and the complete results for the upper and lower Bluefish units are given in Appendices F and G; the factor scores are given in Appendices H and I, and the factor score plots are shown in Figures 9 and 10.

(a) Lower Bluefish Unit

The lower Bluefish unit was combined into eleven variables (see Table 8) and yielded six factors that accounted for 92.4 percent of the total variance.

The plot of factor scores for Factor 1 (Figure 9) show slightly positive values in the lowest part of the section, generally zero or near zero values in the middle part of the column and negative values in the upper part of the section. The factor is dominated primarily, by two variables (*Alnus* and Gramineae) whose loadings show a negative relationship (-0.91 and -0.84 respectively) (Table 8). The variables that indicate significant positive loadings are the Arboreal group (0.65) and to a lesser extent *Corylus* (0.40). The Factor 1 loadings can be compared favourably to the pollen diagram for the lower Bluefish unit. *Corylus* and the Arboreal group (*Picea* and *Pinus*) have their highest relative frequencies in pollen Zones BF7 and BF8 which are at the base of the diagram (see Fig. 5). The significant positive loadings (*Corylus* and the Arboreal variable) for Factor 1 also occur at the base of the section. The negative loadings (*Alnus* and Gramineae) on Factor 1 appear in the upper meter of the factor score plot (Fig. 9), and an examination of the

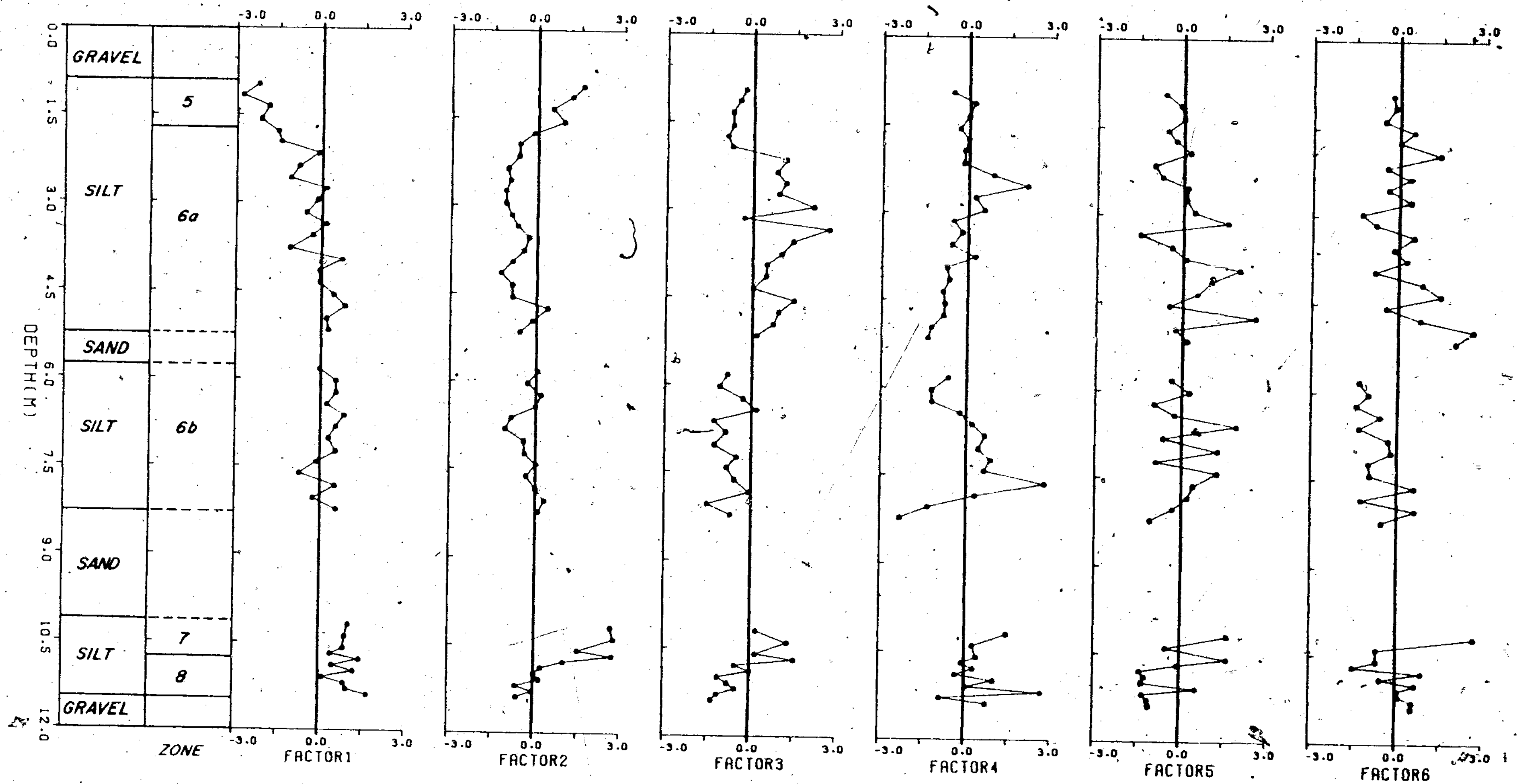

Figure 9: Factor Score Plot lower Bluefish unit

pollen diagram (Fig. 5) also indicates *Alnus* and Gramineae increasing in relative frequency in the upper part of the diagram (Zone BF5). None of the variables affecting Factor 1 play a significant role in the middle part of the section and this is verified by the near zero values for the loadings of these variables in the middle part of Fig. 9.

Factor 2 is loaded heavily by two variables, *Betula* and Cyperaceae (Table 8). The *Betula* variable has a high positive value (0.94), while Cyperaceae shows a high negative value (-0.85) and if the pollen diagram (Fig. 5) is examined this inverse relationship is quite obvious (i.e. where *Betula* is high, Cyperaceae is low and *vice versa*). The factor score plot for Factor 2 (Fig. 9) illustrates two areas with distinct positive peaks (high *Betula*) and these peaks coincide with the two *Betula* highs that occur within the lower Bluefish pollen diagram (Zones BF5 and BF7; Fig. 5). The factor scores for the central portion of the Factor 2 plot have zero or negative values and can be equated with pollen Zone BF 5 (Fig. 6) which is delineated by high percentages of Cyperaceae pollen.

The loadings of Cyperaceae for Factor 3 (Fig. 9) are characterized by two positive peaks, one which occurs at approximately 10.5 meters, the other between 2 and 5 meters. There is only one variable that shows a significant positive loading for this factor and that is *Artemisia* (0.88; Table 8). The herb variable has a positive value (0.46), but this does not carry as much weight as the loading for the *Artemisia* variable. The only pollen type with an important negative loading is the Arboreal group (*Picea* and *Pinus*) which has a value of -0.58. The positive peaks on the factor score plot for Factor 3 (Fig. 9) can be correlated to the higher *Artemisia* percentages that also appear in this part of the pollen diagram (Fig. 5). The negative values in the lower half of the Factor 3 plot can be attributed to the higher relative frequencies of the *Picea* and *Pinus* pollen as well as the lack of *Artemisia* pollen. The negative factor scores on Factor 3 near the top of this unit are most likely due to the reduction of *Artemisia* pollen, because conifers are non-existent in this part of the pollen diagram. The inverse relationship, that is shown to exist in Factor 3, between *Artemisia* and the Arboreal group helps support the division of Zone BF6 into an "a" and "b" subzone (Fig. 5). This zone was originally subdivided because of the appearance of *Artemisia* and disappearance of *Picea* and *Pinus*.

Factor 4 displays three positive peaks which occur at the 11.0, 7.5 and 2 meter marks (Fig. 9). The rest of the factor scores are characterized by loadings that are either negative or zero. This factor is controlled by one variable (Ericaceae) with a high positive loading (0.92) and another variable (*Corylus*) with a lower positive loading (0.55) (Table 8). The positive peaks all coincide with increases in the relative percentage of Ericaceae pollen and to a lesser

TABLE 8
VARIMAX ROTATED FACTOR MATRIX LOWER BLUEFISH UNIT

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6
ARBOREAL	0.65505	-0.02625	-0.58126	0.13090	-0.23192	-0.24030
BET	0.11772	0.94834	-0.07840	0.02863	-0.02457	-0.17885
SAL	0.01526	-0.25172	0.02547	-0.16992	0.01777	0.91609
ALN	-0.91597	0.09868	-0.15489	-0.02429	-0.08170	-0.01172
ERIC	-0.06081	0.16040	-0.13587	0.92030	0.05647	-0.22191
CORY	0.49597	0.32716	-0.22843	0.56393	-0.27608	0.28114
SHRUBS	0.13570	-0.08943	0.17060	-0.01136	0.93820	0.02228
CYPER	0.20106	-0.85418	0.21642	-0.35564	0.06047	0.05171
GRAMIN	-0.84041	-0.08028	0.07117	0.08334	-0.24610	-0.12382
ARTEM	0.03042	-0.26761	0.88823	-0.19171	0.16960	0.00094
HERBS	0.28201	0.39389	0.39599	0.08267	0.46837	0.49334

TABLE 9
VARIMAX ROTATED FACTOR MATRIX UPPER BLUEFISH UNIT

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5
PICEA	0.98325	-0.03055	0.01297	-0.07592	0.09352
BET	0.95378	-0.00667	-0.03083	0.07276	0.25961
SAL	0.05837	0.29966	0.17815	0.90943	-0.11265
ALN	0.95524	0.17165	0.00940	0.10539	0.13848
ERIC	0.41635	0.08536	0.04788	-0.10857	0.89069
CYPER	0.04191	0.84721	0.04710	0.39923	0.17719
GRAM	-0.01185	0.09464	0.93764	0.24613	0.02279
ARTEM	-0.01917	0.56562	0.75963	-0.09786	0.05494
HERBS	0.09603	0.80951	0.46553	0.12699	-0.07746

extent the presence of *Corylus* at the base of the pollen diagram (Fig. 5).

The Shrub variable (*Shepherdia canadensis, Lonicera, Elaegnus, Myrica* and *Cornus canadensis*) is the only variable that demonstrates a significant loading (0.94) on Factor 5 (Table 8). The positive peaks in the upper half of the Factor 5 score plot are probably related to the presence of *Shepherdia* pollen in this part of the diagram (Fig. 5). The lower half of the plot illustrates peaks that can be correlated to peaks in *Myrica* pollen.

Factor 6 is heavily loaded by the *Salix* variable (0.92). The plot of the factor scores indicates that there is no real pattern in this Factor, and this is quite evident when the frequency of *Salix* in pollen diagram is examined. *Salix* occurs thoughout the pollen diagram in relatively abundant amounts and does not show any particular trends that might be useful in helping zone the pollen diagram.

As an aid in zoning the pollen diagram only the first three factors would appear to be of any use in verifiying the pollen zones established in the previous chapter. Factor 1 helps delineate Zones BF5 and BF8 based on the loadings for *Alnus*, Gramineae and the Arboreal variables. Pollen zones BF6 and BF7 (Cyperaceae and *Betula* zones) can be confirmed with the aid of Factor 2, while Factor 3 is useful in dividing pollen Zone BF6 into an upper (BF6a) and lower (BF6b) Zone based on the differences in *Artemisia* pollen percentages versus the percentage of *Picea* and *Pinus* Arboreal group.

(b) Upper Bluefish Unit

The upper Bluefish unit was grouped into nine variables which yielded five factors (see Table 9) that accounted for 95.2 percent of the total variance.

The factor scores for Factor 1 do not show much variation from zero except for the high positive value at the surface of the column and three very small positive peaks in the centre of the plot (Fig. 10). The variables with high positive loadings are *Picea* (0.98), *Betula* (0.95) and *Alnus* (0.95). Ericaceae is also characterized by a positive loading (0.41) although this is not as significant as the other three variables (Table 9). The Factor 1 profile (Fig. 10) coincides with highs in the relative percentages of the four variables, especially the major positive peak at the top of the column, which can be correlated with Zone BF1 (*Picea* - *Betula* - *Alnus*) (see Fig. 6).

Factor 2 is characterized by positive values for Cyperaceae (0.84) and herbs (0.80) (Table 9). *Artemisia* also indicates a positive loading (0.56) but the weight of this variable is not as great as the loadings for the other two variables. A comparison of the factor scores for Factor 2 (Fig. 10) with the pollen diagram for the upper Bluefish unit (Fig. 6) demonstrates with the exception of two samples

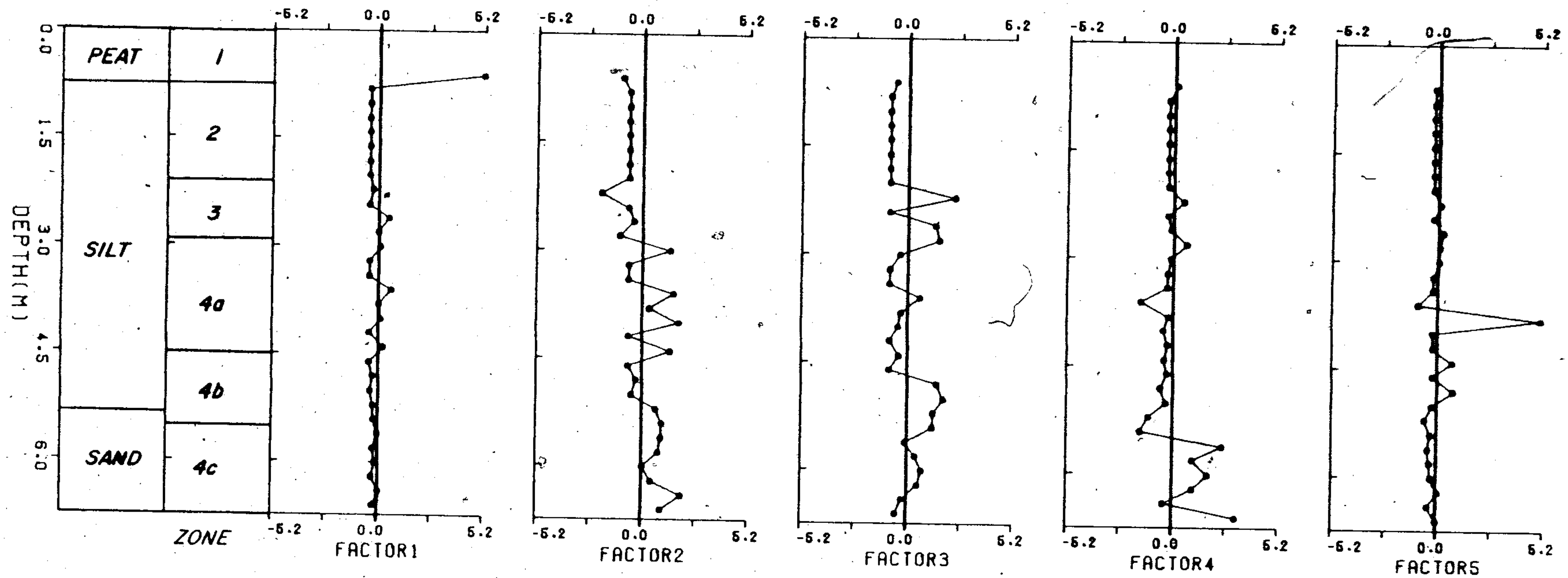

Figure 10: Factor Score Plot upper Bluefish unit

(17, 19), that where the factor scores are positive, the pollen frequencies for Cyperaceae and the herb component (especially Chenopodiaceae - *Amaranthus*, Liguliflorae, Tubuliflorae, Caryophyllaceae and *Arabis*) also attain their highest level (Zone BF4; Fig. 6).

Gramineae has the highest positive loading (0.93) on Factor 3, followed by *Artemisia* (0.75) and to a lesser degree the herb component (0.53). An examination of the factor score plot (Fig. 10) shows that the positive peaks can be correlated with the areas of the pollen diagram (Fig. 6) that illustrate relatively high percentages of grass pollen (Zone BF3) as well as zones that contain high grass and *Artemisia* pollen (Zone BF4b). Zones BF4a and BF4c can be recognized between the areas that show strong positive peaks, and are characterized by factor scores that are around zero.

The patterns for Factor 4 can be described by a positive loading of the *Salix* variable. The factor score plot (Fig. 10) draws a positive peak at the base of the column, and this coincides with the relatively higher percentages of *Salix* pollen that are present at the base of the pollen diagram (Zone BF4a; Fig. 6).

The last significant factor (Factor 5) contains a major positive peak and two minor positive peaks located at the centre of the diagram (Fig. 10). The only variable that shows a significant loading on the factor is Ericaceae

(0.89) and the increases in the pollen frequency of this variable are synchronous with the appearance of the positive peaks in the factor score plot (Fig. 10).

With the exception of Factor 5, all the factors are useful in confirming the zones established for the upper Bluefish unit. Factor 1, which is loaded heavily by *Picea*, *Betula* and *Alnus*, produces a pattern which would support Zone BF1. Pollen Zone BF3 (Gramineae zone) can be justified on the basis of the patterns illustrated by Factor 3. The combination of Factors 2, 3 and 4 helps substantiate the establishment of Zone BF4, as well as delineating the subzones BF4a, BF4b and BF4c.

Chapter VI. Interpretations and Discussion

Zone BF 8

A pollen sample documented by Matthews (1970), from Edmonton, Alberta shows an arboreal pollen spectra that is very similar to the fossil arboreal component described in Zone BF 8. The surface sample, which contains 15% pine, 25% spruce, and 15% birch pollen, was collected in a spruce stand containing a few larches, but no pines. The pine pollen is derived from pine trees that exist on dry sites within the immediate area (Matthews, 1970:249). There are differences, however, between the fossil pollen spectra described from Zone BF 8 and the surface sample documented by Matthews. The major dissimilarity occurs in the non-arboreal component, where Cyperaceae pollen occurs in significantly higher quantities in Zone BF 8 (30 - 35%), whereas, Matthews' surface sample contains less than 10% sedge pollen. This suggests that Cyperaceae was a fairly important component of the local vegetation of the study site area.

If you ignore the *Pinus* pollen found in Zone BF 8, the fossil pollen record is very similar to the surface pollen spectra described by Birks (1977) and Rampton (1971a) from sedge swamps located in spruce forests. The pine pollen present in Zone BF 8 never exceeds 10%, suggesting that pine was probably part of the regional vegetation, but not present in the vicinity of the study site. The relative precent of *Betula* pollen is also more abundant in Zone BF 8 than in either of the surface pollen spectra described by Birks and Rampton. If the *Betula* pollen was derived from shrub birch, as was the case with the surface pollen results of Birks and Rampton, this would suggest that the forest was probably more open than the two modern analogues. Matthews (1974a) has described a fossil pollen record from Cape Deceit, Alaska, which is very similar to the surface pollen spectra described by Birks and Rampton. He suggests his pollen record is representative of a forest tundra vegetation, although he does state that it is difficult to "conceive an analogous contemporary woodland or forest tundra community being represented by such a small percentage of birch pollen" (1974a:1327). The pollen spectra from Zone BF 8 does, however, have 15 - 20% birch pollen and therefore could be conceived of as a forest tundra type vegetation.

The presence of *Corylus* and *Pinus* pose some interesting questions concerning the age of this zone. The modern day northern limit of pine is some 200 kilometers to the south while *Corylus* occurs near the southern boundary of the boreal forest. The fact that these two species occur so much further to the south today suggests the climate must have been milder during this time. This premise is further supported by Matthews (1970), who has described a fossil pollen record from the Lost Chicken mine site, Alkaska. The site is believed to be pre-Wisconsin in age. The sample was taken from frozen silts, and contains 15% *Pinus* pollen, as well as, significant amounts of *Picea* (25%) and *Betula* (20%) pollen. Matthews suggests that the "presence of pine in the Lost Chicken region is evidence of a warmer climate, even warmer than during the early Holocene," (Matthews, 1970:249). Matthews further states that "the Lost Chicken sample probably represents an interglacial,"(1970:249). *Corylus* is also known to be part of the Arcto-Tertiary flora, and could be a remnant of that flora. This could suggest that the base of the lower Bluefish unit maybe early Pleistocene in age.

There are only four other published pollen records from Alaska and the Yukon Territory that are believed to be Illinoian or older. Colinvaux (1964), has described a pollen core from Imuruk Lake on the Seward Peninsula, western Alaska. In his report, Colinvaux suggests that the base of his core contains the complete Yarmouthian pollen record from this area, which he describes as being predominantly a tussock tundra type of vegetation very similar to the modern vegetation of the area. During the Illinoian, the vegetation becomes more steppe like and this is replaced by another modern type of tussock tundra during the warmer Sangamon. Matthews (1974a) has suggested that Colinvaux's ecological interpretations in this part of the core are incorrect. Matthews states that the record does not represent a series of alternating glacial and interglacial environments and that the entire Yarmouthian and Illinoian pollen record of

Imuruk Lake is primarily a steppe tundra environment. Furthermore, Matthews believes that the bottom two thirds of the core represents a glacial environment (steppe tundra). If Matthews' interpretations are correct then the base of Colinvaux's core probably does not correlate with the base of the alluvial section at the study site. Whatever the age of the core or the ecological interpretation (modern tundra vs. steppe tundra) the vegetational record at the base of the Imuruk Lake core is quite different from the base of the section at the Bluefish study site.

The only other pre-Illinoian - Illinoian pollen record comes from Cape Deceit, Alaska (Matthews, 1974a). This site just north of Imuruk Lake is a colluvial section as opposed to a lake or bog core. The base of the section is believed to be Cromerian (this is based on faunal assemblages) in age. The Cromerian interval as described in England, is a series of glacial and interglacial fluctuations occuring 400,000 - 900,000 years ago. During the Cromerian interglacial intervals at Cape Deceit, the pollen spectra is interpreted as a forest or forest tundra type vegetation. The earliest interglacial intervals were dominated by spruce, while larch became the dominant tree during the later interglacials. The glacial intervals are characterized by pollen spectra that suggest the presence of steppe tundras (Matthews, 1974a). Cape Deceit was occupied by an open spruce forest during a pre-Illinoian interglacial which was replaced during the Illinoian by a herbaceous tundra.

The herbaceous tundra was in turn succeeded by modern tundra during the Sangamon.

The vegetational record described from the base of the Cape Deceit section (Cromerian series) indicates a forest or forest-tundra environment that is similar to the record established for the base of the Bluefish section. The difference, however, is the absence of larch in Zone BF 8 at Bluefish.

The last two pre-Illinoian pollen records have been documented by Lichti-Federovich (1972,1974). Her work was based on the analysis of sediments taken from a number of alluvial sections along the Porcupine and Old Crow Rivers (see Fig. 2). Her Zone Va is interpreted as a pine-spruce birch forest with alder and hazel present as shrubs. This is replaced by a more open pine-spruce-birch forest with less herb dominated treeless communities (Zone Vb). The vegetational history during Zone V is very similar to the pollen spectra described in Zone BF 8 from the study site. The one major difference is the larger amount of *Picea* and *Pinus* that is present in the pollen records established by Lichti-Federovich. This difference can be accounted for if one takes into consideration where the study sites are located. Most of Lichti-Federovich's sections are located in the middle of the Old Crow/Porcupine Lake basins. Here the arboreal component will have a much greater influence on the pollen spectra, since there are no local or extra local pollen sources. The Bluefish study site on the other hand, is situated on the edge of the basin and therefore under greater influence of the local vegetation i.e. the greater abundance of Cyperaceae pollen.

From the previous discussion it would appear that the vegetation at the Bluefish site during Zone BF 8 time was probably an open forest type with spruce and to a lesser extent pine being the dominant trees. Birch was also present although it is not known if it was as trees or shrubs. Hazel, alder and willow were also sporadically present as the major shrub components. The relative abundance of heaths suggests the forest was open. The dominance by Cyperaceae pollen suggests sedge fen or meadow vegetation. While the lack of grass pollen also implies a fen as opposed to a meadow. *Sphagnum* and *Selaginella selaginoides* are also common and the presence of *S. selaginoides* supports the interpretation of moist woodland conditions. The climate of the area at this time would have to have been warmer with higher precipitation than at present.

Zone BF 7

The pollen spectra from this zone is similar to Zone 4, the *Betula* zone, described by Rampton (1971) from Antifreeze Pond; Zone I from Tuktoyaktuk 5 (Ritchie and Hare, 1971); pollen assemblage type IV from the Old Crow - Porcupine region (Lichti-Federovich 1972,1974) and pollen zone HL 3 documented by Cwynar (1980) from Hanging Lake. Livingstone's

(1955) Zone II from arctic Alaska and Ager's (1976) Zone 2 from the lakes in the Tanana Valley, Alaska also documents a birch pollen zone. As Lichti-Federovich (1972) and Cwynar (1980) have pointed out there is no easy modern analogue for this *Betula* pollen zone. And it has usually been described as a shrub tundra vegetation dominated by dwarf birch (see above references).

Zone BF 7 at Bluefish, no doubt also represents a shrub tundra environment dominated by shrub birch, with a substantial sedge - *Artemisia* - herb community on the better drained sites. The reduction of conifer pollen especially spruce probably means that the treeline was retreating to the south, although it was still close enough to contribute to the regional pollen rain. Alders, willows and ericads were also present, but perhaps confined to valley bottoms and close to stream banks where there was more moisture. Because of the reduction of conifer pollen and spores from *Sphagnum* and *Selaginella selaginoides*, and the interpreted change from an open forest to a tundra type vegetation, the climate must have become cooler with less precipitation. The presence of *Botrychium* is especially puzzling as it usually occurs in alpine meadows or on grassy slopes (Hulten, 1968). However, there does not appear to be enough evidence to suggest a meadow grass type vegetation.

Neither Colinvaux (1964) or Matthews (1974a) document a similar birch zone around the Sangamon or Illinoian. Both authors describe tundra type vegetations at this time but neither contain pollen spectra which have 50% birch pollen. Lichti-Federovich described a *Betula* zone for pollen assemblage type IV which appears immediately after the first glacial episode (possibly Illinoian) in the area.

Zone BF 6

This zone is the major zone from the lower Bluefish unit. It is dominated by Cyperaceae pollen and the pollen spectra show similarity to the modern surface samples obtained from sedge-moss tundra environments, (Ritchie and Lichti-Federovich, 1967; Rampton, 1971a). Birch pollen frequencies are higher in the Bluefish spectra, however. There is also a very strong resemblance to the pollen spectra described by Schweger (1979) from three alluvial exposures along the Koyukuk and John River in Central Alaska. Schweger (1979:17) describes these as representing:

> a treeless tundra vegetation with much reduced shrub component....The very high frequencies of Cyperaceae pollen implies a sedge rich vegetation; sedge fens, pioneer sedge seres and sedge rich meadows must have dominated the floodplain vegetation.

However, unlike Schweger's record *Betula* and *Sphagnum* appear to have been more abundant around the Bluefish exposure.

Jan Janssens (written communication) has analysed detrital layers from the lower portion (Zone BF 6b) of this zone for fossil bryophytes. Seven well preserved taxa were recovered, these include *Calliergidium pseudostramineum*, *Calliergon richardsonii*, *Cratoneuron filicinum*, *Dicranum groenlandicum*, *Ditrichum flexicaule*, *Drepanocladus* spp. and *Scorpidium scorpioides*. These species are found in a number of environments including tundra and fen type environments as well as bogs, rivers, wet meadows and lakes, but their presence is not incompatible with the pollen taxa that have been described from this zone.

Using the above information the following vegetational reconstruction is suggested for Zone BF 6b. The local vegetation was probably an open shrub tundra type vegetation with Cyperaceae being the dominant ground cover occurring both in sedge fens and sedge seres as well as being dominant in the upland regions. *Sphagnum* mosses were probably also fairly common. Shrub birch would be relatively common but not in the same quantity as Zone BF7, being more sporadic. Alder also appears to be slightly more abundant than in previous zones. The presence of *Myrica* type pollen indicates that this shrub was probably present in the fens or in other areas that were relatively swampy or contained small shallow bodies of water. The relative abundance of spruce pollen suggests that spruce trees were part of the regional vegetation but not abundant near the study site. Ericads were probably common in the more mesic sites. An examination of the habitat characterization of the minor pollen taxa (Table 10) indicates that the majority of the pollen types were found on dry gravelly or sand areas or along stream edges. The herb component including *Potentilla* type, *Papaver*, Caryophyllaceae, *Arabis* type, *Saxifraga tricuspidata* type and *Thalictrum*. *Ribes*, *Mitella nuda* type and *Epilobium* were also probably present along stream edges.

The upper half of Zone BF6 (BF6a) is also dominated by Cyperaceae pollen indicating that it was still the dominant ground cover. But, with the reduction in birch and alder pollen and an increase in *Artemisia* pollen, the local vegetation would appear to have become even more tundra-like with the shrub component much reduced. The consistent but low percentages of *Shepherdia canadensis* pollen suggest that this shrub must have been part of the shrub component albeit in small quantities. The reduction in Ericaceae and *Sphagnum* pollen, and the increase in *Artemisia* suggest a drier climate, or better drained substrate. There appears to be little evidence for trees even in the regional vegetation and what little conifer pollen that is present is probably the result of long distant transportation. This suggests that the treeline had retreated further to the south, as the climate became cooler and drier. The minor herb component appears to be a little richer in diversity when compared to 6b, but this could also be a reflection of the reduction of arboreal pollen rain making the herb component more visible because the herb pollen is no longer masked by the arboreal component. Much of the herb component is still the type of vegetation you would expect to find in alluvial environments (*Arabis* type, *Potentilla* type, Caryophyllaceae, *Thalictrum*

TABLE 10: Habitat Characterization of Minor Pollen Taxa

TAXA	Hulten's Description
Allium	Meadows, Grassy Slopes
Anemone	Meadows, Grassy Mountain Slopes, Dry Forests, Thickets, Snowbeds, Heaths, stony slopes, DRY ROCKY SLOPES, SCREE Slopes
Antenaria	MEADOWS, RIVER FLATS, ALPINE SLOPES, SANDY SOIL ON TUNDRA, MEADOWS ON TUNDRA
Arabis	MOIST STONY PLACES, SCREE SLOPES, ALPINE MEADOWS, DRY ROCKY PLACES
Caltha palustris	MOIST PLACES, BOGS, PONDS,
Cardamine	GRAVELLY PLACES BELOW MELTING SNOW, MOIST PLACES ALONG CREEKS, THICKETS
Circaea	WOODS
Claytonia	WET PLACES, STONY SLOPES IN THE MOUNTAINS, SNOW BEDS, GRAVEL BARS
Cornus canadensis	SPRUCE AND BIRCH FORESTS
Dryas	GRAVEL BAR, HEATHS, WET FORESTS
Elaegnus	DRY SLOPES, GRAVEL BARS
Epilobium	MEADOWS, FORESTS, RIVER EDGE, WET TO MOIST AREAS
Galeopsis	WASTE PLACES
Gentiana	MEADOWS, BOGS, DRY SLOPES
Lonicera	WOODS
Maianthemum	MOIST WOODS, MEADOWS, ALDER THICKETS
Mitella nuda	ALONG STREAM BOGS
Myrica cf gale	SWAMPS, SHALLOW WATER
Myriophyllum spicatum	PONDS, SHALLOW WATER, OR WET SOIL
Nuphar	PONDS, SHALLOW WATER, OR WET SOIL
Papaver	SANDY GRAVELLY SOIL

TABLE 10(con't)

TAXA	Hulten's Description
Plantago	WET PLACES, SALT MARSHES, OPEN WASTE AREAS, SALINE SOIL
Polygonum amphibium	NO DATA
Polygonum aviculare	WET PLACES
Polygonum bistorta	MEADOWS, HEATHS, TUNDRA BOGS
Polemonium	WET MEADOWS, STREAM EDGES, DRY SANDY TO ROCKY AREAS
Potamogeton	PONDS, SHALLOW WATER, OR WET SOIL
Potentilla	DRY OPEN ROCKY TO SANDY AREAS, STREAM EDGES
Ranunculus	SHALLOW WATER, WET MUD, PONDS, POOLS, WET MUDDY SHORES, WET MEADOWS, WET TUNDRA, SNOW BEDS, BOGS, PEATY SOIL
Ribes	MOIST WOODS, ALONG STREAMS, ROCKY SLOPES IN THE LOWLANDS
Rosa acicularis	WOODS, HEATHS, TUNDRA BOGS, THICKETS
Rubus	WET MEADOWS, WOODS, RIVER EDGE
Rumex-Oxyria	WET PLACES, SNOW BEDS IN MOUNTAINS, AND TUNDRA
Saussurea	DRY PLACES ON TUNDRA IN THE MOUNTAINS
Saxifraga hirculus	BOGS AND MEADOWS
Saxifraga oppositifolia	CALCAREOUS ROCKS
Saxifraga tricuspidata	DRY SANDY PLACES, ROCK CREVICES, RIDGES COMMON IN THE MOUNTAINS
Taraxacum	MEADOWS, MOIST PLACES IN MOUNTAINS, WASTE PLACES, ALPINE SLOPES, TUNDRA
Thalictrum	ALPINE MEADOWS, STONY SLOPES IN THE MOUNTAINS, MEADOWS, WOODS
Typha	PONDS, SHALLOW WATER, OR WET SOIL
Valeriana	MOIST PLACES

, *Saxifraga tricuspidata* type) especially along stream edges and on sandy gravelly soils (Table 10).

Zone BF 5

The pollen spectra from Bluefish Zone BF 5, likewise does not appear to have any easily recognizable analogues. A similar pollen spectra occurs in the pollen record from Cape Deceit (Matthews, 1974a). The spectra from above and below peat 5 of the Deering Formation are different in that the alder percentages are lower while the grass component is at least 10% higher than the Bluefish spectra. Matthews describes this spectra as representing a grassy tundra with shrub birches. He further states that alder was probably abundant regionally, and this would indicate an amelioration of the climate (1974a:1377).

It would appear from the pollen spectra that there was a good rich shrub tundra present at this time, with birch and alder dominating an abundant shrub layer. The open areas were probably covered by sedge and grass, with *Sphagnum* moss also being abundant. The presence of *Pterocarya* is unusual becuase it no longer exists in Canada and was last part of the Arcto-Tertiary flora that has been described by Wolfe (1972). Its presence could be the result of long distance transportation probably from Asia or else it is redeposited material. There were no conifers present in the local vegetation and based on the very low percentages the regional landscape was undoubtedly treeless and what little conifer pollen there is, is related to long distance transportation.

The increase in *Betula, Alnus* and *Sphagnum* along with the large amounts of *Pediastrum* suggest that there was an amelioation in the climate with temperatures rising and precipitation increasing throughout the area during the time of deposition of Zone BF 5. The presence of large amounts of *Pediastrum* plus the consistent appearance of *Isoetes* tend to indicate that there was probably a body of water of some form at, or very close to, the site.

The amelioration of the climate, that is suggested by the pollen record, correlates with the general time stratrigraphic framework of the study site section. Zone BF 5 occurs just below the middle Bluefish unit, which is thought to represent the Sangamon Interglacial and therefore the climate of the region was probably getting warmer and more moist.

These four pollen zones (BF5 to BF8) record the vegetational and climatic changes that occured during the deposition of the lower Bluefish unit sediments. The oldest pollen zone (BF8) indicates an open spruce-pine forest was present in the area. The open forest was replaced by a birch shrub tundra (BF7) rich in sedges and *Artemisia*. A shrub tundra also characterizes subzone BF6b, but now Cyperaceae dominates, although shrub birch and alder were present but with reduced frequency. An increase in *Artemisia* and further reduction in the arboreal and shrub components indicates that the vegetation of subzone BF6a was open tundra. Finally, one sees in zone BF5 the reappearance of birch-alder shrub tundra. The four zones witness vegetation changes from open woodland to open tundra and back to shrub tundra.

The vegetational history suggests, the region initially experienced greater precititation and warmer temperatures than exist today (BF8), followed by increasingly colder temperatures and much more arid conditions (BF6,7). Finally, there is a return to a warmer and more moist climate (BF5).

It possible the climatic oscillations from warm to cold and back to warm again might be used to establish a possible time stratigraphic framework for the lower Bluefish unit. This will be discussed in the final chapter.

Zone BF 4

The pollen spectra from Zone BF 4 represents the classic "Herb Zone" that has been described throughout Eastern Beringia by numerous workers. This zone is dominated by Gramineae, Cyperaceae and *Artemisia* and was first described by Livingstone (1955) from his studies in Arctic Alaska. The interpretations of this zone have been quite varied and have ranged from a grassland type environment described by Colinvaux (1964, 1967b) at the Seward Peninsula, to a fell-field and sedge-moss environment outlined by Rampton (1971a) from Antifreeze Pond (Zone 1, 3a, 3b). The most common interpretation is that the herb zone represents a steppe-tundra environment. This has been suggested by Matthews at Cape Deceit (1974a) and the Isabella basin (1974b), by Ager (1975) for his pollen zone 1 from the Tanana Valley, by Lichti-Federovich (1972) in her pollen assemblage Type III from the Old Crow Basin and for the pollen record described by Schweger (1976) for the Epiguruk II alluvial sections along the Kobuk River, Alaska. Similar herb zones have also been described by Terasmae and Hughes (1966) from the Ogilvie Mountains and by Ritchie (1972, 1977) from the MacKenzie delta and Tuktoyaktuk Peninsula, N.W.T.. The most recent documentation of the herb zone and the most thorough discussion of its interpretation is by Cwynar (1980) from Hanging Lake in the northern Yukon. Although the interpretations may be varied, the one common demominator about the herb zone is that it occurred thoughout Eastern Beringia in the late Pleistocene during the last Wisconsin advance and early post glacial. This supports the earlier conclusion that Zone BF 4 is of late Pleistocene and probably late Wisconsin. The base of the Zone maybe 30,000 to 35,000 B.P.(Rampton, 1971a; Cwynar, 1980).

There are no convincing modern analogues for the herb zone although as Cwynar (1980) points out there "are numerous surface pollen spectra from alpine, subarctic and arctic regions that have two of the herb dominants, Gramineae and Cyperaceae, in abundance," (1980:67) but he also points out that "these taxa, together with *Artemisia* and *Salix*, are of limited indicator value because they are represented by many species of varying geographical, as well as ecological, affinities." (1980:67)

Zone BF 4 has been subdivided into three subzones based on the changes in ratio of Cyperaceae-*Artemisia* pollen and the presence of pre-Quaternary spores. It is possible, however, that these differences may not indicate changes in vegetation and that the difference in the subzones might be the result of changes in lithology within this zone. The boundary between subzones BF 4a and BF 4b occurs where there is a marked change in lithology from samples that are 90% sand to samples that are predominantly silt (contain less than 10% sand). It might be possible that the change in Cyperaceae-*Artemisia* ratio is a result of a grain size change and is not related to a vegetational change. Subzone BF 4c is differentiated from BF 4b by the presence of pre-Quaternary spores as well as a relative decrease in *Artemisia* along with a relative increase in Cyperaceae. However, an examination of the indeterminate categories indicates that there is a substantial increase in indeterminate tricolpate-tricolporate pollen, which upon re-examination could very well be badly preserved *Artemisia* grains, and therefore *Artemisia* might be underrepresented in this pollen zone. Based on these assumptions it is possible that the entire Zone BF 4 shows very little vegetational change and that the only significant change is the appearance of large amounts of pre-Quaternary spores. The origin of these spores will be discussed in Zone BF 2.

Using the above information the vegetation of the region during this time (probably the late Wisconsin) was a steppe tundra vegetation dominated by Cyperaceae , Gramineae and *Artemisia*. There were few, if any, shrubs with birch and willow being the most common types. Liguliflorae type and *Arabis* type were the most prevalent of the minor herbs with Chenopodiaceae type, Tubuliflorae type, *Potentilla*, Caryophyllaceae, *Saxifraga hirculus* type, *Polemonium* and *Phlox* also consistently present. Many of the herbs associated with Zone BF 4 are found in alluvial environments and on river beds (see Table 10) which coincides with the general setting of the study site at the time of deposition.

The region must have experienced arctic cold and very arid conditions during this time and the climate was probably very similar to the climate experienced in a polar desert.

Zone BF 3

This zone is unlike any other zone in the pollen diagrams. The presence of 60 - 80% Gramineae pollen has not been documented as far as I know in a modern surface pollen spectrum from North America. *Artemisia* is still relatively common but Cyperaceae eventually disappears altogether.

There is no mention of a similar type of zone in any fossil pollen record from North America. Lichti-Federovich (1974) describes a zone (pollen assemblages type III, Zone E) from the Porcupine River (Site 8, see Fig. 2) which contains between 40 - 80% grass, however this zone also contains 10 - 30% spruce and 10 - 30% sedge. The pollen spectra from Zone BF 3 indicates that the vegetation was predominantly a treeless and shrubless grassland with *Artemisia* also present. It seems unlikely that there were no other herbs but this is probably due to an over-representation of grass pollen which would mask the minor herb taxa.

There are no extensive grasslands found in the northern Yukon today. This is due in large part to the presence of permafrost, which prevents the grasses from developing their extensive underground root system. However, the pollen spectra from zone BF 3 suggests, that grasslands may have exsisted in this part of the Yukon in the late Wisconsin. Furthermore, the presence of grasslands implies the absence of a shallow permafrost layer. This means that the soils were warmer and better drained than they are at the present.

Zone BF 2

This zone is the major sterile fossil pollen or spore zone that occurs near the top of the upper Bluefish unit. This zone is dominated by pre-Quaternary spores and occurs in approximately the same stratigraphic position as the major sterile zone that was found in the Porcupine River section described by Lichti-Federovich (1974). Lichti-Federovich's sterile zone occurs between pollen zones E and F just below the Holocene peats found at the top of the alluvial section. This sterile zone, along with the other sterile zones in the upper Bluefish unit, are somewhat problematical because they create a gap in the vegetational record. There are a number of possibilities that can be used to explain why this sterile fossil pollen zone exists at the Bluefish study site.

Originally it was thought that the presence or absence of pollen might be related to changes in grain size and pollen sedimentation throughout the section, but analysis of the sediment proved to be inconclusive (see Fig. 10 and Appendix C). Samples that were high in sand content contained abundant pollen, while samples that were predominantly silt showed no particular pattern as to why they contained pollen or were sterile. Most of the samples in the middle silt unit from the upper Bluefish unit contained the same ratios of sand-silt-clay and while some of these samples contained pollen, just as many samples were sterile. Therefore, it seemed unlikely that grain size had any bearing on the presence or absence of pollen.

The calcium carbonate content also appeared to have no effect on the presence or absence of pollen. If the calcium carbonate content increases, you create alkaline conditions in the sediment. Deposition of pollen into highly alkaline

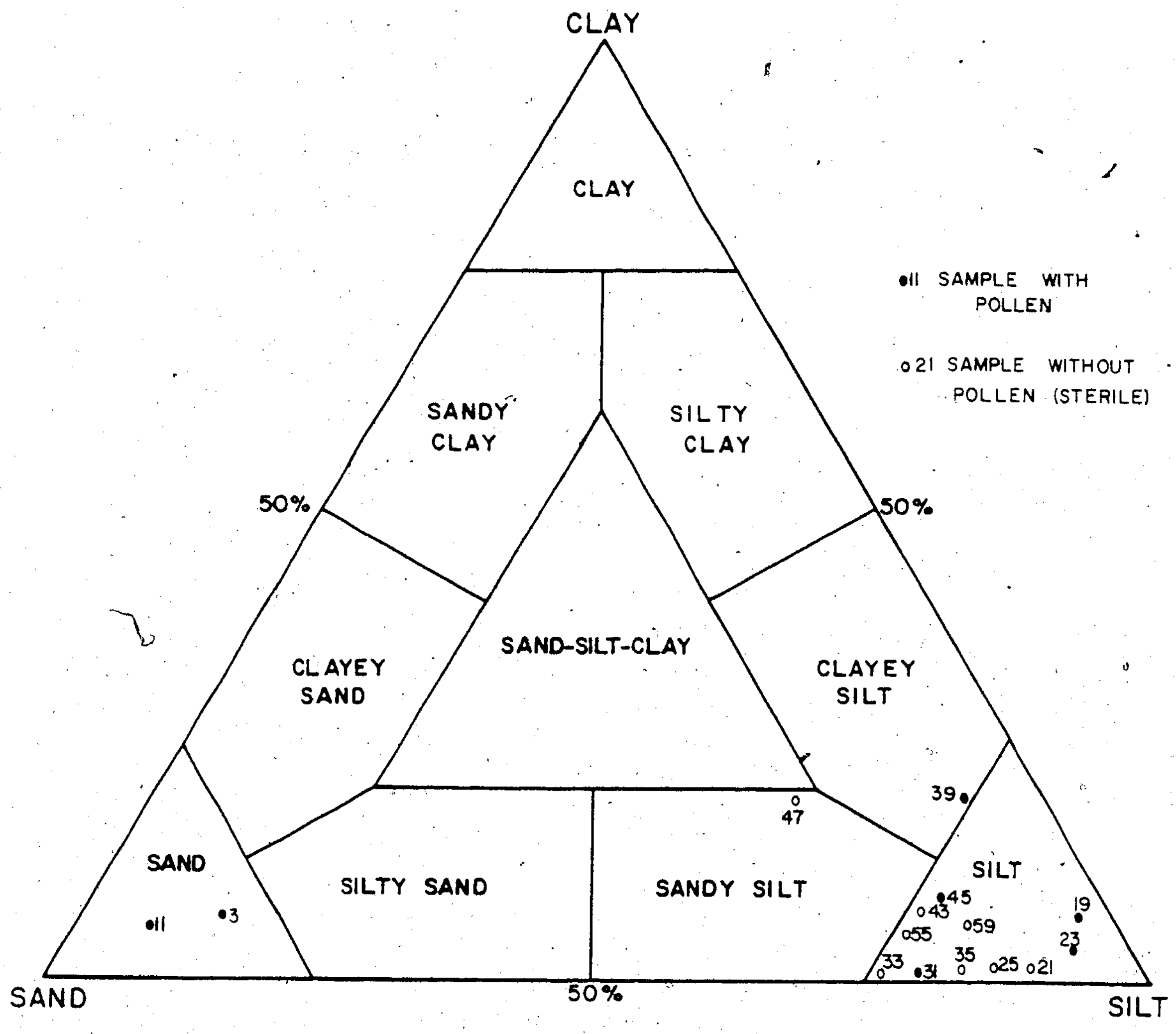

Figure 11: Grain Size Analysis and Textural Classification (after Shepard, 1954)

conditions is detrimental to the pollen grain and it will likely be destroyed. Although the carbonate content did show a very slight increase as one progressed up the section it does not appear to have affected the samples in relation to there being pollen present or absent in the sample, especially since there are sterile zones in the lower parts of the silt unit.

Even if grain size and carbonate content did explain the major sterile zone as well as the other sterile zones, the presence of the pre-Quaternary spores which begin to appear with the first appearance of the sterile zones, must be explained in terms of determining the source from which these spores might be derived. One possible source is material slumped in or eroded from surrounding pre-Quaternary bedrock. Rapid deposition of sediment from a debris flow for example, would also dilute the pollen rain. An examination of aerial photographs failed to reveal potential sources from which this slumped material might come from, especially areas that contained Devonian rocks, as the spores appear to be primarily Devonian in age. It would help if more sedimentological work could be carried out on the area in an aid to determining direction of source of sediment and from this trace back to an original source. Another alternative is that the pre-Quaternary spores are related to the advance and retreat of the last Wisconsin ice sheet. It is possible that the spores are derived from bedrock (possibly near the Peel River) which has been ground up by advancing ice and deposited as outwash by the glaciers. The spores would continue to be deposited during the retreat of the ice as material was released from the receeding mass of ice. The problem with both of the above suggestions is how do you explain the alternating sterile-pollen-sterile zones in the lower half of the silt unit (Zones BF 3 and BF 4a). There is one other problem with the second suggestion and that is, if the ice sheets were responsible for the deposition of the pre-Quaternary spores, as well as, the sterile zones and if the major sterile zone along with the spores are present until the upper contact of the silt unit with the Holocene peats there must have been little if any sediment deposition at the study site from the time of retreat of the glaciers until the onset of widespread peat development during the Holocene. The other possibility of course is that there is a major hiatus in the sedimentary record between the overlying peats and the underlying silts. This would mean that you could have rapid deposition of the silts, followed by a period of erosion and eventually the development of the overlying peats.

Oxidation and/or mechanical deterioration of the pollen grains are two alternative ways in which the pollen may have been destroyed. This would be especially true in a near shore-deltaic environment similar to the one that existed at the study site while the upper Bluefish unit was being deposited. Consequently, if the entire upper unit was laid down as an near shore-deltaic sequence, one would expect that the above two processes would have been continually at work destroying the pollen grains being deposited in these sediments. Therefore, the entire upper Bluefish unit would be expected to contain little or no pollen, or at the very least a large number of degraded pollen grains. However, Zones BF 3 and BF 4, which are part of the upper Bluefish unit, contain abundant identifiable pollen grains.

Perhaps, the best explanation lies in the type of climatic conditions that might have existed in the region during the late glacial and early post glacial. If the climate was relatively harsh(e.g. cold and fairly dry), there might have been very little vegetation growing in the area resulting in a decreased production of the pollen rain. Alternatively, severe climatic conditions may have created a situation more suitable for vegetative reproduction and therefore, similarly reduced the pollen rain being contributed to the fossil pollen record.

Zone BF 1

The pollen spectra from this zone is very similar to fossil pollen spectra described by Rampton (1971a) from Antifreeze pond (Zone 6) and by Ager (1976) in Tanana Valley (Zone 3b). Lichti-Federovich (1972, 1974) also describes a *Picea-Betula-Alnus*-Ericad zone at the top of her sections from the Old Crow Basin and the Porcupine River. The pollen spectrum from Zone BF 1 is very similar to the present day vegetation with spruce being the dominant tree. Birch was also present but whether it was as a tree or shrub is difficult to tell. Based on other pollen records in the Northern Yukon it seems as if birch was more common as a shrub. Alder was also present as were members of the heath family. This suggests that the vegetation was similar to that of the present day northern boundary of the spruce forest. It is difficult to say when this transition from tundra type vegetation to forested conditions took place. Almost all the pollen records from the Yukon and eastern Alaska demonstrate a *Betula* zone between the tundra zone and the forested zone. This shrub birch tundra zone is missing from the Bluefish study site. Rampton (1971) and Ager (1976) both document the appearance of the spruce forest after 6,000 B.P. Ritchie and Hare (1971) indicate a similar spruce forest around the Tuktoyaktuk Peninsula between 8,500 and 5,500 B.P. Therefore all one can say is that the invasion of the area by the spruce forest must have occurred sometime after 8,500 years before present.

Pollen zones BF 1 to BF 4 document the vegetational and climatic changes that took place during the deposition of the upper Bluefish unit sediments. A steppe-tundra vegetation dominated by the presence of Cyperaceae, Gramineae and *Artemisia* characterizes zone BF 4. There were few, if any, shrubs, with birch and willow being the most common types. Changes in the ratio of Cyperaceae, Gramineae and *Artemisia*, as well as the appearance of pre-Quaternary spores allowed Zone BF 4 to be subdivided into three subzones. The steppe-tundra was replaced by a vegetation that is predominantly a treeless, shrubless grassland (BF3). *Artemisia* is still relatively common, but Cyperaceae decreases towards the top of the zone eventually disappearing. Zone BF 2 is a major sterile fossil pollen or spore zone that occurs near the top of the upper Bluefish unit. Changes in sedimentation rates, as well as variations in the fossil pollen rain are two of the possible reasons for the presence of this zone. Finally, there is the appeareance of a Boreal Forest that is very similar to the present day vegetation. Spruce was the dominant tree, with birch and alder common in the shrub layer.

Pollen zones BF 4 and BF 3 suggest the region must have experienced a polar desert type climate with arctic cold and extreme aridity. The presence of grassland (BF 3) would indicate the absence of a shallow permafrost layer, suggesting the soils were warmer and better drained than todays soils. Finally, we have climatic conditions (BF 1) that are very similar to the present day climate.

Chapter VII. Summary

Over the past ten years the Northern Yukon has been the focus of extensive research dealing with Quaternary paleoecological and paleoenvironmental reconstructions. In an attempt to establish a Quaternary vegetational record for the Bluefish Basin and to add further information to the reconstruction of the paleoecology of the Northern Yukon, an alluvial section (67° 23′ W latitude, 140° 21.5′ N longitude) that has been exposed by the downcutting of the Bluefish River, was sampled for pollen analysis. The study section was chosen because it was located on the western edge of the Bluefish Basin, and would allow documentation of the near shore sedimentary facies as well as the near shore pollen spectra. The results obtained could then be compared to other workers who have documented the geology and pollen history for the interior parts of the Bluefish Basin.

The stratigraphy can be summarized as follows. The partially exposed underlying bedrock is a brecciated dolomite that is Paleozoic (possibly Devonian) in age. A lignite coal seam overlies the dolomite and is considered to be Tertiary (Oligocene) or earliest Pleistocene in age. The remaining sediments are all Quaternary in age and maybe subdivided into three major units. (1) A lower Bluefish unit, which is characterized by organic valley fill alluvium, is thought to have been deposited prior to the Sangamon Interglacial. The basal sediments might possibly be earliest Pleistocene in age. This unit was sampled for pollen. (2) A middle Bluefish unit, which was not analysed for pollen, is a channel fill deposit that was probably laid down during the Sangamon Interglacial. (3) An upper Bluefish unit documents the Late Wisconsin Glaciation and is represented by shallow water near shore lacustrine and deltaic deposits. A peat layer that overlies the section is considered to be Holocene in age. The upper unit was sampled for pollen analysis.

Pollen analysis revealed the lower Bluefish unit contained abundant, well preserved fossil pollen. Over sixty different pollen taxa were observed along with a variety of mosses, ferns and algae. There were no pre-Quaternary spores present in the lower unit. Pollen was abundant in the basal parts of the upper Bluefish unit. However, the amount of pollen gradually decreased as you proceeded up the section, eventually becoming sterile near the top of the unit (Zone BF 2). The upper Bluefish unit contained fewer pollen taxa (about forty different taxa) and the general level of preservation was much poorer, when compared with the lower Bluefish unit. Pre-Quaternary spores were present throughout the upper Bluefish unit, reaching their highest levels in Zone BF 2. The overlying peat unit yielded large amounts of well preserved pollen (Zone BF 1).

The pollen data suggested the establishment of eight pollen zones. Pollen zones BF 5 to BF 8 outline the vegetational and climatic changes that occurred during the deposition of the lower Bluefish unit sediments. The vegetational and climatic changes that took place during the deposition of the upper Bluefish unit are documented by pollen zones BF 1 to BF 4. The oldest pollen zone (BF 8) indicates an open spruce-pine forest was present in the area. Birch, hazel, alder and willow were also present as the major shrub components. The open forest was replaced by a birch shrub tundra (BF 7) rich in sedges and *Artemisia*. Zone BF 7 also shows a relative decrease in conifer pollen suggesting that the treeline was retreating to the south. A shrub tundra also characterizes subzone BF 6b, but now Cyperaceae is the dominant ground cover. Although shrub birch and alder were present it is with reduced frequency. An increase in *Artemisia* and further reductions in the arboreal and shrub components indicates that the vegetation of subzone BF 6a was an open tundra. In Zone BF 5, one sees the reappearance of a good rich shrub tundra with birch and alder dominating an abundant shrub layer. The open areas were probably covered with sedges and grasses. A steppe-tundra vegetation dominated by the presence of Cyperaceae, Gramineae and *Artemisia* characterizes Zone BF 4. There were few, if any, shrubs, with birch and willow being the most common types. The pollen spectra from Zone BF 4 represents the classic " Herb Zone " that has been described throughout Eastern Beringia by numerous workers. The steppe tundra was replaced by a vegetation that is predominantly a treeless, shrubless grassland. *Artemisia* is still relatively common but Cyperaceae has almost completely disappeared. Zone BF 2 is a major sterile fossil pollen or spore zone that occurs near the top of the upper Bluefish unit. Changes in sedimentation rates, mechanical and chemical destruction of the pollen grains, as well as variations in the fossil pollen rain are just some of the possible reasons for the presence of this zone. Finally, there is the appearance of the Boreal Forest, that is very similar to the present day vegetation. Spruce was the dominant tree, with birch and alder common in the shrub layer.

The vegetational history suggests, the region initially experienced greater precipitation and warmer temperatures than exist today (BF 8), followed by increasingly colder temperatures and much more arid conditions (BF 6,7). Eventually, there is a return to a warmer and more moist climate (BF 5). Pollen zones BF 4 and BF 3 suggest the region must have once again experienced a climate with arctic cold and extreme aridity. The presence of grassland in Zone BF 3 would indicate the absence of a shallow permafrost layer, suggesting the soils were warmer and better drained than todays soils. Finally, we have climatic conditions (BF 1) that are very similar to the present day climate.

The lack of a tighter chronological framework for the study site section is one of the problems that exist in this thesis. However, with the use of the pollen data and the inferred climatic changes, along with the small amount of dating control available, it is possible to suggest a time stratigraphic framework (see Table 11). As previously mentioned (see Chapter 3) the near shore lacustrine and deltaic deposits of the upper Bluefish unit have been correlated with the youngest glaciolacustrine sediments found in the central parts of the Bluefish Basin. This would suggest the upper unit was deposited during the Late Wisconsin Glaciation. A Late Wisconsin age is further supported by the pollen record, which indicates the Bluefish River study site was covered by a 'herbaceous' vegetation (Zones BF 3 and BF 4) at the time of deposition of the upper unit. Research by other workers has shown that this 'herb' zone was present throughout the interior Yukon and Alaska in the Middle and Late Wisconsin. The overlying peat layer has been correlated to the extensive peat layer, that developed throughout the Bluefish Basin during the Holocene.

The middle Bluefish unit is a channel fill deposit that has been correlated to other fluvial and deltaic sediments, which exist at similar stratigraphic levels in other parts of the Bluefish Basin. The presence of spruce logs within this unit along with a > 54,000 radiocarbon date suggest this unit is older than most of the Middle Wisconsin and is probably Early Wisconsin or Sangamon in age. A Sangamon age is supported by a number of workers who believe the climate was warm enough at this time for the tree line to re-advance

Table 11: Summary Table of Pollen Zones, Vegetation, Stratigraphy and Climate.
(Climatic interpretations should be read from bottom to top)

	Pollen Zone	Vegetation	Suggested Age	Stratigraphy	Precipitation, Temperature
Upper Bluefish Unit	1	Boreal Forest	Holocene	Peat	Moist, Warm
	2	———	Late Wisconsin	Silt	———
	3	Grassland	Late Wisconsin	Silt	Dry, Colder
	4a,b	Steppe Tundra	Late and Middle Wisconsin	Silt	Very Dry and Arctic Cold
	4c	Steppe Tundra		Sand	
Middle Bluefish Unit			Sangamon	Gravel	
Lower Bluefish Unit	5	Rich Shrub Tundra	Early Sangamon	Silt	Moist, Warm
	6a	Steppe Tundra	Illinoian	Silt	Dry, Cold
	6b	Open Shrub Birch Tundra	Illinoian	Silt	Drier, Cool
	7	Shrub Birch Tundra	Pre-Illinoian	Silt	Moist, Cooler
	8	Open Pine Spruce Forest	Pre-Illinoian	Silt	Moist, Warm
				Sands and Gravels	

from the south.

The most difficult unit to try and assign some type of dating control is the lower Bluefish unit. The valley fill alluvium sediments that comprise the lower unit were correlated to fluvial and deltaic deposits in other parts of the Bluefish Basin (see Chapter 3). Unfortunately, because there is such poor dating control on the age of these sediments, they could range in age anywhere from pre-Illinoian to Sangamon. However, the climatic oscillations that can be inferred from the pollen record for the lower Bluefish unit can allow one to propose the following time stratigraphic table (see Table 11). The warm and moist climate that is suggested by the presence of a rich shrub tundra (BF 5) at the top of the lower unit and just below the middle Bluefish unit (which is thought to be Sangamon), indicates the upper part of the lower unit is probably Sangamon in age. The colder and more arid climatic conditions that are inferred by the open shrub-tundra (BF 6b) and the steppe-tundra(BF 6a) are probably indicative of the Illinoian Glaciation. The shrub birch tundra that characterizes Zone BF 7 suggests that the climate in the Bluefish Basin was warmer and more moist than the climate that existed for Zone BF 6. The replacement of a shrub-birch tundra (Zone BF 7) by a steppe-tundra vegetation (Zone BF 6) infers a detioration of the climate. This climatic change is probably indicative of the onset of the Illinoian Glaciation, and therefore means, that Zone BF 7 is pre-Illinoian in age. The oldest pollen zone (Zone BF 8) indicates climatic conditions that were warmer and more moist than at any other time, including today. The sediments from the lower most parts of the lower Bluefish unit are ,therefore, probably pre-Illinoian and maybe Early Pleistocene.

The increasing amounts of information being gathered in the Bluefish Basin will eventually lead to a better time stratigraphic framework. A better understanding of the stratigraphy, improved dating control and further paleoecological research will all hopefully lead to a greater understanding of the Quaternary paleoenvironmental reconstructions for the Northern Yukon.

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APPENDIX A

List of plant species collected from the Bluefish River study site

- *Anemone narcissiflora* L. subsp. *interior*
- *Anemone parviflora*
- *Arctostaphylos rubra*
- *Aster sibiricus*
- *Astragalus alpinus* L. subsp. *alpinus*
- *Betula glandulosa*
- *Caltha palustris* L. subsp. *arctica*
- *Cardamine pratensis* L. subsp. *angustifolia*
- *Carex aquatilis* L. subsp. *aquatilis*
- *Carex capillaris*
- *Carex scirpoidea*
- *Carex vaginata*
- *Cnidium cnidiifolium*
- *Draba cinera*
- *Epilobium angustifolium* L. subsp. *angustifolium*
- *Equisetum arvense*
- *Equisetum scirpoides*
- *Eriophorum vaginatum* L. subsp. *vaginatum*
- *Galium boreale*
- *Hedysarum alpinum* L. subsp. *americanum*
- *Ledum palustre* L. subsp. *decumbens*
- *Ledum palustre* L. subsp. *groenlandicum*
- *Melandrium taimtrense*
- *Oxycoccus microcarpus*
- *Petasites frigidus*
- *Potentilla fruticosa*
- *Rhododendron lapponicum*
- *Rosa acicularis*
- *Rubus chamaemorus*
- *Salix alaxensis* L. subsp. *alaxensis*
- *Salix arbusculoides*
- *Salix glauca* L. subsp. *acutifolia*
- *Salix lanata* L. subsp. *richardsonii*
- *Saussurea angustifolia*
- *Seneccio yukonensis*
- *Solidago multiradiata* Ait. var. *multiradiata*
- *Stellaria longipes*
- *Toefieldia coccinea*
- *Vaccinium uliginosum* L. subsp. *alpinum*
- *Vaccinium vitis-idaea* L. subsp. *minus*

APPENDIX B

Paleoenvironmental Studies, University of Alberta

Palynology Laboratory

Processing sediments for Pollen

1. Weigh out 10-15 g. of sediment into 100 ml. beaker. Add 25 ml. of 10% NaOH, stir well with wooden stirring rod, boil gently with constant stirring on hot plate for 5 minutes. Filter immediately through a fine screen, (coarse screen if sediment is very peaty) into 150 ml. beaker, retaining sand and coarse particles in original beaker. Add 10 ml. distilled water to coarse fraction of sediment remaining in beaker, stir, then swirl for 60 seconds. Allow to settle for exactly 30 seconds, pour supernatent suspension onto screen. Repeat with a second portion of 10 ml. distilled water. Wash the fine sediment on the screen with a few drops of water. Transfer contents of beaker to Nalgene centrifuge tubes, balance tubes by means of centrifuge-tube balance, centrifuge, decant supernatent liquid. Wash sediment in bottom of centrifuge tube with 10 ml. of water to which a few drops of 10% NaOH have been added, balance tubes, centrifuge, decant. Repeat if necessary until supernatent liquid is no longer heavily coloured by humates.
2. Add a few drops of conc. HCL to the sediment, stir well. When the initial reaction has subsided, add a little more HCL, stir again. Continue adding HCL until no

further effervescence occurs, balance tubes, centrifuge. Decant.

3. Add about 15 ml. of $ZnBr_2$ soln. (sp. gr. 1.8-2.0), stir. Balance centrifuge tubes. Stopper tubes with rubber stopper, shake gently, and release any accumulated pressure. Stopper again, shake for exactly 3 minutes, then centrifuge for 20 minutes. Carefully filter with suction the zinc bromide solution through glass filter paper in Nalgene Buchner funnel. Do not discard the filtrate: pour the filtrate into the bottle labelled "<u>Used</u> $ZnBr_2$". Roll up the filter paper on which the pollen is now deposited, place the wad in a clean Nalgene centrifuge tube.

4. <u>CAUTION</u>: <u>USE</u> <u>MASK</u>, <u>GLOVES</u> <u>and</u> <u>APRON</u>. <u>DO</u> <u>NOT</u> <u>BREATHE</u> <u>VAPOURS</u>. Cautiously add a few drops of hydrofluoric acid (HF), swirl. When the violent reaction subsides, add a little more HF, swirl again. Add a total volume of 15-20 ml. HF, stir with a clean wooden stirring rod, loosely stopper with Nalgene stoppers, heat in boiling water bath on hot plate for 1 hour. Allow to stand at room temperature <u>in</u> <u>hood</u> overnight.

5. Centrifuge, decant, add 10 ml. conc. HCL, stir thoroughly, allow to boil in water bath on hot plate for 5 minutes, cautiously stirring once during the 5 minute period. Centrifuge while still hot, decant. Repeat process at least six times.

6. (Transfer if desired to 15 ml. glass centrifuge tube).

Wash with 10 ml. distilled water, centrifuge, decant.

Wash with 10 ml. glacial acetic acid, centrifuge, decant.

7. Acetolysis, etc. (as for peat samples).

Processing Peat for Pollen

1. Place peat sample in 100 ml. beaker. Add 20 ml. of 10% NaOH, stir well with wooden stick, boil gently with constant stirring on hot plate for 5 minutes. Allow to cool, pour off supernatent through fine screen into 150 ml. beaker, retaining most of the peat in the original beaker. Wash peat in beaker with several 10 ml. portions of distilled water, pouring off supernatent each time through screen. Transfer the liquid to Nalgene centrifuge tube, centrifuge, decant. Wash material in bottom of tube with water to which a few drops of 10% NaOH have been added. Centrifuge, decant. Repeat if necessary until supernatent is straw coloured.
2. Wash with 10 ml. glacial acetic acid (transfer if desired to 15 ml. glass centrifuge tubes).
3. CAUTION: make up acetolysis mixture. Measure out the desired multiple of 9 ml. of acetic anhydride into 125 ml. flask. To this, add cautiously in several portions with swirling, the desired multiple of 1 ml. conc. H_2SO_4.
4. Add 10 ml. of acetolysis mixture to centrifuge tube. Stir well with clean stick. Heat for 3-5 minutes in boiling water bath on hot plate. Cool. Centrifuge, decant.
5. Wash with 10 ml. glacial acetic acid. Centrifuge, decant.
6. Wash with 10 ml. distilled water. If it is desired to

stain grains, add several drops of Safranin-O at this stage. Centrifuge, decant.

7. Wash with water to which a few drops of 10% NaOH have been added. Centrifuge, decant.
8. Wash with 10 ml. of 98% ethyl alcohol. Centrifuge, decant.
9. Wash with 10 ml. of acetone. Centrifuge, decant.
10. Suspend the pollen in a few mls of acetone, pour into vial, wash tube with a few drops of acetone, pour into vial. To vial add 2-3 drops of glycerol, allow to evaporate overnight. If necessary add more glycerol and mount on microscope slide.
11. Alternatively, add a few drops of glycerol to the pollen in the centrifuge tube and transfer to the vial by means of a disposable pipette. Mount on slide.

APPENDIX C

Grain size analysis results used for plotting on Figure 4

Sample Number	Sand(%)	Silt(%)	Clay(%)	Soil Texture Classification	Textural Ternary* Diagram	Pollen/ Sterile
59	6.0	80.7	13.3	Silty loam	Silt	Sterile
55	5.8	75.1	19.1	Silty loam	Silt	Sterile
47	23.5	58.2	18.3	Silty loam	Sandy Silt	Sterile
45	8.8	77.0	14.2	Silty loam	Silt	Pollen
43	7.3	76.0	16.7	Silty loam	Silt	Sterile
39	6.8	74.9	18.3	Silty loam	Clayey Silt	Pollen
35	0.8	82.5	16.7	Silty loam	Silt	Sterile
33	0.6	75.2	24.2	Silty loam	Silt	Sterile
31	0.7	79.3	20.0	Silty loam	Silt	Pollen
25	1.2	85.5	13.3	Silty loam	Silt	Sterile
23	2.1	92.9	5.0	Silt	Silt	Pollen
21	0.8	89.2	10.0	Silt	Silt	Sterile
19	1.8	91.5	6.7	Silt	Silt	Pollen
11	88.4	7.4	4.2	Sand	Sand	Pollen
3	81.2	13.8	5.0	Sand	Loamy Sand	Pollen

*Textural Ternary Diagram Classification after Shepard (1954)

APPENDIX D

List of Pollen Percentages (Data Matrix) for the Lower Bluefish Alluvial Unit - each pollen type is assigned the following number:

Picea	- 1
Pinus	- 2
Larix	- 3
Betula	- 4
Tsuga	- 5
Pseudotsuga	- 6
Pterocarya	- 7
Salix	- 8
Alnus	- 9
Ericaceae	- 10
Corylus	- 11
Lonicera	- 12
Elaegnus	- 13
Shepherdia canadensis	- 14
Cornus canadensis	- 15
Myrica	- 16
Cyperaceae	- 17
Gramineae	- 18
Artemisia	- 19
Chenopodiaceae-Amaranthus	- 20
Tubuliflorae	- 21
Liguliflorae	- 22
Compositae:	
- Saussurea	- 23
- Helianthus type	- 24
Ranunculaceae:	
- Caltha type	- 25
- Anemone type	- 26
- Ranunculus type	- 27
- Undifferentiated	- 28
Thalictrum	- 29
Rosaceae:	
- Potentilla type	- 30
- Dryas type	- 31
- Rubus chamaemorus	- 32
- Undifferentiated	- 33
Caryophyllaceae	- 34
Polygonaceae:	
- Bistorta type	- 35
- Amphibium type	- 36
- Aviculare type	- 37
Rumex-Oxyria	- 38
Saxifraga:	
- Tricuspidata type	- 39
- Oppositifolia type	- 40
- Hirculus type	- 41
cf. Mitella nuda	- 42

Sample No.	Grains Counted	Pollen Type 1	2	3	4	5	6	7	8	9	10	11	12
108	221	0.0	1.8	0.0	33.9	0.0	0.0	0.5	3.2	28.0	6.7	0.0	0.0
107	228	0.0	0.4	0.9	29.8	0.0	0.0	0.4	3.0	26.7	8.3	0.0	0.0
106	213	1.9	1.4	0.9	24.8	0.0	0.0	2.8	2.8	21.5	7.9	0.0	0.0
105	267	1.1	0.0	2.3	28.4	0.0	0.0	0.0	5.2	25.2	7.4	0.0	0.0
104	253	1.1	0.0	4.3	17.3	0.0	0.0	0.0	3.9	24.5	8.6	0.0	0.0
103	228	0.0	0.0	2.6	14.4	0.0	0.0	0.0	7.8	15.7	6.5	0.0	0.0
102	245	1.2	0.8	2.4	14.6	0.0	0.0	0.0	3.6	9.3	6.5	0.0	0.0
101	235	0.4	0.8	0.8	9.4	0.0	0.0	0.0	5.1	12.8	9.8	0.0	0.0
100	247	0.0	0.4	2.0	13.4	0.0	0.0	0.0	4.0	12.1	14.2	0.0	0.0
99	255	2.7	0.0	3.9	9.0	0.4	0.4	0.0	5.9	8.6	7.8	0.0	0.0
98	256	0.8	0.0	1.6	11.7	0.0	0.0	0.0	2.3	6.3	7.4	0.0	0.0
97	308	1.9	0.0	1.6	15.9	0.3	0.0	0.0	3.6	13.6	5.5	0.0	0.0
96	262	0.4	0.0	1.1	12.2	0.0	0.0	0.0	6.1	5.7	4.9	0.0	0.0
95	247	1.2	0.4	0.0	18.6	0.0	0.0	0.0	4.9	12.9	4.9	0.0	0.0
94	222	3.2	0.0	0.9	9.9	0.0	0.0	0.0	4.9	21.2	6.8	0.0	0.0
93	267	5.6	0.4	1.1	13.5	0.0	0.0	0.0	3.4	5.6	4.1	0.0	0.0
92	265	2.3	0.8	0.0	8.3	0.0	0.0	0.0	7.2	8.3	3.4	0.0	0.0
91	254	1.2	1.5	2.8	10.2	0.0	0.4	0.0	7.9	6.3	3.1	0.0	0.0
90	235	4.3	2.6	1.3	11.9	0.0	0.0	0.0	4.3	4.7	2.9	0.0	0.0
89	229	0.9	2.2	0.4	18.3	0.0	0.0	0.0	5.2	3.9	3.5	0.0	0.0
88	276	2.5	0.0	0.0	18.5	0.0	0.0	0.0	11.2	4.4	2.2	0.0	0.0
87	256	1.5	0.8	0.8	11.3	0.0	0.0	0.0	8.9	8.6	1.9	0.0	0.0
86	303	8.9	3.6	0.7	24.4	0.0	0.0	0.0	1.9	10.2	6.6	0.0	0.0
85	254	4.7	5.9	1.2	22.8	0.0	0.0	0.0	3.1	8.7	5.1	0.0	0.0
84	299	8.0	3.3	0.3	28.8	0.0	0.0	0.0	2.0	4.7	5.0	0.0	0.0
83	254	3.5	1.6	0.4	20.9	0.0	0.4	0.0	1.9	9.1	6.3	1.2	0.0
82	243	11.9	4.5	0.0	16.9	0.0	0.0	0.0	2.5	4.5	9.5	0.0	0.0
81	234	8.9	5.6	0.0	11.5	0.0	0.0	0.0	3.8	8.9	9.8	1.3	0.0
80	265	9.8	1.9	0.8	24.5	0.0	0.0	0.0	5.7	5.7	11.3	0.0	0.0
79	223	8.1	5.8	0.0	19.7	0.0	0.0	0.0	1.8	8.5	10.3	2.2	0.0
78	228	7.9	2.3	0.4	24.6	0.0	0.0	0.0	2.6	9.7	11.4	0.0	0.0
77	242	3.3	1.2	0.0	19.8	0.0	0.0	0.0	4.9	11.6	14.9	3.7	0.0
76	263	11.4	0.4	0.0	25.5	0.0	0.0	0.0	2.3	5.7	9.9	0.4	0.0
75	296	5.7	5.1	0.7	19.6	0.0	0.0	0.0	5.4	19.3	4.1	0.3	0.0

Sample No.	Grains Counted	Pollen Type 1	2	3	4	5	6	7	8	9	10	11	12
74	240	8.3	1.7	1.3	26.7	0.0	0.0	0.0	3.8	3.3	0.4	0.0	0.0
73	225	1.3	1.8	0.0	43.6	0.0	0.0	0.0	6.7	3.6	10.7	5.3	0.0
72	227	2.2	4.9	0.0	50.7	0.0	0.0	0.0	1.8	4.9	9.6	2.6	0.0
71	216	3.2	7.4	0.0	38.4	0.0	0.0	0.0	2.8	2.8	10.6	0.9	0.0
70	249	0.8	3.6	0.0	53.4	0.0	0.0	0.0	1.2	7.6	9.6	1.2	0.0
69	321	8.4	2.2	0.0	36.8	0.0	0.0	0.0	5.6	3.4	7.8	5.0	0.0
68	245	9.8	3.8	0.0	26.5	0.0	0.0	0.0	3.8	6.1	6.5	1.2	0.0
67	243	12.3	7.8	0.0	20.6	0.0	0.0	0.0	4.9	7.0	8.6	4.9	0.0
66	267	7.5	2.3	0.0	27.3	0.0	0.0	0.0	4.9	4.9	7.9	1.1	0.4
65	229	12.7	3.9	0.0	17.9	0.0	0.0	0.0	3.9	3.9	14.4	4.8	0.0
64	253	11.9	4.7	0.8	24.1	0.0	0.0	0.0	6.3	3.2	3.2	2.8	0.0
63	220	19.9	3.6	0.0	14.5	0.0	0.0	0.0	5.4	2.3	8.6	3.6	0.0

Sample No.	Pollen Type 13	14	15	16	17	18	19	20	21	22	23	24	25	26
108	0.0	0.0	0.0	0.0	10.8	10.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
107	0.0	0.0	0.0	0.4	12.2	14.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.4
10[illegible]	0.0	0.0	0.0	0.5	21.5	10.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
[illegible]	0.0	0.0	0.0	0.0	17.2	9.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
[illegible]	0.0	0.0	0.0	0.0	31.2	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
103	0.0	0.8	0.0	0.0	38.5	8.7	0.8	0.0	0.0	0.0	0.0	0.0	0.8	0.0
102	0.0	0.0	0.0	0.0	46.9	6.1	4.4	0.0	0.0	0.8	0.0	0.0	0.0	0.0
101	0.0	0.0	0.0	0.0	44.5	7.7	3.4	0.0	0.0	0.0	0.4	0.0	0.8	0.0
100	0.0	0.8	0.0	0.0	35.6	8.9	4.5	0.0	0.4	0.0	0.0	0.0	0.0	0.0
99	0.0	0.8	0.0	0.0	47.0	3.3	5.5	0.0	0.4	0.0	0.0	0.0	0.0	0.0
98	0.0	1.6	0.0	0.0	48.4	8.2	8.2	0.0	0.0	0.4	0.0	0.0	0.4	0.0
97	0.0	1.9	0.0	0.3	45.5	5.5	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96	0.0	0.0	0.0	0.0	48.1	6.5	8.8	0.0	0.0	0.4	0.0	0.0	0.0	0.0
95	0.0	0.4	0.4	0.0	40.1	5.7	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94	0.0	0.9	0.0	0.0	32.9	7.2	6.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0
93	0.0	1.1	0.4	1.1	49.1	2.6	6.4	0.0	0.0	0.0	0.0	0.0	1.5	0.0
92	0.0	1.9	0.0	0.0	51.3	5.7	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
91	0.0	1.2	0.0	0.0	49.2	5.9	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Sample No.	13	14	15	16	17	18	Pollen Type 19	20	21	22	23	24	25	26
90	0.0	0.9	0.0	0.0	48.5	6.8	7.2	0.0	0.0	0.4	0.0	0.0	0.0	0.0
89	0.0	2.6	0.0	0.0	40.2	1.7	5.7	0.0	0.0	0.0	0.0	0.0	1.7	0.0
88	0.4	0.4	0.0	0.0	42.4	5.1	5.4	0.4	0.4	0.4	0.0	0.0	0.0	0.0
87	0.0	0.8	0.0	0.0	49.6	2.7	3.9	0.0	0.0	0.0	0.0	0.0	0.4	0.0
86	0.0	0.0	0.0	0.3	33.0	6.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85	0.0	0.8	0.0	0.0	42.1	2.4	0.8	0.0	0.0	0.0	0.0	0.0	0.4	0.0
84	0.0	0.0	0.0	0.0	39.5	5.7	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
83	0.0	0.0	0.0	0.4	44.1	5.1	1.2	0.0	0.0	0.0	0.4	0.0	0.0	0.0
82	0.0	1.2	0.0	0.8	39.9	2.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
81	0.0	0.0	0.0	0.0	41.9	3.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	1.5	32.1	3.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
79	0.0	0.0	0.0	0.0	35.4	4.9	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78	0.0	0.0	0.0	1.3	29.4	5.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
77	0.0	0.0	0.0	1.2	22.9	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
76	0.0	0.0	0.0	0.8	33.1	4.6	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	0.0	0.0	0.0	0.0	29.1	2.7	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0
74	0.0	0.0	0.0	0.0	46.3	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
73	0.0	0.0	0.0	1.8	12.0	1.3	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
72	0.0	0.4	0.0	0.0	7.9	3.1	3.5	0.0	0.0	0.0	0.4	0.0	0.0	0.0
71	0.0	0.4	0.0	1.4	16.6	2.8	2.8	0.0	0.0	0.4	0.0	0.0	0.0	0.0
70	0.0	0.0	0.0	0.8	7.2	3.6	5.2	0.0	0.4	0.0	0.0	0.0	0.0	0.0
69	0.0	0.0	0.0	0.0	26.5	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
68	0.0	0.0	0.0	0.0	33.6	6.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
67	0.0	0.0	0.0	0.0	26.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
66	0.0	0.0	0.0	0.8	31.5	6.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65	0.0	0.0	0.0	0.0	28.8	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
64	0.0	0.0	0.4	0.0	33.9	5.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	32.1	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Sample No.	27	28	29	30	31	32	Pollen Type 33	34	35	36	37	38	39	40
108	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0
107	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0

Sample No.	Pollen Type 27	28	29	30	31	32	33	34	35	36	37	38	39	40
106	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
105	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
104	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
103	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
102	1.2	0.0	0.0	0.4	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
101	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
100	0.0	0.0	0.0	0.8	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0
99	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.8	0.0
98	0.4	0.0	0.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96	0.0	0.0	0.4	1.9	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.4	0.0	0.0
95	0.0	0.4	0.0	0.0	0.0	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.4	0.0
94	0.0	0.0	0.9	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
93	0.0	0.0	0.0	0.7	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0
92	0.0	0.0	0.4	1.9	0.0	0.0	1.1	0.4	0.0	0.0	0.0	0.0	0.0	0.4
91	0.0	0.0	0.0	0.4	0.0	0.0	0.8	0.0	1.2	0.0	0.0	0.0	0.4	0.0
90	0.0	0.0	0.0	1.3	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.4	0.0
89	0.0	0.0	0.0	0.4	0.0	0.0	1.3	0.0	4.8	0.4	2.2	0.0	0.0	0.0
88	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.4	0.0	0.0	0.4	0.0	0.4	0.0
87	0.0	0.0	0.0	0.4	0.0	0.0	1.5	0.4	0.8	0.0	0.0	0.4	0.0	0.0
86	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
85	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
84	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0
83	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0
82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.4	0.0	0.0
81	0.0	0.0	0.0	0.0	0.4	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
78	0.0	0.0	0.4	0.9	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.4
76	0.0	0.4	0.0	0.4	0.0	0.0	0.4	0.8	0.0	0.0	0.0	0.0	0.0	0.4
75	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
74	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.8	0.0	0.0
73	0.0	0.0	0.0	2.6	0.0	0.0	1.3	1.8	9.0	0.0	0.9	0.0	0.4	0.0

Sample No.	27	28	29	30	31	32	Pollen Type 33	34	35	36	37	38	39	40
72	0.0	0.4	0.0	3.9	0.0	0.0	0.0	1.8	0.9	0.0	0.0	0.0	0.0	0.0
71	0.0	0.0	0.0	2.3	0.0	0.0	1.9	1.9	1.4	0.0	0.0	0.0	0.4	0.0
70	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
69	0.0	0.3	0.0	1.6	0.0	0.0	0.0	0.3	0.9	0.0	0.0	0.0	0.0	0.0
68	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
67	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
66	0.0	0.0	0.0	1.5	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.4	0.4	0.0
64	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.4	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0

Sample No.	41	42	43	44	45	46	Pollen Type 47	48	49	50	51	52	53	54
108	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
107	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
106	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
105	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
104	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103	0.8	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
101	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
100	0.4	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
99	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96	1.1	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
94	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
93	0.4	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
91	0.4	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90	0.0	0.0	0.0	0.0	1.3	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
89	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Sample No.	Pollen Type 41	42	43	44	45	46	47	48	49	50	51	52	53	54
88	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
87	0.0	0.0	1.2	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
85	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
84	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
83	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
82	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
81	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
79	0.0	0.0	0.0	0.0	1.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78	0.0	0.0	0.4	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
77	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
76	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
75	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
74	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
73	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
71	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	0.0	0.0	0.0	0.0	0.8	0.0	0.4	0.0	0.0	0.0	0.4	0.4	0.0	0.0
69	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
68	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
67	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0
66	0.4	0.0	0.0	0.0	0.8	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0

Sample No.	Pollen Type 55	56	57	58	59	60	61	62	63	64	65
108	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	0.0
107	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
106	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
105	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0

Sample No.	Pollen Type 55	56	57	58	59	60	61	62	63	64	65
104	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.7
103	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
100	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
99	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0
98	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
93	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
92	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
91	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0
90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
88	0.0	0.0	0.4	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0
87	0.0	0.0	0.0	0.0	0.4	0.8	0.0	0.0	0.0	0.0	0.0
86	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0
85	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0
83	0.0	0.0	0.0	0.0	0.8	3.0	0.0	0.0	0.0	0.0	0.0
82	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
81	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0
79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
77	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0
76	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
74	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	0.0
73	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Sample No.	Pollen Type 55	56	57	58	59	60	61	62	63	64	65
70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
69	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
68	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
67	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
66	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0
63	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	1.8

APPENDIX E

List of Pollen Percentages (Data Matrix) for the Upper Bluefish Alluvial Unit - each pollen type is assigned the following number:

Picea	- 1
Pinus	- 2
Populus	- 3
Betula	- 4
Salix	- 5
Alnus	- 6
Ericaceae	- 7
Shepherdia canadensis	- 8
Cyperaceae	- 9
Gramineae	- 10
Artemisia	- 11
Chenopodiaceae-*Amaranthus*	- 12
Tubuliflorae	- 13
Liguliflorae	- 14
Compositae:	
- *Antenaria*	- 15
- *Taraxacum*	- 16
Ranunculaceae:	
- Undifferentiated	- 17
Thalictrum	- 18
Rosaceae:	
- *Potentilla*	- 19
- *Dryas*	- 20
- *Rubus chamaemorus*	- 21
- *Rosa acicularis*	- 22
- Undifferentiated	- 23
Caryophyllaceae	- 24
Polygonaceae:	
- *Bistorta* type	- 25
- *Amphibium* type	- 26
Rumex-*Oxyria*	- 27
Saxifraga:	
- *Oppositifolia* type	- 28
- *Hirculus* type	- 29
Ribes	- 30
Umbelliferae	- 31
Cruiferae:	
- *Arabis* type	- 32
- Undifferentiated	- 33
Onagraceae:	
- *Epilobium*	- 34
Gentianaceae:	
- *Gentiana* type	- 35
Labiatae:	
- *Galeopsis* type	- 36
- Undifferentiated	- 37
Papaveraceae	- 38
Polemonium	- 39
Phlox	- 40
Typha	- 41

Sample No.	Grains Counted	Pollen Type 1	2	3	4	5	6	7	8	9	10	11	12	13
61	479	32.8	0.0	0.4	38.9	1.0	8.8	8.8	0.0	2.1	4.6	0.6	0.0	0.4
59	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	204	1.0	0.0	0.0	1.0	0.5	0.5	0.5	0.0	0.0	80.4	14.7	0.5	0.0
43	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	215	4.2	0.0	0.0	7.9	0.9	1.9	4.2	0.0	1.9	48.8	19.1	1.9	0.9
39	208	3.8	0.9	0.0	3.4	1.4	0.5	1.4	0.0	6.2	60.6	16.3	3.4	0.0
37	210	4.8	0.9	0.0	5.7	0.9	0.9	1.4	0.0	33.3	20.5	23.7	0.9	0.0
35	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	[illegible]	4.9	1.9	0.0	1.9	0.0	2.9	1.5	0.0	12.1	26.2	31.6	4.4	0.5
29	210	4.8	1.4	0.0	12.9	0.0	2.4	20.0	0.0	20.9	13.3	18.1	0.4	0.4
27	213	3.3	0.0	0.0	3.3	0.5	1.9	0.9	0.0	35.2	20.7	23.9	0.9	0.5
25	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	211	5.2	0.0	0.0	5.7	0.0	1.9	4.7	0.0	32.2	26.5	13.3	0.0	0.5
21	Sterile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	206	3.8	0.0	0.0	1.0	0.5	0.5	4.4	0.0	7.3	41.2	36.4	0.0	1.5
17	251	0.4	0.0	0.0	1.2	0.8	0.0	0.0	0.0	5.2	51.7	35.5	0.0	0.8
15	268	2.6	0.0	0.0	0.4	0.4	0.0	0.4	0.0	8.9	36.2	38.8	1.1	1.9
13	203	0.9	0.0	0.0	1.5	0.0	0.5	1.9	0.0	7.4	32.5	41.4	4.4	0.0
11	202	0.0	0.0	0.0	3.0	4.9	1.9	0.0	0.0	27.2	32.2	15.8	1.9	1.0
9	218	0.0	0.5	0.0	3.2	2.8	0.5	0.5	0.9	19.7	38.1	17.4	0.9	1.4
7	211	0.9	0.0	0.0	1.4	3.8	1.4	0.0	0.0	18.0	41.2	24.6	0.9	0.5
5	210	0.5	0.0	0.0	1.4	2.4	0.9	1.4	0.0	20.9	43.3	16.7	0.9	0.5
3	215	2.3	0.0	0.0	3.3	0.9	1.4	0.9	0.5	29.8	23.3	21.9	3.7	0.0
1	209	0.0	0.5	0.0	3.8	5.7	1.4	0.0	0.9	35.9	23.4	19.1	0.0	0.0

Sample No.	Pollen Type 14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
61	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	7.4	0.0	0.0	0.0	0.0
39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.5	0.0	0.0	0.0	0.0
37	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	1.4
35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.5	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.9	8.3	0.0	0.0	1.5	0.5
29	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.4	0.0	0.0	0.0
27	4.6	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	3.3	0.5	2.3	0.0	0.0	0.5	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.5
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]	0.0	0.0	0.0
19	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	[illegible]	0.0	0.0	0.0
15	1.9	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
13	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	1.9	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	1.5	1.9	0.0	0.5	0.0	0.0
9	3.7	0.0	0.0	0.0	0.0	1.8	1.8	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.5
7	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.0	0.0	0.0	0.0
5	2.4	0.0	0.0	0.0	0.0	0.0	1.4	0.9	0.0	0.0	1.4	0.0	0.0	0.0	0.0
3	2.3	0.0	0.0	0.0	0.5	1.4	0.0	0.0	0.0	0.9	0.5	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.5	0.9	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0

Sample No.	Pollen Type 29	30	31	32	33	34	35	36	37	38	39	40	41
61	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.9	0.0
39	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0
35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.4	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
17	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0
15	0.4	0.0	0.0	4.1	0.7	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
13	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0
11	0.0	0.0	0.0	3.0	0.0	0.0	0.5	0.0	0.0	1.0	1.0	0.0	0.0
9	0.5	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.5	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0
5	1.4	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	1.9	0.9	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0
1	0.0	0.5	0.0	3.8	0.0	0.0	0.0	0.0	0.5	0.0	0.5	0.0	0.0

APPENDIX F

Factor Analysis Results for the Lower Bluefish Alluvial Unit

CORRELATION COEFFICIENTS..

	ARBOREAL	BET	SAL	ALN	ERIC	CORY	SHRUBS	CYPER	GRAMIN	ARTEM
ARBOREAL	1.00000	0.12151	-0.22824	-0.47854	0.18047	0.49739	-0.22143	-0.10083	-0.44213	-0.50172
BET	0.12151	1.00000	-0.36790	-0.05053	0.23740	0.35364	-0.08806	-0.81691	-0.12747	-0.33523
SAL	-0.22824	-0.36790	1.00000	-0.08766	-0.37317	0.03921	0.08668	0.30144	-0.11154	0.15937
ALN	-0.47854	-0.05053	-0.08766	1.00000	0.05814	-0.35484	-0.25788	-0.31786	0.65869	-0.15749
ERIC	0.18047	0.23740	-0.37317	0.05814	1.00000	0.42540	-0.04556	-0.51272	0.06858	-0.33982
CORY	0.49739	0.35364	0.03921	-0.35484	0.42540	1.00000	-0.19801	-0.42160	-0.35021	-0.41735
SHRUBS	-0.22143	-0.08806	0.08668	-0.25788	-0.04556	-0.19801	1.00000	0.18571	-0.26729	0.36952
CYPER	-0.10083	-0.81691	0.30144	-0.31786	-0.51272	-0.42160	0.18571	1.00000	-0.13773	0.45090
GRAMIN	-0.44213	-0.12747	-0.11154	0.65869	0.06858	-0.35021	-0.26729	-0.13773	1.00000	-0.01926
ARTEM	-0.50172	-0.33523	0.15937	-0.15749	-0.33982	-0.41735	0.36952	0.45090	-0.01926	1.00000
HERBS	-0.23868	0.22050	0.29790	-0.31148	-0.02032	0.19401	0.46011	-0.14727	-0.39258	0.27176

	HERBS
ARBOREAL	-0.23868
BET	0.22050
SAL	0.29790
ALN	-0.31148
ERIC	-0.02032
CORY	0.19401
SHRUBS	0.46011
CYPER	-0.14727
GRAMIN	-0.39258
ARTEM	0.27176
HERBS	1.00000

DETERMINANT OF CORRELATION MATRIX = 0.0001727(0.17265260E-03)

INVERSE OF CORRELATION MATRIX..

	ARBOREAL	BET	SAL	ALN	ERIC	CORY	SHRUBS	CYPER	GRAMIN	ARTEM
ARBOREAL	18.47984	26.43564	6.64921	20.98428	9.40757	2.77611	1.87147	32.33379	6.73939	7.61902
BET	26.43564	47.19652	11.12686	34.22025	16.39380	5.71692	2.94693	56.86436	10.21455	11.29121
SAL	6.64920	11.12685	4.28132	7.78119	4.41244	0.62408	0.74467	12.60835	2.36148	2.94007
ALN	20.98428	34.22023	7.78119	28.36862	11.94161	5.17404	2.46552	42.73288	6.92441	9.05201
ERIC	9.40757	16.39380	4.41244	11.94160	7.48725	1.17728	0.66220	20.17847	3.30338	4.11537
CORY	2.77611	5.71691	0.62408	5.17404	1.17728	3.48365	0.98599	7.88898	1.54239	1.70833
SHRUBS	1.87147	2.94693	0.74467	2.46552	0.66220	0.98599	1.84970	3.42184	0.94831	0.61887
CYPER	32.33380	56.86436	12.60836	42.73289	20.17848	7.88899	3.42184	71.40167	12.66043	13.14894
GRAMIN	6.73939	10.21454	2.36148	6.92440	3.30338	1.54239	0.94831	12.66043	4.57134	2.46430
ARTEM	7.61902	11.29120	2.94007	9.05200	4.11537	1.70833	0.61886	13.14893	2.46430	4.94095
HERBS	7.26556	10.43101	1.89268	8.63729	3.80483	1.02518	0.02214	13.95044	3.13054	2.30103

	HERBS
ARBOREAL	7.26556
BET	10.43100
SAL	1.89268
ALN	8.63729
ERIC	3.80483
CORY	1.02518
SHRUBS	0.02214
CYPER	13.95044
GRAMIN	3.13054
ARTEM	2.30103
HERBS	5.08699

VARIABLE	EST COMMUNALITY	FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
ARBOREAL	1.00000	1	3.20533	29.1	29.1
BET	1.00000	2	2.53512	23.0	52.2
SAL	1.00000	3	1.72354	15.7	67.9
ALN	1.00000	4	1.09353	9.9	77.8
ERIC	1.00000	5	0.83134	7.6	85.4
CORY	1.00000	6	0.57333	5.2	90.6
SHRUBS	1.00000	7	0.33363	3.0	93.6
CYPER	1.00000	8	0.25834	2.3	95.9
GRAMIN	1.00000	9	0.23137	2.1	98.1
ARTEM	1.00000	10	0.20876	1.9	99.9
HERBS	1.00000	11	0.00568	0.1	100.0

FACTOR MATRIX USING PRINCIPAL FACTOR, NO ITERATIONS

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
ARBOREAL	0.57069	0.38446	-0.62296	-0.12943	-0.05125	-0.12390
BET	0.70169	0.05956	0.48164	-0.05159	-0.47035	0.03127
SAL	-0.44983	0.27405	-0.00322	0.79048	0.13375	-0.11150
ALN	-0.03101	-0.86609	0.22886	0.18350	0.04200	-0.20311
ERIC	0.63125	-0.09355	0.17495	-0.21652	0.67162	0.10713
CORY	0.69229	0.42979	-0.06476	0.33136	0.23501	0.21279
SHRUBS	-0.36659	0.44388	0.46000	-0.37601	0.22473	-0.44885
CYPER	-0.78871	0.21248	-0.50885	-0.11641	0.09626	0.02729
GRAMIN	-0.11652	-0.86021	0.10596	0.06712	0.14427	0.10277
ARTEM	-0.72728	0.16800	0.28188	-0.23971	-0.01579	0.48238
HERBS	-0.08560	0.59563	0.67464	0.20500	0.02656	0.03322

VARIABLE	COMMUNALITY
ARBOREAL	0.89631
BET	0.95276
SAL	0.93265
ALN	0.88014
ERIC	0.94727
CORY	0.87848
SHRUBS	0.93637
CYPER	0.94970
GRAMIN	0.80064
ARTEM	0.92701
HERBS	0.86107

VARIMAX ROTATED FACTOR MATRIX

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
ARBOREAL	0.65505	-0.02625	-0.58126	0.13090	-0.23192	-0.24030
BET	0.11772	0.94834	-0.07840	0.02863	-0.02457	-0.17885
SAL	0.01526	-0.25172	0.02547	-0.16992	0.01777	0.91609
ALN	-0.91597	0.09868	-0.15489	-0.02429	-0.08170	-0.01172
ERIC	-0.06081	0.16040	-0.13587	0.92030	0.05647	-0.22191
CORY	0.49597	0.32716	-0.22843	0.56393	-0.27608	0.28114
SHRUBS	0.13570	-0.08943	0.17060	-0.01136	0.93820	0.02228
CYPER	0.20106	-0.85418	0.21642	-0.35564	0.06047	0.05171
GRAMIN	-0.84041	-0.08028	0.07117	0.08334	-0.24610	-0.12382
ARTEM	0.03042	-0.26761	0.88823	-0.19171	0.16960	0.00094
HERBS	0.28201	0.39389	0.39599	0.08267	0.46837	0.49334

TRANSFORMATION MATRIX

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
FACTOR 1	0.19538	0.61307	-0.48628	0.48375	-0.26110	-0.21752
FACTOR 2	0.89704	0.02172	0.10773	0.01874	0.31932	0.28446
FACTOR 3	-0.30977	0.62583	0.44863	0.13809	0.51065	0.17684
FACTOR 4	-0.13687	0.10959	-0.17521	-0.05068	-0.36061	0.89775
FACTOR 5	-0.13718	-0.46770	-0.01857	0.82656	0.22416	0.16926
FACTOR 6	0.15372	0.03542	0.72085	0.24657	-0.62354	-0.07675

FACTOR SCORE COEFFICIENTS

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
ARBOREAL	0.27422	-0.10555	-0.36629	-0.05918	-0.01902	-0.15961
BET	0.06974	0.57097	0.07954	-0.30687	-0.05078	-0.13382
SAL	-0.08077	-0.08777	-0.19077	-0.01773	-0.03313	0.75205
ALN	-0.43383	0.05196	-0.25824	-0.04684	0.13295	0.11479
ERIC	-0.08107	-0.20947	0.10018	0.83245	0.12461	-0.09074
CORY	0.18271	0.02672	0.10558	0.41227	-0.29877	0.28599
SHRUBS	-0.05832	-0.09113	-0.31491	0.03264	0.89481	-0.08096
CYPER	0.12457	-0.39792	0.04705	-0.04540	-0.02509	-0.05446
GRAMIN	-0.33517	-0.05927	0.12394	0.16908	-0.16247	-0.00702
ARTEM	0.12640	-0.02065	0.83609	0.11693	-0.28592	-0.16745
HERBS	0.06316	0.24134	0.22223	0.07673	0.18531	0.31111

APPENDIX G

Factor Analysis Results for the Upper Bluefish Alluvial Unit

CORRELATION COEFFICIENTS..

	PICEA	BET	SAL	ALN	ERIC	CYPER	GRAM	ARTEM	HERBS
PICEA	1.00000	0.95792	-0.03385	0.92578	0.48975	0.02694	-0.01468	-0.00110	0.02989
BET	0.95792	1.00000	0.08479	0.93642	0.61517	0.11093	-0.01802	-0.03576	0.06038
SAL	-0.03385	0.08479	1.00000	0.18748	-0.12689	0.56298	0.37410	0.24780	0.46536
ALN	0.92578	0.93642	0.18748	1.00000	0.52969	0.24342	0.04596	0.07327	0.24740
ERIC	0.48975	0.61517	-0.12689	0.52969	1.00000	0.17530	0.02760	0.13444	0.07636
CYPER	0.02694	0.11093	0.56298	0.24342	0.17530	1.00000	0.27498	0.47128	0.68373
GRAM	-0.01468	-0.01802	0.37410	0.04596	0.02760	0.27498	1.00000	0.69050	0.53772
ARTEM	-0.00110	-0.03576	0.24780	0.07327	0.13444	0.47128	0.69050	1.00000	0.73864
HERBS	0.02989	0.06038	0.46536	0.24740	0.07636	0.68373	0.53772	0.73864	1.00000

DETERMINANT OF CORRELATION MATRIX = 0.0000538(0.53767726E-04).

INVERSE OF CORRELATION MATRIX..

	PICEA	BET	SAL	ALN	ERIC	CYPER	GRAM	ARTEM	HERBS
PICEA	50.01135	-38.61600	9.09135	-18.69263	10.95533	-0.34204	-0.91545	-8.17659	7.15926
BET	-38.61598	43.49814	-7.43348	2.19603	-10.72604	0.82035	0.23100	6.43523	-3.17526
SAL	9.09135	-7.43348	3.64799	-3.41650	2.65671	-1.17096	-0.94600	-0.83610	1.04862
ALN	-18.69264	2.19604	-3.41650	19.60681	-3.05089	-0.15173	0.86807	3.38899	-5.46784
ERIC	10.95531	-10.72604	2.65671	-3.05088	4.48341	-0.74230	-0.23434	-2.18570	1.74417
CYPER	-0.34203	0.82035	-1.17096	-0.15174	-0.74230	2.60450	0.66298	-0.26315	-1.34306
GRAM	-0.91545	0.23101	-0.94600	0.86807	-0.23434	0.66298	2.31486	-1.40120	-0.40626
ARTEM	-8.17659	6.43523	-0.83610	3.38898	-2.18570	-0.26315	-1.40120	4.82165	-3.05464
HERBS	7.15925	-3.17527	1.04862	-5.46782	1.74417	-1.34307	-0.40626	-3.05464	5.10227

VARIABLE	EST COMMUNALITY	FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
PICEA	1.00000	1	3.49352	38.8	38.8
BET	1.00000	2	2.86496	31.8	70.6
SAL	1.00000	3	0.99991	11.1	81.8
ALN	1.00000	4	0.72884	8.1	89.9
ERIC	1.00000	5	0.47871	5.3	95.2
CYPER	1.00000	6	0.20735	2.3	97.5
GRAM	1.00000	7	0.17581	2.0	99.4
ARTEM	1.00000	8	0.04045	0.4	99.9
HERBS	1.00000	9	0.01044	0.1	100.0

FACTOR MATRIX USING PRINCIPAL FACTOR, NO ITERATIONS

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
PICEA	0.75744	-0.58031	0.02099	0.21542	-0.15839
BET	0.80858	-0.56084	-0.06053	0.10498	0.01829
SAL	0.38725	0.52342	-0.63390	0.20452	0.31163
ALN	0.87265	-0.41116	-0.12671	0.10983	-0.11677
ERIC	0.59936	-0.35118	0.34340	-0.47418	0.40340
CYPER	0.54719	0.54892	-0.33916	-0.44048	-0.05229
GRAM	0.38393	0.63315	0.37450	0.43182	0.27271
ARTEM	0.46500	0.68539	0.45172	-0.00001	-0.14105
HERBS	0.57644	0.68949	0.02607	-0.11043	-0.28777

VARIABLE	COMMUNALITY
PICEA	0.98239
BET	0.98338
SAL	0.96470
ALN	0.97233
ERIC	0.98805
CYPER	0.91252
GRAM	0.94937
ARTEM	0.90993
HERBS	0.90337

VARIMAX ROTATED FACTOR MATRIX

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
PICEA	0.98325	-0.03055	0.01297	-0.07592	0.09352
BET	0.95378	-0.00667	-0.03083	0.07276	0.25961
SAL	0.05837	0.29966	0.17815	0.90943	-0.11265
ALN	0.95524	0.17165	0.00940	0.10539	0.13848
ERIC	0.41635	0.08536	0.04788	-0.10857	0.89069
CYPER	0.04191	0.84721	0.04710	0.39923	0.17719
GRAM	-0.01185	0.09464	0.93764	0.24613	0.02279
ARTEM	-0.01917	0.56562	0.75963	-0.09786	0.05494
HERBS	0.09603	0.80951	0.46553	0.12699	-0.07746

TRANSFORMATION MATRIX

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
FACTOR 1	0.76899	0.43452	0.31433	0.20639	0.28006
FACTOR 2	-0.53939	0.54051	0.53874	0.30350	-0.18990
FACTOR 3	-0.07697	-0.15793	0.59496	-0.71729	0.31724
FACTOR 4	0.27055	-0.53416	0.47617	0.21507	-0.60703
FACTOR 5	-0.19645	-0.45690	0.17391	0.55183	0.64644

FACTOR SCORE COEFFICIENTS

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
PICEA	0.41932	-0.02529	0.05471	-0.15080	-0.28826
BET	0.31970	-0.09007	0.00651	0.08384	0.01927
SAL	-0.01647	-0.20029	0.00292	0.95264	0.04645
ALN	0.36794	0.08194	-0.04485	-0.00330	-0.19272
ERIC	-0.16995	-0.08345	0.02898	0.07696	1.11944
CYPER	-0.09884	0.59792	-0.35612	0.14353	0.19689
GRAM	-0.01514	-0.46871	0.75762	0.26289	0.11713
ARTEM	-0.00358	0.25042	0.38825	-0.38655	-0.05434
HERBS	0.07217	0.55325	0.02034	-0.27591	-0.28688

APPENDIX [illegible]

Factor Scores for the Lower Bluefish Alluvial Unit

FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	SAMPLE NO.
-2.231	1.588	-0.267	-0.541	-0.625	-0.232	108
-2.782	1.199	-0.459	0.204	-0.108	-0.158	107
-1.872	0.518	-0.735	-0.015	0.006	-0.509	106
-2.164	0.923	-0.710	-0.327	-0.547	0.501	105
-1.553	-0.134	-0.888	-0.008	-0.253	0.014	104
-1.433	-0.633	-0.734	-0.150	0.232	1.415	103
-0.129	-0.649	1.156	-0.161	-0.996	-0.413	102
-0.808	-1.031	0.824	0.880	-0.724	0.362	101
-1.101	-0.927	1.149	2.062	0.161	-0.380	100
0.153	-1.098	0.897	0.244	0.096	0.409	99
-0.168	-1.092	2.117	0.563	0.392	-1.269	98
-0.554	-0.878	-0.298	-0.499	1.573	-0.776	97
0.172	-0.661	2.668	-0.196	-1.486	0.536	96
-0.312	-0.273	1.403	-0.559	-0.379	-0.154	95
-1.104	-0.444	1.012	0.264	0.134	0.302	94
0.730	-0.837	0.502	-0.729	1.991	-0.807	93
-0.069	-1.235	0.467	-0.641	1.006	0.842	92
-0.062	-0.842	0.025	-0.852	0.520	1.501	91
0.439	-0.825	1.455	-0.779	-0.448	-0.395	90
0.845	0.406	0.917	-0.837	2.554	0.799	89
0.189	-0.127	0.739	-1.247	-0.226	2.642	88
0.260	-0.560	0.171	-1.368	0.187	2.016	87
-0.033	0.077	-0.829	-0.640	-0.341	-1.307	86
0.537	-0.275	-1.096	-1.226	0.288	-0.981	85
0.549	0.208	-0.272	-1.192	-0.931	-1.412	84
0.236	0.012	0.202	-0.217	-0.229	-0.575	83
0.846	-0.831	-1.288	0.209	1.916	-1.307	82
0.536	-1.047	-0.865	0.651	-0.619	-0.292	81
0.285	-0.394	-1.268	0.430	1.279	-0.191	80
0.548	-0.364	-0.489	0.880	-0.854	-0.974	79
-0.136	0.045	-0.835	0.627	1.250	-0.932	78
-0.731	-0.312	-0.560	2.746	0.419	0.614	77
0.521	0.018	-0.056	0.322	0.227	-1.223	76
-0.241	0.345	-1.505	-1.329	-0.290	0.637	75
0.560	0.118	-0.696	-2.298	-1.070	-0.532	74
1.034	2.688	0.237	1.466	1.641	2.691	73
0.915	2.787	1.336	0.281	-0.490	-0.668	72
0.869	1.535	0.217	0.424	1.628	-0.665	71
0.427	2.734	1.562	-0.089	-0.079	-1.485	70
1.427	1.041	-0.501	0.306	-1.387	0.889	69
0.485	0.251	0.028	-0.311	-1.218	-0.532	68
1.217	0.009	-1.094	1.017	-1.322	0.668	67
0.139	0.209	-0.750	0.045	0.560	0.081	66
0.885	-0.616	-0.476	2.683	-1.275	0.112	65
0.975	-0.041	-1.106	-0.849	-1.104	0.581	64
1.705	-0.586	-1.307	0.757	-1.055	0.558	63

APPENDIX I

Factor Scores for the Upper Bluefish Alluvial Unit

FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	SAMPLE NO.
5.154	-0.993	-0.578	0.099	-0.221	61
-0.418	-0.668	-0.871	-0.283	-0.233	59
-0.418	-0.668	-0.871	-0.283	-0.2[illegible]	57
-0.418	-0.668	-0.871	-0.283	-0.233	55
-0.418	-0.668	-0.871	-0.283	-0.233	53
-0.418	-0.668	-0.871	-0.283	-0.233	51
-0.418	-0.668	-0.871	-0.283	-0.233	49
-0.418	-0.668	-0.871	-0.283	-0.233	47
-0.262	-2.041	2.314	0.506	0.119	45
-0.418	-0.668	-0.871	-0.283	-0.233	43
0.540	-0.413	1.362	-0.125	0.243	41
0.004	-1.135	1.556	0.668	0.079	39
0.111	1.375	-0.360	-0.133	0.046	37
-0.419	-0.668	-0.871	-0.283	-0.233	35
-0.419	-0.668	-0.871	-0.283	-0.233	33
0.664	1.548	0.626	-1.585	-0.979	31
0.037	0.351	-0.326	-0.226	5.079	29
0.156	1.823	-0.439	-0.476	-0.237	27
-0.418	-0.668	-0.871	-0.283	-0.233	25
0.266	1.368	-0.409	-0.432	0.746	23
-0.418	-0.668	-0.871	-0.283	-0.233	21
-0.233	-0.290	1.443	-0.623	0.774	19
-0.368	-0.523	1.789	-0.334	-0.257	17
-0.199	0.708	1.292	-1.192	-0.625	15
-0.182	1.004	1.270	-1.597	-0.338	13
0.015	0.953	-0.064	2.439	-0.460	11
-0.210	0.834	0.435	0.995	-0.379	9
-0.102	0.055	0.748	1.742	-0.315	7
-0.261	0.484	0.545	0.996	0.025	5
0.084	1.954	-0.232	-0.442	-0.465	3
-0.197	0.953	-0.518	3.113	-0.037	1

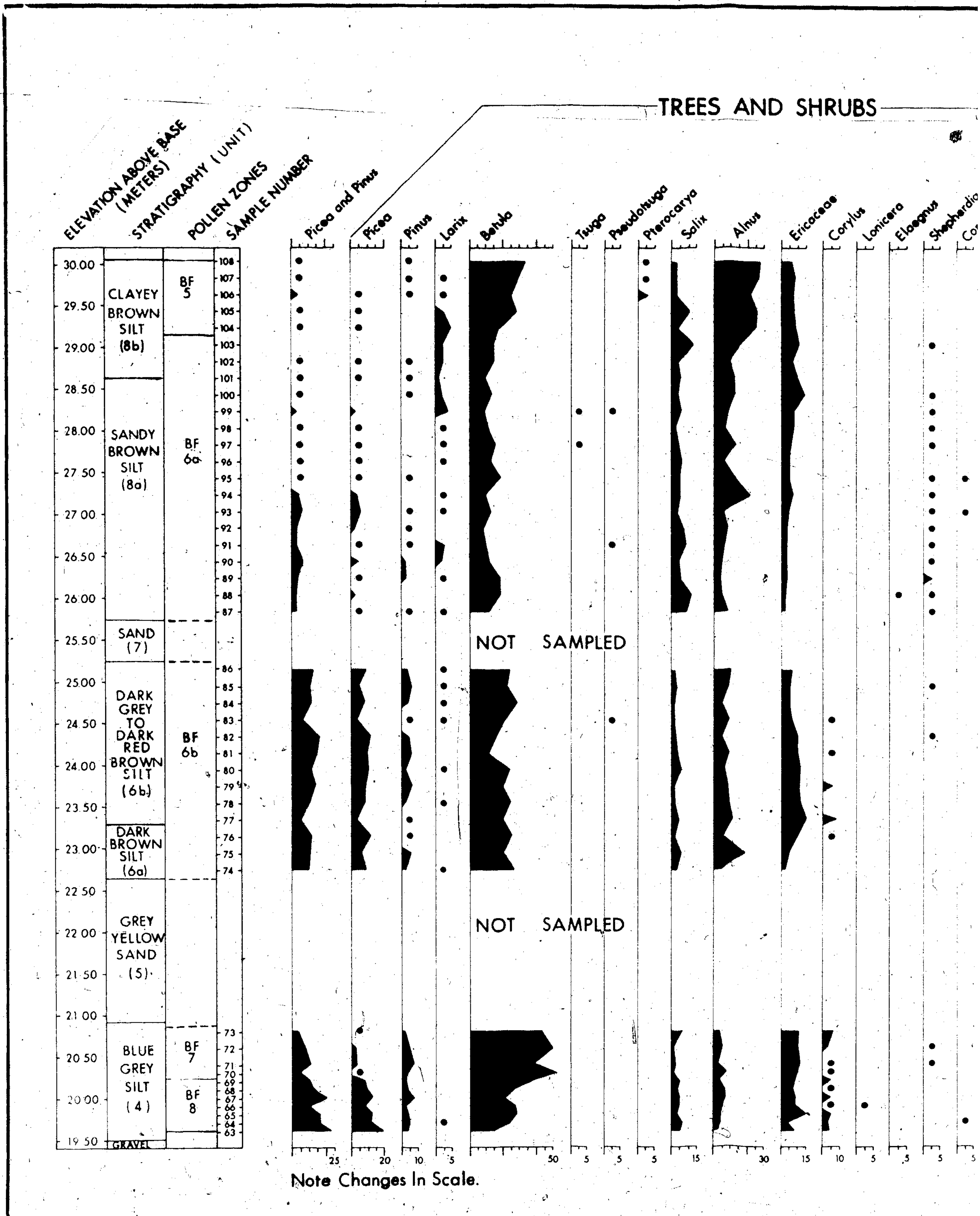
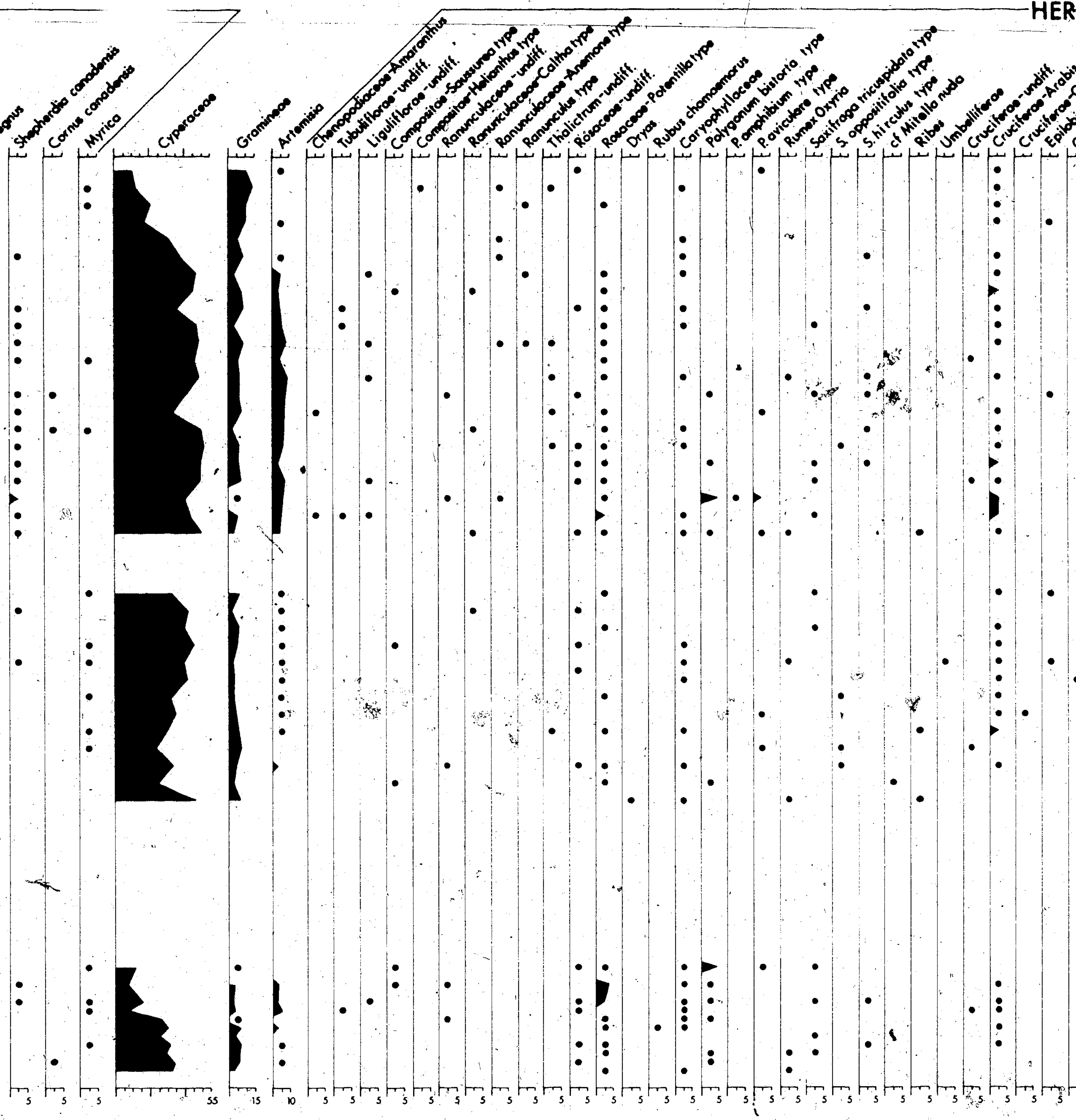

TREES AND SHRUBS
ELEVATION ABOVE BASE (METERS)
STRATIGRAPHY (UNIT)
POLLEN ZONES
SAMPLE NUMBER
Picea and Pinus
Picea
Pinus
Larix
Betula
Tsuga
Pseudotsuga
Pterocarya
Salix
Alnus
Ericaceae
Corylus
Lonicera
Elaeagnus
Shepherdia
CLAYEY BROWN SILT (8b)
SANDY BROWN SILT (8a)
SAND (7)
DARK GREY TO DARK RED BROWN SILT (6b)
DARK BROWN SILT (6a)
GREY YELLOW SAND (5)
BLUE GREY SILT (4)
GRAVEL
BF 5
BF 6a
BF 6b
BF 7
BF 8
NOT SAMPLED
NOT SAMPLED
Note Changes In Scale.

FIGURE 5: RELATIVE PERCENT POLLEN DIAGRAM -

STATION HH 75-24, BLUEFISH RIVER, YUKON TERRITO



-LOWER BLUEFISH UNIT

ITORY, CANADA

3 of

QUATICS
spicatum
MOSSES & FERNS
INDETERMINABLE
ΣP
Sphagnum type
Botrychium
Polypodiaceae
Isoetaceae
Selaginella cf selaginoides
S. cf rupestris
Lycopodium-undiff.
L. cf anotinum
L. cf selago
Equisetaceae
Other spores
Indet. trilete spores
Pediastrum
Indeterminate
Indet.-triporate
Indet.-tricolporate, tricolpate
Indet.-Conifers
ELEVATION ABOVE BASE (METERS)
221
228
213
267
253
228
225
235
247
255
256
308
262
247
222
267
265
254
235
229
276
256
303
254
299
254
243
234
265
223
228
242
263
296
240
225
227
216
249
321
245
243
267
229
253
220
30.00
29.50
29.00
28.50
28.00
27.50
27.00
26.50
26.00
25.50
25.00
24.50
24.00
23.50
23.00
22.50
22.00
21.50
21.00
20.50
20.00
19.50
40
10
5
5
10
5
5
5
5
5
15
10
30
15
15
10
15
ΣP
Sum = ΣP + ΣMosses and Ferns
Sum = ΣP + ΣPediastrum
Sum = ΣP + Σ Indeterminable

4 of 4

DF 3

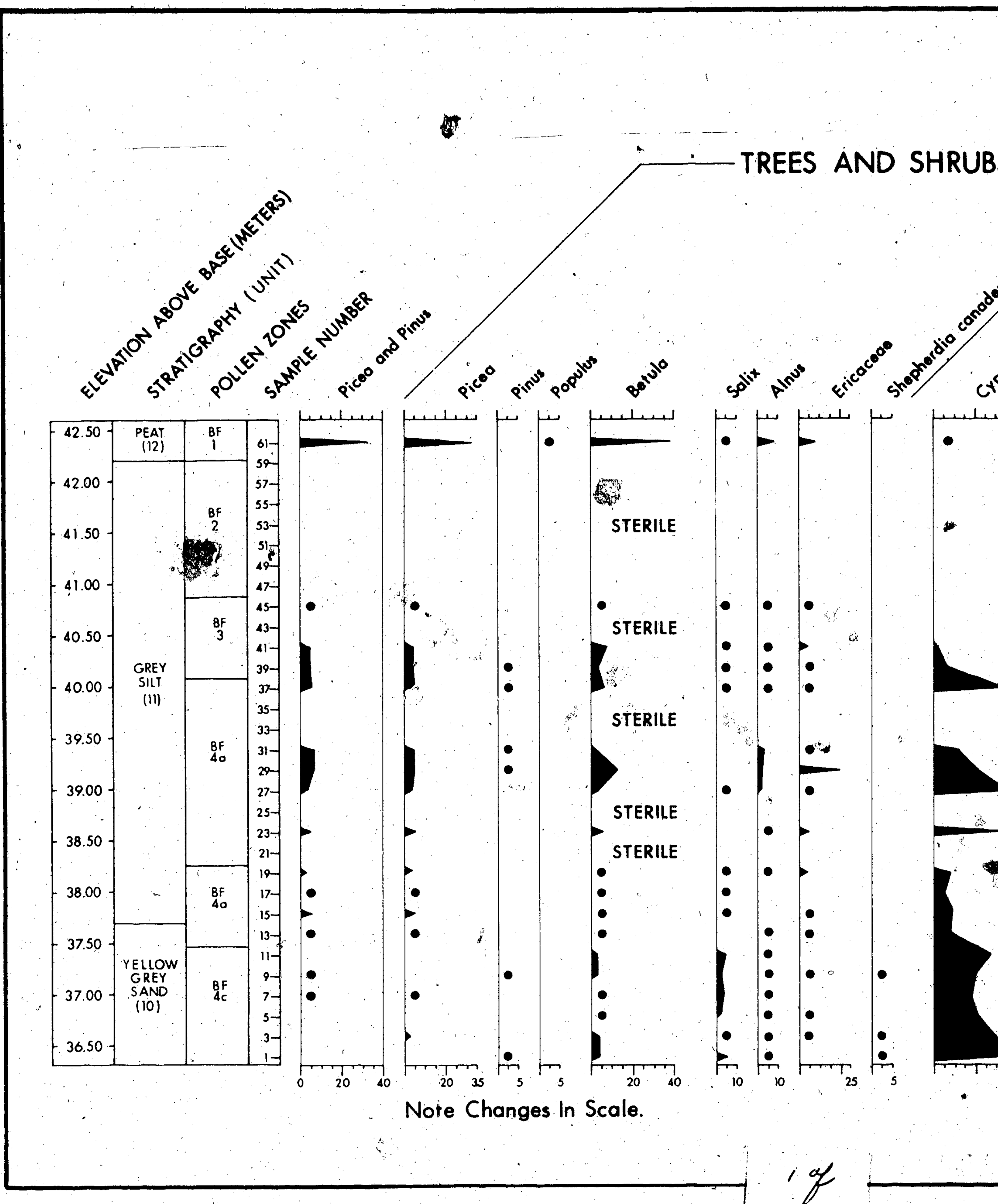
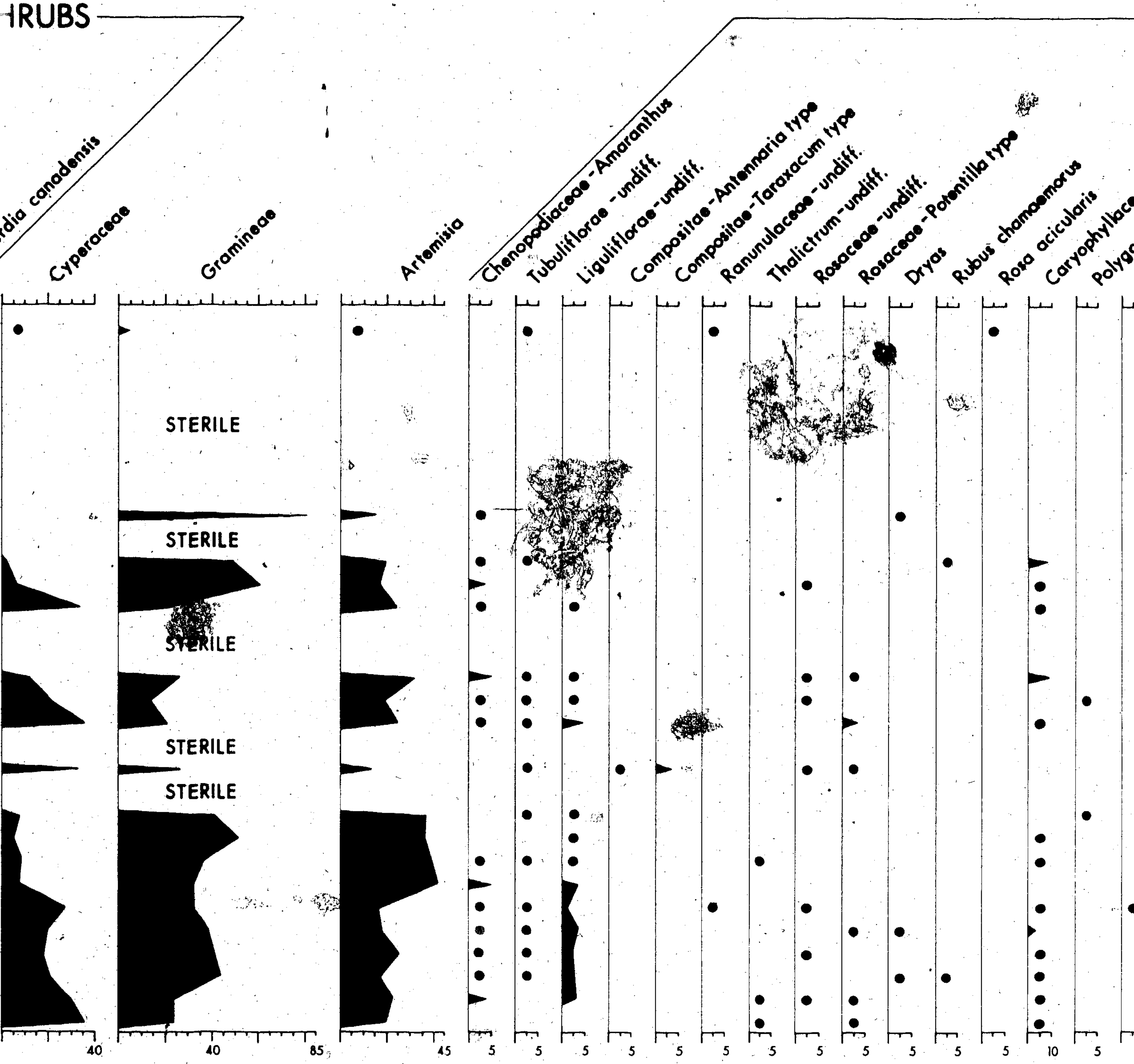

TREES AND SHRUB
ELEVATION ABOVE BASE (METERS)
STRATIGRAPHY (UNIT)
POLLEN ZONES
SAMPLE NUMBER
Picea and Pinus
Picea
Pinus
Populus
Betula
Salix
Alnus
Ericaceae
Shepherdia canade
PEAT (12)
GREY SILT (11)
YELLOW GREY SAND (10)
BF 1
BF 2
BF 3
BF 4a
BF 4a
BF 4c
STERILE
STERILE
STERILE
STERILE
STERILE
42.50
42.00
41.50
41.00
40.50
40.00
39.50
39.00
38.50
38.00
37.50
37.00
36.50
Note Changes In Scale.

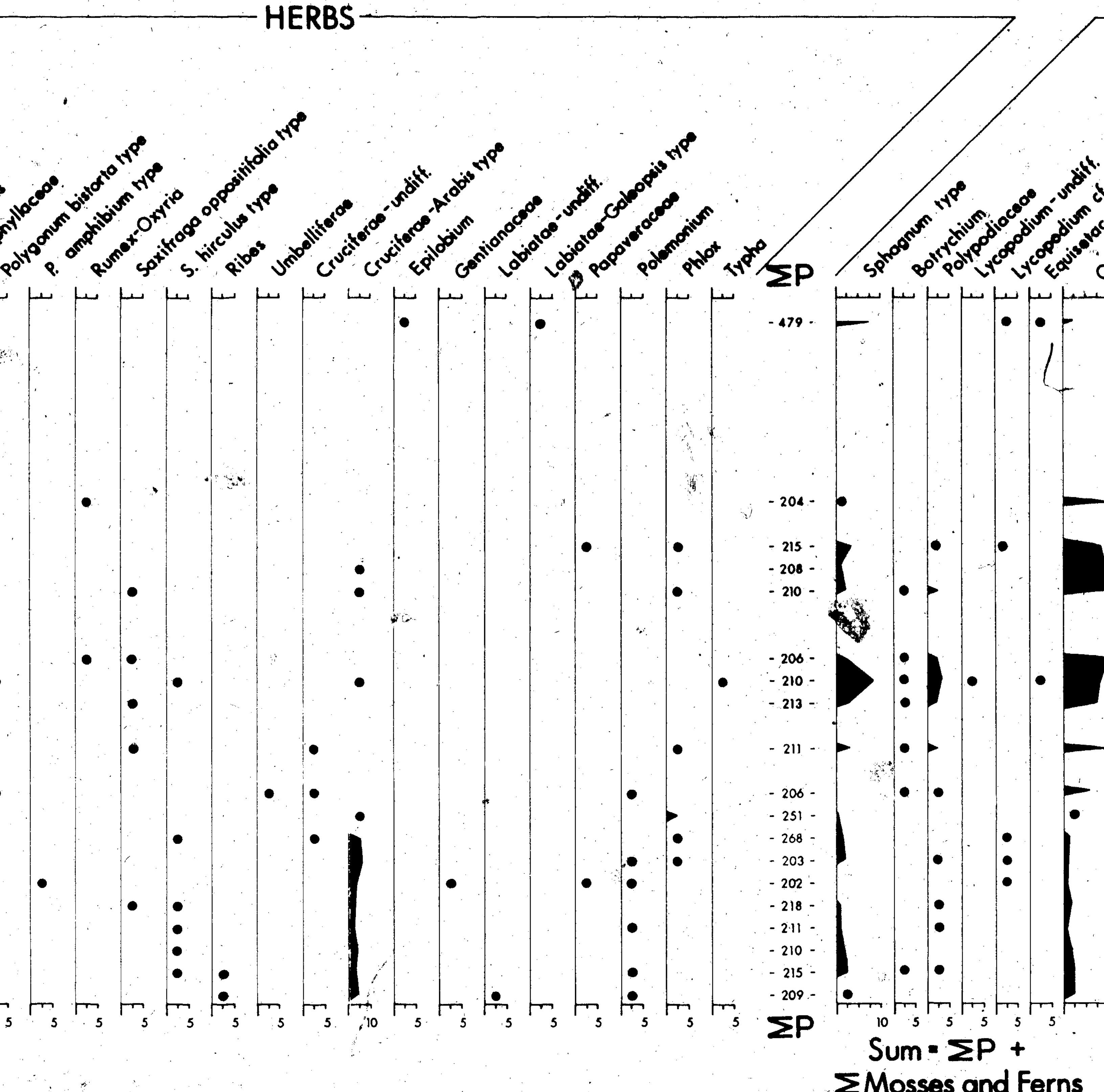
FIGURE 6: RELATIVE PERCENT POLLEN DIA

STATION HH 75-24, BLUEFISH RIVER, YU

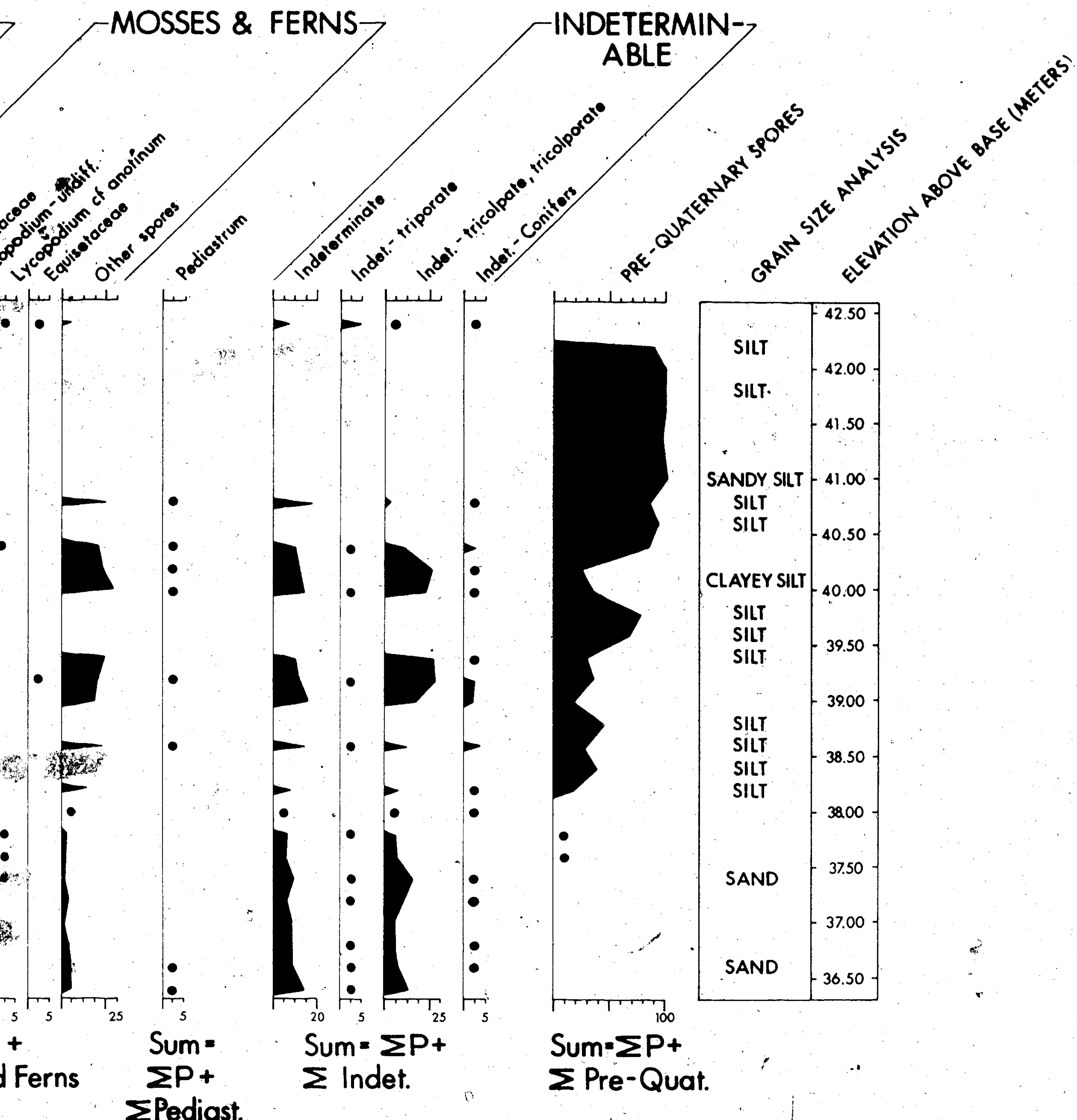


2 of

DIAGRAM - UPPER BLUEFISH UNIT
YUKON TERRITORY, CANADA



3 of


MOSSES & FERNS
INDETERMINABLE
Lycopodium cf anotinum
Equisetaceae
Other spores
Pediastrum
Indeterminate
Indet.- triporate
Indet.- tricolpate, tricolporate
Indet.- Conifers
PRE-QUATERNARY SPORES
GRAIN SIZE ANALYSIS
ELEVATION ABOVE BASE (METERS)
SILT
SILT
SANDY SILT
SILT
SILT
CLAYEY SILT
SILT
SILT
SILT
SILT
SILT
SILT
SILT
SAND
SAND
42.50
42.00
41.50
41.00
40.50
40.00
39.50
39.00
38.50
38.00
37.50
37.00
36.50
5
5
25
5
20
5
25
5
100
d Ferns
Sum = ΣP + ΣPediast.
Sum = ΣP + Σ Indet.
Sum = ΣP + Σ Pre-Quat.