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Zen Fish: A Consideration of the Discordance between Artifactual and Zooarchaeological Indicators of Thule Inuit Fish Use

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Despite fish bone being rare in even the best preserved Classic Thule Inuit (ca. A.D. 1000–1400) faunal assemblages from the Canadian Arctic, it has often been assumed that fish played an important role in Thule economies. This is due to the prominent place of fishing in the harvesting practices of the Historic Inuit and the ubiquity of fishing implements in Thule artifact assemblages. Based on an evaluation of potential taphonomic, sampling, and interpretive biases and the artifactual and zooarchaeological evidence for harvesting of sea mammals, land mammals, fish, and birds, it appears that fishing was of generally limited importance in the eastern parts of the Canadian Arctic and before about A.D. 1400, likely due to resource scheduling conflicts. The nonetheless widespread occurrence of fishing gear invites consideration of alternative scenarios for the place of fishing in Thule society, in which a minor dietary role is not inconsistent with important cultural roles.

Key Words: Thule; Inuit; economy; zooarchaeology; fish; taphonomy; site formation; Arctic, Nunavut.

> I have fished everywhere; but I have not really fished at all.—Iglulingmiut hunter

INTRODUCTION

Thule archaeologists are favored with a tremendously rich faunal record, the result of a conjunction between hunting societies that derived virtually their entire diet from animals and a cold, dry arctic environment that ensures good preservation of near-surface faunal remains and perfect preservation of any bone or soft tissue that becomes enclosed in permafrost. Despite fish bone being rare in even the best preserved faunal assemblages, it has often been assumed that fish played an important role in Eastern Thule economies. This is due to the prominent place of fishing in the harvesting practices of the Historic Inuit and the ubiquity of fishing implements in Thule artifact assemblages. Although arctic archaeologists have often briefly puzzled over this situation, chalking the discordant evidence up to taphonomic and recovery biases, there has been no review of the artifactual or zooarchaeological evidence for fishing, nor any sustained consideration of the possibility that the faunal lacuna is really just an indication that fishing was much less important for Thule than later Inuit groups.

The sample of sites with published faunal and artifactual data now appears sufficient to attempt a critical evaluation of Thule fish use. This necessitates assembling data from later Inuit sites as well, since the conventional importance attached to fish is linked to the reliance on direct historic analogy for interpreting (and patching over gaps in) the Thule archaeological record. Although the terminology in use is inconsistent, archaeologists working on sites belonging to the Neoeskimo cultural tradition, spanning

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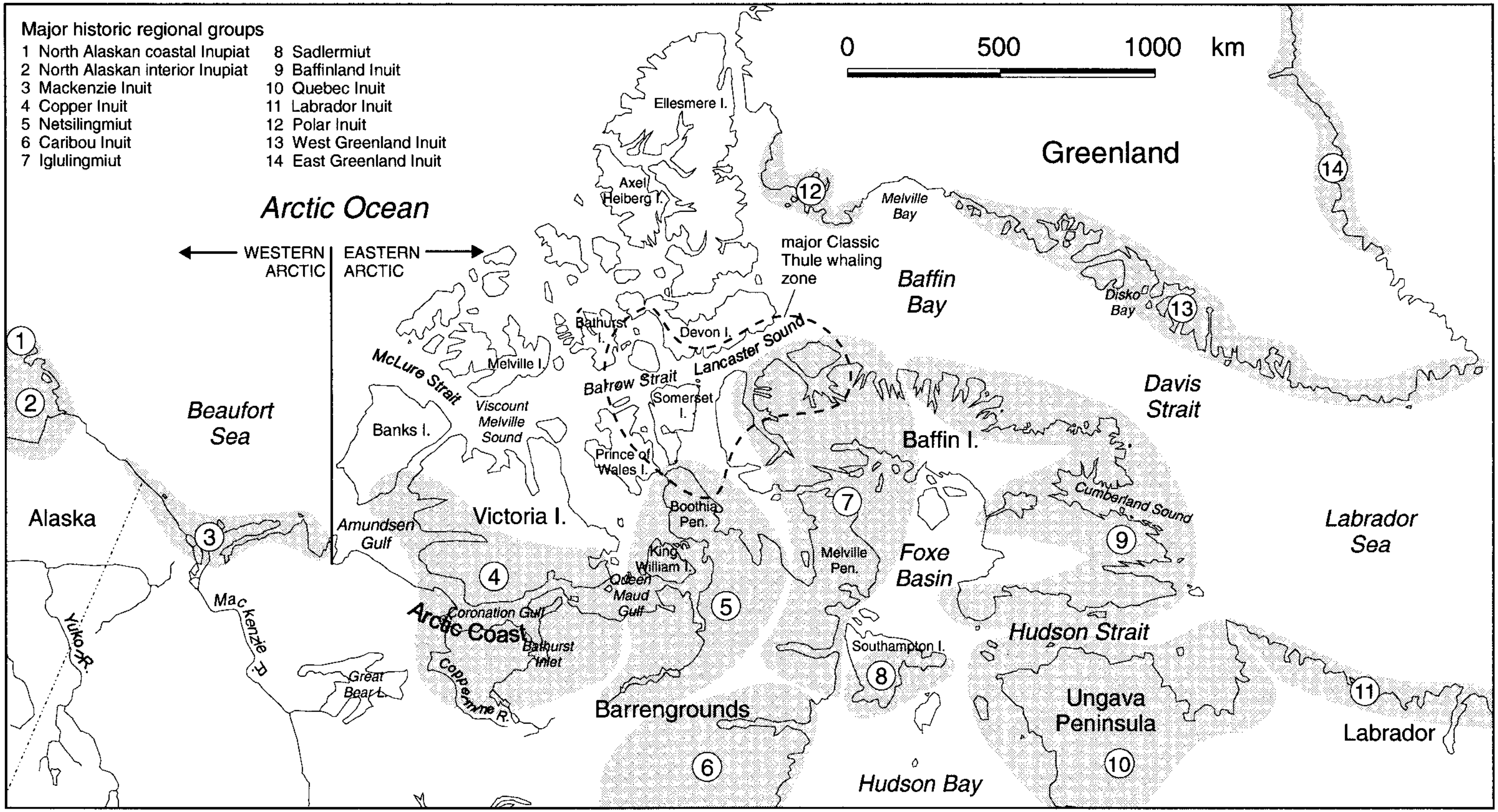

FIG. 1. Canadian Arctic place names and historic distribution of major Inuit regional groups.

the past millennium of Canadian Arctic prehistory, tend to recognize three major chronological subdivisions: the Classic Thule, Modified Thule (or, in the western Canadian Arctic, Late Prehistoric), and Historic periods. The Classic Thule period conventionally encompasses one or more phases of migration of North Alaskan groups into the Canadian Arctic and their subsequent expansion throughout the Eastern Arctic (Fig. 1). However, the earliest or "Pioneering" migration dating to around A.D. 1000 is poorly documented and may not represent the direct antecedent of the widespread Classic Thule culture, which appears to have become established closer to about A.D. 1200 (Whitridge 1999, 2000a; one Pioneering Thule faunal assemblage is included in the following analyses, but for terminological convenience it is subsumed within Classic Thule in the rest of this article). Based on the most recent review of Thule carbon-14 dates (Morrison 1989), the termination of Classic Thule occurred rather abruptly around A.D. 1400, coincident with the onset of the Little Ice Age (LIA).

The subsequent Modified (sometimes "Developed" or "Postclassic") Thule period may have begun slightly earlier in some areas, but by A.D. 1400 is widely evidenced by regional abandonments, a profound reorganization of subsistence-settlement systems, and changes in material culture. The Historic period technically begins at different times in different parts of the Arctic, depending on local contact histories. Greenland and Labrador Inuit experienced repeated contact with explorers, whalers, traders, and missionaries in the 17th and 18th centuries, but with the exception of ephemeral contacts with Frobisher and later explorers, prolonged Inuit–White contact generally began in the mid- to late 19th century in the rest of the Eastern Arctic. However, European goods were increasingly incorporated into Inuit material culture during a protohistoric period that began close to 1800 in many areas and represent an important chronological marker. Because Greenland and Labrador are not included in this analysis, nor any archaeological components dating predominantly to the 20th century (a period of accelerating social and economic change), it is convenient to crudely delineate the major Neoeskimo chronological subdivisions for the remainder of the Eastern Arctic as follows: Pioneering/Classic Thule, A.D. 1000–1400; Modified Thule/Late Prehistoric, A.D. 1400–1800; and Historic, A.D. 1800–1900.

This article considers the proposition that fish use did not remain static over the course of Neoeskimo settlement in the Canadian Arctic. While this would seem to be an almost absurdly straightforward task, problems related to quantification, and the regional, temporal, and seasonal representativeness of available samples, seriously complicate the matter. There are a host of taphonomic and sampling issues peculiar to the interpretation of icthyofaunas and others that bear on the interpretation of harvesting gear assemblages. Attempting a relatively comprehensive evaluation of these problems for the Canadian Neoeskimo case exposes the depth of the taphonomic predicament in zooarchaeological analysis and the difficulty of analytically conjoining faunal and artifactual data sets. Following brief overviews of Thule subsistence-settlement systems, arctic fish resources, and historic fish use, the potential effects of taphonomy, sampling, and artifact assemblage interpretation are outlined. Some factors that may have promoted a low level of fish utilization by some groups are then advanced and evaluated with respect to the assembled faunal and artifactual data from Classic Thule, Modified Thule/Late Prehistoric, and Historic Inuit sites. Although meaningful trends can be discerned in the two datasets, there is lingering ambiguity with respect to the absolute importance of fish in Classic Thule economies. This issue would likely be clarified by more detailed taphonomic analyses of fish bone assemblages, but the hint that fish may be swamped by inadequately quantified sea mammals leads us back into the analytic cul-de-sac. One way of moving forward is to turn the problem over and consider fishing in its social and cultural contexts. In the final section, alternative scenarios for Thule fishing are proposed that embrace not only variability in the availability and relative utility of fish resources, but aspects of harvesting practice that are only partially or indirectly related to economic utility. It is thus ultimately possible to argue that fishing may have made a negligible caloric contribution to diet while performing invaluable cultural functions.

THULE SUBSISTENCE

Beginning around A.D. 1000, the sophisticated Neoeskimo open-water hunting technology introduced into northern Alaska during Birnirk times spread throughout the North American Arctic. While the southward, or Western Thule, expansion appears to have involved mainly the adoption of new technologies and artifact styles by aboriginal Eskimo peoples in western and southern Alaska, the appearance of Eastern Thule material culture in the Canadian Arctic and Greenland represented a great migratory pulse that ultimately resulted in the demise of any surviving indigenous Dorset peoples. The most influential account of this event (McGhee 1969/1970) links the migration to expanding opportunities for open-water bowhead whaling under the milder climatic conditions of the Medieval Warm Period. While Thule groups soon colonized regions where bowhead whales were scarce or unavailable, clusters of Classic Thule whaling settlements along the Central Arctic channels appear to have been critical nodes in a larger interaction sphere. Whaling helped to underwrite settlement in nonwhaling areas, through the promotion of an interregional trade that leveled some resource imbalances (Whitridge 2000b).

Although faunal identifications are occasionally provided in earlier site reports, the details of Thule and Historic Inuit subsistence economies really began to emerge in the late 1970s (Schledermann 1975; Stanford 1976; Binford 1978; McCartney 1979a; Staab 1979; Rick 1980), and reporting of faunal analyses has now become standard procedure. Zooarchaeological investigations have variously focused on the harvesting of seals (Morrison 1983; McCullough 1989; Park 1989; Henshaw 1995, 1999), bowhead whales (Savelle 1987, 1996, 1997; Savelle and McCartney 1988, 1991, 1994, 1999; McCartney and Savelle 1985, 1993; Whitridge n.d.), beluga and narwhal (Friesen and Arnold 1995; Savelle 1994) caribou (Morrison 1988, 1997a; Morrison and Whitridge 1997; Stenton 1989), and muskoxen (Will 1985), and faunal data have been integrated into ecological models of Thule and Historic Inuit harvesting systems (e.g., Sabo 1991; Savelle 1987; Stenton 1989). Basic quantitative data (MNI and NISP) for assemblages containing abundant fish bone have been reported recently for some Late Prehistoric and Historic sites in the Mackenzie Delta region (Morrison 1988; Friesen and Arnold 1994; Friesen 1995; Swayze 1994) but only Balkwill and Rick (1994) and Morrison (2000) have devoted much discussion to taphonomic and sampling issues surrounding the interpretation of Neoeskimo fish bone assemblages.

Seasonality determinations of the animals consumed at winter villages (McCullough 1988; Morrison 1983; Park 1989; Whitridge 1992) indicate that relatively little active harvesting went on from these settlements except during early spring, their occupants relying instead on stores put up during late summer and fall and perhaps from a period spent sealing from snow house villages on the sea ice. The emergence of new mechanisms of alliance formation, likely associated with the legitimation of competition for wealth and prestige, facilitated large-scale harvesting for winter storage of bowhead, walrus, caribou, and beluga and appears to have been equal in importance to environmental change in promoting Thule economic expansion (Whitridge 1999). During the spring families began to scatter across the land in tents or semisubterranean, skin-roofed *qarmat* for small-scale fishing, fowling, and caribou hunting, gathering into large tent or *qarmat* settlements during the late summer and fall open-water season for cooperative harvesting of sea mammals, migrating caribou, or, perhaps, runs of anadromous fish (see Savelle 1987; Savelle and McCartney 1988 for discussion and models of Thule subsistence-settlement systems).

The ethnographic literature, on which this generalized model of the Thule subsistence round is partly based, is virtually unanimous in assessing an important role for fish in most Inuit economies. It is thus odd that fish have received so little attention in the archaeological literature. Taylor drew attention to this fact 20 years ago, in enumerating some of the unresolved issues in Thule prehistory:

> And what about fish! Why, if one wishes to talk of subsistence, do so many ignore that nourishing, dependable, widespread, obtainable, abundant, and storable resource? Can it be simply because we find so few of their bones and scales? Their lack of fur, sinew and blubber? In those omnivorous and flexible economies, just as the whale was oversold (and oversubscribed), the fish seem still underappreciated. But if this celebration of fish is correct, how do we explain the remarkable absence of fish remains, even in Thule culture contexts with excellent preservation? (1979, p. iv)

In the intervening years the scarcity of fish bones on Thule sites has gone much remarked but little investigated, beyond cursory references to the likelihood of taphonomic attrition and the occasional suggestion that biased recovery techniques (infrequent screening of deposits) have militated against their collection. The notion that fish were generally of some importance in Thule economies appears to be widely held (but see McGhee 1984). However, Taylor's characterization of arctic fish resources springs from an appreciation of the importance of fish to the Historic Inuit, who were largely occupants of the arctic mainland and Low Arctic islands (Savelle 1981). For Classic Thule occupants of the Central and High Arctic islands, fish resources may not have been particularly dependable, widespread, obtainable, or abundant. Furthermore, it is not clear that Thule diet is adequately characterized as "omnivorous" (at least, any more so than that of any hunter-gatherers). Although species richness tends to be high in large Thule faunal assemblages, taxonomic evenness tends to be low. Thule groups harvested most useable species in their environment, but normally only a few species made substantial dietary contributions, and the proportional contributions of marine and terrestrial mammals are extremely skewed (i.e., tend to be either very high or very low). This seems to be related in part to the historical peculiarity of Thule models of economic practice. A distinctive constellation of social, ideational, and technological factors fostered a tendency for Thule communities to preferentially target species that could be procured in sufficient bulk to underwrite sedentary winter settlement. Hence even in areas where fish resources were historically important, it cannot be assumed that Thule groups relied upon them.

If Taylor is correct in suggesting that the preservation of Thule faunal assemblages is such that fish remains *should* occur if fish were being harvested, then their scarcity would seem to be self-explanatory. The reason that Thule fish use has remained an open question, in the apparent absence of supporting zooarchaeological data, relates not only to the seductive pull of the ethnographic subsistence model, but to the fact that fishing gear is widespread, and even abundant, on Thule sites. Fishing implements occur in 88% of the Classic Thule components listed in Table 1 and account for up to 46% of all types and 62% of all specimens of harvesting gear, with means of 17 and 12%, respectively. This contrasts with a mean dietary contribution of fish of just .04% for the 25 Classic Thule components with quantifiable faunal data (Table 1; see below for derivation of these values). Herein lies the Thule fish paradox, encapsulated in the epigraph to this article: as the ethnographic evidence would lead us to expect, Thule artifact assemblages appear to reflect widespread fishing, and yet the faunal evidence suggests little serious reliance on this taxon. It seems inescapable that either fish are underrepresented in faunal collections or Thule archaeologists are misinterpreting the artifact assemblages (or both). Before examining these possibilities, it is important to consider geographic variability in arctic fish resources. Because sites assigned to particular periods are not evenly distributed within the study area (Fig. 2), it may be the case that variability in the extent of fish use indicated by ethnographic and archaeological sources may be related to regional fish productivity.

ARCTIC FISH RESOURCES

Taxonomic diversity is generally low for arctic marine fishes, although seasonal availability may be tremendously high for some species. Small cod species and various sculpins are widely distributed in arctic waters, and Pacific herring and capelin are locally abundant in shore spawners in parts of the Western and Eastern Arctic, respectively (Morrow 1980; Scott and Scott 1988). Arctic and starry flounder occur in shallow waters as far east along the Arctic Coast as Queen Maud Gulf, and useful species potentially available in deeper waters of the North Atlantic include various flatfishes, sharks, and Atlantic cod. Because there appears to have been very limited aboriginal use of marine species in the Canadian Arctic, and at the risk of circularity, they are discussed briefly in the next section and not considered further.

Arctic freshwater ecosystems are much less productive than those in temperate latitudes. The major controls on primary production are the availability of sunlight and nutrients. Insolation is nil for several months of the year at high latitudes, and even during the summer period of availability light penetration is inhibited by snow and ice cover for all but 2 or 3 months. This, together with limited nutrient transfer from the impoverished terrestrial ecosystem, results in primary production in arctic lakes that is only about 10% of that in boreal forest lakes, themselves considered of very low productivity (McCart and Den Beste 1979). However, because many arctic fish species are anadromous, freshwater ecosystems receive a substantial “marine subsidy” in biomass (McCart and Den Beste 1979:4). Nutrient availability is generally higher for lakes and rivers in the Mackenzie Valley, along the Arctic Coast west of Boothia Peninsula, and in parts of the Arctic Islands than for those within the Canadian Shield, since the former are underlain by relatively soluble sedimentary bedrock. The Mackenzie Valley and Arctic Coast additionally benefit from fluvial transport of nutrients from more productive southern latitudes and during deglaciation became available for colonizing fish populations much earlier than the Arctic Islands and Hudson Bay drainage (indeed, parts

TABLE 1
Thule and Inuit Sites Included in Analysis

SITE/COMPONENT	PERIOD	SEASON	REGION	# FISH SPECIES	FAUNAL REMAINS TYPE OF DATA	NISP	reference
Washout H. 1	Classic Thule	winter	western	15	n/a		Yorga 1980
Washout H. 2	Classic Thule	winter	western	15	n/a		Yorga 1980
Washout H. 3	Modified Thule/Late Prehistoric	winter	western	15	NISP	1497	Friesen and Hunston 1994
Washout H. 4	Modified Thule/Late Prehistoric	spring/summer/fall	western	15	NISP	191	Friesen and Hunston 1994
Pauline Cove F. 7	Modified Thule/Late Prehistoric	winter	western	15	NISP	4055	Friesen 1995
Pauline Cove F. 1	Historic	winter	western	15	NISP	1254	Friesen 1995
Pauline Cove F. 5/8	Historic	spring/summer/fall	western	15	NISP	1198	Friesen 1995
Radio Creek	Modified Thule/Late Prehistoric	winter	western	17	n/a		McGhee 1974
Gupuk	Modified Thule/Late Prehistoric	winter	western	17	NISP	9919	Friesen and Arnold 1995
Kittigazuit OH	Modified Thule/Late Prehistoric	winter	western	17	n/a		McGhee 1974
Kittigazuit M4	Modified Thule/Late Prehistoric	winter	western	17	n/a		McGhee 1974
Kittigazuit M2	Modified Thule/Late Prehistoric	winter	western	17	n/a		McGhee 1974
Kittigazuit M1	Historic	winter	western	17	n/a		McGhee 1974
Sukunnuk	Modified Thule/Late Prehistoric	spring/summer/fall	western	17	NISP	710	Swayze 1994
Cache	Modified Thule/Late Prehistoric	spring/summer/fall	western	17	NISP	2602	Swayze 1994
Gutchiak	Modified Thule/Late Prehistoric	spring/summer/fall	western	15	NISP	69269	Morrison n.d, pers. comm.
Kugaluk	Historic	spring/summer/fall	western	16	NISP	39635	Morrison 1988
Bison Skull West	Historic	spring/summer/fall	western	15	NISP	788	Morrison 1997
Bison Skull East	Modified Thule/Late Prehistoric	spring/summer/fall	western	15	NISP	885	Morrison 1997
Rita-Claire	Modified Thule/Late Prehistoric	spring/summer/fall	western	15	NISP	6698	Morrison 1997
Iglualuit H. 20	Modified Thule/Late Prehistoric	winter	western	12	NISP	1750	Morrison 1990
Iglualuit H. 11	Modified Thule/Late Prehistoric	winter	western	12	NISP	1908	Morrison 1990
Booth Island	Classic Thule	winter	central	11	n/a		Morrison 1990
Langton Bay	Modified Thule/Late Prehistoric	winter	central	11	n/a		Morrison 1990
Okat	Modified Thule/Late Prehistoric	winter	central	11	n/a		Morrison 1990
Jackson	Classic Thule	winter	central	11	rank order		Taylor 1972
Nelson River	Classic Thule	winter	central	2	%MNI	2176	Arnold 1986
Nichol	Modified Thule/Late Prehistoric	spring/summer/fall	central	3	est %NISP	670	McGhee 1972
Memorana	Classic Thule	winter	central	3	est %NISP	2025	McGhee 1972
Kunana	Historic	spring/summer/fall	central	3	est %NISP	3000	McGhee 1972
Lady Franklin Point	Classic Thule	winter	central	4	NISP	5872	Taylor 1972
Beulah	Classic Thule	winter	central	11	NISP	4290	Morrison 1983
Nuvuk	Classic Thule	winter	central	11	NISP	2198	Morrison 1983
Clachan	Classic Thule	winter	central	11	NISP	38955	Morrison 1983
Bloody Falls	Classic Thule	spring/summer/fall	central	11	est %NISP	388	McGhee 1972
Nadlok	Modified Thule/Late Prehistoric	spring/summer/fall	central	11	est %NISP	5955	Gordon 1994
Malerualik	Classic Thule	winter	central	2	NISP	102	Mathiassen 1927, Savelle 1987
Naujan	Classic Thule	winter	central	3	NISP	732	Mathiassen 1927
Silumiut	Classic Thule	winter	central	5	NISP	15897	McCartney 1977, Staab 1979
Meliadine-1	Modified Thule/Late Prehistoric	spring/summer/fall	central	9	rank order		Clark 1977

TABLE 1—*Continued*

					FAUNAL REMAINS		
SITE/COMPONENT	PERIOD	SEASON	REGION	# FISH SPECIES	TYPE OF DATA	NISP	reference
Hazard Inlet: Qariaraqyuk	Classic Thule	winter	eastern	1	n/a		Whitridge 1999
Hazard Inlet: PaJs-3	Classic Thule	winter	eastern	1	NISP	679	Whitridge 1992
Hazard Inlet: PaJs-3	Classic Thule	spring/summer/fall	eastern	1	NISP	566	Whitridge 1992
Hazard Inlet: PaJs-4	Classic Thule	spring/summer/fall	eastern	1	NISP	1065	Whitridge 1992
Hazard Inlet: PaJs-13	Classic Thule	winter	eastern	1	NISP	8095	Whitridge 1992
Cape Garry	Classic Thule	winter	eastern	1	NISP	2326	Rick 1980
Learmonth	Classic Thule	winter	eastern	1	NISP	4532	Taylor and McGhee 1979, Rick 1980
Brooman Point	Classic Thule	winter	eastern	1	rank order		McGhee 1984
Deblicquy	Classic Thule	winter	eastern	1	rank order		Taylor 1981
Porden Point: RbJr-1	Classic Thule	winter	eastern	1	NISP	4976	Park 1989
Porden Point: RbJr-4	Classic Thule	winter	eastern	1	NISP	3979	Park 1989
Porden Point: RbJr-5	Classic Thule	spring/summer/fall	eastern	1	NISP	378	Park 1989
Ruggles Outlet H. 2	Classic Thule	spring/summer/fall	eastern	1	rank order		Maxwell 1960
Eskimobyen	Classic Thule	winter	eastern	1	NISP	2656	McCullough 1989
Sverdup	Classic Thule	winter	eastern	1	NISP	307	McCullough 1989
Skraeling Island	Classic Thule	winter	eastern	1	NISP	9404	McCullough 1989
Mitimatalik/Qilalukan	Modified Thule/Late Prehistoric	winter	eastern	1	NISP	243	Mathiassen 1927
Native Point	Historic	winter	eastern	1	n/a		Taylor 1960
Lake	Modified Thule/Late Prehistoric	winter	eastern	1	rank order		Clark 1980
Tuktumoon	Modified Thule/Late Prehistoric	spring/summer/fall	eastern	1	NISP	3861	Stenton 1989
B-1	Modified Thule/Late Prehistoric	winter	eastern	1	NISP	19275	Schledermann 1975
Peale Point	Classic Thule	winter	eastern	1	NISP	869	Stenton 1987
Peale Point	Modified Thule/Late Prehistoric	winter	eastern	1	NISP	8331	Stenton 1987
Peale Point	Historic	winter	eastern	1	NISP	8161	Stenton 1987
Crystal II	Classic Thule	winter	eastern	1	rank order		Collins 1950
Itinapik	Modified Thule/Late Prehistoric	winter	eastern	1	NISP	551	Sabo 1991
Okivilialuk	Classic Thule	winter	eastern	1	n/a		Sabo 1991
Okivilialuk	Historic	winter	eastern	1	NISP	440	Sabo 1991
Talaguak	Classic Thule	winter	eastern	1	NISP	2925	Sabo 1991
Talaguak	Modified Thule/Late Prehistoric	winter	eastern	1	NISP	3053	Sabo 1991
Talaguak	Historic	winter	eastern	1	NISP	2795	Sabo 1991

	FAUNAL REMAINS				HARVESTING GEAR																		
	% DIETARY CONTRIBUTION				SEA MAMMAL				LAND MAMMAL				FISH				BIRD				TOTAL	
SITE/COMPONENT	sea mammal	land mammal	fish	bird	n types	% types	n items	% items	n types	% types	n items	% items	n types	% types	n items	% items	n types	% types	n items	% items	n types	n items
Washout H. 1					8	42.1	18	38.3	4	21.1	13	27.7	5	26.3	12	25.5	2	10.5	4	8.5	19	47
Washout H. 2					10	58.8	23	71.9	5	29.4	7	21.9	1	5.9	1	3.1	1	5.9	1	3.1	17	32
Washout H. 3	95.8	1.4	2.8	0.04	10	76.9	22	81.5	3	23.1	5	18.5	0	0.0	0	0.0	0	0.0	0	0.0	13	27
Washout H. 4	29.4	51.0	19.4	0.3																		
Pauline Cove F. 7	64.6	13.0	22.3	0.1	6	54.5	22	59.5	2	18.2	6	16.2	2	18.2	6	16.2	1	9.1	3	8.1	11	37
Pauline Cove F. 1	89.7	9.6	0.5	0.3	4	22.2	5	16.1	3	16.7	4	12.9	9	50.0	16	51.6	2	11.1	6	19.4	18	31
Pauline Cove F. 5/8	90.4	8.1	1.1	0.4	3	30.0	4	30.8	2	20.0	3	23.1	3	30.0	4	30.8	2	20.0	2	15.4	10	13
Radio Creek					3	23.1	4	11.1	4	30.8	10	27.8	5	38.5	17	47.2	1	7.7	5	13.9	13	36
Gupuk	97.4	0.9	1.7	0.02																		
Kittigazuit OH					2	18.2	5	19.2	5	45.5	13	50.0	3	27.3	6	23.1	1	9.1	2	7.7	11	26
Kittigazuit M4					6	24.0	24	28.6	8	32.0	29	34.5	9	36.0	27	32.1	2	8.0	4	4.8	25	84
Kittigazuit M2					5	50.0	9	39.1	4	40.0	13	56.5	1	10.0	1	4.3	0	0.0	0	0.0	10	23
Kittigazuit M1					3	25.0	8	22.2	4	33.3	12	33.3	4	33.3	15	41.7	1	8.3	1	2.8	12	36
Sukunnuk	0.0	9.4	87.1	3.5	0	0.0	0	0.0	4	33.3	8	14.8	7	58.3	45	83.3	1	8.3	1	1.9	12	54
Cache	25.4	63.7	6.1	4.8	1	8.3	1	4.3	4	33.3	9	39.1	6	50.0	11	47.8	1	8.3	2	8.7	12	23
Gutchiak	37.1	38.4	3.4	21.2	6	20.0	17	3.4	10	33.3	71	14.1	13	43.3	406	80.7	1	3.3	9	1.8	30	503
Kugaluk	3.8	92.3	3.7	0.2	6	31.6	19	22.4	6	31.6	26	30.6	6	31.6	35	41.2	1	5.3	5	5.9	19	85
Bison Skull West	0.5	99.0	0.01	0.4																		
Bison Skull East	1.5	97.2	0.1	1.2																		
Rita-Claire	3.2	93.5	1.0	2.4	3	30.0	4	17.4	3	30.0	13	56.5	3	30.0	3	13.0	1	10.0	3	13.0	10	23
Iglualuit H. 20	95.4	4.3	0.2	0.1	5	33.3	10	20.8	4	26.7	28	58.3	5	33.3	9	18.8	1	6.7	1	2.1	15	48
Iglualuit H. 11	91.5	8.2	0.01	0.2	3	17.6	13	36.1	7	41.2	12	33.3	6	35.3	7	19.4	1	5.9	4	11.1	17	36
Booth Island					9	47.4	103	70.1	3	15.8	22	15.0	6	31.6	21	14.3	1	5.3	1	0.7	19	147
Langton Bay					7	35.0	30	34.1	2	10.0	26	29.5	11	55.0	32	36.4	0	0.0	0	0.0	20	88
Okat					9	56.3	17	21.5	3	18.8	16	20.3	3	18.8	45	57.0	1	6.3	1	1.3	16	79
Jackson					7	43.8	43	69.4	3	18.8	10	16.1	2	12.5	2	3.2	4	25.0	7	11.3	16	62
Nelson River	76.4	23.5	0.0	0.1																		
Nichol	95.9	4.1	0.1	0.02	3	50.0	4	33.3	1	16.7	6	50.0	1	16.7	1	8.3	1	16.7	1	8.3	6	12
Memorana	78.9	21.0	0.02	0.01	10	55.6	37	47.4	3	16.7	26	33.3	3	16.7	10	12.8	2	11.1	5	6.4	18	78
Kunana	1.3	98.6	0.01	0.05	7	26.9	91	32.2	6	23.1	122	43.1	12	46.2	65	23.0	1	3.8	5	1.8	26	283
Lady Franklin Point	22.5	77.5	0.001	0.003																		
Beulah	93.8	6.1	0.1	0.01	6	54.5	16	69.6	2	18.2	3	13.0	3	27.3	4	17.4	0	0.0	0	0.0	11	23
Nuvuk	94.4	5.5	0.1	0.03	4	66.7	7	63.6	1	16.7	3	27.3	1	16.7	1	9.1	0	0.0	0	0.0	6	11
Clachan	97.8	2.1	0.1	0.01	14	46.7	210	72.2	3	10.0	32	11.0	12	40.0	48	16.5	1	3.3	1	0.3	30	291
Bloody Falls	1.4	98.5	0.02	0.1	2	18.2	2	7.7	4	36.4	8	30.8	5	45.5	16	61.5	0	0.0	0	0.0	11	26
Nadlok	0.0	100.0	0.002	0.01																		
Malerualik	17.1	74.7	0.2	8.0	8	34.8	29	34.5	2	8.7	36	42.9	7	30.4	10	11.9	6	26.1	9	10.7	23	84
Naujan	75.5	24.5	0.02	0.01	22	53.7	340	61.4	5	12.2	118	21.3	7	17.1	50	9.0	7	17.1	46	8.3	41	554
Silumiut	76.2	23.7	0.03	0.02	9	52.9	143	68.3	3	17.6	47	22.6	3	17.6	11	5.3	2	11.8	8	3.8	17	209
Meliadine-1					2	25.0	3	9.7	2	25.0	14	45.2	2	25.0	12	38.7	2	25.0	2	6.5	8	31

TABLE 1—*Continued*

	FAUNAL REMAINS				***HARVESTING GEAR***																	
	% DIETARY CONTRIBUTION				SEA MAMMAL				LAND MAMMAL				FISH				BIRD				TOTAL	
SITE/COMPONENT	sea mammal	land mammal	fish	bird	n types	% types	n items	% items	n types	% types	n items	% items	n types	% types	n items	% items	n types	% types	n items	% items	n types	n items
Hazard Inlet: Qariaraqyuk					28	51.9	354	47.7	9	16.7	235	31.7	9	16.7	111	15.0	8	14.8	42	5.7	54	742
Hazard Inlet: PaJs-3	98.4	1.1	0.1	0.5																		
Hazard Inlet: PaJs-3	99.3	0.0	0.0	0.7																		
Hazard Inlet: PaJs-4	93.3	6.0	0.1	0.6																		
Hazard Inlet: PaJs-13	98.0	1.8	0.01	0.2																		
Cape Garry	93.4	6.5	0.0	0.1																		
Learmonth	83.5	16.4	0.0	0.1	14	53.8	60	52.2	5	19.2	29	25.2	5	19.2	22	19.1	2	7.7	4	3.5	26	115
Brooman Point					21	61.8	113	54.1	5	14.7	50	23.9	3	8.8	6	2.9	5	14.7	40	19.1	34	209
Deblicquy					8	47.1	17	44.7	4	23.5	16	42.1	3	17.6	3	7.9	2	11.8	2	5.3	17	38
Porden Point: RbJr-1	91.5	8.4	0.002	0.1	16	55.2	73	42.7	5	17.2	55	32.2	3	10.3	11	6.4	5	17.2	32	18.7	29	171
Porden Point: RbJr-4	95.7	4.2	0.0	0.03	10	47.6	19	42.2	4	19.0	11	24.4	2	9.5	4	8.9	5	23.8	11	24.4	21	45
Porden Point: RbJr-5	82.1	17.5	0.2	0.2	9	69.2	12	63.2	2	15.4	5	26.3	1	7.7	1	5.3	1	7.7	1	5.3	13	19
Ruggles Outlet H. 2					5	41.7	7	36.8	3	25.0	3	15.8	4	33.3	9	47.4	0	0.0	0	0.0	12	19
Eskimobyen	86.4	13.6	0.0	0.1	9	56.3	19	42.2	4	25.0	23	51.1	0	0.0	0	0.0	3	18.8	3	6.7	16	45
Sverdup	83.4	16.6	0.0	0.03	5	71.4	6	50.0	2	28.6	6	50.0	0	0.0	0	0.0	0	0.0	0	0.0	7	12
Skraeling Island	90.7	9.2	0.0	0.03	19	54.3	158	34.5	8	22.9	246	53.7	3	8.6	13	2.8	5	14.3	41	9.0	35	458
Mitimatalik/Qilalukan	88.9	11.0	0.0	0.1	21	51.2	259	57.4	5	12.2	101	22.4	7	17.1	38	8.4	8	19.5	53	11.8	41	451
Native Point					12	54.5	93	37.5	6	27.3	149	60.1	3	13.6	5	2.0	1	4.5	1	0.4	22	248
Lake					6	50.0	27	79.4	2	16.7	3	8.8	1	8.3	1	2.9	3	25.0	3	8.8	12	34
Tuktumoon	1.4	97.7	0.1	0.8	1	33.3	1	6.3	1	33.3	11	68.8	1	33.3	4	25.0	0	0.0	0	0.0	3	16
B-1	98.9	1.1	0.0	0.004	17	50.0	213	69.8	6	17.6	53	17.4	4	11.8	12	3.9	7	20.6	27	8.9	34	305
Peale Point	79.0	20.9	0.0	0.1																		
Peale Point	91.0	9.0	0.0	0.04																		
Peale Point	90.1	9.9	0.002	0.01																		
Crystal II					6	50.0	25	69.4	2	16.7	7	19.4	1	8.3	1	2.8	3	25.0	3	8.3	12	36
Itinapik	89.1	10.9	0.0	0.0																		
Okivilialuk					9	75.0	16	72.7	1	8.3	3	13.6	0	0.0	0	0.0	2	16.7	3	13.6	12	22
Okivilialuk	91.2	8.8	0.0	0.0	4	66.7	6	54.5	1	16.7	4	36.4	0	0.0	0	0.0	1	16.7	1	9.1	6	11
Talaguak	59.5	40.4	0.0	0.04	12	52.2	61	69.3	4	17.4	13	14.8	3	13.0	3	3.4	4	17.4	11	12.5	23	88
Talaguak	92.6	7.4	0.0	0.01	13	72.2	22	66.7	1	5.6	2	6.1	4	22.2	9	27.3	0	0.0	0	0.0	18	33
Talaguak	89.1	10.9	0.0	0.01	13	56.5	38	69.1	6	26.1	12	21.8	0	0.0	0	0.0	4	17.4	5	9.1	23	55

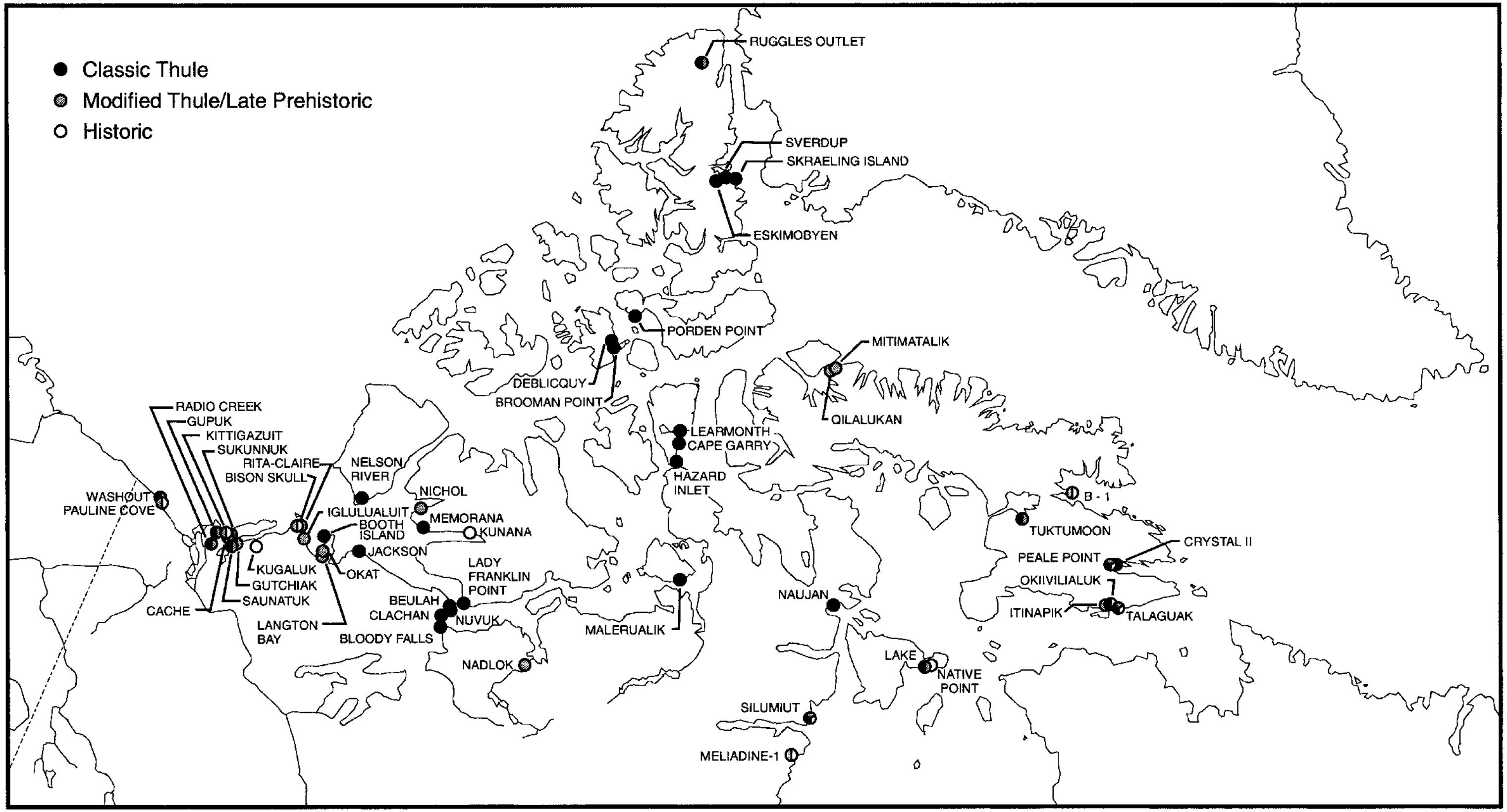

FIG. 2. Thule and Inuit sites included in the analysis.

of the Yukon and northwestern NWT did not experience Wisconsinan glaciation).

The net effect of this variability is a much greater diversity of economically useful anadromous and freshwater species for the Mackenzie drainage and Beaufort Sea coast, and along the Arctic Coast as far east as Bathurst Inlet, than for other parts of the Canadian Arctic. A composite map of the distributions of 23 species fished aboriginally by Inuit and Dene (Fig. 3 and Table 2) reveals that the Mackenzie Delta is a hotspot of fish biodiversity, as it is for terrestrial mammals and birds (Balkwill and Rick 1994:113). Chum and pink salmon are found in small numbers at the northeastern limit of their distribution in the Mackenzie Delta, while coho and chinook salmon occur in the Yukon drainage and would not have been directly available to Canadian Inuit. Several whitefishes, burbot, northern pike, and Arctic grayling are among the more significant species accounting for the zone of fish diversity extending east along the Arctic Coast. Lake trout are available everywhere on the mainland except northern Boothia Peninsula (Sekerak and Graves 1975) and on some of the Low Arctic islands. The ranges of some freshwater sculpins and sticklebacks also extend into the Arctic Islands, but these and other small species are mainly important as forage for other fish and are not included in Fig. 3. Across most of the Arctic Islands, Arctic char is the only notable species frequenting fresh water. Populations of resident and sea-run char are large in some lakes and rivers, but because they reproduce and mature slowly can be easily depleted.

This brief overview of species distributions is intended to provide a rough index of local resource availability for all regions of the Canadian Arctic. While extensive biological data have been assembled for some regions, such as the Mackenzie Delta (Martell et al. 1984), and particular water bodies (Johnson 1994) or study transects (Sekerak and Graves 1975), the comprehensive population data one might prefer are unavailable at this spatial scale for any species, necessitating the use of species richness as a proxy for productivity. A lack of taxonomic diversity does not mean that some species are not locally abundant, but it does imply that spatially averaged productivity across a region is less than that in areas with numerous species. In addition, impoverished fish faunas translate into temporally restricted availability of productive spawning migrations and aggregations. Whereas one or more useful species is readily accessible during all seasons in the Mackenzie Delta region (e.g., winter: burbot; spring–summer: smelts and northern pike; summer/fall: herring, whitefishes, and char), in other areas char runs sufficiently productive to allow a community to put up substantial winter stores occur for only a few weeks of the year. The presence of few taxa also results in high interannual variability in total yields. The upstream char run in late summer/early fall in a river draining into western Hudson Bay declined by 60% between 1973 and 1975, while the run at another river in the region increased by 199% in the same period (Johnson 1980: 56). Beyond ephemeral and highly localized occurrences, the fishes of most of the Arctic Islands appear to be significantly less attractive as a staple resource than those of the mainland, and the Mackenzie Delta region significantly more productive than the rest of the mainland.

ETHNOGRAPHIC FISH USE

Anadromous fish, especially Arctic char and various species of whitefish, are widely reported to have been important subsistence staples of the Historic Copper, Netsilik, and Caribou Inuit (see, e.g., Jenness 1922; Birket-Smith 1929; Rasmussen 1931; Damas 1969; Balikci 1980; over-

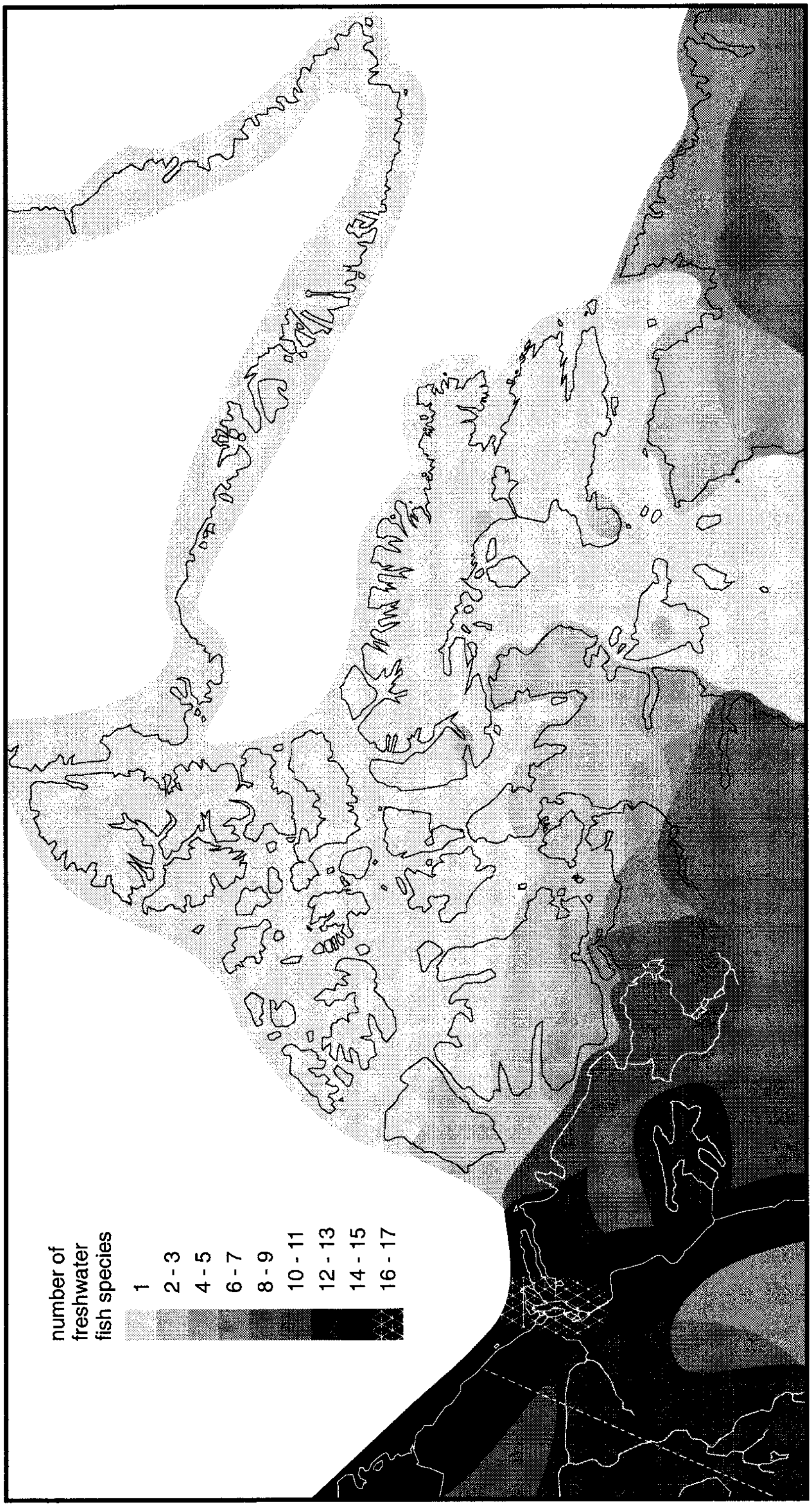

FIG. 3. Composite distribution of 23 freshwater and anadromous fish species utilized aboriginally (species listed in Table 2).

TABLE 2
Freshwater and Anadromous Fish Species of the Canadian Arctic Utilized Aboriginally (Composite Distribution Mapped in Fig. 3)

Family common name subfamily common name common name	Family latin name subfamily latin name latin name	Species record from site in study area
Salmon family	Salmonidae sp.	
Salmons, trouts, chars	Salmoninae sp.	
Pink salmon	*Onchorhynchus gorbuscha*	?
Chum salmon	*Onchorhynchus keta*	?
Coho salmon	*Onchorhynchus kisutch*	
Chinook salmon	*Onchorhynchus tshawytscha*	
Atlantic salmon	*Salmo salar*	
Arctic char	*Salvelinus alpinus*	X
Brook trout	*Salvelinus fontinalis*	
Lake trout	*Salvelinus namaycush*	X
Whitefishes	Coregoninae sp.	
Lake cisco	*Coregonus artedii*	?
Arctic cisco	*Coregonus autumnalis*	X
Least cisco	*Coregonus sardinella*	X
Lake whitefish	*Coregonus clupeaformis*	X
Broad whitefish	*Coregonus nasus*	X
Round whitefish	*Prosopium cylindraceum*	X
Inconnu	*Stenodus leucichthys*	X
Graylings	Thmallinae sp.	
Arctic grayling	*Thymallus articus*	X
Smelts	Osmeridae sp.	
Pond smelt	*Hypomesus olidus*	
Rainbow smelt	*Osmerus mordax*	
Mooneyes	Hiodontidae sp.	
Goldeye	*Hiodon alosoides*	
Pikes	Esocidae sp.	
Northern pike	*Esox lucius*	X
Suckers	Catostimadae sp.	
Longnose sucker	*Catostomus catostomus*	X
Cods	Gadidae sp.	
Burbot	*Lota lota*	X
Perches	Percidae sp.	
Walleye	*Stizostedion vitreum*	

views in Freeman 1976; Damas 1984). Many families spent late spring and summer in temporary tent camps positioned next to rivers and lakes with large populations of char, whitefishes, or lake trout. The upstream migration of sea run char in late August or early September was considered particularly important, since the fish are larger, fatter, and more abundant than during the downstream run in late June or early July (Brice-Bennett 1976:68; Johnson 1980; Mathiassen 1928). Resident populations are also available year-round in some lakes, but tend to be much smaller in body size than anadromous individuals. Mature nonmigratory char in the Central and Eastern Arctic consistently average less than .5 kg, while mature anadromous char average 1–3 kg (Johnson 1980; McCart and Den Beste 1979). Knud Rasmussen stayed with a small group of Netsilingmiut (about 25 people) relying on landlocked char at Amitsoq, “the most famous of all fishing places on King William's Land" (Rasmussen 1931:61), during early August 1923. They harvested 15–30 "medium-sized" char daily, spearing the fish with leisters at a stone weir, or *saputit,* with the result that the group "lived no more than from hand to mouth" (Rasmussen 1931:62). However, "later on in the summer season, or the beginning of autumn, there is often such a wealth of fish at Amitsoq that, in the course of fourteen days, every family can catch so much that they are able to make three or four caches of good, fat trout [Arctic char] for the winter. Each cache represents between two and three hundred kilogrammes" (Rasmussen 1931: 65–66). Central Arctic groups often supplemented these stores (which included whitefishes in many areas) by late fall/ early winter fishing with hooks or lures and leisters. Polar and Greenland cod, char, whitefishes, and spawning lake trout were harvested in this fashion through thin ice along the coast and on rivers and lakes. Ice fishing was also practiced during late spring/early summer, before the move to major char fishing localities (Damas 1969; Jenness 1922; Brice Bennett 1976). Fish catches among these groups, especially during the important fall runs, increased dramatically following the adoption of netting gear in the early 20th century (Arima 1984:448; Brice Bennett 1976:80; Farquharson 1976:36).

The Labrador and Greenland Inuit areas largely fall outside the scope of this article, but provide instructive cases. The West Greenland Inuit were among the few Eastern Arctic groups to make abundant use of marine species. Oil-rich capelin spawn inshore (sometimes on the beach) in vast numbers during early summer and were scooped up in dip nets and dried for winter consumption. Atlantic cod, halibut, and sharks (the latter for dog food) are also reported to have been taken with hooks in open water and through sea ice in winter (Kleivan 1984). However, a well-preserved faunal assemblage from Nugarsuk in the northern Upernavik District, dating to about A.D. 1650–1850, contained not a single fish bone among the 27,000 identified specimens, despite the fact that fish are an important part of winter subsistence in the area today (Møhl 1979:388). While capelin harvesting is well attested from at least the late 16th century (Hakluyt 1985:299) and char fishing gear is widespread prehistorically, it is possible that marine fishes were generally much less important before the appearance of European technology and trading opportunities. In Labrador, the introduction of gill nets by Moravian missionaries in 1772 rapidly resulted in the near-abandonment of weir fishing, as families began to fish char and salmon at sea during the summer (LeDrew 1984:540).

Among Eastern Arctic groups, Baffinland Inuit and Iglulingmiut appear to have been the least reliant on fishing (e.g., Stevenson 1997:44). Open-water sea mammal hunting and harvesting of caribou when their hides were prime were the major summer/fall activities for the Iglulingmiut, although *saputit* fishing of char runs occurred during the summer and there was some ice fishing for char and lake trout. Additionally, on northern Baffin Island sculpin and polar cod were casually jigged through the sea ice by women and children and sharks were sometimes killed when they congregated at narwhal kills, but were only used as dog food (Brody 1976). Baffinland Inuit fished char in the context of late summer/early fall caribou hunting and through lake ice in winter and spring (Kemp 1976; Wenzel 1991; Stevenson 1997).

In the Western Arctic, fishing tended to be a much more important component of the annual subsistence round. The Inuit of the Mackenzie Delta region relied heavily in all seasons on aboriginal seine, gill net, and hook technology to obtain a wide variety of freshwater and anadromous species, and at least one inshore-spawning marine species (herring), to supplement the harvest of marine mammals, caribou, and small game. Settlement systems were very different than those in the Eastern Arctic. Winter camps frequently consisted of one or a few large sodhouses scattered widely across the outer coast, some positioned for winter ice fishing or early spring harvesting of fish leaving tundra lakes on sea-bound or spawning migrations. Late summer/early fall settlements consisted of both large tent camps at which beluga or bowhead whaling was the major subsistence activity and smaller interior fishing, fowling, and caribou hunting camps (McGhee 1974; Morrison 1994, 1997b; Swayze 1994). Fishing was also an important supplement to sea mammal harvesting on northern Alaska coasts, and the principal subsistence orientation for riverine Inupiat populations of Northwest Alaska (Burch 1981; Giddings 1952; Foote 1965). The Yupik occupants of western and southern Alaska were so reliant on fish, including large marine fishes and several species of salmon, that their economies bear little resemblance to those conventionally associated with Eskimo peoples (Fienup-Riordan 1990).

An important feature of historic fish use is the scheduling conflict that existed in many areas. The most productive late summer/early fall season for salmonid harvesting often coincides closely with the period of maximum utility of caribou hides. Caribou hides harvested at this time were considered essential for manufacturing winter clothing (Hatt 1969; Stenton 1991) and were obtained at some expense through trade by Western Arctic groups with restricted access to caribou herds. Copper Inuit groups appear to have alternated uneasily between caribou hunting and fishing during this season (Farquharson 1976), while the Netsilik considered stored fish to be insurance in the event the caribou harvest failed (Balikci 1980; Brice-Bennett 1976). In both areas, women, children, and the elderly were actively involved in *saputit* fishing, allowing the men to concentrate on caribou hunting. Overall, caribou was a more important resource than fish as a source not only of meat but of hides, fat, sinew, bone, and antler. Caribou also tends to rank slightly higher than fish in Inuit dietary preferences (e.g., Freeman et al. 1992). As long as caribou could be procured before, during, or after the upstream char run, both of these resources were embraced as complementary components of the inland, warm-weather portion of the subsistence-settlement round.

In parts of the Canadian Arctic, however, an additional conflict existed because late summer/early fall was the season for open-water sea mammal hunting. Historic Copper Inuit and Netsilingmiut did not practice much open-water hunting, and the season ran through spring and summer along much of the east and south coasts of Baffin Island. The open-water season also began early enough on Hudson Bay that Caribou Inuit of the south Keewatin coast were able to cache seals, walrus, and beluga during summer and then move inland during the fall, during which time women fished and put up winter caches while the men hunted caribou (Welland 1976:87). The Iglulingmiut scheduling dilemma was resolved in some areas by dividing into groups of older and younger hunters, the older ones staying on the coast to hunt walrus and whales and the younger heading inland with their families for caribou hunting and fishing (Damas 1969). This three-way conflict probably accounts for the reduced importance of fishing in Iglulingmiut economies. Morrison (1988, 1994) suggests that the Mackenzie Inuit solved the problem through a status-based division of labor analogous to that employed by the Iglulingmiut, with the less prestigious option being fishing and caribou hunting in the near interior while beluga and bowhead whalers assembled on the coast. The efficiency of gill netting must have reduced the potential conflict between fishing and caribou hunting for the former. An even more complex status-linked pattern of regional economic differentiation and integration appears to have characterized North Alaskan economies from Thule times (Sheehan 1995, 1997; Burch 1981) and contrasts with the sequential use of resource zones predominant in the Eastern Arctic (Morrison 1994).

In general, it can be observed that fish were universally in use among Historic Inuit, but to significantly different degrees. The degree of usage depended on the diversity and productivity of fish species, available technology, allowance for socially differentiated occupational specialties, and especially the opportunity costs when other resources are considered. Caribou were ranked higher than fish and so too were large marine mammals such as beluga, walrus, and bowhead whales, where they were accessible (and where the organization existed to harvest them) during the open-water season. With respect to prehistoric harvesting patterns, it can be predicted that fish utilization will have been restricted where species diversity and productivity are low and where large mammal hunting conflicted with the peak of fish availability, although the conflict may have been eased by special technological or organizational solutions.

FACTORS CONTRIBUTING TO THE INTERPRETIVE DILEMMA

Before evaluating the basic ecological and economic factors that may have controlled the attractiveness of fish resources, it is necessary to consider issues of a purely archaeological nature. These relate to the preservation, collection, and interpretation of the faunal and artifactual assemblages on which the assessment of Thule fish use must ultimately rest. Taphonomic factors may have reduced the zooarchaeological visibility of fishing, while sampling problems at the level of regions, sites, and deposits may have biased the faunal assemblages at our disposal. Neither are the artifact assemblages immune to misinterpretation. Functional identifications of harvesting gear may be in error, or biases in assemblage formation processes inadequately understood. These factors are considered in turn below.

Taphonomic Deletion of Fish Bone

Poor preservation. The explanation most often offered for the scarcity or absence of fish in Thule and Inuit faunal assemblages is a generally heightened susceptibility of fish bone to destruction by taphonomic processes (e.g., McGhee 1972:44; Henshaw 1995:168). Fish bones are considered too small or fragile to survive even, apparently, where preservation of other taxa is excellent. While it is widely surmised that fish bone preserves more poorly than the bones of mammals (Colley 1990; Lyman 1994; Jones 1990; Wheeler and Jones 1989), there do not appear to have been any controlled comparisons of their relative preservation potential.

Bone density has come to be recognized as a useful predictor of mammalian bone survivorship in assemblages subjected to density-mediated attrition (Lyman 1984, 1994). Butler and Chatters have reported determinations of bone mineral content (BMC), linear density (LD), and bulk or volume density (VD) for salmonid bones, allowing estimates of the relative survivorship potential of these taxa (Table 3). Linear (or, more properly, areal) density (measured in grams per square centimeter) divides the measured bone mineral content (in grams) at a photon absorpti-

TABLE 3
Measures of Bone Density for Various Fish and Mammalian Taxa[a]

Taxon	Genus species	*n* scan sites	Mean BMC (g)	Mean LD (g/cm^2)	Mean VD (g/cm^3)
Chinook salmon	*Onchorhyncus tshawytscha*	16	0.11		0.26
Coho salmon	*Onchorhyncus kistuch*	51		0.06	
Large-scale sucker	*Catostomus macrocheilus*	10			0.65
Pronghorn	*Antilocapra americana*	39			0.29
Vicuna	*Lama* spp.	28			0.33
Domestic sheep	*Ovis aries*	73			0.34
Guanaco	*Lama* spp.	28			0.40
Deer	*Odocoileus* spp.	95	2.11	0.81	0.40
Bison	*Bison bison*	101			0.48
Seal	*Phoca* spp.	57			0.56
Marmot	*Marmota* spp.	60			0.65
			Mammal mean		0.43

[a] Abbreviations: BMC = bone mineral content; LD = linear (areal) density; VD = volume (bulk) density. Sources: Lyman 1984, 1994; Butler and Chatters 1994.

ometry scan site by the area scanned, while volume density (in grams per cubic centimeter) divides BMC by an estimate of the volume of the scan site. Mean LD for 95 deer bone scan sites is .81 g/cm^2 (Lyman 1984:276–279) and .06 g/cm^2 for the 51 coho salmon elements in Butler's sample (Butler 1990, cited in Lyman 1994: 442), suggesting a survivorship potential for deer bone an order of magnitude greater than that for salmon. Mean VD for the same 95 deer bone scan sites is .40 g/cm^3 (Lyman 1984:276–279), close to the average of .43 for eight mammalian taxa (Table 3), and .26 g/cm^3 for 16 chinook salmon elements (Butler and Chatters 1994:417), which suggests only slightly poorer survivorship potential for salmon. However, the sample of 16 elements may not be representative of the average VD of salmon bone, since the mean LD of this group of elements for the anatomically similar coho salmon is .09, or 50% greater than the average for the full sample of 51. Scaling mean VD to the differences observed in LD results in an estimate of mean salmon bone VD of .17 for the expanded scan site sample, suggesting a survivorship potential for mammals 2.5 times greater than that for salmon if VD is related to survivorship in a simple linear fashion.

The relationships between the different measures of bone density and survivorship are not well understood and are likely not simple ones. Given the highly variable size and shape of scanned bones, it is generally argued that VD is a more effective measure of survivorship potential than LD (Lyman 1984; Kreutzer 1992; Butler and Chatters 1994), but this is not always the case. A study of human bones subjected to density-mediated attrition revealed a much stronger correlation between element portion frequency and LD than VD (Spearman's ρ of .827 and .096, respectively; Willey and Snyder 1997). LD actually appears to perform better than VD in picking up posited density-mediated attrition in the salmon bone assemblages reported by Butler and Chatters (Table 4). Taking into account frequent anecdotal comments on the poor relative survivorship of fish in the zooarchaeological literature, the values for LD (or even BMC) would appear to be the better index

TABLE 4
Rank Order Correlation (Spearman's Rho) of Bone Density and Salmon %MAU[a]

Bone density index	DO-211		Duwamish		Keatley Creek	
	r_s	Two-tailed p	r_s	Two-tailed p	r_s	Two-tailed p
BMC	−0.102	0.708	0.067	0.806	−0.319	0.229
LD	0.636	0.008	0.604	0.013	0.372	0.157
VD	0.762	0.001	0.532	0.034	0.159	0.556

[a] Based on BMC, VD, and %MAU data from Butler and Chatters (1994:417–418) and LD data from Butler (1990, cited in Lyman 1994:442).

of relative preservation potential for fish and mammal bone than those for VD. Without direct experimental comparisons of taxonomic survivorship, however, it is impossible to accurately gauge the magnitude of the difference in survivorship potential for mammals and fish, though the gap may be substantial in many situations.

Based on the comparison of various density measures for Atlantic cod (*Gadus morhua*) elements to experimentally abraded and archaeologically recovered assemblages, Nicholson (1992b) has argued that shape is a more important determinant of fish bone survivorship than density. Element morphology may control the nature and extent of fracturing of bones subjected to mechanical weathering. Clearly, the unique suite of taphonomic processes operative at a site must be taken into account in evaluating element and taxon frequencies. While decomposition, chemical weathering, trampling, and carnivore ravaging (the latter considered separately below) may all result in density-mediated attrition of bone assemblages and the reduced survival of fish bone relative to other taxa, the particular patterns of element and species survivorship likely vary according to the nature and intensity of the taphonomic agents that have affected a sample.

For the arctic assemblages of concern here, many of the natural attritional processes common on temperate sites are suppressed. The rate of chemical weathering is largely controlled by temperature and humidity and is generally low in arctic environments. Microbial activity is also much reduced. Depending on soil or substrate chemistry (Merbs 1997), the remains of large vertebrates can easily survive for millennia on or near the ground surface in the Central and High Arctic, with preservation declining substantially as one moves into warmer and wetter Low Arctic contexts, along north–south and northwest–southeast gradients, respectively (Fig. 4). However, there is no limit on the survival of animal tissue in permafrost deposits (Sutcliffe 1990). Depending on ground moisture and matrix composition, as little as 25 cm of dense overburden (e.g., midden accumulation, the collapsed walls and roof of a sod house) can insure that the deposits in which faunal remains occur will not thaw during the year. Such remains are effectively stable, barring dramatic changes in the climatic regime or disturbance of surrounding deposits. Perfectly preserved soft tissue, including flesh, hair, sinew, hide, and feathers, are thus routinely encountered in well-buried deposits associated with semisubterranean sod winter houses in the Central and High Arctic. Because warm-weather dwellings frequently consisted of temporary tent structures or shallowly excavated *qarmat* and soil formation may be slow or nonexistent at such sites, spring/summer/fall assemblages tend to be more poorly

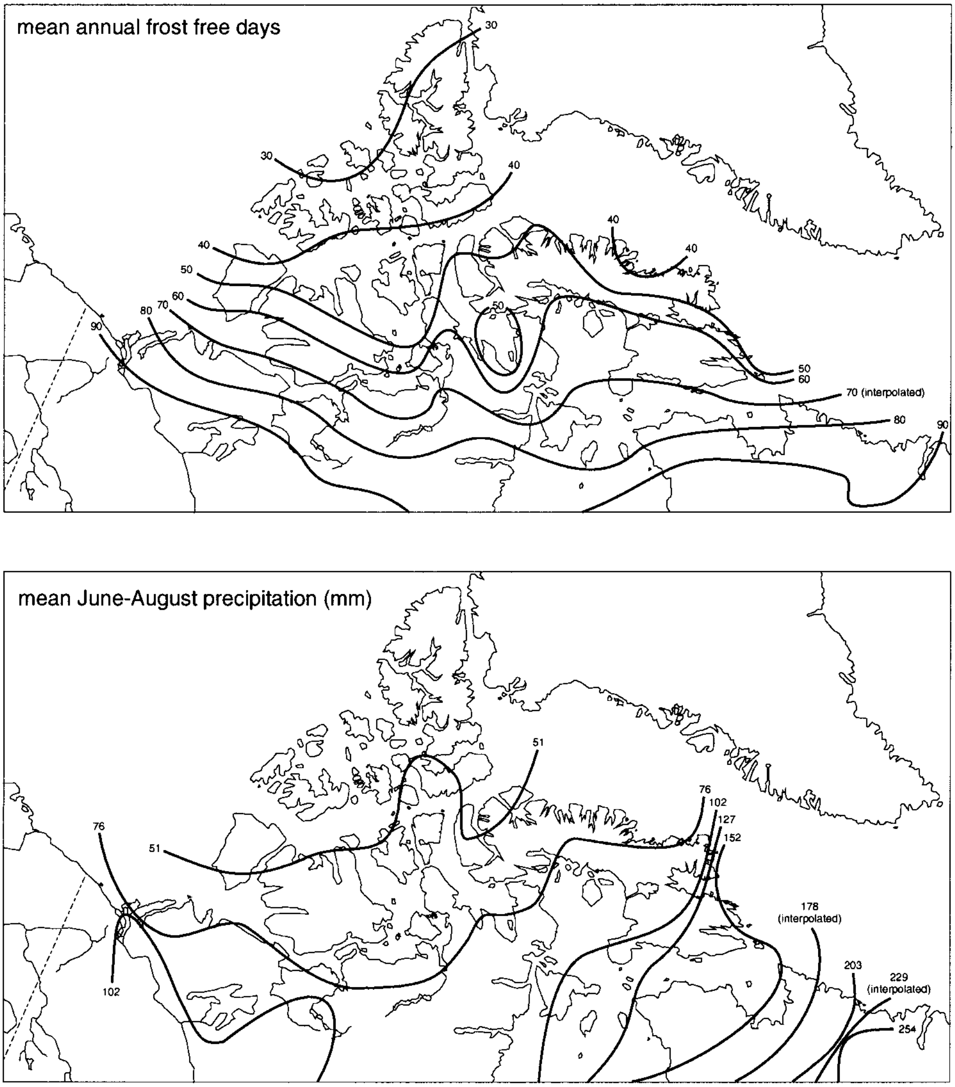

FIG. 4. Climatic controls on bone preservation in the Canadian Arctic. (Upper) Mean annual number of frost-free days. (Lower) Mean June–August precipitation in millimeters (after Fletcher and Young 1976).

preserved than winter assemblages. The former are also more heavily exposed to carnivore ravaging, freeze-thaw, and other mechanical disturbances.

In general, portions of the faunal assemblages from most Thule winter house sites have effectively suffered no post-depositional attrition, while the overall level of preservation is high even for deposits occurring within the active layer which thaws most summers. The preservation of near-surface bone varies from site to site depending on the extent of chemical, mechanical, and biological weathering, hence especially the temperature and moisture regimes. Among the winter house assemblages, only those from southern Baffin Island appear to be have suffered severe weathering (Sabo 1991; see also Henshaw 1995, 1999) and potentially high loss of the more perishable fish bone. This problem is even more severe at Thule winter sites in Labrador, outside the scope of the current study, which may have negligible organic preservation (e.g., Fitzhugh 1994). Fish bone is likely underrepresented to some degree in all winter house assemblages that include material from near-surface contexts, but because faunal remains are rarely reported by preservational context this is impossible to quantify. However, the generally excellent condition of larger vertebrate remains suggests that fish bone deletion due to weathering is normally not severe on winter sites.

The situation at warm weather encampments is very different. The excavated deposits at such sites normally occur within the active layer, and faunal remains are thus regularly exposed to a variety of attritional processes. Particularly at the tent ring sites frequently situated on beaches or rock outcrops, the lack of much of an insulating and protective vegetation mat means that organic preservation is often poor, resulting in impoverished organic artifact assemblages and the likely deletion of less dense faunal elements and taxa. This accounts in large part for the slight interest in excavating these features expressed by Thule archaeologists; few have been reported in the literature. Heavier dwelling forms (especially certain varieties of *qarmat* as opposed to tent rings), rapid cultural deposition, and relatively rapid soil formation and vegetation growth can lead to sufficient burial of faunal materials that the level of preservation of winter houses is approached. Extreme polar desert conditions, or burial beneath perennial snow drifts, may also produce this effect.

Based on the range and condition of recovered organic materials the warm-weather sites included in the present sample seem to have reasonably good organic preservation and indeed, with the exception of the heavily weathered tent ring assemblages from PaJs-3 (Whitridge 1992), all produced fish bone. Fish bone preservation was particularly good at intensively utilized Low Arctic sites in the Mackenzie Delta region, where assemblage burial was probably relatively rapid, but based on the weathered state of winter house assemblages from southern Baffin Island and Labrador, comparable preservation may be rare at the eastern margins of Thule settlement. Deletion of fish bones at warm-weather sites likely ranges from moderate to severe, but given that the most heavily weathered of such assemblages have been deliberately avoided by Thule archaeologists, poor preservation cannot account for the impression of fish scarcity in the literature, as Taylor suggested: quantitative faunal data were only located for four Classic Thule warm-weather assemblages versus 23 winter assemblages.

What is most sorely lacking, however, is consistent reporting of details relevant to the reconstruction of assemblage taphonomy for all taxa. Element frequencies (MNE and/or MAU) are increasingly being reported for seal and caribou (e.g., Morrison 1997a; Henshaw 1999), but are never provided for fish in sufficient detail to assess the scope of density-mediated attrition through comparison with density-based survivorship indices. Similarly, information on degrees of weathering and fragmentation are rarely provided. Until taphonomic analyses become available for a seasonal, chronological, and regional range of assemblage types, it will be difficult to securely estimate the extent of fish use from faunal remains, except where preservationally pristine permafrost deposits (e.g., winter house floor assemblages) are reported separately from active zone deposits.

Consumption of bones by dogs/scavengers. Another mechanism that can generate density-mediated attrition is the activity of dogs and other bone consumers. The degree of bone destruction by dogs (and occasionally other carnivores, rodents, and ungulates) at Arctic sites was likely controlled by a number of variables. The number of dogs kept by the site occupants, the food they received, the nutritional composition of discarded bones, and the length of time bone assemblages lay exposed on the surface may all have contributed to anatomical and taxonomic patterns of bone survival. Since decomposition is slow in the Arctic, fish remains would have been attractive to dogs and other scavengers for some time after discard, and as Foote (1965:270) notes: “Eskimo dogs will eat all portions of animals familiar to them, bones and all.” Carnivore access to discarded bones appears to be heightened at warm-weather sites, perhaps because animal remains are less likely to be frozen or concealed by snow. The %NISP of identified mammalian elements with evidence of carnivore gnawing was 17.2% (295/1,718) for Thule *qarmat* and tent ring assemblages on southeast Somerset Island and 10.4% (1,173/11,234) for the winter house assemblages (Whitridge 1992). Because of the relatively small size of the bones, fish parts or carcasses, unlike those of larger vertebrates, could easily have been consumed whole. Hudson (1993:309) provides ethnoarchaeological support for the argument that prey body size is positively correlated with bone survivorship (measured as NISP/actual number of individuals) in dog-ravaged faunal assemblages. Although Inuit dog teams were much smaller prior to the historic shift to a mobile trapping economy and the introduction of rifles, nets, and market foods (Farquharson 1976:51–52), it can be expected that dogs would have consumed a substantial proportion of any fish remains disposed of on the surface at all seasons.

In addition, Inuit frequently fed fish to dogs directly, either whole or merely the portions (heads, backbones, and viscera) not always consumed by people (Binford 1978:256; Farquharson 1976; Ferguson 1961:16; Brice-Bennett 1976; Giddings 1967; Gubser 1965). Jenness (1922:105, 240) states that Copper Inuit sometimes fed dogs solely on fish bones and a daily cup of fish broth during late spring/early summer. Although caloric requirements vary with the size of the dog, the season, and its workload, Foote (1965:270) suggests an (ideal) average daily ration of about 2 kg of whole fish per working dog. At this rate, a 250-kg cache of char like the ones put up by the Netsilingmiut at Amitsoq, referred to above, would only feed one dog for 4 months. An experimental study by Jones (1986:57) revealed that 11.8% of the bones of medium-sized (25–34 cm) fish ingested by a dog were excreted in identifiable form, with an additional 11.8% unidentifiable fragments, while only a single fragmentary skeletal element survived of a salmon fed to a dog by Butler (Butler and Schroeder 1998). Furthermore, Foote (1965:270) notes that sled dogs will eat their own feces 2–3 times in succession. Presumably, little if any identifiable fish bone would survive multiple ingestions. It is thus not unlikely that a substantial proportion of the bones generated by Thule fishing were ultimately fed to, or scavenged by, dogs and that the vast majority of consumed fish bones were destroyed. Destruction of fish bone by dogs was probably heavy at winter sites and very severe at warm-weather sites, in all periods and regions, and has thus introduced a bias against fish in tabulations of taxonomic relative frequency. Likely dog coprolites appear to be common in permafrost deposits at Thule winter sites, deriving either from animals housed indoors (especially in the entrance tunnel) or from postabandonment processes, so it is possible to directly investigate the diet of sled dogs, though this has not been attempted.

Consumption of bones by humans. Inuit sometimes consumed the bones of fish and other small vertebrates. The long bones of ptarmigan were traditionally chewed and swallowed at Clyde River, and for the Mackenzie Inuit Stefansson (1914:156) reports the same treatment for fish vertebrae, while fish ribs were spit out. Jenness (1922:99) notes that Copper Inuit ate small fish whole, "not even excepting the bones." Calcium appears to be scarce in the traditional Inuit diet (Mann et al. 1962), so there may have been a nutritional imperative behind this practice. Certainly, mastication would appear to be intended to maximize the nutritional benefit of consuming fish bones; unchewed or lightly chewed bones will sometimes pass through the human digestive system relatively intact (Butler and Schroeder 1998). Jones (1986) also conducted experiments with human consumption and excretion of fish bones, resulting in 2.5% identifiable fragments and an additional 16.3% unidentifiable fragments, while Butler and Schroeder (1998) found 26% survivorship for small fish consumed by a human. Again, Foote (1965) and others (Murdoch 1892; Leechman 1945; Matthiasson 1992) note that sled dogs regularly consumed human feces, so few of the fish bones occasionally consumed by humans are likely to be identified in faunal assemblages.

Culling. Processing can result in the deletion of skeletal portions from carcasses transported to points of consumption. Fish intended for storage were either dried or frozen, depending on the season. During productive periods of summer fishing the fish would not preserve well if cached whole, even in ice cellars (Ferguson 1961:16), and so were frequently dried. Details of the preparation of dried salmonids are frustratingly scarce in the Inuit ethnographic literature. There are numerous references to fish being split, gutted, and hung up to dry (e.g., Mathiassen 1928:206; Rasmussen 1931), but little information on the specific disposition of the bones. Jenness provides one of the few detailed accounts of traditional char drying, by Copper Inuit:

> Fish that are intended for drying are split from the anal [sic; probably pectoral] fin to the anus, then from the gills along each side of the spine; finally they are severed at the root of the tail. This leaves the two sides hanging from the tail ready to be laid across a pole to dry, while the head remains attached to the spine. The next step is to cut off the head for the daily meal, and to lay the spine out to dry on a stone or a sealskin, together with any roe the fish may contain. The spines of small fish not particularly rich in oil may be thrown to the dogs with other scraps. (Jenness 1922:105)

Presumably the dried backbones of larger fish were treated as provisions like any dried meat. Fillets for immediate consumption were prepared in a similar fashion by Polar Inuit, but without leaving them attached at the tail:

> The truly proper way to eat them [char] is indicated by the following: First the fins are cut off and four lengthwise cuts made so the skin can be pulled off. Some eat the skin, others discard it. Thereupon the long, meaty part of the back is cut off, beginning at the tail and carving close to the spin down along the fish. Thereafter the balance of the meat is split off the sides while bones and entrails remain hanging by the head and are thrown away. (Holtved 1967:142–143)

An account of fish processing in the Mackenzie Delta region in the late 1950s is consistent with Jenness and the fragmentary reports from other areas (e.g., Birket-Smith 1929:44): "Drying is done by splitting the fish, removing the backbone, head and ribs, scoring the inside of the fillets then hanging them from a rack in the sun" (Ferguson 1961:16). Large fish prepared for drying or cooking in this fashion may thus be virtually bone free, except for the entire dried vertebral columns saved by the Copper Inuit. The heads were frequently made into soup (Mathiassen 1928; Jenness 1922) and ultimately fed to dogs or discarded, often along with the rest of the bones (Binford 1978:256).

Small fish received different treatment. They were sometimes eaten immediately in their entirety, as noted above, or cached whole, as among groups along the lower Selawik River of Northwest Alaska: “The smaller fish were simply placed whole in a large round hole dug in the ground. When the hole was full, it was covered with grass and dirt. Later, during the winter, the partially decomposed but by then frozen fish were dug up and eaten raw. This kind of food was known as *auruq,* rotten fish” (Burch 1998:235). A similar practice of below-ground storage of herring in log-lined or earthen pits (for human and dog consumption, respectively) is indicated historically for the Mackenzie Inuit (Nagy 1994:77) and apparently involved caching whole fish (Smith 1984:341). The “tiny” herring reported to have been preserved in beluga oil by Mackenzie Inuit were also likely whole (Savoie 1971:185). Subject to preservation and recovery biases, the bones of small summer-caught fish may thus be better represented than those of large summer-caught fish in faunal assemblages associated with residential sites.

By late summer fish were being cached whole, at least in the Netsilik area (Rasmussen 1931:485), and fish caught in winter in all areas were frozen whole (Jenness 1922; Rasmussen 1931). There is thus a potential for seasonal differences in the transport of fish bones from processing areas/sites to residential areas/sites. Surplus fish harvested in summer would have been consumed at winter sites as boneless dried fillets (and perhaps some vertebral columns), whereas fish harvested in fall and winter would have been transported whole to residential sites. All the bones of fish consumed immediately at summer/fall sites, or caught during fall/winter, would be potentially available to enter house and kitchen midden assemblages, although many were fed to dogs. Bones culled during summer processing presumably ended up in middens close to harvesting locations (e.g., Chang 1988) or were fed directly to dogs. Unfortunately, the archaeological determination of the extent of bone loss from culling runs up against the same obstacle as the assessment of density-mediated attrition: lack of reporting of element frequencies. These data, together with frequencies of cut marks (see, e.g., Barrett 1997; Barrett et al. 1999), are necessary to reconstruct the patterns of butchery, transport, and discard that would allow estimates of the true economic importance of fish. On average, however, the bones of larger vertebrates would probably have been discarded at processing locations at an even higher rate than those of fish because of their much greater bulk. With the exception of a potential for zero visibility at winter sites of fish caught, filleted, and dried in summer, fish should have regularly entered assemblages of food refuse alongside the bones of mammals and birds.

Destructive preparation techniques. Boiling, even at relatively low temperatures, can produce significant structural damage in fish bone (Richter 1986), so cooking may contribute to its poor survivorship. Freshly caught fish were usually boiled as steak sections (Jenness 1922:104) and occasionally roasted. Fish were sometimes eaten raw, and more rarely slightly fermented, but generally only frozen fish were consistently eaten uncooked (Jenness 1922:98). Heads of large fish were almost always cooked, and even dried fish were sometimes rehydrated by boiling (Birket-Smith 1929; Mathiassen 1928). An unusual and even more destructive preparation technique among some Alaskan Yupik groups involved fermenting the heads of salmon in grass-lined pits: "They are kept there during summer and in the autumn have decayed until even the bones have become of the same consistency as the general mass. They are then taken out and kneaded in a wooden tray until they form a pasty compound and are eaten as a favorite dish by some of the people" (Nelson 1983:267).

All bones of fish caught and immediately consumed in summer, and heads at all seasons, are thus vulnerable to degradation from heating. Head bones are about twice as abundant in the salmonid skeleton as vertebrae (Wigen and Stucki, 1988) and at least for salmon are significantly less dense than postcranial elements (Butler and Chatters, 1994), so under poor preservational conditions it is conceivable that fish NISPs could be significantly depressed (and element abundances skewed) by selective cooking of heads. As discussed above, generically poor preservation (due to decomposition and weathering) is probably not a major determinant of fish bone survivorship in sod house assemblages, but is likely important at warm-weather sites. The more frequent consumption at the latter of entire cooked carcasses, as well as heads, may thus be associated with heightened attrition of fish bones relative to those of other taxa, although it seems likely that access to discarded fish remains by dogs is ultimately more important in determining survivorship.

Ritual disposal. Ritual disposal of food refuse is widely reported for the southern neighbors of Inuit, from the Pacific to the Atlantic seaboards. Various Inuit groups also accorded the bones of prey species ceremonial treatment, ranging from disposal of bones in the ocean to the arrangement of animal skulls in long lines on land (see review in Soby 1969/1970). There is at least one instance, from the Yupik area, of the bones of fish caught in traps (but not netted fish) being ritually disposed of in such a way as to prevent dogs from consuming them (Lantis 1947:44), but no references to ritual treatment of fish remains by Inuit or Inupiat groups have been located. A unique example of four char vertebrae strung on a baleen cord from a Thule house at Cape Kent in northern Greenland (Holtved 1944:276) may represent the use of fish bone for an amulet. However, the sort of systematic ritual treatment of fish bones (burning, suspension on trees, or disposal in water) reported for Athapaskan groups does not appear to have been practiced by Inuit (Hall 1971:53).

Artifactual use of fish bone. Although fish skins were used in some areas for manufacturing waterproof articles of clothing (Hatt 1969), Inuit made little artifactual use of fish bone. Enigmatic objects made of interlocking fox, seal, or bird bones are common on Thule sites and are often interpreted as children's playthings. The strung char vertebrate from Cape Kent might be interpreted as such or as an ornament. Jenness (1922:104) notes that Copper Inuit had names for the various cranial bones of fish based on their specific resemblances to animals. Since seal flipper bones were also named for their resemblances to animals, people, and objects and are widely reported to have been used in Inuit children's games, this possibility might be entertained for fish cranial bones. In fact, Birket-Smith (1945:124) reports a Netsilingmiut "toy" consisting of 13 fish cranial bones, but provides no further information. He also illustrates a men's brow band made of 43 fish otoliths strung on a sinew line (Birket-Smith:46–47), and Issenman (1997:191) notes that capelin vertebrae and cod otoliths were used as decorative clothing attachments by some Greenland Inuit. Giddings reports a cluster of "sharp" fish bones from a subfloor cache in an early Western Thule house at Cape Krusenstern in association with sewing equipment. He tentatively suggests that the fish bones were "intended for some special use" (1967:93), presumably as awls or pins for very light sewing work. Such uses are unlikely to have diverted a significant proportion of fish bone.

Sampling Bias against Fish Bone

Poor recovery. Next to poor preservation, poor recovery is the most commonly cited reason for the absence or underrepresentation of fish bones on Thule and Inuit sites (e.g., Savelle and McCartney 1988:30; Friesen and Arnold 1995:28; Balkwill and Rick 1994:114). This seems to be a particular problem with assemblages collected before the mid 1970s, when research designs began to explicitly address issues related to the subsistence economy. Early investigations of Western Arctic sites failed to fully incorporate fish bones in the then-standard field identifications, even when they were encountered during excavation (see discussion in Balkwill and Rick 1994). In fact, representative faunal collections of any kind are virtually nonexistent for arctic sites excavated before the mid 1970s.

The systematic bias against fish bone (especially of small species) produced by large mesh screening is well documented for other regions and through experiment. Since at least 75% of herring-sized fish bones can be lost through 1/4″ mesh (Singer 1987:85) screening through 1/8″ mesh may be necessary to recover a reasonably representative fish sample when smaller taxa are present. Deposits are not consistently screened on Thule excavations. This is due mainly to the slow pace of excavation where permafrost is involved, which frequently necessitates troweling through a few thawed centimeters of mucky, organic matrix per day in any given unit. Wet screening would seem to be appropriate for these saturated deposits, but Henshaw (1995) reported less success with wet than dry screening at Modified Thule/Historic sod house and *qarmat* sites on southeastern Baffin Island. Many Thule archaeologists appear to have arrived intuitively at the position that the slim potential return makes screening an inefficient use of precious hours in the field, but the circularity of this belief warrants controlled field experiments with the productivity of screening in a variety of field situations. Screening, especially of house floor deposits, is now common on late prehistoric and historic excavations in the Western Arctic (e.g., Friesen and Arnold 1994; Friesen 1995; Morrison 1988, 1994), largely because of the high potential for encountering fish bones and, latterly trade beads.

It would thus appear that a systematic recovery bias against the bones of fish and other small taxa may afflict many Thule faunal assemblages. However, fish bones are present in small quantities at many Thule sites, along with remains of small birds and rodents and very small artifacts. The bones of lemmings (average adult weight, 73 g; Banfield 1974) outnumber fish 70:1 at Cape Garry (Rick 1980) and 11:1 at PaJs-13 (Whitridge 1992), although the lemming elements are on average significantly smaller than the fish elements. Even before the enthusiasm for subsistence-related research problems, arctic archaeologists were attentive to the possibility of encountering fish bone and found its scarcity remarkable (Hall 1971; McGhee 1972; Taylor 1981). Given the sheer size of some hand-collected Thule faunal samples [e.g., fish NISP's of 108/18,318 at Silumiut (Staab 1979), 0/19, 275 at B-1 (Schledermann 1975), and 14/11, 305 at PaJs-13, House 2 (Whitridge 1992)], it seems unlikely that the actual relative frequency of fish in the sampled deposits is very substantial. Fish bones occur in high relative frequencies in some samples, such as Paleoeskimo faunal assemblages from northern Boothia Peninsula, collected with the same techniques common on Thule sites (Whitridge 1990 field observations). Furthermore, Butler (1993:10) found that salmon bone samples generated by careful hand collection were identical in terms of element frequencies to screened samples, so significant bias against smaller elements was presumably absent. Given that the taxa of greatest potential interest in most Thule assemblages are moderately large (>1 kg) salmonids (anadramous char, lake trout, and the larger whitefishes), it cannot be assumed that the lack of screening is primarily responsible for the overall scarcity of fish bone, where attention was paid to bone recovery (see discussion in Hall 1971:53). Although difficult to demonstrate without experimental data on potential recovery bias, excavation procedures on most Thule sites appear to be adequate to establish the presence and approximate relative abundance of large fish bones in sampled deposits. On the other hand, the virtual absence of polar cod [maximum weight, approximately 150 g (Scott and Scott 1988), average adult length 15 cm (Morrow 1980)] and comparably-sized sculpins from Eastern Arctic assemblages and the scarcity of herring in most samples from the Mackenzie Delta region should perhaps be considered ambiguous, since recovery techniques may not be adequate for the smallest taxa.

Small sample size. Another problem with evaluating relative abundance in zooarchaeological assemblages is the effect of sample size on the representation of the rarest taxa. For example, taphonomic factors aside, to obtain a 95% likelihood of recovering at least a single specimen of a taxon whose true proportion in the population is 1%, it would be necessary to draw a random sample of 300 based on binomial probabilities. The absence of the taxon from a smaller sample could not be said to be significant at the standard confidence level. From another perspective, and again excluding the possibility of taphonomic biases, the absence of fish bone from an assemblage with an NISP of 100 only indicates that the true proportion of fish in the population is probably less than 3% if the collection can be considered a random sample of that population. The faunal samples listed in Table 1 have total NISP values ranging from 102 to 69,269 for the taxa under consideration (nonfood species have not been tabulated, and samples smaller than 100 were not included in this study), with a mean of 6,130 and a median of 2,262. Whatever the reasons for the absence of fish bone from some collections, from a sampling perspective most assemblages are theoretically large enough to pick up even very low proportions of fish in the population. However, where the fish NISP is very low, the precise proportion of fish in the population has not been securely estimated. To take an extreme case, the %NISP of fish bone in the hypothetical population of bones from Lady Franklin Point, where a single fish bone occurred in a sample of 5,872, can only be estimated at between .05 and .006%, or to within 2 orders of magnitude.

Intrasite variability. Part of the reason for the scarcity of fish bone could be the focus of Thule archaeologists on the excavation of dwellings and immediately adjoining middens. Stenton and Park (1994) have discussed the variability in depositional processes associated with Thule winter sites that complicates the assignment of particular deposits to particular house occupations (see also McCartney 1979b). Because the analyses that follow rely predominantly on the gross aggregation of assemblages by broad temporal period, rather than the fine-grained discrimination of household assemblages, these problems are largely circumvented. Chang's (1988) ethnoarchaeological study of the North Alaskan fish camp of Nauyalik indicated that fish bones and other refuse resulting from bulk processing were placed in a midden area at least 40 m from the nearest dwelling. Fish that were butchered in processing areas removed from dwellings may have had some of their remains discarded in discrete dumps, as at Nauyalik, but the traditional injunction (and necessity) to make use of all parts of a fish (Jenness 1922:104) probably resulted in little wastage of this sort prehistorically, with most bone ending up in soups and/or being fed to dogs. There is no ethnographic suggestion that the refuse from human meals of fish was disposed of at a greater distance from dwellings than that of other taxa, and so the remainder from *consumed* fish parts should probably occur alongside other small faunal remains. At one of the few sites where both dwellings and various exterior activity areas have been excavated, fish bone was only abundant in the kitchen midden, house floor, and house fill deposits (Morrison 1988). This pattern is complicated by the fact that only house floor deposits were screened, but the excavator is confident that the scarcity of fish bone in most outdoor contexts is real (Morrison 1988:65). Archaeological emphasis on roofed spaces and adjacent middens may actually result in the overrepresentation of fish bone in Thule and Inuit faunal collections relative to its site-wide distribution.

Because of the complete excavation of most Thule houses, any intramural variability in the disposal of fish bone is probably not a serious concern. However, it has often proved difficult to reach the floor levels of the entrance tunnel of winter houses, due to permafrost or flooding, so these deposits are somewhat underrepresented. Since dogs were frequently housed in the entrance tunnel, this may not be insignificant. It is also possible that foodways varied between households and that relatively abundant fish bone occurs in unexcavated dwellings at a site. Danielson's (1994) data on the distribution of ringed seal age classes at PaJs-13 appear to indicate intracommunity differences in access to prime sealing territories. A comparable situation with respect to char fishing weirs could conceivably result in significant interhousehold variability in fish consumption. This is further suggested by the seasonal division of harvesting labor among the Mackenzie Inuit and Iglulingmiut noted above and by observed variability between Thule *qarmat* assemblages at PaJs-3 (Whitridge 1990 field observations). However, it is impossible to properly evaluate this proposition with the current site sample because fish bones are absent or extremely rare at the few sites (e.g., Skraeling Island, RbJr-1) where a large number of individually reported house assemblages is available.

Seasonal intersite variability. Based on the ethnographic patterns of fish processing and transport noted above, stores of dried fish harvested in summer and consumed at winter sites would normally have been boneless. The only major exception is herring, which occasionally appears in Late Prehistoric and Historic assemblages in the Mackenzie Delta region. Otherwise, fish may have made a substantial contribution to winter diet and yet be poorly represented in bone assemblages. To obtain an accurate picture of Thule fish use it would be necessary to have samples from the full range of seasonal site types, including those at which any initial processing occurred. Thule archaeologists, however, have focused their energies on winter settlements (Savelle 1987; Stenton 1989 are exceptions) because they produce much larger artifact and faunal assemblages than warm-weather camps (Table 5). Coastal *qarmat* sites account for most of the components labeled "spring/summer/fall." Although the precise season of occupation is often difficult to determine for any site, due in part to multiseason use of some dwellings, on architectural, artifac-

TABLE 5
Summary of Sample Distribution by Region, Period, and Season

Region	Season	Period: Classic Thule	Period: Modified/ Late	Period: Historic	Total
Harvesting gear					
Western	Spring/fall	0	4	2	6
	Winter	1	9	2	12
Central	Spring/fall	1	2	1	4
	Winter	9	2	0	11
Eastern	Spring/fall	2	1	0	3
	Winter	12	4	3	19
Total		25	22	8	55
Faunal remains					
Western	Spring/fall	0	6	3	9
	Winter	1	5	1	7
Central	Spring/fall	1	2	1	4
	Winter	9	0	0	9
Eastern	Spring/fall	3	1	0	4
	Winter	11	5	3	19
Total		25	19	8	52
Harvesting gear and faunal remains					
Western	Spring/fall	0	4	2	6
	Winter	1	4	1	6
Central	Spring/fall	1	1	1	3
	Winter	7	0	0	7
Eastern	Spring/fall	1	1	0	2
	Winter	7	3	2	12
Total		17	13	6	36

tual, and zooarchaeological grounds these *qarmat* appear to represent predominantly late summer/fall occupations by groups engaged in open-water sea mammal hunting, caribou hunting, and sometimes fishing. During summer in all regions most people normally occupied tents, either on the coast or adjacent to lakes and rivers in the interior, but tent ring assemblages and inland components of any kind have been infrequently reported. Since most summer and some early-fall fishing appears to have occurred from tent camps, the scarcity of fish may be attributable to a biased sample of seasonal site types, along with attritional biases in the few reported tent ring assemblages. This is undoubtedly part of the larger dilemma; summer reliance on fish cannot readily be discounted based on the existing site sample.

However, the evidence reviewed above suggests that fish consumed during winter would have been harvested mainly in late summer/early fall, since this is widely reported to have been the most productive fishing season for char and whitefishes. Given that fish procured at this time were generally cached whole, not filleted and dried (Rasmussen 1931:485), intensive late summer/early fall fish harvesting should be reflected at winter sites by the bones of fish transported whole. Extensive fall and winter ice fishing should be conspicuous at winter sites for the same reason. Because winter settlements were occupied for longer periods (6–8 months, less any time spent in snow house settlements) than any other site type, and since the seasonality evidence frequently suggests relatively little active harvesting from them, winter sites constitute zooarchaeological "sinks" for animals harvested at other times of year. In most areas, the immediately preceding late summer/fall season was the period during which the vast bulk of sea mammals, caribou, and fish were procured (e.g., Savelle 1984:510). Density-mediated attrition aside, the scarcity of fish in winter site assemblages thus implies both little ice fishing during late fall and winter and little surplus harvesting of fish during the late summer/early fall period when fish were being cached whole.

Interregional variability. Another possibility, mentioned briefly here and developed in greater detail in later sections, is that the intensity of fish harvesting varied significantly between regions, and these regions have not been representatively sampled. The assemblages listed in Table 1 are scattered throughout the Canadian Arctic, with only arctic Quebec and Labrador excluded from the present site sample. However, as the distribution of assemblages by period in Table 5 reveals, useable faunal data are not available for any site or site component dating predominantly to Classic Thule times in the western part of the study area, precisely the region where fish resources are greatest (Fig. 3). This is likely due in part to the loss of early Thule sites to coastal erosion. Pioneering and Classic Thule components at important sites such as Nuvurak and Washout have been destroyed in recent decades (McGhee 1974; Friesen and Hunston 1994). However, erosion is not nearly as severe at sites away from the open coast, where most of the Late Prehistoric and Historic sites with abundant evidence of fishing are located. Although it is no longer possible to address Thule fish use in parts of the outer Delta through zooarchaeological data, it is significant that traces of Thule settlement have so far proved elusive in the best inner Delta fishing locations.

The lack of Thule fishing sites in the western Canadian Arctic thus cannot be considered purely a sampling problem, but rather appears to be part of a larger shift in settlement patterns over the past millennium. The most profound period of settlement system reorganization coincided closely with the onset of the LIA, the most severe climatic downturn of the past 4000 years (Kreutz et al. 1997:1294), around A.D. 1400. In the central and eastern parts of the Canadian Arctic this marks the Classic-Modified Thule transition and in the west the Thule-Late Prehistoric transition. There was little human occupation of the Central and High Arctic islands during Modified Thule and early Historic times, and depopulation in the north is mirrored by settlement expansion in Low Arctic regions. Based on the calibrated carbon-14 dates assembled by Morrison (1989), many Modified Thule sites in the east, and Late Prehistoric sites in the west, appear to have been first settled during the 15th century (suggesting that the Thule "return migration" hypothesis warrants revisiting). The region of origin of faunal samples is partly correlated with the period of site occupation, making it difficult to distinguish the effects of changing subsistence-settlement systems from interregional variability in fish availability or utility. The question of Thule and Inuit fish use is thus partly a question of High versus Low Arctic fish use.

Restricted access to fishing sites. The most productive late-summer char fishing locales were major points of population aggregation in historic subsistence-settlement rounds (Rasmussen 1931). If cached fish were later transported over great distances, this could potentially result in a wider consumption of fish at winter settlements than the distribution of important fishing locales would suggest. On the other hand, proprietary access to fishing sites of the sort widely reported for Northwest Coast groups could result in geographically restricted fish bone distributions. Few data are available to seriously address territoriality during Classic Thule times. However, Danielson's (1994) data on intracommunity differences in sealing territories raise the possibility that analogous differences may eventually be recognized between neighboring communities at Hazard Inlet. Although there is no direct supporting evidence, proprietary community access to char fishing weirs could generate intersite variability in fish bone deposition. A similar effect could also be produced by a more likely scenario, in which large communities with the capacity to assemble multiple whaling boat crews (Whitridge 1994) would have tended to neglect char fishing during the open-water season, while smaller communities may have found this late summer/early fall scheduling option more attractive.

Misinterpretation of Artifact Assemblages

Half of the interpretative dilemma surrounding Thule fishing relates to the ubiquity and occasional abundance of fishing gear, so incorrect attributions of artifact function could be a contributing factor. It is also possible that fishing gear differed from other kinds of harvesting gear in the extent to which it was curated and the way in which it moved through the annual settlement round and was eventually discarded. It is thus necessary to review fishing gear function and assemblage formation.

Fishing gear misidentified. Mathiassen (1927) established the functional identifications of most Thule artifact types that have continued in use to the present. However, several of the items of fishing gear identified by Mathiassen have not been recognized in subsequent collections and indeed some of the original identifications were considered tentative. The most commonly reported items include the side prongs, center prongs, and side barbs of leisters (*kakivak*); the self-barbed side and center prongs of fish arrows or trident-type fish spears (*nuyakpak*); zoomorphic lures; and fish stringing needles (Fig. 5). Hand-held ice picks and ice scoops are reported in the western regions, and heavy prongs for gaffs or fish rakes occur occasionally in the Copper Inuit area (Morrison 1983). Specimens Mathiassen reported as a fishing harpoon head (1927:plate 12.7) and foreshaft have rarely been identified as such at other sites (Vanstone 1962:plate 8.17 is an exception), and the identifications of baleen specimens as a fish trap (Mathiassen 1927: plate 60) and fragments of fish nets (Mathiassen 1927:plate 59) have not been duplicated. Based on the published photograph and descriptions (Mathiassen 1927:189–190), the latter identification in particular is highly implausible and is not generally accepted. In fact, fish netting gear (net floats, net sinkers, net gauges, and netting shuttles) occurs quite widely on sites in the Western Canadian Arctic from at least the 15th century A.D. (McGhee 1974), but can be considered absent from the Eastern Arctic prehistorically (Morrison 1990:62–63). Morrison further notes that the easternmost Mackenzie Inuit group, the Iglulualumiut, were aware of fish netting technology but did not employ it and that no firmly identified prehistoric netting gear has been reported east of Cape Bathurst peninsula. Bone and antler objects tentatively identified as net sinkers from Brooman Point (McGhee 1984) and Talaguak (Sabo 1991) do not resemble any of the varieties of stone net sinker that occur in the Mackenzie Delta and North Alaska. In the absence of any independent supporting ev-

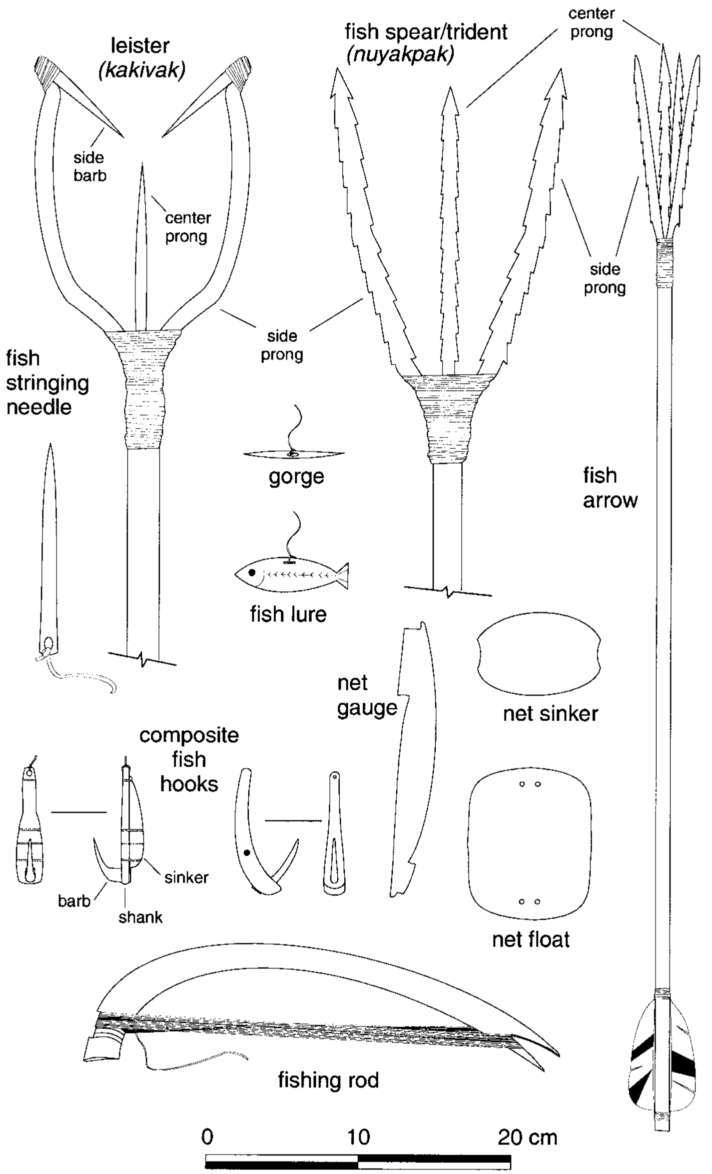

FIG. 5. Some major varieties of Thule and Inuit fishing equipment.

idence for fish nets, alternative identifications (e.g., maul heads for the Brooman Point specimens; similar end-battered pieces occur at the Hazard Inlet winter village of Qariaraqyuk) are probably more appropriate.

Common in the Western Arctic from Thule to Historic times, but virtually absent east of Amundsen Gulf, are several distinctive classes of composite fish hook with a single obliquely inserted barb and often holes for decorative inlays. Various styles of shanks, barbs, and (more rarely) line sinkers occur at most sites in the Mackenzie Delta region and westward but are rare in the Eastern Arctic. A single shank from Malerualik (Mathiassen 1927: plate 83.6) is relatively thick in cross section, slightly curved, and has extra holes that might have held inlays or small spinner attachments, but resembles Western Arctic forms. A second fish hook shank illustrated by Mathiassen (1927:plate 34.5), from Naujan, is unique in the literature and bears a closer resemblance to a gull hook shank, although made of ivory rather than wood. Another simple hook type, in which a curved copper barb is inserted into the base of a blocky sinker or shank, occurs mainly in the Copper and Netsilik Inuit areas (e.g., Gordon 1994; Vanstone 1962). Idiosyncratic shanks with multiple oblique barbs resemble historic cod jigging hooks and are reported from Talaguak (Sabo 1991). From the Belcher Islands, outside the present study area, unusual stone objects identified as fish hook shanks (Benmouyal 1978) appear unrelated to any Western Arctic forms, as do distinctive wooden and double-barbed bone shanks from western Greenland (Gullov 1997). Gorges are widely reported ethnographically, but rarely identified archaeologically, and perhaps would be frequently indistinguishable from gull hook barbs.

A more serious problem than such occasional ambiguous specimens is the potential misidentification of commonly occurring barbed objects as fish spear (*nuyakpak*) prongs. Thule archaeologists are very inconsistent in their identifications of these pieces, alternately reporting them as bird dart and fish spear prongs and occasionally declining a specific functional identification. Given that generic darting technology (throwing boards, throwing board hooks, and dart butt pieces) is much less common than securely identified fishing gear (leister parts, lures, and fish needles), and that most securely identified bird dart side prongs are morphologically distinctive, the identifications of many barbed objects as fishing implements are probably accurate. Many of the smaller barbed prongs may actually be parts of multipronged fish arrows (e.g., Nelson 1983; Vanstone 1980), though they are rarely specifically identified as such. Although the frequent misidentification of bird dart prongs as fish spear prongs seems unlikely, it cannot easily be refuted. Secure identifications of leister side barbs and center prongs are also sometimes difficult, although these artifacts are occasionally highly distinctive (especially a variety of leister barb with drilled lashing holes). A more thorough comparison of ethnographic fishing gear with archaeological examples of all types is called for. In general, there does not appear to be any *systematic* bias promoting the identification of fishing gear, although some such identifications are prone to error.

Fishing gear expedient, more frequently discarded. The highly variable appearance of barbed prongs may be attributable to expedient manufacture. There has been little detailed analysis of this artifact category, but specimens illustrated in the literature and present in the Qariaraqyuk assemblage encompass a great deal of variability in the number, location, shape, and size of barbs. This variability is not typical of most Thule artifacts, which tend to exhibit a high degree of stylistic uniformity across vast geographical areas. It is possible that this variability reflects unusual manufacturing contexts or social or ideological prescriptions (or lack thereof).

For many Inuit groups summer was a period during which social rules were relaxed (Mauss and Beuchat 1979). Ethnographic accounts emphasize the joyfulness of summer fishing camps (Rasmussen 1931), which represented part of a welcome interlude between the boredom and scarcity of late winter/early spring and the hard work of late summer/early fall, when much of the year’s food production occurred. This general easing of social conventions may have been expressed in the production and use of idiosyncratic implements. This could account for the contrast between relatively standardized leister parts and the relatively variable trident or fish arrow parts. Multibarbed tridents and fish arrows appear ill-suited to the rapid harvesting of large numbers of fish during brief periods described for cooperative *saputit* fishing (Rasmussen 1931; Jenness 1922:156), since it would be difficult to rapidly extract the fish from the barbs. However, they may have been suitable for more leisurely harvesting of individual fish in shallows, outside the periods of *saputit* use. Jenness (1922:152) refers to the use of "improvised spears" for this kind of fishing, elsewhere noting that sculpins were occasionally sought with spears made by attaching any barbed implement at hand to a shaft. The latter "were dismantled again as soon as the need for them passed" (Jenness 1946: 111).

Women and children are reported to have done much of the small-scale fishing and small-game harvesting ethnographically (Giffen 1930) and may have been involved in the manufacture of the associated gear. Jenness cites an instance of a woman manufacturing an expedient ice-fishing gorge out of a caribou long bone (Jenness 1922:155). Certain categories of fishing implement may thus have been produced expediently by individuals not otherwise engaged in manufacturing harvesting gear in the context of a relaxed emphasis on adherence to social rules for the production of material culture (Eskimo fishing was generally associated with less ritual practice than other harvesting activities; Lantis 1947:45; Rousselot et al. 1988:152). Subsequently, these implements may have been broken, dismantled, or merely discarded at a higher rate than the formally manufactured, and highly curated, equipment for harvesting large game. However, some categories of fishing gear were very well made and highly curated, most notably lures in all regions and post-Thule composite fish hooks in the western region. Expediency may thus result in slightly exaggerated relative frequencies of some categories of fishing gear within harvesting assemblages, particularly in the eastern regions where *nuyakpak* parts are common, fish hooks rare, and nets absent, but probably does not account for the general ubiquity of fishing gear on Thule sites.

Differential accumulation of fishing gear at winter sites. Because winter sites are overrepresented in the site sample, any mechanism which leads to the overrepresentation of fishing gear at these sites could contribute to a false impression of Thule fishing activity. It may at first appear unusual that fishing gear is abundant on winter sites at all, given that winter was not a major fishing season for most Inuit groups. However, in the same manner that winter sites constitute sinks for much of the annual harvest, harvesting equipment of all sorts occurs more abundantly in winter house assemblages than in any other functional context. This is attributable to the longer period of seasonal dwelling use, and better preservational conditions, of sod houses relative to *qarmat* and tent rings.

In addition, winter houses appear to have been frequently occupied for multiple years. The use-life of winter houses was highly variable and is a point of controversy in the Thule literature (Park 1997; Savelle et al. n.d.). However, Inuit tended to make use of any in situ architectural elements, such as house foundations or boulders for holding down tents, and so frequently reused the sites of individual dwellings (Stefansson 1919:167). House sites were probably owned on a usufruct basis, as in North Alaska historically (Spencer 1959:59; Burch 1988), and refurbished each season by their occupants.

Some house sites appear to have been more or less continuously utilized for long periods, on the order of several decades or even a few centuries. At Qariaraqyuk this is indicated by site structure, artifact styles, and carbon-14 dates on house construction and abandonment (Whitridge 1999). Weighing historic Inuit population numbers against detailed regional counts of Thule winter houses for the Canadian Arctic (McCartney 1979a), it appears that on average individual house sites were reused for decades (Whitridge 1996). This is probably the most important factor contributing to the large size of the artifact assemblages frequently recovered from Thule winter houses, but would not result in the overrepresentation of fishing gear relative to other harvesting equipment.

Winter houses also functioned as caches for the equipment owned by their occupants. Unlike the historic situation in the Central Arctic, in which temporary snow-house villages were the major winter settlement type, Thule and some historic settlement systems were anchored by these heavily constructed dwellings. Sod houses were often associated with storage racks and ice cellars in which materials could be cached during the seasons in which tents and *qarmat* were occupied, and some were occupied throughout the year (Nagy 1994:90–91). In contrast, highly mobile Central Inuit bands cached seasonal harvesting gear in cairns situated at transit points on the landscape, such as the location on the coast from which groups departed for winter sealing once the sea ice formed and to which they returned in spring (Jenness 1922:122). This practice was associated with ritual proscriptions against mixing the foods and raw materials of the land and the sea. Much less mixing of seasonal harvesting gear might thus be expected at Central Inuit than at Thule sites generally.

Furthermore, Thule communities relied on food stores put up during late summer/early fall, rather than active harvesting, during most of the period of occupation of winter houses. Winter appears to have been a time for socializing, ceremonial activities, and especially the repair and manufacture of equipment. The midden associated with a winter *karigi*, or men's house, at Qariaraqyuk contains abundant evidence of men's manufacturing activities (bone, antler and wood debitage, fragments of recycled tools and discarded tools), while the dwelling assemblages contain much refuse from clothing manufacture (Whitridge 1999). Fishing gear, like all types of harvesting gear, is thus predictably abundant at winter sites because much of the year's "gearing up" occurred there. The net effect of all these dimensions of Thule winter house use is long-term accumulation and preservation of lost, discarded, and cached items in house and midden deposits. Their assemblages can thus be considered fairly representative of the sum of annual activities undertaken by their occupants and should not reflect any particular bias toward the inclusion of fishing gear. Fishing gear utilized in summer will probably be somewhat underrepresented to the extent that maintenance-related discard occurred at summer tent or *qarmat* camps.

Summary of Interpretive Issues

Because they are smaller and less dense, fish bones have likely been deleted from Thule faunal assemblages at a greater rate than the bones of larger vertebrates (see Table 6). Although culling and various other cultural practices should not have drastically reduced the amount of bone available to enter houses and adjacent midden assemblages relative to the bones of other taxa, the deliberate feeding of fish bones to dogs, and scavenging of refuse by dogs and other bone consumers, will likely have resulted in substantial destruction of fish bone

TABLE 6
Summary of Taphonomic, Sampling, Interpretive, and Ecological/Economic Factors Bearing on the Extent and Archaeological Visibility of Thule and Inuit Fish Utilization[a]

Factors potentially contributing to interpretive difficulties	Season		Region			Period		
	Spring/summer/fall sites	Winter sites	Western	Central	Eastern	Classic Thule	Modified Thule/Late Prehistoric	Historic Inuit
Taphonomic deletion of fish bone								
Poor preservation	++	−	−	−	+	−	−	−
Consumption of bones by dogs/scavengers	++	++	++	++	++	++	++	++
Consumption of bones by humans	+	+	+	+	+	+	+	+
Culling	+	+	+	+	+	+	+	+
Destructive preparation techniques	+	−	−	−	−	−	−	−
Ritual disposal	−	−	−	−	−	−	−	−
Artifactual use of fish bone	−	−	−	−	−	−	−	−
Sampling bias against fish bone								
Poor recovery	+	+	−	+	+	+	+	+
Small sample size	+	−	−	−	−	−	−	−
Intrasite variability	−	−	−	−	−	−	−	−
Seasonal intersite variability	n/a	n/a	−	+	+	+	+	+
Inter-regional variability	−	+	n/a	n/a	n/a	+	+	+
Restricted access to fishing sites	−	−	−	−	−	+	−	−
Misinterpretation of artifact assemblages								
Fishing gear misidentified	−	−	−	−	−	−	−	−
Fishing gear expedient	+	−	−	+	+	+	−	−
Differential accumulation of fishing gear	−	+	−	−	−	+	−	−
Low-level fish harvesting								
Reduced productivity	−	−	−	−	−	−	−	−
Geomorphological change	−	−	−	−	−	−	−	−
Technological limitations	−	−	−	+	+	+	−	−
Scheduling conflict	++	+	++	+	++	++	−	−
Narrower diet breadth	++	++	++	+	++	++	−	−

[a] Symbols are defined as follows: ++ very important, + somewhat important, − unimportant.

where the bones of larger vertebrates would survive in identifiable condition. This preservational bias against fish will be most strongly expressed at warm-weather sites, where fish bones not consumed by dogs are prone to deletion due to chemical and physical weathering. Attrition will be especially severe at relatively warm and wet Low Arctic sites (Fig. 4). It will also presumably be more severe in older than younger assemblages. However, this cannot be clearly demonstrated until element frequencies and measures of weathering and fragmentation are published for fish taxa for which bone density data are also available. At winter sites, where vulnerability to scavenging is somewhat less than that at warm-weather sites, unconsumed fish bones would have had excellent survival potential. The key unknown factor is the extent to which fish bones were fed directly to dogs, which could potentially be assessed with indices of density-mediated attrition, attention to osteological signs of carnivore gnawing and digestion, coprolite analysis, and perhaps isotopic analysis of dog bones.

Sampling biases do not appear to be the overwhelming determinant of fish bone abundance, at least for the assemblages considered here. The bones of the large fish species that were most valued historically are unlikely to have been consistently missed where any attention was paid to faunal recovery, although the relative frequencies of all small taxa may be slightly depressed in the unscreened assemblages that dominate the site sample. Fish remains tend to be most abundant in the Late Prehistoric and Historic Mackenzie Delta region sites where at least partial screening of deposits occurred, but screening has become standard in that region in large part due to the expectation that fish bone will be encountered, so the abundance of recovered fish is not solely attributable to screening. Fish remains did not occur among the close to 9000 faunal specimens recovered from screened deposits at Kamaiyuk, on Frobisher Bay (Henshaw 1995), although faunal preservation was characterized as “generally very good” (Henshaw 1999:96). The size and intrasite provenience of samples do not appear to be relevant to the dearth of fish bones, but an excavation bias against warm-season sites limits our understanding of the short-term camps from which much fishing may have occurred and the larger harvesting systems of which they were a part. Changes over time in regional subsistence-settlement systems complicate assessments of geographical and chronological variability, since the assemblages available for comparison do not have strictly equivalent depositional histories.

The proportion of fishing implements in assemblages of harvesting gear may be inflated in some areas due to relatively expedient manufacture of some artifact types. To the extent that technological expediency is inversely correlated with the economic importance of fishing, this might have the paradoxical effect of inflating counts of fishing implements precisely where fishing was engaged in most casually. Artifact misidentification is probably not a severe biasing factor; attributions of artifact function appear to be fairly secure due to technological continuity from Thule to early Historic times and the pronounced functional differentiation of Inuit harvesting equipment. The winter site assemblages that dominate discussions of Thule subsistence technology should be reasonably representative of the harvesting activities undertaken in fall, winter, and spring, but the potential for summer fishing and the divergence of regional subsistence-settlement systems from the Classic-Modified Thule transition necessitates attention to the full range of site types. Overall, the range of site formation processes affecting faunal assemblages appears to have resulted in more serious biases against fish bone than those affecting fishing gear assemblages.

ECOLOGICAL AND ECONOMIC CONTROLS ON FISHING

The final set of factors to be evaluated relate to the possibility that fish remains are relatively scarce because fishing was not as actively pursued in Thule times as it was historically, due to ecological and/or economic considerations.

Reduced Productivity

A potential explanation for limited fish harvesting is that fish stocks were smaller or less widely distributed during the mild climatic interval that preceded the Little Ice Age. Some important anadramous species are very sensitive to changes in water temperature. Anderson (Giddings and Anderson 1986) has suggested that salmon may have been more widely distributed (and utilized) in North Alaska during late Birnirk and early Thule times, their range retreating southward with climatic deterioration. Although Arctic char are slightly more sensitive than other salmonids to warm temperatures (Johnson 1980:67) nonmigratory populations thrive at lower latitudes, their ubiquity in arctic waters being attributable to enhanced cold tolerance rather than reduced heat tolerance. While species ranges may have fluctuated somewhat with changing environmental conditions, it seems unlikely that northern char stocks would have been reduced during the Medieval Warm Period, although they may have been outcompeted at the southern margins of the range by Pacific and Atlantic salmon or freshwater species such as northern pike. Overall, it is likely that the productivity of fish resources would have been enhanced by warmer temperatures due to a longer ice-free period, hence heightened planktonic productivity and greater influx of terrestrial nutrients. Climatic controls on ranges and stock sizes cannot account for *limited* Thule fishing.

Geomorphological Change

The Eastern Arctic has experienced high levels of isostatic rebound since deglaciation, although the rate has leveled off substantially in recent millennia and varies regionally depending on the past ice load and timing of retreat. Dyke et al. (1991:48) estimate an average emergence rate of 40 cm/century over the past 5000 years for Prince of Wales Island. This would amount to a change in relative sea level of 3–4 m between Thule arrival in the Eastern Arctic and the present. Wherever downcutting of lake outlets could not keep pace with isostatic emergence, this will have had the effect of progressively isolating char populations and converting them from anadromy to residency in landlocked water bodies. This will have been accompanied by reduction in average adult size. On the other hand, marine inlets will have been progressively converted into freshwater lakes and rivers. This is the case with Stanwell-Fletcher Lake, on Somerset Island, which had a tidal connection to Creswell Bay until about 2400 B.P. (Rust and Coakley 1970). Stanwell-Fletcher is one of the largest lakes in the Canadian Arctic Islands, and during the 20th century has supported a highly productive domestic char fishery along its outlet through Union River (Kemp et al. 1977). This valuable char run would not have been available to Paleoeskimo residents of the area until at least Dorset times, and similar runs may only have become productive in late prehistory. On a regional basis, the loss of economically viable char runs will presumably have been balanced by the establishment of new ones, but in some instances runs that were utilized historically may not have been productive during Thule times (and vice versa).

Technological Limitations

The ethnographic evidence indicates that fishing of all kinds was much more productive, and more intensively pursued, by groups that possessed fish nets, whether acquired aboriginally or from traders and missionaries. The distribution of netting technology may thus have represented an effective limit on the extent of economic reliance on fish. A problem with this line of reasoning is determining whether a particular group did not adopt nets because fishing was unproductive or otherwise unattractive or fishing was unproductive because the group did not possess netting technology. For Modified Thule and Historic groups east of Amundsen Gulf the latter proposition appears more likely while, as discussed below, Classic Thule groups with access to bowheads may have had neither nets nor much interest in fish resources.

Netting equipment is generally rare archaeologically in the Western Arctic, particularly on sites predating A.D. 1400 (Giddings 1952; Giddings and Anderson 1986:111; Morrison 1990:63), although net sinkers are sometimes abundant in Paleoeskimo Choris and Norton-Near Ipiutak assemblages (Giddings and Anderson 1986; Giddings 1964). Netting gear seems to be absent from Ipiutak (Larsen and Rainey 1948; Giddings and Anderson 1986) and from Paleoeskimo sites in the Eastern Arctic [e.g., Maxwell 1985; Møbjerg's (1999) tentative, and isolated, identifications of a Saqqaq netting needle and net sinker are not convincing]. Netting gear is not reported for Birnirk (e.g., Ford 1959; Stanford 1976). Although Giddings suggests that netting was present throughout the Thule and later portions of his Cape Denbigh and Kobuk River sequences, netting gear is absent from the Early Thule levels at Nukleet (Giddings 1964) and is represented at the contemporaneous Ahteut site (dendrochronologically dated to around A.D. 1250) by only three net sinkers, the sole illustrated example of which is an ambiguously unusual form (Giddings 1952:40). These identifications are clearly complicated by the fact that any heavy perforated or grooved object could have functioned as a net sinker, although other uses for such objects are known from the Eskimo ethnographic literature (e.g., maul, flaking hammer, brainer, and counterweight).

That netting gear first appears in the Point Barrow area in association with European goods even led Ford (1959:111) to doubt the prehistoric occurrence of Eskimo nets. However, a few likely net sinkers occur in Punuk contexts (ca. A.D. 800–1300) on St. Lawrence Island (Collins 1937), and netting paraphernalia appears on "late sites" (Punuk and later?) in Chukotka (Rudenko 1961:137). Surprisingly, Collins recovered netting shuttles from Old Bering Sea (ca. A.D. 200–800) levels at Miyowagh (Collins 1937:175), but seems to consider their use to be the manufacture of small dip nets. He sees heavy net sinkers as indicators of the adoption of gill nets per se in early Punuk times (1940: 554). While a convincing net float occurs at Ekseavik (ca. A.D. 1400; Giddings 1952), sinkers and floats are really only common in the 16th century and later components along the Western Arctic rivers that sustained the heaviest historic fish harvests. Netting gauges and shuttles also became widespread at this time. Netting may thus have had a limited distribution in Early Thule times in the Western Arctic, perhaps being restricted to the western side of Bering Strait. It does not appear to have been part of the technological inventory of any Classic Thule groups (e.g., Yorga 1980; Morrison 1990, n.d.; Arnold 1994) or of later prehistoric groups in the east.

Fish nets were ultimately embraced by all Inuit groups in the Eastern Arctic in Historic times, and *saputit* fishing went into decline. Netted fish fed the larger dog teams that permitted geographically extensive fox trapping or were traded with Euro-Canadians (Balikci 1964; Farquharson 1976; LeDrew 1984). It seems likely that those groups that fished heavily before the introduction of nets, including most Copper, Netsilik, and Caribou Inuit bands, would have adopted them aboriginally if they had had the opportunity. The general absence of netting gear from the Eastern Arctic can thus be taken to reflect the prehistoric cessation of sustained reciprocal contacts between the Mackenzie and Copper Inuit areas before the diffusion of netting technology (e.g., Morrison 1990, 1991a). The only evidence undermining this inference is the case of the Iglulualumiut who, as noted above, did not use fish nets, though they apparently had access to them (Morrison 1990). This suggests that fish nets would not necessarily have been eagerly adopted by all Thule groups exposed to the technology, although the much-noted Inuit fascination with technical innovations would make the rejection of this advance somewhat unusual; the Iglulualumiut did, in fact, employ seal nets. The lack of netting technology may have been a crucial factor in making fishing an economically unattractive option for Pioneering and Classic Thule groups (Arnold 1994:92) and for Modified Thule and Historic groups east of the Mackenzie Delta region.

On the other hand, the archaeological occurrence of simple fish hooks appears to be merely a reflection of the degree of reliance on fishing and not an enabling technological factor. On the ethnographic evidence, the use of hooks and gorges was widely distributed in early contact times. Though these artifacts occur very rarely in Eastern Arctic Thule assemblages, the notion of a baited hook is well within the Thule technological repertoire, as witnessed by the common occurrence of gull hooks. Furthermore, simple composite fish hooks (Fig. 5) occur at the early Classic Thule Booth Island site (Morrison 1990), which appears to have participated in an interaction sphere embracing much of the central Canadian Arctic during the 13th and 14th centuries (Whitridge 1999). Basic fish hook technology thus seems to have been a more or less latent component of Eastern Thule material culture to be elaborated only in times and places where the associated ice-jigging techniques proved useful. The numerous local varieties of hook styles in Modified Thule and Historic times likely represent independent developments from this weakly expressed Thule base, since the distinctive composite hook forms so typical of Late Prehistoric and Historic Mackenzie Delta and west Alaskan assemblages do not appear further east.

Scheduling Conflict

An important limit on the utilization of fish is the existence of scheduling conflicts with peak periods of availability of marine and terrestrial mammals. Such conflicts appear to account for the limited historic utilization of fish by Iglulingmiut. While the Netsilik, Caribou, and Copper Inuit were in the difficult position of procuring caribou for winter food and clothing at the same time as the late summer/early fall char and whitefish runs, both activities could frequently be pursued from the same inland camps by separate task groups organized by gender and age. However, the organization of harvesting may have been quite different in Thule times for groups in these areas, since sea mammal hunting at this season is frequently indicated archaeologically (McGhee 1972; McCartney 1977; Morrison 1983; Mathiassen 1927; Savelle 1987; Whitridge 1992). There is even a reference in Netsilik oral history to the former importance of open-water sealing (Rasmussen 1931:365). Of particular importance in this regard is the extensive hunting of bowhead whales in Thule times (McCartney and Savelle 1985, 1993; Savelle 1996; Savelle and McCartney 1988, 1991, 1994, 1999). Even a single 7-tonne yearling would provide approximately 3.2 tonnes of edible meat, skin, and viscera and 2.8 tonnes of blubber that could be rendered into edible and combustible oil (based on proportions in Foote 1965:350). This represents a secure winter's food supply for a sizable community (the caloric requirements of approximately 60 people for 6 months, if used solely as food; see Whitridge 1992).

As described ethnographically, bowhead whaling was a labor-intensive and time-consuming activity. Normally, two or more whaling boat crews of seven to eight hunters each, sometimes accompanied by kayakers, along with people to run the camp, had to devote themselves to the bowhead hunt for anywhere from a few weeks to a couple of months to ensure a reasonable chance of landing a whale. Much advance labor was invested in the manufacture and repair of boats and hunting gear, securing food stores to carry through the whaling period, and ritual activity. Because of the size of this investment, the real risk of failure, and ritual injunctions, only sporadic harvesting of other species took place during the period of bowhead availability (Rainey 1947; Burch 1981). Once a whale was landed, the labor of numerous people had to be coordinated for rapid processing of the carcass or the meat would spoil. Whaling probably consumed the labor of most of the local population throughout the bowhead harvest. If surplus labor was available it could have been devoted to fishing, but caribou hunting to obtain hides for winter clothing would seem to be the more critical undertaking at this time of year.

The scheduling conflict would have been particularly acute in the Central and High Arctic, where bowheads are mainly available during August and September (Moore and Reeves 1993), fully overlapping with the upstream char run. Along the east coast of Baffin Island and northwestern Hudson Bay bowheads may have been locally available from late spring through early fall and in winter off southern Baffin Island, northern Quebec, western Greenland, and Labrador. However, other sea mammal species (walrus, beluga, and harp seal) were important during summer and fall in most of the latter areas. This does not necessarily preclude substantial use of the less productive early June to mid-July downstream char migration by Thule groups. However, this may have conflicted with whaling preparations, and the productive season for *uuttuq* hunting of ringed seals basking on the sea ice, which lasts until about the end of June in the Central and High Arctic (Kemp et al. 1977). In fact, the majority of ringed seals in Classic Thule winter house assemblages appear to have been harvested at this time (Whitridge 1992). The generally greater importance of summer/fall sea mammal hunting for Thule than historic Inuit groups may have produce an irresolvable scheduling conflict and be the principal reason that fish bone is rare in Thule assemblages.

Narrower Diet Breadth

Because many Thule groups conducted highly successful summer/fall sea mammal harvests, putting up winter stores of fish was not only logistically onerous, but unnecessary. The stockpiles of meat and oil appear to have been sufficient to preclude the necessity of intensive ringed seal harvesting until spring. Although a wide variety of species were harvested by Thule groups, only a handful consistently made important dietary contributions. Overall diet breadth was effectively narrow, although numerous species of small game made a minor contribution to diet. The high species counts in some Thule assemblages have led to the frequent characterization of Thule economies as generalized, when in fact the dietary breakdowns frequently reflect a substantial degree of economic specialization on one or two of the highest ranked game species. Low level, opportunistic harvesting of fish, birds, and other small game, especially by women, children, and the elderly, could account for high species counts in the context of a primary reliance on few species. Fish (particularly char) may even have been deliberately sought out as the occasion permitted, since it was a highly favored food (next to whale and caribou; Freeman et al. 1992; Kuhnlein and Souedia 1992), but not targeted for intensive surplus harvesting. However, with the decline of open-water sea mammal hunting at the end of the Medieval Warm Period, many prime whaling and walrus hunting areas in the Central and High Arctic were simply abandoned, while diet breadth increased elsewhere (Savelle 1987, 1994). Fish, along with more winter-harvested ringed seals, appear to have filled this dietary space among historic groups.

Summary of Ecological and Economic Issues

The absolute productivity of Canadian Arctic fish resources has probably not changed dramatically during the past millennium although if anything the LIA would have had an adverse effect on fish stocks. However, the relative economic utility of fish appears to have increased sharply with declining opportunities for (and capacity to undertake) open-water sea mammal hunting in the central and eastern regions of the Canadian Arctic. Less sealing and whaling at this season reduced a key scheduling conflict with the upstream char run, while heightening demand for the storable food surplus that intensive fishing could provide. A similar effect was probably felt in the western Canadian Arctic, although intensive utilization of its highly productive fish resources may have begun before the onset of the LIA. An added complication in this region is interaction with North Alaskan groups, who represented a conduit for the technologies and commodities circulating in the Chukchi–Bering Sea region. Netting technology (along with distinctive fish hook styles) appears to have spread eastward into the Mackenzie Delta region sometime between about A.D. 1200 and 1400, possibly in association with a post-Thule migration from the Kotzebue Sound region (see, e.g., McGhee 1976). In any case, an economic and cultural pattern ancestral to that of the historic Mackenzie Inuit, with a heavier reliance on fishing than that exhibited by Pioneering and Classic Thule groups in the western Canadian Arctic, emerged at this time (unfortunately, the precise timing of the establishment of such important villages as Gupuk and Kittigazuit is not yet clear; see McGhee 1974; Morrison 1989; Arnold 1994; Nolin 1994).

Two major trends should thus be reflected in the Neoeskimo archaeological record of fishing: (1) a pronounced concentration of freshwater fish resources, together with a relatively strong cultural connection to a cosmopolitan source of harvesting innovations in Alaska, will have tended to favor more intensive fishing in the western Canadian Arctic than parts further east, and the southern mainland region more than the northern, insular parts of the Canadian Arctic; (2) the decline of open-water sea mammal hunting opportunities after the onset of the LIA would have promoted fishing among Modified Thule and Late Prehistoric groups; further intensification may have occurred in the Eastern Arctic with the Historic introduction of nets, though the proportional contribution of fishing to food production may have remained constant or even declined since other kinds of harvesting were also intensified following the adoption of such things as rifles and wooden boats.

THE THULE DATABASE

The review of factors bearing on the extent and visibility of Thule fishing has drawn out various taphonomic, sampling, and interpretative biases that have potentially skewed our perception of the archaeological record of Thule fish use. These factors will have operated to different degrees and in different combinations depending on the season, region, and period of site occupation (Table 6). However, there are indications that taphonomic deletion and sampling bias are not universal or pervasive determinants of taxonomic abundances, at least at Thule winter sites. Although it is easy to enumerate a host of possible mechanisms for the removal of fish bone from faunal assemblages, of which consumption by dogs appears to be the most consistent danger, the only major *intersample* effects that were identified are the likelihood of heightened density-mediated attrition of fish on warm weather sites and those on the southeastern margin of the present study area. In addition, there are strong a priori reasons to suspect that fishing may have been less important in Classic Thule times, and in the Eastern Arctic generally, than it was historically and in the Western Arctic generally. To explore these possibilities, and the degree to which patterning in the archaeological data relating to fish use has survived the potential biases, faunal and artifactual data were assembled for a number of Thule and Inuit sites in the Canadian Arctic (Table 1).

Both faunal and artifactual data were only located for 36 components, so to improve the sample 16 components were included with artifactual data lacking and 19 with detailed faunal data lacking [one additional site, Saunaktuk (Morrison and Arnold 1994), has been published only in enough detail to estimate the order of magnitude abundance of fish in the diet]. Greenland, Labrador, and northern Quebec were not included in this survey due to a combination of lack of published data in English, substantially different environmental (hence taphonomic) conditions than in the rest of the Canadian Arctic (see Fig. 4), and very different histories of Thule settlement and European contact. Where the excavator estimated a relatively narrow period of house occupation or stratum deposition, noncontemporaneous assemblages have been reported separately (e.g., Houses 20 and 11 at Iglulualuit both fall within the Late Prehistoric period, but were occupied during the 15th and 18th centuries A.D., respectively). Where such detailed age estimates were not available, house and area assemblages have been aggregated into the broad temporal categories utilized throughout, and each major component was tabulated separately. Where distinguished, assemblages associated with warm-weather and winter occupations at a site are tabulated separately (as at the Hazard Inlet site of PaJs-3). Where season of site use spans the warm and cold seasons, or where the occupation spans the major chronological divides *and* components are not finely subdivided, the assemblage has been assigned to the *predominant* season and/or period of occupation.

Because the interpretative dilemma relates largely to the apparent discordance between the artifactual and zooarchaeological evidence, it is useful to set up a direct comparison of them. The solution adopted here is to convert species abundance data into an index of dietary contribution and then aggregate these into taxonomic categories that correspond to categories of harvesting artifacts: %dietary contribution from fish can thus be weighed against %fishing of all harvesting gear. Canids (dog, wolf, and foxes), mustelids (wolverine, marten, and ermine), and small rodents (lemmings) were excluded from these calculations because they were rarely, if ever, eaten traditionally (Mathiassen 1928; Jenness 1922), although all might be consumed in a starvation situation. A more serious omission is bowhead whale, but this was unavoidable because of inconsistent reporting of this species and the well-documented problems related to active recycling of bowhead bones for artifact manufacture and house construction (McCartney 1979a, 1976b; Savelle 1997). This key problem will be returned to later in the discussion.

Dietary contribution was estimated by multiplying average food weight for a species (the edible proportion of average adult carcass weight) by NISP or %NISP (in the case of Nelson River only %MNI was available and for some other assemblages %NISP for individual species had to be estimated from somewhat imprecise reports). The species meat weights were summed for each of the major harvesting categories adopted here (sea mammals, terrestrial mammals, birds, and fish) and then converted into a percentage of total meat weight for the component, representing an index of the dietary contribution of that taxonomic group. Average weights are taken from Banfield (1974), Scott and Crossman (1973), McAllister and Crossman (1973), Morrow (1980), Scott and Scott (1988) and elsewhere follow the estimates in Friesen and Arnold (1995; the latter are also followed in the adoption of White's values for the edible proportion of various taxa). Although there are numerous potential difficulties with such crude estimates of dietary contribution (see discussion in Reitz and Wing 1999:221–231), due for example to variability in prey anatomy and carcass transport logistics, for the case at hand it is felt that the quick-and-dirty scaling of faunal abundance to carcass size provides a substantially better estimate of dietary contribution (or economic importance) than direct measures of faunal abundance (NISP and MNI) in the absence of the data (MNE and bone weight) necessary for more sophisticated estimates. A single beluga bone should not be considered equivalent to a single sculpin bone in assessing economic or dietary importance given that the former individuals weigh 1000 times more than the latter. The use of NISP where possible seems better justified than the conventional approach of using MNI to calculate this sort of index given that NISP is a more stable index of taxonomic abundance than MNI (Grayson 1984; Driver 1993).

Assembling the artifactual data was relatively straightforward because Thule assemblages are conventionally reported using more or less consistent functional categories for harvesting gear. The number of types of harvesting gear (including each of the separate components of composite pieces) was tabulated, along with the total number of items, for each of the four harvesting categories noted above. Stylistic variants were not considered as separate types, but functional variants were so distinguished (e.g., heavy, scarfed harpoon socket pieces vs cylindrical sleeve-type sockets). This was not always possible because of inconsistent attention by arctic archaeologists to functional variability within categories of harvesting gear. A small number of functional reassignments are included in the artifact tabulations, where the original identifications were particularly problematic. Lance parts were considered sea-mammal hunting implements, unless the author suggested some or all were used for caribou. Sinew twisters and marline spikes, essential for upkeep of the sinew-backed bow, were included (in the terrestrial mammal category), as well as the netting shuttles and gauges required for net production and maintenance, but no other pieces of maintenance or manufacturing equipment. A systematic bias intrudes in the assignment of types and specimens to the category of bird harvesting (and to a lesser extent fishing) gear. All gear generically related to bow-and-arrow hunting, except bird bunts and the occasional fish arrow prong, was included in the terrestrial-mammal category, and all gear related to darting,

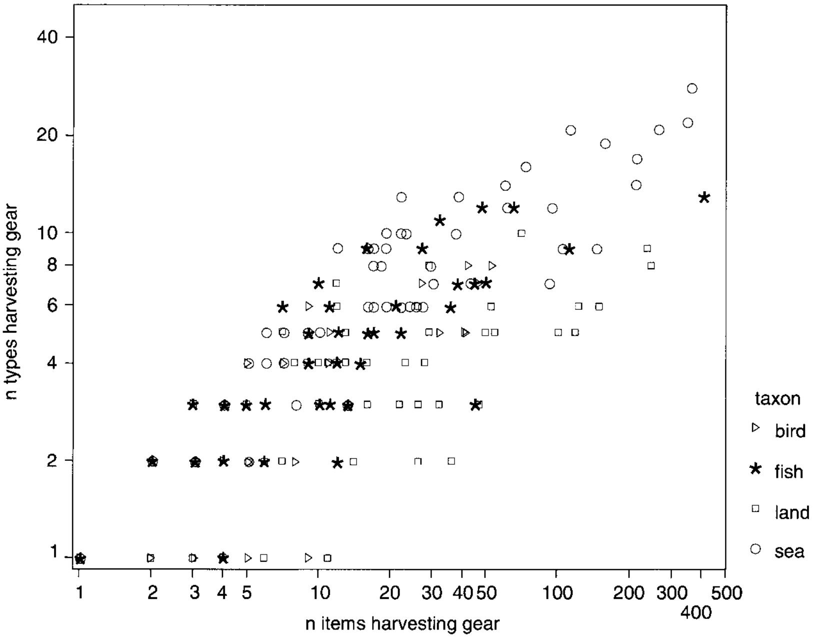

FIG. 6. Log-log scatterplot of number of types of harvesting gear versus number of specimens of harvesting gear, by taxon, illustrating the sample size effect.

except bird dart prongs, was included in the sea-mammal category. This manner of handling the overlapping uses of these pieces of equipment will result in a slight, but systematic, tendency to underestimate the abundance of equipment that would occasionally have been utilized for bird hunting.

For the assemblages at hand, the number of types of harvesting gear in a category is predictably related to the number of items (Fig. 6). This expected sample size effect behaves similarly for temporal, seasonal, regional, and taxonomic subdivisions of the sample, as illustrated here for the latter. Because numbers of items represent much larger sample sizes than numbers of types (mean of 142.0 and 20.9, respectively, for all harvesting gear), the former are more robust measures of relative abundance (in the same way that NISP is generally superior to MNI) and are used in the following to the exclusion of types. However, even number of items suffers from a potential sample size problem, particularly when it is broken down by faunal category (a mean of 35.5 items per category, but a median of only 11.0). The recovered harvesting gear cannot always be assumed to be a representative sample of the population of deposited artifacts, let alone those actually in use at some point in the past, and thus may provide only a crude reflection of relative harvesting intensity.

However, because the artifact types under consideration were virtually all made of relatively durable materials such as whale bone, antler, ivory, stone, or metal (only a handful of types are consistently made of wood or baleen), they are probably more durable on average than the animal bones themselves. The cordage of sinew, hide, or baleen that would have been used for such things as harpoon lines, bow strings, nets, fishing lines, and snares is rarely identified, and preservation of wooden shafts for harpoons,

TABLE 7

Rank Order Correlation (Spearman's Rho) of %Dietary Contribution and %Harvesting Gear by Taxon

	r_s	One-tailed p
All taxa	0.710	0.000
Sea mammal	0.525	0.001
Land mammal	0.328	0.025
Fish	0.514	0.001
Bird	0.117	0.248

lances, darts, arrows, and leisters is uneven, but loss of these types probably does not represent a significant bias against any one harvesting category. While fish and bird bones may be underrepresented relative to mammal (due to density-mediated attrition), and land mammal relative to sea mammal (due to marrow and grease extraction), the associated harvesting gear categories are inferred here to be less vulnerable to *differential* attrition across taxonomic categories. Differential disposal of the various categories of gear must still be considered as a potential biasing factor (as suggested above for expedient fishing equipment), but this problem also afflicts food refuse. In spite of their shortcomings, the artifactual data may actually be superior in some respects to the faunal data for assessing relative harvesting activity among the major taxonomic categories and are discussed below at greater length than the fauna.

ANALYSIS

Faunal and Artifactual Data

Surprisingly, given the host of complicating taphonomic, sampling, and classificatory factors, overall there is a strong, positive, rank order correlation (Spearman's $\rho = .710$, one-tailed probability $<.0005$) between artifactual and zooarcheaological indicators of harvesting intensity (Table 7). This patterning is further borne out by the correlation coefficients for individual taxa, which are weak, but positive and significant, for all but the bird category. Figure 7 illustrates the relationship between estimated dietary contribution and relative frequency of harvesting gear for the four taxonomic groups across 36 components from all regions, time periods, and seasonal site types. For display purposes, a logit transformation [designed to normalize proportional data and given by the equation $\frac{1}{2}\log(p/1 - p)$, where p is the proportion to be transformed; Johnson and Wichern 1992] of both axes has been used to ease clumping, with "0" entries assigned a small positive value so that they will appear on the lower and left-hand margins of the plot. The linear trends in the point clouds representing cases with nonzero values indicates that a reasonably strong, positive correlation between harvesting gear and faunal abundance is present for all taxa except birds, but is obscured in the untransformed data due to the differential attrition of fish and bird relative to sea and land mammals. More detailed taphonomic analyses of fish and bird bone survivorship are clearly called for (e.g., Nicholson 1992a; Davis 1997; Gifford-Gonzalez et al. 1999). In any case, the parallels between faunal and artifactual indicators suggest that Neoeskimo faunal assemblages indeed preserve the true relative abundances of major taxonomic categories, at least at an ordinal level. While fish is the category most likely to exhibit complete faunal underrepresentation, only a handful of assemblages actually have nonzero values for %fishing of all harvesting gear and zero values for %dietary contribution of fish (those at the middle left of Fig. 7). However, these cases appear to be part of the point cloud that exhibits an overall trend toward increasing fish bone with increasing fishing gear; the cases with "missing" fish do not occur

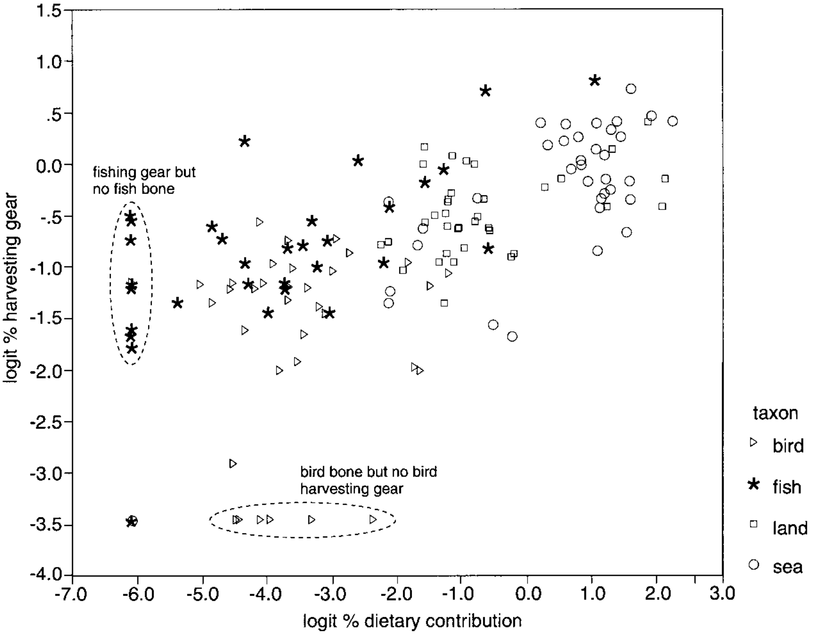

FIG. 7. Scatterplot of logit percentages of dietary contribution versus logit percentages of harvesting gear by taxon. Zero values in the original data have been replaced with a small positive number so that they appear on the lower and left margins of the plot.

as extreme outliers in the upper lefthand portion of the plot. The bird category generally clusters with fish, but is the one most likely to exhibit the opposite pattern of complete artifactual underrepresentation (cases at the bottom of Fig. 7), due no doubt to the assignment of generic bow and arrow equipment to the land mammal category.

Although total taphonomic destruction of fish bone seems to be uncommon, it nevertheless appears that fish are more or less underrepresented in Neoeskimo faunal assemblages. The mean ratio of %dietary contribution to %harvesting gear, where any harvesting gear was present for a taxon, is much lower for fish than for mammals (Table 8). If proportion of harvesting gear is a reliable index of harvesting intensity, then this would suggest that fish bone survivorship is an order of magnitude less than that for mammals or about what the linear density data might lead one to expect. However, the value of this ratio is similar for fish and birds. Bird bones are also vulnerable to dispersal and destruction by scavengers (Walters 1984), but are less likely to have been *systematically* consumed by dogs (or people) and unlikely to have been culled from transported carcass portions or missed through poor recovery techniques. It is thus somewhat surprising that these taxa overlap so closely in Fig. 7. Either fish and bird bones

TABLE 8

Mean Ratio of %Dietary Contribution to %Harvesting Gear by Taxon (Where Some Harvesting Gear Is Present for a Given Taxon)

Taxon	Mean % dietary contribution/ % harvesting gear
Sea mammal	2.04
Land mammal	0.90
Fish	0.10
Bird	0.18

have been selectively deleted from faunal assemblages in parallel fashion or bird and fish harvesting toolkits were maintained (and discarded) at a level out of all proportion to their economic importance. The former explanation clearly has some validity, since bird and fish harvesting gear consistently occurs in at least low frequencies even where bird and (more often) fish bones are absent or extremely rare. One of the outliers in Fig. 7, Bloody Falls, with 61.5% fishing gear and only .016% estimated dietary contribution from fish, represents a particularly transparent instance of this sort (McGhee 1972:40). However, the strong patterning in the data also tends to draw attention to the latter possibility that Thule and Inuit groups actively "geared up" for fishing (and bird hunting) without actually relying on these taxa for a substantial dietary contribution. Faunal abundance is predictably related to harvesting gear abundance, but at a substantially reduced rate for fish and birds than for sea and land mammals.

Faunal Data

The zooarchaeological data can also be examined on their own, particularly by using a log-based transformation like that used to clarify the relationship between fauna and artifacts. Figure 8 depicts the %dietary contribution of fish for the sites in Table 1, using a log interval for the symbols and with the study area broken up into three zones according to fishing potential. The western zone corresponds to the Mackenzie Delta region, the Canadian portion of the Western Arctic, and possesses the most productive and diverse (≥12 species) freshwater fish resources. The central region includes the Arctic Coast and Barrengrounds, and Low Arctic portions of the Canadian Arctic Islands, all of which possess moderately diverse (2–11 species) and/or productive fish resources. The eastern region consists of the northernmost tip of the mainland and the northeastern portion of the Canadian Arctic Islands, including Baffin and Southampton Islands, throughout which char is the only major freshwater fish (except for some localized occurrences of lake trout).

The %dietary contribution of fish is substantial at warm weather sites in the west, but low at such sites in the central and eastern regions (Fig. 8 upper). The contribution of fish at winter sites, consisting both of stores put up during late summer/early fall and of fish jigged or netted through sea and lake ice, is high at some sites in the Mackenzie Delta region and declines even more sharply from west to east (Fig. 8 lower and Fig. 9). Fish bone is absent from the majority of eastern winter site assemblages, including High Arctic sites with superb organic preservation. Taphonomic deletion of fish bone does not adequately account for its very low incidence only at sites outside the Mackenzie Delta region. Though recovery biases may well be an aggravating factor, the zooarchaeological patterning is consistent with limited fish use in the latter areas. This index of fish use did not exhibit strong chronological trends for the sample as a whole, and it is impossible to subdivide the data set further, to examine chronological trends for each region, without running into severe sample size problems, particularly for warm-weather sites and the historic period (see Table 5).

Artifactual Data

Sample sizes are little better for harvesting gear assemblages, but patterning in these data is somewhat stronger, likely because of the reduced importance of intertaxa taphonomic biases. It remains difficult, however, to subdivide the data set so as to simultaneously control for region, period, and season of occupation. The ba-

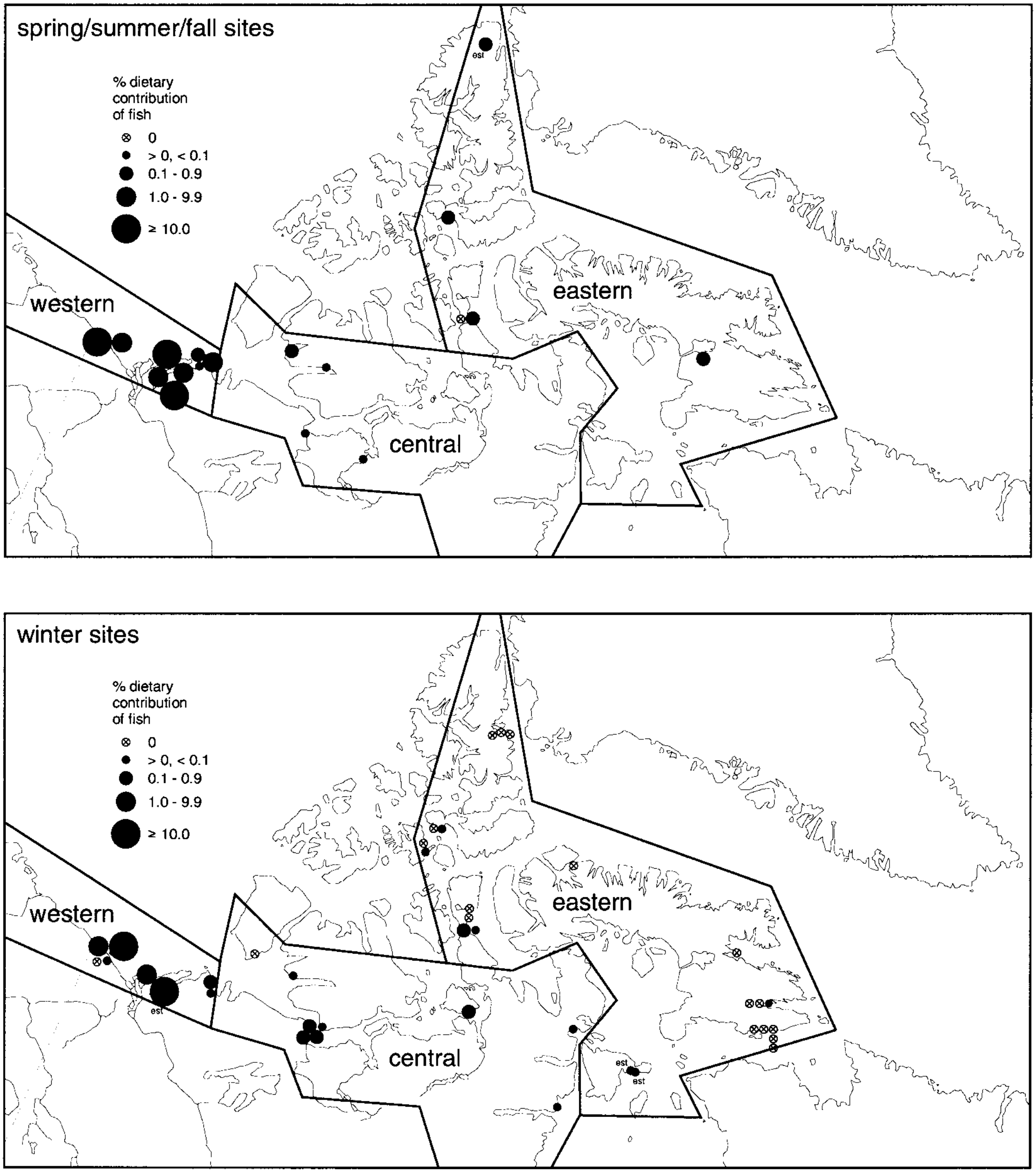

FIG. 8. Dietary contribution of fish at Canadian Thule and Inuit sites. (Upper) Spring/summer/fall sites. (Lower) Winter sites.

sic seasonal contrast in harvesting emphases is depicted in Fig. 10. Land mammal hunting and fishing gear tend to dominate warm-weather assemblages, with only moderate frequencies of sea mammal hunting gear and a negligible contribution from bird hunting. Caution is in order, since this sample is skewed toward the western and west-central regions and the later time periods; only 4 of 13 components are located east of the Coppermine River and only 3 predate the Classic-Modified Thule transition.

Winter components are more evenly

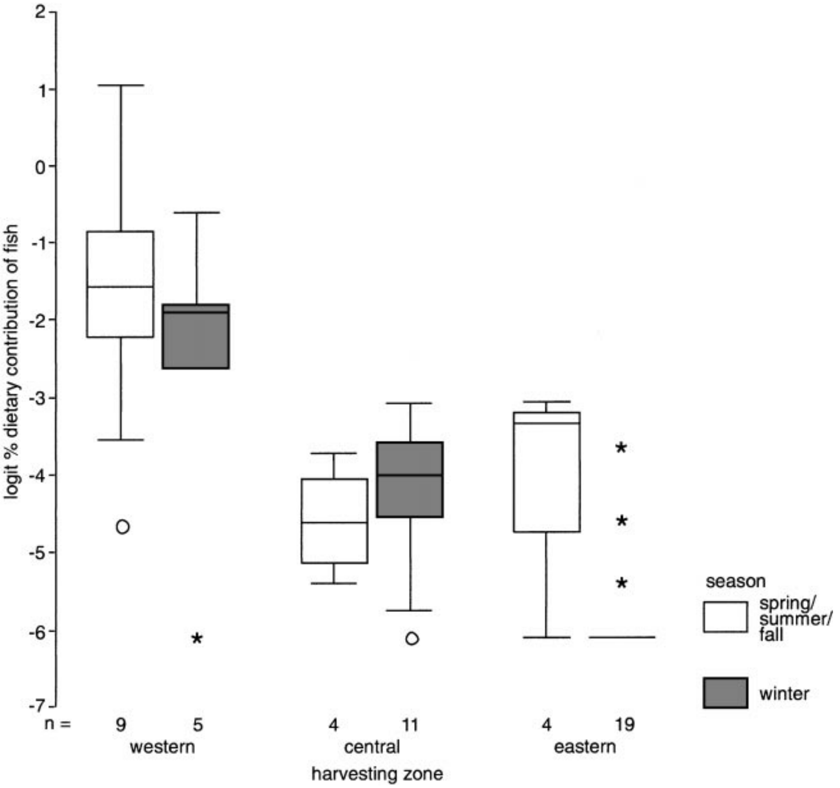

FIG. 9. Boxplot of logit percentages of dietary contribution of fish by region and season (zeroes assigned a small positive value). Note the decline from west to east in the importance of fish in winter assemblages.

distributed across the study area. The sea mammal category tends to account for over half of the harvesting gear on winter sites, with land-mammal hunting gear on average only about half as abundant. Fishing gear frequencies are variable, but generally less than 20%, while bird hunting gear usually accounts for less than 10%. While some winter harvesting was probably focused on sea mammals (mainly ringed seal, but also larger species available at polynyas or the floe edge), many of the animals harvested with this gear would have been procured during early spring, late summer, and fall. Because of the length and nature of winter dwelling occupation, discussed above, this pattern is probably a reasonable representation of the annual economic round of the site occupants. Although fishing and terrestrial hunting were important activities at warm-weather settlements, sea mammals made the most substantial contribution to the yearly diet for the majority of groups. But while proportions of land-mammal and bird hunting gear tend to be fairly consistent from region to region and period to period (and, indeed, season to season), there is a sharp decline from Classic Thule to Modified Thule/Late Prehistoric times in the frequency of sea-mammal hunting gear and a corresponding increase in fishing gear (Fig. 11). Proportions of sea-mammal hunting gear also increase from west to east, while fishing gear declines along this gradient (Fig. 12).

A simple visual summary of the complex relationships among all the variables

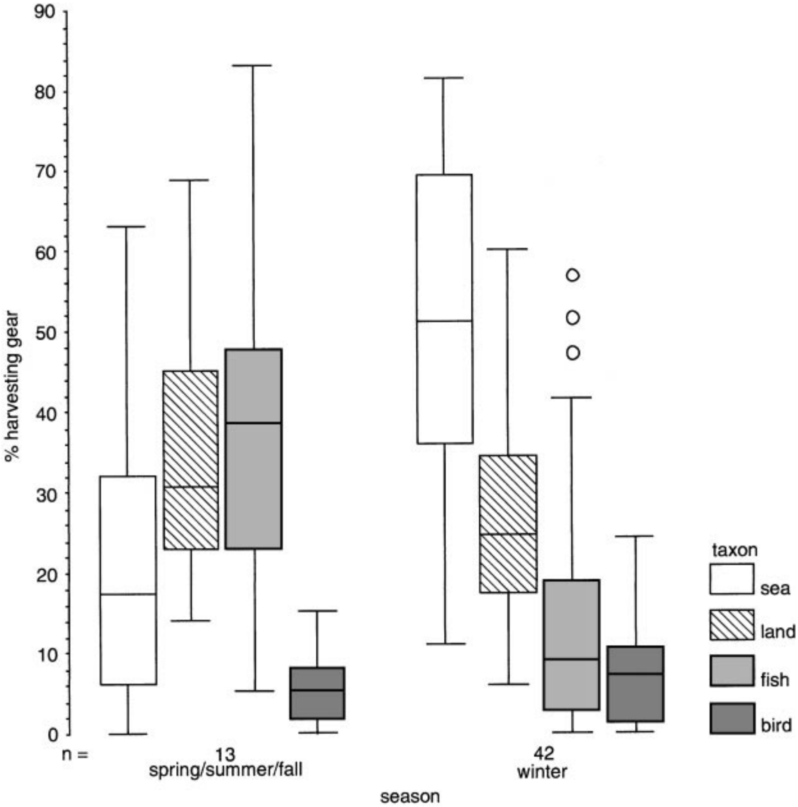

FIG. 10. Boxplot of percentages of harvesting gear by season and taxon. Note the increase in sea-mammal hunting gear from warm weather to winter sites and the decline in fishing gear and, to a lesser extent, land-mammal hunting gear.

and sites can be obtained through a correspondence analysis (CA) of harvesting gear assemblages. The essential goal of CA is to depict in as few dimensions as possible (ideally two) any structure in the departures from expected cell values in a contingency table. Whereas a chi-squared test gauges the overall magnitude of such departures against a probability distribution, CA maps the "shape" of those departures in a low-dimensional space (Baxter 1994). Unlike most other multivariate techniques, the axis scores assigned to cases and variables are commensurate and can be plotted in the same graphical display. The analysis was performed in Statistica, Version 5.1, which provides the option of scoring variables not included in the analysis according to the results obtained with the original suite of variables. Patterning in these supplementary variables can thus be examined with respect to structure in the artifact assemblages, without interfering in the detection of that structure. Here, the basic variables were taken to be the raw counts of harvesting gear in each taxonomic category for the 55 sites (cases) with artifactual data. Period, region, and season of site occupation were then scored as supplementary variables.

The first two axes account for 92% of the inertia, or variability, in the data set, and thus the CA provides a good two-dimensional summary of the data (Table 9). The bird category contributes very little to the results and falls closest to the origin in the

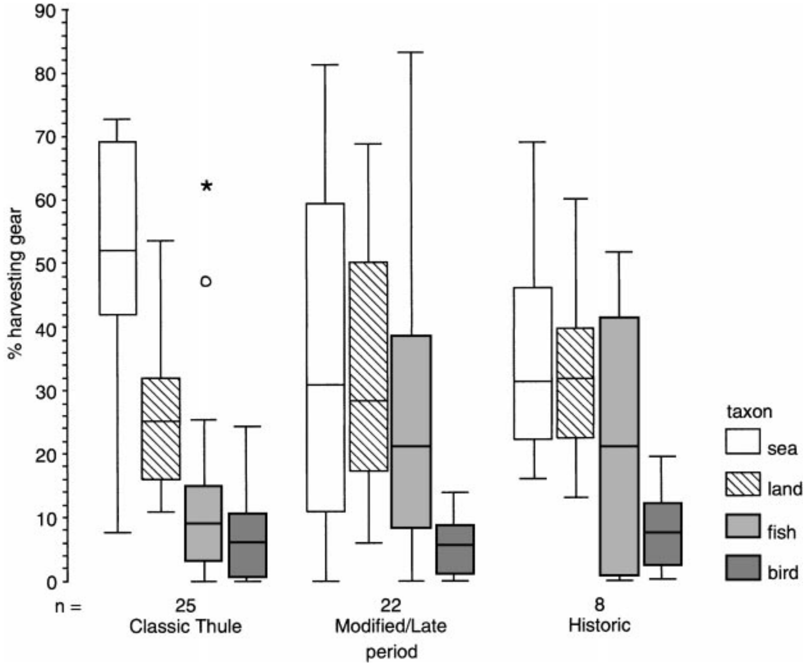

FIG. 11. Boxplot of percentages of harvesting gear by period and taxon. Note the decline in sea-mammal hunting gear and increase in fishing gear from Classic Thule to Modified Thule/Late Prehistoric times. Land-mammal and bird hunting gear remain fairly constant over time.

plot of variables and cases (Fig. 13). In effect, the proportion of bird hunting gear in Thule and Inuit assemblages is uncorrelated with, and varies less than, the other categories. The first axis "explains" 72% of the variability in the data and is largely determined by the opposition between fish (accounting for 78% of the variability in axis 1) and the other categories, especially sea mammal (19% of axis 1 inertia). The second axis accounts for 20% of variability in the data and opposes land mammal (68% of axis 2 inertia) to the other categories, again especially sea mammal (29% of axis 2 inertia). Sea-mammal hunting gear is the most abundant category in the present sample and is at the center of the largest cluster of cases in Fig. 13. It is principally deviations in assemblage composition away from large proportions of sea mammal gear toward either more fish or more land mammal that accounts for the structure in the data set.

While the locations of particular cases and clusters of cases with respect to each other and to the variables are potentially interesting and interpretable, for the purpose at hand it is the relationships of the variables to each other that are of primary concern. The abundance of sea mammal hunting gear represents a pole in Neoeskimo harvesting practices that is closely associated with Classic Thule times, the eastern part of the study area, and winter site assemblages. Moving from the eastern zone to the central and western zones describes a trajectory toward greater emphasis on first fish and then fish and land mammals. The Modified Thule/Late Prehistoric and Historic periods are clustered together at a point along a similar trajectory toward greater proportions of these same categories of harvesting gear. The

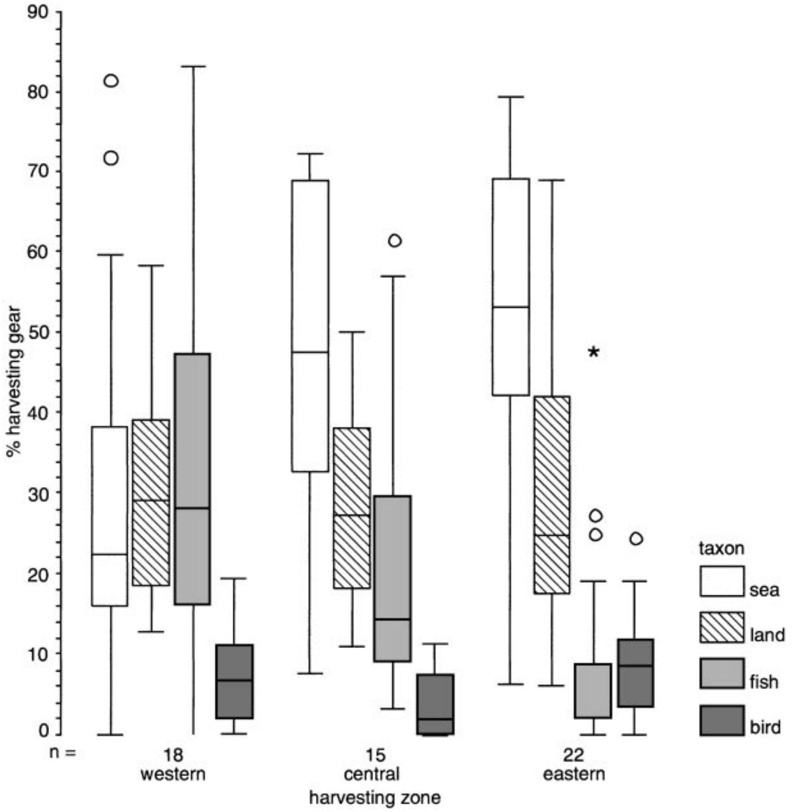

FIG. 12. Boxplot of percentages of harvesting gear by region and taxon. Note the increase in sea-mammal hunting gear and decrease in fishing gear from west to east. Land-mammal and bird hunting gear remain fairly constant across regions.

onset of cooler than modern conditions at ca. A.D. 1400 seems to have had a more profound impact on economic practices than the further climatic cooling during the peak of the Little Ice Age, between about A.D. 1650 and 1850. Winter and summer also represent poles defining a diagonal that closely parallels these geo-

TABLE 9
Results of Correspondence Analysis of Harvesting Gear Assemblages

Taxonomic category	Axis 1 coord.	Axis 2 coord.	Mass	Quality	Relative inertia	Axis 1 inertia	Axis 2 inertia
Sea mammal	0.373	−0.244	0.456	0.974	0.199	0.189	0.290
Land mammal	0.110	0.471	0.286	0.987	0.146	0.010	0.680
Fish	−1.172	−0.121	0.190	1.000	0.567	0.780	0.030
Bird	0.323	−0.010	0.067	0.170	0.088	0.021	0.000
	Axis 1	Axis 2					
% of inertia	71.9	20.1					

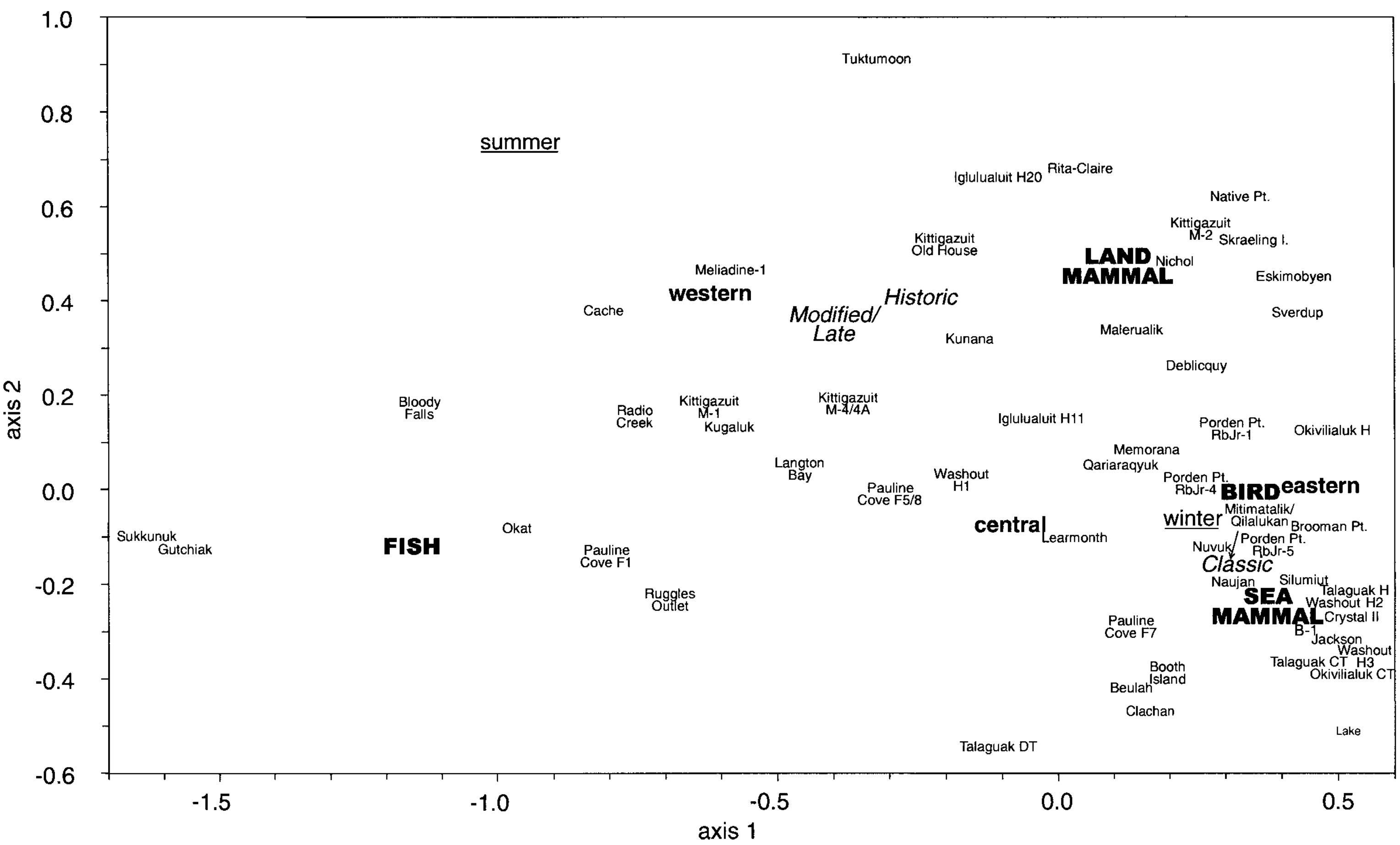

FIG. 13. Scatterplot of sites (rows, or cases) and taxonomic harvesting gear categories (columns, or variables) on the first two axes of a correspondence analysis. Region, period, and season have been plotted as supplementary variables based on the results of the analysis of harvesting gear counts. Note the opposition between sea-mammal hunting and fishing gear on the first axis and sea- and land-mammal hunting gear on the second. Winter, eastern, and Classic Thule sites fall toward the sea-mammal pole on both axes.

graphic and temporal trends. In effect, after the Classic-Modified Thule transition, and with the abandonment of the northern portion of the eastern zone, recovered Inuit harvesting assemblages tend to resemble those initially associated with warm-weather Thule sites.

Part of the apparent decline in sea-mammal hunting gear likely relates to the archaeological invisibility of winter settlement on the sea ice, which appears to have increased in importance at this time; sea mammals remained the economic mainstay, while the *relative visibility* of terrestrial hunting and fishing increased. However, there appears to have been a real shift in the nature of the latter activities. Subsistence during the summer/fall portion of the annual round was increasingly based on terrestrial and freshwater resources, as the open-water sea-mammal hunting so widely attested in Classic Thule times by the predominance of movable over fixed harpoon foreshafts waned with deteriorating sea ice conditions. In addition, groups in some regions increasingly depended on late summer/early fall fishing, together with intensified winter breathing hole sealing from sea ice camps, to help make up the winter stores that had previously been provided by whaling or walrus hunting.

In summary, variability in the relative abundance of fishing gear at Thule and Inuit sites is highly patterned with respect to site seasonality, region, and time period. Generally, fishing gear is more common on warm-weather sites, in the western part of the Canadian Arctic, and after about A.D. 1400. The zooarchaeological data also strongly suggest that fish played a relatively minor economic role outside the Mackenzie Delta region, befiting the low taxonomic diversity and productivity of eastern fish resources. Since the central and northeastern part of the Arctic Archipelago was extensively utilized in Classic Thule times, and accounts for a substantial proportion of the published sample of sites, the overall scarcity of fish bone in Classic Thule assemblages may be largely attributable to occupancy of areas with poor fish resources rather than to taphonomic or sampling loss of fish bone.

In addition to the poverty of fish resources in the major areas of Classic Thule settlement, an economic focus on open-water sea-mammal hunting during a warmer climatic episode likely produced a scheduling conflict with the most productive char runs, while rendering their utilization largely inconsequential. If the dietary contribution of bowheads could be consistently and securely quantified, and the reduced transport to residential sites of bones of other large sea mammals controlled, it would have the effect of drastically reducing the dietary contribution of land mammals, fish, and birds wherever even small amounts of bowhead bone occurred. Bowhead bone is generally abundant on Thule winter sites north and east of Boothia Peninsula (the eastern zone and easternmost part of the central zone as defined here), occurs in low to moderate frequencies on Thule winter sites west of Victoria Island, and is rare or absent on sites along the intervening coasts (McCartney 1979a; Dyke et al. 1996:250). Few of the Modified Thule/Late Prehistoric or Historic sites in this sample are seriously affected by the exclusion of bowheads from the analysis, but dietary estimates for most of the Classic Thule sites outside of the Coronation Gulf area *are* so affected. The effect of including bowheads, however, would be to accentuate rather than obscure the patterning that has become evident in the data. Fish bone is uniformly rare or absent in precisely those Classic Thule winter assemblages that occur within the area of abundant whale bone. Including the bowhead dietary contribution would merely reduce the already minuscule contribution of fish by a few orders of magnitude.

ALTERNATIVE ROLES FOR FISHING IN CLASSIC THULE CULTURE

Once allowance is made for the profound economic importance of bowhead whales (and, in some areas, other large sea mammals such as beluga, walrus, and bearded seal, the bones of which would have been heavily culled at processing sites), even low proportions of fishing (and bird hunting) gear in Classic Thule assemblages seem somehow excessive. While bow-and-arrow equipment would have been heavily utilized to obtain the caribou essential for winter clothing, and secondarily in interpersonal conflict, why should fishing and bird hunting gear occur so consistently if such small-bodied game was not contributing substantially to the diet? An interesting perspective on this problem is provided by the epigraph to this article, taken from the report of the Inuit Land Use and Occupancy Project. It relates to the difficulty of translating Inuit perceptions of their harvesting activities into the land use idiom employed by the government's consultants. Following is the paragraph from which it is drawn, in full:

> One middle-aged man refused to enter ptarmigans, Canada geese or wolves [on the land use maps], saying that such creatures are not hunted in any particular place, but rather are hunted at all times. Much the same difficulty arose with seals in general (though not with seals when discussed according to technique used and time of year). When that man was asked to mark all the places he had hunted seals, he would not enter the routes between Pond Inlet and the Arctic Bay region, saying of those routes: "I am not hunting for seals; I'm merely travelling by dog team and killing seals." In the same spirit, he noted that he was not going to mark those places where he "merely killed caribou," but only those areas into which he regularly went precisely because he expected to find caribou there—those are the real hunting places. In trying to communicate what he meant by the distinction he persistently made during the interview, he said of his pursuit of Arctic char: "I have fished everywhere; but I have not really fished (sought after fish) at all." (Freeman 1976: 54)

This subtle construction of the differences among superficially similar harvesting activities points to the possibility that archaeologists may encounter culturally distinct, even idiosyncratic, forms of economic practice that are not well described by simple formal models based on prey characteristics and the spatial structure of the environment. Indeed, some hunting activity is not "economic" at all, in a narrow rationalist sense, but might better be assigned to a paraeconomic realm subsuming social and ideological formulations of food production and human–environment relations (see, e.g., Bird-David 1992 on a culturalist approach to hunter-gatherer economy). Although indigenous models of the environment often rely upon a great deal of sophisticated technical knowledge [see the literature on traditional ecological knowledge (TEK) of northern hunters; e.g., Freeman and Carbyn 1988; Inglis 1993], they cannot be reduced to this etically recognizable content. For example, in Inuit and Yupik belief systems game species are not simply edible organisms co-inhabiting a mechanistic world, but sentient creatures belonging to a super-society of living things (e.g., Wenzel 1991; Nuttal 1992; Fienup-Riordan 1990). Furthermore, an animal carcass is not merely a package of nutritious and otherwise useful stuff, but a medium in which the connections among people and animals are represented and reproduced. One can thus speak not only of the economic anatomy of the animal body, but of its social anatomy as well, since a social universe embracing animal agents, human consumers, and other entities is mapped onto the carcass in prescriptions for its respectful treatment and the distribution of its products (Wenzel 1991).

Adopting more of a culturalist tack opens up a range of alternative scenarios for Thule fishing, in which it may have been periodically, and even frequently pursued, but rarely made a substantial contribution to overall diet. Such low-intensity fishing might have occurred in a number of contexts, most of which are also relevant to the hunting of birds and small mammals.

Delicacy. Some species of fish were highly preferred foods and so may have been sought out as a delicacy and source of variety in the diet. If a large proportion of a community's subsistence needs was met from a few weeks of whaling, there may have been abundant latitude to pursue such a "gourmet" strategy at other times. Rare and exotic foods were certainly esteemed by Inuit and figured prominently in the potlatchlike Messenger Feast of the Alaskan Inupiat and Yupik (Nelson 1983; Hawkes 1913; Spencer 1959). Interestingly, fish is one of the most common elements of the modern Baffinland Inuit diet, even though it makes a small caloric contribution. In one community on east-central Baffin Island arctic char recently accounted for a mean of only 2.3% of daily adult caloric intake (Kuhnlein et al. 1995:178), but was consumed an average of 2.2 times per week (Kuhnlein and Soueida 1992) or only slightly less frequently than the sea and land mammals (mainly ringed seal and caribou) that accounted for 22.6 and 9.9% of adult caloric intake, respectively. Then as now, fish may have been prized out of proportion to their caloric contribution. Their high culinary value may have an underlying nutritional dimension as well, since they are one of the best sources of scarce calcium in the traditional Inuit diet (Kuhnlein and Soueida 1992; Keene 1985).

Travel food. As a resource that is widely procurable, albeit not always in large numbers, in interior lakes and rivers and through the sea ice, fish were exploited by hunters or family groups in transit between primary harvesting locations (e.g., Jenness 1922:123; Freeman 1976:54). Such utilization of fish as a travel food would have the added characteristic of leaving its material residues, if any, in ephemeral sites that are rarely investigated and at which preservation is often poor.

Opportunistic production by women and the elderly. Among all harvesting activities, women, children, and the elderly participated disproportionately in fishing and other small-game harvesting. For women this appears to have occurred opportunistically as an activity normally secondary to clothing manufacture, childcare, game processing, and household maintenance. However, a special link between women and fishing is reflected in such things as the first fish ceremony held for girls among some groups (Guemple 1979, and see discussion of fishing and gender roles in Giffen 1930:8–10). This symbolic association of women with an easily harvested food recalls the gender and status associations that surrounded shellfish use in Tlingit society (Moss 1993). Giffen notes that while women and men both fished, they tended to use different tools or fulfill different roles within the overall production sequence. Of particular interest, she cites Jenness's (1922:142) observation that Copper Inuit women and children (the elderly can probably also be included here) fished close to camp while men fished at a distance.

This draws attention to a shortcoming of some formal models of foraging behavior, namely the failure to consider the complex array of constraints and opportunities that may *differentially* influence the harvesting behavior of particular individuals or subgroups. All able-bodied Inuit were expected to contribute to the economic life of their household and community, but the manner in which individuals fulfilled this obligation varied according to their inclination, social position, knowledge, physical ability, and the existence of conflicting demands on their time and attention. For example, in the arctic a small child represents a constraint on the harvesting activities of the caregiver. Since Inuit women were conventionally responsible for most childcare, in addition to food processing, clothing manufacture, and household maintenance, women as a subgroup tended to be restricted in their harvesting activities. This does not mean that women did not hunt or trap or fish, but that the technical and spatial variants of these practices with which they were most commonly associated were not identical to men's under the conventional Inuit division of labor. Similar constraints applied to the elderly due to declining physical abilities.

In effect, adult male hunters deployed one set of harvesting strategies and women and the elderly others. Men tended toward a relatively specialized, logistically complex focus on a small suite of large-bodied marine and terrestrial mammals, with occasional harvesting of other species, while women and the elderly tended toward opportunistic foraging for small-bodied game. The "broad spectrum" harvesting strategy often invoked for Thule groups was likely a palimpsest of more specialized strategies differentially employed by women and men, each of whose strategies would have in turn been further differentiated according to age, hunting and traveling skills, wealth, position in social networks, and so on. Low-intensity fishing by individuals with other primary responsibilities (women) or limited labor capacity (the elderly) may thus have been a fairly frequent occurrence without being a major dietary contributor. That essentially all members of the community, including children (see below), engaged in fishing to some degree would also tend to inflate the frequency of fishing equipment relative to the large-mammal hunting gear employed almost exclusively by adult men to procure the bulk of annual food production.

Children's play/training. When children assisted in adult harvesting activities they often did not use a great deal of formal harvesting equipment. In caribou drives they helped women and the elderly drive the animals toward the armed hunters, and in *saputit* fishing they often recovered fish from the trap with their hands, though some were equipped with leisters and fish stringing needles. Children did, however, fish and hunt birds and small mammals on their own. From a very young age they emulated the adult roles appropriate to their gender in play, gradually taking on the real tasks as they acquired the requisite knowledge and skills (Guemple 1979, 1986). Their accomplishments in this regard were marked by a series of progress rituals such as those for a girl's first fish or mittens made or a boy's first goose or seal (Briggs 1991:269; Guemple 1979). Fishing and small game hunting were the least dangerous and demanding harvesting tasks and were not considered inappropriate activities for any gender, so it can be expected that children would have engaged in them frequently. The simpler, easier to produce gear types were likely used in these activities, such as hooks, gorges, and expedient *nuyakpak*-type spears or arrows for fish, and hooks, gorges, snares, and slings for birds. Again, fishing gear might end up common archaeologically even though part of its value would have lain in children's acquisition of adult harvesting skills rather than in serious food production.

Adult recreation. Fishing may also have been engaged in by adults for pure enjoyment rather than out of economic necessity. This is the clear implication of Rasmussen's (1931) account of the "joyful" existence of Netsilingmiut at Amitsoq before the major char run arrived. People were able to obtain enough fish to eat with very little effort and regarded that lifestyle as akin to the paradise in the afterworld. It appears that these bands could have produced more food with more effort (particularly in processing for storage), but chose to regard this early summer season as a respite from the normal demands of making a living. Summer fishing in northwest Alaska is also reported to have had the quality of a sport or a pastime rather than a necessity (Foote 1992), and for the Nunamiut Binford reports that as interest in caribou hunting wanes in early summer "talk shifts to fishing, despite the fact that very little fishing is done and then mostly by young men and boys" (1978:255).

Consistent with this recreational aspect, there is a whimsical quality to some Thule (and Inuit) fishing equipment that contrasts with the sparse design and standardization of most harvesting gear. As discussed above, the relatively unstandardized *nuyakpak*-type barbed prongs suggest a relaxation of the conformity that appears often to have guided artifact manufacture. Fishing lures as well happen to be among the most idiosyncratic of Thule artifact types. They represent the most commonly occurring class of zoomorphic sculpture and one of the few types of harvesting gear to consistently incorporate substantial decorative elements in its design, such as incised anatomical motifs and inlays. In the west, fish hook shanks also sometimes took zoomorphic forms or were elaborately decorated with dangling lures and inlays of precious materials (trade beads and copper). Fish line sinkers were frequently made of striped, mottled, and brightly colored pebbles polished to a high sheen. These ornate and carefully crafted implements exceeded their function, just as the overall attention to fishing frequently exceeded its economic utility. It may also be significant that fishing was not depicted in Thule engravings on drill bows or knife handles, whereas the economically and socially central activities of whaling and caribou hunting were popular themes. The Thule archaeological evidence is thus consistent with the ethnographic reports that fishing was marked as an enjoyable activity rather than an anxious necessity.

Environmental monitoring. Even if fishing was sometimes engaged in casually, in a sense outside the normal economic round, it does not necessarily follow that it was a trivial activity. Indeed, this conclusion would not be supported by the ubiquity of fishing gear in Thule assemblages. The sporadic use of a wide range of resources, with reliance on few, appears to be typical of Thule and Inuit harvesting practices and may reflect a kind of environmental information gathering. By periodically monitoring the availability of resources that are normally of little importance hunters will be prepared, in the event of a primary resource collapse, to switch to secondary species. Polar cod were regarded as just such a starvation food by the Netsilingmiut (Rasmussen 1931:186), but they could only serve that function if their ecology was understood. While the investment of time and energy in low-level harvesting and equipment maintenance may not have a short-term economic payoff, it may provide critical insurance against intermittent resource fluctuations in the form of information on alternate resource distributions, abundances, and accessibility and the acquisition of technical expertise in their procurement. Whatever the affective construction of fishing in Thule society, the constant sampling of fish and other secondary resources appears to have been an integral part of the Thule adjustment to a challenging and changeable environment. The regular occurrence of fishing gear in low frequencies in Thule artifact assemblages thus need not signify a proportional dietary contribution, but rather a risk-averse harvesting strategy that involved broad-based monitoring of resources that fell outside the select set of focal species.

CONCLUSION

Although it is impossible to resolve the precise degree of taphonomic and sampling loss of fish bone with currently available data, the rate of loss may be an order of magnitude greater for fish, and perhaps birds, than for sea and land mammals. However, even allowing for the deletion of fish bone, the dietary importance of fish in Classic Thule economies appears to have been tiny in comparison with that of sea mammals, especially when the contribution of bowhead whales and other large, and usually heavily culled, species are considered. Although many groups may have spent part of the summer living hand-to-mouth off fish and opportunistically harvested birds and mammals, fishing does not appear to have been an important source of winter stores for most Thule groups. Classic Thule communities focused instead on the harvesting of sea mammals, even during the open-water season, and to a lesser extent on caribou and lacked an economic incentive to systematically pursue the simultaneously available upstream runs of char and whitefishes. Open-water hunting of large sea mammals collapsed in the Central and High Arctic beginning around A.D. 1400, precipitating a withdrawal into the Low Arctic islands and mainland. Fishing emerged in Modified Thule times in the latter areas as an important secondary harvesting activity throughout the year, and a major economic enterprise during the productive late summer/early fall upstream runs, for all but those groups in Baffin Island, Foxe Basin, northwest Hudson Bay, and Labrador with continued access to large sea mammals. Even in these areas, bowhead hunting does not appear to have achieved anything akin to the regularity and intensity of Classic Thule whaling, likely due in part to the attenuation of the interregional exchange networks that had been essential for the disposition of surplus whale products (Whitridge 1999, 2000b). In the Mackenzie Delta region, the introduction of fish netting technology occurred during the period of climatic deterioration and accompanied the transition to the Late Prehistoric period. Fishing rapidly emerged as an important harvesting activity at all seasons and was even pursued simultaneously with coastal beluga and bowhead whaling by task groups occupying near interior fishing and caribou hunting camps.

The ubiquitous occurrence of low frequencies of fishing gear in Classic Thule assemblages belies the minor caloric importance of fish. Fishing appears to have been pursued casually by Classic Thule groups to obtain a prized and nutritious food; in transit between primary harvesting sites; as a food source that could be opportunistically procured by women, the elderly, and children; and as a summer pastime. The involvement of virtually all individuals, to a varying extent, in low-intensity fishing may have significantly inflated the abundance of fishing gear relative to that used for sea-mammal and caribou hunting. Fishing was occasionally the dominant subsistence activity, but dominant at a time of year when relatively little food production was occurring; for most of the year groups relied on strategically harvested and cached stores of marine, and to a lesser extent terrestrial, mammals.

The Thule predilection to utilize diverse faunal resources while specializing on only a few species represented, in effect, a form of environmental monitoring. The investment in monitoring such secondary or tertiary resources as fish and birds would have been returned during periodic failures of higher ranked resources and is a cornerstone of the economic flexibility that allowed Thule groups to reconstruct their subsistence-settlement systems with the onset of the Little Ice Age. The embedding of long-term economic strategies in superficially unrelated cultural practices has been suggested for Inupiat myths and oral history, which may have encoded prescriptive economic responses to long-term climatic variability (Minc 1986). However, the peculiar evidence for Thule fishing need not be reduced to purely ecological and economic factors. As a cherished form of communal recreation, and an opportunity for nonhunters to make a symbolically important contribution to food production, the social and ideological dimensions of fishing may have been as important as the economic in Classic Thule communities.

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