"The Way We See It Coming": Building the Legacy of Indigenous Observations in IPY 2007–2008

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ABSTRACT. All early International Polar Year/International Geophysical Year (IPY/IGY) initiatives were primarily geophysical programs and were exemplary products of the long-established paradigm of "polar science." Under that paradigm, scholarly data to be used in academic publications were to be collected by professional scientists and/or by specially trained observers. Arctic indigenous residents had hardly any documented voice in the early IPY/IGY ventures, except by serving as "subjects" for museum collecting or while working as dog-drivers, guides, and unskilled assistants to research expeditions. Natural scientists with strong interest in Native cultures were the first to break that pattern and to seek polar residents as a valuable source of expertise on the Arctic environment. The Smithsonian has a distinguished tradition in working with indigenous experts and documenting their knowledge, from the days of the First IPY 1882–1883 to the most recent projects on indigenous observations on Arctic climate change. The paper explores the unique role of IPY 2007–2008 and of recent efforts focused on the documentation of indigenous knowledge of Arctic environment and climate change, by using the experience of one IPY project, SIKU—Sea Ice Knowledge and Use—and research collaboration with local Yupik Eskimo experts from St. Lawrence Island, Alaska.

INTRODUCTION

This paper explores the emerging links among Arctic people's ecological knowledge, climate change research, and cultural (or "social science") studies in the polar regions. Residents of the Arctic are no strangers to today's debates about climate change and global warming (Kusugak, 2002; Watt-Cloutier, 2005). Their knowledge on the Arctic environment is being increasingly sought as a source of valuable data for documenting and modeling Arctic climate change (ACIA, 2005). Still, such a rapprochement is not yet an established practice, as many scientists still view Arctic people's perspectives on climate change as merely "anecdotal evidence."

Social science's interest in Arctic people's observations of climate change is, similarly, a rather recent phenomenon, barely 10 years old (McDonald et al., 1997). Of course, Arctic residents have been observing changes and reflecting upon fluctuations in their environment since time immemorial. Their knowledge, however, has been "archived" within northern communities and was transmitted in indigenous languages via elders' stories, personal observations,

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and information shared among hunters. As scientists became increasingly attentive to indigenous perspectives on Arctic climate change, several barriers to productive dialog and communication had to be overcome (see discussion in Krupnik, 2002; Laidler, 2006; Oakes and Riewe, 2006). Over the past decade, this new emerging collaboration produced numerous papers, volumes, collections, documentaries, interactive CD-ROMs, and museum exhibits (Figure 1; Ford et al., 2007; Herlander and Mustonen, 2004; Gearheard et al., 2006; Huntington and Fox, 2005; Krupnik and Jolly, 2002; Laidler, 2006; Laidler and Elee, 2006; Oakes and Riewe, 2006.

One of the key tasks of the International Polar Year (IPY) 2007–2008, articulated in its many documents, is to explore how data generated by polar residents can be matched with the observations and models used by polar scientists (Allison et al., 2007:51–52; International Council for Science, 2004:18). For the fist time, the IPY science program includes a special research theme with a goal

> to investigate the cultural, historical, and social processes that shape the sustainability of circumpolar human societies, and to identify their unique contributions to global cultural diversity and citizenship. (International Council for Science, 2004:15; Krupnik et al., 2005:91–92)

The new IPY includes scores of science projects focused on the documentation of indigenous environmental knowledge and observations of climate change (Hovelsrud and Krupnik, 2006:344–345; Krupnik, 2007); it serves as an important driver to the growing partnership between Arctic residents and polar researchers. Many Arctic people also see IPY 2007–2008 as the first international science venture to which they have been invited and one in which

FIGURE 1. New public face of polar science, the exhibit *Arctic: A Friend Acting Strangely* at the National Museum of Natural History, 2006. (Photograph by Chip Clark, NMNH) their environmental expertise is valued and promoted. This growing partnership in the documentation of polar residents' observations of climate change is widely viewed as a cutting edge of today's Arctic social and cultural research.

SOCIAL SCIENCES IN EARLIER INTERNATIONAL POLAR YEARS

All previous International Polar Year initiatives in 1882–1883, 1932–1933, and, particularly, the International Geophysical Year (IGY) in 1957–1958, were framed primarily, if not exclusively, as geophysical programs focused on meteorology, atmospheric and geomagnetic research, and later, glaciology, geology, space studies, oceanography, and sea ice circulation studies (Fleming and Seitchek, 2009, this volume). We have hardly any record of Arctic residents' involvement in previous IPYs, other than serving as guides, manual laborers, unskilled assistants, or being prospects for ethnographic collecting. None of these earlier IPY ventures organized primarily by meteorologists, geophysicists, and oceanographers considered the documentation of indigenous perspectives on Arctic environment a valid topic for scholarly research.

Nevertheless, social scientists and polar residents can justly claim a solid IPY legacy of their own that goes back to the first IPY of 1882–1883. Half of the 12 IPY-1 observational stations and four "auxiliary" missions that operated in the Arctic produced substantial, often extensive, accounts on local populations and their cultures (Barr, 1985; Krupnik et al., 2005:89–90). Four seminal ethnographic monographs, including three on Arctic indigenous people, were published as direct outcomes of the First IPY (Boas, 1888; Murdoch 1892; Turner 1894), in addition to several chapters in expedition reports, scores of scholarly articles, and popular accounts (Barr 1985; Burch, 2009, this volume). Some of these contributions—like those by Murdoch and Ray on Barrow; Tromholt (1885) on Kautokeino, Norway; and Bunge (1895) on the Lena River Delta—were illustrated by photographs and drawings of local communities, people, and cultural landscapes (Wood and Overland, 2007). Today, such records are treasures to museum curators, anthropologists, and historians, but even more so to local communities as resources to their heritage education programs (Crowell, 2009, this volume; Jensen, 2005).

Perhaps the most influential social science contribution to IPY-1 was the research of Franz Boas, a German-born physicist and, later, the founding figure in American anthropology. In 1883, Boas volunteered to do a post-doc study in human geography among the Canadian Inuit as a follow-up to the German IPY-1 observation mission on Baffin Island (Cole and Müller-Wille, 1984; Müller-Wille, 1998). Boas' research among the Baffin Island Inuit in 1883–1884 introduced to polar science much of what constitutes today the core of the "human agenda" of IPY 2007–2008: the study of indigenous knowledge, adaptation, culture change, and Arctic people's views on the environment. There is no wonder that Boas' monograph on the Central Inuit of Arctic Canada (1888/1964), as well as books by Murdoch on the people of Barrow (1892/1988) and by Turner on the Inuit and Innu of Ungava Bay (1894/2001), remain, perhaps, the most widely cited publications of the entire IPY-1 program. It is also no accident that these IPY-1 monographs on Arctic indigenous people and their cultures were published by the Smithsonian Institution. They also remain the only science writings from the First IPY that were ever read and used by Arctic indigenous people, prior to the recent "rediscovery" by the Norwegian Sámi of Sophus Tromholt's photographs of Kautokeino in 1882–1883.[1]

SMITHSONIAN AT THE POLES

The Smithsonian Institution has a distinguished record of pioneering cultural research and collecting in the Arctic (see Fitzhugh 2002; 2009, this volume). By the time of the first IPY 1882–1883, the Smithsonian had established productive partnerships with many federal agencies, private parties, and individual explorers (Fitzhugh, 1988b; Loring 2001). The connection to the Signal Office of the War Department was essential to the Smithsonian involvement in the first IPY, since the Office was put in charge of the preparation for two U.S. IPY expeditions to Barrow and Lady Franklin Bay in 1881. Dr. Spencer Baird, then Smithsonian Secretary, immediately seized the opportunity to advance the foremost role of the institution in national polar research and to expand its Arctic collections. The Smithsonian was instrumental in selecting natural scientists for both U.S. missions and in training them in conducting observations and collecting specimens.[2] According to the Secretary's Annual Reports for 1883 and 1884, the Smithsonian assumed responsibility for the natural history component of both U.S. IPY missions and of their collections (Baird 1885a:15–16; 1885b:15). Baird's relationship with John Murdoch, one of two natural scientists of the Point Barrow IPY team, is very well documented (Fitzhugh 1988a, xiv–xxix; Murdoch 1892:19–20). Lucien Turner's one-man mission to Ungava

Bay was primarily a Smithsonian (i.e., Baird's) initiative (Barr, 1985:204; Loring, 2001:xv).

To the returning IPY missions, the Smithsonian Institution offered its facilities, libraries, and the expertise of its curators for processing the records and specimens; for these and other efforts the Institution was designated to receive all of the collections brought from the north. The Barrow natural history collections were monumental, as were Turner's from Labrador.[3] The ethnological portion of the Barrow collection (1,189 specimens upon the original count[4]—see Crowell, 2009, this volume) is the second largest in the National Museum of Natural History (NMNH) Alaska ethnology collections, and Turner's IPY collection (530 objects) is the second largest among the ethnology acquisitions from Canada. Even most of the ill-fated Greely mission's natural history specimens, including some 100 ethnological objects (Greely, 1888:301–317) and personal memorabilia, ended up in the Smithsonian collections (Neighbors, 2005). All three U.S. IPY missions also produced several dozen photographs that are among the earliest from their respective areas.[5]

By the very scope of their assignments, early IPY scientists combined instrumental meteorological observations with natural history research and collecting; hence, the changes in local climate and natural environment may have been on their minds as well. We know that Boas was deeply interested in Inuit perspectives on their environment. He had been systematically documenting Inuit knowledge of sea ice, snow, weather, place-names, and navigation across the snow/ice covered terrain as part of his research program (Cole and Müller-Wille, 1984:51–53), very much like many IPY scientists are doing today.

In 1912, 30 years after Murdoch and Turner, Smithsonian anthropologist Riley Moore visited St. Lawrence Island, Alaska, and worked with a young hunter named Paul Silook (Figure 2). Silook assisted Moore in translating elders' stories about the famine of 1878–1879 that killed hundreds of island residents (Moore, 1923:356–358). Some scientists believe that the famine was caused by extraordinary sea ice and weather conditions that disrupted the islanders' hunting cycle (Crowell and Oozevaseuk, 2006). In the late 1920s, another Smithsonian scientist, Henry Collins, partnered with Silook in search for local knowledge about the early history of island's population. Collins also asked Silook to maintain a personal diary with the records of weather conditions; this diary has been preserved at the Smithsonian National Anthropological Archives (Jolles, 1995). Silook may have told Collins about the catastrophic storms that destroyed his native village of Gambell in 1913 and other extraordinary events, which he described to other scholars in later years (Krupnik et al., 2002:161–163).

FIGURE 2. Paul Silook, *Siluk* (1892–1946), worked with many scientists who came to his home village of Gambell over more than three decades, between 1912 and 1949. (Photograph by Riley D. Moore, 1912, Smithsonian Institution. NAA, Neg. # SI 2000-693)

CONVERTING LOCAL OBSERVATIONS INTO "IPY SCIENCE"

If partnership between Arctic residents and polar researchers in IPY 2007–2008 is to bring tangible benefits to both sides, each party has to understand how the other observational system works. This implies certain steps needed to make the two systems compatible or, at least, open to data exchange. Local knowledge, very much like science, is based upon long-term observation and monitoring of dozens of environmental parameters, in other words, upon multifaceted data collection. By and large, indigenous experts follow many of the same analytical steps, though in their specific ways (Berkes 1999:9–12). Much like scientists, local hunters exchange individual observations and convert them into a shared body of data. They analyze the signals of change and seek explanations to the phenomena they observe (Krupnik 2002; Huntington et al., 2004).

When the first projects in the documentation of indigenous observations of Arctic climate change were started, scientists were literally overwhelmed by the sheer wealth of local records. As a result, much of the early work on indigenous observations, up to 2003–2005, focused on the mere documentation of various evidence of change coming from different areas.[6] Next, scientists tried to apply certain tools, such as typologies, maps, and matrix tables arranged by ecosystem component, to compare reports from different areas (McDonald et al., 1997:46–47; Krupnik and Jolly, 2002; Huntington and Fox, 2005). These first applications of scientific tools illustrated that Arctic residents observe a consistent pattern of change and that they interpret the phenomena they observe in a comprehensive, integrated manner. It also became clear that local people have documented rapid change in the Arctic environment in a profound and unequivocal way.

The next step in scientists' approach to indigenous records is to look for cases and areas where indigenous and scientific data *disagree* and offer differing, often conflicting interpretations (Huntington et al., 2004; Krupnik and Ray, 2007; Norton, 2002). This approach reveals certain features of indigenous versus scientific observation processes, such as differences in scaling, in the use of prime indicators, and in causes and linkages cited as explanations in two knowledge systems. It also offers a much more systemic vision that goes beyond a popular dichotomy that contrasts *local* or *traditional ecological knowledge* (TEK) and the scientific knowledge. Under such vision, the former is usually labeled "intuitive, holistic, consensual, and qualitative," whereas the latter is perceived as analytical, quantitative, and compartmentalized (Bielawski, 1992; Krupnik, 2002:184). While these labels contain some truth, Native experts have demonstrated repeatedly that they can effectively operate with both types of records and that they often match them more skillfully than scientists do (Aporta and Higgs, 2005; Bogoslovskaya, 2003 Krupnik and Ray, 2007; Noongwook et al., 2007).

Scientists commonly argue that Arctic people's records of climate change would be a valuable contribution to IPY 2007–2008 (Allison et al., 2007). Still, such accommodation requires substantial mutual adjustment of observational and analytical practices. Scientists have to accept that data generated by local observers are crucial to cover certain gaps in instrumental or satellite records, despite some reservations with regard to how local observations are collected and transmitted. From their side, Native experts participating in joint projects have to acknowledge certain standards of science data collection, like consistency, transparency, and independent verification. Here the gap is indeed serious, since indigenous observations are mostly non-numerical, are freely and widely shared within the community, and are rarely if ever reported in writing (Bates, 2007:89–91). Because of these and other factors, indigenous records can rarely be tested by scientists' analytical procedures, like long-term series, statistical averaging, correlation, and trend verification, among others.

Also, indigenous observers have their specific "terms of references" when assessing the validity of their data, such as individual life experience, community-based memory, or verification by elders or individual experts (Noongwook et al., 2007:48; Gearheard et al., 2006). Nevertheless, the sheer volume of data to be generated by many participatory projects in IPY 2007–2008 has already triggered efforts to develop procedures and standards for local observations and for management of indigenous records.[7]

SIKU—SEA ICE KNOWLEDGE AND USE

The experience of one such project illustrates what scientists can learn from local experts and how indigenous knowledge may advance IPY science. "Sea Ice Knowledge and Use: Assessing Arctic Environmental and Social Change" (SIKU, IPY #166) is an IPY project aimed at the documentation of indigenous observations of Arctic climate change, with its focus on sea ice and the use of ice-covered habitats by polar residents. The project's acronym SIKU is also the most common word for sea ice (*siku*) in all Eskimo languages, from Bering Strait to Greenland. As a collaborative initiative, SIKU relies on partnership among anthropologists, geographers, and marine and ice scientists from the United States, Canada, Russia, Greenland, and France, and indigenous communities in Alaska, Canada, Greenland, and Russian Chukotka. SIKU is organized as a consortium of several research initiatives supported by funds from various national agencies. The project was started in winter 2006–2007 and it will continue through 2008 and 2009. The Alaska-Chukotka portion of SIKU has its three hubs at the Smithsonian Arctic Studies Center (managed by Igor Krupnik), the Russian Institute of Cultural and Natural Heritage in Moscow (Lyudmila Bogoslovskaya), and the University of Alaska, Fairbanks (Hajo Eicken). The Canadian portion of SIKU is called Inuit Sea Ice Use and Occupancy Project (ISIUOP); it is coordinated by Claudio Aporta and Gita Laidler at Carleton University, Ottawa (see http://gcrc.carleton.ca/isiuop).

Research under the SIKU-Alaska and SIKU-Chukotka program takes place in several local communities, such as Gambell, Shaktoolik, Wales, Shishmaref, Barrow, Tununak, Uelen, Lavrentiya, Sireniki, and so on (Figure 3). It includes daily ice and weather observations, collections of Native terms for sea ice and weather phenomena, documentation of ecological knowledge related to sea ice and ice use from elders and hunters, and searches for historical records of ice and climate conditions (see http://www.ipy.org/index.php?ipy/detail/sea_ice_knowledge_and_use/). This paper examines the contribution of one of such local SIKU observers, Leonard Apangalook Sr., a hunter and community leader from the Yupik village of Gambell on St. Lawrence Island, Alaska. Apangalook, 69, is a nephew of Paul Silook and he continues an almost 100-year tradition of his family's collaboration with Smithsonian scientists (Figure 4). Since spring 2006, Apangalook has produced daily logs on sea ice, weather, and local subsistence activities in his native community of Gambell. His personal contribution to the IPY 2007–2008 now covers two full "ice years," 2006–2007 and 2007–2008, and will hopefully extend into 2008–2009.

St. Lawrence Island residents' knowledge of sea ice has been extensively documented in recent years via several collaborative projects with two local Yupik communities of Gambell and Savoonga (Huntington, 2000; Jolles,

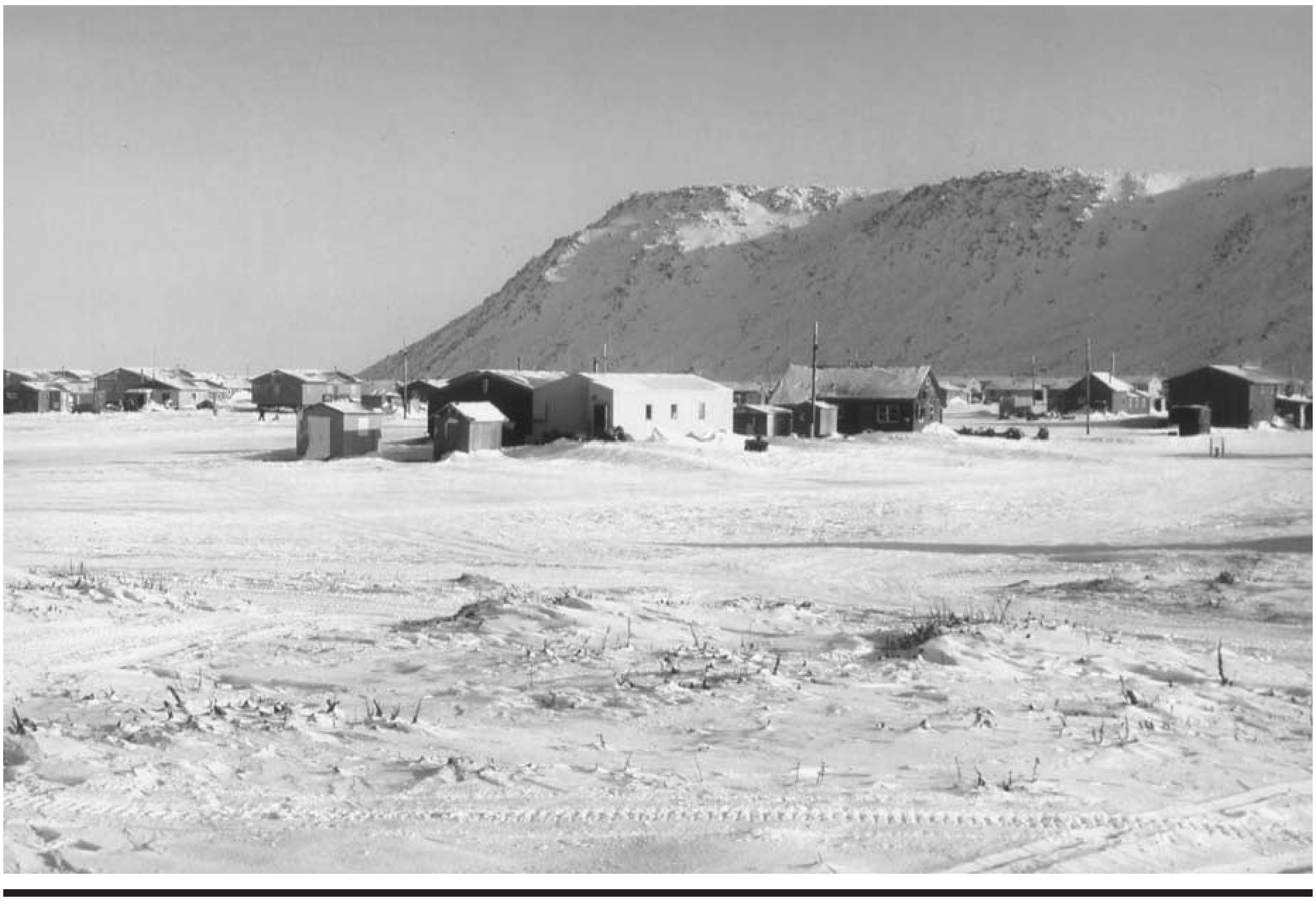

FIGURE 3. The Yupik village of Gambell on St. Lawrence Island, Alaska, is one of the key research "sites" for the SIKU project. (Photo, Igor Krupnik, February 2008)

FIGURE 4. Leonard Apangalook Sr., SIKU participant and local observer in the village of Gambell, St. Lawrence Island (courtesy of Leonard Apangalook).

1995; 2003; Krupnik, 2000; 2002; Krupnik and Ray, 2007; Metcalf and Krupnik, 2003; Noongwook et al., 2007; Oozeva et al., 2004). The island people have long voiced concerns about shifts in the local environment they observed and about the growing impact of climate change upon their economy and way of living. Apangalook's observations help convert these statements into a written record open to scientific scrutiny and analysis.

New Patterns of Fall Ice Formation

St. Lawrence Islanders have a highly nuanced vision on how the new sea ice is being formed in their area or, rather, how it *used to be* formed in the old days. Their native Yupik language has more than 20terms for various types of young ice and freezing conditions. Winds and currents would drive small chunks of floating ice (*kulusiit*) from the north in October or even in late September (Oozeva et al., 2004:133–134). Most would melt or would be washed ashore; but some would freeze into the locally formed slush or frazil ice. Around the time the first local ice is established (in late October or early November), the prevailing winds would shift direction, from primarily southerly to northerly, followed by a drop in daily temperatures. Depending upon year-to-year variability, but usually by late November, the thick Arctic ice pack, *sikupik*, would arrive from the Chukchi Sea, often smashing the young locally formed ice. Crashing, breaking, and refreezing would continue through December, until a more solid winter ice was formed to last until spring (Oozeva et al., 2004:136–137).

Since the 1980s, hunters started to observe changes to this pattern, which had until then been seen as normal. First, drifting ice floes, *kulusiit*, were late to arrive, often by a full month, and by the late 1990s, they have stopped coming altogether. The new ice is now being formed entirely out of local frozen slush or frazil ice, via its thickening, consolidation, repeated break-ups, and refreezing. Then the main pack ice ceased to arrive until January or even February; and in the last few years it did not arrive at all. Even when the pack ice finally comes from the north, it is not a solid thick ice, *sikupik*, but rather thin new ice that was formed further to the north. Because of this new set of dynamics, the onset of winter ice conditions on St. Lawrence Island is now delayed by six to eight weeks, that is, until late December or even January.[8]

Apangalook's observations during two IPY winters of 2006–2007 and 2007–2008 help document this new pattern in great detail. In addition, his daily records may be matched with the logbooks of early teachers from his village of Gambell that covered three subsequent winters of 1898–1899, 1899–1900, and 1900–1901 (Doty, 1900:224–256; Lerrigo, 1901:114–132; 1902:97–123; see Oozeva et al., 2004:168–191). According to Apangalook's logs, no drifting ice floes were seen in winter 2006–2007 and none in the month of November 2007. Although in 2007–2008 the formation of slush ice started more than two weeks earlier than in 2006–2007, the ice was quickly broken up by a warming spell, so that on 22 November 2007, Apangalook reported: "Thanksgiving Day with no ice in the ocean; normally [we] would have ice and hunt walrus on Thanksgiving Day but not anymore." In both 2006 and 2007, the temperature dropped solidly below freezing on the first week of December—and that was two to four weeks later than a century ago. The change of wind regime, from southerly to predominately northerly winds, also occurred in early December, that is, two to four weeks later than in 1898–1901 (Oozeva et al., 2004:185). Due to shift in wind and temperature, local slush ice solidified rapidly. On 16 December 2006, Apangalook reported that "when locally formed ice gets thick and encompasses the entire Bering Sea around our island, our elders used to say that we have a winter that is locally formed" (Figure 5).

Winter Weather and Ice Regimes

Apangalook's daily logs substantiate statements of other St. Lawrence hunters about the profound change in winter weather and ice regime over the past decades (cf. Oozeva et al., 2004; Noongwook et al., 2007). With the

FIGURE 5. The new ice is being formed from the pieces of floating icebergs and newly formed young ice. There are terms for every single piece of ice in this picture and many more in the local language ("Watching Ice and Weather Our Way," 2004, p. 114; original photo by Chester Noongwook, 2000).

FIGURE 7. Hunters rarely venture onto young unstable ice and they usually prefer to be accompanied by an experienced senior person. (Photo, Hiroko Ikuta, 2006)

absence of solid pack ice, people have to adapt to a far less stable local new ice that can be easily broken by heavy winds, storms, and even strong currents (Figure 6). According to the elders, this ice is "no good," as it is very dangerous for walking and winter hunting on foot or with skin boats being dragged over it, as used to be a common practice in the "old days" (Oozeva et al., 2004:137–138, 142–143, 163–166). As a result, few hunters dare to go hunting on ice in front of the village in wintertime (Figure 7). Instead, they have to rely upon shooting the animals from the shore or from ice pressure ridges (Figure 8) or upon hunting in boats in the dense floating ice, a technique that is now the norm in Gambell during winter months (Figure 9). In the early teachers' era of 100 years ago, boat hunting for walruses did not start in Gambell until early or even late March (Oozeva et al., 2004:187–188).

Winter conditions in Gambell, with the prevailing northerly winds, are often interrupted by a few days of vi-

FIGURE 6. "Winter that is locally formed." Thin young ice solidifies along the shores of St. Lawrence Island, February 2008. Leonard Apangalook stands to the right, next to his sled. (Photo, Igor Krupnik, 2008)

FIGURE 8. Two Gambell hunters are looking for seals from ice pressure ridges. The ridges look high and solid, but they can be quickly destroyed under the impact of strong wind or storms. (Photo, Igor Krupnik, February 2008)

FIGURE 9. Hunting in boats in dense floating ice is now a common practice in Gambell during the wintertime. (Photo, G. Carleton Ray)

olent storms and warm spells brought by southerly winds. This happened twice in the winters of 1899–1900 and 1900–1901, and three times in the winter of 1898–1899 (Oozeva et al., 2004:185). According to Conrad Oozeva, an elderly hunter from Gambell, the warm spells have been also typical in his early days:

> We commonly have three waves of warm weather and thawing during the wintertime. After these warmings, we love to go hunting in boats on water opening, before it covers again with the new ice. The only difference I see is that these warm waves were not long enough, just a few days only. We now have longer warming waves during the winter, often for several days. (Oozeva et al., 2004:186)

These days, violent winter storms often lead to numerous episodes of ice breakups and new ice formation every winter. Apangalook's record indicates at least four episodes of complete ice disintegration in Gambell in the period from December 2006 until March 2007. On 10 January 2007, he wrote in his log, "It is unusual to have swells and to lose ice in January compared to normal years in the past. Locally formed ice that covered our area to 9/10 easily disappears with rising temperatures and storm generated swells." Then on 31 January 2007, he reported again:

> What a twist we have in our weather situation at the end of January! Wind driven waves cleared away pressure ridges on west side with open water west of the Island. Part of the shore-fast ice broke away on the north side beach also from the swells. Unusual to have so many low pressures channel up the Bering Straits from the south in a sequence that brought in high winds and rain. Much of the snow melted, especially along the top of the beach where we now have bare gravel. Undeniably, the climate change has accelerated over the past five years where severity of winds and erratic temperatures occur more frequently every year.

Elders on St. Lawrence Island and in other northern communities unanimously point toward another big change in winter conditions. In the "old days," despite episodic snowstorms and warm spells, there were always extended periods of quiet, cold weather, with no winds. These long cold stretches were good for hunting and traveling; they also allowed hunters to predict the weather and ice conditions in advance. In the teachers' records of more than a century ago, those stretches of calm cold weather often covered two to three weeks. This pattern does not occur today. According to Apangalook's logs, there were a few periods of relatively quiet weather during the winter of 2006–2007; but they lasted for a few days only. December 2006 was particularly unstable and windy, with just one calm day. In comparison, during December 1899, the weather was quiet for 18 days, in two long stretches. In December 1900, quiet and calm weather persisted for almost 10 days in a row (Oozeva et al., 2004:185–186). No wonder Arctic elders claim that "the earth is faster now" (cf. Krupnik and Jolly, 2002:7).

Changes in Marine Mammal Behavior and Habitats

Local hunters' observations are naturally filled with the references to wildlife and subsistence activities. When seen upon a broader historical timeframe, those records provide compelling evidence of a dramatic shift that is taking place in the northern marine ecosystems. Apangalook reported (6 March 2007):

> A few years back when the polar pack ice did not reach our area anymore, we sighted bowhead whales in our area sporadically in the middle of winter. Back when our seasons were normal, we saw whales in the fall going south for the winter and didn't see any in mid-winter, until they start coming back in mid-March-April and May. Now, with more whales in our area in mid-winter we know that they are (mostly) wintering in our area. Without polar pack ice we had suspected that some of the whales stopped that migration north of our island and are not going further south anymore. . . . We know today that their wintering area is further north.

Many local hunters, like Apangalook, argue that whale migrations have been deeply affected by climate change. Hunters started observing bowhead whales off St. Lawrence Island in December (usually, a few animals) since 1962. Since 1995, winter whaling has become a common practice in both Gambell and the other island community of Savoonga, so that some 40 percent of bowhead whales are now being taken in wintertime (Noongwook et al., 2007:51). The difference is indeed remarkable compared to the conditions of a century ago, when the bowhead whales were not hunted in Gambell until early April (as in 1899) or even early May, as in 1900 and 1901 (Oozeva et al., 2004:189). To the contrary, in early 2007, Apangalook reported sightings of bowhead whales on February 6, and the hunters first tried to pursue them on 10 February 2007. The whales were then seen off Gambell repeatedly for the entire month. Local hunters in Barrow have also spotted bowhead whales in mid-February 2007; recent underwater acoustic recording off Barrow documented the presence of gray whales (*Eschrichtius robustus*) during the winter of 2003/2004 (Stafford et al., 2007:170). If whales have become frequent in the northern Bering Sea and southern Chukchi Sea in mid-winter, that would be a strong indicator to the dramatic shift in their migration and distribution pattern across the North Pacific–Western Arctic region.

Pacific walrus, another marine mammal species of critical importance to St. Lawrence Island hunters is also becoming more common in wintertime. Back in the "olden days," walrus used to come to the island in great numbers in late October or early November, ahead of the moving polar pack ice (Krupnik and Ray, 2007:2950). The bulk of the herd usually moved south of the island in December; but a small number of bull walruses commonly remained around Gambell in wintertime, mostly in offshore leads and polynyas. Still, the main hunting season for walrus did not start until late April or May. According to Apangalook's records, the fall arrival of walrus in both 2006 and 2007 was delayed by several weeks, so that the first walruses were not seen until mid-December. After that, walruses have been hunted in Gambell on almost daily basis throughout the winter of 2006–2007, which indicates that, like bowhead whales, they are also staying in growing numbers during the winter months.

Besides "wintering" walruses, Gambell hunters in winter 2007–2008 have observed several ribbon seals (*Phoca fasciata*) that are normally not seen in the area until late April or May. In February 2007, SIKU observers in Wales, some 200 miles to the north of Gambell, have spotted belugas (white whales); in the "old days," beluga whales had not been seen in the Bering Strait area until mid-April. Whereas some species are becoming more common in winter, others are moving out. Apangalook reports:

> One species of birds we used to hunt ever since I was a young child was the old squaw [*Clangula hyemalis*—IK]. Flocks of these birds in the thousands would fly north every morning at daybreak and return in the evening to [the] leeward side of the island. This pattern of movement daily I have seen every day in the sixty plus years of my life; but within the past five years the numbers have dwindled to near zero. [. . .] Are their food sources moving to a different area or is [it] getting depleted? (1 February 2007)

CONCLUSIONS: MESSAGES FROM INDIGENOUS OBSERVATION

The evidence from the first systematic monitoring by local IPY observers confirms a substantial shift in sea ice and weather regime over that past decade, as has been claimed by polar scientists and indigenous experts alike. It is characterized by a much shorter presence of sea ice, often by several weeks. Many types of ice are becoming rare or have completely disappeared from the area, such as solid pack ice or forms of multi-layered ice built of old and new ice. Most of the ice formations are now built of young and fragile first-year ice. The ice is also becoming increasingly unstable and dangerous for hunters.[9] In Apangalook's words, "Even marine mammals avoid this kind of ice condition, as it is hazardous to the animals too. It looks like game animal are taking refuge in more solid ice elsewhere."

Hunters' observations also confirm the profound northward shift in the Bering Sea marine ecosystem, which is also detected by scientists (Grebmeier et al., 2006; Litzow, 2007). Arctic residents refer to such shift in many of their descriptions of climate change, although they use their own "flagship species" as prime indicators. Indigenous hunters, naturally, pay most attention to large marine mammal and bird species as opposed to fish, invertebrates, and benthic communities that are popular indicators of change among marine biologists and oceanographers (Grebmeier et al., 2006; Ray et al., 2006; Sarmiento et al., 2004).

Arctic residents are extremely worried about the impact of ecosystem change on their economies, culture, and lifestyles. As Apangalook put it,

> Predictability of our game animals of the sea are inconsistent and erratic compared (to) how it used to be back in the normal seasons. We, the hunters, along with the marine mammals

we hunt, are truly at the mercy of our rapidly changing environment. (Apangalook, 2 March 2007)

The last message from indigenous records is that local observations could be a valuable component of any instrumental observation network built for IPY 2007–2008 and beyond. Many hunters in small Alaskan villages are trained to keep daily weather logs and are very familiar with the practices of instrumental observation and forecasting. Also, their daily records can be matched with historical instrumental data from the same areas that sometimes go back to the years of the First IPY of 1882–1883 (Wood and Overland 2006), as well as with the readings of today's weather stations and ice satellite imagery. Such cross-reference with the long-term instrumental series would create the needed comparative context to indigenous observations and would help introduce analytical scholarly tools to the analysis of indigenous data. Arctic residents' observations are too precious a record to be discounted as "anecdotal evidence" in today's search for the documentation and explanation of environmental change.

Besides, local observations in places like Gambell, with the now-shortened ice season and thinned first-year ice, may offer a valuable insight into the future status of the Arctic sea ice of many climate models. Those models predict the shrinking, thinning, and eventual loss of multi-year ice over almost the entire Arctic Ocean by the middle of this century (Bancroft, 2007; Johannessen et al., 2004:336–338; Overland, 2007; Richter-Menge et al., 2006). Arctic residents' integrative vision of their environment can be invaluable to our understanding of this new Arctic system in the decades to come.

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NOTES

1. Sophus Tromholt's photographs taken in 1882–1883 have been displayed at the "Indigenous Opening" of IPY 2007–2008 and used in a special trilingual calendar produced for the event. See http://www.ip-py.org/news_cms/2007/january/tromholdt_exhibit_at_the_opening_ceremony/6 (accessed 30 March 2008).

2. Point no. 51 in Hazen's instructions, "Observations and collections in the realms of zoology, botany, geology, &c." (Ray, 1885:13; Greely, 1888:104).

3. The Barrow collections included

> 497 bird-skins, comprising about 50 species, and 177 sets of eggs; [. . .] a small collection of skins, skulls, and skeletons of mammals; 11 or 12 species of fishes; a very few insects; and some marine and fresh-water invertebrates. The plants of the region were carefully collected. A considerable number of Eskimo vocabularies were obtained, together with a large collection of implements, clothing, &c. (Baird, 1885a:15)

Turner's collections from Labrador were described as

> [. . .] of birds, 1,800 specimens; eggs, 1,800 specimens; fishes, 1,000 specimens; mammals, 200 specimens; ethnological, 600 artifacts; plants, a great number; insects, over 200,000; geological specimens, a great variety; Eskimo linguistics, over 500 pages of manuscript, embracing thousands of words and over 800 sentences. (Baird, 1885b:17)

4. In fact, there are 1,068 ethnological objects, according to today's electronic catalog, with Lt. P. Ray recorded as *donor*; plus 6 objects donated by Capt. Herendeen, another member of the Barrow mission.

5. Barrow team also conducted a census of the residents of Barrow, with 137 names of men, women, and children (Ray, 1885:49); that makes it one of the earliest samples of personal Inuit names from Arctic Alaska.

6. See reviews of several individual documentation projects on indigenous observations in Krupnik and Jolly, 2002; also Herlander and Mustonen, 2004; Huntington and Fox, 2005.

7. One of such projects, ELOKA (Exchange for Local Observations and Knowledge of the Arctic, IPY # 187) works "to provide data management tools and appropriate means of recording, preserving, and sharing data and information" from Arctic communities—See http://nsidc.org/eloka/ (accessed 30 March 2008).

8. This pattern has been consistently reported by indigenous observers across the Arctic area—see Gearheard et al., 2006; Laidler, 2006; Laidler and Elee, 2006; Laidler and Ikummaq, 2008; McDonald et al., 1997; Metcalf and Krupnik, 2003.

9. See similar conclusions from other projects in the documentation of indigenous knowledge on sea ice change (Gearheard et al., 2006; Laidler, 2006; Laidler and Elee, 2006; Norton, 2002). Murdoch's work in Barrow even inspired a special IPY 2007–2008 project aimed at replicating his ethnological collections by today's specimens (Jensen, 2005)

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