Inuit Knowledge of beluga whale (*Delphinapterus leucas*) foraging ecology in Nunavik (Arctic Quebec), Canada

K. Breton-Honeyman, M.O. Hammill, C.M. Furgal, and B. Hickie

**Abstract:** The beluga whale (*Delphinapterus leucas* (Pallas, 1776)) is expected to be influenced by changes in the environment. In Nunavik, the Arctic region of Quebec, Nunavimmiut (Inuit of Nunavik) have depended on beluga for centuries, developing an extensive understanding of the species and its ecology. Forty semidirective interviews were conducted with Inuit hunters and Elders from four Nunavik communities, who had a range of 28–47 years of beluga hunting experience. Interviews followed an ethnocartographic format and were analyzed using a mixed methods approach. Hunters most commonly reported prey species from the sculpin (Cottidae), cod (Gadidae), salmon (Salmonidae), and crustacean families; regional variations in prey and in foraging habitat were found. Hunters identified significant changes in body condition (i.e., blubber thickness), which were associated with observations about the seasonality of feeding. The timing of fat accumulation in the late fall and winter coupled with the understanding that Hudson Bay is not known as a productive area suggest alternate hypotheses to feeding for the seasonal movements exhibited by these whales. Inuit Knowledge of beluga foraging ecology presented here provides information on diet composition and seasonality of energy intake of the beluga and can be an important component of monitoring diet composition for this species into the future. An Inuittituut version of the abstract is available (Appendix A).

**Key words:** beluga whales, *Delphinapterus leucas*, Inuit Knowledge, Arctic, feeding ecology.

**Résumé :** Il est prévu que le béluga (*Delphinapterus leucas* (Pallas, 1776)) sera influencé par des changements dans l’environnement. Au Nunavik, la région arctique du Québec, les Nunavimmiut (Inuits du Nunavik) dépendent sur les bélugas depuis des siècles et ont développé une connaissance approfondi de l’espèce et de son écologie. Quarante chasseurs et Ainés Inuits, parvenant de quatre communautés du Nunavik et ayant entre 28–47 ans d’expérience avec la chasse au béluga, ont participé à des entrevues semi-structurées. Les entrevues ont suivi un format ethnocartographique et les résultats soumis à une analyse d’approche méthodes mixtes. Les espèces de proie du béluga identifiées les plus fréquemment par les chasseurs appartiennent aux familles du chabot (Cottidae), de la morue (Gadidae), du saumon (Salmonidae), et des crustacés; des variations régionales dans les espèces de proie et les habitats fréquentés relativement à la quête de nourriture ont été identifiées. Les chasseurs ont aussi identifié des changements importants dans l’état corporel (ex : l’épaisseur de la couche de graisse), qui étaient associés à leurs observations du cycle saisonnier d’alimentation. Le cycle d’accumulation de graisse à la fin de l’automne et à l’hiver, combinée avec la compréhension que la Baie d’Hudson n’est pas connue comme une région productive, suggère l’existence d’hypothèses alternatives à celle de la quête de nourriture pour expliquer les mouvements saisonniers de ces baleines. Les connaissances Inuites de l’écologie alimentaire du béluga que nous présentons fournissent de l’information sur la composition du régime alimentaire et de l’apport énergétique saisonnier du béluga, et peuvent contribuer un élément important pour la surveillance du régime alimentaire de cette espèce présentement, et dans le futur. Une version inuittituut du résumé est disponible (appendice A).

**Mots-clés :** béluga, *Delphinapterus leucas*, connaissances Inuites, arctique, écologie de nourriture.

**Introduction**

Understanding foraging ecology improves understanding of trophic structure, relationships among species, and knowledge of how species may be affected by environmental and ecosystem change. In the Arctic, changes in the environment are altering food webs, with evidence of dietary shifts in seabirds (Gaston et al. 2003) and pinnipeds (Chambellant et al. 2013; Crawford et al. 2015). These changes increase the urgency of gathering data on foraging ecology to monitor changes or shifts over time, although the opportunity for baseline data has likely already passed (Laidre et al. 2008).

Studying foraging ecology of Arctic cetaceans is inherently challenging given their remote ice-covered environment, the limited time that they spend at the surface, their migratory nature, and the cost of research under these conditions. As a result, Arctic wildlife research has generally focused on relatively few locations in the spring and summer seasons (e.g., aerial surveys: Asselin et al. 2012) (Gagnon and Berteaux 2009).

Beluga whales (*Delphinapterus leucas* (Pallas, 1776)) are mediumsized odontocetes occupying a central role in the Arctic ecosystem. They have a circumpolar distribution and are often associated...
with seasonally ice-covered waters, but are known to travel through areas of heavy ice cover (Suydam et al. 2001). The absence of a dorsal fin is thought to be an adaptation to ice-covered waters (Harington 2008).

Climate change forecasts predict that ice cover in the Arctic will decline, with some areas formerly covered by the multyear ice pack becoming seasonally ice-free (Stroeve et al. 2012). This provides an opportunity for Arctic species, whose distribution is limited by ice, to expand their ranges, while more temperate species are also expected to expand their ranges northwards (Laidre et al. 2008). Monitoring changes in distribution and foraging ecology among apex predators is one approach to monitoring climate change impacts on the marine ecosystem (e.g., range expansion in northern reaches of species distribution and changes in diet). Beluga are often considered generalist feeders, with regional variations in diet (Loseto et al. 2009; Bailleul et al. 2012; Quakenbush et al. 2015), which may confer diet plasticity allowing them to adapt to these changes. Owing to their wide distribution, and how well beluga are known, this species would appear to be an excellent model to understand the impacts of climate change, because one would expect that ecosystem changes might be reflected in changes in diet as more southerly prey species move north.

Despite the extensive distribution of beluga, and the long history of research on this species, there have been few studies on beluga diet in Canada (e.g., Vladykov 1946; Doan and Douglas 1953; Loseto et al. 2009; Kelley et al. 2010; Marcoux et al. 2012) and elsewhere (Kleinenberg et al. 1964; Tomlin 1967; Seaman et al. 1982; Heide-Jorgensen and Teilmann 1994; Quakenbush et al. 2015). Stomach content analyses, largely from harvested whales, provided some of the earliest, and most recent, evidence of prey species (Vladykov 1946; Sergeant 1962, 1973; Quakenbush et al. 2015). Molecular methods such as fatty acids, stable isotopes, and trace elements have provided indirect evidence for diet, trophic level, habitat use and location, as well as how diet differs by beluga size, sex, and reproductive status (Loseto et al. 2008a, 2008b, 2009; Thiemann et al. 2008; Marcoux et al. 2012). Satellite-linked tagging studies have also increased our understanding of feeding behaviour. Dive profiles from tagged beluga have provided data regarding target depth, feeding behaviour, and likely prey choice (Richard et al. 1998, 2001a; Kingsley et al. 2001; Bailleul et al. 2012; Citta et al. 2013; Hauser et al. 2015).

Nunavimmiut (Inuit of Nunavik) have developed an extensive understanding of the beluga whale and its ecosystem based on a long dependence on beluga for their cultural, health, and economic well-being that continues today (Van Oostdam et al. 2005). Inuit adults in Nunavik participate in harvesting traditional or country foods, the greatest percentage (81%) of all regions in the Canadian Arctic, with beluga being the most frequently consumed species of marine mammal (Blanchet and Rochester 2008; ITK 2008). Beluga inhabiting Nunavik coastal waters come from several different stocks, some of which are considered endangered (Turgeon et al. 2012).

In the past, Inuit Knowledge (IK) has been considered anecdotal (Krupnik 2009), or used as the basis for a hypothesis generation for further scientific inquiry (e.g., Smith and Stirling 1975), and not recognized as a legitimate source of data and knowledge (Simpson 2004). For beluga whales, however, IK has contributed greatly to our understanding of foraging ecology, including seasonal variability, diet, and interactions among species (Kilabuk 1998; Huntington et al. 1999; Myrm in et al. 1999; Huntington 2000; Dods ge et al. 2002), and it is clear that IK has great potential to further increase our understanding of the foraging ecology of these animals.

In this paper, we present results from interviews with Inuit hunters and Elders regarding the foraging ecology of beluga whales in northern Quebec (Nunavik) Canada. Our purpose was to document knowledge of diet composition and seasonal changes in body condition of beluga whales from interviews to augment existing data. Given the significant challenges of working in the North, such collaborations could be used to develop a long-term program to monitor changes in composition of prey species and the effects of those changes as climate warming occurs.

**Materials and methods**

Semidirective interviews (Huntington 1998) were conducted with expert beluga whale hunters and Elders in the Nunavik communities of Kangiqsualujuaq, Quaqtaq, Ijuvik, and Kuujjuaq (Fig. 1) in 2009 and 2010. These Inuit communities range in population from 315–1517 and were selected because of their long history of beluga harvesting and to ensure a broad geographic coverage. In each community, a purposeful sampling strategy (Creswell 2009) was used, selecting key interviewees with beluga hunting and ecology expertise in particular. “Expert” was defined by the number of times and years in which a hunter hunted and recognition by community members as an expert or knowledge holder (Davis and Wagner 2003). The structure for the interview was based on seasonal cycles starting with questions related to the ecology of the species from the time when beluga are first seen in the year (e.g., spring migration). Throughout the interviews, questions were focused around migration and important habitat areas for different life-history traits. Topics included, but were not limited to, migration, body condition, foraging ecology, predation, breeding, calving, and behaviour. Particular attention was also given to how any of these aspects have changed according to each participant’s frame of reference. The results presented here are part of an extensive research project (Nunavimmiut Knowledge of Beluga); however, only the information pertaining to feeding ecology is presented here. Interviews also contained a participatory mapping component where participants documented beluga behaviour and habitat use (e.g., foraging locations) by drawing on local and regional maps (Gadamus and Raymond-Yakoubian 2015). A guide to prey species, in Inuititut and English, was also created specifically for the project interviews to allow for more detailed identification of prey (McLeod et al. 2009). Interviews were conducted in the participants’ chosen language via the assistance of an English–Inuititut interpreter and were audio recorded.

Participants identified prey species, foraging behaviour and locations, and timing of foraging activity through several different observational methods. Prey species were identified both by direct observations of feeding and by observations of stomach contents of killed animals, and indirectly through observations of foraging behaviour. Only species that were confirmed in subsequent discussions with participants are included in the results. Foraging behaviour was identified as the active pursuit of prey, or indirect behaviours such as beluga circling prey and pushing schools of fish together and driving them towards shore (e.g., capelin, Mallotus villosus (Müller, 1776)).

A mixed-methods approach for data analyses was taken, using quantitative statistical analyses to further explore the results of qualitative analyses (Creswell 2009). Interviews were first transcribed and the maps of participants’ observations of beluga were digitized into a geographic information system, ArcGIS version 9.2 (ESRI, Inc., Redlands, California, USA). Once interviews were transcribed and verified, they were imported into the qualitative analytical software package NVivo version 8 (QSR International Pty. Ltd., Doncaster, Victoria, Australia). Thematic content analysis was conducted on the transcripts in that themes were created using the topics from the interview guide, as well as other topics that emerged in the interviews (Creswell 2009). Through this process, it was possible to consolidate and summarize participants’ responses to different topics and determine patterns of responses among participants. In the qualitative presentation of responses, the terms “a couple”, “several”, and “most” or “majority of” are used consistently throughout the presentation of the results and refer to observations and statements that were noted by two par-
Frequencies of participant responses were analyzed by thematic categories to statistically examine differences among communities. Descriptive statistics were used to illustrate the distribution of participant observations presented in the thematic analysis. Nonparametric statistical tests were prioritized given small sample sizes. For tests that are sensitive to variance, homogeneity of variance was tested prior to analysis. A Kruskal–Wallis test was used to examine differences in participants’ age and experience by community and a Wilcoxon matched-pairs signed-ranks test was used for observations of body condition (i.e., the continuous data). Fisher’s exact test was used for observational count data (e.g., prey species and habitat type) by community. Results were defined as statistically significant at $p < 0.05$. Analyses were performed using JMP version 11.0.0 (SAS Institute Inc., Cary, North Carolina, USA).

Following the digitization of the maps, common beluga features (e.g., feeding locations) drawn by participants were combined and kernel density estimation was applied to aggregate collective responses and include a source of uncertainty for all features (Worton 1989). Maps presented therefore represent the collective responses from either a specific community or all communities.

Preliminary results were verified and validated (Creswell 2009) with Kangiqsualujjuaq, Quaqtaq, Ivujivik, and Kuujjuaraapik participants and final results were reported through meetings open to the whole community during 2010 and 2011. Some topics particularly benefited from validation. For example, changes in blubber thickness were discussed in all of the verification and final
reporting meetings, and through group discussions, consensus was reached in each community regarding a mean blubber thickness and the associated time of year. Similarly, in some cases, the consensus around stomach fullness was developed during either the verification or the final reporting workshops.

Results

Participant information

A total of 40 participants were interviewed in four communities. Participants had a median age of 63 years (range 34–86 years old) (Table 1). The age of the participants was not statistically different between communities (Kruskal–Wallis, \( \chi^2_{[3]} = 5.40, p = 0.14 \)). The majority of participants were male; less than 20% were female. The median time that participants had spent in their hunting area was 61 years and ranged between 48 years in Ivujivik to 67 years in Kangiqsualujjuaq. No difference in length of interviewee experience was observed between communities (Kruskal–Wallis, \( \chi^2_{[3]} = 5.07, p = 0.17 \)). The majority of participants noted that they began hunting beluga when they were young teenagers, but had followed older hunters for years prior to actually hunting. Therefore, each participant had, on average, over 40 years of experience in his or her area. On average, 86% of the participants were active hunters, with the lowest proportion in Kangiqsualujjuaq (73%; \( n = 11 \)) and the highest proportion in Ivujivik (100%; \( n = 8 \)).

The size of community beluga hunting areas (i.e., all individual beluga hunting areas combined) varied between communities. Hunters in Ivujivik and Quaqtaq identified the smallest hunting areas, whereas Kangiqsualujjuaq and Kuujjuaapik hunters used larger areas (Table 1). For all communities, with the exception of Kuujjuaapik, the feeding areas were larger than the beluga hunting areas. The time of year beluga are observed varied by community. Although all communities observed beluga throughout the year, Quaqtaq and Ivujivik hunters observed large numbers during the spring and fall migrations, whereas Kuujjuaapik hunters observed whales intermittently throughout the summer. Kangiqsualujjuaq hunters observed beluga during the spring and fall migrations, whereas Kuujjuaapik hunters used large areas (Table 1). The time spent in hunting area* (year) was 67.2 (49–86) a 60.7 (24–84) a 48.0 (22–76) a 53.2 (11–84) a 57.3 (11–86).

Community beluga hunting area (km²) was 1966 490 183 4374 —. Size of foraging habitat (km²) was 3114 821 331 1504 —.

*Values are means, with ranges in parentheses.

Note: Different letters represent statistically significant differences between communities (each pair Wilcoxon test or Fisher’s exact test).

Table 1. Summary statistics of participants in beluga (Delphinapterus leucas) foraging ecology interviews conducted in Kangiqsualujjuaq, Quaqtaq, Ivujivik, and Kuujjuaapik.

<table>
<thead>
<tr>
<th>Community</th>
<th>Kangiqsualujjuaq (n = 11)</th>
<th>Quaqtaq (n = 11)</th>
<th>Ivujivik (n = 8)</th>
<th>Kuujjuaapik (n = 10)</th>
<th>All (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age* (year)</td>
<td>69.7 (49–86) a</td>
<td>64.5 (34–84) a</td>
<td>53.5 (35–76) a</td>
<td>57.3 (39–77) a</td>
<td>61.3 (34–86)</td>
</tr>
<tr>
<td>Male (n; %)</td>
<td>10 (91%)</td>
<td>8 (73%)</td>
<td>8 (100%)</td>
<td>7 (70%)</td>
<td>33 (83%)</td>
</tr>
<tr>
<td>No. of interviews with interpretation (n; %)</td>
<td>8 (73%)</td>
<td>6 (55%)</td>
<td>5 (63%)</td>
<td>4 (40%)</td>
<td>23 (58%)</td>
</tr>
<tr>
<td>Current hunter (n; %)</td>
<td>8 (73%)</td>
<td>10 (91%) a</td>
<td>8 (100%) a</td>
<td>8 (80%) a</td>
<td>34 (86%)</td>
</tr>
<tr>
<td>Time spent in hunting area* (year)</td>
<td>67.2 (49–86) a</td>
<td>60.7 (24–84) a</td>
<td>48.0 (22–76) a</td>
<td>53.2 (11–84) a</td>
<td>57.3 (11–86)</td>
</tr>
<tr>
<td>Community beluga hunting area (km²)</td>
<td>1966</td>
<td>490</td>
<td>183</td>
<td>4374</td>
<td>—</td>
</tr>
<tr>
<td>Size of foraging habitat (km²)</td>
<td>3114</td>
<td>821</td>
<td>331</td>
<td>1504</td>
<td>—</td>
</tr>
</tbody>
</table>

Some regional differences were reported. For example, there was significant variation in the reporting of salmonid species within Nunavik (see Table 2). Hunters in Kangiqsualujjuaq (73% of participants) and Quaqtaq (55% of participants) reported Arctic char (Salvelinus alpinus (L., 1758)) more frequently than Ivujivik or Kuujjuaapik hunters (Fisher’s exact test, \( p = 0.00002 \)). One participant in Ivujivik reported Arctic char, but there could not be confirmed by other participants agreed that it was possible. Dolly varden (Salvelinus malma) was identified as a beluga prey in both Kangiqsualujjuaq and Kuujjuaapik, but the current known distribution of this species makes this unlikely (Scott and Crossman 1973). It is likely that it was an Arctic char and brook trout (Salvelinus fontinalis (Mitchill, 1814)) hybrid (Hammar et al. 1991; Glemet et al. 1998). Quaqtaq hunters noted that shorthorn sculpin, Arctic char, and shrimp are the most common beluga prey, particularly in the winter. Hunters in Kuujjuaapik noted that there are two types of whitefish (species of the genus Coregonus L., 1738), inshore and offshore, and that both types are important beluga prey species. High seasonal variability in beluga prey occurred for Arctic char, capelin, and sand lance. Participants in both Quaqtaq and Ivujivik, however, observed that location accounted for more variation in beluga diet than season.

Prey species

Nunavimmiut identified a diverse range of fish and invertebrate prey species (Table 2; Fig. 2). Participants were able to identify prey to either the genus or the species level, depending on the experience of the participant, the level of digestion of stomach contents, and the conditions during harvest. To increase sample sizes, prey species were grouped by family for comparison among communities. A full list of species identified is included in Table 2. Sculpin (Cottidae), cod (Gadidae), salmon (Salmonidae), and crustaceans were more frequently reported by participants as known beluga prey than smelt (Osmeridae), sand lance (Ammodoidae), and herring (Clupeidae). Sculpins, cods, and crustaceans were identified in all communities. Two fish species, shorthorn sculpin (Myoxocephalus scorpius (L., 1758)) and Greenland cod (Gadus ogac Richardson, 1836), were identified as beluga prey in all communities. Direct observation of beluga feeding on sculpins and cod was identified by 55% and 53% of all participants, respectively. Although no significant difference was found among communities for sculpins or cod, they were more commonly reported in Ivujivik (75% for both species) and Kuujjuaapik (70% and 60% of participants, respectively). Capelin was identified in all communities, except Quaqtaq, which reported sand lance (species of the genus Ammodytes L., 1758). It was thought that it was likely American sand lance (Ammodytes americanus DeKay, 1842) based on the type of behaviours observed (i.e., close to shore). Sand lance are present when the ice first breaks up and very early in the summer, the middle of July, as well as on the beach in August. Capelin was reported by 24% of the participants from the other three communities with no significant regional variation. Participants in Ivujivik and Kuujjuaapik said that capelin is among the most important prey items for beluga and Ivujivik hunters noted the particular importance of capelin during the fall when they are present in large schools. Kuujjuaapik and Kangiqsualujjuaq participants also observed new species of fish in their areas due to warming waters but did not identify the species.

Ya, there was usually the fish that usually are from this area that I used to see inside the stomach, but nowadays with the warming of the … Arctic we’re starting to have different fish inside their stomach. (Willie Tooktoon)

Some regional differences were reported. For example, there was significant variation in the reporting of salmonid species within Nunavik (see Table 2). Hunters in Kangiqsualujjuaq (73% of participants) and Quaqtaq (55% of participants) reported Arctic char (Salvelinus alpinus (L., 1758)) more frequently than Ivujivik or Kuujjuaapik hunters (Fisher’s exact test, \( p = 0.00002 \)). One participant in Ivujivik reported Arctic char, but this could not be confirmed, although other participants agreed that it was possible. Dolly varden (Salvelinus malma) was identified as a beluga prey in both Kangiqsualujjuaq and Kuujjuaapik, but the current known distribution of this species makes this unlikely (Scott and Crossman 1973). It is more likely that it was an Arctic char and brook trout (Salvelinus fontinalis (Mitchill, 1814)) hybrid (Hammar et al. 1991; Glemet et al. 1998). Quaqtaq hunters noted that shorthorn sculpin, Arctic char, and shrimp are the most common beluga prey, particularly in the winter. Hunters in Kuujjuaapik noted that there are two types of whitefish (species of the genus Coregonus L., 1738), inshore and offshore, and that both types are important beluga prey species. High seasonal variability in beluga prey occurred for Arctic char, capelin, and sand lance. Participants in both Quaqtaq and Ivujivik, however, observed that location accounted for more variation in beluga diet than season.

Foraging habitats and locations

Hunters identified beluga feeding locations throughout Nunavik coastal waters. Sixty-five percent of participants spoke about specific habitat types, noting that beluga forage in rivers, bays,
onshore, and offshore (Table 3) and identified these foraging areas on maps (Figs. 3a–3d). Rivers were reported much more often as feeding locations (73%) throughout Nunavik, whereas bays (31%), shores (23%), and offshore areas (12%) were identified less frequently (Table 3).

There is regional variation in habitats used for foraging (Table 3). Participants from Kangiqsualujjuaq, Quaqtar, and Kuujjuaraapik who discussed habitat types mentioned rivers significantly more often than participants in Ivujivik, where rivers were not mentioned in the context of foraging locations. Ivujivik hunters men-

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**Table 2.** Percentages of participants who identified beluga (*Delphinapterus leucas*) prey species to the family taxonomic level (set in boldface type) during initial interviews and that were later validated.

<table>
<thead>
<tr>
<th>Prey species</th>
<th>Kangiqsualujjuaq (n = 11)</th>
<th>Quaqtar (n = 11)</th>
<th>Ivujivik (n = 8)</th>
<th>Kuujjuaraapik (n = 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sculpin (Cottidae):</strong> shorthorn sculpin (Myoxocephalus scorpius), Arctic sculpin (Myoxocephalus scorpioides (Fabricius, 1780)), spatulate sculpin (Icelus spatula Gilbert and Burke, 1912), fourhorn sculpin (Myoxocephalus quadricornis (L., 1758)), slimy sculpin (Cottus cognatus Richardson, 1836)</td>
<td>4 (36%)</td>
<td>5 (45%)</td>
<td>6 (75%)</td>
<td>7 (70%)</td>
</tr>
<tr>
<td><strong>Cod (Gadidae):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arctic cod (Boreogadus saida)</td>
<td>4 (36%)</td>
<td>5 (45%)</td>
<td>6 (75%)</td>
<td>6 (60%)</td>
</tr>
<tr>
<td>Greenland cod or rock cod (Gadus ogac), Atlantic cod (Gadus morhua L., 1758)</td>
<td>1 (9%)</td>
<td>0 (0%)</td>
<td>1 (13%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>Salmon, trout, and whitefish (Salmonidae):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arctic char (Salvelinus alpinus), Arctic salmon (Salmo salar), Dolly varden (Salvelinus malma), brook trout (Salvelinus fontinalis), lake trout (Salvelinus namaycush (Walbaum in Artedi, 1792)), Arctic cisco (Oncorhynchus autumnalis (Pallas, 1776))</td>
<td>9 (82%) a</td>
<td>6 (55%) ab</td>
<td>0 (0%) c</td>
<td>2 (20%) cb</td>
</tr>
<tr>
<td><strong>Shrimps and crabs (Crustaceans):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>grey sand shrimp (Crangon septemspinosa Say, 1818), Sars shrimp (Sabinea sarssi S.I. Smith, 1879), striped pink shrimp or Aesop shrimp (Pandalus montagui Leach, 1814), snow crab (Chionoecetes opilio (J.C. Fabricius, 1798))</td>
<td>5 (45%)</td>
<td>4 (36%)</td>
<td>4 (50%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td><strong>Smelts (Osmeridae):</strong> capelin (Mallotus villosus)</td>
<td>4 (36%)</td>
<td>0 (0%)</td>
<td>2 (25%)</td>
<td>2 (20%)</td>
</tr>
<tr>
<td><strong>Sand lance (Ammodoidae):</strong></td>
<td>0 (0%)</td>
<td>3 (27%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>Herring (Clupeidae):</strong> Clupea harengus harengus L., 1758</td>
<td>2 (18%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

**Note:** All prey identified to species are listed by family, with the exception of cod. Other prey include lumpsucker, squid, seaweed, plankton, sea urchins. Different letters represent statistically significant differences between communities (Fisher’s exact test).

**Fig. 2.** Reporting of beluga (*Delphinapterus leucas*) prey species by family group from all participants. Different letters represent statistically significant differences between family groups (Fisher’s exact test).
tioned bays more frequently than Kuujjuaraapik hunters, who did not mention bays at all (Fisher’s exact test, \( p = 0.005 \)). Iivujivik and Quaqtaq participants similarly reported that beluga feed along the shore or coast near their communities (40% and 43%, respectively). Feeding along shore, particularly as beluga arrive, was also mentioned in Kuujjuaraapik specifically in relation to feeding on capelin. Quaqtaq hunters who discussed feeding habitats said that beluga feed in offshore areas (29%) (for all feeding locations identified see Figs. 3a–3d), though this was not significantly different from other communities. It was also noted, particularly in Quaqtaq and Kuujjuaraapik, that beluga move between inshore and offshore areas, probably associated with tide-related feeding opportunities.

At the low tide they would go down, feed off shore and high tide they would come in again. (Alec Tuckatuck)

Strong currents and upwellings are important for feeding.

Beluga depend on currents very much for feeding. (David Okpik)

The noted association with currents was particularly common in Kangiqsualujjuaq and was reported by 55% of participants.

In August and September, Arctic char and Atlantic salmon (Salmo salar L., 1758) migrate upriver, giving rivers greater importance as feeding habitat. Communities along Hudson Strait, however, observed less feeding during this time. Quaqtaq participants reported that beluga do not feed while they are migrating, particularly during the spring migration, and feed mainly in their wintering, but also their summering, areas. Beluga that remain in Hudson Strait during the summer are observed feeding in rivers, particularly those southeast of Kangiqsualujjuaq. They were reported to be most likely feeding on sand lance and Arctic char. Winter feeding was noted to take place in Hudson Strait and by Killiniq at the tip of the Quebec–Labrador peninsula (Fig. 1).

Several hunters in Kangiqsualujjuaq (27%) and two in Quaqtaq (18%) noted differences in foraging associated with gender or reproductive status. In Kangiqsualujjuaq, participants reported that males generally feed farther offshore than females and calves. During the final reporting meeting in Quaqtaq, females were reported to often leave their calves at the river mouths of known “good char rivers” during the summer while they fed on char. Also in Quaqtaq, a hunter reported females exhibiting cooperative feeding behaviour to feed their calves by these rivers.

One time a bunch of us we were watching a calf being fed by the parent whales. During the month of July we were going fishing here and we saw a calf there (in the rivers near Kangiqsualujjuaq, Innangajuit – char river). We stopped for lunch and we saw a whole bunch of whales coming from the ocean into the bay. They were coming in this way and there were calves here, beluga calves. When they were coming we didn’t notice any unusual activity, but then a few minutes later we started finding out they’re drawing in a school of Arctic char fish right to their calf. And they circled and just let the calf eat from that. And every time the pool of fish tried to get away they were diverting them right to where the calf was. It was something else. The most unusual mo-

Table 3. Percentage of participants who discussed beluga (Delphinapterus leucas) foraging habitat, as well as particular habitat types (as a proportion of the respondent group) (n; %).

<table>
<thead>
<tr>
<th></th>
<th>Kangiqsualujjuaq (n = 11)</th>
<th>Quaqtaq (n = 11)</th>
<th>Iivujivik (n = 8)</th>
<th>Kuujjuaraapik (n = 10)</th>
<th>All participants (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants who discussed foraging habitats</td>
<td>5 (45%)</td>
<td>7 (64%)</td>
<td>5 (63%)</td>
<td>9 (90%)</td>
<td>26 (65%)</td>
</tr>
<tr>
<td>Rivers*</td>
<td>5 (100%) a</td>
<td>6 (86%) a</td>
<td>0 (0%) b</td>
<td>8 (89%) a</td>
<td>19 (73%) c</td>
</tr>
<tr>
<td>Bay*</td>
<td>1 (20%) ab</td>
<td>3 (43%) ab</td>
<td>4 (80%) a</td>
<td>0 (0%) b</td>
<td>8 (31%) d</td>
</tr>
<tr>
<td>Shore</td>
<td>3 (43%)</td>
<td>2 (40%)</td>
<td>1 (11%)</td>
<td>0 (0%)</td>
<td>6 (23%) d</td>
</tr>
<tr>
<td>Offshore</td>
<td>1 (20%)</td>
<td>2 (29%)</td>
<td>0 (0%)</td>
<td>3 (12%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

Note: Different letters represent statistically significant differences between habitats or between communities (Fisher’s exact test).

*Indicates those habitat types for which there is a statistical difference.

ment I have watched in the beluga, how they worked together. And these were about maybe five, six whales working together bringing in the pool of Char fish! We were witnessing very clearly what was happening there. (Harry Okpik)

Seasonality of foraging

Participants also spoke about the time of year beluga forage in their hunting areas. All communities agreed that beluga feed intensively during the winter and less so during the summer.

All year ‘round even in the winter time the beluga are here in the open water. All over around here they’re going like back and forth the whole winter … in Hudson Strait. They’re feeding and they gain weight around here. (Quitsaq Tarrissiak)

Feeding during the late summer (July and August) was mainly observed for communities with large runs of fish nearby, such as Kangiqsualujjuaq and Kuujjuaraapik.

They wait for the blueberries to turn blue and they come along to the mouth of the river. That’s when the fish come in. (Sappa Fleming)

Although some participants reported that there is some feeding occurring during migration, others from each of the communities which observed beluga during migration said that beluga are feeding very little during that time. Observations of feeding during migration were frequent in Quaqtaq (73%). It was also noted that there is more feeding during the fall than during the spring migration.

In addition to prey identification, hunters’ observations of stomach contents provided indirect observations about the amount of feeding. Hunters in all communities looked at beluga stomachs (73% of all participants), and although it varied by community, this variation was not significant (Table 4). The percentages reported represent the number of hunters interviewed who had looked at beluga stomachs; however, most hunters have done so on many occasions. In the past, when beluga stomachs were used as floats for harpoons, Nunavimmiut observed stomach contents more commonly. For those communities observing beluga stomachs during their migration, most observed them to be quite full during the spring migration and quite empty during the fall migration (Table 4).

Body condition

Participants were asked about the general body condition of beluga, specifically the blubber and skin, with attention to seasonal variation and overall beluga health. There were individuals in each community who observed the pattern of beluga being fattest in late winter and early spring and thinnest during the fall. In Quaqtaq and Iivujivik, the pattern was strong and reported by 100% and 75% of participants, respectively. In Kangiqsualujjuaq and Kuujjuaraapik, the pattern was less noticeable, reported by 55% and 10% of participants, respectively. Given the strength of this pattern in the Hudson Strait communities, participants from Quaqtaq and Iivujivik were further asked if they could quantify the change in blubber thickness by estimating mean thickness at the same location (behind the head on the dorsal side) at different
Fig. 3. Maps showing Nunavimmiut-identified feeding areas of beluga (*Delphinapterus leucas*) for (a) Kuujjuaraapik, (b) Ivujivik, (c) Qaqaqtaq, and (d) Kangiqsualujjuaq. Colour intensity represents kernel density estimation of commonality of reported observations. **Note:** This map is not to be reproduced in any way, whole or in part. Information presented on these maps only represent what was drawn by participants of this study from the four communities included. It does not represent all Nunavimmiut Knowledge of beluga foraging locations for this region.
times of the year. Based on the estimates that hunters from Quaqtaq and Ivujivik provided, beluga lose 5 cm (median) of blubber thickness between spring and fall (Wilcoxon matched-pairs signed-ranks test, $S = -33.00$, $n = 11$, $p = 0.001$). The median spring blubber thickness reported was 11 cm (range = 6.3–20 cm) and the median fall blubber thickness reported was 4 cm (range = 1–9 cm) (Fig. 4). During the final reporting meeting in Quaqtaq, it was cautioned that there can be considerable variation between whales, and that blubber thickness is dependent on other factors such as size and whether it is a migratory or resident whale. Observations of these changes from all communities are summarized in Table 5.

Observations of body condition were associated with whether beluga float or sink when killed. Beluga usually float in the late winter and spring, when they have thick blubber, and sink in the fall when they are thinner (Kangiqsualujjuaq: 45%; Quaqtaq: 45%; Ivujivik: 34%). That’s (March) when they don’t sink anymore. Like if you shoot them they’ll float. Blubber is so thick they don’t sink. (Joshua Annanack)

When discussing fall hunting, it was frequently stated that a different hunting approach is necessary to retrieve beluga, such as hunting in shallow waters or with a heavy hook. It was emphasized, especially during the final reporting trip, that it is important to not over simplify this pattern of mass change because there are beluga that do not follow this and will sink in the spring or float in the fall, and in general, blubber thickness is more variable in the fall. Several interviewees also noted an overall trend, saying that beluga are fatter than they used to be, particularly in the fall. Hunters in Ivujivik associated these changes in body condition with behavioural changes, noting that beluga are more “skittish” (i.e., cautious) in the fall. Similar behavioural observations were made by Kuujjuaraapik hunters but were associated with moulting rather than changes in body condition.

In Quaqtaq, two participants discussed the characteristics of blubber, noting that the blubber is yellower, oilier (containing more liquid), and denser in the spring. The changes in the characteristics of the blubber were also discussed in the final reporting meeting and it was noted that beluga have more oil in the summer-time but are not necessarily more fat and that beluga fat is denser in the spring than in the fall. In the final reporting meeting, it was added that grey whales (i.e., juveniles) tend to be very oily.

### Discussion

Using a mixed-methods approach provided an effective way to analyze IK to add to the existing knowledge base regarding beluga whale diet composition, foraging time and location, and seasonal changes in body condition in Nunavik waters. Participants had, on average, 40 years of beluga hunting experience within their hunting areas, thus differences among communities in diet, condition, and behaviour are likely reflecting real differences in regional or seasonal activity. The timing of when whales are nearby communities varies regionally and impacts on hunters’ observations. For example, although all communities reported some observations of beluga throughout the year, the two Hudson Strait communities (Quaqtaq and Ivujivik) primarily observed beluga during their spring and fall migrations, whereas Kangiqsualujjuaq hunters observed a migration of fewer animals and traveled to both Quaqtaq and Killiniq for hunting during the larger migration. All communities observed beluga throughout the summer, although the observations were sporadic in all communities except Kuujjuaraapik, which observed beluga throughout the summer.

#### Prey species

In total, 21 species were identified as beluga prey by hunters, with sculpin, cod, salmon, trout, whitefish, and crustaceans dominating diets, which is similar to that described in earlier unpublished traditional ecological knowledge studies from this region (McDonald et al. 1997; Doig et al. 2002; Lee et al. 2002). According to scientific studies of more northern populations such as the Beaufort Sea, Cumberland Sound, and Greenland (Heide-Jorgensen and Teilmann 1994; Løseth et al. 2009; Marcoux et al. 2012; Table 6), beluga in Nunavik consumed sculpin, cod, salmon, and crustaceans more often than Arctic cod (Boreogadus saida) (Lepechin, 1774) (Table 2). Arctic cod was identified as a beluga prey by Salluit hunters in a previous TEK study (Lee et al. 2002), but only a single hunter from both Kangiqsualujjuaq and Ivujivik mentioned Arctic cod during this study. Hunters did not indicate a change in diet related to cod and the regional differences are more likely related to a north–south cline in prey availability. Capelin, which was identified in all but one community and qualitatively described as a dominant prey species, has also been identified as a dominant prey for western Hudson Bay beluga (Kelley et al. 2010), as well as in beluga from the St. Lawrence River estuary (Vladykov 1946). One of the predictions of climate change is that there will be fewer northern prey species, such as Arctic cod, and more temperate species, such as capelin, may replace

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| Table 4. Observations of beluga (Delphinapterus leucas) stomach contents (n; %). |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Kangiqsualujjuaq (n = 11)       | Quaqaq (n = 11) | Ivujivik (n = 8) | Kuujjuaraapik (n = 10) |
| Participants who looked at beluga stomach contents (%) | 9 (82%) | 5 (45%) | 6 (75%) | 9 (90%) |
| Quantity of beluga stomach contents | Often empty; spring: can have some contents; fall: quite empty | Spring: fairly full; fall: quite empty | Spring: quite full; fall: empty (though more variable) | Summer: one-quarter to half full, though can be empty |

**Fig. 4.** Beluga (Delphinapterus leucas) blubber thickness (cm), showing quantiles (boxes and whiskers in red on the Web and in gray in print), in spring and fall as reported by hunters in Quaqtaq and Ivujivik.
them. However, it is not known whether capelin has always been an important prey species for beluga in eastern Hudson Bay or whether that is a recent shift as has been shown for Thick-billed Murres (Uria lomvia (L., 1758)) in northern Hudson Bay (Gaston et al. 2003) and hypothesized for the Cumberland Sound beluga (Marcoux et al. 2012) and ringed seal (Pusa hispida (Schreber, 1775)) populations (Chambellant et al. 2013). Although the observed importance of capelin could suggest that temperate species may be moving in with warming sea temperatures, Watts and Draper (1986) documented beluga preying upon capelin in western Hudson Bay over 30 years ago, indicating that capelin is not a new arrival, at least on that coast of the bay. Hunters in the more southern communities (i.e., Kangiqsualujjuaq and Kuujjuaraapik) noted that they are observing new types of fish, although there were few other noted changes in prey. This suggests it may be related to the latitudinal gradient, although there are alternate possibilities (e.g., species introductions).

Regional differences characterized beluga diet in Nunavik, with only two species (Greenland cod and shorthorn sculpin) reported throughout the region (Arctic char was the most reported prey in Kangiqsualujjuaq and capelin was qualitatively described to be common in Ivujivik and Kuujjuaraapik) noted that they are observing new types of fish, although there were few other noted changes in prey. This suggests it may be related to the latitudinal gradient, although there are alternate possibilities (e.g., species introductions).

Table 5. Observations of changes in beluga (Delphinapterus leucas) blubber thickness at different times of the year.

<table>
<thead>
<tr>
<th>Community</th>
<th>Time of the year</th>
<th>Estimated blubber thickness (cm)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kangiqsualujjuaq</td>
<td>Spring migration (end of April to mid-July)</td>
<td>12</td>
<td>Based on measurements around the back of the neck</td>
</tr>
<tr>
<td></td>
<td>Fall migration (beginning of September to December)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Quaqtaq</td>
<td>Spring migration (end of May to mid-July)</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fall migration (October to December)</td>
<td>1-4</td>
<td></td>
</tr>
<tr>
<td>Ivujivik</td>
<td>Arrival (June)</td>
<td>7.5–10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Departure (September to November)</td>
<td>5–7.5</td>
<td></td>
</tr>
</tbody>
</table>

Foraging habitats and locations

Hunters have observed beluga using a range of habitats (e.g., rivers, bays, offshore, and nearshore) for foraging throughout Nunavik, with rivers identified most by participants from all communities, except for Ivujivik. Rivers, particularly in the fall, are likely important because of anadromous fish runs (e.g., Southeast Baffin and Alaskan beluga populations for Arctic char and salmon, respectively) (Kilabuk 1998; Huntington et al. 1999); therefore, community location likely influences reported habitat use. For example, in Ivujivik, where there are few large rivers, hunters reported beluga foraging in bays more commonly than hunters in Kuujjuaraapik, where there are several large rivers. The observation of beluga feeding along the shore in most of the communities likely coincides with capelin spawning (late June to August in the North Atlantic) (Davoren and Montecucchi 2003) and also when sand lances are nearshore (late summer) (participants and Robards and Piatt 1999). The observation, particularly by Quaqtaq participants, that beluga are feeding in offshore areas is also corroborated by telemetry data for this beluga population and others (Richard et al. 2001b; Bailleul et al. 2012). For example, in Lewis et al. (2009), beluga whales spent 76% of their time in areas greater than 15 km from shore and traveled to deep-water troughs (600 m) in the Labrador Sea in the winter, most likely associated with foraging activities. Observations of movement between offshore and inshore areas are thought to be associated with feeding by hunters, which has also been hypothesized for these and other populations by biologists (Richard et al. 2001a; Bailleul et al. 2012).

Seasonality of feeding

Hunters shared observations of beluga foraging throughout the year and participating communities agreed that feeding activity peaks during the winter. This comes from direct observations of feeding, when Inuit used to hunt beluga during the winter. This practice is less common now due to changes in the environment and management regulations. Feeding in the winter is also in-
Dominant prey species for beluga (Delphinapterus leucas) populations by latitude and method.

<table>
<thead>
<tr>
<th>Region</th>
<th>Latitude (°N)</th>
<th>Method</th>
<th>Dominant Prey Species</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Hudson Bay</td>
<td>55–60</td>
<td>Observation; fatty acid and stable isotope analysis</td>
<td>American sand lance, salmon, Arctic cod and polar cod</td>
<td>Watts and Draper 1986; Kippen et al. 2015</td>
</tr>
<tr>
<td>Nunavik Coastal Waters</td>
<td>55–65</td>
<td>Stomach contents</td>
<td>Salmon, Arctic cod, capelin, and Greenland whale</td>
<td>McFarlane et al. 1990; Loseto et al. 2009</td>
</tr>
<tr>
<td>Cook Inlet and Bristol Bay</td>
<td>60–70</td>
<td>Stomach contents</td>
<td>Arctic cod and polar cod</td>
<td>Hobbs et al. 2008; Quakenbush et al. 2015</td>
</tr>
<tr>
<td>St. Lawrence River</td>
<td>45–50</td>
<td>Stomach contents</td>
<td>American sand lance, capelin, and Greenland whale</td>
<td>Vladykov 1946; Nairn 1986; McLeay et al. 2010</td>
</tr>
<tr>
<td>Cumberland Sound</td>
<td>60–70</td>
<td>Stomach contents</td>
<td>Arctic cod and polar cod</td>
<td>Hobbs et al. 2008; Quakenbush et al. 2015</td>
</tr>
<tr>
<td>Beaufort Sea</td>
<td>65–75</td>
<td>Fatty acid analysis</td>
<td>Arctic cod and polar cod</td>
<td>McFarlane et al. 1990; Loseto et al. 2009</td>
</tr>
<tr>
<td>St. Lawrence River</td>
<td>55–65</td>
<td>Stomach contents</td>
<td>Arctic cod and polar cod</td>
<td>Hobbs et al. 2008; Quakenbush et al. 2015</td>
</tr>
<tr>
<td>St. Lawrence River</td>
<td>60–70</td>
<td>Stomach contents</td>
<td>Arctic cod and polar cod</td>
<td>Hobbs et al. 2008; Quakenbush et al. 2015</td>
</tr>
<tr>
<td>South East Baffin Sea</td>
<td>60–70</td>
<td>Stomach contents</td>
<td>Arctic cod and polar cod</td>
<td>Hobbs et al. 2008; Quakenbush et al. 2015</td>
</tr>
<tr>
<td>Baffin Sound</td>
<td>65–70</td>
<td>Stomach contents</td>
<td>Arctic cod and polar cod</td>
<td>Hobbs et al. 2008; Quakenbush et al. 2015</td>
</tr>
<tr>
<td>West Greenland</td>
<td>60–70</td>
<td>Stomach contents</td>
<td>Arctic cod and polar cod</td>
<td>Hobbs et al. 2008; Quakenbush et al. 2015</td>
</tr>
<tr>
<td>South East Baffin Sea</td>
<td>65–70</td>
<td>Stomach contents</td>
<td>Arctic cod and polar cod</td>
<td>Hobbs et al. 2008; Quakenbush et al. 2015</td>
</tr>
<tr>
<td>Sea (Upernavik)</td>
<td>70–75</td>
<td>Stable isotope analysis</td>
<td>Arctic cod and polar cod</td>
<td>Hobbs et al. 2008; Quakenbush et al. 2015</td>
</tr>
</tbody>
</table>

Seasonal observations of foraging activity are also supported by the examination of stomach contents, which was common practice among the majority of hunters interviewed (73%). Variation in the practice was related to community differences in harvest conditions. For example, the spring harvest in Quaqtaq is usually done from the ice edge where time is limited and therefore fewer people look at stomach contents. In the verification and final workshops with participants, consensus was developed and generally indicated that beluga migrating in the spring had fuller stomachs, whereas more stomachs were empty in the fall, which participants thought was reflective of the amount of feeding that took place prior to migration.

**Body condition**

The annual changes in body condition suggest that beluga go through a considerable seasonal change in blubber thickness, gaining in the winter and losing throughout the rest of the year, primarily during migrations. Hunters from Kuujuaraapik thought the reduction in blubber thickness after molting was due to high energy expenditures during breeding and calving. To quantify the changes, Quaqtaq and Ivvujivik hunters reported blubber thickness during spring and fall migrations and a matched-pair analysis was performed. The timing of fat accumulation, coupled with the understanding that Hudson Bay is not known to be a productive region (Stewart and Lockhart 2005), indicates that there are likely other factors for the migration into Hudson Bay, lending support to alternate hypotheses. For example, the elevated temperatures and low salinity conditions of estuaries in Hudson Bay provide conditions for molting (St. Aubin et al. 1990; Koski et al. 2002). Alternatively, this movement could be related to predator avoidance, given that killer whales (Orcinus orca) have only recently become more numerous in Hudson Bay (Higdon and Ferguson 2009; Hammill 2013).

Seasonal differences in body condition have been observed in Baffin Island populations of beluga (Kilabuk 1998) and Alaskan hunters also noted similar observations of beluga being fattest in the spring (the “winter coat”) and thinnest in the fall (Huntington et al. 1999). This seasonal pattern also parallels other marine mammals such as polar bears (Ursus maritimus) that have the highest adipose stores at the end of the winter (Derocher et al. 2004). Given the pervasiveness of the loss in mass, hunters inferred that it is related to the energetic cost of migration and the lack of foraging in the summer, though given the significant cost of lactation for females (Matthews and Ferguson 2015), the change may be related to multiple factors. For example, the warmer waters of the summering areas require less blubber for thermoregulation and therefore beluga do not forage as extensively at that time of year. The changes related to lactation may account for some of the individual variation (but only in females) observed by hunters. These seasonal changes in body condition have poten-
tially significant implications for bioenergetics (e.g., energy budget, heat loss, and feeding rate).

Some caution is needed when interpreting the quantitative results. The methodological approach (i.e., semidirective interviews) meant that although participants spoke to the same general topics, they did not necessarily speak to the same points. In many cases, analysis was done on all responses received regardless of whether they were the result of a specific question. For example, because participants were not consistently and specifically asked about whether beluga float or sink when harvested at different times of the year, the proportion of participants who would have contributed to that topic was underrepresented.

Although we were able to quantify much of the information collected, in some instances observations were not particularly supported by quantitative results but were strongly supported by the qualitative. For example, capelin was only reported by 24% of participants overall, while participants in the Hudson Bay communities clearly emphasized their importance as beluga prey. This qualifying of the quantitative results, and vice-versa, speaks to the importance and strength of a mixed-methods approach (Fetters et al. 2013). Results were greatly improved by the verification and validation process conducted in workshops. By reviewing the information that had been collected during the interviews, we were able to correct, clarify, and further describe results. Finally, these results can only truly represent the participating hunters’ experiences and knowledge, and not the community’s knowledge as a whole, and any extrapolation needs to be done with caution.

Inuit Knowledge provides a complementary approach to other dietary methods (i.e., stomach contents, stable isotope, and fatty acid analysis); each approach is limited by the realities of methodology and the challenges of research in the Arctic (Bowen and Iverson 2013). The year-round and long-term nature of the observations and experiences that hunters shared about beluga whale foraging ecology adds considerably to beluga whale foraging ecology literature, specifically contributions regarding diet composition, foraging behaviour, locations, and seasonal changes in body condition. Documentation of Nunavik IK of foraging ecology also provides reference data that can be used for monitoring and detecting change, as well as for the conservation of this species by providing information that can be used to develop mitigation measures for industrial activity such as commercial fisheries and marine development (Gavrilchuk and Lesage 2014). This study demonstrates that IK can greatly add to current knowledge and be incorporated into long-term monitoring programs (that identify prey in stomachs and listen to local hunters) to monitor for changes in the marine ecosystem (e.g., appearance of more temperate species). More specifically, the information on diet can contribute to a circumpolar spatial model of diet composition for beluga whales that is able to monitor latitudinal and temporal shifts in prey. With the communities as monitoring sites and the hunters as researchers, a cost effective, efficient, and experienced monitoring program could be developed.

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Appendix A
An Inuititut version of the abstract appears on the following page.
(Delphinapterus leucas) 0°C to 2°C / 0°C to 2°C. 

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