Paleoeskimo Demography and Holocene Sea-level History, Gulf of Boothia, Arctic Canada

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ABSTRACT. Surveys in six areas along the Gulf of Boothia produced large collections of radiocarbon samples from raised beaches that yield six new relative sea-level curves and information on Holocene bowhead whale ranges. In addition, on the lower beaches, we documented 482 Paleoeskimo dwelling features spanning about 3500 years (4200–800 ^{14}C years BP). Spatial densities of sites are only about half those reported by us from adjacent regions, but other attributes are remarkably similar. On the basis of feature elevation, corroborated by radiocarbon dates, Paleoeskimo occupation appears to have passed through a series of boom-and-bust cycles, the first being the most prominent. After the first peopling about 4200 BP, populations rose between about 3900 and 3600 BP to their all-time maximum, which was followed by a dramatic crash. Population recoveries after the initial crash were small and perhaps temporary. A final increase between 1900 (1500) and 800 ^{14}C years BP was followed by the disappearance of the Paleoeskimo. No compelling evidence yet points to the cause of the population declines; climate change and resource over-exploitation are equally plausible. The frequency distributions of dwelling sizes and numbers of dwellings per site closely resemble those in adjacent regions, suggesting similar social dynamics. Specifically, dispersed nuclear families or small extended families characterized Paleoeskimo settlement patterns for most of the year, but annual aggregations involved 100 or more people. The only significant architectural change coincides with the arrival of Late Dorset people bringing distinctive triangular midpassages and soapstone lamp supports.

Key words: archaeology, Paleoeskimo, Pre-Dorset, Dorset, Holocene, sea-level history, paleodemography, dwellings, radiocarbon dates, bowhead whales, driftwood

RÉSUMÉ. Des levés réalisés dans six régions situées le long du golfe de Boothia ont permis de recueillir de vastes collections d'échantillons au carbone 14 provenant de plages surélevées. Les résultats découlant de ces levés produisent six nouvelles résonances relatives du niveau de la mer de même que des renseignements sur le parcours des baleines de l'Holocène. Par ailleurs, dans le cas des plages inférieures, nous avons répertorié 482 caractéristiques d'habitations paléoesquimaudes s'étendant sur environ 3 500 ans (de 4200 à 800 ^{14}C années BP). Les densités spatiales des sites ne constituent environ que la moitié des densités qui nous avons repérées dans des régions adjacentes, mais les autres attributs sont remarquablement semblables. En ce qui a trait à l'élévation des caractéristiques, corroborée par la datation par le carbone 14, l'occupation paléoesquimaude semble avoir traversé une série de cycles d'expansion et de ralentissement, le premier de ces cycles étant le plus éminent. Après le premier peuplement vers 4200 BP, les populations se sont élevées entre 3900 et 3600 BP pour atteindre leur summum de tous les temps, ce qui a été suivi par un déclin dramatique. Les reprises de population après le déclin initial étaient minces, voire peut-être temporaires. Une dernière augmentation entre 1900 (1500) et 800 ^{14}C années BP a été suivie de la disparition des Paléoesquimaux. À ce jour, aucune preuve évidente ne nous laisse comprendre les déclins de population. Le changement climatique et la surexploitation des ressources sont des causes toutes aussi plausibles les unes que les autres. La distribution statistique relativement à la taille des habitations et au nombre d'habitations par site s'apparente de près à celle des régions adjacentes, ce qui laisse entrevoir une dynamique sociale semblable. Plus précisément, des familles nucléaires dispersées ou de petites familles étendues caractérisaient les modèles de peuplement des Paléoesquimaux pendant la plus grande partie de l'année, bien que les rassemblements annuels regroupaient une centaine de personnes ou plus. Le seul changement architectural important coïncide avec l'arrivée du peuple du Dorset tardif ayant mis en valeur des couloirs triangulaires distinctifs et des supports à lampes en saponite.

Mots clés : archéologie, paléoesquimau, pré-Dorset, Dorset, Holocène, historique du niveau de la mer, paléodémographie, habitations, datation par le carbone 14, baleines boréales, bois flotté

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INTRODUCTION

This paper presents the results of two archaeological and palaeontological surveys on southeast Somerset Island and in four other areas along the coast of the Gulf of Boothia, the latter being the first systematic surveys in these areas (Fig. 1). We previously presented the results of similar surveys in four regions farther west, namely southwest Victoria Island (Savelle and Dyke, 2002), western Boothia Peninsula (Savelle and Dyke, 2009), and Kent Peninsula and King William Island (Dyke and Savelle, 2009), and we presented partial results of surveys of islands in Foxe Basin, east of the Gulf of Boothia (Savelle et al., 2009). All of these reports documented boom-and-bust profiles of Paleoeskimo occupation, with the largest populations and most prominent crashes early in the occupation sequence.

In the Gulf of Boothia region, Mary-Rousselière (1964) reported the first Paleoeskimo features, specifically in the Pelly Bay area. Schledermann (1978a) reported on surveys conducted on northern and southern Somerset Island and at several localities on the Boothia Peninsula during the Polar Gas Archaeology Project in 1977. Damkjar surveyed the southeast coast of Somerset Island for Paleoeskimo features in 1983 – 85 and reported on sites north and south of our survey areas (Damkjar, 2000, 2003, 2005). Bielawski

(1988) reported Paleoeskimo sites from northwest and central Somerset Island. However, unlike the research reported here, none of these previous studies were specifically designed to investigate regional Paleoeskimo demography using reconstructed sea-level history.

This paper fills a large gap in our previous surveys across the lower tier of islands in the Canadian Arctic Archipelago and adjacent mainland coast. As in the earlier studies, we focus on the changing abundance of dwelling features by elevation on raised beach sequences—a proxy for age—and on individual dwelling sizes, as well as on overall site sizes and architecture. We present new radiocarbon age determinations from these sites and compare them to our previous results. Our purpose is to further document changing levels of human occupation, to explore chronological patterns in these changes, and to seek evidence of changes in social organization. We also present new relative sea-level (RSL) curves and use these to assess and constrain archaeological site chronologies.

Early Paleoeskimos, the first people to occupy the Canadian Arctic Archipelago and adjacent mainland coastal regions, are generally referred to as the Pre-Dorset culture in the Central Canadian Arctic, and Late Paleoeskimos are known as the Dorset culture. The latter is thought to have derived from the former about 2500 ^{14}C years BP (henceforth BP) and to have been replaced by Neoeskimos from the Bering Strait region about 700 – 1000 BP. Neoeskimo Thule culture sites have been studied on southeast Somerset Island and eastern Boothia Peninsula (Savelle, 1987, 2000).

METHODS

From six aircraft-deployed field camps (Cape Garry, Hazard Inlet, Murray Bay, Abernethy Bay, Cape Chapman, and Crown Prince Frederik Island (henceforth CPFI); Fig. 1), two observers surveyed raised beach sequences and other terrain from all-terrain vehicles between 12 and 30 July 2007 and between 7 July and 8 August 2008. We inspected beaches between modern sea level and the highest accessible terrain (range: 50–160 m) in each area. The limit of postglacial marine submergence on southeast Somerset Island is about 160 m, but it rises southward from there along the Gulf of Boothia coast, reaching about 250 m (Dyke et al., 2005). We concentrated our search on middle and late Holocene relict shorelines, generally the lower 30 – 40 m, where archaeological sites are most abundant. During about six days at each camp, we searched linear coastal segments of about 20 km. We traversed on ATVs each day in roughly parallel lines, proceeding obliquely upslope and down outward from camp and then back. Most of the terrain within the search area was fairly uniformly and thoroughly inspected. We recorded the elevations above high tide line of all archaeological sites using a surveying altimeter. Altimeter readings were corrected for changes in atmospheric pressure and are probably accurate to ± 0.5 m. All feature locations were recorded by hand-held GPS.
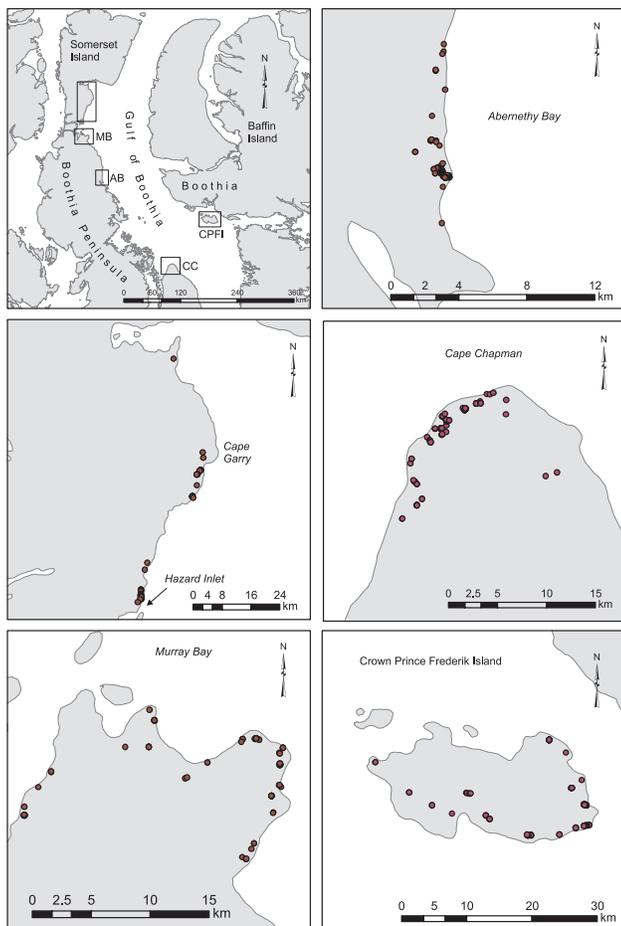

FIG. 1. Location of the survey areas and of Paleoeskimo sites.

Feature sizes were measured with a steel tape, and dwelling features were classified according to familiar Paleoeskimo architectural types (Ryan, 2003; Sutherland, 2003; Dyke and Savelle, 2009; Savelle and Dyke, 2009). In the case of tent rings, dimensions were taken on what appeared to be the original outside dimensions. Included in the tent ring category here are scattered (disturbed or indistinct) rings.

Small samples of charcoal and burnt moss from hearths and of wood and bone debitage on or near the surface were collected for radiocarbon dating. Charcoal and wood samples were identified by cell anatomy at the Geological Survey of Canada Paleoecology Laboratory as either local dwarf willow (*Salix* sp.) or spruce (*Picea* spp.) driftwood after leaching in multiple baths of HCl to remove secondary carbonate. Willow charcoal grains were chosen for dating where present; otherwise, driftwood charcoal was used, if mammal food bone was not available. The mammal bones submitted for dating were longbone fragments with evidence of marrow cavities and with curvatures indicating that they came from large animals of caribou, muskox, or polar bear size. Because they were not morphologically identifiable to genus, we used their stable isotope values to assess whether they were from animals with terrestrial or marine diets. The burnt moss samples were not identified to genus but were identical in appearance to samples reported earlier by us that had been identified at the Canadian Museum of Nature. We also dated a few samples of dead plant material from beneath structural flagstones. These were wet-sieved to remove the humic fraction and identified only to broad category (e.g., lichen).

Samples of whale bones, driftwood, and marine shells were also collected. The outermost layers of driftwood logs were cleaned for dating by removing exterior wood. All bone samples were mechanically reduced to clean interior portions prior to submission. Shells were surface leached prior to dating. New radiocarbon samples were analyzed at the AMS facility at the University of California at Irvine (UCIAMS). Bone dates were run on ultrafiltered collagen fractions larger than 30 kiloDaltons (kD) in size. Collagen quality was assessed through percent yield, colour, and C/N ratios. We also report conventional dates determined on earlier geological collections, mainly by ourselves, which were analyzed by laboratories at the Geological Survey of Canada (GSC) and the Saskatchewan Research Council (S). All dates listed in tables are conventionally normalized for carbon isotope fractionation.

The dates were calibrated with the online version of CALIB 6.0.0 (accessed 10 June 2010) using the ± 2 sigma range with the largest area under the probability curve (Reimer et al., 2009). Dates on terrestrial materials were calibrated using the Intcal09 dataset, and dates on marine materials, using the Marine09 dataset. For marine shell and polar bear bone dates, a "delta R" value of 240 ± 50 years was applied (total correction 740 years), whereas for whale bone dates, a delta R value of 0 ± 50 years was applied, as discussed below. Calibrated dates are presented in the tables, but our discussion uses the radiocarbon time scale.

ENVIRONMENT

All six study areas are within the Middle Arctic vegetation belt as defined by Edlund (1986). Environment Canada no longer reports climate normals for Taloyoak (formerly Spence Bay), the nearest community. However, data for 1941–70 from that station indicate a mean annual temperature of -15.4°C (compared to -34.4° for January and 7.1°C for July) and precipitation of 153.4 mm (Atmospheric Environment Service, 1975). The Middle Arctic typically has a vegetation cover of 30–50% on mesic substrates. Willow is the only large shrub, and common plants include sedges, grasses, forbs, and ericaceous shrubs. The Middle Arctic lies between the High Arctic (polar desert), where the vegetation cover is typically 1–5%, and the Low Arctic, where vegetation cover commonly attains 50–100%. In both the Middle and High Arctic, vegetation cover is suppressed on highly alkaline substrates and is enhanced on the nutrient-rich acidic substrates. On both substrates, plant cover responds markedly to soil drainage conditions, being greater on moister sites.

Our survey areas are dominated by flights of raised beaches composed mainly of gravel, ranging from fine gravel to boulder gravel. Carbonate clasts predominate in all areas except in parts of the Cape Garry area, where red sandstone is common to predominant and where the beaches are composed of sandy gravel to gravelly sand. Vegetation cover is typically only 1–5% on the dolomitic gravels, where even lichens and dwarf willows are rare, but more extensive vegetation (20–80%) covers the beaches rich in sandstone clasts. Vegetation cover is also enhanced at sites of former human occupation. Richer vegetation in swales and small wetlands between raised beaches, as well as on glacial till, finer-grained raised marine sediment, and alluvium, supports small caribou and muskoxen herds.

Our study sites are along about half the 800 km length of the Gulf of Boothia. The gulf has a near-perennial sea-ice cover, but the open-water season is extended locally in polynyas around the east end of Bellot Strait (south of Hazard Inlet) and around the west end of Fury and Hecla Strait, east of CPFI (Stirling and Cleator, 1981). Prince Regent Inlet, at the north end of the gulf, becomes clear of ice earliest, typically in mid to late July, whereas Committee Bay, at the south end, often retains an extensive sea-ice cover throughout the summer because it is a cul-de-sac for the prevailing, sea-ice bearing, southward current. The bowhead whale reached its historic range limit approximately in Prince Regent Inlet (Dyke et al., 1996a). The largest known Thule bowhead whaling villages in Arctic Canada are in the northern Creswell Bay, Cape Garry, and Hazard Inlet areas, but only one substantial whaling site is known south of there, at Bowles Bay on eastern Boothia Peninsula (Savelle, 2000). These villages were occupied until the onset of the Little Ice Age (Douglas et al., 2004; J.M. Savelle and A.S. Dyke, unpubl. data), when the bowhead probably retracted its range.

The Quaternary geology and general environmental conditions are described in Dyke (1983, 1984) and in Dyke and Dredge (1989). Postglacial uplift rates were unevenly documented in this region (Dyke et al., 1991), but the entire region shows evidence of late Holocene emergence.

SIGNIFICANT FAUNAL RESOURCES

One of our strategies in studying Canadian Arctic Paleoeskimo demography has been to sample regions with differing food resources as a possible way of assessing the relative roles of resource failure and climate change in determining human population changes. For the Paleoeskimo, critical food resources were terrestrial and marine mammals and fish. Previously we have sampled western areas rich in muskox, caribou, and seal, west-central areas with caribou, seal, and muskox, and in the east, Foxe Basin, which is dominated by walrus, seal, and caribou. The Gulf of Boothia is perhaps the most seal-dominated of our sampling areas to date.

The historic Netsilik Inuit of this region made relatively little use of the Gulf of Boothia side of their territory in comparison to the western side, except for the Lord Mayor Bay and Pelly Bay areas. The species most important to them were ringed seals (*Phoca hispida*) and caribou (*Rangifer tarandus*). Ringed seals, probably the most abundant resource, rely on landfast sea ice and occupy the central Arctic region year-round. Sealing was traditionally the primary subsistence activity in winter and spring (Ross, 1835; M'Clintock, 1859; Rasmussen, 1931; Brice-Bennett, 1976), which together account for most of the year.

Barren-ground caribou (*R. t. tarandus*; 80 – 110 kg) are summer migrants to the Boothia Peninsula, where they overlap with the year-round Peary caribou (*R. t. pearyi*; 55 – 80 kg), which also occupy Somerset Island and more northerly islands. The Boothia-Somerset caribou herd is small in comparison to that farther west on the mainland and on Victoria Island. CPFI probably receives occasional small groups of caribou (relatives of the barren-ground group) from Baffin Island, but CPFI has limited forage. Large Thule archaeological sites just southwest of our Gulf of Boothia study area are located near barren-ground caribou river crossings (Savelle, 1987), but no such sites are known within our survey areas, where the small Peary form predominates.

Small herds of muskoxen (*Ovibos moschatus*; averaging 340 kg) are also present year-round on Somerset Island and the Boothia Peninsula, which the species has recolonized following its 20th-century extirpation (Barr, 1991:52 – 53). Muskoxen are historically unknown on Baffin Island and have probably never visited CPFI. The aggregate Boothia-Somerset herd numbers in the hundreds, in contrast to those on Victoria and Banks islands, which may attain tens of thousands.

Walruses are rare in the Gulf of Boothia, and the archaeological sites there, in sharp contrast to sites in adjacent Foxe Basin, rarely contain walrus remains (Savelle et al., 2009). However, polar bears (*Ursus maritimus*) are common today and also show up significantly in our small bone samples from Paleoeskimo sites.
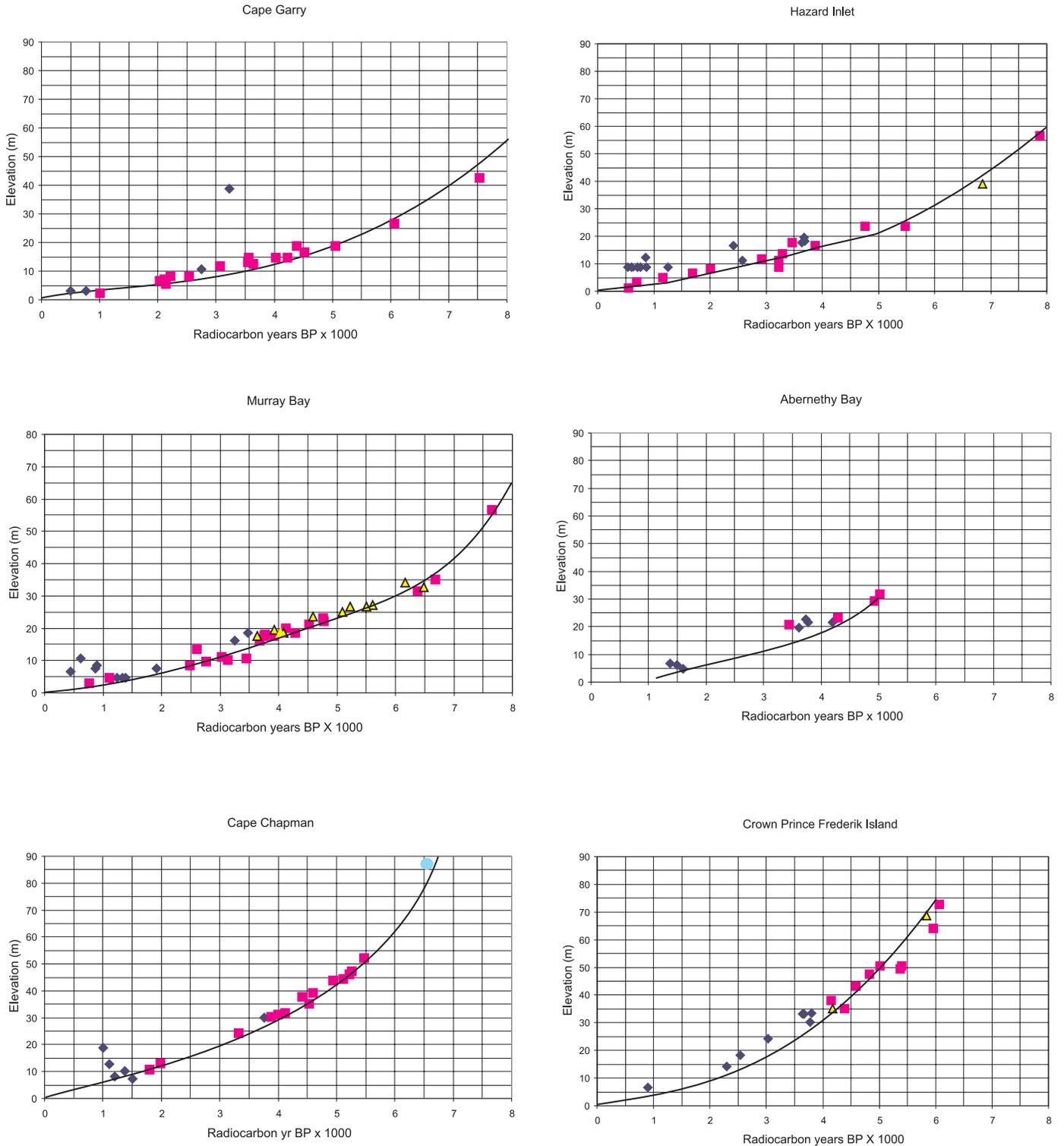
Arctic char (*Salvelinus alpinus*) is an important food resource in the region, and again Neoeskimo sites mark major sea-runs. Arctic cod (*Boreogadus saida*) is also important, especially as the primary prey of the ringed seal. Data for eastern Arctic coastal Inuit indicate that fish probably constituted a significant part of the Neoeskimo diet (Kelly, 1995:67; Stewart, 2006). Fish presumably were also important for the Paleoeskimo diet, and certainly fish bones show up in our Paleoeskimo sites near major char runs.

RESULTS AND DISCUSSION

Relative Sea-level History

The raised beaches along the Gulf of Boothia are sufficiently rich in archaeological sites and especially in the remains of bowhead whales that RSL curves are fairly well constrained (Fig. 2). Dates on archaeological sites (discussed below) should fall on or above those curves, while dates on whale bones, driftwood, and shells (Table 1) should fall on or below the curves. The plots in Figure 2 do not include early Holocene data, because these are not relevant to the archaeology. Nevertheless, all RSL-relevant geological samples are listed in Table 1. Marine shell ages in this region should be reduced by 740 years from the conventionally normalized ages to account for the average empirical age of the modern marine reservoir, as measured in pre-bomb molluscs (McNeely et al., 2006). Polar bear ages (all archaeological) are reduced by the same amount on Figure 2, which may be somewhat excessive if these animals fed for part of the year in waters with lower reservoir ages to the east or south. We reduce bowhead whale bone ages by 400 years, a figure close to the global ocean reservoir age, including that of the Labrador Sea where they winter. We lack an empirical reservoir correction for bowheads in this region. However, these animals would have spent only brief intervals in the central Arctic each year, and comparisons of driftwood–whale bone age pairs from raised beaches in the Canadian Arctic Archipelago, as well as data discussed below, indicate that a larger correction for whale bone dates might be excessive (Dyke et al., 1996b). Walrus (3 samples only) are treated in the same manner as bowheads.

Because only the middle and late Holocene parts of the RSL curves are pertinent here, all geological samples involved except one are bowhead bones, driftwood, and walrus, the large majority being bowhead. Were it not for certain taphonomic effects, the elevations of all of these samples would represent former RSLs, because all originated as flotage on raised beaches. However, some dated materials may have been displaced above high-tide level by sea-ice push, and some dead whales undoubtedly grounded or sank in shallow water. The modern beach ridge crest is

FIG. 2. Relative sea-level curves. The Cape Garry, Hazard Inlet, and CPFI plots include dates on Thule archaeological sites not discussed in the text.

typically about 2 m above high tide level, and in this region it is constructed largely by ice push. These factors probably account for much of the modest scatter in the data and justify a visual best fit for the RSL curves.

The Cape Garry and Hazard Inlet RSL curves are based entirely on bowhead, walrus, and archaeological dates. The two curves are all but indistinguishable, yet the latter probably sits slightly above the former. This difference is

TABLE 1. Radiocarbon dates on marine shells, whale bones, walrus bones, and driftwood used for relative sea-level curves; all ages conventionally normalized based on measured or assumed fractionation. Laboratory codes are for UCIAMS-dates unless otherwise indicated. Area in last column is the area under the probability distribution for the calibration. The stated range is that with the largest area and is rounded to decade.

Laboratory code	Taxon dated	Elev. (m)	^{14}C Age	δ^{13}C	Calib 5.0.2 2-sigma range	Area
Cape Garry						
GSC-6119	Hiatella arctica	132	9740 ± 80	0.42	10220 – 10500	1.000
42183	Balaena mysticetus	111	9590 ± 30	-16.2	10290 – 10570	1.000
42182	Balaena mysticetus	90.5	9115 ± 25	-16.1	9670 – 10110	1.000
43972	Balaena mysticetus	42	7960 ± 20	-16.1	8320 – 8540	1.000
47767	Balaena mysticetus	26	6500 ± 20	-16.0	6860 – 7150	1.000
49804	Balaena mysticetus	18	5485 ± 20	-16.8	5720 – 5980	1.000
47761	Balaena mysticetus	18	4815 ± 20	-16.2	4930 – 5380	1.000
48012	Balaena mysticetus	16	4955 ± 25	-16.0	5110 – 5450	0.990
49803	Balaena mysticetus	14	4460 ± 20	-16.0	4490 – 4810	1.000
47756	Balaena mysticetus	14	3990 ± 15	-16.3	3840 – 4140	1.000
49800	Balaena mysticetus	14	4655 ± 20	-16.3	4770 – 5040	1.000
47766	Balaena mysticetus	12.5	3980 ± 15	-15.2	3830 – 4130	1.000
48013	Balaena mysticetus	12	4050 ± 25	-16.3	3900 – 4250	1.000
49802	Balaena mysticetus	12	4070 ± 15	-16.0	3940 – 4280	1.000
49824	Balaena mysticetus	11	3500 ± 15	-16.5	3250 – 3520	1.000
49805	Balaena mysticetus	7.5	2975 ± 15	-15.3	2650 – 2880	0.998
49823	Balaena mysticetus	7.5	2645 ± 15	-16.8	2160 – 2490	1.000
47762	Balaena mysticetus	6.5	2540 ± 15	-15.2	2070 – 2330	1.000
47760	Balaena mysticetus	6	2465 ± 15	-16.2	1980 – 2290	1.000
47764	Balaena mysticetus	5	2570 ± 20	-15.1	2090 – 2350	1.000
47763	Balaena mysticetus	1.5	1440 ± 15	-16.1	890 – 1130	1.000
Hazard Inlet						
GSC-136	Mya truncata, Hiatella arctica	127	9580 ± 170		9880 – 10440	1.000
53024	Balaena mysticetus	90	9020 ± 35	-16.5	9530 – 9910	1.000
53026	Balaena mysticetus	89.75	8995 ± 30	-16.1	9520 – 9870	1.000
53027	Balaena mysticetus	88	9085 ± 30	-16.2	9600 – 10080	1.000
53025	Balaena mysticetus	86	9055 ± 30	-16.7	9550 – 9960	0.985
43976	Balaena mysticetus	81	8945 ± 25	-16.4	9480 – 9790	1.000
43975	Balaena mysticetus	74.5	8670 ± 25	-16.5	9190 – 9470	1.000
43977	Balaena mysticetus	66	8595 ± 25	-17.1	9080 – 9410	1.000
43978	Balaena mysticetus	56	8305 ± 20	-15.8	8670 – 9000	1.000
S-3512	Odobenus rosmarus	38.5	7290 ± 160	-16.0	7450 – 8090	1.000
S-3563	Balaena mysticetus	23	5195 ± 170	-16.0	5110 – 5940	0.993
47757	Balaena mysticetus	23	5910 ± 20	-16.4	6210 – 6440	1.000
S-3514	Balaena mysticetus	17	3900 ± 140	-16.9	3480 – 4290	1.000
49801	Balaena mysticetus	16	4310 ± 15	-15.5	4270 – 4590	1.000
S-3513	Balaena mysticetus	13	3725 ± 140	-15.8	3320 – 4060	1.000
S-3509	Balaena mysticetus	11	3355 ± 140	-15.8	2830 – 3560	1.000
47758	Balaena mysticetus	10.5	3655 ± 20	-16.1	3410 – 3700	1.000
S-3511	Balaena mysticetus	8	3660 ± 130	-16.2	3250 – 3940	1.000
48011	Balaena mysticetus	7.5	2445 ± 25	-16.1	1940 – 2270	1.000
S-3508	Balaena mysticetus	6	2125 ± 130	-16.0	1380 – 2040	1.000
S-3507	Balaena mysticetus	4.25	1590 ± 130	-15.6	840 – 1410	1.000
53022	Balaena mysticetus	2.75	1125 ± 15	-16.4	590 – 780	0.981
53020	Balaena mysticetus	0.5	985 ± 15	-15.3	500 – 650	1.000
Murray Bay						
GSC-2720	Mya truncata	185	9630 ± 130	1.40	10070 – 10480	0.992
GSC-6141	Hiatella arctica	150	9680 ± 90	1.86	10170 – 10470	1.000
GSC-6120	Mya truncata	144	9710 ± 100	3.31	10190 – 10490	1.000
42184	Balaena mysticetus	101	9105 ± 25	-17.3	9650 – 10100	1.000
42185	Balaena mysticetus	56	8080 ± 25	-15.9	8400 – 8700	1.000
43982	Balaena mysticetus	34.5	7115 ± 20	-16.7	7480 – 7690	1.000
42168	Picea driftwood	33.5	6195 ± 20	-22.8	7010 – 7170	1.000
42171	Larix driftwood	32	6515 ± 25	-24.4	7420 – 7480	0.935
44005	Balaena mysticetus	31	6805 ± 30	-16.0	7210 – 7430	1.000
42172	Larix driftwood	26.5	5645 ± 20	-24.3	6400 – 6490	0.975
42163	Picea driftwood	26	5530 ± 20	-24.1	6290 – 6400	1.000
42167	Picea driftwood	26	5255 ± 20	-24.5	5930 – 6180	1.000
42170	Picea driftwood	24.5	5130 ± 20	-24.0	5760 – 5930	1.000
42169	Larix driftwood	23	4620 ± 20	-23.3	5310 – 5450	1.000
49808	Balaena mysticetus	22.5	5195 ± 20	-16.0	5440 – 5670	1.000
44004	Balaena mysticetus	21.5	5205 ± 25	-15.8	5450 – 5690	1.000
49810	Balaena mysticetus	20.5	4960 ± 20	-15.9	5120 – 5460	1.000
49826	Balaena mysticetus	19.5	4560 ± 20	-16.5	4580 – 4890	1.000
42166	Picea driftwood	19	3955 ± 20	-23.2	4300 – 4520	1.000
42165	Larix driftwood	18	4125 ± 20	-23.6	4530 – 4810	1.000

TABLE 1 – continued: Radiocarbon dates on marine shells, whale bones, walrus bones, and driftwood used for relative sea-level curves; all ages conventionally normalized based on measured or assumed fractionation. Laboratory codes are for UCIAMS-dates unless otherwise indicated. Area in last column is the area under the probability distribution for the calibration. The stated range is that with the largest area and is rounded to decade.

Laboratory code	Taxon dated	Elev. (m)	^{14}C Age	δ^{13}C	Calib 5.0.2 2-sigma range	Area
Murray Bay – continued:						
42173	*Picea* driftwood	18	4065 ± 20	-24.1	4440 – 4780	1.000
43983	*Balaena mysticetus*	18	4720 ± 15	-16.9	4820 – 5140	0.988
49806	*Balaena mysticetus*	17.5	4200 ± 15	-16.5	4130 – 4430	1.000
42164	*Picea* driftwood	17	3670 ± 20	-23.7	3930 – 4080	1.000
43984	*Balaena mysticetus*	17	4190 ± 15	-16.1	4120 – 4420	1.000
49807	*Balaena mysticetus*	17	4355 ± 20	-15.8	4350 – 4690	1.000
43999	*Balaena mysticetus*	15.5	4105 ± 25	-15.7	3980 – 4340	1.000
44003	*Balaena mysticetus*	13	3035 ± 25	-15.6	2710 – 2940	1.000
49811	*Balaena mysticetus*	10.5	3465 ± 20	-15.5	3200 – 3470	1.000
49825	*Balaena mysticetus*	10	3885 ± 15	-16.8	3690 – 4010	1.000
44001	*Balaena mysticetus*	9.5	3565 ± 25	-15.1	3330 – 3600	1.000
43986	*Balaena mysticetus*	9	3190 ± 15	-16.4	2840 – 3160	1.000
43987	*Balaena mysticetus*	8	2915 ± 15	-15.6	2500 – 2800	1.000
43985	*Balaena mysticetus*	4	1540 ± 15	-15.9	970 – 1220	1.000
49809	*Balaena mysticetus*	3.5	1535 ± 15	-15.3	960 – 1220	1.000
44000	*Balaena mysticetus*	2.5	1190 ± 25	-14.5	650 – 870	1.000
Abernethy Bay						
43979	*Balaena mysticetus*	31	5460 ± 15	-16.1	5700 – 5950	1.000
43981	*Balaena mysticetus*	28.5	5365 ± 20	-15.9	5610 – 5870	1.000
43980	*Balaena mysticetus*	22.5	4725 ± 15	-15.7	4830 – 5140	0.978
44131	*Balaena mysticetus*	20	3875 ± 15	-15.4	3680 – 3990	1.000
Cape Chapman						
77706	*Mytilus edulis*	86	7335 ± 20	0.2	7467 – 7671	1.000
53252	*Balaena mysticetus*	51.5	5910 ± 25	-15.6	6210 – 6440	1.000
64619	*Balaena mysticetus*	46.5	5690 ± 20	-15.3	5950 – 6230	1.000
53251	*Balaena mysticetus*	45.5	5650 ± 25	-15.5	5910 – 6190	1.000
53253	*Balaena mysticetus*	43.75	5555 ± 25	-14.8	5810 – 6120	0.996
64624	*Balaena mysticetus*	43	5375 ± 20	-15.7	5620 – 5890	1.000
64623	*Balaena mysticetus*	38.5	5025 ± 20	-15.5	5270 – 5530	1.000
64617	*Balaena mysticetus*	37	4850 ± 20	-15.8	4980 – 5290	1.000
64621	*Balaena mysticetus*	35.5	4970 ± 20	-16.0	5170 – 5460	0.983
64622	*Balaena mysticetus*	34.5	4970 ± 20	-15.4	5170 – 5460	0.983
64625	*Balaena mysticetus*	31	4555 ± 20	-15.4	4570 – 4880	1.000
64620	*Balaena mysticetus*	30.5	4430 ± 20	-15.5	4440 – 4780	1.000
64618	*Balaena mysticetus*	29.5	4320 ± 20	-16.2	4280 – 4610	1.000
53049	*Balaena mysticetus*	23.5	3750 ± 20	-16.3	3540 – 3840	1.000
53254	*Balaena mysticetus*	12.5	2410 ± 25	-16.0	1880 – 2210	1.000
53271	*Balaena mysticetus*	10	2230 ± 20	-15.5	1700 – 1970	1.000
CPFI						
S-3433	*Balaena mysticetus*	72	6490 ± 130	-16.3	6660 – 7290	1.000
GSC-5295	*Picea* driftwood	68	5870 ± 70		6630 – 6790	0.982
GSC-5087	*Hiatella arctica*	65.5	6330 ± 100	1.9	6340 – 6680	1.000
64615	*Balaena mysticetus*	63.5	6385 ± 20	-15.7	6710 – 7000	1.000
S-3431	*Balaena mysticetus*	50	5440 ± 120	-16.8	5570 – 6140	1.000
S-3432	*Balaena mysticetus*	50	5835 ± 120	-16.7	5930 – 6510	1.000
53043	*Balaena mysticetus*	48.75	5810 ± 20	-16.0	6100 – 6350	1.000
S-3434	*Balaena mysticetus*	47	5265 ± 120	-15.8	5330 – 5900	1.000
53046	*Balaena mysticetus*	42.5	5015 ± 20	-16.6	5260 – 5520	1.000
TO-5016	*Odobenus rosmarus*	41	4940 ± 70		4990 – 5480	1.000
64616	*Balaena mysticetus*	37.5	4585 ± 15	-15.7	4630 – 4940	1.000
GSC-5294	*Picea* driftwood	34.5	4210 ± 70		4630 – 4850	1.000
53044	*Balaena mysticetus*	34.5	4815 ± 20	-16.6	4930 – 5380	1.000
CAMS-38434	*Odobenus rosmarus*	26	4670 ± 70	-14.7	4680 – 5210	1.000

expected from the similar positions of the two sites with respect to glacial ice-loading centres (Dyke and Prest, 1987; Dyke, 2004). For our current purpose, however, three points are important. First, the two neighbouring RSL datasets virtually reproduce each other, lending credence to both. Second, the difference in isostatic rebound between the Cape Garry and Hazard Inlet areas is small enough that we can treat them as one region for our archaeological analysis. Third, any substantial increase in reservoir correction for the bowhead dates would bring the curves into conflict with the archaeological dates.

Apart from archaeological dates, the Murray Bay curve for the last 8000 years is based primarily on a mix of bowhead and driftwood dates, the only curve with an abundance of dates on both these materials. All of the driftwood logs are several metres long and well embedded in beach gravel, hence not displaced by people (cf. Dyke and Savelle, 2000). The middle and late Holocene part of this curve

too is essentially indistinguishable from the neighbouring curves to the north, which again is generally expected from previously drawn isobase patterns (Dyke et al., 1991). Two points seem pertinent to our present purpose. First, curves drawn through driftwood dates and bowhead dates independently for this area would be indistinguishable. Second, as for Cape Garry and Hazard Inlet, any substantial increase in reservoir correction for the bowhead dates would bring the curve into conflict with the archaeological dates.

The Abernethy Bay curve has only four geological samples and needs further dating control. The highest three bowhead samples produce an accordant trend of ages that merge well with the early group of archaeological dates. However, the lowest bowhead sample (20 m) is about 200 years younger than an archaeological site 1 m lower. Although most of the bowhead samples we dated throughout the region were ear bones from large, typically embedded, skulls, this sample (UCIAMS-44131) consisted of two short, weathered rib fragments that were on the surface near a Paleoeskimo dwelling. We suspect, therefore, that the fragments are associated with the occupation of the dwelling and were brought there from a slightly lower stranding site. If interpreted that way, the 20 m bowhead date is not in conflict with the curve. The best-dated segment of this RSL curve places it slightly higher than the contemporaneous part of the Murray Bay curve.

The Cape Chapman curve has a small scatter amongst the more important samples. Although there is only one high-level archaeological date and only one of the dated Late Dorset encampments was closely associated with a shoreline, the bowhead dates are nicely accordant amongst themselves and with the two mentioned archaeological dates. Cape Chapman is significantly closer to the centre of glacial ice loading in Keewatin than the sites discussed above. Consequently, the middle and late Holocene shorelines are distinctly higher there than they are farther north.

CPFI, although north of Cape Chapman, is within a region isostatically dominated by a different sector of the Laurentide Ice Sheet. The Foxe (Basin) Dome of ice disintegrated much later than the Keewatin Dome, ensuring stronger middle Holocene rebound (Dyke, 2004). The CPFI curve places the site within the isostatic domain of the Foxe Dome because middle Holocene shorelines there are even higher than they are at Cape Chapman. Although there is no geological sample control on shorelines younger than 4000 BP at CPFI, the trend from 6000 to 4000 BP is nicely constrained by bowhead, driftwood, and walrus dates. Furthermore, the archaeological samples dating after 4000 BP strongly support a continuation of the same trend of RSL decline. Here again, a larger reservoir correction for bowheads would introduce conflicts with the driftwood dates.

The most important shorelines for the archaeology of this region are those that are contemporaneous with the earliest Pre-Dorset (4500 BP) and earliest Dorset (2500 BP) peoples. These shorelines are now found at 18 to 40 m and 8.5 to 16 m throughout the region (Table 2). Terminal Dorset is so recent, well under 1000 BP, that site elevation is unhelpful

TABLE 2. Present elevations of the earliest Pre-Dorset and earliest Dorset beach levels in the areas represented by RSL curves of Figure 2.

RSL curve area	4500 BP beach (m)	2500 BP beach (m)
Cape Garry	18	8.5
Hazard Inlet	19	8.5
Murray Bay	20	8.5
Abernethy Bay	24	10
Cape Chapman	36	16
CPFI	40	12–16

in the discussion about exactly when site occupation(s) may have occurred.

Faunal Ranges

The blue mussel, *Mytilus edulis*, is a key thermophile in Arctic waters. Its presence in a single sample from the Gulf of Boothia, albeit the highest site visited at Cape Chapman (Table 1), may represent a rare eastward extension of the Pacific blue mussel or a northward extension of the Atlantic blue mussel from Hudson Bay at a time when Hudson Bay and the Gulf of Boothia were still contiguous. Its apparent absence throughout the Holocene on King William Island, west of the Boothia Peninsula (Dyke and Savelle, 2009), favours the second interpretation. The sample elevation (86 m) confirms connection of the Gulf of Boothia and Hudson Bay at that time.

Bowhead whale remains are abundant in the Gulf of Boothia, though unevenly distributed in time. The remains at Cape Chapman are perhaps the clearest example of local range extension and retraction within the gulf. As mentioned, the southern part of the Gulf of Boothia is a sea-ice cul-de-sac that typically retained its summer ice cover during historic time. As can be seen from the Cape Chapman RSL curve, no bowheads accessed that region between 8000 and 5500 BP, but bowheads subsequently occupied the region in sufficient abundance to leave numerous remains in beaches dating between 5500 and 3900 (or possibly 3300) BP. Only two remains date younger than 3300 BP (these date from 2000 to 1800 BP). Somewhat fewer bowheads seem to have reached CPFI during the middle Holocene, and they evidently retreated from there by about 4200 BP (Fig. 2).

General Archaeological Site Distribution

All dwelling features are located on well-drained beach gravel, ranging from fine gravel to boulder gravel. Sandy beaches are common on parts of southeast Somerset Island. We found no dwelling features in sandy areas, a pattern that we have also observed in other surveys. In all survey areas, there is a distinct clustering of Paleoeskimo features on headlands (Fig. 1), even though gravel substrates are almost equally common elsewhere. Sites show no particular affinity for proximity to ponds or streams.

In this paper—as in our previous reports—we define a site as an individual dwelling feature isolated from, and generally not within sight of, any others, or as an obvious grouping of two or more dwellings on the same beach, or at closely similar elevations on adjacent beach ridges, where the dwellings are spaced a few metres apart.

Feature Frequencies and Ages

We recorded 482 Paleoeskimo dwelling features distributed as follows: 25 at Cape Garry, 58 at Hazard Inlet, 82 at Murray Bay, 107 at Abernethy Bay, 109 at Cape Chapman, and 101 on CPFI. Intervals of time spent searching were similar in each area, though shortened by about one-third at Abernethy Bay and CPFI because of weather conditions. These abundances are one-half or less of those we recorded in similar intervals in almost all other areas we have surveyed. The highest-elevation dwellings are at 43.5 m at Cape Garry, but dwellings are rare above 18 m; 23 m at Hazard Inlet; 40 m at Murray Bay, but rare above 26 m; 34 m at Abernethy Bay, but rare above 28 m; 39.5 m at Cape Chapman, but rare above 34 m; and 34 m at CPFI. We found no Paleoeskimo sites at higher elevations despite searching much higher terrain, and inland sites in these regions are extremely rare (e.g., Schledermann, 1978a).

Because of the relatively low abundance of sites on southeast Somerset Island and the slight, if any, isostatic tilting along that segment of coast, the Cape Garry and Hazard Inlet areas are combined in the following discussion. The five graphs of frequency of features by elevation show some remarkable similarities (Fig. 3). Each histogram shows the most prominent mode on beach levels older than 3500 BP and one or more less prominent modes on younger beaches. The youngest features occur at 4 to 7 m elevation. In some areas, for example, Abernethy Bay, the distribution of relatively high-level sites gives the impression of a gradual rise of population to a maximum. In other areas, e.g., CPFI, the maximum abundance of sites is at the highest occupied levels, perhaps reflecting the sudden arrival of established band-size populations from elsewhere in the region, as opposed to smaller "pioneering" populations. In all areas, however, the peak abundance is followed by a precipitous decline.

As we have discussed elsewhere (Dyke and Savelle, 2009; Savelle and Dyke, 2009), it is difficult to explain the tight clustering of sites by elevation, especially the commonality of that pattern through such a large region, as indicating anything other than sudden changes in populations of people camped close to the shoreline. If residential sites were not rather closely tethered to shorelines, they should be uniformly or randomly distributed and should not be limited to the middle and late Holocene raised beaches. If these features were occupied when the shoreline was on average only a few metres below the campsites, as the distributions suggest, the RSL histories (Figs. 2 and 3) would indicate that the vast majority of sites throughout the region date from early in Pre-Dorset time, with later groups, including

Dorset, much more weakly represented. An overall similarity in the style of Dorset and Pre-Dorset dwellings in the region, inasmuch as they indicate high mobility, suggests that changing dwelling frequencies reflect changing population levels rather than changes in mobility (sedentism) through time. For example, we found that, with the exception of three Late Dorset "winter" houses at Murray Bay, all features recorded are certainly those that represent temporary occupations and thus relatively high mobility. This is in contrast to Dorset components at sites such as Alarnerk (Meldgaard, 1962) and Kapuivik (Meldgaard, 1962; Savelle et al., 2009), where many of the dwellings represent long-term winter occupations.

Dwelling features in the Gulf of Boothia produced a meagre yield of appropriate datable materials, if seal remains are excluded. We continue the tradition of avoiding seal bones for dating but lament the lost opportunity, which could be restored by dating pre-bomb collections of marine mammals to establish reservoir corrections. The radiocarbon dates obtained (Table 3) are free of any evident conflict with the RSL curves (above). They are also consistent with the RSL-indicated ages of the occupation modes and with the notion that the main early modes are synchronic around the entire region. Although some sites are shown to be younger than expected from their elevations, the upper group of features throughout the region, excluding one bear and one charcoal result, date to a remarkably narrow age range. Eight terrestrial mammal dates, two *Salix* charcoal dates, and a reservoir-corrected bear date fall between 3835 ± 20 (UCIAMS-71590) and 3645 ± 15 BP (UCIAMS-42205). An additional reservoir-corrected bear date (3515 ± 15 BP [UCIAMS-42211]) would extend that interval by another century, if the reservoir correction of 740 years is accepted. Only a single date on *Salix* charcoal (4230 ± 15 BP [UCIAMS-43960] at Abernethy Bay) extends occupation into earliest Paleoeskimo time.

Paleoeskimo temporal subdivisions are not entirely agreed upon (Maxwell, 1985; Helmer, 1994), and we are not attempting to resolve the issue here. Instead, we follow the scheme outlined by Helmer (1994): Early Pre-Dorset 4500–3600 BP (includes his Initial and Early horizons); Middle Pre-Dorset 3600–3200 BP; Late Pre-Dorset 3200–2500 BP (includes his Transitional horizon); Early Dorset 2500–2000 BP; Middle Dorset 2000–1500 BP; Late Dorset 1500–1000 (500) BP. Readers who object to these definitions can use the original radiocarbon ages in another scheme.

If our RSL curves are correct, sites of obligate Dorset age (Table 2, Fig. 2), those on or below the 2500 BP beach, are relatively rare, with 10 sites each at Murray Bay and Cape Chapman, 5 at Abernethy Bay, and 1 each at CPFI and southeast Somerset Island. Nevertheless, these sites proved richer in datable materials, particularly burnt moss, than sites of older ages. Thirteen dates on burnt moss, caribou, and lichen from these sites are mainly of Late Dorset age and range from 1945 ± 25 BP (UCIAMS-44002) to 925 ± 15 BP (UCIAMS-42208). The oldest date (worked caribou bone) came from a Thule *qarmat*, presumably
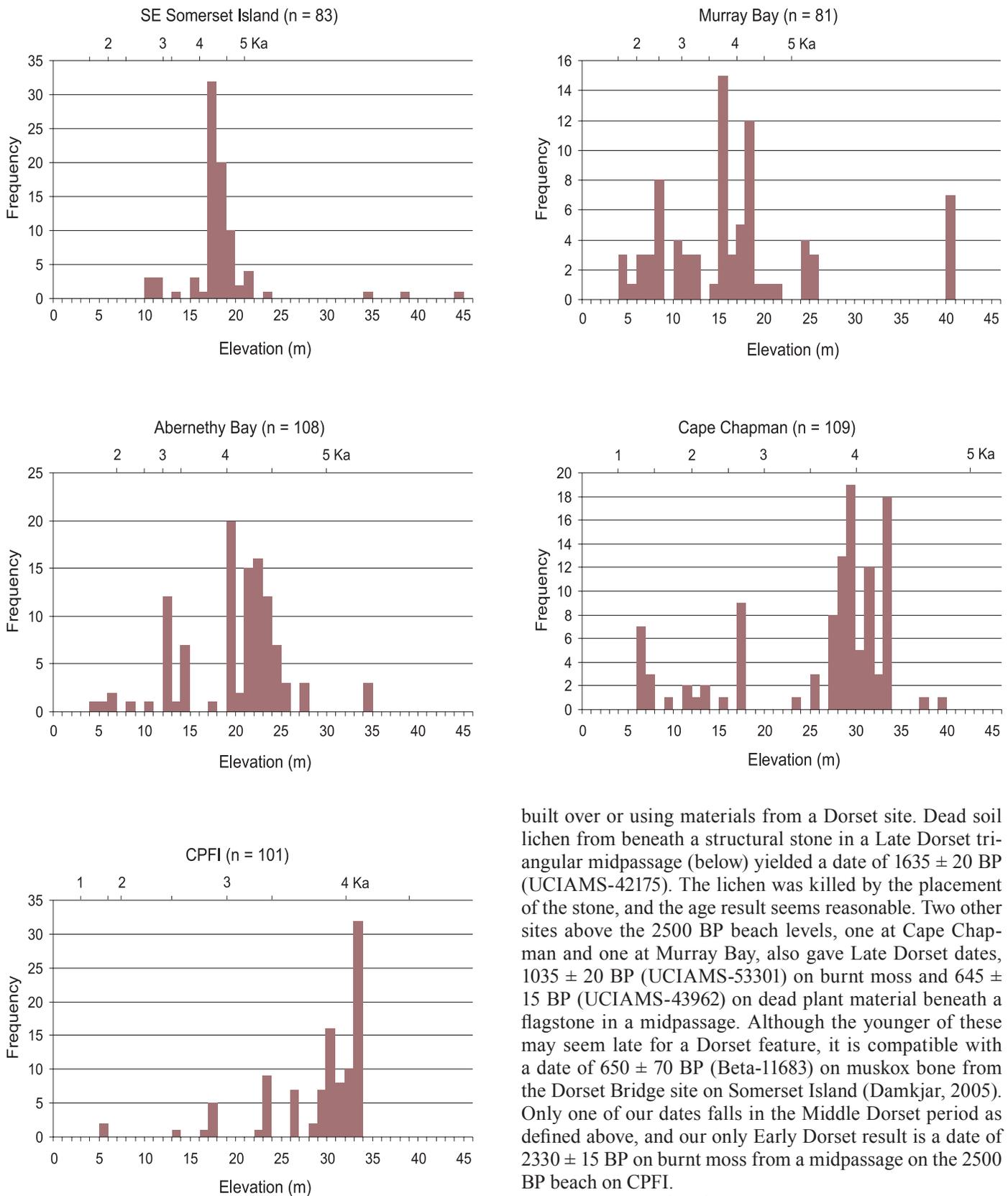
FIG. 3. Distribution of dwelling features by elevation above sea level.

built over or using materials from a Dorset site. Dead soil lichen from beneath a structural stone in a Late Dorset triangular midpassage (below) yielded a date of 1635 ± 20 BP (UCIAMS-42175). The lichen was killed by the placement of the stone, and the age result seems reasonable. Two other sites above the 2500 BP beach levels, one at Cape Chapman and one at Murray Bay, also gave Late Dorset dates, 1035 ± 20 BP (UCIAMS-53301) on burnt moss and 645 ± 15 BP (UCIAMS-43962) on dead plant material beneath a flagstone in a midpassage. Although the younger of these may seem late for a Dorset feature, it is compatible with a date of 650 ± 70 BP (Beta-11683) on muskox bone from the Dorset Bridge site on Somerset Island (Damkjar, 2005). Only one of our dates falls in the Middle Dorset period as defined above, and our only Early Dorset result is a date of 2330 ± 15 BP on burnt moss from a midpassage on the 2500 BP beach on CPFI.

The relatively few features between the 2500 BP beach levels and the prominent Early Pre-Dorset decline seen above the 3500 BP beach levels, except for those dated to Dorset time, represent possible Late to Middle Pre-Dorset occupations. We obtained only four radiocarbon samples

TABLE 3. Radiocarbon dates on Paleoeskimo archaeological sites. Laboratory codes are for UCIAMS-dates, unless otherwise specified, beside which are the Borden codes. Value in last column is the area under the probability distribution for the calibrated age range.

Laboratory and Borden codes	Material	Elev (m asl)	^{14}C Age (δ^{13}C)	Calib 6.0 2-sigma range BP	Area
Cape Garry					
42204 PeJq-36	*Ursus maritimus*	38	4005 ± 15 (-13.0)	3560 – 3850	1.000
43959 PeJq-27	*Picea* charcoal	10	2780 ± 15 (-24.6)	2840 – 2930	0.932
Hazard Inlet					
53021 PaJs-67-F4	Caribou or muskox bone	19	3710 ± 20 (-19.1)	3980 – 4090	0.924
53023 PaJs-70-F2	Caribou or muskox bone	17.5	3720 ± 20 (-18.4)	3990 – 4150	1.000
53270 PaJs-77-F11	Caribou or muskox bone	17	3670 ± 20 (-19.0)	3930 – 4080	1.000
KIA-18939[1]	*Ovibos moschatus*	16	2450 ± 20	2360 – 2700	1.000
KIA-18938[1]	*Ovibos moschatus*	11.5	890 ± 25	740 – 910	1.000
KIA-18940[1]	*Rangifer tarandus*	10.5	2610 ± 25	2720 – 2770	1.000
53266[2] PaJs-13-RI3	*Rangifer tarandus*	8	1290 ± 25 (-18.3)	1180 – 1280	1.000
Murray Bay					
42211 OkJr-34-F8	*Ursus maritimus*	18	4255 ± 15 (-12.9)	3870 – 4190	1.000
42210 OkJr-30-F5	*Ursus maritimus*	15.5	4030 ± 15 (-13.0)	3580 – 3870	1.000
43962 OkJr-31-F2	Plant material	10	645 ± 15 (-27.4)	560 – 660	1.000
42208 OkJr-23	*Rangifer tarandus*	8	925 ± 15 (-19.6)	790 – 910	1.000
44002[3] OkJt-25-F3	*Rangifer tarandus*	7	1945 ± 25 (-18.8)	1830 – 1950	1.000
42178 OkJr-35-F1	*Picea* wood	4	1365 ± 20 (-24.3)	1270 – 1310	1.000
42179 OkJr-35-F2	*Larix* wood	4	1420 ± 25 (-26.8)	1290 – 1360	1.000
71589 OkJs-10	*Picea* charcoal	4	1265 ± 25	1170 – 1280	0.970
Abernethy Bay					
2207 OfJo-25-F1	*Ursus maritimus*	22	4505 ± 15 (-14.3)	4220 – 4520	1.000
43960 OfJo-24-F3	*Salix* charcoal	21	4230 ± 15 (-24.5)	4820 – 4850	0.912
42206 OfJc-24-F4	Caribou or muskox	21	3805 ± 15 (-18.1)	4150 – 4240	0.982
42205 OfJo-20-F1	Caribou or muskox	19	3645 ± 15 (-18.5)	3900 – 3990	0.917
42177 OfJo-41	Burnt moss	6	1405 ± 25 (-23.4)	1290 – 1350	1.000
42174 OfJo-14	Conifer wood	5.5	1520 ± 25 (-25.6)	1340 – 1520	1.000
42175 OfJo-37	Lichen remains	4	1635 ± 20 (-15.9)	1420 – 1600	1.000
Cape Chapman					
71592 NhJd-10-F1	*Salix* charcoal	29.25	3790 ± 20	4090 – 4240	1.000
53301 NhJd-5	Burnt moss	18	1035 ± 20 (-24.1)	930 – 970	1.000
53302 NhJe-5-F1	Burnt moss	12	1135 ± 15 (-25.3)	980 – 1070	1.000
53300 NhJd-4	Burnt moss	9.5	1410 ± 15 (-23.5)	1290 – 1340	1.000
53303 NhJd-21-F1	Burnt moss	7.5	1240 ± 15 (-24.1)	1090 – 1260	1.000
53299 NhJd-1-F3	Burnt moss	6.5	1540 ± 15 (-24.2)	1380 – 1520	1.000
CPFI					
71591 OaHt-7-F3	*Salix* charcoal	32.75	3835 ± 20	4150 – 4300	0.943
53047 OaHu-3-F1	*Rangifer tarandus*	32.5	3705 ± 15 (-17.6)	3980 – 4090	0.998
53048 OaHu-3-F4	*Rangifer tarandus*	32.5	3675 ± 20 (-18.3)	3960 – 4090	0.924
53269 OaHu-1-F3	Caribou or muskox	29.5	3810 ± 20 (-18.5)	4150 – 4250	0.943
53297 NlHt-2-F4	Burnt moss	23.5	3065 ± 15 (-22.4)	3240 – 3350	0.996
53045 NlHt-4-F1	*Rangifer tarandus*	17.5	2675 ± 15 (-19.7)	2750 – 2790	0.966
53298 OaHt-5	Burnt moss	13.5	2330 ± 15 (-24.3)	2340 – 2350	1.000

[1] Damkjar (2003).

[2] Sample collected below the floor of a Thule house.

[3] Sample collected below sod in the centre of the floor of a Thule *qarmat*; age indicates re-occupation of a Dorset site.

from these sites, and the age determinations, ranging from 3290 ± 15 (UCIAMS-42210) to 2575 ± 15 (UCIAMS-53045) BP (the former being a reservoir-corrected bear date), are appropriate for these elevations. Thus our current assemblage of radiocarbon dates leaves a chronological gap between 3515 (or possibly 3645) and 3290 BP, and only one site currently dates to the interval 2675 to 1945 BP. Dorset sites are proportionally over-represented in our radiocarbon sampling, mainly because datable materials were more readily available from them.

Common Dwelling Types

We recognized six common types of Paleoeskimo occupation features in the five areas surveyed (Table 4).

However, there is substantial variation from area to area. The simple tent ring is the most common feature on Somerset Island, at Murray Bay, and at Abernethy Bay. At Cape Chapman, in contrast, midpassages lacking tent rings are most abundant by far, followed by midpassages within tent rings. Simple tent rings are relatively uncommon there: only slightly more common than paved areas. A third pattern emerges on CPFI, where paved areas are the most abundant feature type. Here midpassage features (with and without tent rings), simple tent rings, and isolated hearths are also common. The hearths are generally box hearths made of vertical (or formerly vertical) flagstones, though some are boiling-stone concentrations. The most amorphous Paleoeskimo dwelling type, the "sod patch," exceeds 1% in abundance only at Cape Chapman in our survey area, although it

TABLE 4. Common types of Paleoeskimo occupation features.[1] TR, tent ring; TR/H, tent ring with hearth; TR/MP, tent ring with midpassage; MP, midpassage; PA, paved area; SP, sod patch; IH, isolated hearth; 1, Somerset Island; 2, Murray Bay; 3, Abernethy Bay; 4, Cape Chapman; 5, Crown Prince Frederik Island; elevations and percentages are rounded.

	TR	TR/H	TR/MP	MP	PA	SP	IH
1 n (%)	59 (71)	4 (5)	6 (7)	7 (8)	5 (6)	1 (1)	1 (1)
1 Elev	13–23	11–18	17–38	10–44	10–21	17	15
2 n (%)	37 (45)	2 (2)	3 (4)	13 (16)	6 (7)	1 (1)	17 (21)
2 Elev	7–25	12–13	10–25	4–17	4–18	18	8–40
3 n (%)	50 (47)	5 (5)	7 (7)	9 (8)	20 (19)	0	16 (15)
3 Elev	14–27	13–34	14–24	4–21	8–24		7–27
4 n (%)	14 (13)	4 (4)	16 (15)	49 (45)	10 (10)	5 (5)	11 (10)
4 Elev	7–40	32–33	7–29	7–38	7–34	31–34	8–34
5 n (%)	25 (24)	2 (2)	7 (7)	21 (20)	29 (28)	1 (1)	18 (18)
5 Elev	18–34	18–24	17–27	6–34	18–34	34	29–34

[1] In addition to the features listed, there are three Dorset winter houses at 8 m elevation at Murray Bay.

is relatively common at sites on western Boothia Peninsula (8%; Savelle and Dyke, 2009). The proportions of the most common dwelling types on Somerset Island and in the two areas on eastern Boothia Peninsula resemble those reported by us from western Boothia Peninsula and King William Island. Cape Chapman dwellings resemble those on Kent Peninsula in that respect, whereas CPFI is unique within our surveys.

Tent rings are most commonly rectangular (includes square) in all areas, though circular to oval forms occur. Most dwelling feature types occur across the elevation span of occupied sites and hence lack any temporal significance.

Within multi-dwelling sites, it is fairly common to find that all features have the same architecture for sites of eight dwellings and less, but it is considerably more common to find features of different architecture. No sites with more than eight dwellings display homogeneity of dwelling type (Table 5). No one type of dwelling dominates at sites of homogenous architecture, but these sites impart a particular impression of contemporaneous occupation. Our descriptive classification of features probably leads to an under-measurement of the original homogeneity of sites. Some paved areas, in particular, may represent former midpassages or box hearths that have been disrupted by frost heaving and weathering.

Uncommon Dwelling Features

Two of the more striking Paleoeskimo dwelling features are Dorset longhouses, which attain lengths of over 40 m, and Dorset winter houses, features shallowly dug into the ground. We found no longhouses in our survey areas. However, two are reported from just north of the Cape Garry area on Somerset Island (Damkjar, 2000). Radiocarbon dates on these features place them in Late Dorset time, when Dorset populations appear to have been at their regional maximum. We recorded three Dorset winter houses at a site at Murray Bay and obtained a Late Dorset date (925 ± 15 BP [UCIAMS-42208]) on caribou bone from beneath the central floor sod in one of them.

TABLE 5. Range of dwelling types according to site size.

Dwellings per site	1 type	2 types	3 types	4 types	5 types	Homogeneity
2	11	11				50%
3	8	12	5			32%
4	2	6	2			20%
5	1	3	1	2		14%
6		1	1			0%
7	2	1	5	1		22%
8	1					100%
9			1		1	0%
10		1				0%
12		2	1			0%
13					1	0%
16			1	1		0%
19			1			0%
30					1	0%

We previously reported that some Late Dorset midpassages on western Boothia Peninsula (Fig. 6 in Savelle and Dyke, 2009) and on King William Island (Fig. 7 in Dyke and Savelle, 2009) stand out as architecturally distinct from older midpassages in the same region. Such passages remain unreported from outside the Gulf of Boothia-King William Island region, other than on northwest Greenland (J. Darwent and C. Darwent, pers. comm. 2008), and are found only in the narrow, lower-elevation range of Late Dorset dwellings. Most are fairly well preserved and all occur without associated tent rings, though some are within prepared floor areas. All have one end much narrower than the other, the two rows of side stones converging so as to resemble a slender arrowhead. Most have still-erect lamp stands, usually one but rarely two, and these are adjacent to heavy, flat, stone slabs that may have served as meat-cutting surfaces. We encountered seven of these features at the following sites: 07-120 at Abernethy Bay; 07-176 at Murray Bay; 08-103 (2 features) on CPFI; and 08-131 and 08-156 (2 features) at Cape Chapman. In addition, a distinctly tapered midpassage, though with a still-open narrow end, at site 08-121 on CPFI represents a form intermediate between the parallel and triangular forms (Fig. 4). Whether these forms represent functional or temporal stylistic differences is a subject of further investigation at present (by C. Darwent, J.

FIG. 4. Early Dorset tapered midpassage at site OaHt-5.

FIG. 5. Sizes of Paleoeskimo sites along the Gulf of Boothia, as measured by the number of dwelling features per site.

Darwent, and the authors). Still another midpassage, at site 08-141 at Cape Chapman, has an hourglass shape. It contains a lamp stand at each end, and the middle part of this 5.5 m long feature narrows to resemble two triangular midpassages built tip to tip. All Late Dorset parallel (normal) midpassages, like the triangular ones, contain lamp stands and usually associated burnt moss. The tapered, possibly intermediate, form on CPFI lacks lamp stands, and interestingly, it dated on burnt moss to early Dorset (2330 ± 15 BP [UCIAMS-53289]). Radiocarbon dates from the distinctly pointy features have the same general (Late Dorset) range as those from parallel features. At one site, 08-131, the two types are side by side, and burnt moss from the parallel midpassage gave an age of 1540 ± 15 BP (UCIAMS-53299).

Social Dynamics Based on Number of Features per Site

Here we draw inferences about Paleoeskimo societies based on site sizes, with "size" defined as the number of dwelling features. Because of the small sample sizes from all survey areas, we amalgamate the data in the following discussion. Of the 146 sites recorded, 60 (41%) are single-dwelling features, 22 (15%) have two dwellings, 26 (18%) have three dwellings, 10 (7%) have four dwellings, 7 (5%) have five dwellings, 2 (1%) have six dwellings, and 7 (5%) have seven dwellings (Fig. 5). Larger sites are rare, but the largest has 30 dwellings. Sites with more than five dwellings occur only on the early Pre-Dorset beach levels. Dorset longhouse sites may represent similar band aggregations. These distributions are similar to those reported by us from western Boothia Peninsula, King William Island, and Kent Peninsula, the only difference being the slight mode at seven features seen in the Gulf of Boothia sites but not elsewhere.

We have previously interpreted this pattern of site sizes as being consistent with seasonal fission-fusion behaviour. For most of the year, single families, or groups of two or three families, lived and hunted together, moving frequently, whereas the larger sites are the result of seasonal micro-band (4−6 dwellings) or macro-band (7−30 dwellings) aggregations. Although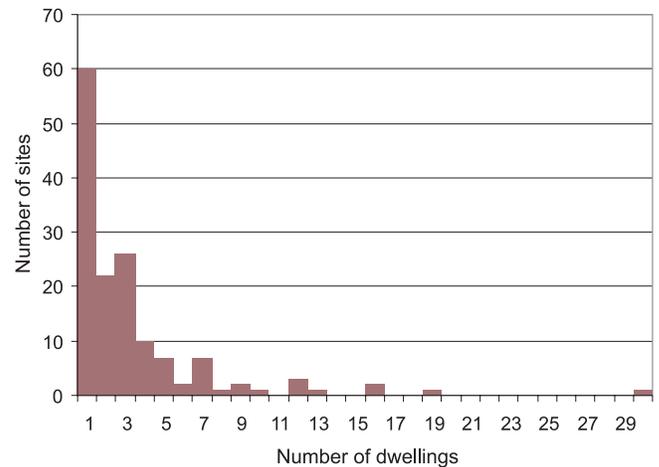 we cannot prove contemporaneity of all features at large sites, the only available evidence of band aggregations, in the absence of large communal structures, will be sites with large numbers of dwellings. The various types of dwellings at large sites may indicate occupations during different seasons, but we are not aware of any studies that conclusively tie the types described here to particular seasons.

Family aggregations of up to 30 or so are consistent with our previous data and with historical Inuit behaviour. Maximal band aggregations amongst the Netsilik Inuit of Boothia Peninsula (Damas, 1969; Balikci, 1984) and the Copper Inuit farther west averaged about 100 people (Damas, 1984), with the largest recorded being 150−166. Although the number of occupants of each Pre-Dorset dwelling would have varied, if average nuclear family size was similar to that of the Central Arctic Inuit (4.5 for Netsilik Inuit [Rasmussen, 1931:84−90]), our presumed Pre-Dorset seasonal aggregations are within the size of, and consistent with, historic Inuit aggregations.

Social Dynamics Based on Dwelling Sizes

Because of full exposure and good preservation, most dwelling feature sizes can be measured accurately. Detailed measurements for all features are given in Savelle and Dyke (2008, 2010). In Table 6, the statistics for tent rings include those with midpassages. In tent rings with midpassages, the average ratio of tent-ring width to midpassage length (MPL) is 1.28 (n = 39). Therefore, in Table 6 we calculate the area of a midpassage dwelling lacking a tent ring to be 1.28 MPL^2.

We measured the outside dimensions of tent rings, but did not include peripheral rocks that seemed to have been displaced outward. Thus total areas include the areas of the peripheral hold-down stones. However, given the nature and size of the tent rings dealt with and the small size of hold-down stones, any extra included area is generally small.

Caveats to interpreting number of occupants from dwelling sizes are stated in a previous report (Dyke and Savelle,

TABLE 6. Dimensions of Paleoeskimo tent rings and midpassage dwellings, Gulf of Boothia. SE: standard error; SD: standard deviation.

Parameter	Mean	SE	Median	Mode	SD
Tent ring length	3.22	0.06	3.10	3.00	0.87
Tent ring width	3.04	0.07	3.00	2.80	1.05
Tent ring area	10.36	0.37	9.30	8.12	5.79
Midpassage length	2.84	0.08	2.70	2.00	0.94
Midpassage width	0.88	0.02	0.80	0.70	0.28
Midpassage area	2.58	0.12	2.16	2.16	1.41
Midpassage dwelling area	11.51	0.75	9.45	5.12	8.88
Ratio TRW/MPL	1.28	0.06	1.27	1.00	0.40

2009) and not reiterated here. Most Arctic archaeologists would agree that larger dwellings probably were inhabited by more people than were smaller dwellings, because the environment is not one that affords opulent use of space. Rather, Paleoeskimo dwelling sizes were very likely tailored to the number of occupants in order to conserve heat, maximize fuel efficiency, and minimize transport of building materials (skins and poles). Using historical analogy from the Caribou and Netsilik Inuit, social units of four or five individuals are a reasonable estimate for Paleoeskimo social units. Accepting that, we can suggest trends in populations represented by individual feature size and, through total feature area at multi-dwelling sites, trends in overall site population.

Table 6 gives summary statistics of tent ring dimensions and dimensions of dwelling features with midpassages, whereas Figure 6 illustrates the range of floor areas in both types of dwellings. The average tent ring size is 10.4 m^2 (n = 239) and the average midpassage dwelling is 11.5 m^2 (n = 139). The largest tent ring encountered was 41.6 m^2, similar to the largest encountered by us elsewhere, but tent rings larger than 20 m^2 are rare. The largest midpassage dwelling encountered was 77.9 m^2, the largest such feature we have yet encountered, but again midpassage dwellings larger than 20 m^2 are rare.

If we regard dwellings smaller than 4 m^2 as errors due to our inclusion of partial features or bivouacs, we then assume that the 4–6 m^2 dwellings accommodated one or two adults. Dwellings of 6–10 m^2 may then represent the average nuclear family of four or five. Dwellings between 10 and 20 m^2 presumably represent extended families or other kin groups.

Paleoeskimo paved areas (average 5.3 m^2, maximum 17.8 m^2, n = 70) are systematically smaller than tent rings, as in other regions. Hence they probably represent only partial dwelling floor areas. As mentioned above, some may be particularly disturbed midpassages. Nevertheless, their size frequency distributions indicate a predominance of nuclear families of size comparable to those indicated by tent rings.

When feature area is considered in the context of elevation (Fig. 7), no meaningful pattern emerges, because the overall range of feature sizes changes little through time. Fifth-order polynomial regressions of the data suggest no clear trends for either of the two main feature types.
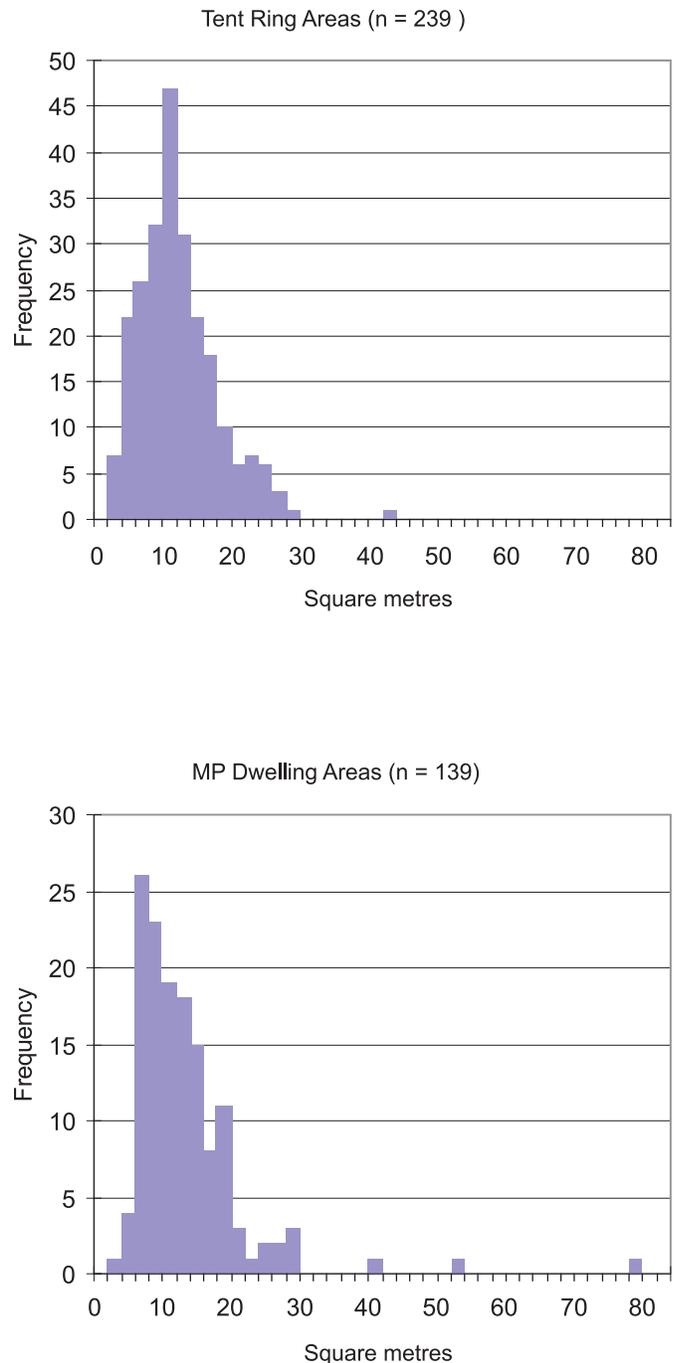

FIG. 6. Floor areas of tent rings and midpassage dwellings, Gulf of Boothia.

However, the anomalously large outliers are clearly identified in the context of the overall dataset. Of the four features larger than 38 m^2, two are at site 07-105, a site with 16 dwellings at 22 m elevation at Abernethy Bay. A femur fragment from one of these, which has isotope values indicative of bear, gave a reservoir-corrected age of 3765 ± 15 BP (UCIAMS-42207). This age demonstrates occasional use of large, presumably extended or multifamily, dwellings early in Pre-Dorset time, as we have found with equal rarity in earlier surveys. The 38.7 m^2 midpassage is single-feature site 08-141 at Cape Chapman, the hour-glass shaped

late Dorset midpassage with two lamp stands, discussed above. The 77.9 m^2 midpassage dwelling is at 8.5 m at Murray Bay. Although the dwelling is undated, its elevation requires a Late Dorset age. Two other dwelling features at this site are of ordinary size. If 6–10 m^2 dwellings represent nuclear families of four or five people, then these very large features must have been occupied by several times that number. We interpreted very large features at small Dorset sites on western Boothia Peninsula as representing band aggregations (Savelle and Dyke, 2009).

Wobst (1974), on the basis of computer simulations, suggested that the minimal size of a viable breeding human population ranged between 175 and 475 individuals. The latter figure compares well with populations of known Inuit groups: the Netsilik were estimated at 450 – 500 individuals (Damas, 1969), the Igloolik at 500 – 550 (Damas, 1963), the Caribou at 430 – 500 (Birket-Smith, 1929), and the Copper at 800 (Jenness, 1922). The data from the Gulf of Boothia suggest that our peak early Pre-Dorset populations probably represent regional populations of 500 or more individuals. This figure is the same as estimated in our previous surveys, because maximum site sizes are the same. However, the number of sites found per time unit surveying in the Gulf of Boothia is much lower than in our previous surveys. A band in the Gulf of Boothia, therefore, appears to have been using a comparatively much larger area. The moderate Late Pre-Dorset, Early Dorset, and Late Dorset recoveries, the last being the strongest, may represent regional populations closer to Wobst's minimum of 175. We are not suggesting that all populations in our study areas were necessarily members of the same regional group, but following Sutherland's (1996) suggestion, that they may have been parts of regional groups occupying territories of similar size to those of historic Inuit groups.

Paleoeskimo Boom-and-Bust

The Gulf of Boothia clearly saw its largest Paleoeskimo populations early in the Pre-Dorset period, specifically from 4200 to 3600, and mainly from 3900 to 3600 BP. About 86% of all Paleoeskimo dwelling features documented by us on southeast Somerset Island, about 64% of those at Murray Bay, 75% at Abernethy Bay, 70% at Cape Chapman, and 82% on CPFI appear to date to that period (Fig. 3). Subsequent population recoveries during late Pre-Dorset and Dorset times were weak in comparison. Radiocarbon dating suggests that Late Dorset is the strongest of these and also the most distinctive architecturally. A decline of the Pre-Dorset population at about 3600 – 3700 ^{14}C years ago in Arctic Canada in general has been discussed for some time (e.g., McGhee, 1972). We documented a dramatic population crash of essentially identical proportion and timing on western Boothia Peninsula (Savelle and Dyke, 2009), on King William Island, and on Kent Peninsula (Dyke and Savelle, 2009). On southwest Victoria Island (Savelle and Dyke, 2002), our westernmost series, the crash was of similar proportion but occurred perhaps a century or two
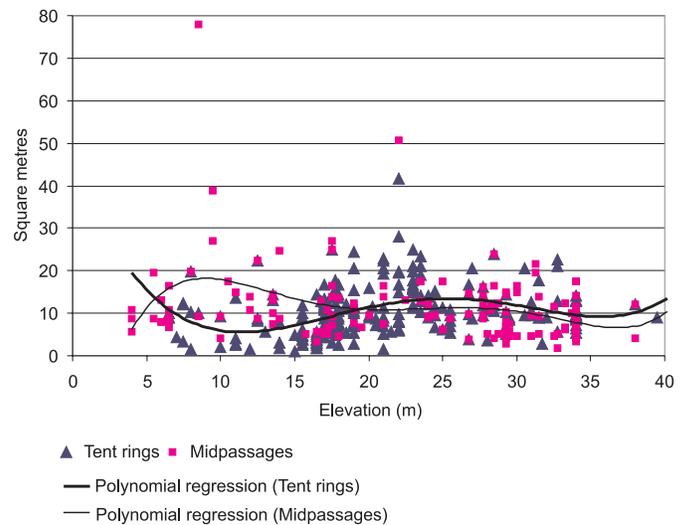

FIG. 7. Area-elevation scatter plots of dwelling features, Gulf of Boothia.

earlier. Hence, the boom-and-bust cycle of the early Paleoeskimo seems to have been a nearly synchronous, possibly a truly synchronous, event from the western Canadian Arctic through to at least the Gulf of Boothia. Schledermann (1978b) may have documented the same, or a similar, event in the Cornwallis–Bathurst Island region, north of Somerset Island. He plotted frequency of dwellings by elevation and showed peak abundance on raised beach levels that are probably of early Pre-Dorset age. Furthermore, Sutherland (1992) showed a maximum frequency of dated early Pre-Dorset features on northern Ellesmere Island and adjacent Greenland terminating around the same time.

As discussed earlier (Dyke and Savelle, 2009), our earliest and most dramatic peaks pre-date the oldest securely dated Paleoeskimo sites in the so-called core area (Foxe Basin and vicinity). The major known Pre-Dorset sites there (Igloolik and Jens Munk) are too low to record earliest Paleoeskimo times (Savelle et al., 2009). Whether the "boom" cycles subsequent to the first in our surveys was the result of immigration from Foxe Basin or simply the recovery of local "bust" populations cannot be determined from the sort of data we present. However, the early Paleoeskimo population crash in the region next door to the putative core was no less severe than elsewhere. Furthermore, Paleoeskimo populations appear to have suffered boom-and-bust cycles in the Foxe Basin area as well (Savelle et al., 2009; J.M. Savelle and A.S. Dyke, unpubl. data).

We recently reviewed suggestions that have been advanced to explain these reductions in Paleoeskimo populations (Savelle and Dyke, 2009). Briefly, they include the inevitability of die-offs of hunter-gatherer bands in peripheral environments, over-exploitation of critical food resources, and climate forcing of food resource availability. To that list might be added pandemic disease. Despite recent advances in paleoclimate reconstructions based on pollen stratigraphy (e.g., Zabenskie and Gajewski, 2007), it is not possible at this time to choose between climate forcing and resource over-exploitation as the primary cause of

the Paleoeskimo crash about 3600–3700 BP. Paleoecologists have yet to produce high-resolution results for that critical interval. However, a revised theoretically calculated chronology of the ice core from Agassiz Ice Cap, Ellesmere Island (David Fisher, Geological Survey of Canada, pers. comm. 2010), places the beginning of a pronounced cold event of a few centuries' duration at 3900 calendar years (= 3600 ^{14}C years) BP. Furthermore, the crash occurred at closely similar times across regions with substantially different food resource bases, and it appears to have had proportionally similar effects in regions with higher and lower regional population densities. These observations may indicate a climate change similarly affecting diverse ecosystems. On the other hand, there is little in the well-dated Gulf of Boothia bowhead whale record to indicate any sudden change of conditions around 3600 BP. And the initial "boom and bust" sequence, as we have noted elsewhere (Savelle and Dyke, 2009:280–281), is consistent with the behaviour of species moving into previously unoccupied territories. A predator species, given a limited number of prey species, quickly exceeds carrying capacity (boom). This excess results in predator population reduction, and in extreme cases, population crashes (bust). Accordingly, there is no necessary correlation between population change and climate change.

CONCLUSIONS

The Gulf of Boothia region is one of the harshest and perhaps most seal-reliant regions in our series of Paleoeskimo demographic surveys. Early Paleoeskimo dwelling features are comparatively scarce there. Nevertheless, the relative frequency distribution of dwellings through time closely resembles those of regions to the west, with all regions passing through a series of boom-and-bust cycles. These cycles began with rapidly growing populations between about 4200 and 3600 BP, followed by a dramatic crash. Slight later recoveries are poorly dated, but the most important seems to have been in Late Dorset time. Small groups of Dorset people lingered until about 650 BP. Currently available paleoclimate data do not indicate any regionally consistent pattern of relationship between climate changes and these boom-and-bust cycles. Thus, another possibility is that these cycles may relate to repeated episodes of overharvesting of local resources, if not to disease.

Paleoeskimo seasonal patterns here, as in adjacent regions, appear to have been ones in which nuclear or small extended families were dispersed for much of the year, aggregating annually in groups of about 100 or more individuals. Minimal social units do not appear to have changed during seasonal aggregations in Pre-Dorset times, though there are occasional multi-family dwellings. The most obvious cultural change was the arrival of Late Dorset people with a new style of midpassages, including lamp stands.

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