concerning ecological studies are made. It is out of the question, in this case, to use some denomination just in order to incorporate the line into the nomenclature. Its general heterogeneity is such, that one must not think of using certain sections of the line for constructing artificial description lines, since it was impossible to find sufficient homogeneity to justify even a partial description.

Interpretation: Line 002

Horizontal structure

The presence of 13 species was noted in this survey. Each of them was present on average 27 times. The general heterogeneity reached 42 bits, which was equivalent to 69% of the maximum theoretical heterogeneity. Overall, the line was thus heterogeneous.

This high degree of indetermination is due mainly to the presence of *Calamagrostis neglecta*, *Triglochin maritima*, *Potentilla anserina*, *Stellaria longipes*, *Lathyrus palustris*, *Festuca rubra*, *Hierochloe odorata* and *Sium suave*, the distribution of which is extremely variable.

On the other hand, alongside species such as *Carex paleacea* which are practically omnipresent, many low-frequency species could be found, such as *Carex salina*, *Rumex fenestratus* and *Hordeum jubatum*.

For reasons we cannot specify, since they are located in the vegetation found before the start of the line, it is impossible to explain why Carex paleacea, which is so constant over the entire line, begins significantly "late".

Table 2: Matrix 002

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Calamagrostis neglecta	1111111111100100011111111111100011111110110000000010001100010010 0
2-	Triglochin maritima	1111111001111100111111111000000000000111110000011000001000001011 1
3-	Sium suave	1101100110000011000001000000100000000000001010000101000000010110 0
4-	Festuca rubra	1110001110111111010010011111011101011111110010101101101011111011
5-	Galium trifidum	1001010100111010011101000011110111011011011101111111111111111111
6-	Stellaria longipes	1111110011100000010000100111111000001000011010110011010001100000
7-	Potentilla anserina	0111000000011001101111100100011111010100111011100100101100011010
8-	Carex paleacea	0011110111111111111111110111111111111111111111111101111111111111
9-	Hierochloe odorata	0000101110001000010000000001100000000000010000100101000100001 10[illegible]1
10-	Lathyrus palustris	0000001111110000000000000110111111111110111100101111111001111110 1
11-	Carex salina	0000000000000000000000001000000000000000000000000000000000000000
12-	Rumex fenestratus	0000000000000000000000000000000000000000100000000000000000000000
13-	Hordeum jubatum	0000000000000000000000000000000000000000000000000000000100000000 000

Even though the test for obtaining the optimum boundary (figure 3) does not indicate exact limits on the survey, it is noted that there is a certain break at the 25th segment and a heterogeneity level between the 18th and the 49th segments.

The results obtained based on surveys 012 and 015 allow us, however, to submit the following hypothesis: there is no doubt as to the preponderence, in this survey, of the co-enological group dominated by Carex paleacea; however, from the 25th segment onward, several species appear that belong to the co-enological group dominated by Carex limosa. Locally, heterogeneity is enormously increased by this peculiarity.

On the other hand, the barycenter for all species except Rumex fenestratus is located at the center, which tends to confirm the absence of breaks and the very uniform distribution found in this survey. As we mentioned, in spite of these characteristics and of the position of the barycenters, the vegetation cannot be considered to be homogeneous and described as such, since there are huge variations within the internal structure of the survey.

Links between species

At the 99% threshold the correlation coefficients test did not reveal any positive links between species. On the other hand, a negative link may be noted between Triglochin maritima and Lathyrus palustris on the one hand, and Carex paleacea and Carex salina on the other.

The existence of these negative links while no positive links could be found (as opposed to surveys 012 and 015, in which they abound) leads us to believe that this is a competition zone occupied previously by Carex paleacea or with a strong dominance of Carex paleacea, but into which the Carex limosa group has infiltrated, destroying in the process the equilibrium of the vegetation in such a fashion that even the ratio existing elsewhere between the two groups of species has not yet been established here.

Furthermore, general heterogeneity increases as a function of mesh size. However, when the number of segments grouped together reaches 8, the variations of general heterogeneity from one mesh to the other become minimal for the first time. Since it can be seen from the data collected from lines 012, 015 and 002 that the smallest mesh used (25cm) is still too large to detect ecological varaitions between the two co-enological groups and since, on the other hand, this distinction would require an amount of work beyond the scope of this inventory, a 2-metre mesh would be largely sufficient for an appropriate description of the coverage of co-enological blocks and of the major differences between this zone and those around it.

Phenology and stratification

The physiognomy of the vegetation is characterized in the main stratum (stratum 4) by a sizeable coverage (60%) of Carex paleacea accompanied by Festuca rubra and by Calamagrostis neglecta, the coverage of which does not, however, exceed 10%. A few stems emerge from stratum 5:

<u>Carex paleacea</u> (coverage: 20%) and <u>Sium suave</u> (coverage: 1%).

The 13 species present in this survey were distributed phenologically as follows:

<u>Triglochin maritima</u>	In strata		2	3	4
<u>Festuca rubra</u>	" "		2	3	4
<u>Calamagrostis neglecta</u>	" "		2		4
<u>Sium suave</u>	" "	1	2		
<u>Lathyrus palustris</u>	" "		2	3	4
<u>Galium trifidum</u>	" "		2	3	4
<u>Carex paleacea</u>	" "		2		4
<u>Carex salina</u>	" "		2		4
<u>Hordeum jubatum</u>	" "			3	
<u>Rumex fenestratus</u>	" "		2		
<u>Stellaria longipes</u>	" "		2	3	
<u>Potentilla anserina</u>	" "	1	2		
<u>Hierochloe odorata</u>	" "				4

Testing of coefficients of correlation has revealed the existence of the following positive links at the 99% threshold:

Calamagrostis neglecta	(3)	Sium suave	(1)
Calamagrostis neglecta	(4)		
Triglochin maritima	(2)		

Triglochin maritima	(4)	Carex salina	(4)
Hordeum jubatum	(3)	Galium trifidum	(4)

Festuca rubra (2)
Festuca rubra (3)
Festuca rubra (4)

Lathyrus palustris (2)
Lathyrus palustris (4)
Carex paleacea (4)

as well as the existence of the following negative links:

Calamagrostis neglecta	(3)		
		Galium trifidum	(3)
Calamagrostis neglecta	(2)		
		Lathyrus palustris	(2)
Triglochin maritima	(2)		
		Lathyrus palustris	(4)
		Carex paleacea	(4)
Triglochin maritima	(3)		
Carex paleacea	(2)		
		Carex salina	(2)
		Sium suave	(3)

Conclusion:

We must abandon any attempt to describe the vegetation of the *Carex* zone in any fashion other than as an overlap of areas of co-enological blocks, since such a description would require us to use such a fine mesh that one season in the field would be hardly sufficient to complete this task. However, by using a convenient mesh it will be possible to isolate the factor of ecological difference between the *Carex* zone and the zones around it.

Interpretation: Line 003

Horizontal structure

Nine species were present on this line. The average number of presences per species was 20. Average general heterogeneity was 23 bits, i.e. 38% of the maximum theoretical heterogeneity, a very reasonable magnitude if we take into account the fact that this heterogeneity was introduced mainly by two species: Puccinellia lucida and Festuca rubra.

It must be noted that certain species finish "extraordinarily" soon on the left: these are Carex paleacea, Potentilla anserina, Salicornia europaea. They give the impression that they are anomalies due to a change of medium. In fact, they are merely some residual segments from an adjacent zone and they must be discarded.

Puccinellia remains the species of highest heterogeneity; its distribution, at the 95% threshold, is contagious and distributed over 11 groups. Thus, if Puccinellia, as well as Festuca rubra are excepted, the vegetation of this survey is relatively homogeneous. This peculiarity must be borne in mind at the time of drawing conclusions.

The test of optimal boundaries shows clearly the existence of several steps of varying heterogeneity. The first two,

Table 3 : Matrix 003

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Scirpus paludosus	1111111111111111111111111111111111111111111111111111111111111111
2-	Carex paleacea	1111000000000000000001100000000000000000000000000000000000000000
3-	Puccinella lucida	0100110001110111111110111111100011111000011111011101110110001111
4-	Festuca rubra	1111100000011111111111011111111111111100111111111111101110111111
5-	Potentilla anserina	1111110000000000000001100000000001001000000000000000000000000000
6-	Salicornia europaea	1000000000000000000000000000000000000000000000000000000000000000
7-	Polygonum Fowler	0000100000000000000000101000000000011110000000000000000000000000
8-	Triglochin palustris	0000000000000000000000000000000000000000000000000000000000000000
9-	Hippuris tetraphylla	1000000000000000000000000000000000000000000000000000000001000000

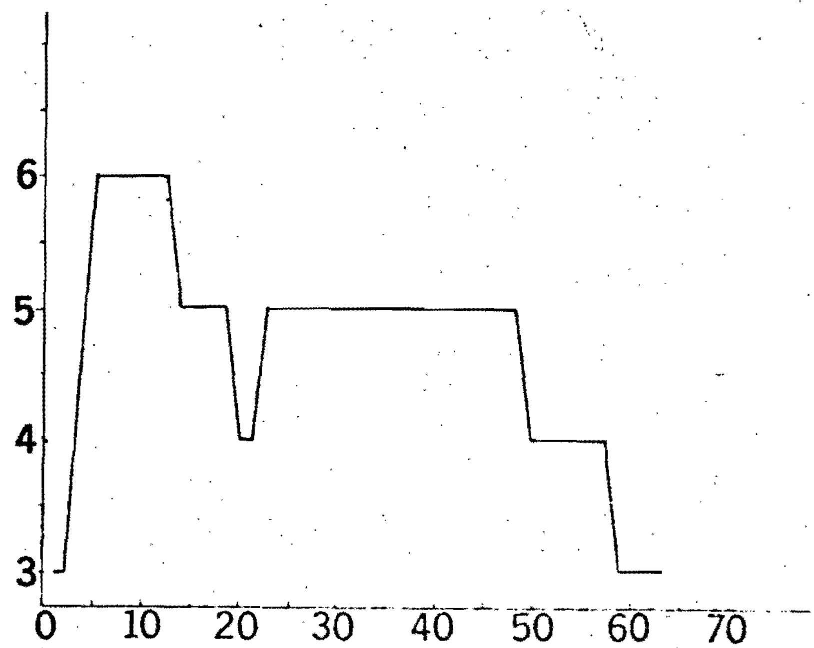


Fig.4 Optimum boundary for line 003

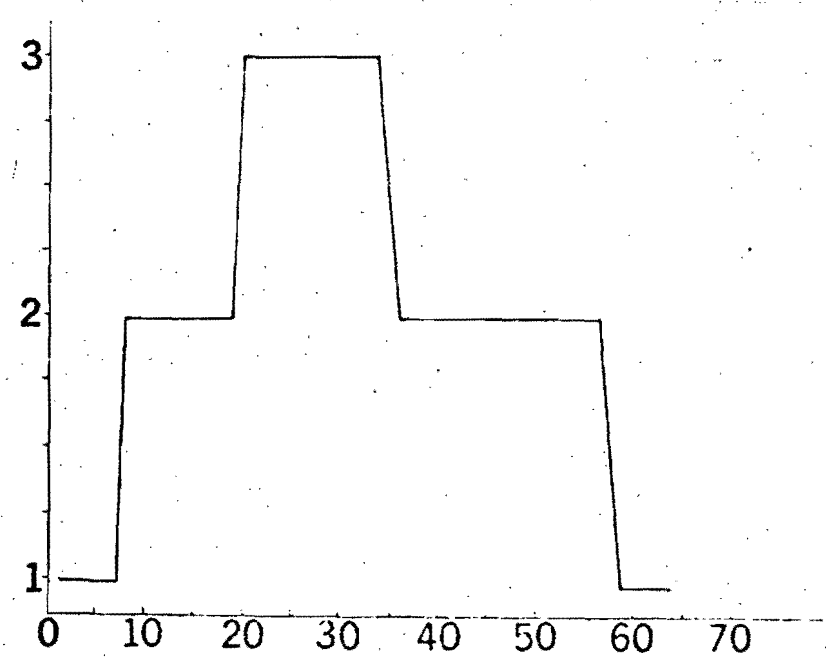


Fig.5 Optimum boundary for line 004

the absolute values of which are enormously different, correspond to the end of the adjacent zone (first step) and to the transition zone that separates the adjacent zone from the Scirpus paludosus area (second step). The third step corresponds to the zone containing Scirpus. The relatively high heterogeneity within this conglomeration is due to the presence of Puccinellia and of Festuca. Finally, the last step seems to correspond to the first symptoms of the presence of a second adjacent zone to the right of the Scirpus-dominated zone. The presence of Triglochin palustris and of Hippuris tetraphylla, two species entirely absent otherwise, supports this theory.

It is of particular interest to note the variations of general heterogeneity when the mesh and the number of segments grouped together are made to vary. For example, when NSR equals 2, the statement made earlier, namely that there is a transition zone between segments 5 and 13, is supported by ample proof. Indeed, heterogeneity decreases in this case as mesh size increases. Moreover, when NSR equals 8, the decrease becomes even more pronounced, indicating that a point has been reached where Puccinellia lucida imprints upon the vegetation a pattern composed of the microheterogeneous elements due to its distribution.

Links between species

At the 95% threshold, Carex paleacea and Potentilla anserina are linked, as well as Salicornia europaea and Hippuris tetraphylla. At the 99% threshold only the link between Carex paleacea and Potentilla still remains.

It must be noted that this latter link was also observed at least in survey 001. No negative links were found.

Phenology and stratification

Scirpus paludosus covered 50% of stratum 4, thus being the most important species of the survey from the point of view of physiognomy. In stratum 5, the coverage by *Puccinellia* was approximately 20%. Coverage by the other species was quite limited.

Phenologically, the 9 species were found in the following stages:

Scirpus paludosus	2 3 4
Puccinellia lucida	2 3 4
Polygonum fowlerii	2 3 4
Festuca rubra	2 3
Carex paleacea	2
Potentilla anserina	2
Salicornia europaea	2
Triglochin palustris	2
Hippuris tetraphylla	2

Thus, in this case, *Carex paleacea* is irrelevant from the point of view of food production because - with the vegetation season in this zone almost over - it had not yet reached the blooming stage or had become sterile (it was not possible to determine which alternative was the correct one).

This does not apply to the first three species, which have had the time to complete their vital cycle. Moreover, the stages in this survey appeared to be entirely independent from each other at the 99% threshold.

Conclusion

Analysis of this survey leads us to suspect the existence of an extremely complicated mosaic within which all species would be independent.

Interpretation: Line 004

Horizontal structure

Even though this may seem surprising for a zone similar to that of survey 005, the general heterogeneity of this line is 18 bits, i.e. 30% of the maximum theoretical heterogeneity. Each one of the 5 species found appears on the average 34 times.

The presence of Ranunculus cymbalaria between segments 16 and 22 is purely random. This cluster must thus be considered as a "bridgehead" for Ranunculus in a region from which it was previously absent; provided that it manages to survive, Ranunculus will extend its area of distribution from the bridgehead year after year. Our Ranunculus, judging by the various phenological stages, was thriving.

Links between species

Testing of the coefficients of correlation did not reveal any links, whether positive or negative, between the species of this line.

Table 4 : Matrix 004

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Scirpus paludosus	1111111111111111111111111111111111111111111111111111111111111111
2-	Festuca rubra	1111111111111111111111111111111111111111111111111110111111111111
3-	Senecio congestus	1111011001111111111111111111111111111011011111111111111111010111
4-	Triglochin palustris	0000000000000000011111000000000000000000000000000000000000000000
5-	Ranunculus cymbalaria	0000000000000000000000000000000001100000000011000000100000000000

Phenology and stratification

The vegetation developed on two very distinct levels. Firstly, Scirpus paludosus dominates stratum 4 with a 60% coverage, accompanied by Senecio congestus, the coverage of which does not exceed 5%. Much lower in stratum 2, Puccinellia lucida was found, barely present with a 1% coverage. The two strata are thus extremely jagged, and this jagged characteristic explains to a degree the presence on the same site of species with different requirements. Undoubtedly, they do not draw their nourishment from the same medium.

The phenological distribution of the species was as follows:

Scirpus paludosus	at stages 2 3 4
Senecio congestus	at stages 2 3 4
Ranunculus cymbalaria	at stages 2 3 4
Triglochin palustris	at stages 2 4
Puccinellia lucida	at stage 2

Phenologically, the various species are well represented overall. Testing of the coefficients of correlation showed the existence of only one positive link at the 99% level: the link between stages 3 and 4 of Ranunculus cymbalaria.

Conclusion

This survey should be compared to line 005. Taken together with certain parts of the latter, it could be used to describe the overlap zone which, quite surprisingly, can achieve a considerable stability. Scirpus paludosus, as well as Ranunculus cymbalaria, seem to characterize these transition zones.

Interpretation: Line 005

Horizontal structure

Only 8 species are present in the vegetation of this zone; the frequency of presences is 20 on average. General heterogeneity is 31 bits, i.e. 50% of the maximum theoretical heterogeneity. It thus becomes obvious that the vegetation catalogued in this survey is heterogeneous and cannot constitute a mappable unit, unless it is described as a transition zone.

Let us note, however, that certain species begin "abnormally" late. This applies, among others, to Triglochin palustris and Ranunculus cymbalaria. On the other hand, Puccinellia lucida stops "abnormally" early. Moreover, the test of the optimal boundary indicates a rapid increase in general heterogeneity up to the 9th segment. The level of heterogeneity then remains high, assuming the shape of a step sloping slightly downward to the 39th segment. Heterogeneity then drops rapidly towards the end of the line.

We can say, based on these peculiarities, that our survey lies astride on a transition zone that separates a conglomeration characterized by Triglochin (conglomeration must be taken here to mean a conglomeration of superposed areas), from a zone characterized by the presence of Puccinellia lucida. This transition zone contains

Table 5: Matrix 005

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Scirpus paludosus	111111111111111111111111111111111111111111111111111111111111111
2-	Deschampsia cespitosa	111111110110010000110101000000101000110100000101000000000000100
3-	Festuca rubra	001111010000000000000000000000000000000000000000000000000000000
4-	Triglochin palustris	000000000111111111111111011100111101010010100101111001101111111
5-	Polygonum fowleri	000000000000001000011000000000000000000000000000000000000000000
6-	Eleocharis uniglumis	000000000000000000000110000000001111000000000001000000000000000
7-	Ranunculus cymbalaria	000000000000000000000000000000000000011110011110011011100000000
8-	Senecio congestus	000000000000000000000000000000000000000001000000010010000100000

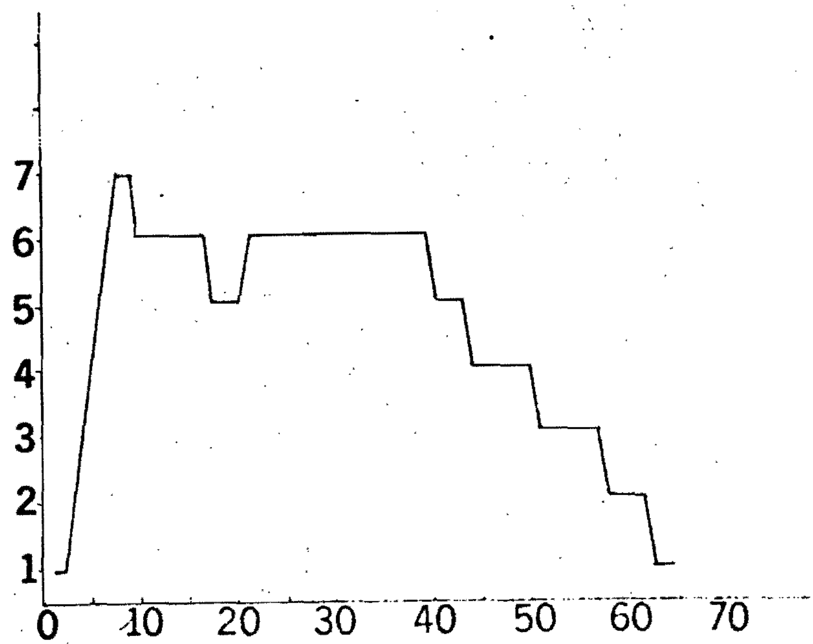


Fig.6 Optimum boundary for line 005

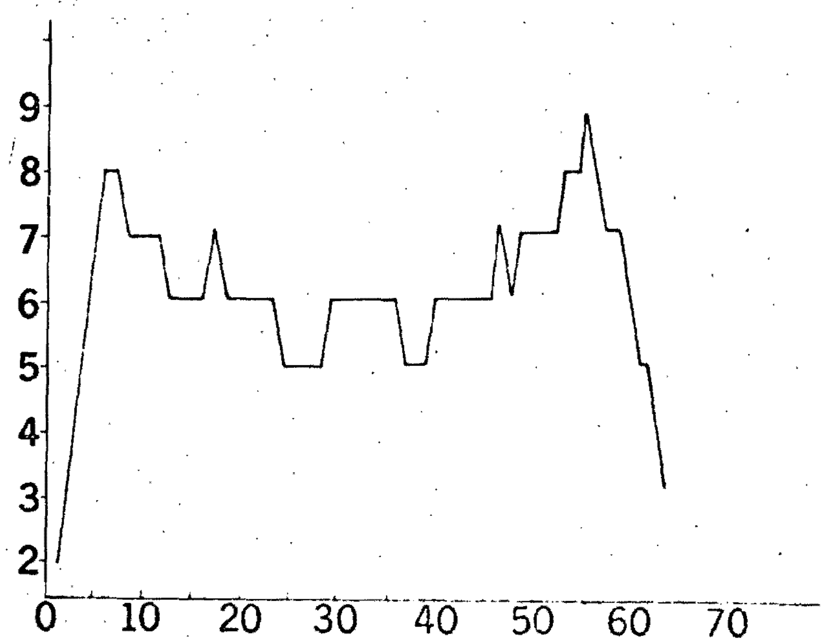


Fig.7 Optimum boundary for line 006

species belonging to each conglomeration. Moreover, Scirpus paludosus, the tolerance of which towards the discriminating factor seems quite high, should be used as a differential for the precise location of this type of transition zone.

Links between species

Testing of the coefficients of correlation clearly shows that all species present in this survey are mutually independent.

Phenology and stratification

The physiognomy of the vegetation clearly depends on the presence of Scirpus paludosus, the coverage of which exceeds 80% in stratum 4. The other main species are Deschampsia cespitosa, also in stratum 4, with a coverage of 5%,and,in stratum 3, Triglochin palustris and Eleocharis smalii, the coverage of which does not exceed 5%.

Deschampsia cespitosa can be found in all phenological stages, except in stage 1, while Scirpus paludosus, the dominant species, can only be found in stages 2, 3 and 4.

Testing of the coefficients of correlation showed the existence of a positive link at the 99% level between stages 3 and 4 of *Deschampsia cespitosa* on the one hand, and between stages 2 and 3 of *Eleocharis smalii* on the other hand. The growth of these two species in their various stages thus occurs simultaneously, at least within the transition zone.

Conclusion

The zone covered in this survey may not rightly be considered as a unit to be used for describing the vegetation. It could, however, be mapped as a transition zone if a convenient scale is used. To be noted: the line was surveyed in the direction of the gradient; this explains the reversal of the conglomeration sequence.

Interpretation: Line 006

Horizontal structure

The vegetation in this survey was characterized by the presence of seven different species averaging 25 presences each. Average general heterogeneity was 27 bits, i.e. 46% of the maximum theoretical heterogeneity. Thus the survey, overall, is not very heterogeneous and constitutes a perfectly mappable unit.

However, certain further details should be noted. Some species begin abnormally late on the line, as shown in the corresponding tests. Suaeda maritima, Deschampsia cespitosa, Triglochin palustris, Scirpus paludosus are such cases. On the other hand, only one species, Triglochin maritima, ends too early. The test of the barycenters also supports this somewhat peculiar distribution of the species on the line.

Suaeda maritima and Deschampsia cespitosa, on the other hand, exhibit a contagious, low-probability distribution that introduces the greatest part of line heterogeneity; said heterogeneity, however, is not high enough to rank the survey among heterogeneous surveys and to treat it accordingly.

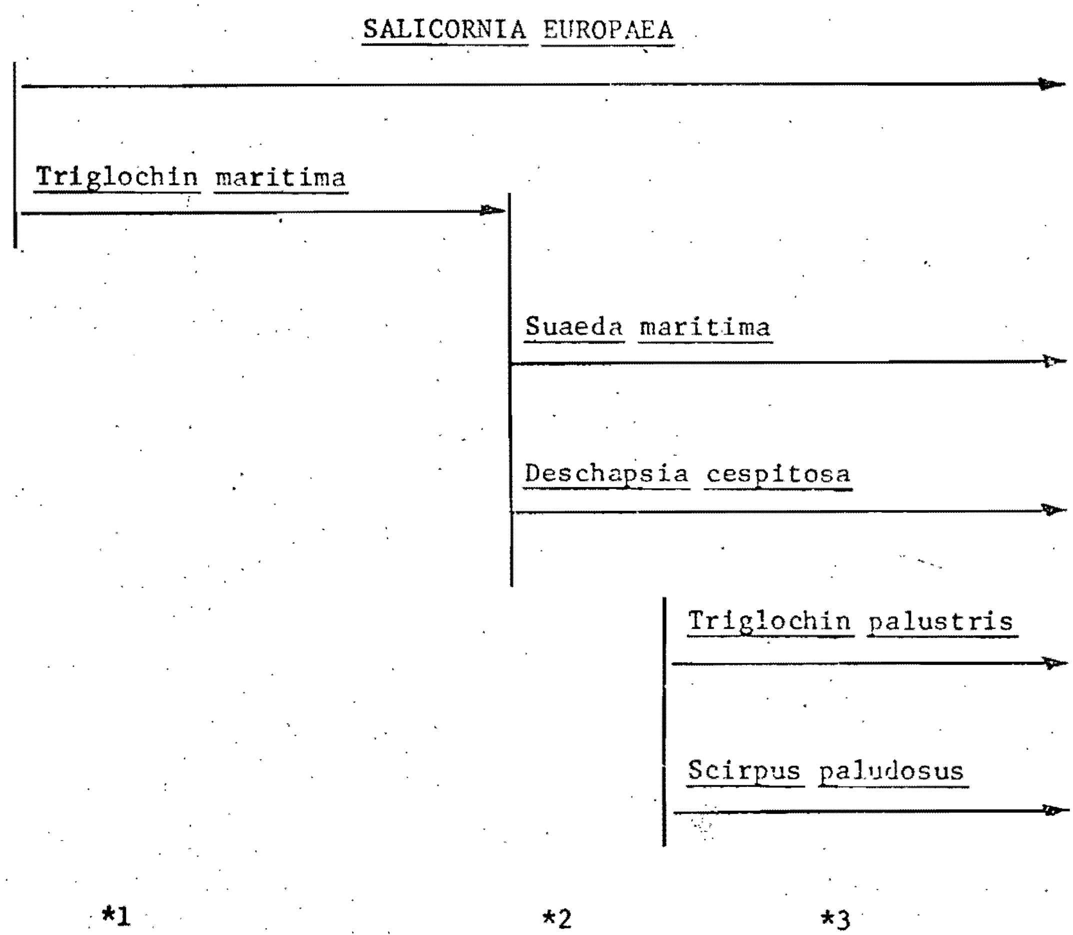
<u>Table 6 : Matrix 006</u>

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Salicornia europaea	10111111111111111111111111111111111111111111111111111111111110101
2-	Triglochin maritima	1101111000000000000000000000000000000000000000000000000000000000
3-	Suaeda maritima	00000011100111111111111111110011111111111110011111111111111111110
4-	Deschampsia cespitosa	0000001111110100001111111111111111111110111001111111111111100011110
5-	Potentilla anserina	000000000000000000000000000000000000100000000001000000010000000000
6-	Triglochin palustris	0000000000000000000000000000000000000000000000000000000011111111
7-	Scirpus paludosus	0000000000000000000000000000000000000000000000000000000000000011

We are obviously faced with a case of "imbricated" vegetation. This statement is moreover confirmed by the test of the optimal boundary, which clearly indicates a double break in a relatively homogeneous conglomeration. Indeed, *Triglochin maritima* definitely ends at the 7th segment where *Suaeda maritima* and *Deschampsia cespitosa* suddenly appear and the latter two do not disappear at the 56th segment when *Triglochin palustris* appears at the 56th segment and *Scirpus paludosus* at the 63rd segment.

This imbrication may be shown graphically as follows:



The asterisk * symbols indicate the places where readings should be made relative to the variation of ecological factors in order to discover the reasons for this structure. In other words, we have here an overlap of areas, since all plants are capable of bearing the majority of the ecological conditions present in the zone that contains Salicornia. It is possible that the differential factor here is microsalinity.

This "plurality" of sorts of the survey is further confirmed by the variations of the general heterogeneity. When NSR equals 2, the whole appears to be less heterogeneous than its components. When NSR is equal to 16, on the contrary, three different units come to the fore, even though in a quite vague fashion.

Links between species

Testing of the coefficients of correlation shows that all species are mutually independent.

Phenology and stratification

The vegetation studied by means of the present survey seems to be very open. Total coverage by all species falls quite short of 100%. There is domination by stratum 3 of Suaeda maritima, with a 20% coverage and by stratum 2 of Salicornia europaea, with a 30% coverage.

None of the species present were senescent; most were at the vegetative or blooming stage and only one, namely Deschampsia cespitosa, exhibited some sterile individuals besides the vegetative and blooming ones.

No links between strata were revealed by testing of the coefficients of correlation.

Interpretation: Line 007

Line 007 was eliminated from the interpretation, since it proved impossible to define its direction relative to at least two ecological gradients.

Table 7 : Matrix 007

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

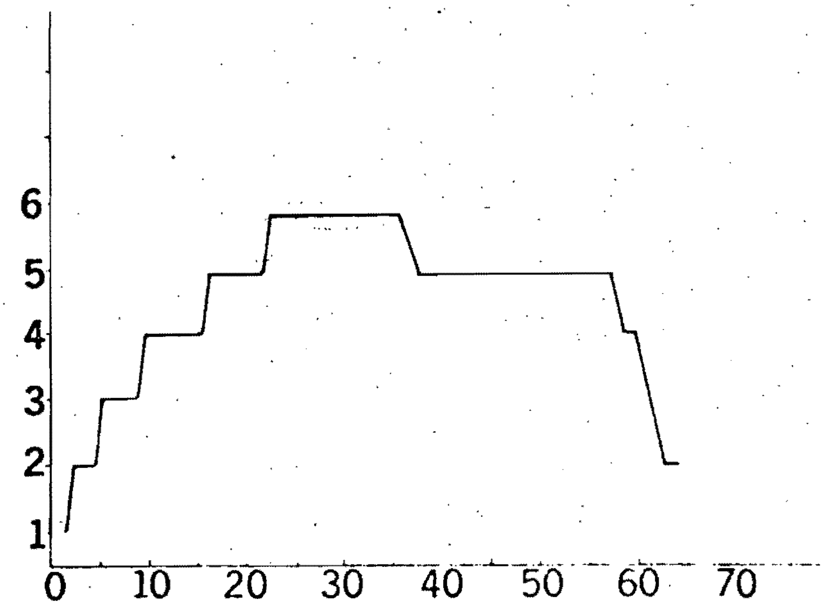


Fig. 8 Optimum boundary for line 007

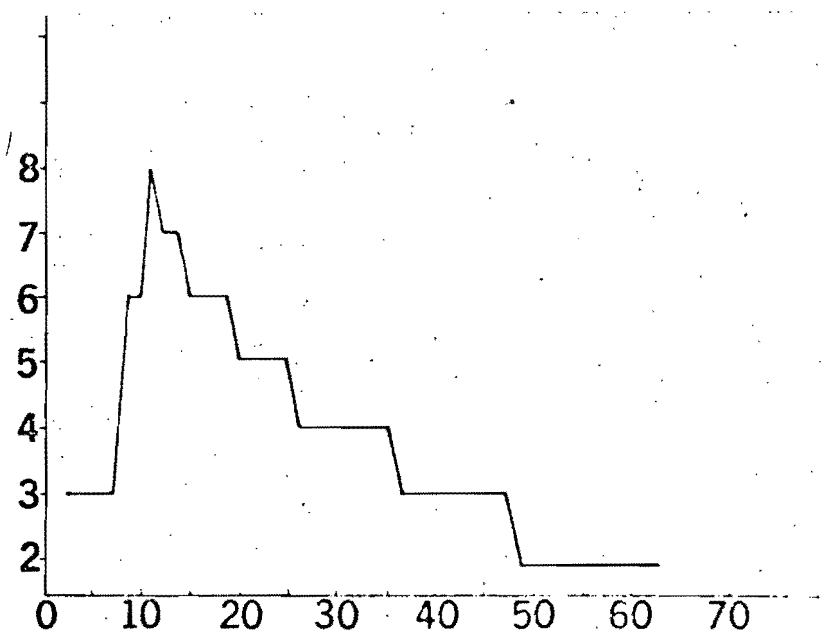


Fig. 9 Optimum boundary for line 008

Interpretation: Line 008

Horizontal structure

Once again we are faced with a type of vegetation that contains very few species. 4 species were counted, with an approximate average number of presences of 34 per species. Average general heterogeneity attained 10 bits, i.e. 17% of the maximum theoretical heterogeneity. It is thus possible to state that we are dealing here with a perfectly homogeneous vegetation.

It should be noted, however, that the *Ranunculus cymbalaria* and *Triglochin palustris* species end "abnormally" early. Indeed, the probability for these two species' vanishing at the place where they in fact do is barely 1/100,000 and 13/10,000, respectively. This observation leads us to consider them as transgressive and as much more akin to a type of vegetation located further ahead, of which they are merely the traces within our survey.

The test of the optimum boundary supports this opinion, since it shows a clear break between the 11th and the 12th segments.

On this line, we identify only one homogeneous conglomeration, if the term "conglomeration" can at all be used in the case of imbricated species. This conglomeration

Table 8 : Matrix 008

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Scirpus paludosus	111111111111111111111111111111111111111111111111111111111111
2-	Hippuris tetraphylla	111111111111111111111111111111111111111111111111111111111111
3-	Ranunculus cymbalaria	000001111100000000000000000000000000000000000000000000000000
4-	Triglochin palustris	110000010000000000000000000000000000000000000000000000000000

is made up of the superposition of *Scirpus paludosus* and *Hippuris tetraphylla* areas. As to the first 11 segments, they should be considered as a transition zone.

Links between species

Testing of the coefficients of correlation shows the independence of all species present in this survey.

Phenology and stratification

This zone is clearly characterized by *Scirpus paludosus* and *Hippuris tetraphylla*. Indeed, the bulrush attains a 60% coverage in stratum 4, while *Hippuris* covers 80% of the ground in stratum 2.

All species were in stratum 2, except *Scirpus paludosus*, which was also found in strata 3 and 4. This means that foliar development is not simultaneous for all species. Since *Hippuris* emerges quite late in the season, it is probable that a survey made at the beginning of July would not include this species. It would however not be justified to think that the growth of *Scirpus paludosus* may inhibit the growth of *Hippuris* because - as has been shown by the tests of the coefficients of correlation - all phenological stages are independent.

Conclusion

Line 008 is yet another example of imbricated vegetation. However, the size of the present enclave seems sufficient to make it into a mappable unit.

Interpretation: Line 009

Horizontal structure

The vegetation here is characterized by the limited number of species. There were only three, with an average presence frequency of 43 each. General heterogeneity is very low, namely 4 bits; the vegetation can thus be considered homogeneous. The tests prove that the appearance of *Scirpus americanus* at segments 43 and 45 of the line is entirely accidental. This survey ust be taken together with all the others that relate to imbricated vegetation.

Links between species

Testing of the coefficients of correlation showed that all species present in this survey were mutually independent.

Phenology and stratification

Hippuris tetraphylla dominates here, since its coverage attains 85% in stratum 3. On the other hand, the coverage by *Eleocharis smallii* is only 10% in stratum 2.

Table 9 : Matrix 009

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Hippuris tetraphylla	1111111111111111111111111111111111111111111111111111111111111111
2-	Eleocharis smallii	1111111111111111111111111111111111111111111111111111111111111111
3-	Scirpus americanus	0000000000000000000000000000000000000000001010000000000000000000

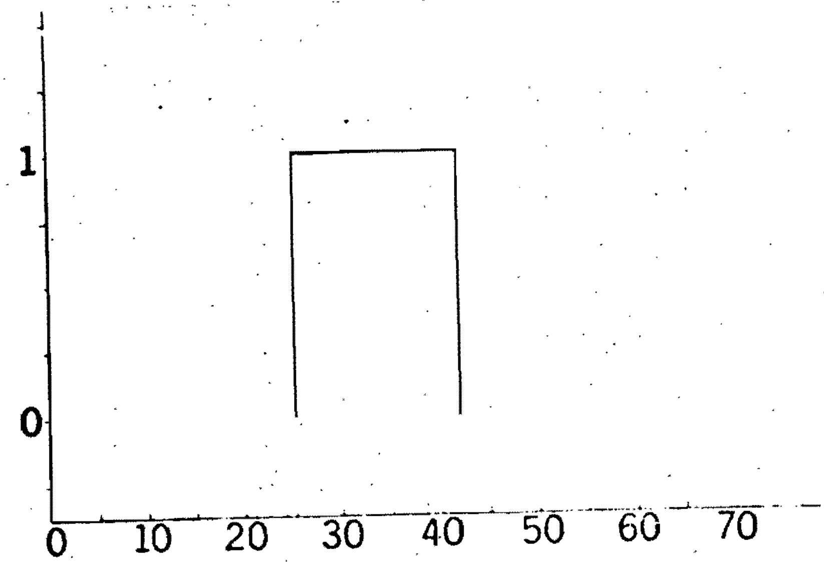


Fig. 10 Optimum boundary for line 009

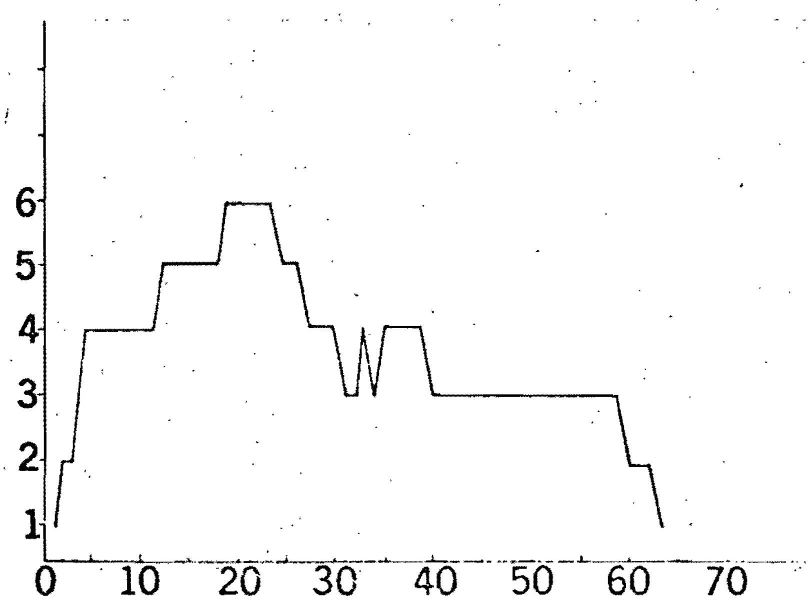


Fig. 11 Optimum boundary for line 010

All phenological stages are present, except that of plantlets. The various species have the following stage distribution:

Hippuris tetraphylla	at stage 2
Eleocharis smallii	at stages 2 5
Scirpus americanus	at stages 2 3 4

According to the test of the coefficients of correlation, most phenological stages are mutually independent There is thus no phenological continuity, except for stages 2 and 3 of Scirpus americanus, which are linked at the 99% level.

Conclusion

This zone may be considered as a mappable unit due to the homogeneity of the survey and to the size of the homogeneous section.

Interpretation: Line 010

Horizontal structure

Only 9 species were found on line 010. Each of them appeared 29 times on average. General heterogeneity reached 30 bits, i.e. 50% of the maximum theoretical heterogeneity. We may thus classify this survey as not very heterogeneous. These results are surprising for a survey that contains - as explained hereinafter - a double substitution of species.

This heterogeneity is due to the presence of several species having a contagious distribution. These are, among others, Ranunculus cymbalaria and Potentilla anserina. Moreover, certain species such as Festuca rubra and, once more, Potentilla, are located in extreme fashion. The former begins abnormally late, while the latter, centrally located, has nevertheless fringes at the extreme limits of the survey. All these characteristics resemble very much those of a repetitive pattern.

The optimum boundary reaches a peak between the 19th and the 24th segments, a section in which there is also a gradual replacement of Ranunculus cymbalaria by Potentilla anserina. A second break may be observed at the 40th segment, where Ranunculus cymbalaria is once again reinstated and Potentilla disappears. A third reversal occurs between segments 54 and 55; it is barely visible because of its brevity. In this case, it will be relatively

Table 10: Matrix 010

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Aster puniceus	1111111111111111111111111111111111111111111111111111111111111111
2-	Angelica atropurpurea	0100000000000000000000000000000000000000000000000000000000000000
3-	Sium suave	0000000000000001000000000000000000000000000000000100011000000000
4-	Ranunculus cymbalaria	1111111111111111111111010000000000000000010111100000000011001111
5-	Carex paleacea	1111111111111111111111111111111111111111111111111111111111111111
6-	Hierochloe odorata	0011100000000000011100010010000110010001010000001000000010100001
7-	Heracleum maximum	0000001000000000010000000000100010100000000000000000000000111010
8-	Festuca rubra	0000000111110111110111011111100010111111111111111111111100101111
9-	Potentilla anserina	0000000000000000000000011111111111111000000000000000110000000000

easy to locate ecological surveys suited for detecting the reasons for these successive reversals, since the mesh used was perfectly convenient and since the successive dominance periods of each species were sufficiently large.

However, according to the test of general heterogeneity variation, the first 16 segments are microheterogeneous, while the remaining parts of the survey are macroheterogeneous. In order to simplify the sampling, it would thus be advisable to select the points at which the surveys will be made within the last 48 segments of the line.

Links between species

Testing of the coefficients of correlation did not establish any positive links at the 9[illegible]% threshold. However, at this level of accuracy, there are two opposing species: Ranunculus cymbalaria and Potentilla anserina. This negative link is absolutely not surprising if we take into account the repetitive substitution pattern between these two species.

Phenology and stratification

This survey, having been made parallel to a small canal, was greatly affected by the presence of plants from well-drained media. The appearance of these very same species close to the drainage canals had been noticed earlier in the season on the reefs of Shipsands Island, at the mouth of the Moose River. Even though the basic component is still the _Carex paleacea_ co-enological group, many of its companions were replaced by species typical for dryer media, such as _Ranunculus_, _Potentilla anserina_ and mainly _Aster hesperius_, the coverage of which in the main stratum (stratum 4) attained 20%. _Carex_ coverage peaked at 70% in this same stratum. In stratum 5, _Carex_ was sparse, with a 5% coverage. In stratum 3, a plant belonging to the _Carex limosa_ co-enological group dominates with a 5% coverage. Even though _Carex paleacea_ is dominant, the brilliant _Aster_ flowers could be very convenient for locating our zones.

Species distribution within the various phenological stages was as follows:

Carex paleacea	at stages	2	3	4
Aster hesperius	" "	2	3	
Potentilla anserina	" "	2		4
Festuca rubra	at stage	2		
Sium suave	" "	2		
Heracleum maximum	at stages	2	3	4
Ranunculus cymbalaria	" "	2		4
Angelica atropurpurea	at stage	2		
Hierochloe odorata	" "			4

It must thus be noted that only the dominant species were in bloom. It is possible that this is the result of a competition between biological forms.

Testing of the coefficients of correlation showed all phenological stages to be independent at the 99% threshold.

Conclusion

No substitution zone in this survey may be mapped individually. The whole, however, may be mapped without difficulties as a mosaic.

Interpretation: Line 011

Line 011 was eliminated from the interpretation due to its nonconformity to the rest of the sampling.

Table : Matrix 011

1-	Potentilla anserina	11111111111011111111110000100111111111111011111110000111001010011
2-	Aster puniceus	11111111111111111111101111111111111111111111111111111111111111111
3-	Thalictrum confine	10100100000110101110011010011111111111010100110111111011111010111
4-	Poa eminens	11111111111110000001101111111111111000000000000000000000000000000
5-	Angelica atropurpurea	10010111110111111011111111110110111111011011001111101011101111111
6-	Mentha arvensis	10110101111101100000000000000110000000000000000101100000001000010
7-	Iris versicolor	10100010000000001100000000000110000000001001011000000000000000000
8-	Lathyrus palustris	01001111001111010100000000000000110001000000000100000000000100000
9-	Carex paleacea	00111111100011111100111011111111111111111111111111111111111111111
10-	Achillea boreale	00000000001000000000000000000000000000000000000000000000000000010
11-	Sium suave	00000000000000001000000000000000000000000000000001000000000000000
12-	Rumex fenestratus	00000000000000000000000000000000000000000000000000001010000000000
13-	Agropyron trachycaulum	00000000000000000000000000000000011100111011000000000000100100000
14-	Stellaria longipes	00000000000000000000000000000000000101100011010110011111100110011
15-	Festuca rubra	00000000000000000000000000000000000000100000101111111111110011111
16-	Hierochloe odorata	00000000000000000000000000000000000000100000000000000000000000001
17-	Triglochin maritima	00000000000000000000000000000000000000010000100000000000000000000
18-	Galium trifidum	00000000000000000000000000000000000000000000100000000000010000000
19-	Calamagrostis canadensis	00000000000000000000000000000000000000000000000000000000000111111

Interpretation: Line 012

Horizontal structure

This survey, while being very similar overall to line 015, permits us nevertheless to detect the existence of a pattern and to attempt to define it.

26 species were counted on this line, with an average frequency of 16 each. General heterogeneity reached 25,7 bits, i.e. 44% of the maximum theoretical heterogeneity. The vegetation described in this survey is thus not very heterogeneous, in spite of the presence of certain species the relative frequency of which approaches 50%.

Among the species deserving to be mentioned, let us note *Carex paleacea* and *Pedicularis macrodonta*, both distributed contagiously, and *Epilobium leptophyllum*, the distribution of which seems random, but which begins late on the line (95% threshold).

Several other species begin abnormally "late". These are *Potentilla palustris*, *Festuca rubra*, and *Euphrasia disjuncta*. Among those that stop abnormally "early", let us mention *Rumex fenestratus* and *Caltha palustris*. It is

Table 11: Matrix 012

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Menyanthes trifoliata	111111111111111111111111111111111111111111111111111111111111111
2-	Potentilla palustris	001110111111100110111111111111111111111110111111111111111111111
3-	Calamagrostis neglecta	111111111111111111111111111111111111111111111111001111111111111
4-	Carex paleacea	100100110010010011111110110110001100100000001110100000000011111
5-	Triglochin maritima	000000100100000001110000000000000000000001000000000000000000100
6-	Pedicularis macrodonta	100101111001111111111111001111111000011111111111000011111011111
7-	Rumex fenestratus	100000000000000000000000000000000000000000000000000000000000000
8-	Galium trifidum	110101111001111111111111001111111000011111111111000011111011111
9-	Campanula aparanoides	100000010000000001001000000100000000000110001000000011111000000000
10-	Lathyrus palustris	010000001[illegible]00000000001110000000000100000000000000000000000000011
11-	Sium suave	010000000000000110001000000000001011000000000001000101011110001000
12-	Triglochin palustris	010001000000000000000000000000000000000010000000000000000000000
13-	Aster simplex	001001000000001000000000000000000011111110000000000000000110011001
14-	Caltha palustris	000[illegible]100000110000000001101010000010000000000000000000000000
15-	Stellaria longipes	000000100000100011000000000000000000000000000100001010011000001
16-	Malaxis brachypoda	000000010000000000000000000000000000000000000000000000000000000
17-	Epilobium leptophyllum	000000000100011100100010000100010000101110110100000000100001010 0
18-	Carex MacKenziei	000000000100000000000000000000000000000000000000000000000000000
19-	Eleocharis smallii	00000[illegible]0001000000000000000000000000000000000001111110100010000 0
20-	Hierochloe odorata	000000000000000000001000000000000000000000000000000000000000000
21-	Festuca rubra	000000000000000000001101110111010100000000000000000000000000010
22-	Iris versicolor	000000000000000000000110000000000000000000000000000000000000000
23-	Salix candida	000000000000000000000010000000000000000000000000000000000000000
24-	Carex limosa	000000000000000000000000000000110000000000000000000000000000000
25-	[illegible]	[illegible]

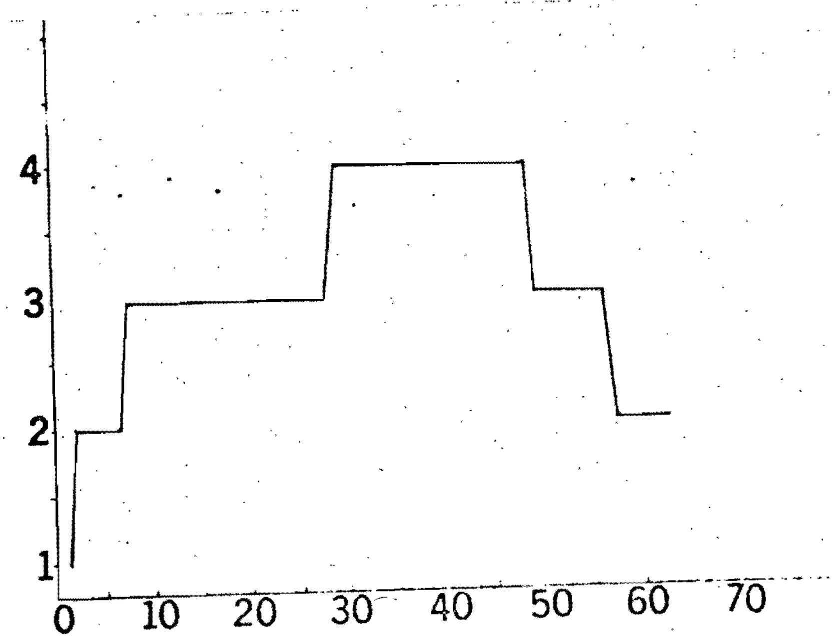


Fig.12 Optimum boundary for line 012

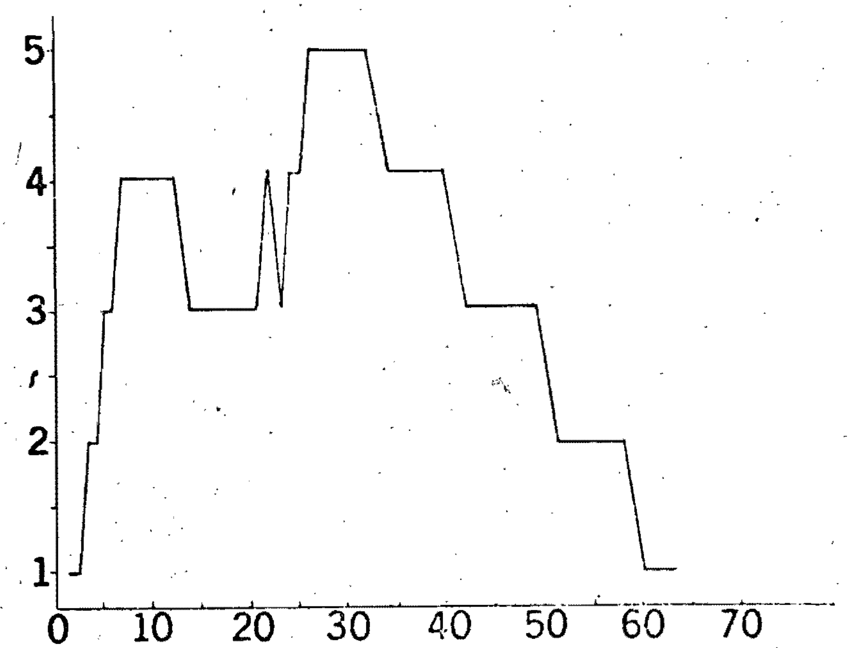


Fig.14 Optimum boundary for line 013

important to note here that these peculiarities become apparent at the 95% probability threshold, which is a lower threshold than that generally used. We shall thus not retain them when effecting our synthesis, since they indicate tendencies that are not clear enough.

As we mentioned earlier, certain species- not very many - exhibit contagious distribution. Random species are much more numerous. There are 8 of these. 9 species, however, are distributed in a single group, making it practically impossible to classify their distribution in any manner whatever, since it is the knowledge about the number of groups, together with the length and the location of the groups, that supply our data.

Testing of the optimum boundary yields nothing of interest, inasmuch as we could not detect any sizeable break within one or several co-enological groups. However, some breaks may shed some light on the behaviour of certain species.

The tests reveal the microheterogeneity of this survey and the fact that this heterogeneity diminishes significantly as a function of the mesh.

We can thus qualify this as a case of overlapping areas of co-enological groups, since - as we will see later on - testing of the coefficients of correlation has revealed the existence of such groups. However, local

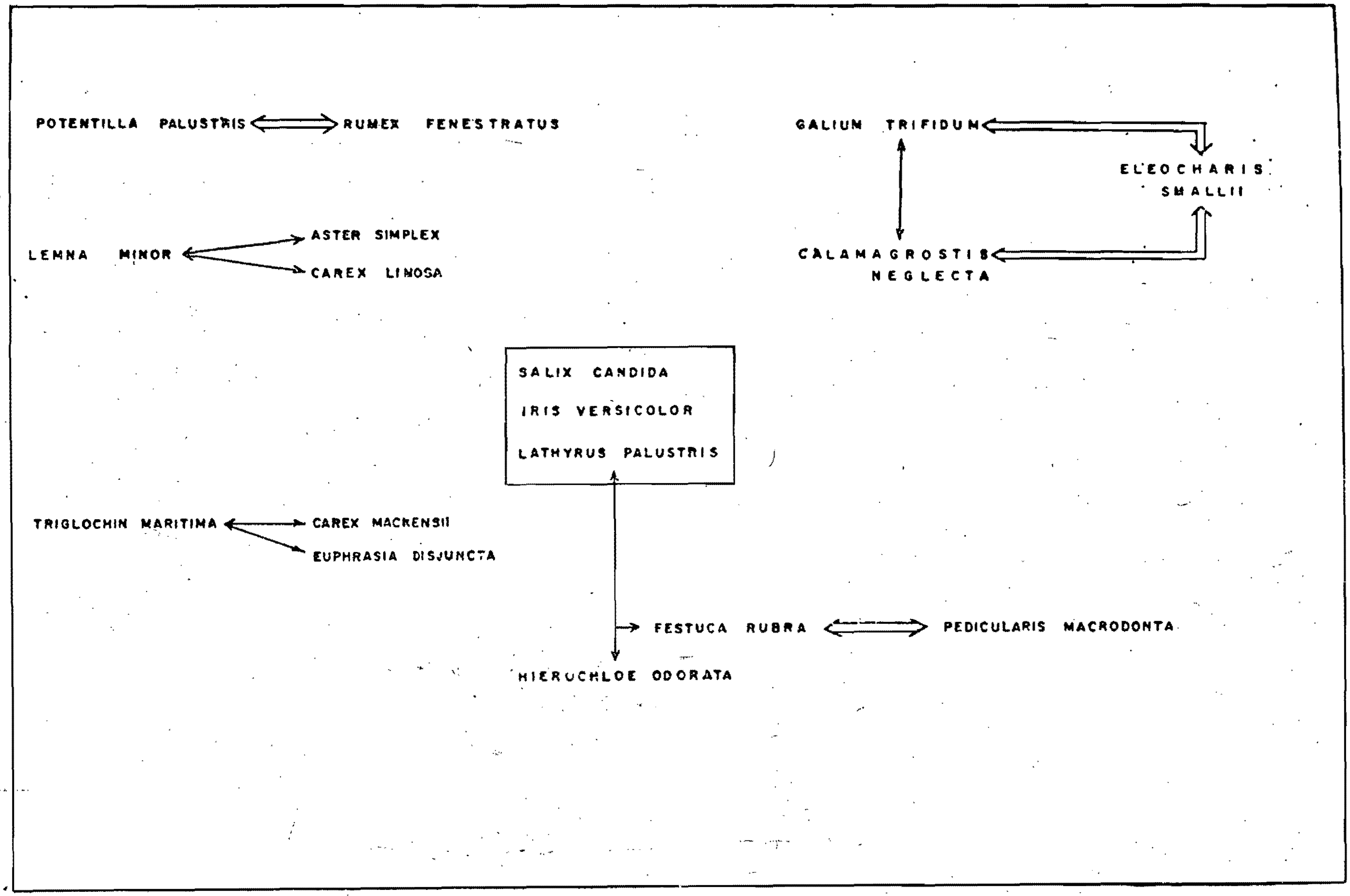
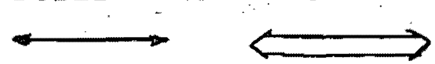


FIGURE 13: POSITIVE AND NEGATIVE LINKS ON LINE 012 AT THE 99% THRESHOLD.



ecological conditions allow the superposition of at least two groups, to which must be added several species that have been found to behave with absolute independence. It is not surprising at all, then, that it is impossible to define an association within this zone.

Links between species

Testing of the coefficients of correlation has defined certain positive or negative links at the 99% perception level. Figure 13 shows these results. They must be compared with the results obtained in survey 015. A comparison pertaining to this zone was made in the chapter containing the synthesis.

Phenology and stratification

Vertically, the vegetation is clearly dominated by *Menyanthes trifoliata* (50% coverage) in stratum 3, to which must be added *Potentilla palustris* in stratum 4 (also 50% coverage). Let us mention the sporadic presence of *Sium suave*, the tall stem of which is readily identifiable.

Phenologically, the distribution of species in the various stages was as follows:

19 species in stage 2
11 species in stage 3

18 species in stage 4
8 species in stage 5

Testing of the coefficients of correlation revealed the following positive links at the 99% level:

Menyanthes trifoliata	(4)
Carex limosa	(4)
Lemna minor	(2)
Festuca rubra	(2)
Caltha palustris	(5)
Potentilla anserina	(2)
Potentilla anserina	(3)
Potentilla anserina	(4)
Pedicularis macrodonta	(4)
Lathyrus palustris	(4)
Hierochloe odorata	(4)
Festuca rubra	(4)
Galium trifidum	(3)
Campanula aparanoides	(2)
Sium suave	(2)
Aster simplex	(3)
Stellaria longipes	(4)
Eleocharis smallii	(2)
Eleocharis smallii	(4)
Stellaria longipes	(2)

Triglochin maritima	(2)
Carex paleacea	(4)
Triglochin maritima	(4)
Rumex fenestratus	(2)
Triglochin palustris	(2)
Caltha palustris	(2)

Carex paleacea	(5)
Carex MacKenziei	(5)
Stellaria longipes	(4)
Carex paleacea	(2)
Campanula aparanoides	(4)
Lathyrus palustris	(2)
Epilobium leptophyllum	(4)

Lathyrus palustris	(5)
Sium suave	(5)

Calamagrostis neglecta	(2)
Calamagrostis neglecta	(4)

Carex paleacea	(2)
Galium trifidum	(2)
Galium trifidum	(4)

Rumex fenestratus	(2)
Campanula aparanoides	(3)
Lathyrus palustris	(3)
Sium suave	(3)
Aster simplex	(2)

Aster simplex	(3)
Stellaria longipes	(2)
Stellaria longipes	(3)
Malaxis brachypoda	(3)
Epilobium leptophyllum	(2)
Epilobium leptophyllum	(3)
Hierochloe odorata	(4)
Festuca rubra	(2)
Festuca rubra	(4)

Iris versicolor	(5)
Salix candida	(5)
Euphrasia disjuncta	(3)
Euphrasia disjuncta	(4)

At the same significance level, the opposed species were the following:

Potentilla anserina	(2)	Menyanthes trifoliata	(4)
Potentilla anserina	(3)	Carex paleacea	(4)
Potentilla anserina	(4)	Rumex fenestratus	(2)
		Galium trifidum	(2)
		Lathyrus palustris	(5)
		Sium suave	(5)
		Triglochin palustris	(4)
		Caltha palustris	(2)
		Stellaria longipes	(4)
		Iris versicolor	(5)
		Salix candida	

Pedicularis macrodonta	(2)	Festuca rubra	(2)
		Caltha palustris	(5)

Calamagrostis neglecta	(2)	Campanula aparanoides	(4)
		Stellaria longipes	(2)
		Eleocharis smallii	(2)
		Eleocharis smallii	(4)
Calamagrostis neglecta	(4)	Triglochin palustris	(2)
		Stellaria longipes	(3)
		Eleocharis smallii	(2)
		Eleocharis smallii	(4)
		Stellaria longipes	(3)
		Stellaria longipes	(4)
Galium trifidum	(2)	Aster simplex	(2)
		Carex MacKenziei	(5)
		Eleocharis smallii	(2)
		Eleocharis smallii	(4)
Galium trifidum	(4)	Aster simplex	(2)
		Carex MacKenziei	(5)

Conclusion

By making a comparison with the results obtained in survey o15, it has been possible to determine the temporary co-enological groups (see synthesis)the areas of which overlap in the zone that contains bogbean. This zone is sufficiently large to be mapped as such. For our purposes, a detailed study of the ecological differences between the two co-enological groups is not feasible.

Interpretation: Line 013

Horizontal structure

17 species were counted on this line, with an average frequency of presence of 12 per species. General heterogeneity was 22 bits, i.e. 36% of the maximum theoretical heterogeneity. The line is therefore overall not very heterogeneous.

Most of the heterogeneity, however, was introduced by only 4 species. In the first place, Ranunculus cymbalaria, the distribution of which is contagious (at the 95% probability level) and the groups of which have a far-flung distribution. The relative heterogeneity of this species amounts to 98%. Sium suave and Triglochin maritima behave in similar fashion. Festuca rubra, which has a contagious distribution (5% threshold), stops abnormally early.

This concentration to the left of Festuca rubra affects Calamagrostis neglecta and Bidens cernua as well.

Testing of the optimum boundary shows a break between the 26th and the 34th segments, a zone that corresponds

<u>Table 12: Matrix 013</u>

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Carex paleacea	1111111111111111111111111111111111111111111111111111111111111111
2-	Carex paleacea	1111111111111111111111111111111111111111111111111111111111111111
3-	Sium suave	1011111000000000011000010000010010000000001110001001000000000001
4-	Sium suave	0000001000000000000000000000000000000000000000000000000000010100
5-	Sium suave	0000100000000000000000000000000000000000000000000000000000000100
6-	Triglochin maritima	1111111111001000011111100111111111111110100000111001100111111011
7-	Triglochin maritima	0111111101000000010110100010110111111111010000010100110011111011
8-	Triglochin maritima	0010001100000000000000000000000000000000000000000000000000000000
9-	Calamagrostis neglecta	0111111111000000000000000110100000000000000000000000000000000000
10-	Calamagrostis neglecta	0111111100000000010000011010000000000000000000000000000000000000
11-	Festuca rubra	0100111111000000110111011110000000000000000000000000000000000000
12-	Eleocharis uniglumis	0010000000000000000000011000000010000000000000000000000000000000
13-	Eleocharis uniglumis	0010000000000000000000010000000000000000000000000000000000000000
14-	Aster sp.	0001000000000000000000000000000000000000000000001000000000000000
15-	Hierochloe odorata	0001000000000000000000000000000000000000000000000000000000000000
16-	Ranunculus cymbalaria	0000110011000000001100000000101011111100010110110111110000001000
17-	Ranunculus cymbalaria	1100010000000000000000000000000000000000000000000110000000000000
18-	Bidens cernua	0100010000000000000000000000000000000000000000000000000000000000
19-	Potentilla anserina	0000000000100000000000000000000000000000000000000000000000000000
20-	Carex salina	0000000000000000000000000000000000000000000010000010110001000000
21-	Carex salina	0000000000000100000000000000000000000000000000000000000000000000
22-	Carex salina	0000000000000000000000000000000000000001000010000010110001000000
23-	Menyanthes trifoliata	0000000000000100000000000000000000000000000000000000000000000000
24-	Hippuris tetraphylla	0000000000000000000000010000000000000000000000000000000000000000
25-	Lathyrus palustris	0000000000000000000000001000000000000000000000000000000000000000
26-	Carex limosa	0000000000000000000000000000000000100000000000000000000000000000
27-	Triglochin palustris	0000000000000000000000000000000000000000000011000000000000000000

to the disappearance of species that stop abnormally early. A remarkable fact is that these species which disappear are not replaced, as if this were the beginning or the end (since the gradient direction followed by the line is unknown) of a zone of influence rather than the passage from one conglomeration to the next. It is clearly observable here that the dominant co-enological block is that of *Carex paleacea*. To the left of the transition zone a quite strong influence of the *Carex limosa* block was noted; this influence disappears suddenly to the right of the survey.

General heterogeneity diminishes as a function of the mesh, undoubtedly due to the mode of distribution of the abovementioned heterogeneous species which lends to the whole a microheterogeneous aspect.

Links between species

Testing of the coefficients of correlation shows the presence of four groups of species positively linked at the 99% threshold. These are:

Bidens cernua
Calamagrostis neglecta
Festuca rubra

Eleocharis smallii
Lathyrus palustris

Asper sp.
Hierochloe odorata

Carex salina
Menyanthes trifoliata

On the other hand, only two species were negatively correlated at the same threshold: Triglochin maritima and Carex salina.

Phenology and stratification

The vegetation is clearly dominated by Carex paleacea, which covers 80% in stratum 4. Carex is also present in stratum 5, but with a much smaller coverage (5%).

Most species were in the 2nd phenological stage (14 species) or in the 4th (9 species) only. Only three species, namely Sium suave, Triglochin maritima and Carex salina could be found in other stages.

Testing of the coefficients of correlation shows no links, whether positive or negative, at the 99% threshold. At the 95% level, however, it is possible to establish the following groups, many of them relative to the development of two stages for the same species.

Sium suave	(3)
Sium suave	(4)
Triglochin maritima	(5)
Triglochin maritima	(5)
Calamagrostis neglecta	(2)
Calamagrostis neglecta	(4)
Eleocharis uniglumis	(4)

Eleocharis smallii	(2)
Festuca rubra	(2)

Sium suave	(2)
Lathyrus palustris	(2)

Ranunculus cymbalaria	(4)
Bidens cernua	(3)

Triglochin maritima	(2)
Triglochin maritima	(4)

Aster sp.	(2)
Hierochloe odorata	(4)

Carex salina	(2)
Carex salina	(4)

Carex salina	(3)
Menyanthes trifoliata	(2)

Triglochin palustris	(2)
Triglochin palustris	(4)

Conclusion

Once again there is confirmation of the presence of two co-enological blocks in the _Carex_-dominated area. The _Carex_ zone may be mapped as a zone of overlapping areas. A proper description of this zone would require such a fine mesh that the work involved would exceed our means.

Interpretation: Line 014

Horizontal structure

Survey heterogeneity was 12 bits, i.e. 29% of the maximum theoretical heterogeneity for this line. It may thus be stated that the survey is not very heterogeneous. Incidentally, the entire heterogeneity is contributed by the presence of *Scirpus americanus* and by its surprise disappearance after the 41st segment. However, *Scirpus* spreads contagiously wherever it is found. That is, if the overall line is homogeneous, the reasons for this sudden and temporary disappearance of the American bulrush should be sought among the ecological factors.

Testing of the optimum boundary does show an absolutely significant break after the 41st segment. The test does not signal the reappearance of the bulrush, since this test ignores secondary boundaries for the sake of economy.

These facts are confirmed by the test of the general heterogeneity; the latter increases up to a maximum peak attained when the number of segments grouped together reaches 32. At this perception level the line pattern becomes macroheterogeneous.

Table 13: Matrix 014

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Scirpus americanus	1111111111111111111111111111111111111111110001000010000000001111
2-	Eleocharis smallii	1111111111111111111111111111111111111111111111111111111111111111
3-	Triglochin palustris	0000000000000000000000000000000000000000100001000000000000000000
4-	Ranunculus cymbalaria	0000000000000000000000000000000000000000000001100000000000000000

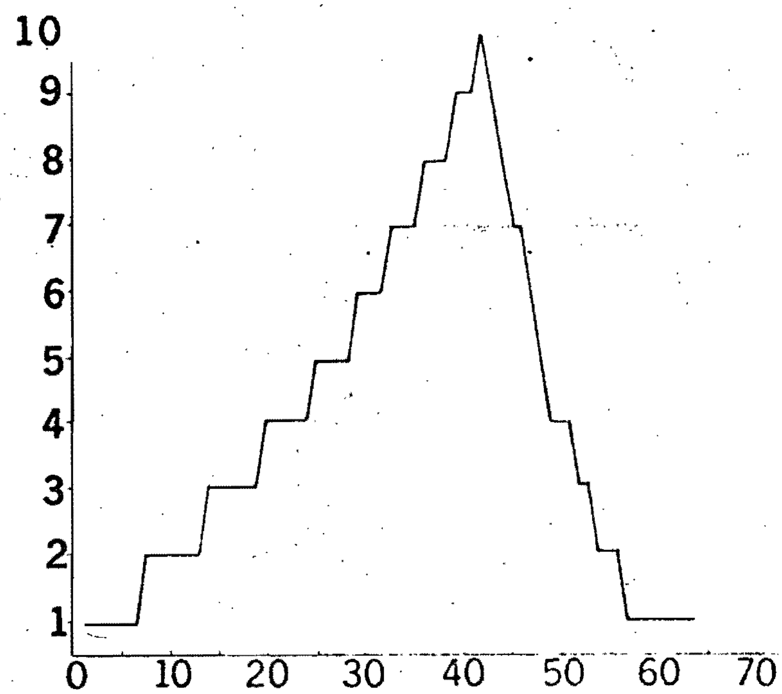


Fig. 15 Optimum boundary for line 014

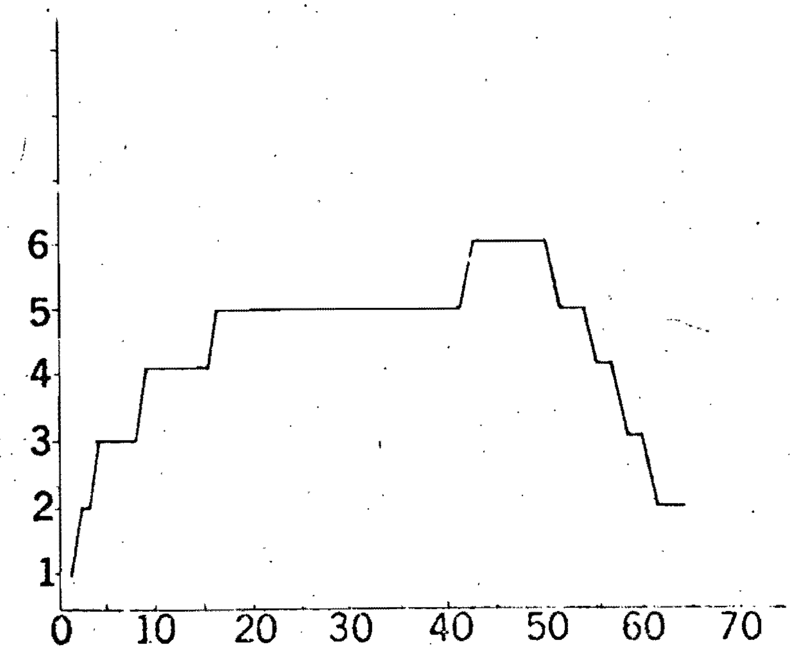


Fig. 16 Optimum boundary for line 015

Links between species

All species on this line have a perfectly independent behaviour.

Phenology and stratification

Vertically, the vegetation is very clearly dominated by the presence of *Eleocharis smallii* in stratum 3 (80% coverage) and of *Scirpus americanus* in stratum 4 (10% coverage).

Except for *Triglochin palustris*, which was present in phenological stage 3, all other species were either in the vegetative or in the sterile state. As regards the bird-food producing capabilities of this conglomeration, they must thus be qualified as low.

Only two phenological stages are positively linked at the 99% level: these are stages 2 and 4 of *Triglochin palustris*.

Conclusion

It is undeniable that line 014 constitutes a perfectly mappable and homogeneous unit. However, when studying the important ecological factors, there should be a search for the cause of this sudden disappearance of Scirpus americanus, which appears again just as suddenly towards the end of the survey.

Interpretation: Line 015

Horizontal structure

It must be mentioned here that this line was established by the field team in a zone that seemed to be clearly dominated by two species: *Menyanthes trifoliata* and *Equisetum fluviatile*. However, all the tests employed prove that these two species are absolutely not differential in the present case. Even more, the test of the general heterogeneity shows that we are in the midst of a transition zone where elements of several associations meet. It was impossible, however, to detect a gradient direction. This is a zone, therefore, where there is a total lack of predominance of a differential factor among all important ecological factors.

26 species were counted, each of them appearing 21 times on average. Average heterogeneity was 39 bits, i.e. 64% of the maximum theoretical heterogeneity. The survey is thus quite heterogeneous.

Even though the results show that at the 99% probability level only 7 species have a contagious distribution, their number increases to 11 if the threshold is lowered to 95%. The heterogeneity of the line is due to these species that have a contagious mode of distribution.

Table 14: Matrix 015

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Menyanthes trifoliata	1111111111111111111111111111111111111111111111111111111111111111
2-	Equisetum fluviatile	1111111111111111111111011111111111111111111111111110111111111
3-	Aster simplex	0001111111010010100011111110111111111010011011010001010000111100
4-	Calamagrostis neglecta	000010001010000000000001111011101101111010101111010001011111111
5-	Caltha palustris	0000000110010001100001100110001110101001001001100011100100110110
6-	Lemna minor	1001000000001101111110100000101100000000000010011110111010001110
7-	Eleochoris smallii	1101000000001111011110000001111111011111111110100000000000000000
8-	Eriophorum gracile	0111100000000000000000000110110011010011001000000000000000000000
9-	Carex paleacea	0001000011010000000001100110101010111111000011111010111111111111
10-	Sable	0000000000000000000000000000000000000000000000000111110000000
11-	Potentilla palustris	0000100100111011111110100011101100010000000000000011111110000000
12-	Galium trifidum	0000101111111000000110111111111111111111110011110111111111111111
13-	Euphrasia disjuncta	0000111111110000000000111110010001111100000001000000000000000000
14-	Selaginella sp.	0000111111100000000011111011011011111110000001100001110000000001
15-	Pedicularis macrodont[illegible]	000[illegible]0000000000101100100000011110110011000000001100000[illegible]11
16-	Carex retrorsa	0000001110001000000000000000000000000011000000000000000000000000
17-	Lathyrus palustris	0000001000000000000000001000000000000000000000000000000000000000
18-	Festuca rubra	0000000001110000000000001001000000000000000000000000000000000000
19-	Salix candida	0000000000001000000000000000000000000000000000000000000000000000
20-	Carex salina	00000[illegible]000001010000000000001000[illegible]000000000100000000000000000000000
21-	Sium suave	00000000000000010000000101100000001001000100010100110010110000001
22-	Epilobium leptophyllum	000000000000000001000010100000000000001000000010000001101101110010
23-	Stellaria longipes	00000000000000000000110000100000000000000000000000001000001000110
24-	Campanula aparanoides	00000000000000000001111001011011111011110100000000000000001000000
25-	Carex limosa	0000000000000000000000000000000000000001110000000000000000000000
26-	Rumex fenestratus	0000000000000000000000000000000000000000000010000000000010000001

The test of the optimum boundary shows that maximum heterogeneity is attained between the 42nd and the 50th segments. If we refer to the presence-absence matrix (table 14), it becomes obvious that these are the segments where there is minimum representation of the various peripheral associations. In other words, it is that part of the survey where not all groups are to be found.

Maximum heterogeneity increases as a function of the mesh, independently of the number of segments grouped together. It would thus be meaningless to look for the presence of sub-units that may have an appropriate degree of homogeneity internally. This is rather a typical case of macroheterogeneity and if we were searching for a pattern or a structural model to define this zone, we would probably select a sequence of blocks having an internal structure based on equally probable numbers of absences and presences.

Links between species

In opposition to many other surveys made further down on the shore, this one has shown - by means of the tests of the coefficients of correlation - the existence of temporary co-enological groups. Our transition zone comprises indeed various elements originating from the neighbouring associations; they are probably homogeneous and their influence is felt. Figure 17 shows the details pertaining to these co-enological groups. It must be noted

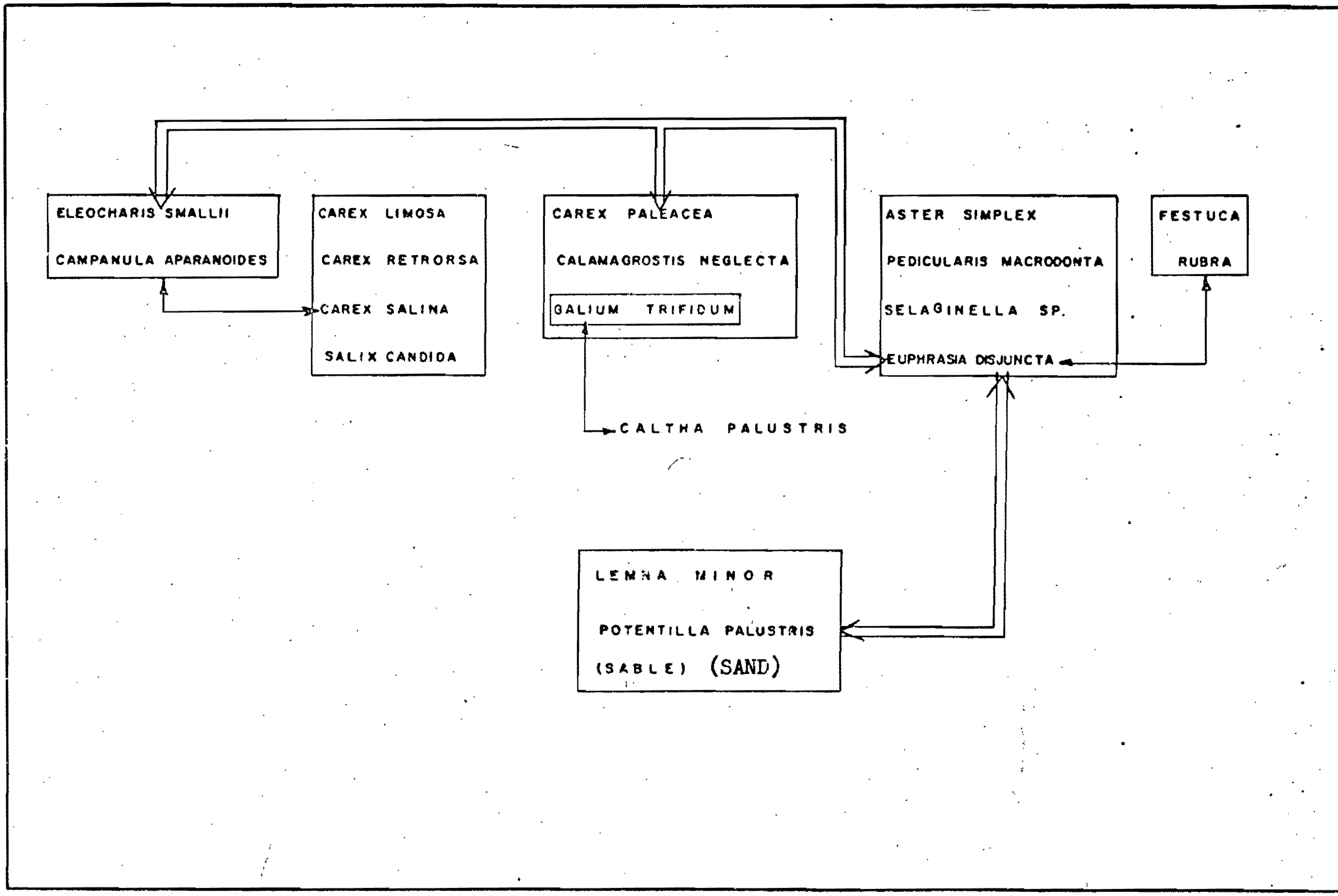


FIGURE 17: POSITIVE AND NEGATIVE LINKS, ON LINE 015, AT THE 99% THRESHOLD.

that all these groups, except for the one made up of *Lemna minor* and *Potentilla palustris* on sandy soil, are groups originating from a relatively dry medium. The tolerance *Eleocharis smallii* has for this effect is surprising. Tests show a positive link with *Campanula aparanoides*. This species, the dispersion area of which lies much further down on the shore, seems to have reached its upper limit.

One of these groups is of particular interest. This is the group composed of *Aster simplex*, *Pedicularis macrodonta*, *Selaginella* sp., *Euphrasia disjuncta* and *Festuca rubra*. *Pedicularis* and *Euphrasia* are hemiparasites: instead of extracting their nourishment from the soil, their roots penetrate inside the roots of the host plant and rob them of their nutrients. It is known in Europe that certain *Euphrasia* species attach themselves as parasites to graminaceae; very little research, however, was carried out in America to date on this subject. According to the results yielded by the analysis of this survey, it seems that *Pedicularis* and *Euphrasia* live as parasites at the expense of *Aster simplex*, while *Festuca rubra* may only be attacked by *Euphrasia* alone. Let us recall that this hypothesis is based on correlations calculated at the 99% threshold. The strength of this link, however, is somewhat moderated by the results obtained on other lines (see synthesis).

Therefore, of our three groups, only those dominated by *Aster simplex* and *Lemna minor* are linked by a negative relationship. However, there are negative links between

between species that affect exclusively certain species within the groups and not the others. Figure 17 also shows these links.

The detailed internal structure of each group included in figure 17 should be studied by means of further surveys. This study is not feasible by means of line 015 alone.

Phenology and stratification

From the point of view of physiognomy, the vegetation is dominated by the presence of Menyanthes trifoliata the coverage of which in stratum 4 was estimated at approximately 60%. The surface covered by all the other species is insignificant, so that only Menyanthes may be used to characterize the vegetation.

Of the 26 species present on this line, 18 were at the vegetative stage, 10 at the reproductive stage, 18 at the reproductive stage affected by sterility and 11 at the senescent stage. The distribution of the species within the various phenological classes was as follows:

Aster simplex	at stages 2 3 4
Carex retrorsa	" " 2 3 4
Pedicularis macrodonta	" " 2 3 4

<u>Eleocharis smallii</u>	at stages 2 4 5
<u>Potentilla palustris</u>	at stages 2 3 4 5
<u>Euphrasia disjuncta</u>	" " 2 3 4 5

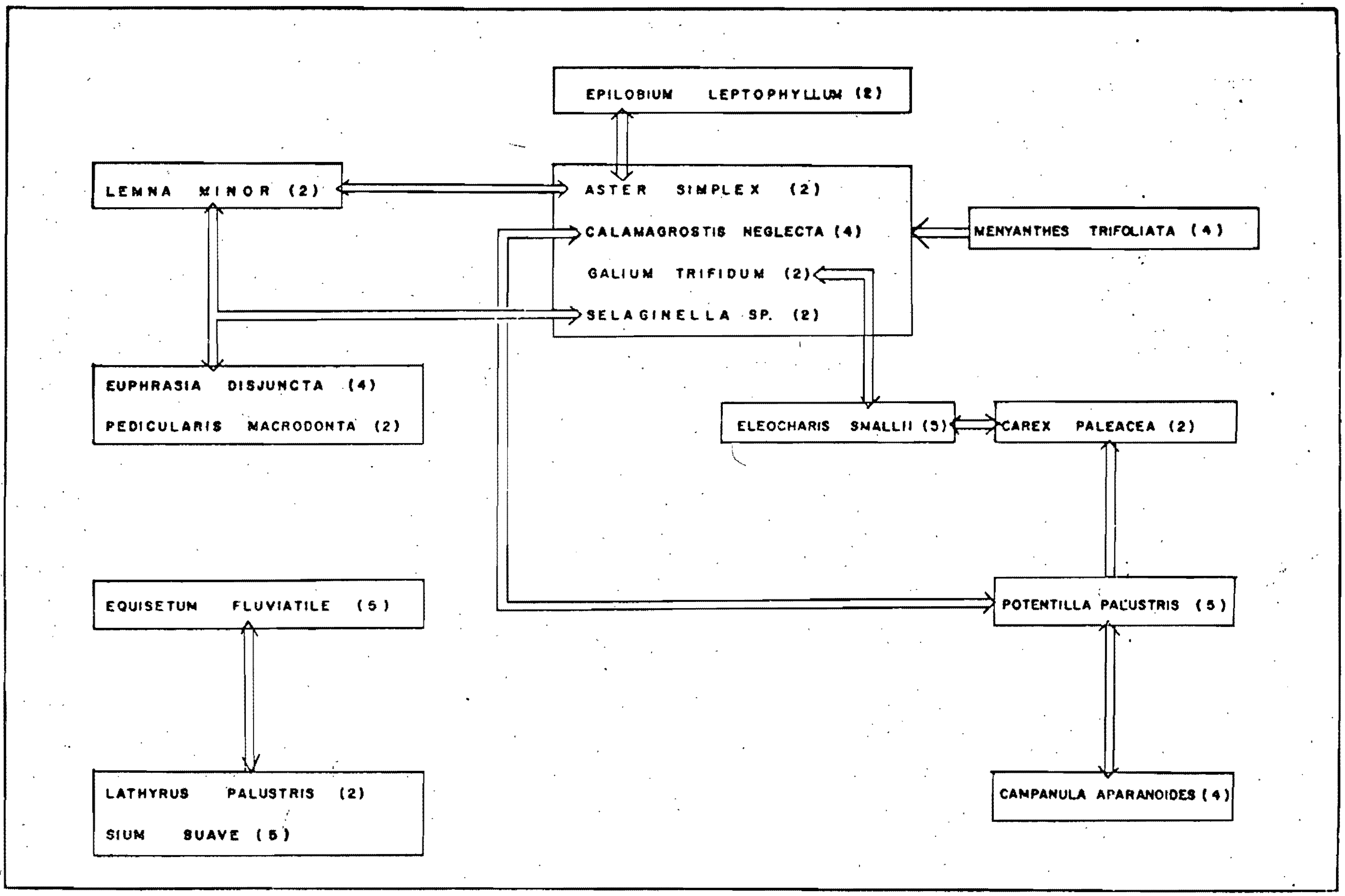


FIGURE 18: NEGATIVE PHENOLOGICAL LINKS ON LINE 015 AT THE 99% THRESHOLD

Epilobium leptophyllum	at	stages	2	3	4	5
Campanula aparanoides	"	"	2	3	4	5
Sium suave	"	"	2	3	4	5
Menyanthes trifoliata	"	"			4	5
Calamagrostis neglecta	"	"		3	4	
Equisetum fluviatile	"	"	2			5
Caltha palustris	"	"	2			5
Galium trifidum	"	"	2		4	
Rumex fenestratus	"	"			4	5
Carex paleacea	"	"	2		4	
Stellaria longipes	"	"	2		4	
Carex salina	"	"		3	4	
Lemna minor	"	"	2			
Eriophorum gracile	"	"			4	
Selaginella	"	"	2			
Lathyrus palustris	"	"	2			
Festuca rubra	"	"	2			
Salix candida	"	"				5
Carex limosa	"	"			4	

The large number of species found at all stages is an obvious symptom of their vitality and of the particularly short evolutionary cycle of these species.

9 temporary phenological groups were established by testing the coefficients of correlation. Figure 18

contains the negative links between these groups. Several species belonging to these groups refer to certain groups of species that are positively linked; details thereon are given below. We ask the reader to refer to them.

Aster simplex	(3)
Aster simplex	(2)
Euphrasia disjuncta	(5)
Euphrasia disjuncta	(4)
Euphrasia disjuncta	(2)
Pedicularis macrodonta	(4)
Pedicularis macrodonta	(3)
Festuca rubra	(2)
Selaginella	(2)
Carex retrorsa	(3)
Carex retrorsa	(2)

Aster simplex	(4)
Epilobium leptophyllum	(5)
Epilobium leptophyllum	(3)
Sium suave	(3)
Sium suave	(2)
Rumex fenestratus	(5)
Rumex fenestratus	(4)

Menyanthes trifoliata	(4)
Potentilla palustris	(5)
Lemna minor	(2)
Carex salina	(3)
Stellaria longipes	(2)
Campanula aparanoides	(5)

Eriophorum gracile (4)
Equisetum fluviatile (2)

Carex limosa (4)
Carex retrorsa (4)
Carex salina (4)
Salix candida (5)
Eleocharis smallii (4)

Calamagrostis neglecta (4)
Carex paleacea (2)
Caltha palustris (5)
Caltha palustris (2)
Eleocharis smallii (2)

Potentilla palustris (4)
Potentilla palustris ([illegible])
Potentilla palustris ([illegible])
Sium suave ([illegible])
Epilobium leptophyllum (2)
Sand

Epilobium leptophyllum (4)
Campanula aparanoides (4)
Campanula aparanoides (3)
Galium trifidum (4)
Pedicularis macrodonta (2)

Sium suave (5)
Stellaria longipes (4)
Lathyrus palustris (3)

Conclusion

The vegetation of the zone described by line 015 may not be used for descriptive purposes. However, if it is sufficiently large, this zone may be mapped as a mixed or transition zone.

Interpretation: Line 016

Horizontal structure

The vegetation appears to have a perfectly homogeneous horizontal structure, since the general heterogeneity of the line is equal to 0, i.e. 0% of the maximum theoretical heterogeneity. This is normal, since no segment of the line is different from the others. As expected, the test of the optimum boundary also gives a nil result; let us recall that said test calculates the general heterogeneity on both sides of a variable boundary that moves from one segment to the next. There is no variation whatever of general heterogeneity as a function of the mesh, so that theoretically a single segment of arbitrary size should suffice to properly describe this type of vegetation.

Links between species

Since every species is present in each segment, their respective distributions must be considered to be perfectly independent.

Table 15: Matrix 016

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

Phenology and stratification

Hippuris vulgaris dominates this conglomeration with a 70% coverage. *Eleocharis*, the foliar development of which is practically non-existent, is also present in surprising quantities, since its coverage - almost exclusively dependent on the stems - attains 25%. Both species were in the senescent stage. However, a certain recovery of *Hippuris* could be observed, since it was present in each segment in the vegetative stage as well.

The modes of development of the various strata of all species were perfectly independent.

Interpretation: Line 017

Horizontal structure

The vegetation is not very heterogeneous, since general heterogeneity was 26 bits, i.e. 42% of the maximum theoretical heterogeneity. The average frequency per species was 27.

Two species cause the greatest part of the heterogeneity. First, Triglochin maritima has a contagious distribution and the rough data supplied by the size and location of each group contributes a great deal to heterogeneity. Furthermore, Scirpus americanus, even though it has a smaller number of groups, behaves in much the same manner. Scirpus paludosus causes heterogeneity mainly because of the very great peculiarity of the start and the end of its distribution.

Even though this is quite obviously a case of imbricated distribution of species, the appearance of Scirpus paludosus, which occurs in a manner different from the ordinary one, corresponds to the break indicated by the test of the optimum boundary. It would be no doubt advisable to look for certain variations of the ecological factors on the segments occupied by this species; these variations would occur in a very localized manner , unlike the findings on the other lines, where they occurred very slowly and thus allowed a very regular distribution of Scirpus paludosus.

Table 16: Matrix 017

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Eleocharis smallii	1111111111111111111111111111111111111111111111111111111111111111
2-	Triglochin maritima	0001000110110011110011011011100010000000000000011001110111110010
3-	Scipus americanus	1111111111111111001001100001111111111011111111111111111111111111
4-	Scirpus paludosus	0000000000000000000000000011111100001111100000000000000000000000
5-	Triglochin palustris	0000000000000000000000000000000000000001000000000000000000001000
6-	Festuca rubra	0000000000000000000000000000000000000000000000000000000000110000

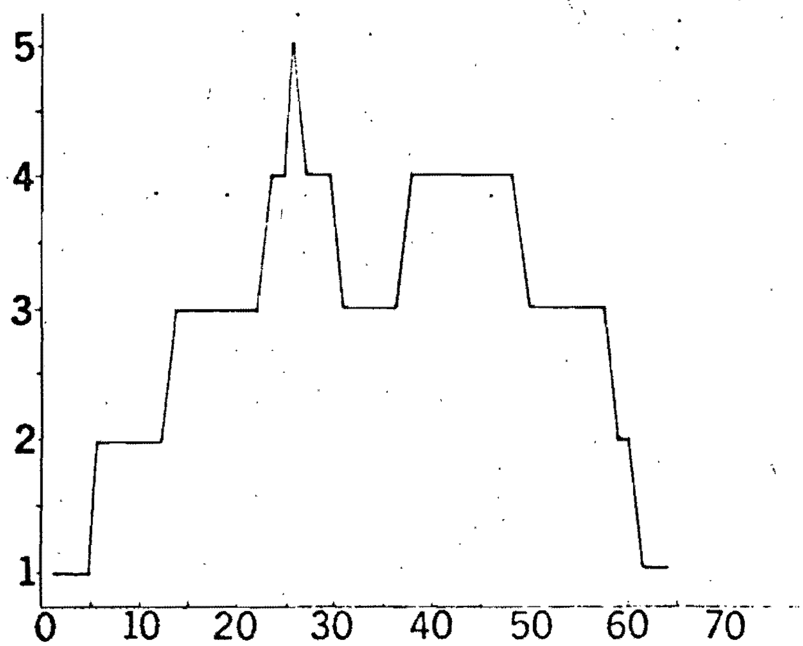


Fig. 19 Optimum boundary for line 017

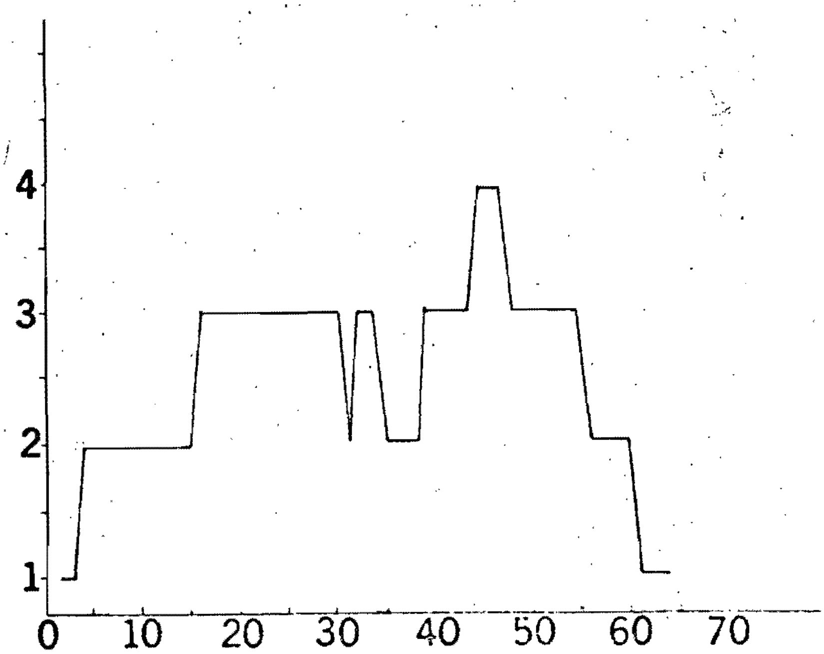


Fig. 20 Optimum boundary for line 018

The general heterogeneity increases as a function of the mesh and the overall appearance thereby becomes macroheterogeneous.

Phenology and stratification

Two species clearly mark the physiognomy of the vegetation: Eleocharis smallii and Scirpus americanus, even though it is difficult in this case to speak of an impressive coverage, since their foliar surface is very small. The distribution of the species within the various phenological stages was as follows:

Eleocharis smallii	at	stages	4	5
Triglochin maritima	"	"	4	5
Scirpus americanus	"	"	4	5
Scirpus paludosus	"	"	4	5
Triglochin palustris	"	"	4	
Festuca rubra	"	"	4	

It was observed that the productivity of the vegetation seems very low due to the sterility of most species.

Testing of the coefficients of correlation revealed a single positive link at the 99% threshold, that between Scirpus americanus (4) and Scirpus americanus (5).

Conclusion

Since it is not feasible to map each species separately, there should be a map of the whole. A chart of the overlap areas and of the tolerance of each species should be attached to this map.

Interpretation: Line 018

Horizontal structure

13 species were counted on this line. The average frequency of appearance wa approximately 20. Average general heterogeneity was 25 bits, i.e. 41% of the maximum theoretical heterogeneity. This line can thus be qualified as having little heterogeneity.

This does not mean, however, that it is possible to isolate on it well-defined and systematically and mutually different units. Scirpus americanus, located at the centre and contagiously subdivided into four groups may have suggested the existence of an American bulrush sub-group. There is no such thing. The behaviour of Ranunculus sp., to the right of the survey and also of contagious distribution and of Sium suave, which was distributed into fifteen groups, could also have induced us to reason along these lines. All our efforts, however, remained fruitless: it was impossible to characterize this survey by giving it the name of a truly characteristic species.

Let us note nevertheless the presence of Calamagrostis neglecta, located entirely to the left, a probable trace of the vegetation located before the beginning of the line.

Table 17: Matrix 018

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Carex paleacea	1111111111111111111111111111111111111111111111111111111111111111
2-	Eleocharis smallii	1111111111111111111111111111111111111111111111111111111111111111
3-	Triglochin maritima	1001111111101001111001101101111010111001000000010111111111111111
4-	Sium suave	0001010010010010000101111010001110111011101111100010100000010000
5-	Deschampsia cespitosa	0000100000000000000000000000000000000000000000000000000000100000
6-	Ranunculus sp.	0000011001111111100110001001110111000011011000111110001000111001
7-	Juncus balticus	0000000000000000000011010000000000010000000000011000000000000000
8-	Calamagrostis neglecta	0000000000000000000010111000000000000000000000000000000000000000
9-	Scirpus americanus	0000000000000000000001001111111110011111100010000000000000000000
10-	Festuca rubra	0000000000000000000000010000000000110100010000000010000000000000
11-	Stellaria longipes	0000000000000000000000000000100000000000000000000000000000000000
12-	Puccinellia lucida	0000000000000000000000000000000000001000000000000000000000000000
13-	Ranunculus cymbalaria	0000000000000000000000000000000000000000000000100000000000000000

The test of the optimum boundary reaches a peak between the 44th and the 47th segment. However, the values obtained are sufficiently small so that one does not have to consider them highly significant. General heterogeneity increases as a function of the mesh, overall, thereby creating a macroheterogeneous line aspect. Sium suave, on the other hand, is distributed into clusters, so that one might be tempted to speak of this species in microheterogeneous terms.

Links between species

Testing of the coefficients of correlation shows that all species on this line are perfectly independent from each other.

Phenology and stratification

Vertically, the vegetation was composed of

- Carex paleacea in stratum 4 (50% coverage)
- Eleocharis smallii in stratum 3 (20% coverage)
- Triglochin maritima in stratum 5 (2% coverage).

The physiognomy of this conglomeration is thus clearly marked by the presence of Carex paleacea and of Eleocharis smallii. Furthermore, 11 of the 13 species present were in sterile stage and in senescent stage. Only two were vegetative. This means that at the end of August most species were well beyond the productive stage.

It is, incidentally, disturbing to see so many sterile species within one conglomeration.

A positive link at the 99% level was discovered between stages 4 and 5 of Calamagrostis neglecta and a negative link, at the same level, between Carex paleacea (stage 4) and Puccinellia lucida (stage 5).

Conclusion

The survey was sufficiently homogeneous to be considered as a mappable unit. However, just as several other surveys do, it suggests that in certain cases - so far as the riparian vegetation is concerned - there are no "associations" within the meaning of the Zurich-Montpellier School. One should speak of imbrication instead.

Interpretation: Line 019

Horizontal structure

The main characteristic of line 019 is certainly the small number of species present on it. Indeed, only 5 species were counted there, with an average frequency of appearance of approximately 30 per species. General line heterogeneity reaches 21 bits, i.e. 35% of the maximum theoretical heterogeneity. The vegetation of this zone can thus be considered to have little heterogeneity.

However, there are certain reasons why this zone cannot be considered to form a unit.

Tests have shown that *Sagittaria latifolia* begins "abnormally" late. Furthermore, *Eleocharis smallii* and *Triglochin palustris* exhibit all the characteristics of a contagious distribution (few groups and a high group number probability). As regards *Sagittaria latifolia*, the I_g variable (data relative to the number of groups) clearly shows that the location and the size of the groups plays a very important rôle. This, incidentally, is reflected by the heterogeneity relative to this species.

Table 18: Matrix 019

N.B.: Meaning of digits: 1 indicates a presence, 0 indicates an absence

1-	Hippuris tetraphylla	111111111100000000000000000000000000000000000000000000000000111
2-	Eleocharis smallii	111111111011111111111111111111111111111111111111111111111111111
3-	Sagittaria latifolia	000000000011100111111111110000000111111110011111111111111111111
4-	Triglochin palustris	111111111111111111111111111111111111111111111111111111111101111
5-	Polygonum fowleri	000000000000000100100000000000000000000000000000000000000000000
6-	Sagittaria sp.	000000000000000000000000000000000000000000000000000000000010000

One look at the presence-absence matrix (table 18) is sufficient to realize that there is a substitution of species, probably connected with a change in the conditions of the environment. Testing of the optimum boundary locates this break at the 10th segment. Within a zone dominated by Eleocharis smallii and Triglochin palustris, it is thus possible to observe two enclaves: Hippuris tetraphylla to the left, and Sagittaria latifolia to the right. This distinction is verified by the test of the variations of general heterogeneity as a function of the mesh. The first 8 segments constitute an homogeneous block with respect to the rest of the survey, the rest of the survey being also homogeneous but containing micro-zones created by the somewhat irregular distribution of Sagittaria latifolia.

Links between species

Testing of the coefficients of correlation has shown that all species in this survey were perfectly independent.

Phenology and stratification

The vegetation on this line is extremely low, since there are only two strata, the highest of which does not exceed 6 inches. In stratum 2 (the highest one) Eleocharis smallii has a 40% coverage, Triglochin palustris has 40% and Hippuris tetraphylla 2%. In stratum 1, Sagittaria latifolia only covers 20% of the ground surface.

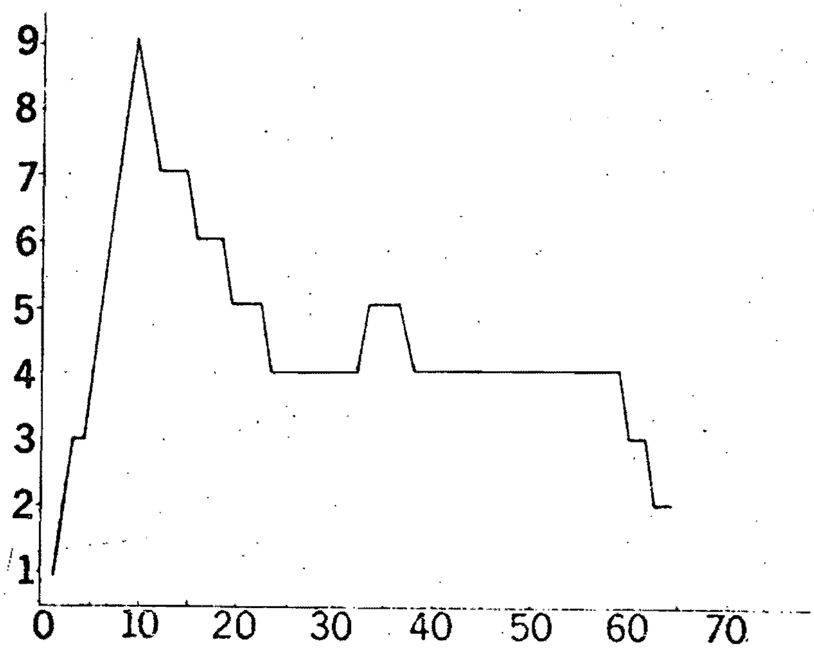


Fig. 21 Optimum boundary for line 019

Phenologically, we found:

Hippuris tetraphylla	at	stages	2	3	4	5
Eleocharis smallii	"	"			4	5
Sagittaria latifolia	"	"	2		4	
Triglochin palustris	at	stage				5
Polygonum Fowleri	"	"		3		

Testing of the coefficients of correlation shows a positive link, at the 99% threshold, between *Hippuris tetraphylla* (stage 4) and *Hippuris tetraphylla* (stage 5) on the one hand, and *Eleocharis smallii* (stage 5) on the other hand. This seems to indicate that-at this level-*Hippuris* has a phenological continuity and that at the beginning of the season - before new representatives of this species start to grow - the growth of *Hippuris* is linked to that of *Eleocharis smallii*.

The test has also revealed the existence of a negative correlation, at the 99% threshold, between *Triglochin palustris* (stage 5) and *Sagittaria latifolia* (stage 4). However, the correlation in this instance is based only on the substitution of *Triglochin* by *Sagittaria* in one segment. It should be checked whether a repetition of this phenomenon occurs on the other lines.

Conclusion

Even though line 019 may clearly be considered as a mappable unit, it will undoubtedly be impossible to make a practical distinction between the two enclaves within the entire zone. This unit will probably have to be mapped as a mosaic and described separately. The results obtained confirm the assumption that this is a case of imbricated vegetation.

Synthesis

Imbrication

This inventory of the Rupert Bay intertidal swamps was based on one preliminary assumption: that the species clustered together into "associations" which could be used to map the bay and to construct a proper sampling plan of the ecological factors in a way such as to link these factors to certain associations dependent on them. This inventory of ecological factors was to be carried out during a second work season in the field.

It was repeatedly noted during the interpretation of each individual survey that the tests revealed most of the time the total absence of any link, whether positive or negative, between the species. As mentioned by Godron (1967), such behaviour is typical for "imbricated" vegetation. According to this author, imbricated vegetation is midway between the "continuum" of the Curtis school and the "association" of the Zurich-Montpellier school.

Generally speaking, there is imbrication when the boundary of local ecological conditions is not detected by the appearance or the disappearance of species that may be considered differential. On the contrary, there is in this case an overlap of the areas of distribution, since the tolerance of each species relative to a factor or to a group of factors varies.

Figure 22 shows the distribution of our species into temporary ecological groups. Relative to the direction of the gradient in the figure (from left to right), the presence of some ubiquitous species is noted first. These are *Eleocharis smallii*, *Triglochin*, of which there are two species here - *maritima* at the bottom of the gradient and the other one, *palustris*, at the top - and *Salicornia europaea*. The inventories made were insufficient for specifying the exact upper boundary of these four species. However, there are reasons to believe that *Salicornia* has a lower tolerance than the others.

The block formed by *Scirpus americanus* and *Sagittaria latifolia* is next; its requirements are certainly more restrictive. This group is located at the bottom of the transection; however, it is above the low-tide level.

At the very top of the gradient there is the group made up of the temporary co-enological block dominated by *Carex limosa*, of that dominated by *Carex paleacea* and *Menyanthes trifoliata*. This group should certainly be linked to a dryer or better drained medium, since the plants present within each block testify to this. Let us note that the location of *Menyanthes* at this site remains to be confirmed by later studies. The sampling effected was clearly insufficient for this purpose.

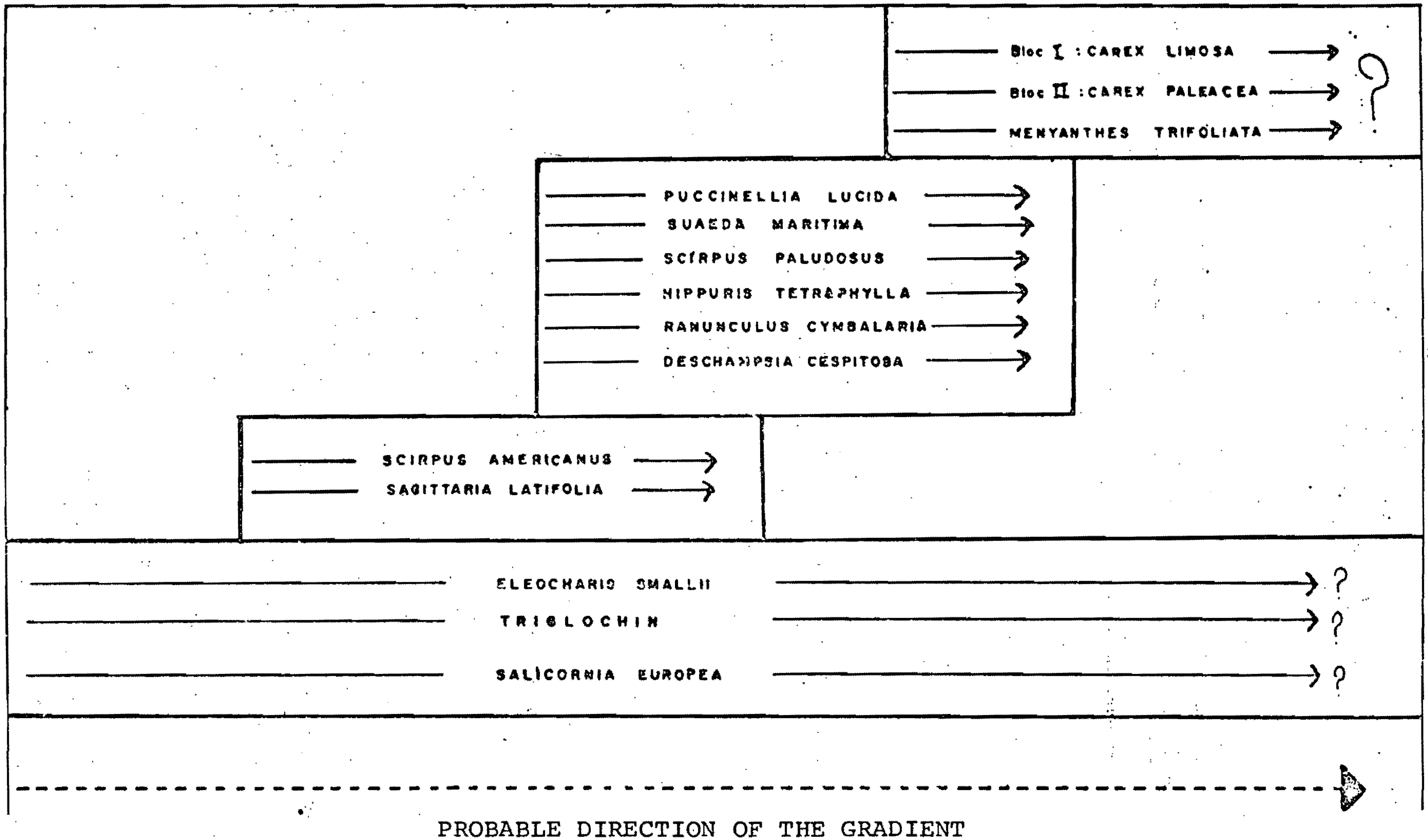


FIGURE 22: IMBRICATED STRUCTURE OF THE SPECIES PRESENT ON INTERTIDAL BEACHES.

A fourth temporary ecological group was identified. This is the group composed of Puccinellia lucida, Suaeda maritima, Scirpus paludosus, Hippuris tetraphylla, Ranunculus cymbalaria and Deschampsia caespitosa. It has a sort of transition position between the two neighbouring blocks.

Temporary co-enological blocks

As we have mentioned, the top of the gradient is occupied by Menyanthes trifoliata on the one hand and on the other hand by two co-enological blocks positive or negative links at the 99% precision level were found in both blocks. Figure 23 shows these blocks.

Block I, which is dominated by Carex limosa, may also contain the following associated species: Carex retrorsa, Carex salina and Salix candida. Aster simplex, Selaginella sp., Lathyrus palustris are to be found as a sub-tier, directly associated to one of the major species, as shown in the diagram. A sizeable number of companions, such as Bidens cernua, Hierochloe odorata, Festuca rubra, Campanula aparanoides, Eleocharis smallii, Rumex fenestratus, Malaxis brachypoda, Calamagrostis neglecta are to be found linked to these sub-tier species.

Block II, dominated by Carex paleacea to which no species is directly associated, except for Galium trifidum, contains much fewer species. Generally, Triglochin sp. (maritima and palustris), Carex MacKenziei and Caltha palustris are to be found as a sub-tier. However, this block is much more agressive than the previous one and

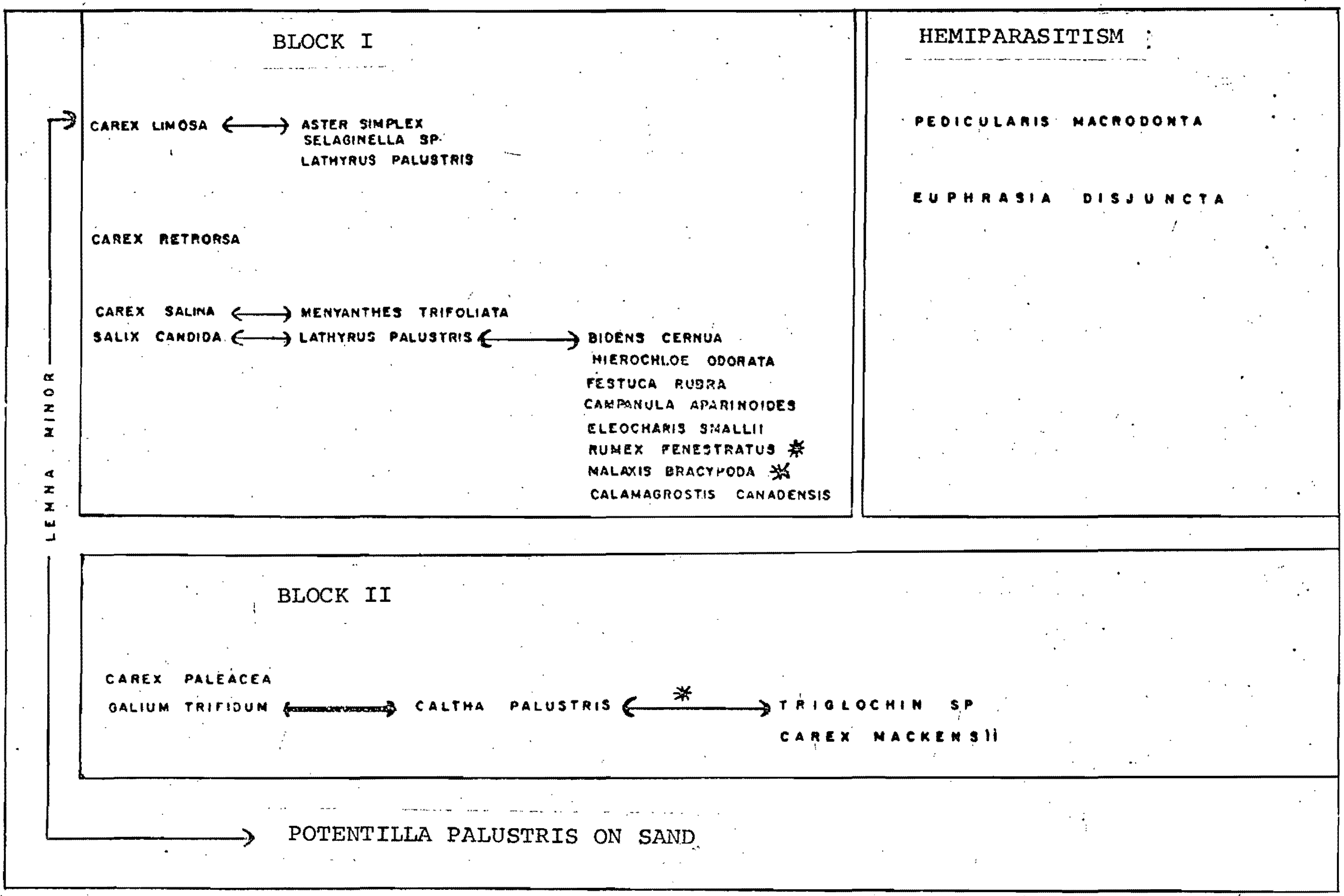


FIGURE 23: TEMPORARY CO-ENOLOGICAL BLOCKS
LINKS ARE AT THE 99% THRESHOLD, EXCEPT THOSE MARKED WITH AN *, WHICH ARE AT 95%.

appears to be better adapted to local ecological conditions, whatever they are.

Potentilla palustris, incidentally, seems tied to certain very peculiar conditions, at least within this environment. Indeed, it was found on sand bed, within muddy or clayey areas.

As to Lemna minor, it seems to take advantage of the existence of loose vegetation, covering the ground completely between the stems of the other species present.

Even though Menyanthes trifoliata was found within block I, positively linked to Carex salina, the short time available for subsampling prevented our finding an example of positive links with a species of block II.

It must be noted that our division into blocks does not imply that the presence of one species of a block implies automatically the presence of all the other species. On the contrary, representation within each block varies enormously according with local conditions. There is almost always an overlap of the distribution areas of the two blocks. In some cases the two blocks compete with each other; in other cases, there seems to be an equilibrium with a clear domination by block II, but where a certain representation - sometimes quite small - of block I still exists.

Even though additional sampling is required to prove it beyond any doubt, block I, in its pure state, would seem to us to correspond to a set of ecological conditions found further up on the gradient, while blockII would really belong to the intertidal swamps, above the average-tide line, but below the high-tide line.

Hemiparasitism

Figure 23 contained a block reserved for hemiparasitism. Two hemiparasitisms were found on lines 012 and 015: Pedicularis macrodonta and Euphrasia disjuncta, both of which are scophulariaceae. Parasitism phenomena relative to these two species are very little known. In the case of Pedicularis palustris, however, the host would be a graminacea, at least in Europe.

Our surveys have shown the existence of positive links (at the 99% level) between these two species and Aster simplex, Festuca rubra and Triglochin palustris. Figure 24 shows these links.

A detailed study of this phenomenon could undoubtedly be of the highest interest. Unfortunately, it is entirely outside the scope of our work.

Drainage systems

A somewhat special vegetation grows parallelly to the canals that cross the intertidal swamps and thus in particularly well-drained spots. Co-enological blocks I and

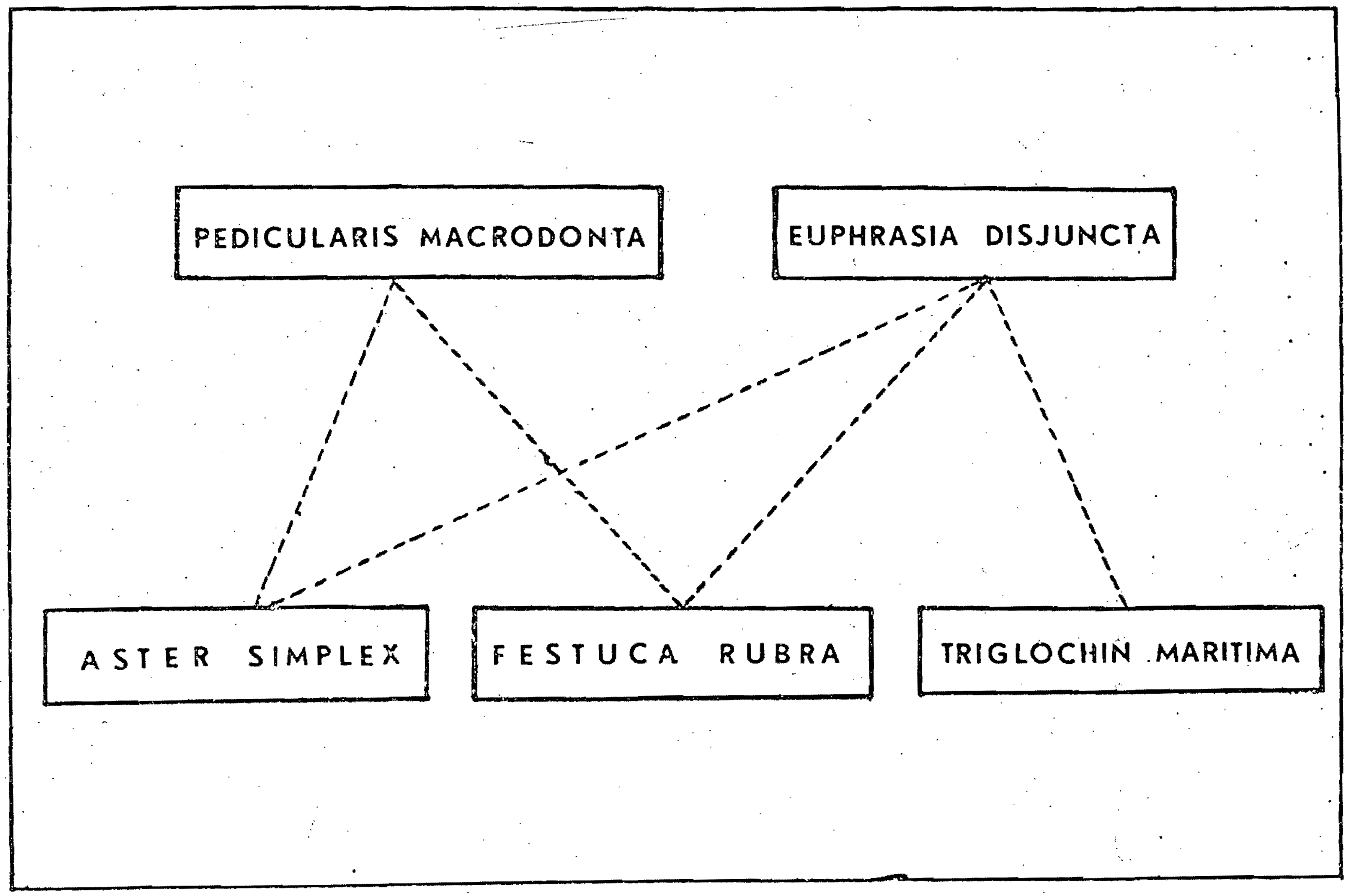


Fig. 24: HEMIPARASITISM (LEVEL: 99%) AT LINES 012 and 015

II, however, still constitute the basis on which certain characteristic species, such as Aster hesperius, graft themselves. Line o10 was located within such a vegetation. The latter must however be considered as essentially marginal. It always remains very localized and relatively easy to map.

Mapping

As mentioned earlier, it was impossible to define a single association within the area surveyed. On the contrary, there is always an overlapping of areas at the level of species or of the temporary coenological blocks.

Furthermore, very often the variations within each zone that we tried to describe were such that this zone can only be mapped as a mosaic. This variation may become considerable when several factors act simultaneously or in a non-directional manner. Such is the case, for instance, at the mouth of the brooks, where the fresh water gradient acts radially and in opposition to the salinity gradient, which has a line of action perpendicular to the shoreline.

In accordance with the structure of the area overlappings found, it can be suspected that salinity, drainage and the structure of the rooting horizon are the preponderant ecological factors.

Conclusion

The present inventory was designed to identify the types of intertidal vegetation growing on the shores of James Bay in order to plan properly the methods to be used for future inventories. The objective of the latter will be to determine the relationship between the mappable groups of species and the important ecological factors, in order to foresee any change likely to occur due to the hydroelectrical development of the main rivers. The following conclusions can be drawn for this purpose:

- no structured and mappable association could be described based on the data collected in Rupert Bay

- the vegetation appears as a mosaic within which co-enological blocks and mainly overlaps of areas can be identified

- In most cases, the establishment of a connection between ecological factors and elements of the mosaic would require a quantity of work and personnel in excess of those at our disposal

- the inventory method employed in 1972, whereby lines were established at the centre of each physiognomical element that could be singled out, is not valid under these circumstances, since it assumes that each zone is homogeneous and since the tests have shown in most cases that these zones were heterogeneous.

Regarding the inventories for 1973 and subsequent years, we propose the following method:

- that the inventories be made from transections made parallel to the gradient

- that these transections be continuous, so that the individual reactions of each species as a function of the gradient may be studied if necessary

- that the mapping be done at the level of the distinct mosaic units rather than at the level of the component elements of the mosaic

- that readings relative to the ecological factors be made along the transections, since they can now be made more economically due to our knowledge of the vegetation structure

- that the statistical stratif cation of ecological factor samples be planned wi h respect to the heterogeneity of the vegetat on of each z ne

- that the corresponding segments of the lines drawn in 1973 and of those drawn in 1972 be joined together into artificial lines which will render possible a complete description of the vegetation and the determination of the relationship with the local ecological factors.

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