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The Archaeology of Yukon Ice Patches: New Artifacts, Observations, and Insights

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ABSTRACT. Since 1997, more than 207 archaeological objects and 1700 faunal remains have been recovered from 43 melting ice patches in the southern Yukon. The artifacts range in age from a 9000-year-old (calendar) dart shaft to a 19th-century musket ball. This paper provides an update on Yukon ice patch research and summary data on select areas of research conducted since 2003. More than 200 radiocarbon dates have been run on ice patch archaeological and faunal materials, and these data allow us to observe and comment on apparent temporal trends. Analysis undertaken since 2003 has improved our understanding of the development and maintenance of hunting technologies, including dart shaft design, wood selection, and point styles. Of particular interest is the description of three different techniques for the construction of throwing darts and the observation of stability in the hunting technology employed in the study area over seven millennia. Radiocarbon chronologies indicate that this period of stability was followed by an abrupt technological replacement of the throwing dart by the bow and arrow after 1200 BP.

Key words: ice patch archaeology, throwing dart, bow and arrow, Yukon, alpine, woodland caribou, Dall sheep, caribou dung

RÉSUMÉ. Depuis 1997, plus de 350 objets archéologiques et de 1 700 restes fauniques ont été récupérés dans 43 névés en fusion dans le sud du Yukon. L'âge de ces artefacts varie, allant d'une tige de propulseur de 9 000 ans (années civiles) à une balle de mousquet du XIX^{e} siècle. Dans cet article, nous faisons la mise à jour des données sommaires et des travaux de recherche effectués dans les névés de régions choisies du Yukon depuis 2003. Plus de 200 dates au carbone 14 ont été établies pour le matériel faunique et archéologique des névés. Ces données nous permettent d'observer les tendances temporales apparentes et de formuler des commentaires à leur sujet. Les analyses qui ont été effectuées depuis 2003 nous ont permis de mieux comprendre l'évolution et le maintien des techniques de chasse, notamment en matière de conception des tiges de propulseurs, de choix du bois et des types de pointes. La description de trois techniques différentes de fabrication de tirs au propulseur de même que l'observation de la stabilité entourant la technique de chasse employée au cours de la période visée par l'étude, soit plus de sept millénaires, revêtent un intérêt particulier. Les chronologies au carbone 14 indiquent que cette période de stabilité a été suivie d'un remplacement technique abrupt, qui est passé du tir au propulseur aux arcs et aux flèches après 1200 BP.

Mots clés : archéologie des névés, tir au propulseur, arcs et flèches, Yukon, alpin, caribou des bois, mouflon de Dall, déjection de caribou

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INTRODUCTION

The summer of 2010 marked the 13th field season of ice patch research in the Yukon Territory, Canada. Through this period, melt conditions at alpine ice patches have fluctuated considerably, and recovery of artifacts and faunal remains has varied commensurately from season to season. At the time of this report, 207 archaeological artifacts constructed of wood, antler, stone, and bone have been recovered; these have now been curated and reside in the collections of the Yukon Archaeology Program, Government of Yukon. The assemblage indicates a tradition of alpine hunting that spans most of the Holocene epoch and provides evidence of transitions from ancient technologies of throwing darts to bows and arrows to musketry. The analysis of these collections has added significantly to our knowledge of the archaeological record in the Yukon and technological change through time. In addition to the archaeological material, Yukon ice patch research has generated a large collection of Holocene fauna, including more than 1700 skeletal remains, principally caribou and sheep, and several dozen mummified small mammals and birds, as well as large quantities of preserved dung from caribou and other herbivores.

Previous publications (Bowyer et al., 1999; Kuzyk et al., 1999; Farnell et al., 2004; Hare et al., 2004; Dove et al., 2005) described the discovery and initial research foci and interpretations of the Yukon ice patch sites. This paper will

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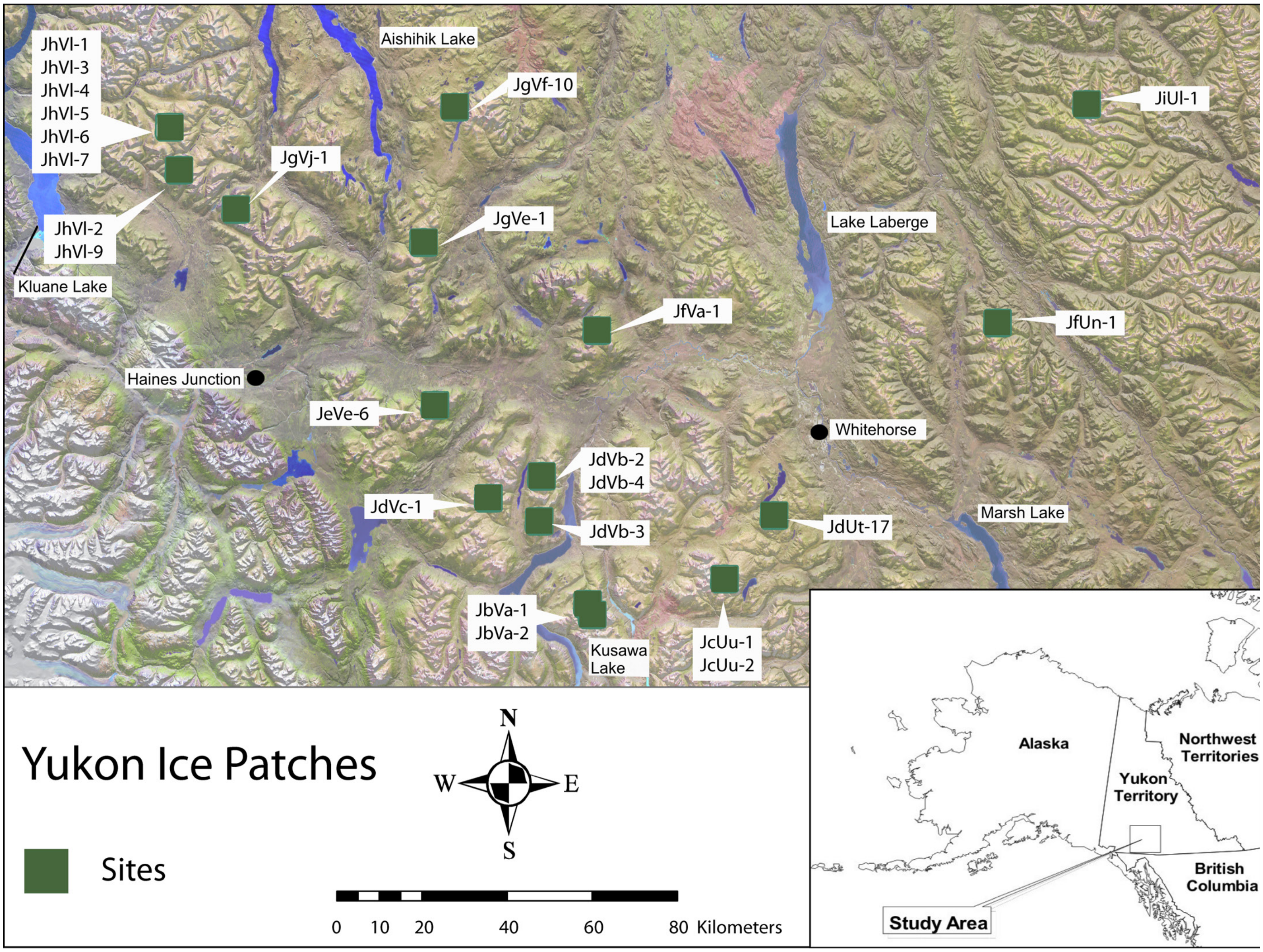

FIG. 1. Study area showing archaeological ice patches in the southern Yukon.

update and elaborate on previously reported data. All radiocarbon dates presented in this paper are uncorrected and uncalibrated unless otherwise stated.

STUDY AREA ENVIRONMENTAL SETTING

The ice patches described in this paper are located geographically between Kluane Lake and the Whitehorse/Carcross area of the southern Yukon, within the Coast Mountains and adjacent Yukon Plateau. The study area (Fig. 1) includes the traditional territory of six Yukon First Nations: the Carcross/Tagish First Nation, the Kwanlin Dün First Nation, the Ta'an Kwäch'än Council, the Champagne and Aishihik First Nations, the Kluane First Nation, and the Teslin Tlingit Council, all of whom are partners in the ice patch research (Greer and Strand, 2012).

The study area measures approximately 18 000 km^2 and lies within the Yukon Southern Lakes, Ruby Ranges, and Yukon-Stikine Highlands ecoregions (Smith et al., 2004). The mean low-elevation temperature for the region is -3˚C, with mean temperatures of ca. 10˚C in summer and ca. -17˚C in winter. Common winter inversions lead to milder temperatures at higher elevations. The region receives 250 – 300 mm mean annual precipitation and is considered semi-arid (Wahl et al., 1987). The lack of moisture limits the growth of glaciers at higher elevations. Lower slopes and valley bottoms are forested by white spruce (*Picea glauca*) and black spruce (*Picea mariana*), along with alder (*Alnus crispa*), willows (*Salix* spp.), birches (*Betula papyrifera* and *B. glandulosa*), and ericaceous shrubs. Black spruce, willow, birch, and mosses (*Sphagnum* spp.) are common to poorly drained sites. Alpine fir (*Abies lasiocarpa*) occurs in the subalpine region, often forming the tree line at 1050 – 1200 m asl. Alpine communities include mountain avens (*Dryas* spp.), dwarf willow, shrub birch, ericaceous shrubs, graminoid species, and mosses (Smith et al., 2004). Large mammals are moose (*Alces alces*), caribou (*Rangifer* spp.), and Dall sheep (*Ovis dalli*); the principal predators are wolf (*Canis lupus*), brown bear (*Ursus arctos*) and black bear (*U. americanus*), lynx (*Lynx canadensis*), coyote (*Canis latrans*), and wolverine (*Gulo gulo*).

FIG. 2. Southern Yukon ice patch site with dung visible melting out at the ice patch front.

PREVIOUS RESEARCH

The project's first publication (Kuzyk et al., 1999) reported on a single ice patch, located at an elevation of 1850 m near Kusawa Lake in the southern Yukon. At that location, a small fragment of wooden dart shaft was recovered and radiocarbon dated to 4360 ± 50 ^{14}C yr BP (TO 6870). Also reported was a caribou dung pellet dating to 2450 ± ^{14}C yr BP (TO 6871) collected from a nearby ice core 1.6 m below the surface (Kuzyk et al., 1999:214). That first brief research report represented one of the earliest accounts of ancient, non-glacial ice in North America and drew attention to the potential of alpine ice to be a productive source of paleobiological and archaeological information.

Six years of subsequent field research resulted in the discovery of dozens of ice patches containing ancient archaeological and biological remains in the southern Yukon. Farnell et al. (2004) reported 72 ice patches in the region, all characterized by the presence of significant quantities of caribou dung (Fig. 2). Of the 72 patches reported, 35 had produced biological specimens, and 18 of those had also been shown to contain archaeological artifacts.

METHODS

Survey Strategy

Since that 2004 publication, field investigations have been conducted every summer except in 2007, when melting and weather conditions were not considered conducive to sample recovery. Given the remote locations of Yukon ice patches, all field research is supported by helicopter and carried out by a three-person field crew, generally consisting of an archaeologist, a biologist, and a First Nation researcher. Multiple teams may visit different patches or work together to investigate a single patch more thoroughly. Field research usually takes place in August to take advantage of the short seasonal window between the melting of the previous winter's snowfall and the arrival of the first snowfall of the coming winter.

FIG. 3. Marking the location of a spear shaft melting out of the ice at an ice patch.

Ice patches are surveyed on foot using informal transects. The locations of any recovered artifacts are mapped using hand-held Global Positioning System instruments, and artifacts are photographed in situ (Fig. 3). Faunal material is generally bagged by ice patch, but not mapped.

Summer field investigations are usually dependent on the degree of melt at alpine ice patches, but even in years with accelerated ice melt, not all known ice patches are revisited. In recent years, the project has focused primarily on monitoring known ice patches, rather than identifying new ones. In an average season, 15 to 20 hours of helicopter flying results in visits to 10 to 15 ice patches. These visits have included both archaeological patches and ice patches that have significant dung, but have yet to produce artifacts.

Curation and Analysis

Recovered artifacts and faunal materials have been curated at the Yukon Archaeology laboratory facilities in Whitehorse. Specimens collected wet were stored in freezers and allowed to dry slowly. Specimens collected dry were photographed, catalogued, and placed in dry, protective storage: gasketed cabinets or custom-made corrugated plastic boxes. Analysis of wood type was conducted by

Claire Alix, University of Paris (Sorbonne) and University of Alaska Quaternary Centre, and by Greg Young, Canadian Conservation Institute Services. Faunal remains were identified and analyzed by Paul Matheus, researcher at the University of Alaska Quaternary Centre, and D. Balkwill and S. Cumbaa, Canadian Museum of Nature. Faunal data presented in this paper are the results of basic counts of elements listed in the catalogues. All data are presented as the number of identified specimens.

Selected artifacts and faunal elements were radiocarbon dated. Where possible, samples for dating were removed from exposed medial breaks in wooden shafts, or from non-diagnostic areas of antler artifacts or faunal specimens. Bone samples were generally taken from areas of greatest bone density. Caribou dung pellets were generally sampled from discrete bands or stratigraphic horizons on the ice face or from ice cores that had not been exposed to surface melting. Various facilities have been used for AMS radiocarbon dating: Beta Analytic, the Lawrence Livermore National Laboratory, the University of Southern California, the University of Toronto Isotrace Laboratory, and Waikato Radiocarbon Dating Laboratory. All dates are expressed as uncalibrated radiocarbon dates.

Statistical Analysis

To facilitate examination of cultural and technological trends and caribou use in alpine regions of the southern Yukon, we organized AMS radiocarbon results using the Parzen window method (Duda and Hart, 1973). Individual radiocarbon dates were placed in 400-year-interval kernels (or bins), and a Gaussian curve was used to smooth the data line. Data placed in temporal kernels are assumed to represent the density of specimens and stand as proxy indicators for intensity of site use at particular 400-year intervals. When the data were organized in this manner, trends or patterns emerged that were not obvious when discrete points were plotted.

RESULTS

Survey Area

In 2004 and 2005, surveys were carried out to identify new alpine ice patch locations in the Yukon. New areas inventoried included the Pelly Mountains, the Hess Mountains, and portions of the Selwyn Mountains in the southeastern Yukon, and the Richardson Mountains in the northeastern Yukon. Inventories focused on visiting alpine settings where perennial non-glacial ice was present. No new ice patch sites that contained deposits of caribou dung were observed in these surveys, however. The presence of preserved caribou dung is considered a diagnostic attribute of ancient ice patches.

Since 2005, field research in the principal study area (southern Yukon) has focused on annual monitoring, primarily at known archaeological ice patches, with visits to new sites as opportunities arose. The annual recovery of artifacts at known archaeological ice patches has diminished since the early years of the project. Cooler summers combined with greater winter snowfall are partly responsible for this change; in addition, fewer artifacts have been melting out of ice patches, even in accelerated melting years. Figure 4 provides a summary of overall artifact collections for each year of the research program.

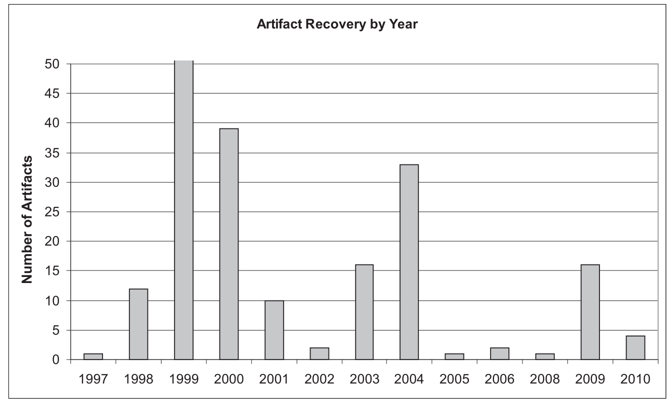

FIG. 4. Number of artifacts recovered each year of the Yukon Ice Patch Project.

Since 2004, several new ice patches have been documented, primarily in the Gladstone Lakes area east of Kluane Lake. As of 2010, the total count of Yukon patches has grown to 84. Of these patches, 43 have yielded biological specimens, and 24 of these also contained archaeological objects (Fig. 1). Table 1 provides an inventory of all archaeological ice patches.

Hare et al. (2004) described a total of 146 artifacts collected from ice patches in the southern Yukon up to 2003. Since that time, the artifact count has increased to 207 objects, from 24 different ice patches. The collection is characterized by artifacts associated with throwing dart (atlatl) technology and bow and arrow technology. In addition to a number of stone projectile points, it contains artifacts variously made of wood, antler, leather, bone, and feather. More than 100 objects are classified as belonging to throwing dart technology (n = 104) and 40 artifacts are assigned to bow and arrow technology. A few objects from other artifact classes have also been recovered (see below). Table 2 provides a summary of artifact types.

THROWING DART TECHNOLOGY

Judging by the assemblage recovered from the Yukon ice patches, throwing dart technology appears to be the sole projectile technology type for the southern Yukon archaeological record prior to about 1200 years ago (an exception will be discussed below). Dates previously reported for ice patch throwing darts range from 8360 BP (uncalibrated) to 1250 ^{14}C yr BP (Hare et al., 2004:265). A total of 81 wooden dart elements have been identified within the collection,

TABLE 1. Inventory of archaeological ice patches.

Borden #	Name	Latitude	Longitude	Elevation (m)	Patch size	Discovery year
JdVb-2	Thandlät	60˚35′	136˚15′	1830	Large	1997
JdVb-3	Jo Jo 8	60˚01′	136˚15′	1760	Small	1998
JdUt-17	Granger	60˚32′	135˚15′	1875	Large	1998
JeVe-6	Van Bibber	60˚43′	136˚43′	1610	Medium	1998
JdVc-1	Marmot	60˚32′	136˚28′	1670	Medium	1998
JbVa-2	Sandpiper	60˚19′	136˚01′	1830	Large	1998
JhVl-3	Little Gladstone	61˚17′	137˚59′	1975	Large	1999
JhVl-1	Gladstone	61˚16′	138˚05′	1915	Large	1999
JcUu-1	Friday Creek	60˚23′	135˚26′	1950	Medium	1999
JcUu-2	Alligator	60˚24′	135˚27′	1945	Medium	1999
JgVe-1	Thulsoo	61˚04′	136˚36′	1675	Medium	1999
JgVf-10	S. Long Lake	61˚09′	136˚50′	1640	Small	1999
JbVa-1	Texas Gulch	60˚18′	136˚00′	2011	Medium	1999
JfVa-1	Sifton	60˚54′	136˚02′	1760	Medium	2000
JhVl-4	East Gladstone	61˚16′	137˚57′	1915	Large	2003
JhVl-2	Oakley	61˚11′	137˚54′	1875	Medium	2003
JgVj-1	Lower Killermun	61˚06′	137˚38′	1875	Medium	2003
JfUn-1	Argillite	60˚57′	134˚19′	1550	Medium	2003
JiUl-1	Fannin	61˚25′	133˚57′	1900	Large	2004
JhVl-5	East of East	60˚15′	137˚56′	2030	Small	2004
JhVl-6	North Gladstone	61˚17′	137˚55′	1850	Medium	2004
JhVl-7	Highfield	61˚16′	137˚59′	2030	Small	2004
JhVl-9	Unnamed	61˚13′	137˚48′	1850	Small	2010
JdVb-4	Little Thandlät	60˚37′	136˚13′	1830	Large	2010

TABLE 2. Summary of artifact types recovered from ice patches.

Artifact type	No. of pieces	No. of artifacts
Arrow point	17	16
Arrow shaft (and complete arrows)	25	24
Bow	3	1
Stone point (with hafted foreshaft)	22	22
Microblade slotted point	2	1
Dart shaft	203	81
Bone point	3	3
Shaft fragment (untyped)	15	13
Broomed shaft	2	2
Microblade core	1	1
Debitage	3	1
Biface	2	2
Walking stick	6	4
Antler tine	7	7
Moccasin	1	1
Carved wood	4	4
Modified bone	1	1
Sinew cord	1	1
Musket ball	1	1
Feathers	9	4
Unmodified wood	26	17
Total	354	207

ranging from complete, full-length darts measuring more than 220 cm to short, non-diagnostic, medial dart segments that cannot be refitted with other segments. The exact number of dart elements is subject to change as new pieces are recovered or radiocarbon dated, allowing for further refitting. In addition to the wooden dart elements, 22 stone dart points have been recovered (Fig. 5).

While many of the dart elements are fragmentary, 27 specimens are considered complete enough to identify construction techniques. Three classes of dart have been identified: one-piece darts, darts with foreshafts, and segmented darts.

FIG. 5. Stone dart points recovered from Yukon ice patch sites. Scale is in centimetres.

One-Piece Darts

On the basis of the overall length of darts that are complete enough to preclude the likelihood of multi-piece construction, we conclude that there are 10 one-piece darts in the Yukon ice patch collection (JcUu-1:16 shown in Fig. 6 is an example). Complete or nearly complete darts range in length from 152 cm to 220 cm. Precise measurements and averages are not possible because most of these "one-piece" darts have at least a small portion of the shaft missing. Variously made of willow, birch, or spruce (see below), these darts are constructed from either a natural sapling or a split stave (a section of a tree trunk or branch split longitudinally into segments). In the proximal end, where this end is present, most of these shafts have a small concavity or dimple for insertion of the throwing dart spur (see Hare et al., 2004:

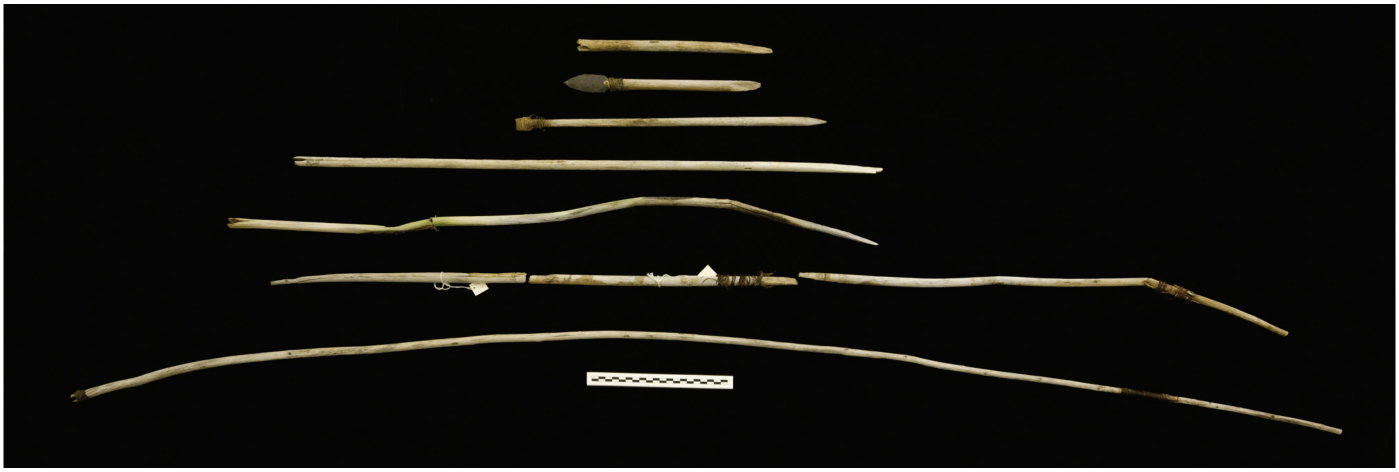

FIG. 6. Representative examples of dart construction techniques. From top to bottom: dart foreshafts JcUu-2:10, JcUu-1:15, JhVl-4:2; segmented darts JcUu-2:8, JbVa-1:19, JcUu-2:1; one-piece darts JcUu-1:16. Scale is in centimetres.

FIG. 7. Close-up view of haft element of dart (JdVb-2:9) showing sinew lashing. The basal fragment of a stone dart is visible in the distal slot. This is the dart shown in situ in Figure 3.

Fig. 2). The exception is dart JcUu-1:17, which has a blunt proximal end with no evidence of a dimple. Presumably this dart was propelled using a throwing board that cradled or cupped the butt end of the dart. In the distal end, where this end is present, all of the one-piece dart shafts have open, U-shaped hafting slots (Figure 7 shows an example of the standard hafting technique). Again, the exception is dart JcUu-1:17, which has a shallow-cupped, open socket at the distal end, made to accommodate a spatulate-stemmed antler projectile point. This dart was referred to in the 2004 article (Hare et al., 2004:265–266, Fig. 4) and is notable for being the most recent dart shaft, with an AMS radiocarbon date of 1260 ± 40 BP. Its different design elements perhaps presage bow and arrow technology.

Darts with Foreshafts

There are eight examples of wooden dart foreshafts, several with stone points still attached (sample shown in Fig. 8), and three foreshafts made of antler (Hare et al., 2004: Fig. 5). The foreshafts in our collection range from an 11 cm long antler foreshaft (JhVl-1:28) to the 46 cm long sample (JhVl-4:2) shown in Figure 3. The proximal end of a foreshaft may be beveled to create a scarf joint surface, conically tapered (shown here) or V-shaped. The outer circumference of the scarf joint often shows evidence of scoring expressed by lightly incised lines that presumably act to improve the attachment of the sinew lashings. On some specimens, the interior contact surface of the scarf joint is also lightly scored to improve the attachment of the two dart segments, though in some instances the observed marks may also be "chatter marks" produced by the act of carving rather than intentional scoring.

The criteria for distinguishing segmented darts from darts with foreshafts require some discussion. Generally, and within the archaeological literature, a dart foreshaft is described as a short wood, bone, or ivory shaft that contains the dart point, and which fits into the longer dart body. This design is well documented among cultures practicing marine mammal hunting using a harpoon. This compound dart system is purported to be more versatile than the one-piece dart, as it allows hunters to carry fewer main shafts and re-arm them with spare foreshafts from a quiver (Justice, 2002:32). However, many of the distal end segments of the Yukon darts are not "short," but are actually as much as half of the assumed overall length of a finished dart. The presumed versatility of "foreshafts" would not apply to the much longer distal end types, and the two construction designs should be distinguished. For the purposes of our study, it was decided that a foreshaft should be less than approximately 1/4 of the assumed overall length of a dart (i.e., the foreshaft for a dart 200 cm long should not measure more than 50 cm).

Segmented Darts

Segmented darts are dart shafts constructed of multiple pieces of wood, joined together using a beveled surface or scarf joint to achieve a shaft of uniform diameter. Scoring, as described for dart foreshafts, is also present on scarf joints of segmented darts. In the ice patch collection, some segmented dart shafts consist of only two segments, while others are made up of multiple pieces. Two dart segments shown in Figure 6 (JcUu-2:8 and JbVa-1:19) measure 87 and

FIG. 8. Close-up of dart foreshafts JcUu-2:10, JcUu-1:15, and JhVl-4:2, also shown in Figure 7. Scale is in centimetres.

FIG. 9. Close-up showing beveled joint surfaces of segmented darts (top to bottom) JcUu-2:8, JbVa-1:19, and JcUu-2:1. Scale is in centimetres.

95 cm, respectively, and each appears to represent nearly half the full length of a complete dart. JcUu-2:1 (also shown in Fig. 6) shows the proximal portion of a dart shaft that, judging by the number of scarfed or beveled surfaces, must have been constructed of at least three pieces, with the middle segment 75 cm long. Examples of the beveled surfaces, some with sinew still attached, are shown in Figure 9.

Segmented darts are not as numerous in the collection as the other types, but there appear to be at least six examples. The reasons for segmented dart construction may be circumstantial rather than design-oriented. In some cases, darts may be segmented in order to repair a broken shaft because suitable longer pieces are not available or to facilitate transport. Possibly using shorter pieces made it easier to maintain a consistent diameter.

Dart Wood Types

Wooden darts in the ice patch collections are made of birch, willow, spruce or, in a single case, maple. The various wood types of the 27 darts in the ice patch collection are summarized in Table 3. In each category, birch is the

TABLE 3. Material types by construction technique.

Construction technique	Birch	Willow	Spruce	(Antler)	Unknown
One piece darts	7	2	1		
Dart foreshafts	5	3		3	
Segmented darts	2				4

most commonly used wood, and all birch shafts and foreshafts are made from split staves. However, shafts and foreshafts made from willow and spruce are all made on natural saplings, with the exception of a single willow foreshaft. There is no evidence that multiple wood types were used for a single dart with any of the construction techniques.

Radiocarbon Dates on Dart Technology

The three types of dart construction appear to have been used throughout the early to mid Holocene, with no apparent preference for one technique over another at any point in time. Radiocarbon dates for dart types are presented in Table 4. The oldest dart segments (> 7000 BP) are excluded from Table 4 because none was complete enough to determine what construction technique was employed.

BOW AND ARROW TECHNOLOGY

Bow and arrow technology is represented by 41 artifacts in the Yukon ice patch collection, including 24 arrow shafts, 16 unattached antler arrowheads, and a bow (see Table 2, Figs. 10 and 11). Dates for the technology range from 1200 BP to the early 20th century, although there is one outlier date (discussed below).

Arrow shafts are typically made of spruce, and less frequently, of birch. As previously reported (Hare et al., 2004), none of the arrow shafts from Yukon ice patches is tipped with a stone point, and no diminutive stemmed or

TABLE 4. Radiocarbon dates by construction technique.

	Artifact number	C^{14} date	Lab number
One piece darts	JcUu-2:2	3900 ± 70	Beta 136345
	JcUu-2:3	3580 ± 40	Beta 140629
	JcUu-1:16	3640 ± 40	Beta 137723
	JcUu-1:17	1260 ± 60	Beta 136340
	JdUt-17:3	1840 ± 40	Beta 140631
	JbVa-2:1	3220 ± 60	Beta 137730
	JgVe-1:10	1600 ± 40	Beta 152444
	JhVl-1:2	5240 ± 40	Beta 152443
	JdVb-2:9	4460 ± 40	Beta 172877
	JhVl-3:1	3050 ± 40	Beta 185968
	JbVa-1:20	ND	
Dart foreshafts	JgVe-1:7	5660 ± 40	Beta 152452
	JbVa-1:7	1980 ± 40	Beta 137728
	JcUu-2:10	4440 ± 40	Beta 140627
	Jhvl-1:23	3590 ± 40	Beta 162658
	JhVl-4:2	2050 ± 40	Beta 197683
	JbVa-1:17	5870 ± 40	Beta 274211
	JcUu-1:15	4480 ± 60	Beta 137722
	JhVl-1:28	3880 ± 40	Beta 185970
	JbVa-2:4	6760 ± 60	Beta 224144
	JcUu-2:21	4360 ± 40	CAMS71938
Segmented darts	JcUu-2:8	1640 ± 40	Beta 140625
	JhVl-1:50	4740 ± 40	Beta 274212
	JhVl-1:51	ND	
	JbVa-1:19	ND	
	JcUu-2:1	4580 ± 40	Beta 136344
	JcUu-2:23	3910 ± 50	Beta 162354

side-notched stone points have been recovered at Yukon ice patches, despite the presence of these point types in components from the Late Prehistoric period (< 1200 yr BP) at other sites in the Yukon. Detailed comparisons of some Northwest Territories arrow shafts with stone points to some Yukon arrow shafts without points now suggests that several Yukon shafts appear to have been designed for use with stone points (see Alix et al., 2012). The antler arrow points from Yukon ice patches are stylistically diverse in appearance (Hare et al., 2008:326), but typically are unilaterally (or rarely bilaterally) barbed with conical hafting tangs (Hare et al., 2004).

DATING THE INTRODUCTION OF BOW AND ARROW TECHNOLOGY IN THE YUKON

The most recent date on a dart shaft (JcUu-1:17) is 1240 ± 40 BP (Beta 172879) (redated to 1260 ± 60 BP; Beta 136340), while the oldest date on bow and arrow technology is from a bow dated at approximately 1180 BP ± 40 BP (JcUu-2:6, Beta 200939). The bow is made of coastal maple, which is of interest because bow and arrow technology was introduced on the coast 300–400 years earlier than in the southern Yukon (Ames and Maschner, 1999:210–213). The only classificatory "arrow" that falls outside of the post-1200 BP timeline is artifact JcUu-1:1. This birch shaft appears in many respects to be the proximal end of a slender dart: its incomplete length measures 100 cm, with its point of maximum thickness at the distal end. A key diagnostic attribute associated with arrows is present, however, in the form of the distinct U-shaped nock on the proximal end, which is consistent with arrow design in the ice patch collection (see Hare et al., 2004:268 for full details). This aberrant artifact has been dated at 3510 ± 70 BP (Beta 136341) and 3600 ± 40 BP (Beta 140630). While this early arrow date is anomalous when compared with other dates from ice patch arrows, bow and arrow technology was known to have been present prior to 4000 BP within the Arctic Small Tool tradition in the western Arctic and the Pre-Dorset culture in the eastern Arctic (Anderson, 1984:84; Maxwell, 1984:361; Gordon, 1996), so it is not inconceivable that these influences extended, however briefly, to the Yukon interior.

MISCELLANEOUS ARTIFACTS

Musketry

The transition from prehistoric indigenous hunting technology to early historic Euro-Canadian technology is represented in the Yukon ice patch record by a lead musket ball (see Fig. 12) recovered from the edge of Little Gladstone ice patch (JhVl-3) in 2009. To date, this artifact is the only evidence of historic hunting at these sites. The musket ball is a .54-calibre ball (230 grain [14.9 grams]); it has a visible seam line but no evidence of a casting sprue. There is no evidence of deformation, such as flattening, indicating that the ball was dropped rather than fired. This calibre of shot was common throughout the 19th century. Although items of European (and Russian) manufacture began to be traded into the Yukon by Coastal Tlingit middlemen in the late 18th century, muskets became generally available only with the arrival of the Hudson's Bay Company in the region in the mid-19th century (Wright, 1976: 59).

Moccasin

In 2004, Hare et al. (2004: Fig. 13) reported on what was presumed to be a "leather pouch" (JhVl-1:25) with a drawstring from the Gladstone ice patch, dated at 1430 ± 40 ^{14}C yr BP (Beta 182661). In subsequent efforts over a period of many months, Valery Monahan, conservator of the Yukon Government Museums Program, succeeded in carefully cleaning, unfolding, and finally reassembling the hide pieces, revealing the substantial remains of a leather moccasin (Fig. 13). The moccasin was made from three pieces of hide, sewn with sinew thread and secured at the ankle with a babiche tie. It has faint traces of red staining that is likely ochre near the heel counter, and there are repairs to both the toe and the sole. The moccasin is approximately the size of a North American men's shoe in size 5. At about 1400 years old, this is the earliest example of Yukon footwear and one of the oldest found in Canada.

Microblade Core

A single tabular chert microblade core (JhVl-3:7) was recovered at JhVl-3. The core has evidence of bi-directional

FIG. 10. Barbed antler points recovered from Yukon ice patch sites. Scale is in centimetres.

FIG. 11. Bow (JcUu-2:6) (broken in three pieces) made of coastal maple. Scale is in centimetres.

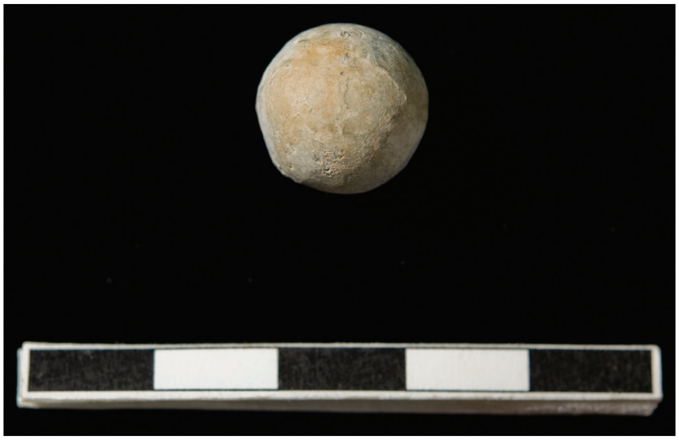

FIG. 12. Musket ball (JhVl-3:9) recovered from the edge of the Little Gladstone ice patch. Scale is in centimetres.

FIG. 13. Moccasin (JhVl-1:25) dated to 1430 BP. Scale is in centimetres.

blade removal and platform rejuvenation by the removal of a core tablet with minor edge retouch extending onto the platform (Fig. 14). The core is 4.41 cm long (face height), 2.78 cm wide, and 2.3 cm thick (blade face to dorsal face). A red substance on the back of the core appears to be ochre. The core was collected less than 1 m from the musket ball described above. Unfortunately, there were no associated organic artifacts from which to obtain a direct date for the core.

Table 2 provides a complete list of other miscellaneous artifact types from the ice patch collections.

FAUNAL ASSEMBLAGE

A variety of faunal materials has been retrieved from ice patches across the southern Yukon. At present, 1725 specimens have been collected that range from broken bone fragments, to tufts of fur or feather, to complete small mammal and bird carcasses. This list does not include dung from caribou, sheep, or bison, which has also been collected. The collections originate from 43 different localities, with 91% of the collection (n = 1571) coming from 19 ice patches that are also archaeological sites. The geographic distribution of faunal specimens may be a consequence of the collection strategy, which has focused on archaeological ice patches, and it is further biased by focused collection efforts at the most productive of these patches, including JcUu-2 (Alligator: n = 146), JhVl-1 (Gladstone: n = 381), JcUu-1 (Friday Creek: n = 341), JbVa-2 Sandpiper: n = 369), and JbVa-1 (Texas Gulch: n = 122).

The faunal species identified to date in the ice patches are listed in Table 5. The various bird species include raven (*Corvus corax*), ptarmigan (*Lagopus* sp.), grouse (*Dendragapus obscurus*), several species of small bird (Passeriformes), duck and goose (Anseriformes *branta* and *anas*), and hawks (Accipitridae). Several insect remains, including warble flies (Hypoderma), have been collected but are not discussed in this paper. Dozens of frozen biological specimens (mostly rodent and bird) that have yet to be catalogued or examined are also excluded from the data set presented

FIG. 14. Microblade core (JhVl-3:7) recovered from the Little Gladstone ice patch. Scale is in centimetres.

here. Instead, we focus on medium and large mammal species, for which there are complete catalogues up to the year 2009.

Caribou (n = 933) and sheep (n = 415) are the species with the greatest representation, making up 54.1% and 24.1% of the assemblage respectively. A further 17.4% of the collection includes unidentifiable large or medium mammal bone (n = 301) that is likely caribou or sheep. The taphonomic history of the fauna is not well understood. Very few specimens show obvious evidence of human butchering, while the vast majority of the collection exhibits signs of carnivore chewing from either predation or scavenging. Predation is the most likely cause for the deposit of large mammal bones at the ice patches though it cannot be determined which predatory population, humans or wolves or bears, has most influenced the deposition and taphonomy of the collection.

TABLE 5. Summary of all recovered faunal elements by species.

Type	Number	Percent
Caribou, *Rangifer tarandus caribou*	933	54.1
Sheep, *Ovis dalli*	415	24.1
Unidentified large mammal	301	17.4
Various bird	47	2.7
Moose, *Alces alces*	1	0.1
Goat, *Oreamnos americanus*	2	0.1
Bison, *Bison bison*	8	0.5
Grizzly bear, *Ursus arctos*	1	0.1
Porcupine, *Erethizon dorsatum*	1	0.1
Red fox, *Vulpes vulpes*	1	0.1
Wolf, *Canis lupus*	1	0.1
Hare, *Lepus americanus dalli*	3	0.2
Marmot, *Marmota caligata*	2	0.1
Lemming, *Lemmus sibiricus*	3	0.2
Arctic ground squirrel, *Spermophilus parryii*	5	0.3
Vole, *Microtus* sp.	1	0.1
Total	1725	100

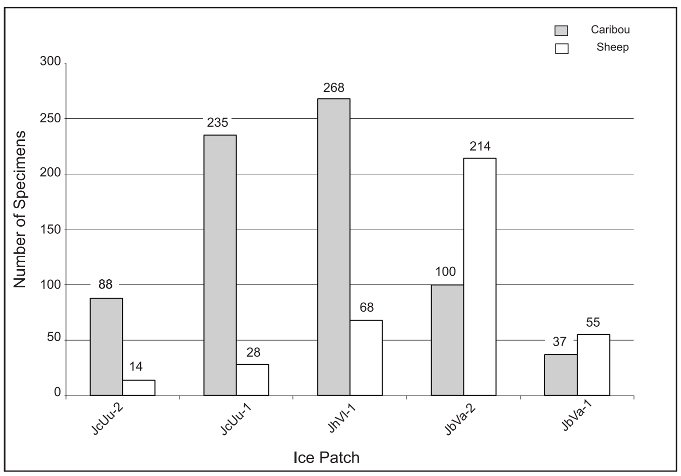

FIG. 15. Frequency of caribou and sheep faunal remains at selected ice patches.

Of the 1663 large and medium mammal specimens represented, only three have been positively identified as predatory species: one bear, one wolf, and one fox. In the collection of large mammal specimens, 81.9% (n = 1362) have been positively identified to species. Caribou represent 68.5% and sheep represent 30.5% of the identified specimens. Bison (8), goat (2), moose (1), bear (1), wolf (1), and fox (1) make up the remaining 14 specimens (1%).

Inter-site variation in species frequencies is notable, especially in the collections from five sites that have more than 90 identifiable caribou and sheep specimens (Fig. 15). Basic counts indicate that caribou remains are more frequent at JcUu-2 (Alligator: 86%), JcUu-1 (Friday Creek: 89%) and JhVl-1 (Gladstone: 80%), whereas sheep are more frequent in collections from JbVa-2 (Sandpiper: 68%) and JbVa-1 (Texas Gulch: 60%) (see Fig. 15). This variation may be explained by differing caribou and sheep population frequencies in the Yukon Southern Lakes region. However, while accurate modern population estimates are available for southern Yukon caribou herds, comparable numbers are

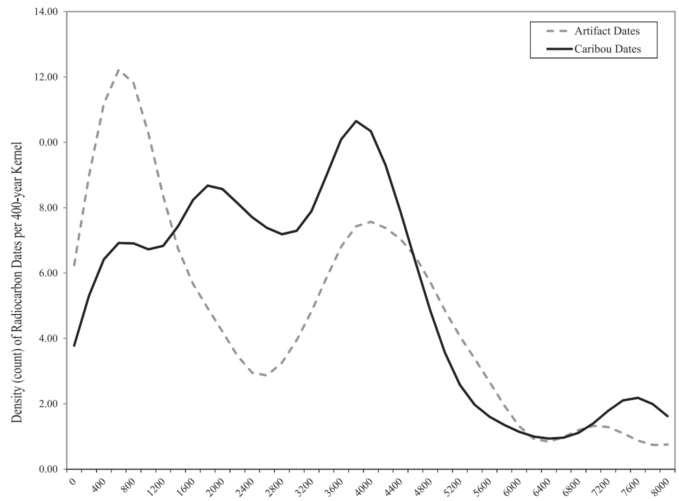

FIG. 16. Graphed results of all artifact and faunal radiocarbon dates, organized in 400-year bin intervals.

not available for sheep, which makes it difficult to compare modern animal frequencies with faunal remains observed in ice patches (Troy Hagen, pers. comm. 2010). Ancient population numbers for these animals are not known.

RADIOCARBON RESULTS

Since 1997, more than 200 radiocarbon dates have been obtained from specimens recovered from Yukon ice patches. These include 105 AMS dates on artifacts (Table 6) from a total collection of 207 artifacts, and 95 radiocarbon dates on caribou faunal material (bone, antler, and dung; Table 7). Faunal material ranged in age from 8330 BP to modern, while artifacts ranged from 8360 BP to modern.

For the purpose of display, we graphed radiocarbon dates for both artifacts and caribou faunal material using the Parzen window method (Duda and Hart, 1973) with a kernel interval of 400 years (Fig. 16). This data display method groups radiocarbon dates in 400-year kernel intervals that indicate the density of artifact or caribou dates for a given time period. The observed density of artifact dates reveals two apparent peaks in alpine hunting activity: the first at approximately 4000 ^{14}C yr BP, and the second after 1000 ^{14}C yr BP. A marked drop in artifact density can be seen between 3000 BP and 2000 ^{14}C yr BP. Density of dated caribou material appears to peak at about 4000 BP, but decreases thereafter. (Note that only three Yukon ice patches contained material older than 6000 years, so the absence of dated material from the early Holocene may simply reflect a lack of preservation rather than a change in intensity.) Artifact and caribou densities were then compared using the correlation coefficient r^2. This analysis resulted in a coefficient of correlation of $r^2 = 0.4574$, indicating a weak positive relationship between the variables.

TABLE 6. Radiocarbon dates for artifacts recovered from Yukon ice patches.

Site	Artifact number	Lab number	C^{14} Date	SD	Label
JgVe-1	3	Beta 224135	modern	–	antler point
JcUu-2	11	Beta 224132	30	50	antler point
JcUu-2	7[1]	Beta 140625	90	40	arrow shaft
JgVe-1	8	Beta 224138	130	50	antler point
JcUu-2	12[1]	Beta 137724	140	40	bone point
JhVl-4	3	Beta 224136	150	50	arrow shaft
JcUu-2	16[1]	Beta 152445	190	40	arrow shaft with point
JcUu-2	19	Beta 274210	250	40	arrow shaft
JgVe-1	6	Beta 224141	290	40	arrow shaft
JhVl-4	8	Beta 224142	290	40	arrow shaft
JcUu-2	28	Beta 227524	340	40	arrow shaft
JcUu-2	17	Beta 212892	360	40	arrow shaft with point
JbVa-1	2[1]	Beta 139098	360	40	antler point
JbVa-1	5[1]	Beta 37726	400	40	arrow shaft
JgVe-1	6	Beta 212886	430	40	arrow shaft
JbVa-1	1[1]	Beta 137725	440	50	arrow shaft
JgVe-1	5	Beta 139101	590	40	antler point
JbVa-1	4[1]	Beta 224137	590	50	antler point
JcUu-2	26	Beta 197686	620	40	arrow shaft
JgVe-1	4	Beta 224131	630	50	antler point
JhVl-7	2	Beta 274209	660	40	arrow shaft
JgVe-1	1[1]	Beta 139100	660	40	antler point
JhVl-2	1[1]	Beta 172878	670	40	arrow shaft
JgVe-1	2[1]	Beta-137729	680	40	arrow shaft
JcUu-2	25	Beta 224140	700	40	arrow shaft
JcUu-1	10[1]	Beta 1329097	740	40	antler point
JhVl-7	1	Beta 197688	760	40	arrow shaft with feather
JcUu-1	23	Beta 224133	770	50	antler point
JiUl-1	2[2]	Wk-28993	807	30	arrow shaft
JcUu-1	3	Beta 136342	810	40	arrow shaft
JcUu-2	5[1]	Beta 140628	810	40	arrow shaft
JgVf-10	1	Beta 185973	840	40	antler point
JbVa-1	13	Beta 274206	860	40	arrow shaft?
JcUu-1	13	Beta 224134	880	50	antler point
JhVl-5	1	Beta 224145	880	40	arrow shaft
JiUl-1	1	Beta 197687	920	40	antler point
JbVa-1	12[1]	Beta 139099	930	40	antler point
JbVa-1	3[1]	Beta 137727	1010	40	arrow shaft
JcUu-2	6	Beta 197690	1060	40	bow fragments
JcUu-2	6	Beta 200939	1180	40	bow fragments
JfUn-1	1[1]	Beta 185969	1210	40	wooden handle?
JcUu-1	9[1]	Beta 172879	1250	40	dart shaft with fletching
JcUu-1	17[1]	Beta 136340	1260	60	dart shaft
JcUu-2	6[1]	Beta 136343	1300	60	bow fragments
JhVl-1	25[1]	Beta 182661	1430	40	moccasin
JcUu-2	18[1]	Beta 162360	1590	40	dart shaft fragment
JgVe-1	10[1]	Beta 152444	1600	40	dart shaft
JcUu-2	8[1]	Beta 40626	1640	40	dart foreshaft
JhVl-4	5	Beta 197684	1700	40	dart shaft with fletching
JiUl-1	2[2]	Beta 274207	1710	40	arrow shaft
JdUt-17	3[1]	Beta 140631	1840	40	dart shaft
JbVa-1	7[1]	Beta 137728	1980	50	dart foreshaft?
JbVa-1	15	Beta 189295	2010	40	knife handle?
JhVl-4	2	Beta 197683	2050	40	dart foreshaft with point
JhVl-4	9	Beta 212888	2160	40	walking stick fragment?
JiUl-1	3	Beta 274208	2300	40	dart shaft fragment
JcUu-1	7	Beta 224139	2740	50	antler point
JhVl-1	34	Beta 227523	2960	40	socketed shaft
JhVl-1	14	Beta 165101	3010	40	dart shaft fragment?
JhVl-3	1[1]	Beta 185968	3050	40	dart shaft with point
JeVe-6	1	Beta 212883	3060	40	dart shaft fragment
JhVl-1	18	Beta 224143	3070	40	dart shaft fragment
JbVa-2	1[1]	Beta 137730	3220	60	dart shaft
JcUu-1	1[1]	Beta-136341	3510	70	arrow shaft
JcUu-2	3[1]	Beta 140629	3580	40	dart shaft
JhVl-1	23[1]	Beta 162658	3590	50	dart foreshaft
JcUu-1	1	Beta 140630	3600	40	arrow shaft
JhVl-1	20	Beta 189294	3660	40	dart shaft fragments
JhVl-1	45	Beta 200935	3660	40	antler point
JcUu-2	20	Beta 152439	3720	40	antler tine
JhVl-1	21[1]	Beta 162352	3770	50	dart shaft fragments

TABLE 6. Radiocarbon dates for artifacts recovered from Yukon ice patches – *continued:*

Site	Artifact number	Lab number	C^{14} Date	SD	Label
JdUt-17	11	Beta 152438	3810	40	antler tine
JdUt-17	13	TO-7554	3830	50	broomed shaft
JcUu-1	21	CAMS 71939	3870	40	antler/bone point
JdVb-3	1	Beta 165100	3880	40	carved shaft
JhVl-1	28[1]	Beta 185970	3880	40	antler foreshaft
JcUu-2	2[1]	Beta 136345	3900	70	dart shaft
JcUu-2	23	Beta 162354	3910	50	shaft
JcUu-1	5	Beta 274205	3950	40	dart shaft fragment
JhVl-1	4	Beta 152442	4100	40	dart shaft fragment
JcUu-2	21	CAMS 71938	4360	40	antler foreshaft - lance
JdVb-2	1[1]	TO-6870	4360	50	dart shaft fragment
JcUu-2	10[1]	Beta 140627	4440	40	dart foreshaft
JdVb-2	9[1]	Beta 172877	4460	40	dart shaft
JcUu-1	15[1]	Beta 137722	4480	60	stone point
JhVl-1	22[1]	Beta 162351	4500	50	dart shaft fragments
JhVl-1	31[1]	Beta 185971	4540	40	dart shaft fragments
JcUu-2	1[1]	Beta 136344	4580	70	dart shaft
JcUu-1	16[1]	Beta 137723	4700	60	dart shaft
JhVl-1	50	Beta 274212	4740	40	dart shaft fragments
JhVl-1	54	Beta 274212	4740	40	dart shaft fragment
JhVl-1	7	Beta 227522	4760	40	dart shaft fragment
JbVa-1	11	Beta 152440	5000	40	antler tine
JhVl-1	2[1]	Beta 152443	5240	40	dart shaft
JcUu-1	25	Beta 162659	5320	50	dart shaft fragment?
JhVl-1	43	Beta 197685	5320	40	dart shaft fragment
JhVl-3	2	Beta 212887	5340	40	dart shaft fragments
JhVl-1	35	Beta 197689	5460	40	dart shaft fragments
JgVe-1	7[1]	Beta 152452	5660	40	dart foreshaft
JbVa-1	17	Beta 274211	5870	40	dart foreshaft
JbVa-2	4	Beta 224144	6760	60	antler foreshaft
JdVb-2	2	TO-7552	6860	70	dart shaft fragment
JhVl-1	19[1]	Beta 162353	7290	50	dart shaft fragments
JhVl-1	1	Beta 154960	7310	40	antler point
JhVl-1	39	Beta 200936	8290	50	dart shaft fragments
JhVl-1	32[1]	Beta 185972	8360	60	dart shaft fragments

[1] Previously reported in Hare et al., 2004.
[2] Same artifact dated twice.

DISCUSSION

Interpreting Radiocarbon Dates: Observed Trends at Ice Patches Over Time

One of the challenges in reporting on the results of the Yukon Ice Patch Project is to move beyond simply describing the objects that have been recovered to interpreting trends through time. With the dates that have been obtained on archaeological objects and faunal remains, we are now in a position to infer some changes in land-use patterns and caribou populations through time.

Prior to 1997, only two archaeological sites above an elevation of 1250 m asl had been documented in the Yukon (Yukon Archaeological Sites Database 2010, on file with Yukon Cultural Services Branch, Whitehorse, Yukon). Published ethnographies and contemporary oral histories indicated the importance of alpine hunting in the Aboriginal seasonal round (McClellan, 1975; Legros, 1981, 2007); however, from the perspective of archaeological research, it was difficult to identify specific areas of resource harvest activity upon which to focus field investigations. Now, after 13 years of field research on the southern Yukon ice patches, the recovery of abundant artifacts and faunal remains, and subsequent analysis, patterns of land use in alpine areas of the Yukon through the Holocene have been brought into focus. And while alpine hunting is now well represented in the Yukon archaeological record, initial observations based on the radiocarbon dates obtained from 105 archaeological objects recovered from 24 Yukon ice patches indicate that alpine hunting activity may have been quite variable over the past 9000 years.

The observed changes in artifact quantity shown in Figure 16 may be interpreted to indicate different land-use strategies through time, changes in animal distributions, environmental change over time, or a combination. In a somewhat similar exercise for the central Alaskan archaeological record, Potter (2008) interpreted archaeological radiocarbon dates to indicate differential use of upland areas at various times in the Holocene, with upland sites constituting 32% of early Holocene components, 52% of middle Holocene components, and 36% of late Holocene components.

The interpretation of the ice patch radiocarbon dates is based on two assumptions: 1) that artifact and caribou specimen densities are proxy indicators for intensity of site use (i.e., more artifact dates in a particular kernel indicate

TABLE 7. Radiocarbon dates on caribou faunal material.

Submission number	Lab number	Ice patch	Material	Date (uncalibrated)
YHB-06-12[1]	Beta 164994	JhVl-1 (Gladstone)	bone	modern
YHB-05-19[1]	Beta 212897	IP 50 East Thulsoo	bone	190 ± 40
YHB-05-04[1]	Beta 212882	IP 80 (Irvine)	bone	190 ± 40
YHB-06-14[1]	Beta 217512	IP 50 East Thulsoo	bone	240 ± 40
YHB-06-07[1]	Beta 217505	IP 31 (Upper JoJo)	bone	790 ± 40
YHB-06-10[1]	Beta 217508	JhVl-1 (Gladstone)	bone	900 ± 40
YHB-06-09[1]	Beta 217507	JhVl-1 (Gladstone)	bone	1630 ± 40
YHB-06-06[1]	Beta 217504	JcUu-1 (Friday Creek)	bone	1720 ± 40
YHB-01-42[1]	Beta 162887	JcUu-1 (Friday Creek)	bone	1940 ± 40
YHB-05-12[1]	Beta 212890	JbVa-1 (Texas Gulch)	bone	1980 ± 40
YHB-01-51[1]	Beta 162896	JcUu-1 (Friday Creek)	bone	2270 ± 40
YHB-01-44[1]	Beta 162889	JcUu-1 (Friday Creek)	bone	2320 ± 40
YHB-01-41[1]	Beta 162886	JcUu-2 (Alligator)	bone	2340 ± 40
YHB-01-43[1]	Beta 162888	JcUu-1 (Friday Creek)	bone	2510 ± 40
YHB-06-11[1]	Beta 217509	IP 34 (Vand Creek)	bone	2570 ± 40
YHB-05-06[1]	Beta 212884	IP 34 (Vand Creek)	bone	2700 ± 40
YHB-06-15[1]	Beta 217513	JhVl-1 (Gladstone)	bone	2910 ± 40
YHB-01-49[1]	Beta 162894	JdVb-2 (Thandlät)	bone	3140 ± 40
YHB-01-40[1]	Beta 162885	JcUu-1 (Friday Creek)	bone	3150 ± 40
YHB-01-52[1]	Beta 162897	JcUu-1 (Friday Creek)	bone	3220 ± 40
YHB-06-08[1]	Beta 217506	JcUu-1 (Friday Creek)	bone	3470 ± 40
YHB-05-16[1]	Beta 212894	JhVl-1 (Gladstone)	bone	3480 ± 40
YHB-05-13[1]	Beta 212891	IP81 (East Long Lake)	bone	3580 ± 40
YHB-06-04[1]	Beta 217502	JcUu-1 (Friday Creek)	bone	3610 ± 40
YHB-01-36[1]	Beta 162881	JcUu-1 (Friday Creek)	bone	3640 ± 40
YHB-01-55	Beta 164995	JcUu-1 (Friday Creek)	bone	3650 ± 40
YHB-06-02[1]	Beta 217500	JhVl-1 (Gladstone)	bone	3720 ± 40
YHB-01-47[1]	Beta 162892	JcUu-1 (Friday Creek)	bone	3740 ± 40
YHB-01-37[1]	Beta 162882	JcUu-1 (Friday Creek)	bone	3760 ± 40
YHB-01-39[1]	Beta 162884	JcUu-1 (Friday Creek)	bone	3890 ± 40
YHB-04-10[1]	Beta 197692	JhVl-4 (East Gladstone)	bone	3940 ± 40
YHB-06-03[1]	Beta 217501	JcUu-1 (Friday Creek)	bone	4060 ± 40
YHB-06-05[1]	Beta 217503	JhVl-4 (East Gladstone)	bone	4070 ± 40
YHB-05-17[1]	Beta 212895	JhVl-3 (Little Gladstone)	bone	4190 ± 40
YHB-06-16[1]	Beta 217514	JhVl-1 (Gladstone)	bone	4460 ± 40
YHB-01-45[1]	Beta 162890	IP 18 (Bratnober)	bone	4760 ± 40
YHB-05-18[1]	Beta 212896	JhVl-1 (Gladstone)	bone	4830 ± 40
YHB-06-01[1]	Beta 217499	JhVl-1 (Gladstone)	bone	4840 ± 40
YHB-06-17[1]	Beta 217516	JhVl-1 (Gladstone)	bone	5400 ± 40
YHB-06-13[1]	Beta 217511	JhVl-1 (Gladstone)	bone	5700 ± 40
YHB-01-38[1]	Beta 162883	JbVa-2 (Sandpiper)	bone	5710 ± 40
YHB-01-46[1]	Beta 162891	JbVa-1 (Texas Gulch)	bone	6320 ± 40
YHB-99-R34	Beta 136359	JdUt-17 (Granger)	dung	119.9 ± 0.6 pMC
YHB-04-15	Beta 197697	IP 74 (Big Bend)	dung	250 ± 40
YHB-04-14	Beta 197696	IP 74 (Big Bend)	dung	340 ± 40
YHB-99-R21	Beta 136346	JcUu-1 (Friday Creek)	dung	460 ± 60
YHB-98-9	TO-7560	JdUt-17 (Granger)	dung	960 ± 50
YHB-98-12	TO-7563	JdUt-17 (Granger)	dung	970 ± 50
YHB-98-13	TO-7564	JdUt-17 (Granger)	dung	1030 ± 50
YHB-98-8	TO-7559	JdVb-2 (Thandlät)	dung	1440 ± 50
YHB-01-25	Beta 162356	JdUt-17 (Granger)	dung	1460 ± 40
YHB-99-R48	Beta-140621	JdUt-17 (Granger)	dung	1600 ± 40
YHB-98-14	TO-7565	JdUt-17 (Granger)	dung	1600 ± 50
YHB-98-6	TO-7557	JdVb-2 (Thandlät)	dung	1620 ± 50
YHB-99-R46	Beta-140619	JdUt-17 (Granger)	dung	1630 ± 40
YHB-99-R22	Beta-136347	JcUu-1 (Friday Creek)	dung	1650 ± 40
YHB-99-R23	Beta-136348	JcUu-1 (Friday Creek)	dung	1660 ± 50
YHB-98-7	TO-7558	JdVb-2 (Thandlät)	dung	1670 ± 50
YHB-98-16	TO-7567	JdUt-17 (Granger)	dung	1770 ± 60
YHB-03-09	Beta 185974	JhVl-3 (Little Gladstone)	dung	1810 ± 40
YHB-98-11	TO-7562	JdVb-2 (Thandlät)	dung	1850 ± 50
YHB-98-17	TO-7568	JdUt-17 (Granger)	dung	1910 ± 60
YHB-98-15	TO-7566	JdUt-17 (Granger)	dung	1920 ± 50
YHB-99-R47	Beta-140620	JdUt-17 (Granger)	dung	1960 ± 40
YHB-99-R49	Beta-140622	JdUt-17 (Granger)	dung	2230 ± 40
YHB-01-24	Beta 162355	JdUt-17 (Granger)	dung	2380 ± 40
YHB-97-1	TO-6871	JdVb-2 (Thandlät)	dung	2450 ± 50
VanB 0	GSC-6824	JeVe-6 (Van Bibber)	dung	2480 ± 70
VanB 30	GSC-6813	JeVe-6 (Van Bibber)	dung	2650 ± 70
YHB-99-R24	Beta-136349	JcUu-1 (Friday Creek)	dung	2850 ± 50
YHB-98-5	TO-7556	JdVb-2 (Thandlät)	dung	2890 ± 50

TABLE 7. Radiocarbon dates on caribou faunal material – *continued:*

Submission number	Lab number	Ice patch	Material	Date (uncalibrated)
VanB 15	GSC 6823	JeVe-6 (Van Bibber)	dung	2960 ± 70
YHB-98-18	TO-7569	JdUt-17 (Granger)	dung	3030 ± 50
YHB-03-10	Beta 185975	JhVl-3 (Little Gladstone)	dung	3180 ± 40
YHB-01-28	Beta 162359	JcUu-1 (Friday Creek)	dung	3250 ± 40
YHB-99-R25	Beta 136350	JcUu-1 (Friday Creek)	dung	3550 ± 70
YHB-01-14	Beta 152451	JhVl-1 (Gladstone)	dung	3690 ± 40
YHB-01-10	Beta 152447	JcUu-1 (Friday Creek)	dung	3830 ± 40
YHB-99-R35	Beta 136360	JdUt-17 (Granger)	dung	3850 ± 40
YHB-99-R51	Beta 140624	JdUt-17 (Granger)	dung	4180 ± 40
YHB-01-13	Beta 152450	JcUu-1 (Friday Creek)	dung	4190 ± 40
YHB-99-R28	Beta 136353	JcUu-1 (Friday Creek)	dung	4200 ± 40
YHB-01-11	Beta 152448	JcUu-1 (Friday Creek)	dung	4310 ± 40
YHB-99-R27	Beta 136352	JcUu-1 (Friday Creek)	dung	4410 ± 40
YHB-01-12	Beta 152449	JcUu-1 (Friday Creek)	dung	4440 ± 40
YHB-99-R26	Beta 136351	JcUu-1 (Friday Creek)	dung	4520 ± 50
YHB-99-R33	Beta 136358	JdUt-17 (Granger)	dung	4780 ± 40
YHB-98-19	TO-7570	JdUt-17 (Granger)	dung	6730 ± 70
YHB-98-4	TO-7555	JdVb-2 (Thandlät)	dung	7440 ± 60
YHB-01-26	Beta 162357	JdUt-17 (Granger)	dung	7450 ± 40
YHB-99-R32	Beta 136357	JdUt-17 (Granger)	dung	7500 ± 60
YHB-99-R50	Beta 140623	JdUt-17 (Granger)	dung	7850 ± 50
YHB-99-R30	Beta 136355	JdUt-17 (Granger)	dung	7890 ± 80
YHB-99-R31	Beta 136356	JdUt-17 (Granger)	dung	8330 ± 60
YHB-01-50	Beta 162895	JcUu-2 (Alligator)	tooth	360 ± 40
YHB-01-48	Beta 162893	JcUu-1 (Friday Creek)	tooth	2550 ± 40

[1] Indicates a date not previously reported.

increased alpine hunting within that period) and 2) that preservation is constant through time. Radiocarbon-dated specimens included all organic, diagnostic hunting artifacts (105 of 207; Table 6), as well as 95 miscellaneous caribou elements from a variety of ice patches (Table 7). Regarding constant preservation, Farnell et al. (2004) reported that while Yukon ice patches underwent a marked increase in snow and ice accumulation over the past 2000 years, all of the ice patches appear to have been relatively stable for the past 5000 years, except for the rapid melting events within the past century.

The peaks and drops in density of artifacts and caribou remains revealed by the graph in Figure 16 allow us to correlate caribou abundance and alpine hunting activity. The high density of both artifacts and caribou remains around 4000 ^{14}C yr BP indicates greater hunting activity in a period of caribou abundance. Between 2300 and 2800 ^{14}C yr BP, the data indicate little or no hunting activity at Yukon ice patches. After 1000 ^{14}C yr BP, the density patterns of dated artifacts and caribou remains diverge: alpine caribou appear to be less abundant, while the number of recovered artifacts increases. The increasing density of artifacts could indicate either an actual increase in hunting activity or a change in hunting technology. The observed shift from atlatl to bow and arrow technology at about 1100 ^{14}C yr BP (Hare et al., 2004:270) may be an explanatory factor. More arrows can be released than darts thrown in a given hunting episode, and arrows are also smaller than darts and therefore easier to lose. After 800 ^{14}C yr BP, the apparent decline in quantity of caribou specimens from alpine ice patches continues and is mirrored by a sharp drop in artifact quantity.

At the opposite end of the temporal span, the low density of both artifacts and caribou specimens prior to 6000 ^{14}C yr BP is likely due to poor preservation. As reported in Farnell et al. (2004), the Holocene appears to have been particularly warm in this period, and many of the Yukon ice patches melted away. Only four ice patch sites have archaeological material and preserved faunal material older than 6000 ^{14}C yr BP: JbVa-1 (Texas Gulch), JdUt-17 (Granger), JdVb-2 (Thandlät), and JhVl-1 (Gladstone).

In considering caribou data, it is important to remember why caribou congregate on alpine ice patches: for thermal regulation and to avoid insect harassment (Downes et al., 1986; Ion and Kershaw, 1989). However, persistent snow patches may be larger and more numerous in colder, wetter periods, causing caribou to be distributed over broader areas. So while radiocarbon dates suggest that caribou were present at ice patches throughout the Holocene, it is recognized that number of caribou radiocarbon dates may not be a completely accurate proxy indicator of overall caribou population abundance.

After 4000 ^{14}C yr BP, caribou numbers at the southern Yukon ice patches fluctuate, but a steady overall decline in numbers is apparent to the present day. The explanation for and significance of this decline lie outside the scope of the present paper, but it should be the focus of future research with a larger, more robust radiocarbon dataset for Yukon caribou and other large mammals recovered from the southern Yukon ice patches. Farnell et al. (2004) also reported three radiocarbon dates on bison faunal material at Yukon ice patches in the range of about 3500 to 4600 ^{14}C yr BP, suggesting that the apparent hunting peak at 4000 ^{14}C yr BP may not be based entirely on caribou and sheep hunting. Furthermore, the dates on Yukon ice patch bison coincide with the early part of a previously reported peak in bison populations in Yukon and Alaska (Stephenson et al., 2001).

Variations in Dart Construction Techniques

The number and preservation of throwing darts recovered from Yukon patches provide the opportunity to observe construction techniques that have not previously been reported. Throwing darts made of single shafts and composite darts employing foreshafts have been widely described for North America (Knecht, 1997; Justice, 2002), but the identification of segmented darts that employ double-beveled wooden segments is most unusual. Double-beveled ivory rods recovered from Clovis-age sites in the continental United States have been interpreted as dart foreshafts (Lahren and Bonnichsen, 1974), but segmented wooden shafts are rarely mentioned in archaeological literature. Interestingly, Alaskan atlatl practitioner Mike Richardson has employed a segmented dart design, although in his reproductions the dart segments are held together using a hide sleeve rather than sinew lashings. Richardson maintains that a segmented dart does retain the accuracy, "knock-down power," and penetration capabilities of darts manufactured using alternative methods (M. Richardson, pers. comm. 2010).

The advantages of segmented darts are readily apparent: ease of transport, ease of field repair, and greater availability of suitable materials. What is less well understood is how accurate and durable a segmented dart would be compared to a one-piece or foreshaft-type dart. Because all three dart constructions occur over a broad span of time, it appears that the constraints and preferences of the individual maker may have outweighed any notion of technological tradition regarding dart shaft manufacture. Any dart type could be found in any millennium. This variability or flexibility in construction technique for darts, perhaps influenced by circumstances, may be a further manifestation of the range of diversity noted in the stone and antler projectile points recovered from ice patches, as previously reported by Hare et al. (2008).

Post 1100 ^{14}C yr BP: Technological Replacement in the Southern Yukon

As reported in our earlier publication on the southern Yukon ice patches (Hare et al., 2004:270), radiocarbon dates on ice patch artifacts indicate that hunting technology using throwing darts (atlatl) was abruptly replaced by bow and arrow technology between about 1200 and 1100 ^{14}C yr BP. New data obtained subsequently reaffirm the abrupt nature of the change from darts to arrows (see Table 6 for all dates).

The replacement of dart technology with bows and arrows coincided with a volcanic eruption along the Alaska-Yukon border (Lerbekmo et al., 1975; Clague et al., 1995), which blanketed much of central and southern Yukon with pyroclastic tephra (White River ash), in places up to 2 m thick. A number of researchers have speculated on the environmental and cultural consequences of this event (Workman, 1973, 1979; Derry, 1975; Clark, 1991), and many link the White River eruption (or the earlier eruption from the same source, dated to about 1900 ^{14}C yr BP) with the well-documented movements of Athapaskan-speakers in the Late Prehistoric period, which include the appearance of the Carrier and Chilcotin in central British Columbia and the Navajo and the Apache in the American Southwest (Workman, 1979:352; Ives, 1990:44).

The ice patch archaeological data support the theory that the White River ash fall coincided with the technological changes in the southern Yukon. When dart technology was replaced by bow and arrow technology, the preferred wood for projectile shafts shifted from birch to spruce, and the preferred armature for projectiles changed from stone to antler (Hare et al., 2004:270). Dart and arrow radiocarbon dates indicate that this replacement occurred at the same time as the ash fall, ca. 1200 BP (Froese et al., 2008). It is very likely that local populations were forced to abandon the area near the volcanic vent and relocate to a new region as a result of ecological devastation. Once the southwest Yukon became habitable again, the re-colonizing group appears to have arrived bearing bow and arrow technology.

Despite the abundance of archaeological and faunal radiocarbon dates from the ice patches, it is difficult to determine how long people—and animals—may have been displaced from the ash zone. On the basis of multidisciplinary research, including radiocarbon dating, dendrochronology, and historic records, Froese et al. (2008) conclude that the White River ash event likely occurred between AD 750 and 810. The most recent date on an artifact prior to the ash event is 1250 ± 40 BP (Beta 172879; from artifact JcUu-1:9, a dart shaft with fletching). The first post-eruption radiocarbon date of an artifact is 1060 ± 40 BP (Cal AD 900 to 1030, Beta 197690), while the first dated evidence of post-eruption caribou falls at 1030 ± 50 BP (Cal AD 950 to 1050, TO-7564).

Recent genetic studies on ice patch caribou remains provide additional indications of the magnitude of the impact of the White River ash fall on the regional biosphere. Research by Kuhn et al. (2010) suggests the extirpation of resident caribou and partial herd replacement in southern Yukon immediately after the White River ash event.

SUMMARY

The archaeological component of the Yukon Ice Patch Project has been updated after 13 years of field investigations, recovery of more than 200 organic archaeological objects and 1700 faunal elements, and more than 200 radiocarbon dates. We interpret the data to represent more than 9000 years of general continuity in land use in the Yukon's alpine regions, punctuated by dramatic technological change immediately after the volcanic event known as the White River ash fall ca. 1200 years ago, when throwing dart technology was completely replaced by the bow and arrow.

Within the 8000-year history of throwing dart use in the Yukon, we note three different dart construction techniques, identified as one-piece, darts with foreshafts, and segmented darts. The different techniques do not appear to be time-sensitive and are consistent with the high stylistic variability of forms observed in projectile points recovered from given patches (Hare et al., 2008).

Finally, we speculate that on the basis of higher frequencies of radiocarbon dates for artifacts and caribou faunal remains, it may be possible to discern long-term trends in both land use and caribou abundance. The compiled radiocarbon dates suggest that both caribou and alpine hunting activity were most pronounced in alpine areas of the southern Yukon ca. 3800 BP. It also appears that from ca. 1100 BP to 500 BP, alpine hunting activity (or the number of artifacts lost) increased, while overall caribou specimens declined.

Annual monitoring of the ice patches continues in partnership with the six Yukon First Nations whose traditional territories encompass the 24 archaeological ice patches. While artifact recovery has diminished in recent years, we anticipate that discoveries will continue and will further improve our understanding of the human and natural history of the Yukon.

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