Northern Alaska Sea Ice Project Jukebox: Phase III

Principal Investigator
Leslie McCartney
Elmer E. Rasmuson Library, University of Alaska Fairbanks

Co-Investigator
Karen Brewster
Elmer E. Rasmuson Library, University of Alaska Fairbanks

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UAF
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Contact Information:
email: UAF-CMI@alaska.edu
phone: 907.474.6782
fax: 907.474.7204

Coastal Marine Institute
College of Fisheries and Ocean Sciences
University of Alaska Fairbanks
P. O. Box 757220
Fairbanks, AK 99775-7220

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ABSTRACT

This project created ten oral history interviews with one sea ice scientist and twelve residents of Kotzebue, Utqiaġvik (formerly known as Barrow), Point Hope, Wainwright and Wales, Alaska, about their observations of changing sea ice conditions. The interviews were added to the archives and website interface of the *Northern Alaska Sea Ice Project Jukebox*, a longitudinal qualitative project where recorded observations of changing sea ice in Barrow previously spanned a time period from 1978 to 2013. The inclusion of recordings from residents of Kotzebue, Point Hope, Wainwright, and Wales will serve as a benchmark of observations from those communities. Understanding how the sea ice is changing on the outer continental shelf area around these communities will support future development and management of resources. Additionally, photo and video galleries that show various ice conditions and features were added to the *Northern Alaska Sea Ice Project Jukebox* website.

INTRODUCTION

Sea ice is a key feature of the Arctic ecosystem and has been an essential resource for life in coastal arctic Alaska for thousands of years. Shorefast sea ice provides habitat for marine mammals, influences the food chain for fish, seabirds and marine mammals, and offers access to subsistence foods for northern hunters. Given these important roles in the coastal ecosystem, it is no surprise that the shorefast ice also is a key feature of the icescape for humans. Functioning as an extension of the land, nearshore coastal sea ice (Figure 1) is used as a hunting and traveling platform by Arctic coastal communities (Gearheard et al. 2006; Krupnik 2010) and for the construction of ice roads (Potter et al. 1981; Masterson 2009) and runways used by communities and industry.

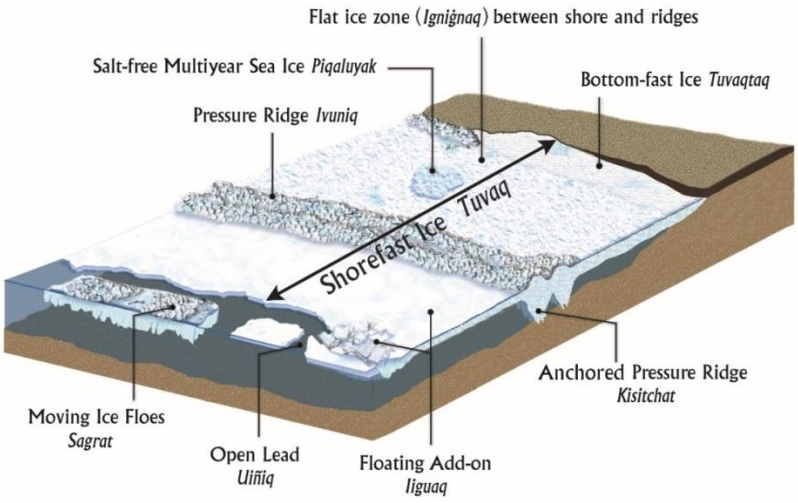

Figure 1: Schematic representation of coastal sea ice in the Chukchi Sea near Utqiaġvik, Alaska (George et al. 2004).

Iñupiat subsistence hunters have relied upon shorefast sea ice as a platform from which to hunt and harvest whales, seals, and walrus to feed their families and communities. Generations of Iñupiat gained knowledge of this dynamic environment, learning to identify and avoid hazards, predicting ice behavior to ensure safe travel, and understanding its seasonal and cyclical processes. Observations from local users highlight the relationship between people and their environment and demonstrate the effect of changing conditions on their behavior and adaptability. Together, such observations offer a multi-layered case study of nearshore and shorefast sea ice conditions in arctic Alaska that can add to long-term understanding of the physical environment.

Arctic Alaska is a focal point for oil and gas development, and an increased rate of sea ice retreat is of great significance to commercial activities. For example, the retreat of year-round sea ice coverage may have implications for access to the Northwest Passage shipping channels. Further, the presence and stability of shorefast sea ice is of considerable importance because it presents a platform for offshore oil and gas activities (Eicken et al. 2009), impacts which

development and spill response methods can be utilized, and offers a place of safe refuge for maritime activities (CRRC 2009).

There has been a significant amount of scientific study of sea ice dynamics and the effects of climate change in the Arctic. Scientific study of sea ice has focused on examining the dynamics of the ecosystem, energy flow, incidental and temporal changes, and climate effects. However, less effort has been directed to understanding how humans have learned to use and interact with ice environments. This project complements the scientific research by providing direct observations on ice characteristics and changes over the past years. It was critical to address, in people's own words, how changes in the sea ice are impacting subsistence and marine resources, how the community is adapting to these changes, and how climate change is affecting the ecosystems (which in turn affects the local people). With this in mind, we posed the following questions to local inhabitants and scientists: How has the sea ice changed in Barrow/Utqiaġvik and Kotzebue since the 1970s? What are the implications for the human use of the environment? Future management regimes can be better planned and implemented when informed by these historical perspectives.

Increased activity in the Arctic and related safety and oil spill concerns require the development of management strategies based on a good understanding of the sea ice environment. Effective responses to hazardous substance spills in coastal, seasonally ice-covered waters continues to be a critical challenge to sustainable offshore development in northern Alaska, yet the understanding of currents and ice motion patterns that could inform emergency response planning remains limited. To address this shortcoming, workshops were held in 2013 in Barrow and Wainwright, Alaska, bringing together scientists and indigenous experts from Barrow, Nuiqsut, Wainwright, and Point Lay to discuss ice conditions and ocean circulation and to share knowledge critical to emergency preparedness and response (Johnson et al. 2014). The workshops broadened the collective understanding of coastal currents, river and lagoon freeze-up, nearshore freezing, and ocean circulation of the Chukchi Sea and Beaufort Sea barrier islands. As demonstrated in these and similar workshops, local knowledge gained from hunting and traveling is rich in detail and complements the larger scales of remote sensing and ice-ocean models. Local and indigenous knowledge, developed from years of sea ice experience whaling and hunting on the ocean, is a substantial resource that can inform and guide sea ice and ocean circulation research and design. Such practical knowledge provides a foundation for efficient fieldwork and resource development and can improve the safety.

This project supports the idea that access to long-term observational records, as found in oral history, can enhance scientific understanding of the environment today (Huntington et al. 2009; Eicken 2010; Johnson et al. 2014). Numerous collaborative projects have demonstrated that scientists and Arctic residents can learn from each other (George et al. 2004; Tremblay et al. 2006; Druckenmiller et al. 2010; Wenzel 2014). This project added to a growing dataset of indigenous observations and experiences that reflect changes occurring in the Arctic's nearshore ice environment, providing an online digital historical record for the future. The new interviews

can be compared with earlier collections to investigate what has changed about the sea ice over the past forty years and how the Iñupiat are adapting to these changes.

Northern Alaska Sea Ice Project Jukebox began in 2013 with funding from the North Pacific Research Board (NPRB). The initial project created archival oral history recordings regarding sea ice offshore from Barrow, making them available through an interactive website (www.jukebox.uaf.edu/seaice, Figure 2). Seventeen recordings were made in 1978 (thirteen people interviewed) to inform research related to sea ice pileups (Metzner and Shapiro 1979; Shapiro et al. 1979). The initial collection also included twelve recordings of local whalers interviewed to inform mapping of sea ice conditions along snow machine trails across the sea ice near Barrow (Druckenmiller 2011). This collection consists of ten people interviewed in twelve recordings. Together, the Shapiro and Druckenmiller oral history collections document a variety of traditional knowledge and include information about seasonal ice conditions in different time periods. The *Northern Alaska Sea Ice Project Jukebox* also includes recordings from in Barrow in 2013. Nine people were interviewed in thirteen recordings that chronicled observations of unusual ice conditions in the winter/spring of 2012–2013. The original project website provided access to historical and current oral history recordings about sea ice in the Barrow/Utqiaġvik region and created a retrospective database of traditional knowledge showing human adaptation to climate change.

Figure 2: Northern Alaska Sea Ice Project Jukebox homepage.

In 2015, NPRB provided funding for Phase II of the Sea Ice Jukebox. This phase added five new oral history interviews from Barrow and five interviews with local sea ice users in Kotzebue. The additional interviews in Barrow provided continuity in documenting changing nearshore sea ice conditions and a record of "unusual" years. This expanding record is useful to researchers trying to understand the ice environment and to social scientists studying human adaptation, decision making, and risk-taking behavior. The Kotzebue interviews initiated documentation of traditional knowledge for this lesser-known section of the northern coast. The interviews are useful as a comparative dataset for a location with vastly different ice conditions than Barrow and as the start of another longitudinal research plan in that area.

The work completed in this project continued collection of local-scale traditional knowledge to augment the earlier *Northern Alaska Sea Ice Project Jukebox* work. It also complements information from joint local expert-scientist workshops such as the Barrow Symposium on Sea Ice (held in 2000, George et al. 2004), Field Techniques for Sea Ice Research (held 2007–2009, Eicken et al. 2009), Experts Workshops to Comparatively Evaluate Coastal Currents and Ice Movement in the Northeastern Chukchi Sea (held in 2013, Johnson et al. 2014), and the Alaska Arctic Observatory and Knowledge Hub Workshop (A-OK, held in 2015, IARC 2015). Recordings from this project complement ongoing ice studies at the University of Alaska Fairbanks Geophysical Institute. By offering detailed discussion and context for specific locations and seasons, the traditional knowledge captured in the *Northern Alaska Sea Ice Project Jukebox* also complements information from local observatory networks such as the Barrow Sea Ice Observatory (http://seaice.alaska.edu/gi/observatories) and the Seasonal Ice Zone Observing Network (SIZONet, http://www.sizonet.org). SIZONet includes a network of Arctic residents who keep a diary of ice observations that are entered into a publically accessible database.

At its core, the *Northern Alaska Sea Ice Project Jukebox* is an educational resource available to anyone with an internet connection. Educating others about the unique and special environments in the Utqiaġvik and Kotzebue areas can lead to an appreciation for, and protection of, the natural resources and subsistence lifestyles and that these communities rely upon. The new interviews from this project expanded the *Northern Alaska Sea Ice Project Jukebox* archive, a longitudinal qualitative project with prior observational recordings from the Barrow area. The *Northern Alaska Sea Ice Project Jukebox* promotes the use of local and traditional knowledge to help understand the nearshore sea ice environment and rescues historical material from the shelves of the archives by digitally preserving it and making it widely available through an easy to use website.

Objectives

The collection of sea ice recordings is valuable for informing ongoing and future collaborative community-based observation and research projects. The goals of this project were (1) to capture traditional knowledge about sea ice in the nearshore environments near Barrow and Kotzebue, Alaska, (2) to record observed changes in the environment, (3) to identify how the

Iñupiat are adapting to these changes, and (4) to consider how this knowledge can be useful in natural resource management and development decision making.

This project created ten oral history recordings from interviews with twelve residents of Kotzebue, Utqiaġvik (formerly known as Barrow)[1], Point Hope, Wainwright and Wales, Alaska (Figure 3), and one sea ice scientist. Additionally, the project added a photo gallery of various ice conditions and features to the Project Jukebox website and supported public presentation of the project in Barrow and Kotzebue.

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Figure 3: Map of communities represented by oral history interviews.

The project fulfilled two recommendations for future study from the 2013 Experts Workshops: document ice seasonality (including slush ice formation and shoreline freezing) and continue to reconcile disparities between the frames of reference, scales of observation, and vocabularies that exist between local experts and scientists when discussing ice and ocean observations (Johnson et al. 2014). The project also addressed issues raised by local experts

[1] Utqiaġvik will be used when discussing the community of today. The name Barrow will be used when discussing the community prior to the adoption of the name of Utqiaġvik on December 1, 2016.

during the 2015 A-OK Workshop, including the need for further study and documentation of changes in the seasonal cycle in the Arctic and a desire for their perspective to be included in future research and development planning discussions (IARC 2015).

The project also addressed CMI framework issues in that it provided a traditional knowledge component to on-going scientific studies that are trying to understand the marine, coastal, and human environments that are potentially affected by offshore oil and gas exploitation or renewable resource development in the Chukchi and Beaufort Seas. This traditional knowledge component can inform development and management approaches to gas and oil resources and help local communities feel more involved in the process. Finally, the project provides traditional ecological knowledge that scientists can use in problem-solving for the protection of natural resources.

This project collected oral history data using the qualitative research methodology of semi-structured, open-ended interviews. The interviews captured both traditional ecological knowledge and western scientific knowledge. Traditional ecological knowledge (TEK) has been defined as "…a cumulative body of knowledge and beliefs, handed down through the generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes 1993:3). As stated by Grant Spearman, a long-time resident of Anaktuvuk Pass and ethnographer of the Nunamiut people, "It [TEK] represents nothing less than the totality of knowledge about the environment, both physical and spiritual, in which a people live" (Spearman 2005). TEK is specific cultural knowledge associated with a particular group of people based on long-term observation and experience of individuals living in a place (Cruikshank 2005; Huntington 2005). Cruikshank (2005) illustrates this point with an example of Mrs. Ned, an elder in her eighties from a southern Yukon First Nation community, who announced at a meeting that she wanted to talk not from paper but from "grandpa" and proceeded to tell her audience about human and environmental history from her own experience. This form of knowledge, an informal and dynamic system for obtaining information essential for continued survival, is passed on through oral communication. This differs from the western scientific approach with its formal system of standardized methodology, hypothesis testing, and written proof of results.

While traditional knowledge relies upon the wisdom of the past, it is important to recognize that it also is shaped, refined, and applied in the present. As the environment changes, people adapt and create new understanding built on their own experiences, knowledge, and relevant pieces of information that have passed down through the generations. In this way, traditional knowledge is ancient and modern, consistent and changeable. It is now widely accepted that TEK and observations of local residents are a helpful resource for scientists trying to understand the natural world.

METHODS

Video and audio recordings were collected during oral history-style, semi-structured, open-ended interviews with participants. The interview protocol included queries about unusual ice features, observations of change, coastal processes, hazards encountered, hunting and travel strategies, the applicability of traditional knowledge, and the need for adaptation. We also focused on unusual ice events that occurred in recent years. Interview guides were developed for northern and western regions (Appendix I and II). The interviews varied in length from thirty-five minutes to two hours, as determined by the availability and comfort of the narrator. All interviews were conducted in accordance with the Oral History Association's Principles and Best Practices for Oral History (http://www.oralhistory.org/about/principles-and-practices/). Each narrator gave their permission for the recording to be archived and made accessible to the public (Appendix III).

One interview was recorded on a digital audio-only recorder in uncompressed .wav at 44,000HZ, 16 bit, and later converted to the web delivery format of .mp3 and ogg. The remaining nine interviews were recorded on a Sony HVR-VU1 HDV DVCAM digital video camera with an external Audio-Technica shotgun condenser microphone to capture the audio. Videocassette recordings were made on 60-minute Sony DV Premium Digital Video Cassettes. Videocassettes were processed through a Sony HDV player with Final Cut Pro software on a Macintosh G5 computer to digitize into .mov formats. The video was then converted to .mp4, .ogv, and .webm for web delivery using EasyHTML5Video software on the Macintosh G5 computer. The original videotapes are archived and stored at Elmer E. Rasmuson Library in a secure, temperature and humidity controlled magnetic media vault. Audio was recorded on a professional-level Marantz Model PMD660 digital recorder with a Lexar Professional CompactFlash (8 GB capacity). Two external Sony Electret condenser lapel microphones (ECM-55B) were used, one for the narrator and one for the interviewer.

Recordings were manually transcribed in Microsoft Word, reviewed, and processed using InqScribed. InqScribe inserts time codes, which are required for synchronized access to the audio/video, written transcript, and table of contents that, together, comprise our online delivery schema. Release agreements and photographs were digitized. All digital files were uploaded into Drupal templates to create online pages. A metadata spreadsheet was continuously updated to track completion of various steps in data processing.

Metadata collected was compiled on a Microsoft Excel worksheet (.xlsx). The metadata details information and process completion relating to each interview recorded for this project. Metadata headings included: name of person recorded, recording number (UAF Oral History Program accession number), interview date, interviewer, language, transcript details, release agreement details, photo details, length of recording, recorded format, InqScribe details, completion of table of contents (for website), biography details, added to website, and further notes.

The recordings were accessioned into the Oral History Collection at the Alaska and Polar Regions Collections & Archives at UAF's Elmer E. Rasmuson Library. This process involved the following steps: assigning a unique number to the recording; creating the series record; cataloging the recordings in OCLC WorldCat library catalog for worldwide access; digitizing all the recordings as noted above; storing the original videocassettes in our secured, humidity and temperature controlled vault for preservation purpose. Backup copies of the digital files are kept on the library's server and separate hard drives for redundancy.

We created the *Northern Alaska Sea Ice Project Jukebox* webpages as follows: a 'Person' page for each person interviewed which includes biographical information, date of birth, and date of death (if applicable); an 'Interview' page, as shown in Figure 4, which contains all the interview's metadata, such as recording number, date of interview, name and photo of interviewee, name of interviewer(s), videographer, transcriber, translator, location of interview, topics discussed, time-coded transcript and table of contents, associated release form, and associated media (audio or video files). Since this project added new material, the existing 'Project' page that explains the project's purpose, identifies the funding source, and includes a list of people interviewed as well as links to related material and associated websites was updated with the new interviewees and related material, and a link to the new photo gallery. The existing 'Project Background' page, which provides more detailed background and acknowledgment information on the project, was also updated. Project generated documents were added to the 'Additional Related Materials' page that includes background information (documents and websites) to help educate users about the broader context of sea ice studies. A new photo gallery was added to the website and videos were added to the existing collection.

Figure 4: Sample interview page.

RESULTS

Funds received in this project allowed us to add ten new interviews to the existing *Northern Alaska Sea Ice Project Jukebox*. These additions broaden the record of seasonal sea ice conditions and provide continuity to the existing longitudinal record. By combining present-day sea ice observations with historical traditional knowledge, scientists and resource developers have an opportunity to better understand the Arctic environment over a long time scale and from a variety of perspectives. Such broad understanding is essential for safe and responsible oil and gas exploration and development and supports scientific research efforts in the outer continental shelf area.

The collection of observational/traditional knowledge recordings from this project offers a broader picture of changing ice conditions in recent years than would be possible from a single season of observations. Recordings from residents of all communities provided first-hand observations of the effect of climate change and personal accounts of resilience and adaptability. In Kotzebue, recordings focused on residents with longer-term knowledge (including elders) who could document historical conditions. This information provides a foundation and context for information from current hunters and travelers who talk about the conditions they face when using the sea ice. As listed below, thirteen people were recorded in ten interviews. Nine interviews were with local ice experts from various communities, and one interview was with an ice scientist in Fairbanks, Alaska.

Kotzebue Interviews

John Goodwin with wife Pearl
Interviewed May 17, 2017

John talks about changing sea ice conditions in Kotzebue Sound, including thinning ice, timing of freeze-up and break-up, and the effect of wind and current. He also talks about hunting ringed seals in the winter on the landfast ice, traveling by boat in the early summer through the scattered ice floes to hunt bearded seal, and how to stay safe on the ice.

Joe Harris, Sr. (left) and Willie Goodwin, Jr. (right)
Interviewed May 17, 2017

Joe and Willie share their observations of and experiences with sea ice in the Kotzebue Sound region. They talk about being on the ice or in a boat hunting seals, and how things have changed in their lifetimes.

Frank “Obbie” Greene
Interviewed May 17, 2017

Obbie talks about sea ice conditions in Kotzebue Sound. He talks about the effect of wind and current and how to stay safe on the ice. He also talks about seal hunting and an experience he had of drifting out on moving ice.

Utqiaġvik Interviews

Roy (left) and Larry “Savik” (right) Ahmaogak
Interviewed June 1, 2017

Roy talks about changing sea ice conditions, including thinning ice, ice piling up, and the effect of wind and current. He also talks about being a whaler and seal hunter, scouting the ice, traveling on the ice, building trails, and deciding on a safe camp location. Savik, Roy’s father, joined in at the end of the interview and spoke about changes in the sea ice and whaling activities during his lifetime.

Wesley Aiken
Interviewed June 3, 2017

Wesley talks about changing sea ice conditions and climate change during his lifetime including thinning ice, ice piling up, and the effect of wind and current. He shares his experiences as a whaler, including scouting the ice, traveling on the ice, building trail, setting up camp, and drifting out on the sea ice. He also talks about seal hunting with a net and how important it was as a hunter to understand the ice environment.

Craig George
Interviewed June 4, 2017

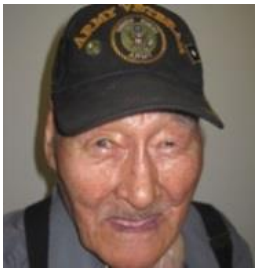
Craig talks about what he has learned about sea ice from Inupiat traditional knowledge during his forty years of living in Barrow and conducting bowhead whale research based on the shorefast ice. He discusses the history of the North Slope Borough’s bowhead whale census project and their efforts to set up observation points and camps in safe locations. He talks about changes in the sea ice, including a lack of multi-year ice, thinning ice, ice pileups and ridging, trail locations, and ice break-off events.

Point Hope Interview

Steve Oomittuk
Interviewed June 2, 2017 (in Utqiaġvik)

Steve talks about sea ice conditions around Point Hope and how they have been changing in his lifetime. He talks about thinning ice, the effect of wind and current, the presence and location of the open lead, and the timing of freeze-up and break-up. He also talked about whaling, their reliance on sea ice, and the effects of climate change.

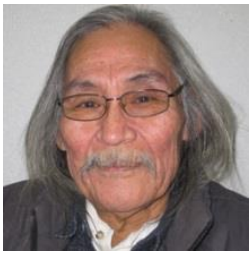
Wainwright Interview



Rossman Peetok
Interviewed June 2, 2018 (in Utqiaġvik)

Rossman talks about how 1969/1970 was the year he first started noticing environmental changes in the Wainwright area associated with warming temperatures. He also talks about being out on the sea ice, the seasonal variations and effects of wind and current, and changes in ice conditions, such as a lack of thick, heavy ice.

Wales Interview



Luther Komonaseak
Interviewed January 24, 2018 (in Anchorage)

Luther talks about his experiences as a whaling captain and hunting on the sea ice around Wales. He talks about the re-introduction of whaling to his community, different ice conditions and ice types, the effect of wind and current, selecting a good spot to whale from, and the importance of paying attention to and observing both the ice and the weather. He also discusses changes he has observed in the ice conditions and his thoughts about the future of the sea ice environment and of whaling. Finally, he expresses how much he wants the young generation to continue their hunting and whaling traditions and how critical it is to ask questions and pay attention to elders in order to learn.

Scientist Interview

Hajo Eicken
Interviewed February 28, 2018 (in Fairbanks)

Hajo talks about his career as a sea ice physicist conducting research on nearshore ice conditions in northern Alaska. Hajo explains ice dynamics and effects of wind and current from a scientific perspective and discusses successful collaborations he has had with the Iñupiat whalers in Utqiaġvik.

A photo gallery consisting of twenty-seven photographs and descriptions was added to the *Northern Alaska Sea Ice Project Jukebox* website (Figure 5). The photos show various ice conditions and features, such as sea ice forming (Figure 6). Ideally, oral history interviews would be done on the sea ice so the narrators could point out the features they are talking about. This is not always possible, so the photo gallery helps create the "on ice" experience. The ice imagery helps listeners who are not familiar with northern sea ice understand the ice types and terminology discussed in the oral history interviews and provides a better context for learning from the material.

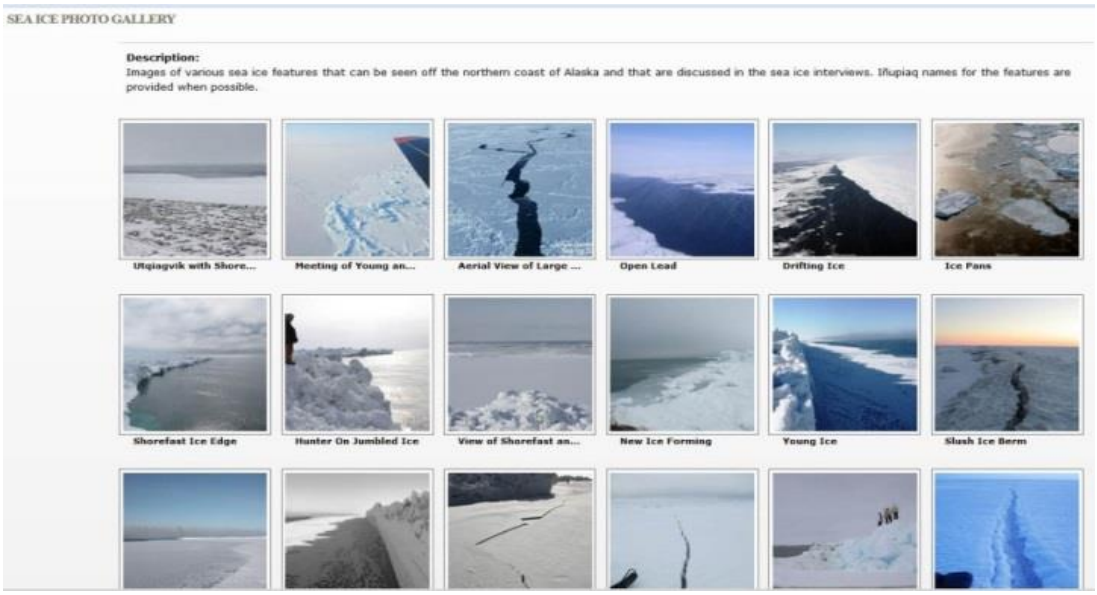


Figure 5: Sea ice photo gallery page**.**

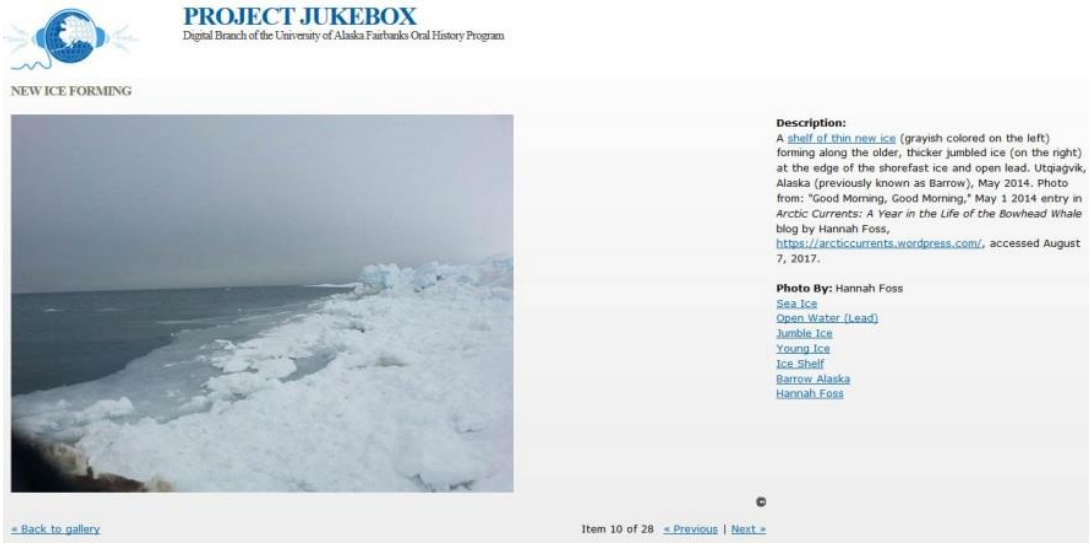


Figure 6: Photo of sea ice forming.

Sixty-two videos were added to the existing video collection. The video gallery page (Figure 7) includes links to videos of related topics, such as the Utqiaġvik sea ice webcam, scientific fieldwork being conducted, elders speaking about ice conditions, animated radar imagery, and videos of seasonal ice conditions shot by local residents. Videos can be viewed by clicking on a thumbnail image.

Sea Ice Secure, episode of the film series *Tied to the Land: Voices From Northwest Alaska* filmed and edited by Sarah Betcher, 2015. This video showcases ways in which local people are seeking adaptive ways to go about their subsistence way of life in the wake of rapid change in sea ice conditions. It is part of a series titled *Sustainable Futures North* that was supported by a grant from the National Science Foundation Arctic Science, Education, and Engineering for Sustainability program (Arctic SEES). (10:14 min.) For other films by Sarah Betcher about Native cultures, subsistence, climate change, and adaptation in Alaska, see the website for her company, Farthest North Films.

Video of elders talking about sea ice in Utqiaġvik, Alaska (previously known as Barrow) in 2008, Part 1 of 2. Excerpt from Dr. Hajo Eicken's Sea Ice Field Course in Barrow, Alaska titled: "Field Techniques for Sea Ice Research International Polar Year 2007-2009." Recorded by Maya Salganek. Speakers include Warren Matumeak, Wesley Aiken, Joe Leavitt and Nancy Leavitt. The video also includes shots out on the ice while talking about conditions, and researcher, Henry Huntington, explaining the project. (6:57 min.)

Video of elders talking about sea ice in Utqiaġvik, Alaska (previously known as Barrow) in 2008, Part 2 of 2. Excerpt from Dr. Hajo Eicken's Sea Ice Field Course in Barrow, Alaska titled: "Field Techniques for Sea Ice Research International Polar Year 2007-2009." Recorded by Maya Salganek. Speakers include Warren Matumeak, Joe Leavitt, and Wesley Aiken. The video also includes shots out on the ice while talking about conditions, and researcher, Henry Huntington, explaining the project. (6:09 min.)

Figure 7: Video gallery page.

Supplementary material added to the Additional Material Related to Sea Ice page included scientific articles, informational websites, and the Wales Sea Ice Dictionary, which includes photographs of ice conditions labeled with Iñupiaq terms for the features.

DISCUSSION

In this phase of the project, we focused on understanding sea ice behavior and human use from a local perspective. For example, the timing of freeze-up and break-up, knowing when it's safe to go out on the ice, the effect of tide on ice formation and stability, the effects of wind and current, the presence of open leads and overflow, particular dangerous spots to avoid, and understanding nearshore landfast ice versus moving pack ice. We also discussed changes in the ice environment observed during someone's lifetime and what that means for access to subsistence resources, as well as the current applicability of traditional knowledge about sea ice.

Utqiaġvik and Kotzebue have many differences in the environment, ice conditions, and subsistence activity. Kotzebue has protected waters in Kotzebue Sound and the freshwater Kobuk Lake, and residents use the sea ice environment for seal hunting, crabbing, and as a travel corridor. Frozen Kobuk Lake is a prime subsistence fishing location. Utqiaġvik and Point Hope face more open ocean conditions with regularly shifting pack ice and leads. They have a long tradition of seal and whale hunting from this dynamic ice, but today there is less seal hunting than in the past and the majority of time spent on the ice is during spring whaling. The interviews with residents of the various communities reflected these differences. For instance, whalers in Utqiaġvik regularly mentioned the loss of multi-year ice (*piqaluyak* in Iñupiaq, shown in Figure 8) whereas it was not discussed as much in the Kotzebue interviews as multi-year ice has always been rare.

Figure 8: Old multi-year ice (*piqaluyak*) incorporated into the shorefast ice. Photo by Matthew Druckenmiller.

Discussion about changes occurring in the Arctic and with northern sea ice was a central focus in the interviews. Two common themes were that ice is much thinner than it used to be and this is affecting subsistence. For example, Frank Greene of Kotzebue echoed other interviews noting, "The ice is a lot thinner than when I first settled in Kotzebue. When it gets thinner, it breaks up easier. And you got to watch the ice that you're on. It's not safe to be out there" (Greene 2017). Rossman Peetok from Wainwright connected thinner ice to climate change when he stated, "In 1970, the ice was still thick. Today you don't see that heavy ice, those big ice floes, anymore. For me, that's the year global warming started" (Peetok 2017).

In Utqiaġvik, Roy Ahmaogak noted that the thinning of pack ice moving in and hitting against the shorefast ice results in less breaking and cracking at the edge (Figure 9) This difference is important for the whalers camped on the shorefast ice. As Roy explained,

> In my early days, we were scared of ice the size of skyscrapers. That was the dangerous ice. Once the ice started coming in, it was heavy and there was nothing that could stop it. Now in this day and age, there's nothing heavy coming in. It's not one big gigantic piece anymore, it's broken up small pieces of pan ice that are not as powerful as one solid mass, so it is not a threat. There's no more heavier ice to pose a risk. Heavy ice back then was something that we should never, ever question. (Ahmaogak 2017)

Figure 9: Drifting ice floes (left in photo) along the edge of the shorefast ice. Photo by Matthew Druckenmiller.

Shortening of the useable ice season was another common theme in interviews. Warmer temperatures in the fall delay freeze-up and warmer spring temperatures cause earlier break-up (Figure 10).

Figure 10: Formation of thin, young ice (*sikuliaq*) in the fall in Utqiaġvik, Alaska. Photo by Matthew Druckenmiller.

> Over the last thirty or forty years, that's a guaranteed easy-to-say fact that freeze-up is happening later every year, and to a lesser degree break-up is happening earlier. So we're shortening our freezing season. In the 1980s, in the fall time, we'd come home in slush ice, and it was already frozen along the beach. Richard Glenn of Utqiaġvik (Glenn 2016)

Today, the ocean is open with no freezing in sight until November or December. Willie Goodwin, Jr. of Kotzebue indicated a similar situation with Kotzebue Sound not freezing all the way across until after Christmas when it used to freeze in October or November. Willie noted that the lack of ice promotes erosion, a serious problem facing coastal communities. "We're getting more fall time storms before freeze up when there's no ice to protect the shoreline" (Goodwin and Harris 2017). On the other end of the season, break-up is occurring sooner and in different ways, which affects subsistence activities. For example, late spring/early summer is prime bearded seal hunting season. Historically, the ice broke up into brash ice, and the seals were hauled out onto ice floes that were easily accessed by boats navigating through the open passages around floating ice chunks. However, as Steve Oomittuk of Point Hope described, this type of hunting is being affected by changes in break-up.

> It seems like the broken pieces of ice used to stay around when it opened up in June, July, but nowadays you don't see it. Once the ice is gone, it's gone. Like in spring 2016, we only had a week of hunting and then the ice was gone. Once the ice is gone, the animals are gone. The ice is everything to us. Without the ice, we wouldn't be who we are. (Oomittuk 2017)

Understanding the effect of wind and current on ice movement is essential for any hunter venturing out onto the ice. Their lives depend on it. For example, in both Utqiaġvik and Kotzebue, south or southwest winds can bring a tidal surge that lifts up the ice and creates pileups that can be extremely dangerous (Figure 11).

Figure 11: A hunter standing on top of jumbled ice at the edge of the shorefast ice. Photo by Matthew Druckenmiller.

Local ice experts talked about what you need to know to be safe on the ice in terms of wind and current. "When ice is coming out from underneath the ice you're standing on, that means the current is eating away at the bottom of the ice. This is dangerous and time to move" (Oomittuk 2017).

During the brash ice season, as Frank Greene experienced when out bearded seal hunting:

> Sometimes if you're in a boat, you'll see the wind going one direction and the ice going the opposite direction. Makes it look like the current has no respect for the wind. One time I saw the ice going one way, and the wind going the other way, I told my uncle let's get out of here. No sooner than we got out of there, then it closed up. (Greene 2017)

While both wind and current have an effect on how the ice moves, the most dangerous situation is when they work together. This can happen in the spring at the edge of the open lead. Wesley Aiken of Utqiaġvik described such a situation in 1957.

> The wind was blowing about ten, fifteen miles an hour from the south, and all of a sudden it started blowing from the west about thirty, forty miles an hour. Suddenly heavy pack ice started coming in towards us on the shorefast ice. It happened fast. The current and the wind were moving together and that ice kept moving. It was getting closer and then the ice *ivu*'d (piled up) right in front of us. That's when it took our boat and I lost all my whaling equipment. (Aiken 2017)

As with the other elements, people mentioned winds and currents are changing. "The currents that we have now, they're a lot swifter. The current's a lot faster because there's no deterrent of

slowing down the current, you know. Back then you had big ice that created the slowing of the current" (Ahmaogak 2017).

Utqiaġvik and Point Hope are at locations where moving pack ice and shorefast ice interact, and ice pileups or pressure ridges (Figure 12, called *ivu* or *ivuniq* in Iñupiaq) were frequently mentioned in the interviews from these communities. Pressure ridges are critical for grounding and stabilizing the ice, but everyone we talked to in Utqiaġvik noted that the ridges are not as tall as they used to be and are less grounded. Wesley Aiken stated that pressure ridges used to be fifty feet high. All of this makes for a less stable platform for hunting. Roy Ahmaogak observed:

> In the past, you'd get tall *ivuniqs* made up of big, thick, monster pieces of heavy ice that would ground to the bottom. *Ivuniqs* created stability within the areas of flat ice. Within the last ten years, the pressure ridges are made of paper thin ice that just all crumbles up so are not capable of grounding totally to the bottom. The highest *ivuniq* that we saw in the last three or four years was less than a story high. Twenty years ago, they would have been three or four times higher. (Ahmaogak 2017)

Figure 12: An ice pileup (*ivu*). Photo by Matthew Druckenmiller.

The ice in Kotzebue Sound is protected from this type of movement, so pressure ridging occurs less often and the ridges tend to be smaller. Ross Schaeffer of Kotzebue mentioned that pressure ridges were important because seals build dens within the broken ice piles. He believes that the seal population has declined due to a lack of ridging in Kotzebue Sound in recent years. Without the protected den sites, seal pups have to stay up on the ice, making them more susceptible to fox predation and death from exposure to the wind and cold (Schaeffer 2016).

Figure 13 shows an example of large break-offs. Large ice break-off events at Utqiaġvik during spring whaling have been happening more frequently in recent years and are often viewed as a new phenomenon, the result of thinning ice and changing environmental conditions. However, the oral history demonstrates that drifting out on the ice is not new or that uncommon. A few examples were mentioned in interviews:

1932 – Seal hunters drift out on moving ice, Cross Island **(**Nashaknik 1978)

1950s – Doc Harris spent a week on ice drifted out from Sealing Point, Kotzebue (Harris 2016)

Date Unknown – Story about a man drifting from Utqiaġvik to Siberia and returning two years later (Aiken 2017)

1960 – Frank Greene and other seal hunters drifting out from Sisualik to off of Cape Krusenstern and returning safely to shore via an ice bridge formed by two pieces of ice coming together (Greene 2017)

1997 – Large break-off event that left hundreds drifting off of Utqiaġvik (Brower, R. 2016; Brower, L. 2016)

1999 – Two seal hunters drift out and are lost in Kotzebue Sound (Schaeffer 2016)

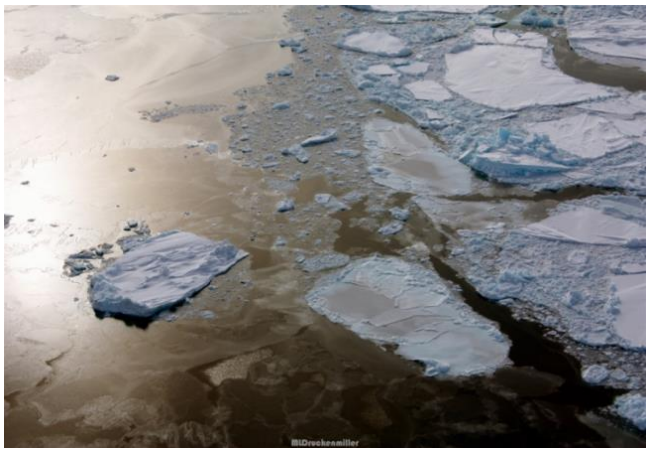


Figure 13: Large pans of ice in the pack ice of the Chukchi Sea. Photo by Matthew Druckenmiller.

Oral history interviews from this project provide significant local knowledge and observations of modern sea ice conditions and perspectives on climate change. Ice safety was also a common theme, and all of the people interviewed emphasized the need for vigilance out on the ice. Comments highlighted the importance of constantly paying attention to wind and weather, checking the current and cracks, and testing the ice thickness before venturing ahead. This knowledge is as relevant today for young hunters as it was for their ancestors, but they will

need to translate and transform this knowledge and skills to apply to what may be the new norm for northern ice conditions.

It appears that, given the less dynamic nature of the ice in Kotzebue Sound and fewer hunters utilizing the ice for seal hunting, we may have interviewed most of the local elder experts who can speak to how conditions have changed over a long time span. Similarly, there are a decreasing number of Utqiaġvik elders available to share stories and memories of how things used to be, and the ice experience of current whalers is often limited to recent years when the ice has been less predictable or stable.

CONCLUSIONS

Recorded observations from ice scientists and local experts from Utqiaġvik and Kotzebue residents regarding changes in ice conditions and subsistence activities provide a strong base for a longer-term cross-sectional longitudinal study. The recordings show the environmental differences between communities; Utqiaġvik and Point Hope have more open ocean conditions with regularly shifting pack ice and leads, and the Kotzebue ice environment is moderated by the protective the waters of Kotzebue Sound. Common themes in interviews included the following:

- Season changes were noted in that freeze-up is later and break-up earlier due to warmer falls and springs. This shortened freezing time makes the usable ice season shorter and reduces time available for subsistence activities on the ice.
- Ice is thinner than it used to be. This has affected subsistence practices as the shorefast ice platforms are less secure to hunt on. When pack ice moves in and hits the shorefast ice, it breaks easier now because it is thin. The combination of no/thinning ice and more storms in the fall has led to greater erosion of the shoreline.
- The wind and currents are strong. The swifter currents are attributed to lack of ice as thicker ice slowed down the currents. The pressure ridges are much smaller and thinner, crumble easily, and are not stable or safe to be on.
- The occurrence of drifting out to sea on ice break-offs or driving is not a new phenomenon. Stories of people drifting out on ice break-offs go back to at least 1932, and even farther in the oral history record of traditional stories shared through the generations.
- All of the narrators emphasized safety; being vigilant out on the ice, paying attention to wind and weather, checking for currents and cracks, and testing ice thickness, as shown in Figure 14. Safety and the understanding of safe conditions are as relevant today as it was for their ancestors.

Figure 14: Cyrus Harris testing the ice in Kotzebue Sound, March 28, 2016. Photo by Karen Brewster.

As has been noted in qualitative research theory, data saturation occurs when a researcher is no longer receiving new information (Glaser and Strauss 1967). After having completed so many interviews in the same communities over a number of years, we have found repetition in the information being gathered, and it is possible that saturation may have been reached. However, this is not unusual in oral history projects of this nature where the main experts are of a particular cohort or age group. While there is a limited number of people with decades of sea ice experience and/or a willingness to participate in public recordings, we recommend a follow-up to this oral history collection in five years to capture changes over that time period.

The efforts from this project and the larger *Northern Alaska Sea Ice Project Jukebox* produced an important resource for use by the public and scientists. For example, Dr. Mahoney (UAF Geophysical Institute) used his participation in the Kotzebue interviews to inform collaboration in a successful grant application for the *Ikaaġvik Sikukun* project, which will co-produce scientific research on the Chukchi Sea with local indigenous experts. The funding from CMI/BOEM has, therefore, been used as leverage for further funding to address questions posed by Mahoney who noted, "We want to address lofty science questions about changing sea ice and its impacts on social and ecological systems but do so in a way that incorporates western and indigenous knowledge" (Mahoney personal communication 2018). Additionally, there has been preliminary discussion with scientists at the National Snow and Ice Data Center (NSIDC) regarding coordination between *Northern Alaska Sea Ice Project Jukebox* and a related NSIDC project in Barrow to share information and results in order to reduce repetition of interviews. Finally, the National Park Service linked to the *Northern Alaska Sea Ice Project Jukebox* on their TEK website (https://www.nps.gov/subjects/tek/websites.htm).

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STUDY PRODUCTS (PUBLICATIONS AND PRESENTATIONS)

Northern Alaska Sea Ice Project Jukebox (www.jukebox.uaf.edu/seaice) website

Brewster, K. *Living with Sea Ice: Voices from Barrow and Kotzebue.* Human Dimensions session, Alaska Marine Science Symposium, January 26, 2017, Anchorage, AK. (oral)

Brewster, K. *Northern Alaska Sea Ice Project Jukebox Phase II*. CMI Annual Research Review, January 27, 2017, Anchorage, AK. (oral)

Brewster, K. *Northern Alaska Sea Ice Project Jukebox.* Public presentation, May 16, 2017, Kotzebue, AK.

Brewster, K. *Northern Alaska Sea Ice Project Jukebox.* Public presentation, June 1, 2017, Utqiaġvik, AK.

Brewster, K. *Northern Alaska Sea Ice Project Jukebox.* Public presentation, Elders/Youth Conference, June 1, 2017, Utqiaġvik, AK.

Brewster, K. *Observations of a Changing Ice Environment in Northern Alaska.* Alaska Marine Science Symposium, January 23–26, 2018, Anchorage, AK. (poster)

Brewster, K. *Northern Alaska Sea Ice Project Jukebox Phase II*. CMI Annual Research Review, January 27, 2018, Anchorage, AK. (oral)

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APPENDICES

Appendix I: Kotzebue interview questions.

1. Describe your seasonal round or annual cycle of subsistence harvest and travel.
2. At what age did you first start going out onto the ice and how did you learn to understand it and know how to be safe on it?
3. Who taught you about ice safety?
4. How do you use the ice, e.g., for sheefish fishing, seal hunting, travel across?
5. Where do you consider the boundary line between freshwater ice and sea ice? Is this the same from year to year?
6. How long is the useable ice season?
7. What marks the beginning of the ice season – how do you know when it's safe to go out on the ice and where might you go?
8. What marks the end of going out on the ice – what happens to let you know that it's time to stop going out, that it's not safe anymore?
9. How many months per year are you out on the ice.
10. How far do you travel?
11. How many months per year are you boating? How far do you travel?
12. Timing of freeze-up. Change in this timing over time.
13. Where ice start to freeze-up? Freeze up first in Sound or Kobuk Lake or ocean? Changes?
14. What do you consider freeze-up, e.g., slush ice forming (*qinu*), ice thick enough for safe travel, Kobuk Lake frozen, Kotzebue Sound frozen, shorefast ice forming?
15. Timing of break-up. Changes over time.
16. Where does it break up first and what effect does this have on other places? Effect of large rivers open first and water run onto Kobuk Lake/ Sound causing melting while Sound choked with ice and water of breakup?
17. *Suppi* – flooding at mouths of creeks in spring
18. How do you know when the ice is safe to go out on it? Indicators that you look for, e.g., color, air temperature, time of year, etc.?
19. What ice conditions would make you decide not to go out on the ice? Is this different for Kobuk Lake vs. the Sound out from Kotzebue vs. the sea ice off of Sealing Point?
20. Can you talk about lifting of the ice. What that is and when it happens, and what effect it has on your seasonal activities?
21. Effect of tide on ice formation and stability in Sound or ocean?
22. Presence of open leads in the ice of the Sound? Inner vs. Outer Sound. Utilized for hunting?
23. Effect of channels in the Sound on ice behavior, freezing and breakup?
24. Presence of smooth ice versus ice with many cracks in it? What does this means in terms of how the ice is used? Safe to be on or avoided? Lot of hunting there or poor hunting?
25. Effect of winds and/or current on ice conditions. Good wind versus bad wind. Wind direction that raises water level, causes flooding, brings in ice, drops water level, pushes out ice.
26. Effect of large Fall storms breaking up ice on Sound? Change in frequency of such storms.
27. Are there particular areas of rough ice that occur regularly and that are avoided by travelers? What do if come to rough ice?

28. Particular dangerous spots taught to stay away from?
29. Presence of overflow on the Sound or Lake ice? How to avoid it? What to do when come across it?
30. Do folks still go to Sealing Point for *ugurk* and *natchiq* hunting? When do they go and how do they get there, e.g., snow machine or boat? Do folks still camp out on the ice there for extended periods like they used to or do they come back to town?
31. Ice conditions at Sealing Point for spring seal hunting: shorefast ice, drifting pieces of broken ice?
32. Have there been years when the landfast ice does not form? If so, how does this affect your hunting and travel?
33. Seal breathing-hole hunting? How much still done? Where find breathing holes and how know where and how to find them?
34. Distance of landfast ice in Chukchi Sea and presence of leads?
35. Stability of ice cover in the Sound, safety of ice edge, presence of leads?
36. Changes in the ice (e.g., thinning) and what does this mean for subsistence activities and life in Kotzebue. Is thinning ice bad?
37. Frequency of hunters drifting out on ice historically, more recently?
38. Ice push-up (*ivu*) events happen in Sound or open ocean? (Uhl mentioned in May 25, 2003 journal entry)
39. Heard about elders warning and tradition of not venturing out onto ocean ice until January or after Christmas. People still do this? Why is this important? Still applicable or is there another date/time used as cut-off?
40. Have you changed any of your hunting activities because of changing ice conditions, e.g., hunt for seals by boat in summer vs. breathing holes in winter; broken ice of spring/early summer not around long enough for seals to be present and to be able to get boats out; having to hunt bearded seal in open water vs. broken ice which leads to more loss and sinking.
41. Has the timing changed in terms of when seals and walrus are around, and how has that affected your hunting of them?
42. Has your ability to access hunting areas been affected by changing sea ice, e.g., no ice present or too thin to be out on when the animals are here?
43. Can you talk about changes you may have seen during your lifetime in the ice conditions off of Kotzebue (timing of freeze-up and break-up; length of ice season; smooth vs. rough ice; more or less frequency of mid-winter open water)?
44. Has your hunting or use of the ice changed because of this? If so, how?
45. What are some of the key things you have learned during your lifetime or from elders about ice survival and being safe while on it (predicting, assessing, and forecasting)?
    a. Are you still able to apply this knowledge today?
    b. If not, then what are you doing differently?
    c. How are you learning new skills and behavior?
46. Is this traditional knowledge about ice still useful? Is it still being passed on to kids today? How might you think this transfer of knowledge could be improved? Could this project help in any way?
47. What are the important things that you are teaching young hunters today about understanding and living with and on the ice?

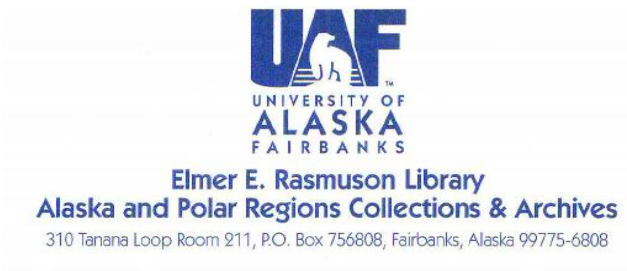
48. Role of observing the ice during freeze-up and through the winter as way to understand what is happening out there and be a predictor for spring hunting conditions?
    i. What has been happening this fall/winter with the ice?
    ii. What are conditions like now?
    iii. How are things shaping up for the upcoming spring season?
49. 2000 and 2001 when ice locks up and can travel all the way across
50. 10 most important Inupiaq terms for different types of ice or understanding of ice
51. Do you have different terminology for ice in Kobuk Lake, versus Kotzebue Sound, versus the ocean ice off of Sealing Point?
52. Marking of trails/ice roads. Routes maintained by NWAB?
53. Are there any things you've observed in relation to ice conditions that you have questions about and would like to see a scientific research project done on?
54. Something that you've observed that you've wondered about and that science might be able to help explain?

Appendix II: Utqiaġvik interview questions.

1. Personal background: when and where born, what age when first went onto the ice/went whaling, how did you learn about ice safety and travel, from whom did you learn?
2. In general how would you describe the landfast ice last spring and this year?
    a. Conditions at the lead edge, pack ice interaction, presence of multi-year ice, grounded ridges, amount of level ice versus pressure ridges?
    b. How was this different or unusual?
3. In general, were conditions good for whaling in the Spring of 2015?
    a. Did conditions prevent you from whaling during parts of the whaling season (prevailing west winds keeping lead closed)?
    b. Were you prevented from whaling during what is normally considered favorable winds (east/ northeast)?
4. Was last spring season's landfast ice easier or more difficult to travel on?
    a. Is the landfast ice getting smoother every year or was last year exceptional with rough ice?
5. What role did the winds play in creating last year's ice conditions?
6. What role did the currents play in creating last year's ice conditions?
7. What determines whether it is a year where the shorefast ice is well grounded with a lot of big ridges versus years when the ice doesn't appear well grounded?
8. What drives whether or not there are large rows of ridges off Barrow?
9. Have you noticed any changes during your lifetime in how the ice between Barrow and the Point develops versus the ice further to the south – between Barrow and Monument? What about north of the Point?
10. What are the things you look for to determine if the ice is safe to be on, such as color, testing the thickness, wind direction, testing current flow in cracks, etc.?
    a. When do you usually first go out on the ice?
    b. When do you decide it is safe enough and what factors effect that decision?
11. Do ice conditions effect your decision to go out whaling or not?
12. If the ice is thin, do you consider that unsafe and so you won't go out?
13. If there are a lot of cracks?
14. Being on younger ice attached to landfast and no pressure ridges that may be more likely to break-out?
15. Where did your whaling crew hunt in spring 2015? Which trail(s)?
16. Why did your crew choose the area that you did?
17. Tradition or habit, safe spot, or good for hunting?
18. What type of ice conditions do you prefer for locating your camp?
19. What types of ice did your trail cross?
    a. Major ridges, cracks, level young ice, etc.
    b. How easy was your trail to negotiate with a snow machine? Straight or windy, narrow or wide?
    c. Was travel easier or harder because of the ice conditions?
20. How much work went into building your trail in Spring 2015 in relation to past years?
    a. Start and end dates, how many people, how many hours, etc., length of trails, number of trails, location of trails
    b. Did you change trails during the season? If so, why?

    c. How did ice conditions last year effect the work going into trail preparation (i.e., have to move more so make new trails versus make one trail and use throughout season)?
    d. Did your crew join with another crew for part of the trail building?
    e. Differences from past?
21. What was your assessment of safety and stability at the time you made your trail and established camp?
    a. Did the ice conditions effect your decision to go out whaling or not?
22. Did your crew have a designated spot to relocate the camp if conditions at the ice edge or along the trail were unfavorable? Where on map?
    a. Did your crew have to evacuate the ice or pull back to a safe camp? How many times? Where did you go?
23. What was the ice like at the lead edge where you had your camp?
    a. Was the ice there thick enough to haul a whale onto?
24. Did you use any informational products this year, such as NWS forecasts, satellite imagery, the UAF sea-ice radar, etc.?
    a. What other types of information would be useful (e.g., information of roughness, thickness, stability)?
25. After there is a large ice break-out event, such as happened in February 2013, how do you decide when it is safe again to go back out on this area?
26. If these types of ice conditions (no multi-year ice, little grounded ice, more frequent early break-outs) are the new trend, what do you see as the future of whaling from sea ice?
27. Can you talk about changes you may have seen during your lifetime in the ice conditions off of Barrow (less multi-year ice, less grounded ice, more frequent break-outs, later freeze-up)?
    a. Has your whaling or use of the sea ice changed because of this? If so, how?
28. What are some of the key things you have learned during your lifetime or from elders about sea ice survival and being safe while whaling (predicting, assessing, and forecasting)?
    a. Are you still able to apply this knowledge today?
    b. If not, then what are you doing differently?
    c. How are you learning new skills and behavior?
29. What are the important things that you are teaching young whalers today about understanding and living with and on the ice?
30. Role of observing the ice during freeze-up and through the winter as way to understand what is happening out there and be a predictor for spring whaling conditions?
31. What has been happening this fall/winter with the ice?
32. What are conditions like now?
33. How are things shaping up for the upcoming whaling season?
34. Have you changed any of your hunting activities because of changing ice conditions, e.g., hunt for seals by boat in summer vs. breathing holes in winter; broken ice of spring/early summer not around long enough for seals to be present and to be able to get boats out; having to hunt bearded seal in open water vs. broken ice which leads to more loss and sinking.
35. Has the timing changed in terms of when seals and walrus are around, and how has that affected your hunting of them?
36. Has your ability to access hunting areas been affected by changing sea ice, i.e., no ice present or too thin to be out on when the animals are here?

Appendix III: Oral history release agreement



(907) 474-6773
FAX (907) 474-6365
fyapr@uaf.edu
www.library.uaf.edu

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the sound use of our land and water resources, protecting our fish, wildlife and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.

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