Foraging efficiency and small game: The importance of dovekie (*Alle alle*) in Inughuit subsistence

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ABSTRACT

The archaeological site at Iita in Northwest Greenland offers a unique opportunity to investigate the importance of small game in Inughuit (Polar Eskimo) and Thule subsistence. The presence of large colonies of dovekie (*Alle alle*) at Iita has played a key role in attracting people to this area for the past eight hundred years. An estimated 15 million pairs of dovekie breed along the northwest coast of Greenland during the summer months, offering humans access to reliable meat for winter storage as well as bird skins for clothing. Of the +25,000 faunal remains recovered from the 2006 excavation of two winter houses at Iita, dating from AD 1400-1920, the majority were dovekie bones (N=17,287), which suggests a reliance on these small birds. Under optimal foraging models, the presence of small animals in the diet is generally associated with reduced foraging efficiency, but many such interpretations do not account for the changed costs and benefits associated with mass capture. Ethnographic accounts from Northwest Greenland indicate that dovekie were captured en masse using nets, changing the appropriate unit of comparison from the individual dovekie to the total prey biomass caught simultaneously. This paper addresses the importance of dovekie as a reliable food source at Iita, and considers whether they were ranked highly as a result of mass capturing technology or whether they were a starvation food, relied upon when large game was unobtainable due to loss of important hunting technology.

KEY WORDS
Dovekie,
Alle alle,
Mass capturing,
Thule, Inughuit,
Northwest Greenland,
Optimal foraging.

RÉSUMÉ
*Efficacité de collecte et petit gibier : l'importance du mergule nain (*Alle alle*) dans la subsistance des Inughuit.*
Le site archéologique de Iita, au nord-ouest du Groenland, offre une occasion unique de documenter l'importance du petit gibier dans l'alimentation Inughuit (Esquimaux polaires) et thuléenne. La présence d'importantes colonies de mergules nains à Iata a joué un rôle clé pour attirer les hommes dans cette région au cours des huit derniers siècles. Environ 15 millions de couples de mergules nains nichent sur la côte nord-ouest du Groenland durant les mois d'été, fournissant aux hommes un accès fiable à la viande stockée pour l'hiver, et à des peaux d'oiseaux pour confectionner des vêtements. Des quelques 25 000 restes fauniques provenant de la fouille de 2006 de deux maisons d'hiver de Iita, datées de 1400 à 1920 AD, la majorité était constituée de restes de mergules nains (NR = 17 287), ce qui suggère une dépendance à ces oiseaux de petite taille. Dans les modèles de récolte optimale, la présence de petits animaux dans le régime alimentaire est généralement associée à une réduction de l'efficacité de collecte, mais nombre de ces interprétations ne tiennent pas compte des variations de coût et de bénéfice associées à la capture de masse. Des récits ethnographiques du nord-ouest du Groenland indiquent que les mergules nains étaient capturés en masse à l'aide de filets, modifiant l'unité adéquat de comparaison d'un mergule nain individuel à la biomasse totale capturée simultanément. Cet article traite de l'importance des mergules nains en tant que source de nourriture prédictible à Iita et discute de leur préférence en raison de cette technique de capture de masse ou s'ils étaient une nourriture de période de famine sur laquelle on comptait lorsque le gros gibier ne pouvait être obtenu par suite d'une forte perte de la technologie de chasse.

MOTS CLÉS
Mergule nain,
Alle alle,
capture de masse,
Thule,
Inughuit,
nord-ouest du Groenland,
récolte optimale.

INTRODUCTION

It becomes clear when reading the extensive ethnographic material pertaining to the Inughuit of Northwest Greenland that dovekies, also known as little auk (*Alle alle*), played an important role in their subsistence. Much of the literature (e.g., Ekblaw 1919; Rasmussen 1921, 1935; Steensby 1921) discusses the reliance on these small birds as a result of the loss of knowledge of important hunting technologies such as the bow and arrow for caribou hunting as well as the kayak and fishing spear for water related subsistence pursuits. These sources argue that as the Inughuit lost the ability to hunt such important food sources they came to rely more heavily on the dovekies due to their predictability and ease of capture as well as the low processing costs involved in their procurement. Still, even after the missing technology was reintroduced in 1862 by Canadian Inuit emigrating from Baffin Island, the Inughuit appear to have continued to include dovekies in their diet in similar proportions.

BACKGROUND

The site of Iita is located along eastern Smith Sound at the southern end of Inglefield Land in Northwest Greenland (Fig. 1). Southern Inglefield Land is also the closest landfall for immigrants from Ellesmere Island and is believed to have been the most frequently used route for human colonization of Greenland in prehistory (Schledermann 1990). Iita is located on the northern end of the North Water Polynya, which is an area of

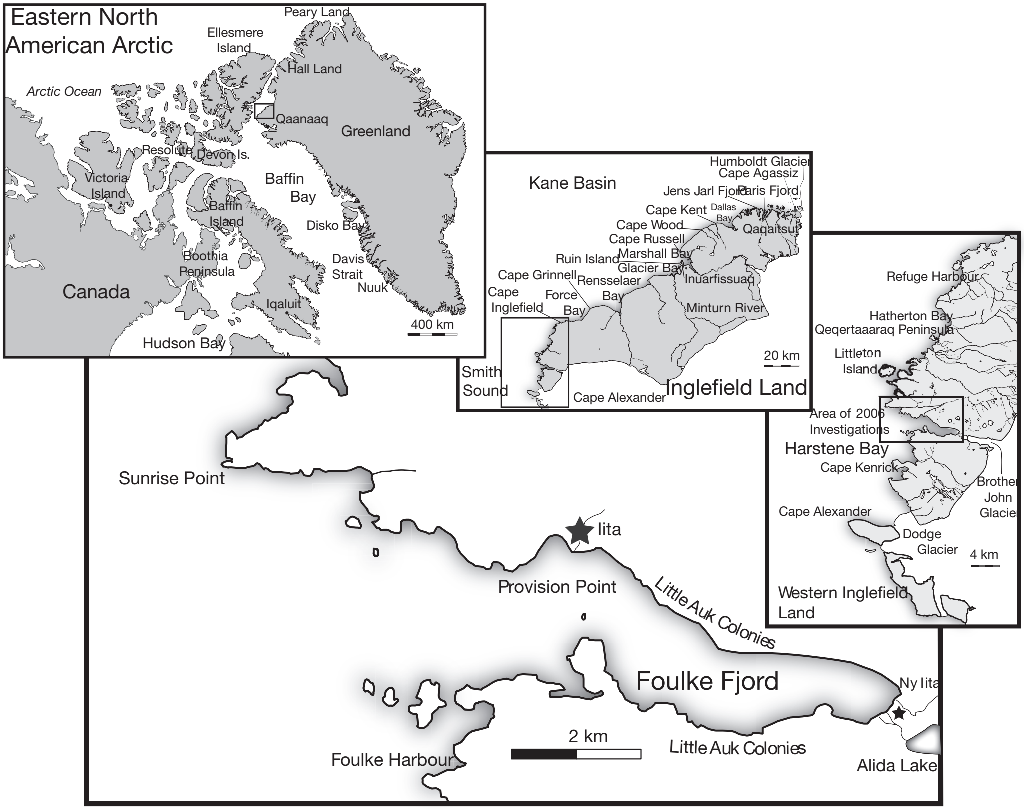

Fig. 1. — Map of Northwest Greenland showing overview of site location (map by John Darwent).

permanently open water created by variation in ocean currents. It is associated with a wealth of marine life which is a major factor for human settlement (Schledermann 1980; Stirling 1980). Walrus and seals (mostly ringed) are able to stay in this area year round due to the polynya. Narwhals are frequent visitors during the summer months. Terrestrial mammals most commonly identified in this area include caribou, muskox, hare and fox. In addition, an estimated 15 million pairs of dovekie breed along the west coast of Greenland (Egevang *et al.* 2003). They fertilize the tundra with literally tons of excreta around their colony. The guano contains ammonia and soluble mineral salts that are valuable for plant growth such as moss, lichen and grasses (Stempniewitcz 1990). These plants contribute to increased species diversity as they attract herbivores, scavengers, and predators creating a viable ecosystem for human subsistence.

The site of Iita is located on an alluvial fan on the north side of Foulke Fjord and is characterized by a known historic Inughuit occupation as well as the remains of MacMillan's 1913-1917 Crocker Land Expedition lodge. During six weeks of field work in 2006, as part of a joint University of California, Davis and Bowdoin College research project, the whole site was mapped and two winter houses and associated middens were excavated (LeMoine & Darwent 2010). These two houses were selected for excavation based on a number of factors including photographic evidence that they had already been abandoned by 1913, their relatively good preservation, and their proximity to an actively eroding bank that forms the edge of the site (LeMoine & Darwent 2010). The site was densely occupied for a significant period of time; the surface is littered with relatively recent artifacts, many associated with the Crocker Land Expedition occupation, and with at least 181 archaeological features including Thule and historic-period winter houses, tent rings, burials, caches, and snare lines (LeMoine & Darwent 2010). Based on a combination of C14 dates, artifact styles, and stratigraphy, four discrete cultural periods were indentified at the site. Each house is represented by an early and late component constituting two pre-contact (early and late) and two post-contact (early and late) assemblages useful for investigating changes in subsistence practices through time.

THE INUGHUIT

Ethnographic material pertaining to Inughuit culture is plentiful both in terms of writings and objects that have been compiled and collected over nearly two hundred years from the first encounter at Kap York in 1818 by John Ross (1819) until the present day. The early writings authored by people such as Elisha Kent Kane (1856), Evin Astrup (1895), Robert E. Peary (1898), Knud Rasmussen (1915,1921) and Steensby (1910, 1917) offer significant insight into everyday life detailing hunting implements and techniques, clothing styles, and types of dwellings. The Inughuit are the last cultural group to occupy the site of Iita and ethnographic records place them here as late as the 1920s (e.g., Rasmussen 1921). They are the descendents of the Thule and are differentiated from the Thule by a lack of systematic hunting of large whales. The abundance of baleen and whale bone utilization typically seen in Thule occupations is no longer present with the Inughuit. Ethnographic accounts (e.g., Holtved 1967; Rasmussen 1921) emphasize the reliance on seal and walrus harpoon hunting by the Inughuit, but interestingly most of these accounts also discuss the inclusion and importance of dovekies in their diet. However, this addition is often interpreted as a result of loss of important hunting technology such as the bow and arrow, the kayak, and fishing spears (Astrup 1895; Peary 1898; Rasmussen 1921).

CONTACT AND LOSS OF TECHNOLOGY

The Smith Sound region long served as the primary locus of contact between European and American explorers and Inughuit, but also between Baffin Island Inuit and Inughuit (Oswalt 1979). John Ross, a British whaling captain, was the first westerner to encounter the Inughuit near Kap York in 1818, and he noted that they were lacking many of the technological implements he had seen in southern Greenland such as kayaks, bow and arrow, and fishing leisters (Ross 1819). Isaac Israel Hayes, who had functioned as the ship physician on Kane's expedition, returned to Smith Sound in 1860 to undertake his own Arctic explorations (Hayes 1867). Hayes and his crew spent the winter of 1860-61 at Iita, further building on the relationship and dependence between Inughuit and Euro-Americans (Steensby 1910). Like Ross and Kane, Hayes also noted the lack of technology among the Inughuit, especially the absence of the bow and arrow, which meant that people could not readily hunt caribou (Steensby 1910). This illustrates with certainty an absence of these important hunting technologies in the period between 1818 and 1861, though it is still not known when the technology was given up or lost. However, shortly after Hayes' (1867) visit with the Inughuit the kayak, bow and arrow and fishing spear were back in use as a result of contact with a migrating group of about 14 Inuit from Baffin Island, which is believed to have happened around 1862 (Birket-Smith 1918; Gilberg 1994; Holtved 1967; Mary-Rousselière 1991; Rasmussen *et al.* 1918; Steensby 1910; Thomsen 1912). Further outside influences came in the late 1800s with the polar expeditions led by Robert E. Peary (1898), who hired local hunters from Iita to assist him in his quest for the North Pole, and the 1909 opening of the Thule Trading Station by Knud Rasmussen. Most of the ethnographic literature relating to the Inughuit includes some discussion of the loss of technology along with theories as to why it had been forgotten (Astrup 1895; Birket-Smith 1918, 1919-20; Ekblaw 1919; Freuchen & Salomonsen 1958; Gilberg 1994; Holtved 1967; Mary-Rousselière 1991; Oswalt 1979; Petersen

1962; Rasmussen 1921, 1935; Steensby 1910, 1917; Thomsen 1912; Ulloriaq 1985).

DOVEKIE AT IITA

Ethnographic information plays a significant role in reconstructing at least the more recent occupation at Iita and indicates that the Inughuit relied on dovekie for winter storage as well as for their skins to create inner shirts to keep warm. Early ethnographic writings from the late 1800s and early 1900s discuss the importance of the dovekies in Inughuit subsistence and more recent ethnographies agree with this observation. These accounts indicate that the Inughuit relied more on the birds when they lacked technology to capture large game during the summer months, but recent work (e.g. Gilberg 1994) shows that they kept catching them after hunting technology was reintroduced. I propose that dovekie continued to be a valuable contribution to Inughuit subsistence most likely as a result of mass capturing technology, their great numbers, and their reliability.

DOVEKIE BIOLOGY AND DISTRIBUTION

The dovekie, which measure about 18-25 cm in length and weigh about 150 g (Roby *et al.* 1981; Vibe 1981), arrive at their breeding colonies in the Thule District in early May, and egg laying begins in the second half of June, continuing until early July (Evans 1981; Gaston & Jones 1998; Harris & Birkhead 1985; Vibe 1981). Breeding occurs in colonies ranging from about 1000 to several million pairs; the Thule District population is estimated at 30 million birds or 15 million breeding pairs (Boertmann & Mosbech 1998; Brown 1985; Ekblaw 1919). These colonies account for nearly half the world's population of dovekies estimated at 33 million pairs (Egevang *et al.* 2003; Kamp *et al.* 2000). They usually place their nests among eroded crevices of cliff faces and areas of extensive boulder screes and talus with a density of 0.3-1.0 nest/m2 (Boertmann & Mosbech 1998; Egevang *et al.* 2003; Evans 1981). Only one egg is laid per breeding pair (Evans 1981; Gaston & Jones 1998). At the colony at Horse Head, Upernavik, West Greenland, the breeding success of twenty dovekie nests was observed: out of 20 eggs, 65% hatched and of those 77% made it through fledging resulting in an overall breeding success of 50% (Evans 1981:10). The mean age for dovekies at first breeding is around four years (Gaston & Jones 1998; Vibe 1981), and therefore there are larger dispersed groups of non-breeders occupying areas outside the breeding colonies; most of these individuals will not enter the breeding grounds until they have reached reproductive maturity. This behavior helps maintain a more or less stable population, as it allows for population recovery, though potentially slow, should something happen to the breeding colony (Gaston & Jones 1998). The birds abandon the colonies in August, once moulting is complete, and migrate westward to their wintering grounds, the Grand Banks, located off the southeastern coast of Newfoundland (Evans 1981; Boertmann & Mosbeck 1998).

HUNTING TECHNIQUE AND UTILITY

The ability to catch the dovekies came in the form of a "ketcher", a net attached to the end of a long pole (Freethy 1987; Freuchen 1921-22, 1961; Holtved 1967; Vaughan 1991). The nets were made by knitting together light strings of sealskin and the poles appear to have been manufactured either from narwhal tusk or many small pieces of dry willow branches straightened out and lashed together (Freuchen & Salomonsen 1958; Holtved 1967; Vaughan 1991). This technique of bird netting has also been noted among Bering Sea Inupiat, Icelanders and Faeroese to catch puffins (Gaston & Jones 1998). Not all early explorers found dovekies to be worth catching, but their method of shooting at the birds with double-barreled shotguns may have significantly reduced their success rate: "Four men armed with double-barreled guns killed only 150 birds in an hour" (Belcher 1855: 70; Vaughan 1991). A net seems a better option.

Vaughan (1991) notes that the Inughuit would use the hollows between boulders as catching stations, while Freuchen & Salomonsen (1958) mentions the necessity of constructing a small wall to hide behind to capture the birds. One netting event usually resulted in the capture of seven to ten birds, which were killed at once either by pressing on the breastbone to stop the heart or by crushing the head between their teeth (Freuchen & Salomonsen 1958; Holtved 1967; Vaughan 1991).

SUMMER SUBSISTENCE

As Steensby (1910) writes, the loss of the kayak resulted in a sole reliance on ice hunting, and therefore it became necessary to re-locate to areas with bird colonies when the ice was gone (July and August). This also meant that the Inughuit were bound to a more or less sedentary lifestyle during the summer months and the successful maintenance of such living conditions were to a great extent based on the presence of the dovekies (Ekblaw 1919; Rasmussen 1921; Steensby 1910; Vaughan 1991). The reliance on dovekies as a key food source during the summer months was possible due to their large quantities and it therefore made good economic sense for the Inughuit to spend the summer near the bird cliffs (Astrup 1895; Ekblaw 1919; Steensby 1910; Vaughan 1991). Kane (1856:360) observed the capturing of dovekies at Iita first hand equating the ease and cost of capture of the birds with that of the time and energy it takes a cook to gather vegetables; an individual could literally approach the colony (the garden) and easily gather enough birds within a few minutes to make a meal.

Due to their lack of boating technology it was important for the Inughuit to reach the bird colonies by dog sledge before the ice melted to take advantage of the few places offering food reserves in the form of birds, such as at Iita, Thule, and Kap York (Ekblaw 1919; Freuchen & Salomonsen 1958; Steensby 1917; Rasmussen 1921; Vaughan 1991). Walrus and seals could only be hunted from the ice foot, a much less successful technique and the dovekies therefore offered a generous alternative during the summer. The dovekie colonies are situated less than a 1 km from Iita. Enough birds were caught and cached to also serve as an important winter store. Before the reintroduction of the kayak and bow and arrow, birds such as dovekies and guillemots, were the focus of the winter caches (Rasmussen 1921).

IMPORTANCE OF WINTER STORAGE

As a direct result of the uncertainty associated with hunting large game during the summer months, Rasmussen (1921) also noted the importance that dovekies played in terms of winter storage. Dovekies were caught in such great quantities that they lasted through most of the winter (Rasmussen1935). The presence of dovekies in both winter houses at Iita demonstrates that Thule and Inughuit did store these birds and that they utilized them off season. Autumn would have been a particularly difficult time for the Inughuit in terms of availability of food with the bird colonies abandoned and the sea ice still out; cached dovekies therefore offered important sustenance until seal hunting could be resumed. The Inughuit would often cache the dovekies under stones right as they were caught and killed, marking these caches so they could be located later in the winter months when it was time to utilize their contents (Ekblaw 1919; Freuchen & Salomonsen 1958; Holtved 1967; Vaughan 1991). A common method of procuring the birds involved stuffing hundreds, as many as 700-800, dovekies inside sealskins with the blubber still adhering to it and then storing them this way for several months in a stone cache (Freuchen & Salomonsen 1958; Holtved 1967; Vaughan 1991). The fermented result known as kiviaq was and is considered a delicacy among the Inughuit. It would take a practiced bird catcher about two days to fill a sealskin (Freuchen 1961). The utilization of the bird caches would have been most prominent during the times when the ice was out: fall, early winter, and late in the spring.

FAUNAL ASSEMBLAGE

A total of 25,325 bones were recovered from the four temporal components identified at Iita in 2006. Of these, 22,421 bones were identified to genus and/or species, 1189 were identified to higher-taxonomic categories, and 833 were classified as unidentified (these are not included in the analysis) (Table 1). Each specimen (a bone or tooth or fragment thereof) was identified to species when possible and to higher taxonomic categories when not (following Grayson 1984; Lyman 1994), based on size, shape, and texture. Five such categories were utilized, including large terrestrial mammal (polar bear, musk-ox, caribou, dog), small terrestrial mammal (hare and fox), marine mammal (seals, walrus, whale), mammal (not bird or fish), and bird (shaft fragments). Each specimen was identified to element (an anatomically complete bone or tooth) and portion (specified portion of an anatomically discrete skeletal element) (following Grayson 1984; Lyman 1994, 2008) using the University of California, Davis comparative collection along with two musk-ox skeletons borrowed from the California Academy of Sciences, San Francisco, and several northern bird species obtained from Britain (e.g., dovekie and Brünnich's guillemot). Each house was excavated in 10 cm arbitrary levels and all materials were collected in 50 cm quadrants and dry screened through a 6.35mm mesh. The faunal remains were all collected in bulk along with metal debris, broken glass, wood, and lithic debitage. A total of 18.5 m^2 was excavated in House 1, 6.5 m^2 inside the living area, 2 m^2 inside the entrance tunnel, and 10m^2 outside the house in an associated midden. A total of 14 m^2 was excavated in House 2, 8 m^2 inside the living area, 3 m^2 inside the entrance tunnel, and 3m^2 outside the house in associated midden (LeMoine & Darwent 2010). High concentrations of permafrost contributed to the well preserved nature of most of the excavated materials at Iita such as wood, fur, baleen, and feathers. Many of the bones still had tissue and skins attached; this was especially noticeable among the dovekie remains, some of which were intact birds preserved with feathers and skin. The overall preservation of the assemblage was excellent, with limited weathering and root etching.

Aggregation

Through a combination of C14 dates, artifact styles, and stratigraphy, five discrete cultural periods were indentified within the two sod houses (House 1 and House 2) excavated at Iita: early Thule, ca. AD 1400-1500 (Period A); middle Thule, ca. mid-1600s (Period B); early historic, ca. mid-late 1800s primarily, although some materials could be from the early 1800s (Period C), late historic, ca. 1900-1910 (Period D), and the Crockerland expedition from 1913-1917. The focus of this study is on the Thule-Inughuit occupation (Periods A-D). Period A is represented by an early Thule house buried under House 1's midden, Period B is a middle Thule occupation of House 2, Period C is an early historic Inughuit occupation of House 2's house and midden in front of the house, and Period D is a late historic Inughuit occupation of House 1's house and midden in front of the house.

Dovekie

Of the 25,325 bones identified to species 17,287 were identified as dovekie (Table 1). No cut-marks or indications of burning were identified on the dovekie remains. When small game are included in the diet we should expect to see a large quantity of small bones in the faunal remains since it takes more small bodies to fill an individual as opposed to larger sized game. This might answer part of the question as to why dovekies are so numerous in the Iita assemblage. However, it also illustrates their importance as a food resource in the Inughuit diet. It is interesting to note that hare, which is also considered small game, represents the second most abundant group of animals in two of the temporal components. Again, this indicates that small game played a significant role in the Thule-Inughuit subsistence strategy. These results could suggest that there was a shortage of large game at Iita and therefore a decline in foraging efficiency or that small game could provide sufficiently high energetic returns that they were a high ranked resource.

DISCUSSION

Starvation food or high ranked resource?

Body size is a primary proxy for resource ranking in the diet breadth model of optimal foraging and there has been a tendency to equate the smaller bodied animals in archaeological contexts as evidence

Table 1. — Number of Identified Specimens (NISP) across the five temporal components identified at Iita, Northwest Greenland.

	Period A Early Thule (ca. AD 1400-1500)		**Period B Middle Thule** (ca. mid-17th cen.)		**Period C Early Historic Inughuit** (mid-late 19th cen.)		**Period D Late Historic Inughuit** (early 20th cen.)		**Crocker Land Expedition** (1913-17)		**Total Iita Assemblage** (ca. AD 1400-1917)	
	NISP	**%**	**NISP**	**%**	**NISP**	**%**	**NISP**	**%**	**NISP**	**%**	**NISP**	**%**
FISH												
Fish indet.	1	0.05	—	—	4	0.04	1	0.01	1	0.06	7	0.03
Total fish	**1**	**0.05**	**—**	**—**	**4**	**0.04**	**1**	**0.01**	**1**	**0.06**	**7**	**0.03**
BIRDS												
Fulmar	—	—	—	—	—	—	2	0.3	—	—	2	<0.1
Snow goose	4	0.21	9	0.52	55	0.51	31	0.39	15	0.87	114	0.47
Duck/goose	2	0.11	18	1.04	78	0.72	29	0.37	33	1.92	160	0.66
Gull	1	0.05	4	0.23	48	0.44	10	0.13	—	—	63	0.26
Brünnich's guillemot	4	0.21	—	—	3	0.03	1	0.01	—	—	8	0.03
Dovekie	563	29.80	1502	87.17	9218	0.85	4907	61.93	1097	63.97	17287	71.62
Bird indet.	3	0.16	13	0.75	136	1.3	35	0.44	30	1.75	217	0.9
Total bird	**577**	**30.70**	**1546**	**89.73**	**9538**	**87.61**	**5015**	**63.29**	**1175**	**68.5**	**17,851**	**73.96**
MAMMALS												
Arctic hare	288	15.26	88	5.11	389	3.57	732	25.17	96	5.6	1593	6.6
Arctic fox	127	6.73	13	0.75	274	2.52	359	4.53	46	2.68	819	3.39
Dog	42	2.23	5	0.29	39	0.36	324	4.09	28	1.63	438	1.81
Polar bear	1	0.05	—	—	2	0.02	3	0.38	2	0.12	8	0.03
Ringed seal	629	33.50	26	1.51	300	2.76	758	9.57	142	8.28	1855	7.69
Bearded seal	63	3.34	11	0.64	22	0.2	90	1.14	32	1.87	218	0.9
Walrus	53	2.81	13	0.75	141	1.3	242	3.05	117	6.82	566	2.35
Pinnipedia	55	2.91	9	0.52	68	0.62	225	2.84	52	3.03	409	1.69
Caribou	31	1.64	12	0.70	89	0.82	140	1.77	15	0.87	287	1.19
Musk-ox	7	0.37	—	—	14	0.13	17	0.21	8	0.47	46	0.19
Artiodactyl	3	0.16	—	—	2	0.02	7	0.09	1	0.06	13	0.05
Narwhal	—	—	—	—	1	<0.01	1	0.01	—	—	2	<0.01
Bowhead whale	1	0.15	—	—	—	—	—	—	—	—	1	<0.01
Whale indet.	9	0.48	—	—	4	0.04	10	0.13	—	—	23	0.1
Total mammal	**1309**	**69.74**	**177**	**10.27**	**1345**	**12.35**	**2908**	**36.7**	**539**	**31.42**	**6278**	**26.01**
Number of identified specimens	**1887**	**90.55**	**1723**	**97.84**	**10,887**	**97.61**	**7924**	**93.32**	**1715**	**93.46**	**24,136**	**95.31**
Richness (Ntaxa)	**16**		**10**		**16**		**17**		**13**		**18**	
UNIDENTIFIED SPECIMENS												
Small terrestrial mammal indet.	43		6		65		56		12		182	
Large terrestrial mammal indet.	13		2		34		86		8		143	
Marine mammal indet.	29		5		30		61		16		141	
Mammal indet.	112		25		138		364		84		723	
Total unidentified	**197**	**9.45**	**38**	**2.16**	**267**	**2.39**	**567**	**6.68**	**120**	**6.54**	**1189**	**4.69**
TOTAL VERTEBRATES	**2084**		**1761**		**11,154**		**8491**		**1835**		**25,325**	

of resource stress (Broughton 1994; Broughton *et al.* 2011; Hawkes *et al.* 1982). The ranking of resources is based on the number of calories a hunter expends in pursuit and processing of a resource and how many calories are gained (Bettinger 1991). The breadth of a forager's diet should therefore reflect the resources that offer the highest energetic returns for the time or energy spent in pursuit and processing. As a result, small game are frequently perceived as low ranked resources indicative of a decline in overall foraging efficiency. Due to its small size, a single dovekie does not provide many calories and would therefore typically be considered a low ranked resource – a starvation food used only during times of need. However, the dovekies' breeding habits combined with the Inughuit's use of mass capturing techniques may actually have increased its rank in the Inughuit diet. Understanding whether the inclusion of dovekies in the Inughuit diet at Iita is an indicator of resource depression due to loss of technology or is a result of the profitability of mass capturing, is significant to interpreting overall foraging efficiency among the Inughuit. The presence of dovekie in the Thule occupation at the site suggests a reliance on these birds even when lack of technology did not limit access to other food sources.

Back and Front loaded resources

Back-loaded resources are characterized by high overall handling time resulting from high processing cost associated with preparation for eating, but such foods may still be favored for caching if they are cheap to cache in bulk and if the probability the cache will be used is low (Bettinger 2009). This model deals with pairs of resources that contrast with each other because the former is cheap to acquire and store but costly to prepare for consumption and the latter is costly to acquire and store but easy to prepare for consumption (Bettinger 2009). Ethnographers discuss the importance of dovekies for winter storage among the Inughuit, indicating that the birds once captured were cached as a backup for shortfalls in hunting (e.g. Rasmussen 1921). These accounts also emphasize the heightened use of such storage during the absence of important hunting technologies like the bow and arrow and the kayak (e.g. Gilberg 1994; Rasmussen 1921). Therefore, during times when other resources were too scarce or time-consuming to procure and/or process, such caches would have played an important role in limiting starvation (Bettinger 2009). Dovekies would have been an especially easy resource to both acquire and store in bulk, and may therefore have acted as a back-loaded resource as defined in the front- and back-loaded resource model (e.g. Bettinger 2009), because 1) they appear to be cheap to acquire and store and 2) we can assume that processing for consumption may be high especially if the skins are being removed from each individual bird before they are consumed. If dovekies at Iita are a back-loaded resource then it would appear that the Inughuit were less successful in their pursuits of front-loaded resources such as seals and caribou and that they may well have been utilizing low-ranked or less efficient resources regularly. This may explain why they are present in the two winter houses excavated at Iita. However, it is possible that dovekie are higher ranked than expected if the high processing costs associated with back-loaded resources do not apply.

Eating dovekie

As discussed earlier the Inughuit's preferred method of caching the dovekie for later consumption was either to store them immediately under stone heaps as they were caught or to stuff them inside seal skin bags to make kiviaq. A single dovekie would not provide much sustenance, but the meat of twelve birds is equal to about one pound of meat, which is not a poor dietary option, especially when it is possible to catch as many as ten birds in one netting event (Vaughan 1991). The birds were prepared and eaten in different ways; freshly caught and boiled (though they were also commonly eaten raw soon after they were captured) or frozen or fermented after having been cached (Ekblaw 1919; Freuchen 1961; Freuchen & Salomonsen 1958; Kane 1856; Vaughan 1991). Freuchen (1961) explains in great detail the various ways the birds were consumed when they had been retrieved from a cache in their frozen state. The Inughuit would consume the frozen dovekies whole by chewing away at the icy bodies while spitting out bones and feathers (Freuchen 1961). Once thawed the Inughuit would brush off the feathers, and suck the skin free of fat before swallowing it whole. The breast would be eaten along with other easily obtainable meat, and the wings, back bone, and pelvis were all put in the mouth and chewed thoroughly (Freuchen 1961: 148-49). Table 2 & 3 illustrates the skeletal part

TABLE 2. — Skeletal part frequency of dovekie remains from early and middle Thule occupations at Iita. L = Left, R = Right, n = indeterminate. Note that the NISP values differ from Table 1 as long bone elements and unidentified bone elements were not included in the calculation of skeletal part frequencies.

	Early Thule (Period A)							Middle Thule (Period B)						
	NISP	L	R	n	MNE	MAU	%MAU	NISP	L	R	n	MNE	MAU	%MAU
Cranium (1)	7	—	—	—	4	4	10.2	115	—	—	—	48	48	62
Mandible (2)	6	1	1	1	2	1	2.6	74	16	17	20	33	27	35
Vertebrae (24)	1	—	—	—	1	0.04	0.11	16	—	—	—	16	0.7	0.9
Ribs (28)	6	—	—	—	2	0.07	0.18	116	—	—	—	48	1.7	2.2
Furculum (1)	14	4	7	2	11	11	28.2	68	29	15	21	44	47	60.3
Coracoid (2)	55	18	25	—	43	21.5	55	84	41	41	—	82	42	54
Scapula (2)	22	8	8	—	16	8	20.5	85	33	36	—	69	34.5	44.2
Sternum (1)	35	—	—	—	13	13	33.3	146	—	—	—	47	47	60.3
Humerus (2)	130	25	41	1	76	38	97.4	125	46	45	1	91	62	79.5
Radius (2)	16	6	5	1	11	5.5	14.1	66	32	33	—	65	33	42
Ulna (2)	105	44	34	1	78	39	100	100	45	43	2	88	49	63
Carpometac. (2)	21	11	10	—	21	10.5	27	66	34	30	—	64	33	42.3
Carpals (4)	—	—	—	—	—	—	—	3	—	—	—	3	0.8	1
Phalanges (16)	—	—	—	—	—	—	—	56	—	—	—	53	3.3	4.2
Synsacrum (1)	1	—	—	—	1	1	2.6	16	—	—	—	14	14	18
Synsacrum + pelvis (1)	—	—	—	—	—	—	—	7	1	3	3	4	4	5.1
Pelvis (2)	4	3	1	—	4	2	5.1	35	15	10	—	25	17.5	22.4
Femur (2)	4	2	1	—	3	1.5	3.8	12	4	5	—	9	6	7.7
Tibiotarsus (2)	85	26	35	1	61	30.5	78.2	173	80	76	—	156	78	100
Tarsometat. (2)	10	3	3	—	6	3	7.7	81	40	40	—	80	40.5	52
Total	522	151	171	7	353			1444	416	394	47	1039		

representation of dovekie across the four temporal components at the site demonstrating that the back bone (synsacrum), and pelvis are relatively less frequent across all components. Also, no cut-marks or burning were recorded on any of the remains. This indicates a relatively low processing cost involved in the procurement of these birds and yet another reason to include them in the diet even when larger prey became more easily obtainable. Table 4 lists the number of indentified specimens and the minimum number of individuals accounted for in the four temporal components identified in the Iita assemblage. These numbers indicate that dovekie contributed significantly to both the Inughuit and the middle Thule diet, and even the most recent component demonstrates that these birds were still part of the Inughuit subsistence strategy after the reintroduction of the lost hunting technology.

Mass Capturing

Much of the archaeological literature dealing with optimal foraging theory asserts that faunal assemblages dominated by larger-sized animals represent a higher level of foraging efficiency compared to assemblages dominated by smaller-sized animals (e.g.Broughton 1994, 1999, 2002; Broughton & Bayham 2003; Broughton *et al.* 2011). Normally, individual dovekies would not be a high-ranked resource, but this interpretation changes when the biomass of prey caught simultaneously is considered as the comparative unit (Jones 2006; Madsen & Schmitt 1998). This means that the total body weight of dovekies netted in a single netting episode (usually 8-10) should be considered the comparative unit when investigating foraging efficiency at Iita. If mass collecting is involved, the faunal assemblages dominated by smaller animals such as birds may indicate more efficient foraging. Abundance, proximity, and mass capturing technology may have produced return rates that would have exceeded those from hunting large mammals, especially when considering the associated search, transport, and processing costs. However, small game captured en mass usually lose their return value once captured as cost becomes independent of the number captured. This is because each

Table 3. — Skeletal part frequency of dovekie remains from early and late historic occupations at Iita. Note that the NISP values differ from Table 1 as long bone elements and unidentified bone elements were not included in the calculation of skeletal part frequencies.

	Early Historic (Period C)							Late Historic (Period D)						
	NISP	L	R	n	MNE	MAU	% MAU	NISP	L	R	n	MNE	MAU	% MAU
Cranium (1)	338	—	—	—	140	140	36.5	103	—	—	—	44	44	16.4
Mandible (2)	323	47	50	16	97	48.5	12.7	160	34	43	16	77	38.5	14.4
Vertebrae (24)	42	—	—	—	42	2.5	0.7	4	—	—	—	4	—	0.01
Ribs (28)	494	—	—	—	213	7.6	2	184	—	—	—	87	3.1	1.2
Furculum (1)	406	145	148	33	293	293	76.5	166	66	63	22	129	129	48.2
Coracoid (2)	619	276	269	—	545	272.5	71.1	387	164	175	1	339	169.5	63.4
Scapula (2)	530	196	215	2	411	205.5	54	228	92	89	1	181	90.5	34
Sternum (1)	1071	—	—	—	172	172	45	494	—	—	—	98	98	37
Humerus (2)	1114	367	381	7	748	374	98	869	262	273	2	535	267.5	100
Radius (2)	514	235	227	3	462	231	60.3	183	85	68	1	153	76.5	29
Ulna (2)	854	326	401	5	727	363.5	95	628	217	235	1	452	226	84.5
Carpometac. (2)	511	224	259	1	483	241.5	63	148	67	66	—	133	66.5	25
Carpals (4)	24	—	—	—	24	6	1.6	2	—	—	—	2	0.5	0.2
Phalanges (16)	182	—	—	—	178	11	2.9	31	—	—	—	29	1.8	0.7
Synsacrum (1)	77	—	—	—	53	53	13.9	34	—	—	—	34	34	13
Synsac. pelvis (1)	32	9	9	3	18	18	4.7	10	3	4	3	7	7	2.6
Pelvis (2)	195	74	58	16	132	66	17.2	68	19	28	4	47	23.5	8.8
Femur (2)	59	21	28	—	49	24.5	6.4	68	29	25	1	54	27	10
Tibiotarsus (2)	916	382	384	8	766	383	100	472	181	163	9	344	172	64.2
Tarsometat. (2)	360	174	158	1	332	166	43.3	137	64	61		125	62.5	23.4
Total	8661	2476	2587	95	5885			4376	416	1293	61	2874		

Table 4. — The number of identified specimens and the minimum number of individual dovekie versus all other fauna identified across the four temporal periods at Iita.

		Early Thule (A)	Middle Thule (B)	Early Historic (C)	Late Historic (D)
Dovekie	NISP	563 (29.8%)	1502 (87.2%)	9218 (84.7%)	4907 (61.9%)
Other	NISP	1324 (70.2%)	221 (12.8%)	1669 (15.3%)	3017 (38.1%)
Dovekie	MNI	44 (50.0%)	80 (83.3%)	401 (88.5%)	42 (35.9%)
Other	MNI	44 (50.0%)	16 (16.7%)	52 (11.5%)	75 (63.1%)

animal generally has to be processed individually, and such processing tends to be a large portion of overall handling (Ugan 2005: 83). Still, there are examples of small mass captured resource with low handling time, such as certain fish and invertebrates (Ugan 2005). I argue that the dovekies at Iita likewise required little processing once captured and therefore maintained their value once caught.

When mass capturing is efficient

The circumstances and the technology associated with collecting resources en mass can make some small prey more profitable than would be predicted by body size (Bird *et al.* 2009; Jones 2006; Lupo 2007; Madsen and Schmitt 1998). The proximity of the dovekie breeding colony to the site at Iita means that there is no search cost associated with the encounter of these animals. Other factors to consider include their abundance and reliability. This combined with mass capturing technology may have made the dovekie a valuable resource. Ethnographic sources suggest that these birds were cached whole and eaten whole in their frozen state (e.g. Freuchen 1961; Kane 1856). Such practices would eliminate the high processing costs otherwise associated with small game, thereby increasing the dovekies' overall return rates. The question that remains is if the overall cost associated with consumption is low enough that these birds should always be included in the diet of the Thule and Inughuit, or if their presence is the result of low encounter rates of higher ranked prey and that the reliance on dovekies is a sign of reduced foraging efficiency.

FUTURE RESEARCH

To test these two hypotheses it is necessary to collect observational data on actual return rates in terms of pursuit, capture, and processing. Reliable techniques to both collect and quantify such data have been generated through numerous human behavioral ecology studies of indigenous populations (Bird & Bliege Bird 2000; Bird *et al.* 2009; Hawkes *et al.* 1982; Winterhalder 1981). Present day dovekie hunts in the village of Siorapaluk located about 50 km from Iita would serve as a means to generate the appropriate data to measure the efficiency of dovekie mass capturing and processing. Such work would entail timing an individual hunter's search, pursuit and processing of a net of dovekies, and weighing the prey before and after processing and consumption (Bird *et al.* 2009; Brand Miller *et al.* 1993). It would be useful to collect similar observational data on pursuit and processing of terrestrial and sea mammal prey species among present day Inughuit. Such information will be significant in attempting to understand the role of dovekies in the diet of the Inughuit.

CONCLUSION

Though small, the dovekies at Iita play an important role in creating and maintaining a viable ecosystem in which humans and other animals can successfully subsist. The use of mass capturing techniques and possible low processing costs raises interesting questions about how small game in the archaeological record should be interpreted in terms of rank and foraging efficiency. The answers might show that utilization of smaller resources is not necessarily evidence of starvation. I suggest we look closer at small game in archaeological contexts. Their presence in a faunal assemblage should not automatically be interpreted as a sign of decline in foraging efficiency. Rather, it would be unwise not to exploit smaller meat packages when the setting is right, as may have been the case at Iita.

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