

# The Holocene Paleoecology of Jenny Lake Area, Southwest Yukon, and Its Implications for Prehistory

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**ABSTRACT.** The pollen stratigraphy of a core extracted from Jenny Lake, southwest Yukon, in 1984 has marked archaeological significance. Five palynological zones are identified as follows: Zone JL1, the oldest (ca. 12 500-9500 B.P.), is a *Betula* shrub tundra assemblage; Zone JL2 (ca. 9500-8500 B.P.) an *Alnus* shrub tundra; Zone JL3 (ca. 8500-4500 B.P.) a *Picea* forest; Zone JL4 (ca. 4500-2000 B.P.) a *Picea-Alnus* woodland; and JL5 (ca. 2000 B.P.-present) a *Picea* forest. The widely held belief that the Kluane-Aishihik area of the SW Yukon was covered by extensive grasslands well into the Holocene period is not supported by the palynology of the Jenny Lake Core. Instead, palynological evidence suggests that the area, which initially was a *Betula* shrub tundra, then *Alnus* shrub tundra, became a *Picea*-dominated forest by approximately 8500 B.P. and remained forested to the present. The hypothesis stating early prehistoric hunters and gatherers in the SW Yukon were adapted to extensive Holocene grasslands until ca. 3300-2600 B.P. will have to be modified in view of these findings.

**Key words:** Yukon, paleoecology, palynology, archaeology

**RÉSUMÉ.** La stratigraphie pollinique d'une carotte extraite de Jenny Lake, au sud-ouest du Yukon, en 1984, revêt une grande importance archéologique. Cinq zones palynologiques sont identifiées comme suit: la zone JL1, la plus ancienne (v. 12 500-9500 av. notre ère) est une toundra formée de buissons *Betula*; la zone JL2 (v. 9500-8500 av. notre ère) est une toundra de buissons *Alnus*; la zone JL3 (v. 8500-4500 av. notre ère) est une forêt de *Picea*; la zone JL4 (v. 4500-2000 av. notre ère) une région boisée de *Picea* et d'*Alnus*; et la zone JL5 (v. 2000 à nos jours) une forêt de *Picea*. Le fait à propos duquel on s'accordait, à savoir que la région Kluane-Aishihik du sud-ouest du Yukon constituait une vaste prairie jusqu'à une période avancée de l'holocène, n'est pas appuyé par la palynologie de la carotte de Jenny Lake. Au contraire, les preuves palynologiques semblent indiquer que la région, qui était à l'origine une toundra de buissons *Betula*, puis une toundra de buissons *Alnus*, devint une forêt à dominance de *Picea* aux environs de 8500 av. notre ère et resta une forêt jusqu'à l'heure actuelle. L'hypothèse voulant que durant la préhistoire, les premiers hommes à chasser et à faire la cueillette étaient adaptés aux vastes prairies de l'holocène jusqu'aux environs de 3300 à 2600 avant notre ère, devra être modifiée à la vue de ces découvertes.

**Mots clés:** Yukon, paléocologie, palynologie, archéologie

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## INTRODUCTION

The first major study of the archaeology and paleoenvironment of the southwest Yukon was undertaken by Johnson and Raup (1964) during the Andover-Harvard Expedition of 1944-48. Based on their research, Johnson and Raup (1964:11-123) hypothesized that a major portion of the Kluane-Aishihik lakes region (Fig. 1) was open grassland during much of the Holocene Epoch. They acknowledged, however, that data concerning the existence of these extensive grasslands consisted largely of negative evidence.

Several paleoenvironmental research programs have been undertaken in the southwest Yukon since 1948 (i.e., Bostock, 1948, 1952, 1957, 1969; Bushnell and Ragle, 1969, 1971, 1972; Denton and Stuiver, 1969a,b; Terrain Analysis and Mapping Services Ltd., 1978). Unfortunately, none has provided data directly relevant to the problem of determining the extent or even the existence of Holocene grasslands in the Kluane-Aishihik lakes area. Hills and Sangster (1977) and Ritchie (1985) provide précis of previous Holocene palynological data from Alaska, Yukon and the District of Mackenzie. These summaries indicate the lack of data in the Kluane Lake area. Major elements of Johnson and Raup's paleoenvironmental reconstruction, therefore, remain unsubstantiated.

Despite the limited empirical foundation for this interpretation, the "grassland hypothesis" has been fully incorporated into numerous reconstructions of prehistoric man/land relationships in the southwest Yukon (Damp and

Van Dyke, 1982; Helmer, 1980; MacNeish, 1963, 1964; Morlan and Workman, 1980; Van Dyke, 1979; Workman, 1973, 1974, 1977, 1978). A palynological study of Jenny Lake was, therefore, undertaken to acquire the needed paleoenvironmental data (Stuart, 1986). In order to accomplish this, sediment cores were recovered from Jenny Lake — a small (ca. 1.0 × 2.0 km × 2 m deep) kettle lake with no apparent inlets or outlets, located 55 km northwest of Haines Junction, Yukon Territory (Fig. 1).

Jenny Lake (Fig. 2) is located at 138°22'W and 61°02'N. It lies in the Shakwak Trench between the Kluane ranges of the St. Elias Mountains and the Ruby Range of the Kluane Plateau at approximately 840 m above mean sea level. It was selected for pollen analysis because Denton and Stuiver (1969a) had previously reported a date of 12 500 B.P. from the lowest strata of the lake. Hence, it was anticipated that the palynological record from this lake would span the entire postglacial period. Furthermore, it is located just south of the multi-component Christmas Bay archaeological site (JgVo-1), which had recently been excavated (Helmer, 1980); thus any paleoenvironmental data would be closely related to adjacent archaeological components.

## FIELD AND LABORATORY METHODS

A 173 cm long sediment core was obtained from Jenny Lake in the winter of 1983/84 by drilling through 50 cm of ice and 1.5 m of water using a modified Livingstone sampler with

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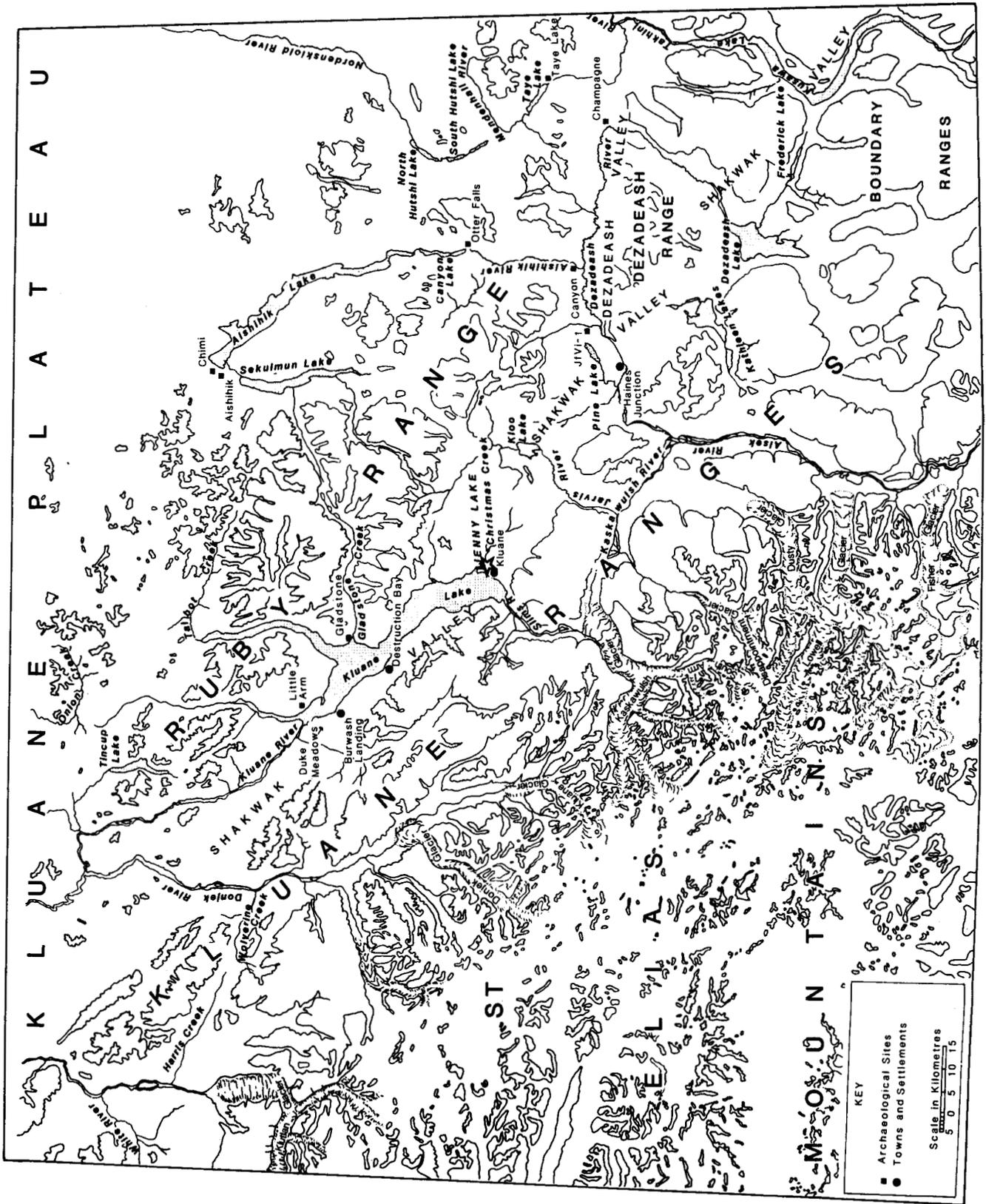


FIG. 1. Research area (after Johnson and Raup, 1964).

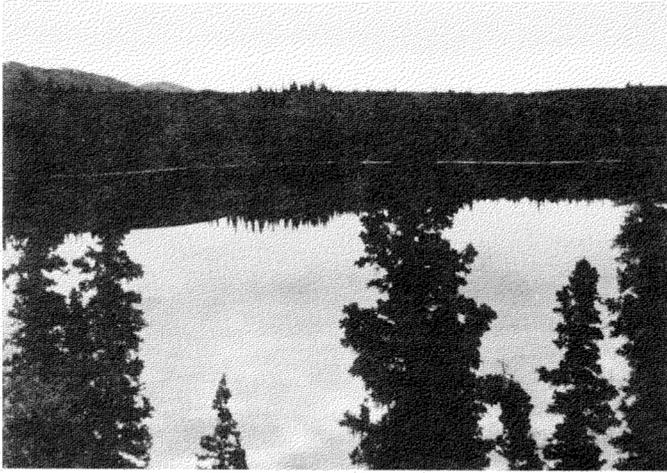


FIG. 2. View of Jenny Lake, Yukon Territory.

a 5 cm diameter barrel. The core was visually divided into 15 strata (Fig. 3). One cubic centimetre samples were recovered from the beginning and termination and at 5 cm intervals within each stratum, except for the lowest stratum, which was sampled at 1 cm intervals. One tablet containing  $11\,300 \pm 400$  exotic pollen grains was added to each sample prior to chemical preparation. The laboratory procedure consisted of treating the sample with 10% HCL, HF, Schulz solution and 10%  $K_2CO_3$ . Each sample was then sieved ( $10\ \mu\text{m}$  sieve), dyed, mounted on microscope slides in polyvinyl alcohol and scanned at  $400\times$  magnification to identify and count a minimum of 300 palynomorphs. Relative pollen frequencies are shown in Figure 3.

#### ZONATION

The Jenny Lake pollen diagram was divided into five zones labelled JL1 to JL5. In the following discussion, the zones are referred to by the designation JL (Jenny Lake), followed by a zone number, e.g., JL4 refers to Jenny Lake, Zone 4.

##### *Zone JL1 (173-165 cm, ca. 12 500-9500 B.P.)*

The dominant species in this zone is dwarf *Betula*, probably *B. glandulosa* (based on grains less than  $20\ \mu\text{m}$  size), which is represented by pollen frequencies of approximately 40%. *Populus*, *Juniperus* and *Potamogeton* also are characteristic of this zone. Gramineae pollen initially occurs at 14% but drops quickly to 2%, whereas *Alnus* pollen initially occurs in low percentages but rises quickly at the zone boundary. *Artemisia* counts also rise through the zone. *Dryas* pollen occurs early in this zone and then disappears from the pollen record.

##### *Zone JL2 (165-135 cm, ca. 9500-8500 B.P.)*

Zone JL2 is separated from Zone JL1 by the dramatic decline of *Betula* pollen and the concomitant rise in *Alnus* pollen. *Betula* counts remain low for most of the zone but rise again toward the top. *Artemisia* achieves an early peak but then drops to approximately 18% throughout most of the zone. *Picea* pollen makes its first appearance in this zone.

Cyperaceae and *Shepherdia* pollen achieve their highest percentage in this zone.

##### *Zone JL3 (135-88 cm, ca. 8500-4500 B.P.)*

*Picea* pollen, at approximately 80%, is the dominant species present. *Alnus* maintains a level of approximately 15%. *Populus* and *Betula* pollen almost disappear, except for a small peak. *Artemisia* decreases at the JL2/JL3 boundary and maintains a low level throughout Zone JL3. The base of this zone marks the major incursion of *Picea* into the area.

##### *Zone JL4 (88-27 cm, ca. 4500-2000 B.P.)*

The key characteristic of this zone is the overall decrease in *Picea* from approximately 80% at the JL3/4 boundary to approximately 60% at the JL4/5 boundary and the concomitant rise in *Alnus* from approximately 15 to 25%. This zone is characterized by a lower interval with marked fluctuations in the percentage of *Picea* versus *Alnus* and an upper interval where both species remain relatively constant.

##### *Zone JL5 (24-0 cm, ca. 2000 B.P.-present)*

*Picea* pollen dominate zone JL5. *Alnus* ranges from about 8% at the base of the zone to 18% at the top. The rise in *Alnus* corresponds to a progressive decline in *Picea*.

#### INTERPRETATION

##### *Zone JL1 (Birch-Shrub Tundra)*

Zone JL1 is interpreted as a dwarf *Betula* shrub tundra. Dwarf birch is inferred to be present as the pollen is predominantly less than  $20\ \mu\text{m}$ . This shrub tundra environment is estimated to have existed from ca. 12 500 B.P. until approximately 9500 B.P. Denton and Stuiver (1969b:213-214) report a radiocarbon date of  $12\,500 \pm 200$  B.P. on wood from the beginning of organic sedimentation in the lake. It is assumed that the date was obtained from context equivalent to our Zone JL1. The existence of a dwarf birch shrub tundra during this period has been well documented elsewhere in northwestern Canada and Alaska (Zone II: Terasmae and Hughes, 1966; Zone 1: Ritchie and Hare, 1971; Ritchie, 1977, 1982, 1984; Zone HL3: Cwynar, 1982; Cwynar and Ritchie, 1980; Zone 4: Rampton, 1971; Ager, 1982; Hopkins *et al.*, 1981; Nakao *et al.*, 1980; Slater, 1985).

##### *Zone JL2 (Alder-Shrub Tundra)*

Although this zone marks the original appearance of spruce pollen, the dominant species within the zone is *Alnus*. An uncorrected radiocarbon date of  $9020 \pm 320$  B.P. (Beta-15228) was obtained on wood recovered from Zone JL2 at a depth of approximately 155 cm. A date of ca. 9500 B.P. is suggested as an acceptable basal date for this zone.

In general, the pollen record from Zone JL2 indicates the beginning of a period of temperature amelioration in combination with a drying trend that may correspond to the onset of the Holocene Climatic Optimum in the SW Yukon. An extrapolated date of 9500 B.P. for the base of the zone establishes the maximum age of Zone JL2. The zone terminates



with a major spruce influx approximately 8500 years ago.

Direct correlatives of JL2 may be found at John Klondike Bog (Matthews, 1980), Tuktoyaktuk (Ritchie, 1984), Doll Creek, Yukon (Ritchie, 1982), Hanging Lake (Cwynar, 1982), Antifreeze Pond (Rampton, 1971), Brooks Range, Alaska (Livingstone, 1955), Tangle Lakes, Alaska (Ager and Sims, 1981), south-central Alaska (Ager, 1983) and Atlin area, British Columbia (Anderson, 1970).

#### Zone JL3 (Spruce Forest)

The major characteristic of Zone JL3 is the occurrence of *Picea* at very high levels (80-90%), indicating that a spruce forest dominated the Jenny Lake area at this time. The history — including arrival time — of spruce forestation has been documented at Antifreeze Pond, Yukon (Rampton, 1971), Chapman Lake (Terasmae and Hughes, 1966), Kluane Lake (Hopkins *et al.*, 1981), White River valley, Yukon (Denton, 1974), Hanging Lake (Cwynar, 1982), Tuktoyaktuk Peninsula (Ritchie, 1984), Inuvik (Hopkins *et al.*, 1981) and Tanana Valley, Alaska (Ager, 1983).

#### Zone JL4 (Spruce-Alder Woodland)

There are no major changes in the actual species recorded in the Jenny Lake pollen data beginning with Zone JL4. Instead, fluctuation in the relative percentages of previously established species occur, especially in the case of *Picea* and *Alnus*. Therefore, fewer comparisons to surrounding areas are required to interpret the pollen record.

There are two significant aspects to be dealt with in Zone JL4. The first is the frequent oscillations in the relative percentages of *Picea* and *Alnus* pollen, and the second, the overall decrease in *Picea* pollen and increase in *Alnus* pollen.

As *Alnus* is a fire successional genus that peaks shortly after major fires and then declines as *Picea* becomes re-established, the most likely explanation for the observed oscillations is that they represent evidence of cyclical fire successions. This would explain why *Picea* troughs when *Alnus* peaks and why *Pinus*, another fire successional genus, attains its highest levels when *Picea* frequencies are at their nadir. Unfortunately, charcoal — which would corroborate this argument — was not discovered in the core sediment.

In addition to marked oscillations, Zone JL4 displays an overall decrease in *Picea* pollen frequencies and an increase in *Alnus* pollen counts. Following Anderson (1970), this pattern may be due to an overall increase in moisture.

In general, then, a series of fire successional alder to spruce woodland communities combined with an overall increase in moisture resulting in the general increase in alder is hypothesized for Zone JL4. Ritchie (1984) postulated that the termination of the Holocene Climatic Optimum was at approximately 4500 B.P. The JL3/4 boundary may also mark the termination of the Holocene Climatic Optimum in the study area and may therefore date to roughly the same time.

#### Zone JL5 (Spruce Forest)

At the JL4/5 boundary, *Picea* rises dramatically, whereas *Alnus* declines, indicating a return to conditions favourable for *Picea*. The *Alnus* decline may be interpreted as a response to drier conditions. Indeed, drops in the relative frequencies of both *Shepherdia* and *Cyperaceae* may indicate a return

to slightly moister conditions, or alternatively, the cessation of loess deposition. The thin strata deposited at the JL4/5 boundary adds some support to the interpretation of the termination of loess deposition.

Zone JL5 interface may be marked by slightly warmer and drier conditions than Zone JL4, but with increasing moisture occurring through the zone. Determining how variations in spruce relate to paleotemperature variation constitutes a major problem for this interpretation. However, some of the difficulties encountered may stem from the fact that *Picea glauca* var. *albertiana* presently grows in habitats in this area in which it is not normally found (Johnson and Raup, 1964). A study of modern pollen rain may help to alleviate some of these problems.

#### SUMMARY

Zone JL1 at Jenny Lake spans the interval *ca.* 12 500-9500 B.P. and probably represents a time period colder than any subsequent period. The vegetation consisted of a dwarf birch shrub tundra. Limited evidence suggests an increase in moisture in the later stages of the zone. This zone compares favourably with data from other areas in the Yukon and the Northwest Territories (N.W.T.).

Zone JL2 data are indicative of ameliorating conditions resulting in a warmer climate than present. These data also suggest a period of marked drying conditions. The dominant vegetation consisted of alder. The zone is believed to date from *ca.* 9500 to 8500 B.P. Zone JL2 does not correlate well with other areas in the Yukon and N.W.T. The Jenny Lake profile, however, indicates a definite increase in alder prior to the arrival of spruce. Similar circumstances have been reported for southwestern and northwestern Alaska.

Zone JL3 represents a period dominated by spruce forest. The climate appears to have stabilized or cooled slightly, although likely maintaining warmer than present conditions. The drying trend observed in Zone JL2 also appears to have stabilized, as spruce prefers moist soil. This zone dates from approximately 8500 to 4500 B.P. The terminal date is an approximation based on Ritchie's (1984) interpretation of events farther north. The contemporaneous occurrence of spruce forestation in other areas of the Yukon, N.W.T. and Alaska is well documented.

After forestation, changes in the pollen record at Jenny Lake reflect variations in the quantity of various types of pollen deposited within a spruce-dominated landscape. Similar patterns are documented for surrounding regions, although the pollen record from Jenny Lake displays more variation than is represented in pollen cores from farther north.

The dominant characteristic of the lower part of Zone JL4 is the marked oscillations of spruce and alder percentages. This is likely the result of a sequence of fire successional periods. A general increase in moisture is also hypothesized. This interval dates from *ca.* 4500 B.P. to 3000 B.P. The upper part of the zone with essentially constant *Picea/Alnus* ratios indicates stable conditions and absence of fire.

Zone JL5, which occurs at approximately 2000 B.P., may relate to a short warming period. This interpretation assumes that Neoglacial activity suppressed spruce growth during the Zone JL4 period.

## DISCUSSION AND CONCLUSIONS

As noted in the introduction, the pioneering paleoclimatologists/archaeologists Johnson and Raup (1964) hypothesized that the SW Yukon was an open grassland environment for much of the past 8000 years. They believed that the early post-Pleistocene human inhabitants of the Kluane/Aishihik lakes area were economically adapted to the exploitation of grassland species such as muskox (*Ovibos moschatus*), caribou (*Rangifer tarandus*) and, most important, bison (*Bison* sp.) (Johnson and Raup, 1964:122-123). According to Johnson and Raup (1964:123), the exploitation of predominantly boreal forest species — the economic pattern characteristic of the ethnographic Athapaskan-speaking Tutchone — was a relatively recent post-Neoglacial adaptation in the area.

Subsequent archaeological reconstructions of the SW Yukon prehistory echo this view. MacNeish (1964:288), for example, has suggested that nomadic "microbands" of hunter-gatherers were exploiting such tundra grassland species as bison, the occasional caribou and muskox, as well as elk, in the study area as early as 8500 B.P. By 7500 B.P. MacNeish (1964:289) perceives an economic adjustment to the mixed grassland/woodland environment of the Holocene. This adjustment is reflected in the expansion of the diet breadth of the indigenous population to include bear, moose, birds, wolf and other small mammals. MacNeish (1964:471) hypothesized that the human inhabitants of the SW Yukon may have become fully adapted to boreal forest conditions by approximately 4000 B.P.

Workman (1977, 1978) also used Johnson and Raup's paleoclimatic reconstruction as a basis for interpreting changing man/land relationships in the area. Workman (1977:52, 1978:403-404) stated that between 7000 and 8000 years ago, the original inhabitants of the Kluane/Aishihik lakes region (the Little Arm Phase) were hunting a now extinct species of bison on the open grasslands covering the bed of former Glacial Lake Champagne. Caribou, elk and moose also contributed to their diet.

Approximately 4500-5000 years ago a new technology (the Taye Lake Phase) replaced the Little Arm Phase in the SW Yukon. Workman (1977:51, 1978:414) believed that this phase was ancestral to the boreal forest-adapted northern Athapaskan populations of the area. Despite this acknowledged affinity, he noted that the bearers of the Taye Lake Phase technology exploited the resources of the open grassland environment, which, according to Johnson and Raup, still covered the Kluane/Aishihik lakes area between 4500 and 5000 years ago. Workman (1977:54, 1978:428) therefore rejected the possibility that the demise and/or replacement of the grassland-adapted, bison-hunting Little Arm Phase by the Taye Lake Phase was causally correlated with the encroachment of boreal forest vegetation into the study area.

According to Workman (1978:54), climax spruce forest was established in the SW Yukon between ca. 3300 and 2600 B.P. — an interval corresponding to the initial stages of the Neoglacial period. The transition from a grassland to a boreal forest orientation did not, in Workman's opinion, have any observable impact on the material cultural inventory of the Taye Lake Phase (Workman, 1977:49, 1978:416).

The preceding summary reveals that the dichotomy between grassland and boreal forest adaptations form an integral com-

ponent of all contemporary syntheses of the human history of the SW Yukon. Johnson and Raup, MacNeish, Workman, Damp and Van Dyke (1982), Helmer (1980), Morlan and Workman (1980) and Van Dyke (1979) implicitly assume that necessary differences in economic strategies practiced by groups adapted to one or the other biotic zone would result in concomitant differences in their settlement patterns and material cultural inventories.

Unfortunately, none of the preceding authors was able to marshal sufficient archaeological data to even attempt to correlate the hypothesized transition from a grassland to a boreal forest adaptation with significant shifts in the economic, settlement pattern and/or material cultural record. Instead, all have relied on conjectural behavioural reconstructions based on the rather simplistic assumption that the early occupants of the SW Yukon were adapted to a grassland environment and that they subsequently "adjusted" their exploitive strategies, settlement patterns and artefact inventories to accommodate the steady encroachment of boreal forest vegetation.

In this paper we have demonstrated that *Alnus* shrub tundra established in the study area by ca. 9500 B.P. and that spruce forest was established by at least 8500 B.P. Our interpretation of the Jenny Lake core also reveals that the boreal forest remained the dominant vegetative regime in the Kluane/Aishihik lakes area after ca. 8500 B.P. Furthermore, in contrast to previous reconstructions, we have found no evidence of extensive grasslands occurring in the region other than those associated with the early post-glacial shrub tundra pollen zone.

Our data thus reveal that the Jenny Lake area was forested for the last 8500 years. This suggests that the earliest archaeologically known arrivals to this region must have been adapted to boreal forest conditions and not to an open grassland environment. Therefore, our paleoenvironmental interpretation of the Jenny Lake core severely compromises and perhaps even invalidates conventional hypotheses about the significance of the transition from a grassland to boreal adaptation to the indigenous prehistoric populations of the study area.

We fully acknowledge the important contributions of Johnson and Raup (1964), MacNeish (1964) and Workman (1977, 1978) to our understanding of the cultural dynamics of SW Yukon prehistory. These contributions notwithstanding, the results of our palynological investigations at Jenny Lake lead us to recommend that previous interpretations of changing man/land relationships in this region be abandoned and that new syntheses, consistent with the paleoenvironmental framework outlined above, be formulated to replace them.

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