

Inuvialuit traditional ecological knowledge of beluga whale (*Delphinapterus leucas*) under changing climatic conditions in Tuktoyaktuk, NT¹

Devin Waugh, Tristan Pearce, Sonja K. Ostertag, Verna Pokiak, Peter Collings, and Lisa L. Loseto

Abstract: This paper documents Inuvialuit traditional ecological knowledge of beluga, including ecology and behavior, hunting techniques, and food preparation under changing climatic conditions in Tuktoyaktuk, NT. Beluga whale (*Delphinapterus leucas*) is an important food source for Inuvialuit in the western Canadian Arctic, a region that is experiencing dramatic climate change. Data were collected using semi-directed interviews with 17 Inuvialuit beluga harvesters and participant observation. The research found that Inuvialuit beluga harvesters possess detailed rational knowledge of beluga, particularly regarding hunting techniques and food preparation, both which are guided by a moral code about how to behave with respect to beluga. In terms of beluga ecology and behavior, Inuvialuit knowledge is limited to anecdotal reasoning drawing on generalized observations of beluga and the accounts of others. Inuvialuit are experiencing the effects of climate change, but seem to be coping thus far in the context of beluga harvesting but ongoing change in the region may increase the risks associated with hunting and preparing beluga in the future.

Key words: Arctic, climate change, traditional ecological knowledge, Indigenous, co-management.

Résumé : Cet article documente les connaissances écologiques traditionnelles des Inuvialuit au sujet des bélugas, y compris l'écologie et le comportement, les techniques de chasse et la préparation alimentaire dans un contexte de changement des conditions climatiques à Tuktoyaktuk, T.N.-O. Les bélugas (*Delphinapterus leucas*) sont une importante source alimentaire des Inuvialuit dans l'ouest de l'Arctique canadien, une région qui subit des changements climatiques sérieux. Les données ont été recueillies au moyen d'entrevues semi-dirigées avec 17 chasseurs de bélugas Inuvialuit et en observant les participants. Les recherches ont permis de constater que les chasseurs de bélugas Inuvialuit possèdent des connaissances rationnelles détaillées des bélugas, particulièrement quant aux techniques de chasse et de la préparation alimentaire, lesquelles sont régies par un code moral du comportement à adopter en ce qui concerne les bélugas. En matière d'écologie des bélugas et de

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leur comportement, les connaissances Inuvialuit sont limitées au raisonnement anecdotique tiré des observations générales des bélugas et des comptes rendus des autres. Les Inuvialuit subissent les effets des changements climatiques, mais ils semblent bien y faire face jusqu'à présent dans un contexte de capture des bélugas, mais les changements en cours dans la région pourront faire augmenter les risques en relation à la chasse et la préparation du béluga à l'avenir. [Traduit par la Rédaction]

Mots-clés : Arctique, changement climatique, connaissances écologiques traditionnelles, autochtone, cogestion.

Introduction

Beluga whales (*Delphinapterus leucas*) are widely distributed across the Arctic, and are hunted by Inuit. The eastern Beaufort Sea population is one of Canada's largest beluga populations, migrating between the Bering and Beaufort Sea (DFO 2000; Harwood and Smith 2002; Harwood and Kingsley 2013). The migratory pattern of this population brings it into close proximity to communities in the Inuvialuit Settlement Region (ISR) from late May to September. Beluga is an important food source for the Inuvialuit, Inuit of the western Arctic, and the harvesting, preparation and sharing of the species are an important cultural activity. All communities within the ISR hunt beluga; the community of Tuktoyaktuk, located on the east side of Kugmallit Bay in the Mackenzie River Estuary, is typically the most active (Harwood et al. 2002). Inuvialuit possess detailed collective bodies of traditional ecological knowledge (TEK) of beluga whales, including ecology and behavior, hunting techniques, and food preparation methods. This body of TEK has been developed through an accumulation of location-specific observations and refinement of techniques over time, passed down through the generations. This knowledge is continually updated to reflect new observations and to take advantage of new technologies (Wenzel 1991; Aporta et al. 2005). The term "TEK" is one of several terms used to describe the knowledge held by Indigenous peoples of the Arctic, including traditional knowledge (TK), Inuit knowledge (IK), and Inuit Qaujimagatuqangit (IQ). TEK is used here consistent with its use by the Government of Northwest Territories and the familiarity of the term in Tuktoyaktuk. In this paper, we are interested in facets of TEK about beluga less well represented in the literature that not only include the knowledge of beluga ecology and behavior, but also the knowledge of how Inuvialuit currently use and value beluga (Usher 2000).

This research builds on a body of scholarship on Inuit TEK of different species of wildlife in the Arctic. Previous studies have examined aspects of bodies of TEK around various species, including eider duck by Nakashima (1986) in northern Quebec, polar bear by Wenzel (1983) in the Northwest Territories, beluga by Huntington et al. (1999) and Mymrin and Huntington (1999) in Alaska and Russia, Greenland shark by Idrobo and Berkes (2012) in Pangnirtung, caribou by Ferguson and Messier (1997) on Baffin Island, and ringed seal by Furgal et al. (2002) in Arctic Bay. Outside of Canada, a handful of studies have documented TEK of beluga in the Chukchi and northern Bering Sea working with communities in Alaska and Russia (Huntington et al. 1999; Mymrin and Huntington 1999). Hunting and butchering techniques of beluga have also been examined in Alaska in the community of Buckland (Morseth 1997). However, despite a long history of Inuvialuit interaction with beluga and its continued nutritional and cultural importance, there has been limited documentation of Inuit/Inuvialuit knowledge of beluga whale in the Canadian Arctic (Breton-Honeyman et al. 2016). This is particularly relevant at time when the Arctic is experiencing rapid climate change with uncertain consequences for beluga and Inuvialuit hunters and a dataset on beluga that is limited to scientific measurements.

This paper responds to this knowledge need and documents what Inuvialuit know about beluga and how they use and value beluga, focusing on knowledge of beluga behavior and ecology, hunting techniques, and subsistence food preparation. This paper then examines these facets of Inuvialuit TEK of beluga in the context of ongoing climatic changes in the region to understand how these changes are affecting Inuvialuit, beluga, and beluga harvesting activities.

Background

Wildlife and fisheries are jointly managed by federal, regional, and local institutions in co-management arrangements throughout the Canadian Arctic. Co-management is an approach to resource governance characterized by a sharing of authority and power between states and various resource stakeholders (Carlsson and Berkes 2005). The modern era of co-management in northern Canada, characterized by greater power sharing with Inuit stakeholders, was catalyzed by various land claim agreements, such as the Inuvialuit and Nunavut Final Agreements (Richard and Pike 1993; Armitage et al. 2011; Dale and Armitage 2011). Beluga across the Canadian Arctic falls under the managerial jurisdiction of Fisheries and Oceans Canada, and the eastern Beaufort Sea stock that migrates through the ISR are also governed by Inuvialuit institutions including the Inuvialuit Game Council (IGC), the Fisheries Joint Management Committee (FJMC), the Wildlife Advisory Management Committee (WMAC), and the local community Hunters and Trappers Committees (HTCs) (Fast et al. 2001). The ISR also hosts the largest and longest running beluga harvest monitoring programs in Canada, first established in 1973 to monitor the size and timing of the harvest (Harwood et al. 2002). The program has since expanded to monitor other biological parameters in landed whales, particularly mercury exposure, as well as persistent organic pollutants (POP) exposure (Kuhnlein and Chan 2000; Loseto et al. 2008; Ostertag et al. 2009). A key feature of the beluga monitoring program in the ISR is the established relationships between Inuvialuit harvesters and researchers. Inuvialuit harvesters are increasingly more involved in data-collecting activities through collaborative fieldwork with scientists and data analysis and results dissemination. Several Inuvialuit beluga monitors receive training each year and assist in recording metrics of harvested whales including the length, weight, colour, and sex, in addition to collecting tissue samples (Harwood et al. 2002; Bell and Harwood 2012). While Inuvialuit are clearly engaged in the monitoring process, questions remain as to what degree Inuvialuit TEK and traditional management styles are included in monitoring. This research builds upon the strength of these established relationships among Inuvialuit and researchers and seeks to contribute to advancement of beluga co-management that better reflects the knowledge and experience of Inuvialuit.

The inclusion of TEK and the recognition of its value along with western science in decision-making processes continues to be one of the cornerstones of natural resource co-management arrangements in the Arctic (Nadasdy 1999). Numerous studies have examined the nature and content of IK systems (Wenzel 2004; Berkes 2009), the transmission of TEK (Pearce et al. 2011), and the ongoing efforts of including Inuit and Inuit knowledge in these natural resource management institutions (Armitage 2005; Berkes et al. 2007; Kendrick and Manseau 2008; Armitage et al. 2011; Dale and Armitage 2011). The practical challenges in these endeavours have been studied in the context of narwhal co-management in the eastern Canadian Arctic, examining how knowledge co-production acts to inform social learning and adaptive capacity building (Armitage et al. 2011; Dale and Armitage 2011). Inuvialuit TEK of beluga has been documented directly in the ISR, most notably by Byers and Roberts (1995), who examined Inuvialuit TEK of beluga, as well as the historical context of beluga hunting. However, this study was not

published in an academic journal and it is not available online, limiting its accessibility to a wider audience.

The Arctic is experiencing climate change faster and to a greater magnitude than elsewhere in the world, with observed reductions in sea ice and snow cover, increased coastal erosion, thawing permafrost, ocean acidification, and changes in river inflow being linked to increased temperatures (Callaghan et al. 2011; Overeem et al. 2011; Stroeve et al. 2012; Steiner et al. 2013; Larsen et al. 2014). These changes in the physical environment are affecting wildlife through changes in the availability and quality of primary forage/prey and habitat, which in turn can lead to change in species abundance and distribution, and trophic decoupling and cascades (Laidre et al. 2008; Moore and Huntington 2008; Larsen et al. 2014; Van Hemert et al. 2015). Some marine mammal species like beluga are increasingly considered to be “climate change sentinels”, and ice-associated species like beluga are changing the timing of their migrations in response to earlier ice break-up in the spring and delayed ice formation in the fall (Moore 2008; Moore and Huntington 2008; Dr. L.L. Loseto, personal communication, July 6, 2017). The growth rate of eastern Beaufort Sea beluga has declined over the past several decades, and although this cannot be directly linked to climate changes, it indicates a reduction in general fitness that may make them more vulnerable to future change (Harwood et al. 2014). In general, beluga is considered to be moderately sensitive to the effects of climate change, and less sensitive than narwhal and bowhead (Laidre et al. 2008; Asselin et al. 2012). Much attention has been directed towards how these changes in the biophysical environment are translated to communities and individuals, particularly in the hunting sector (Ford et al. 2006, 2007; Pearce et al. 2015).

Case study: Tuktoyaktuk, NT

Tuktoyaktuk or “Tuk” (69°26′34″N and 133°01′52″W), traditionally known as Tuktuujaartuq in Inuvialuktun, is located in the Mackenzie River Delta in the northwest corner of the Northwest Territories (see Fig. 1), and is one of the major population centers within the ISR [Inuvialuit Regional Corporation (IRC) 2007]. Inuvialuit in Tuktoyaktuk are descended from the Siglit people of the Beaufort coast/Mackenzie River mouth area, who were part of the original Thule migration from the west sometime around 1200 CE (IRC 2007). The Siglit people were particularly sea oriented, harvesting bowhead, beluga, and seals (Usher 1971). Groups of Siglit living in the Kugmallit Bay area without access to the deeper water preferred by bowhead relied more heavily on beluga harvesting (Usher 1971). These populations mixed with Alaskan Inupiat, inland Gwich’in and European and American explorers, fur traders and whalers, especially in the early 1900s after smallpox and measles drastically reduced their original numbers (Usher 1971; Alunik et al. 2003). Permanent settlement began in the 1930s around the Hudson Bay outpost of Port Brabant, which provided most of the economic activity of the time (Pool 2015). Tuktoyaktuk’s deep water harbour became the center of the oil and gas boom in the region from the 1960s through the 1990s after on and off shore reserves were discovered in the 1950s (IRC 2007). As of the 2016 population census, the hamlet had 898 residents (Statistics Canada 2017).

Tuktoyaktuk is located on Kugmallit Bay, an important calving area for the eastern Beaufort Sea beluga whale population. This means that there is a seasonal congregation of beluga that is accessible to hunters from Tuktoyaktuk with a day trip from town by boat. In general, shallow depth of the bay makes hunting possible despite the turbid water from the Mackenzie River outflow, whereby hunters follow the eddies produced by the fluke of the whale as it swims under the surface, and by the water that whales push ahead of themselves as they near the surface. Most of the hunting occurs in the shallowest area, extending from the mouth of the river to around Hendrickson Island on the west side of the bay. It is protected as the Kittigaryuit Marine Protected Area (MPA), a sub-area of the wider Tarium

Fig. 1. Location of Tuktoyaktuk within the Inuvialuit Settlement Region.



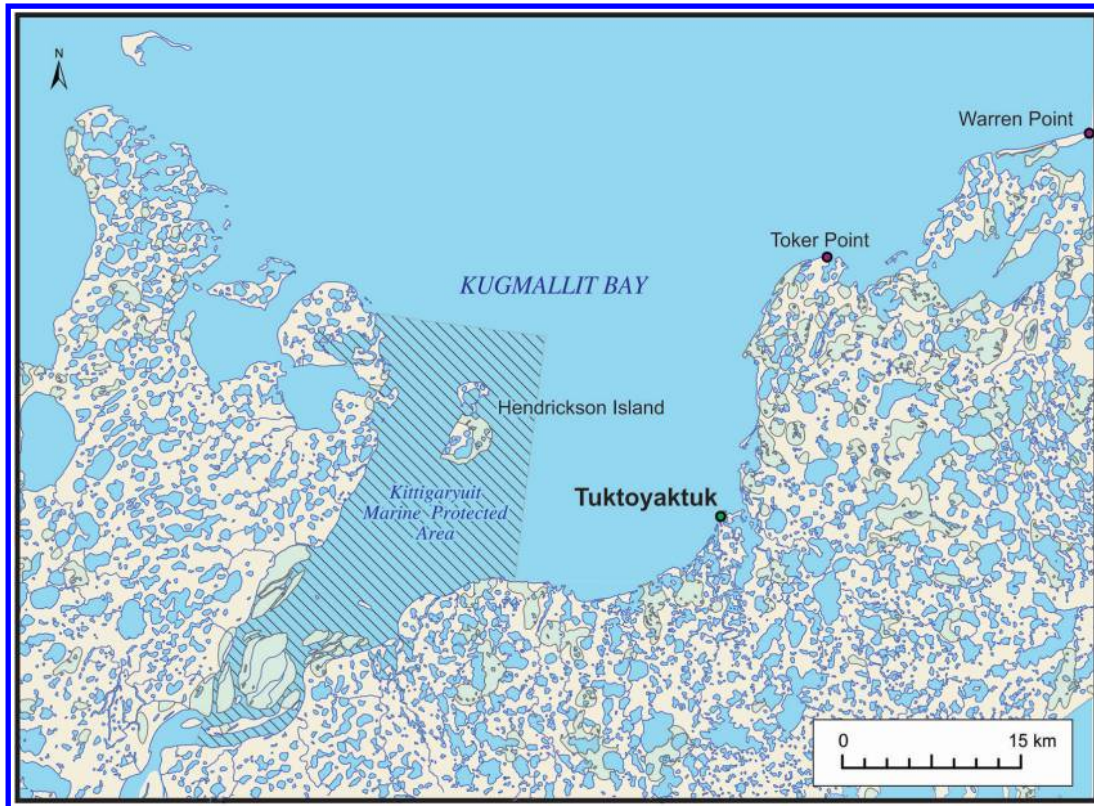
Niryutait MPA (see Fig. 2) that covers two other areas in the Mackenzie River Estuary (Harwood et al. 2014).

Beluga hunting strategies in Tuktoyaktuk are regulated through the beluga hunting bylaws set out by the Tuktoyaktuk Hunters and Trappers Committee (THTC) and the Fisheries Joint Management Committee (FJMC). Hunters typically employ 18 ft (5.5 m) aluminum Lund boats with 50 hp outboard motors to hunt whales. Some hunters will use larger 20 ft (6 m) Harbercraft or Princecraft boats and larger outboards. Hunters prepare for the hunt by gathering the necessary equipment, including the primary hunting tools of harpoons, rifles and knives, as well as precautionary equipment in the event of stranding due to inclement weather. This emergency equipment typically includes extra gasoline, a food box, water, and a tent for shelter. The products of harvested whales feed people in the community, but are also distributed to a lesser extent in the wider ISR through personal sharing networks, and through the Inuvialuit Joint Secretariat.

Methods

To address the objectives of the research, we focused our study and data collection on Tuktoyaktuk, NT, the community with the largest modern harvest, under Aurora

Fig. 2. Tuktoyaktuk coastal environs and Kittigaryuit Marine Protected Area (MPA).



Research Institute (ARI) license number 3435, and ethics review No. 16MY008 from the University of Guelph. Data collection occurred during a field season from 15 June to 9 August 2016. Draft study design for TEK collection was presented to the THTC, the body responsible for overseeing research conducted in the community, through a preresearch community visit in February 2016. The visit allowed for feedback from the THTC to be incorporated into research design, and for early meetings and consultation with potential research participants in the community.

The primary field season began with the hiring of V. Pokiak as the local research assistant to assist the lead author, with interviews throughout the summer. Verna had extensive experience with the scientific beluga monitoring program, having worked as a monitor at the sampling camps for several seasons. Interviews were conducted with 17 active and formerly active beluga harvesters (see Table 1). These participants were selected using purposive and snowball sampling strategies, with input from V. Pokiak's experience as a beluga harvest monitor, Dr. Sonja Ostertag's involvement in the beluga harvest monitoring program, participant recommendations, and consultation with two community elders. The interviews lasted an average of 56 min, ranging from 23 to 95 min in length. The interview guide (Supplementary Data²), consisting of 23 questions, addressed the three main topics of inquiry, including beluga behavior and

²Supplementary data are available with the article through the journal Web site at <http://nrcresearchpress.com/doi/suppl/10.1139/as-2017-0034>.

Table 1. Demographics of Inuvialuit participants.

Total	Male	Female	Average age	Average years of harvesting Beluga
<i>n</i> = 17	<i>n</i> = 15	<i>n</i> = 2	59.2	45.3

ecology, hunting techniques, and subsistence food preparation, and was based on similar work conducted in Ulukhaktok (Collings et al. 2018). Semi-directed interviews were utilized to allow participants to discuss other topics that they considered to be relevant and included information not covered by the initial interview guide (Huntington et al. 1999). This method worked particularly well with participants' inclinations to convey their knowledge in the form of narratives about their experiences with beluga. The interviews were audio recorded with the exception of one participant who requested otherwise. Data were analyzed using thematic analysis following the structure of the interview guide: knowledge on beluga ecology and behavior, hunting techniques, food preparation, values, and observations of environmental changes (Braun and Clarke 2006). In addition, the theme of values was also identified during analysis (Braun and Clarke 2006). Participant observation complemented knowledge shared during interviews, and was particularly useful for observing three incidences of preparation of beluga at shore-side smokehouses accessible from town. This enhanced interpretation of the data by providing first hand observation of the beluga processing process. Non-Inuvialuit are not permitted in boats during beluga hunts, which limited the utilization of participant observation to inform results pertaining to hunting techniques.

Individual interview summaries were reviewed with participants before the end of the field season to ensure accuracy, and to allow participants to add additional information if they desired. A follow-up visit was conducted in February 2017 to disseminate results, which was a research component requested by the THTC. The researcher met with the THTC to present a plain language summary of the work, and a community meeting was held where the results of this project and another project were presented in the town hall, along with a question and answer period.

Results

Interviews revealed a wealth of knowledge on beluga ecology and behavior, hunting techniques, food preparation, values, and observations of environmental changes. Interviews focused on documenting Inuvialuit knowledge of beluga; questions about climate change were not included in the interviews. However, when informants described changing climatic conditions, subsequent questions were asked about how these changes affected beluga and beluga hunting.

Ecology and behavior

The typically turbid water conditions in Kugmallit Bay represent a significant impediment to direct observations of beluga. In general, Beluga arrive in Kugmallit Bay from the west in late June or early July, closely following leads in the spring ice during breakup. Depending on ice conditions, beluga will either travel north of Richards Island following the coast, or through the Mackenzie Delta to reach Kugmallit Bay. Beluga congregates in the area between the mouth of the Mackenzie River and Hendrickson Island, where the water is shallow and warm. They will seek shoals where they will rub themselves on the bottom to help with cleaning their skin, changing their colour from yellow to white. This area is also where the females give birth to their young, presumably due to the

favourable water conditions. Beluga is noted to be particularly sensitive to anthropogenic noise, and will “beeline” away from human sources of sound. However, many participants noted that whales are sometimes curious of boats, and they respond differently to humans if there are guns or harpoons in the boat. There were several instances described of groups of whales approaching boats that were not hunting and swimming alongside, even allowing people to touch them. If too many boats are moving in the area, beluga will move from their favoured area south of Hendrickson Island northeast across Kugmallit Bay to Warren and Toker Point areas, but will usually return within a day after being disturbed.

“As soon as they hear boats they rush back out into the deep water, and it’s hard to hunt them in the deep water, where its muddy eh? You can’t see them” – Sam Gruben, 72

Females with calves will generally not travel as far, as newborn whales do not yet have the strength early in the season to travel longer distances. In addition to the area south of Hendrickson Island, beluga congregates in shallow bays along the coast, where the water is also warmer and shallower, and where they also feed. The behavior of the beluga in Kugmallit Bay changes distinctly around the 3rd week of July. They begin to roam farther from the area south of Hendrickson Island into deeper water. They also begin to behave differently when being pursued by hunters, being “craftier”. Instead of fleeing from boats pursuing them, whales will turn and charge them, targeting sources of noise such as the outboard motor, muffler, and depth sounders.

“Close to the end of July. . .their attitude, or the way they run from a boat changes. . .they get crafty and they stop or they turn, you never get a clear shot to throw a harpoon” – Lucky Pokiak, 37

Hunting techniques

Hunters typically go out in pairs, with one driver, and one harpooner/shooter. Partnerships develop over time, with the benefits of friendship and familiarity of abilities contributing to better hunting experiences. Hunters spot whales when they surface to breathe, either by their contrasting white skin, or by their exhalations, which can be spotted from 200 to 300 yards away. After moving closer, hunters will observe the whale to determine if it is a female with a calf, and will not harass or hunt it if there is a visible calf. Other than if there is a visible calf with the whale, there is no way to determine the sex of the animal. However, groups that have calves are assumed to be groups of related females and groups of whales without calves are assumed to be males. The health of the whale can be determined by observing if the back is concave or convex, where convex back would indicate a particularly thin, and therefore less desirable whale.

Once a whale has been picked out, the driver will move the boat into range of the harpooner to make a throw, as it is required by hunting bylaws to harpoon the whale before shooting. This practice helps to reduce the amount of “struck and lost” whales, as beluga often sink after being killed. The outflow of the Mackenzie River and coastal erosion means that the water of the delta is turbid, with visibility usually reduced to essentially zero. Therefore, the driver cannot rely on directly seeing the whale in the water to follow it, and instead follows the trail of eddies at the surface produced by the fluke of the whale, or by the wave pushed in front of the whale. There is a delay in the appearance of the eddy at the surface and the position of the whale, and the driver must position the boat in anticipation of the whale surfacing. Some hunters are skilled enough to harpoon whales under the water using only these visual cues. Hunters favour the shallowest areas of Kugmallit

Bay due to this phenomena, where the difference between the position of the whale and the eddy at the surface is minimized and whales are not able to dive and change the direction as easily.

“[Beluga] leave wakes behind them, some big ones, they’re easy to follow. . .in dirty water like this from the river it’s the only way to follow them” – Wayne Cockney, 58

The harpooner typically makes a throw at 20–30 ft (6–9 m), with the harpoon line being up to 40 ft (12 m) long with a float attached to one end. The harpoon throw represents perhaps the greatest risk of the hunt, and the harpooner must avoid entanglement in the line as it pays out after a successful strike. After a successful strike, the driver follows the whale as the float attached to the harpoon line tires it, while the harpooner switches to the rifle to make the kill. Hunting bylaws require the use of an appropriately powerful rifle to minimize the suffering of the animal, with hunters typically using .30-30 rifles with 120–150 grain bullets. The shooter aims for the vulnerable area between the blowhole and the eye of the whale to hit the neck as it surfaces to breathe. Whales with thicker maktuk may require more than one shot in the same spot to kill, but the animal is usually killed quickly with 1–3 shots. If possible, hunters wait after the animal has stopped moving to ensure it is dead, as whales have been known to have residual reactions after death, such as snapping their jaws. Hunters pull the whale from the float end of the harpoon line, making sure not to pull too hard and dislodge the harpoon head from the maktuk. Hunters will then tie the whale to the side of the boat from the tail and with a line through the lower jaw, to be towed typically to Hendrickson Island to be sampled and butchered by the whale monitors, or back to town to be butchered by the hunters themselves.

“Just chasing the whale, looking for the whale you want. . .take you about four to five hours, then you get your whale and drag it to the island, takes another four to five hours cutting it up, then you’re ready to go [back to town]” – Roy Cockney, 73

Hunters will wait for specific conditions to hunt whales, which serves to reduce risk to the hunters, increase the chance of success, and avoid the loss of time and fuel from unsuccessful hunts. Ideal conditions are calm, glassy surface water with no wind, at low water (tide), and sunny. A calm surface contributes to more success for hunting activities, namely harpooning and shooting. Calm conditions also reduce the risk to the hunter from boat movement. Low water (tide) enhances the ability of the hunters to follow whales, by reducing the ability of the whales to dive to avoid hunters that are pursuing them. In sunny conditions, it is easier to spot the whales than in overcast or partly cloudy conditions.

“We always try to wait for calm, not too windy, and sunny, cause. . .they’re harder to hunt when it’s cloudy, they’re harder to follow” – Wayne Cockney, 58

Preparation

Inuvialuit primarily eats the skin with blubber (muktuk), the blubber (uqsuq), and the dried meat (mipku) of beluga whales. The fluke and flippers are considered the optional part of the whale. In the past, the head, lungs, and other organs were also consumed. After being towed to Hendrickson Island, the skin/blubber layer is cut off the whale into manageable pieces, typically 2 ft × 2 ft (0.6 m × 0.6 m) in size, with a “handle” sliced into the piece to allow for easier carrying. Depending on the thickness of the

blubber, which can range from 3 to 6 in (7.5–15 cm), these pieces can weigh up to 50 lbs (22.6 kg). The meat of the whale is then cut off in strips, and the meat and muktuk slabs are loaded into the hunters' boat. Inclement weather at this stage can strand hunters on the island, hindering the proper preparation of the meat and muktuk at the hunters' smokehouses back in town. The carcass of the whale is then taken out by boat to deeper water and disposed of.

"You gotta make sure you have everything to be out at the island. . .for four days. . .while you're heading out. . .when you're cutting meat, cutting your whale, the wind could come right up"
– Roy Cockney, 73

The slabs of meat and muktuk are then taken back to town by the hunters, and are allowed to sit overnight to "drain" of excess water, blood, and fat if it is not too hot out. The next day, the slabs of muktuk are then cut into smaller blocks connected at the corners to form a chain of diamond shaped blocks. These chains are then left to hang out of the sun typically for 1–2 days but up to 5 days to tenderize the muktuk.

"Ah well you don't want to be working on your whale when it's too hot. If it's too hot you have to work on it really quick" – James Pokiak, 62

This process also prevents the muktuk from sticking together as much if it is to be frozen. After hanging, the muktuk can be prepared fresh as is, cooked, or aged, before being frozen in ziplocks, plastic pails, or plastic lined cardboard boxes. Cooked muktuk is typically prepared outside on a fire. Muktuk is placed in a large drum or container with water and brought to a slow boil for about an hour. Bringing the water to a boil before adding the muktuk, or too rapid of a boil will result in the separation of the muktuk. The container is stirred occasionally with a large wooden paddle. After cooking, the muktuk is removed from the water and allowed to cool overnight on cardboard or other clean surface. After cooking, the muktuk is then frozen in re-sealable plastic bags in personal chest freezers or in the community ice house.

Aged/fermented, or "stink" muktuk is prepared from fresh muktuk taken from the whale. After rinsing, portion-sized squares of muktuk are layered in five-gallon plastic pails with strips of blubber. The pails are covered with a portion of breathable cloth like cotton to prevent contamination from debris and insects. These pails are kept in a cool, shaded location, typically a personal smokehouse, and stirred at least twice a day depending on the temperature.

"Once you prepare it you gotta watch it, you have to stir your pails [of uqsuq] depending how hot it is, maybe 4 times a day" – Charles Pokiak, 52

The muktuk is aged in this way from 2 to 5 days depending on preference. The muktuk develops a strong smell and a light green colour. Longer aging can result in stronger flavoured muktuk with more distinct and varied colours. Some hunters only age parts of the tail and flippers.

"If you want to age the muktuk. . .if it's aged for two or three days it's pretty good, but if you age it about a week it tastes even better, it's a little stronger" – Roy Cockney, 73

Bubbles forming in the pails indicate botulism, and the pail may have to be disposed of if it is not caught soon enough. Three participants in the study had been hospitalized

due to botulism from beluga, and most of the participants noted they personally knew several community members who had been hospitalized or passed away due to the pathogen.

“And you really have to be on top of looking after your whale when you’re preparing it, cause it don’t take much for the sun to turn it bad eh?” – Peter Nogasak, 70

The beluga meat is typically prepared into whale dry meat, or mipku. The beluga meat is cut into thin strips from larger blocks from the initial butchering. The strips are then salted to protect from insects, and are hung over horizontal wooden poles or on racks, in personal smokehouses. Driftwood is burned to produce smoke, to both preserve and flavour the meat and repel insects. The meat is typically dried by the ambient air temperature, but if it is too cold, the fire is built up to provide heat as well as smoke. If heat is not provided when it is cold, the meat will not dry and may begin to rot. If the mipku has been hung on poles in the smokehouse, the strips must be turned over half-way through the process to ensure even drying. The use of racks has the advantage of precluding this step. Mipku is the preferred preparation method because beluga meat is noted to be quite strong in flavour, but some participants described that the meat could be soaked in water and baking soda overnight to make it more palatable for use in regular cooking.

Harvested whales were utilized more extensively in the past than they are today. A number of participants noted that more of the whale was used, and with corresponding variation in the preparation techniques. The head of the beluga was aged whole in pits in the ground, and was considered a delicacy. Lungs were dried similar to how the meat of the whale is still utilized. The stomach of the whale was dried and could be used as a container, into which combinations of muktuk, mipku, unripe aqpiqs (cloudberries), uqsuq, and dry fish could be stored. One participant noted that they still consume the intestines after cleaning them out and boiling them.

Values

Although the interview guide did not explicitly include questions about the values that participants had surrounding the beluga, it emerged as a consistent theme from the data produced. Some Inuvialuit consider beluga to be staple food, comparable to how potatoes might be a staple food for other people. Several participants noted that the process of hunting and preparing beluga, even if it was hot or buggy out, was made enjoyable in part by knowing that they would be eating well for the winter.

“Its enjoyable for me to go out and hunt, and know that we’ll be eating good all winter. . .It’s a very important food that we need throughout the winter” – Lucky Pokiak, 37

Respect for beluga was a theme throughout the interviews, and participants noted that it was important not to kill an animal for nothing, and to be careful when hunting beluga so that the whale was not lost. This respect for the animal extended to the preparation process, and many participants noted that the hunter had to take responsibility for preparing the animal so that it was not lost to spoilage. Uqsuq, especially for older generations, cannot be replaced with something bought from the store, and some people crave it if they don’t have it often enough.

“And that’s what we live on, that’s our grub, elders can’t go without it, they run out of uqsuq, the blubber, they would ask people, how much craving they have for it” – Roy Cockney, 73

The inclusion of beluga in the diet adds a valued variety from other species such as caribou and fish, and uqsuq is often used as a dip for other traditional foods.

“Yeah we need the [beluga] oil, just like your ketchup” – Charles Pokiak, 52

Many participants noted that they share beluga with their extended families and elders in the community who may not be able to hunt whales themselves. One participant noted that he usually shares his first whale with the community, particularly if he is one of the first hunters to harvest a whale. In the 2016 season, he brought it back to a beach in town, and it was open to the community to take what they liked from the carcass. Some participants noted the importance that whales once had in keeping not only people fed, but also their dogs. One participant noted that 1 year when they still had dog teams, 17 whales were harvested for use between four families, and they “used everything”.

Observations of change

Participants noted a number of changes they have observed, relating to beluga and to the broader biophysical environment. Numerous participants noted the timing of the arrival of the whales in the spring as follow the breakup of the ice from west to east, to be the most striking change. In the 2016 season, whales arrived approximately 2–2.5 weeks earlier than the previous number of years. Participants also noted that whales are thinner in general now than they were in the 1970s and 1980s.

“And the whales then were a lot fatter when I was growing up, there was a lot more uqsuq on them eh?” – Charles Pokiak, 52

In addition to changes noted regarding the whales, almost all the participants noted changes regarding weather patterns. Participants noted that weather is less predictable and changes faster than in the past. In the last 2–3 years, there has been more wind and the wind direction has been changing to more easterly winds. In the same period of time, there has been an increase in cloud.

“It does seem it’s been a lot windier for the past two or three years, more wind and cloud” – Lucky Pokiak, 37

“The weather I find in the past five years really changed and it changes so quick now” – Raymond Cockney, 32

“The weather [has] become unpredictable, day to day, hour to hour sometimes” – Peter Nogasak, 70

Ice conditions have also been changing in recent history. Ice break up is occurring earlier than in the past, and there is less ice overall. With less ice, especially in the case of land fast ice, shorelines are exposed to more wave action, with a subsequent increase in the rates of shoreline erosion. This had led to the loss of Gull Island, located on the west side of Kugmallit Bay. The rough water also affects the whales, which will avoid rough conditions in shallow water by moving to deeper water where the conditions are calmer.

Implications of these changes may be beginning to manifest themselves in beluga harvesting outcomes. General increase in temperature means that some hunters are waiting to harvest later in the season to reduce the risk of botulism. However, participants noted that there is a distinct period of the season where the whales are easiest to harvest, that roughly coincides with the warmest period of the summer, which is typically the first half of July. After this period around the third week of July, the behavior of the whales is noted

to change, and they become “craftier” or “smarter” and are more difficult to hunt. This seems to coincide with the time when the birthing mothers and calves disperse from south of Hendrickson Island when the calves are strong enough to move greater distances.

Discussion

The results of the research are consistent with current understandings of the Beaufort Sea beluga population. Observation of whales is limited to surface behavior by the turbid water conditions in Kugmallit Bay, explaining the lack of knowledge of whales feeding behavior relative to other studies (Huntington et al. 1999). There was a belief among participants that whales know the intentions of people out on the water, fleeing when they are being hunted but sometimes approaching boats that are not carrying guns or harpoons. Belugas' sensitivity to anthropogenic noise was noted by many participants and is a well-documented phenomenon, and an important consideration in the creation of the Kittigaryuit MPA that limits commercial boat and plane traffic in the area (Huntington et al. 1999; Bell and Harwood 2012; Harwood and Kingsley 2013; Harwood et al. 2014). In Buckland, Alaska, harvesters have experienced a steep decline in belugas entering the Eschscholtz Bay, with unmitigated increases in anthropogenic noise in the area implicated as a factor along with overhunting and ice entrapment mortality (Morseth 1997).

Hunting strategies are broadly similar to those described elsewhere, refined over time with hunters having adopted new technologies like outboard motors and high powered rifles (Morseth 1997). Unlike hunting strategies described by Morseth (1997) in Buckland, where modern hunters make most strikes in deep water where their larger boats can pursue whales, hunters in Tuktoyaktuk prefer the shallowest areas of Kugmallit Bay, and describe hunting in deep water as difficult or impossible. These are reflective of the location specific nature of TEK, adapted to local conditions.

Inuvialuit values about beluga are an inseparable aspect of the knowledge of this species that has contributed to the historical and contemporary well-being of Inuvialuit. Inuvialuit in Tuktoyaktuk continue to value beluga as an important part of their environment, culture, and diet. Hunters avoid targeting mothers with calves, and have adopted harpoon-first tactics that adds a challenge to the hunt, but has helped to reduce the struck and lost whales. Great care is taken in the preparation process to avoid wastage, and muktuk, mipku, and uqsuq are generously shared within the community. These values have shaped and continue to direct co-management initiatives in the region, contributing to their momentum and continual improvement that has made them a model of co-management in the Arctic. This local support and enthusiasm for the beluga harvest monitoring program have been instrumental in the wealth of data it has produced that has furthered understandings of beluga in the Beaufort.

Previous TEK studies of beluga did not include information on how people value beluga, something that is recognized as important to better represent bodies of TK and the cultural context in which they are embedded (Nadasdy 1999; Reo 2011). Understanding traditional values and belief systems help to increase mutual understanding between co-managing parties, which is often a major contributor to the success of management partnerships (Reo 2011). Greater understanding between parties may in turn contribute to the improvement of co-management arrangements. The importance of beluga to Inuvialuit contributes to the ongoing success and cooperation of beluga monitoring initiatives in the region. This aspect of TEK shapes and is shaped by the relationship between Inuvialuit and belugas, a relationship that has supported Inuvialuit in the areas for hundreds of years.

The research indicates that Inuvialuit are experiencing changes that are impacting beluga harvesting and preparation activities and are coping thus far, but ongoing or accelerating changes may lead to conditions outside of hunters coping ranges in the near future.

Numerous hunters noted that weather is becoming more unpredictable and unstable, challenging their ability to get out on the water to hunt. Increasing temperatures are challenging to the preparation of uqsuq and muktuk, reducing the time hunters have to prepare the whale. Some hunters indicated that they are changing the timing of their hunts to avoid hot weather days, but others noted that they would still hunt regardless of temperature. However, hunters did note that greater attention and speed were required for the preparation procedure to ensure products did not spoil.

This could lead to fewer hunting opportunities for hunters who prefer not to hunt on hot days. For hunters who are still willing to hunt during hot weather, there could be reduced margins of timing in the preparation process, with associated increased risks of spoilage, food borne illness, and wastage. These risks are not trivial. Hunters invest considerable time, energy, and money into beluga hunting, which sometimes requires several expeditions to secure a whale. The primary pathogen of concern when aging muktuk and making uqsuq is *Clostridium botulinum*, which produces botulinum toxin, one of the most poisonous biological substances known (Nigam and Nigam 2010). All the hunters in the study knew of at least a few members of the community who had passed away or been hospitalized due to botulism.

Ongoing cooperation through the beluga monitoring program may be helping to counteract the impacts of climatic changes on the hunting and preparation processes. Several hunters noted that they and other hunters appreciate being able to bring a whale to the monitoring station on Hendrickson Island to have it butchered by the whale monitors while they take a break and have a cup of tea. This is supported by the high levels of participation the program enjoys, and as a result, its ongoing success in monitoring the health of the beluga population. While hunters are still responsible for processing the raw by-products into finished muktuk, mipku, and usquq, the reduction of what is the most labour intensive part of the preparation process may contribute to the efficiency, and in turn, the success of beluga preparation in the context of a changing climate. One participant noted that towing the whale back to town is slower, which could increase the risk of getting stranded at Hendrickson Island, or being exposed to inclement weather. This would be an additional, if unintended, benefit of the program, one that would help to address ongoing climate stressors.

Conclusion

The aim of this research was to document Inuvialuit TEK of beluga under changing climatic conditions. The research demonstrates that Inuvialuit in Tuktoyaktuk possess in-depth, detailed understanding of beluga whale, particularly regarding effective hunting techniques and subsistence food preparation, and the species remains an important and valued part of the environment. Changes in sea ice dynamics, seasonal temperatures, wind, and the frequency and intensity of extreme weather events have affected beluga hunting and food preparation. The research shows that Inuvialuit are coping with these changes and their knowledge of beluga is continually being updated and modified in light of new observations and experiences.

The impetus for this research is the lack of explicit documentation of Inuit TEK of beluga in the academic literature, despite beluga representing an important aspect of Inuit culture and diet throughout the Canadian Arctic, and particularly in the ISR. This research contributes to efforts to extend Inuvialuit TEK and perspectives to a wider audience, and to contribute to the advancement of beluga co-management in the Arctic that better reflects the knowledge and experiences of Inuvialuit. Some of the knowledge examined in the study reinforces the ability of TEK, as a continually updated source of knowledge, to highlight the novel knowledge, and address the knowledge gaps in current local understandings of

beluga. Similar to how Moore (2008) describes how beluga could be considered a sentinel species for environmental change in the Arctic, TEK can take on the role of sentinel in the realm of observations of change, bringing to light subtle changes in the environment that are often not captured in conventional scientific studies due to cost and time constraints. This research characterizes Inuvialuit knowledge of beluga but the question of how to meaningfully and equitably incorporate Inuvialuit TEK into monitoring and management remains unanswered and should be the focus of future work. The results of this study are situated to further this conversation and to highlight the need for similar studies of TEK of beluga and other species throughout the Arctic.

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2. Sonja K.Ostertag, Lisa L.Loseto, KathleenSnow, JenniferLam, KristinHynes, David VictorGillman. 2018. "That's how we know they're healthy": the inclusion of traditional ecological knowledge in beluga health monitoring in the Inuvialuit Settlement Region. *Arctic Science* 4:3, 292-320. [[Abstract](#)] [[Full Text](#)] [[PDF](#)] [[PDF Plus](#)]