ARCTIC
VOL. 65, NO. 4 (DECEMBER 2012) P. 421–432

Harvest-based Monitoring in the Inuvialuit Settlement Region: Steps for Success

ROBERT K. BELL[1] and LOIS A. HARWOOD[2]

(*Received 2 August 2011; accepted in revised form 1 March 2012*)

ABSTRACT. We define harvest-based monitoring as the long-term collection of data or samples from a subsistence harvest in order to reveal, document, and track changes in biophysical resources. Our objective is to describe five practical steps that have guided us over the past two decades during delivery of harvest-based monitoring studies in the Inuvialuit Settlement Region (ISR). Studies have usually been designed to detect (but not necessarily explain) change, to involve local harvesters, and to incorporate indigenous and science-based knowledge. The five steps are to (1) formulate a scientific research or long-term monitoring question that can reasonably be answered by analyzing data from harvests or harvested specimens, (2) design the program according to scientific and indigenous protocols, (3) determine respective partner roles for delivery of the field program, (4) conduct the field work, and (5) analyze data and communicate results. At all steps, it is important to ensure that science and indigenous knowledge partners respect and trust each other's skills, knowledge, and abilities; that regular communication is fostered; and that provisions are in place to monitor progress. The credible blending of indigenous and scientific views and skills improves the likelihood of ultimately understanding the resource, its habitats, and its inherent ecological relationships.

Key words: harvest-based monitoring, Inuvialuit Settlement Region, collaborative research, participatory research

RÉSUMÉ. Nous définissons la surveillance des captures comme la collecte à long terme de données ou d'échantillons provenant des captures ou récoltes de subsistance et ce, dans le but de révéler, de documenter et de suivre les changements caractérisant les ressources biophysiques. Notre objectif consiste à décrire cinq étapes pratiques qui nous ont servi de guides ces deux dernières décennies dans le cadre d'études de surveillance des captures dans la région désignée des Inuvialuit (RDI). Habituellement, les études sont conçues pour détecter (et non pas nécessairement pour expliquer) le changement, pour faire appel aux personnes faisant les captures dans la région et pour favoriser l'intégration des connaissances indigènes et scientifiques. Ces cinq étapes sont les suivantes : 1) formuler une question de recherche scientifique ou de surveillance à long terme à laquelle on peut raisonnablement répondre au moyen de l'analyse des données de captures ou des échantillons capturés; 2) concevoir un programme qui respecte les protocoles scientifiques et indigènes; 3) déterminer le rôle des partenaires respectifs en ce qui a trait à l'exécution du programme sur le terrain; 4) réaliser le travail sur le terrain; et 5) analyser les données puis communiquer les résultats. À toutes ces étapes, il est important de faire en sorte que les partenaires en matière de connaissances scientifiques et de connaissances indigènes respectent les compétences, les connaissances et les aptitudes de chacun, et se fassent confiance; que les partenaires communiquent régulièrement; et que des dispositions soient en place pour suivre les progrès. Le mélange crédible de points de vue et de compétences indigènes et scientifiques améliore la probabilité que l'on finisse par comprendre la ressource, ses habitats et ses relations écologiques inhérentes.

Mots clés : surveillance des captures, région désignée des Inuvialuit, recherche collaborative, recherche participative

Traduit pour la revue *Arctic* par Nicole Giguère.

INTRODUCTION

The subsistence harvest of fish and marine mammals provides a unique opportunity for obtaining long-term sets of biological samples, data, and observations, which we term here "harvest-based monitoring." This paper highlights five practical steps that have guided us over the past two decades during delivery of harvest-based monitoring studies in the Inuvialuit Settlement Region (ISR). Monitoring studies were designed to detect (but not necessarily explain) change, to answer scientific questions, to involve local harvesters, and to blend indigenous and scientific skills, experience, and knowledge in a collaborative or participatory approach.

Valuable information about natural systems is often referred to as traditional ecological knowledge (Dowler, 1996; Berkes, 1999; Huntington, 2000; Usher, 2000; Kofinas et al., 2002; Carmack and McDonald, 2008). Here we use the term *indigenous knowledge*: knowledge that resides in the experience and understanding of the local harvesters and residents. This concept is well aligned with the

[1] Norplan, Box 548, Blaine Lake, Saskatchewan X0J 0J0, Canada; robert.bell@rkbell.ca
[2] Corresponding author: Department of Fisheries and Oceans, Suite 301, 5204–50th Avenue, Yellowknife, Northwest Territories X1A 1E2, Canada; lois.harwood@dfo-mpo.gc.ca

definition of traditional ecological knowledge provided by Huntington (1998), which is knowledge gained by experience, observation, and analysis of natural events, transmitted among members of a community (or family). In a subsistence economy, indigenous knowledge, skills and experience are used to find, harvest, process, store, and sustain natural resources that are needed for food, clothing, and shelter (Huntington, 1998; Usher, 2000).

Indigenous knowledge also includes the ability to recognize, avoid, and get out of dangerous situations. It is the knowledge needed for physical and cultural survival in a subsistence society (Huntington, 1998). An example from the ISR illustrates this important aspect of indigenous knowledge:

> …we had crossed Prince Albert Sound in our 18′ Lund to investigate a river for future study. We conducted our assessment and when the time came to leave, a huge storm blew up. We were wind bound, waiting, and on the third day when the radio call came in the middle of the night that it had calmed in Holman, we were ready to travel. The Sound was still rolling with huge waves up to 30 feet in height when we set out in near total darkness. Local harvester John Alikamik drove the boat with a light breeze as his only guide, and Robert and I watching for shifts in the breeze; John saw all the shifts and was undaunted even when we didn't and argued. We made the four-hour crossing safely and the first sign of the far shore was a few rocks poking out of the water. J., amazing as always, said, "I know this rock, we have to turn left." We did and arrived at camp 20 minutes later. A further 20 minutes later the wind had picked up and the angry seas were back, but we were safe."
>
> P. Sparling, 1988

An ongoing challenge for many researchers has been to find the best method for including indigenous knowledge in the delivery of science-based projects (Wenzel, 1999; Huntington, 2000, 2011; Usher, 2000; Kofinas et al., 2002; Carmack and Macdonald, 2008). Its inclusion may even be a legal requirement in the environmental assessment process (Usher, 2000), but methods for acquiring, organizing, and presenting it are limited (Huntington, 2011). In the literature and in practice, indigenous knowledge is usually collected using methods from the social sciences, such as semi-directive interviews, questionnaires, and workshops (Huntington, 2000). The knowledge obtained in such ways is then often reported in separate manuscripts or chapters (Remnant and Thomas, 1992; Byers and Roberts, 1995; Fehr and Hurst, 1996; Gwich'in Elders, 1997; Huntington et al., 1999; Mymrin et al., 1999; Day, 2002), or if included in a scientific report, it often takes the form of a token paragraph, largely because it is difficult for scientists to acquire, organize, and present this type of information (Huntington, 2011; Huntington et al., 2011).

The fourth method described by Huntington (2000) is collaborative fieldwork, and this is the foundation of the approach we have used in the ISR. The indigenous knowledge holder and the scientist work more or less as a team during program delivery (Huntington et al., 2011). We contend that the involvement of local harvesters in the design, field delivery, and reporting of a scientific study provides an effective way to obtain indigenous knowledge and incorporate it into scientific studies.

This approach has become increasingly accepted in recent years, with the overarching objective of increasing opportunities to include local concerns, skills, experience, priorities, and perspectives in scientific studies (Dowler, 1996; Berkes and Fast, 2005; Carmack and Macdonald, 2008; Huntington, 2011). The perspectives and information we present here are informed by our respective roles as chairperson of the Fisheries Joint Management Committee (FJMC), a co-management body in the ISR, and as coordinator of various harvest-based programs in the ISR over two decades.

After a brief look at the history of subsistence harvest enumeration studies in Canada's Arctic, we examine a variant of this approach, which we have termed harvest-based monitoring. This collaborative approach has underpinned a range of studies conducted in the ISR; we present five basic steps in the process and conclude with a synthesis and discussion of its strengths and limitations.

BACKGROUND

Co-management is a process of management in which government and resource users share authority, rights, and responsibilities in the gathering of information and decision making. It has played a significant role in fostering interactions between holders of indigenous knowledge and scientists, managers, and politicians in the ISR (Manseau et al., 2005; Berkes et al., 2007). The Inuvialuit Final Agreement (IFA) requires that beneficiaries be meaningful participants in fish and wildlife management activities and initiatives (Western Arctic Claims Settlement Act, 1984). The resource management regime laid out by the IFA includes five co-management bodies, one of which is the FJMC, established in 1986. The FJMC, composed of two beneficiaries appointed by the Inuvialuit Game Council and two members appointed by Canada, is responsible for advising the Minister of Fisheries and Oceans on all matters relating to fish, marine mammals, and their habitats in the ISR. The FJMC has adopted an approach ensuring that ecological and biological studies involve community harvesters and address contemporary community issues and concerns by supporting long-term, community-based projects (Bell, 1994: Dowler, 1996; Manseau et al., 2005). The FJMC has a long track record of support for long-term, harvest-based studies using the collaborative fieldwork approach, having supported programs of this type for more than two decades (www.fjmc.ca).

The Precursor: Harvest Enumeration Studies

While the recording of the size, timing, and composition of hunter harvests has long been a tool of wildlife and fisheries managers, its use within the communities of subsistence hunters has a shorter history. In Canada, the fur trade records of the Hudson's Bay Company constitute the earliest (albeit commercially focused) records. More recent glimpses of subsistence harvests in the NWT are provided by RCMP and game warden reports (early 1950s to early 1970s) (Usher, 1975; Smith and Taylor, 1977) and reports submitted by Aboriginal hunters as part of their obligation when they received a General Hunting License under the Northwest Game Act of 1949 (Usher and Wenzel, 1987). The first comprehensive survey of a subsistence harvest was inspired by the first of Canada's modern land claims, the James Bay and Northern Quebec Agreement of 1975 (Usher and Wenzel, 1987). That survey was designed to document subsistence harvest in the claim area for a five-year period. The results were to be used to establish a minimum preferential harvest allocation for the beneficiaries of the claim, on a species-by-species basis. This allocation had to be set aside before any harvest by non-beneficiaries could be considered.

Wildlife managers beyond James Bay and northern Quebec watched these developments closely since negotiations of other regional claims were either underway or on the drawing board. Three studies in the eastern and central Northwest Territories (Donaldson, 1984; Jingfors, 1986; Gamble, 1988; Berkes, 1990) are representative of what was at the time a new focus on subsistence harvest. These were all recall surveys, which generally involved having a harvest study coordinator or his or her field worker visiting active harvesters on a set schedule and asking them to recall their harvests by species over a specified period. The time periods varied from study to study, usually increasing or decreasing depending on available funding. These studies were almost exclusively designed to provide inputs to the hunting mortality component of the wildlife productivity equation or to provide guidance in the land-claim negotiating process.

The second modern land claim in the Canadian Arctic was the Inuvialuit Final Agreement of 1984 (Government of Canada, 1984). This claim was negotiated largely when the assumed economic underpinning of the Mackenzie Delta-Beaufort economy, the hydrocarbon industry, was in a downward phase of the economic cycle. Thus, negotiators looked to other sources of economic activity, based on local indigenous knowledge of the fish and wildlife richness of the ISR, that would augment the local economy (Nuligak, 1966). Inuvialuit negotiators felt that if they could provide a regulatory atmosphere under which fish and wildlife populations could be harvested at a level up to, but not exceeding, that which was sustainable, then that harvest could provide economic benefit for the people of the region. Clearly this plan would require thorough understanding of both the timing and size of the harvest and the population dynamics of the species. The answer to the first unknown, harvest levels, was to be drawn from the Inuvialuit Harvest Study (IHS) (Joint Secretariat, 2003), the most comprehensive and intensive such study undertaken to date in the Canadian Arctic.

The Inuvialuit Settlement Region covers 906 430 km^2 including 91 000 km^2 of private lands (AANDC, 2010) and is home to 3115 beneficiaries (Statistics Canada, 2012) living in six communities (Fig. 1). While perhaps not to the extent visualized by IFA negotiators of the mid-1980s, beneficiaries, to varying extents, continue a traditional lifestyle that includes seasonal subsistence hunting, fishing, and trapping for more than 78 species (Usher, 2002; Joint Secretariat, 2003). During the IHS, all beneficiaries in the ISR who identified themselves as hunters were interviewed each month to determine the number, sex, and approximate kill locations for all animals taken. Interviews were conducted in home communities by beneficiaries employed from a central office and were sufficiently confidential that most of those who examined the information could not connect harvests to individuals. IHS participants were judged to be careful in their reporting (Usher et al., 1996). Large mammals such as beluga (*Delphinapterus leucas*) were well suited for a recall survey of this nature since, because of their size and their food contribution, a hunter was less likely to make an error when reporting a kill of 0 to 3 animals than when estimating, for example, how many herring were caught over an entire month (1000s).

Harvest enumeration studies continue to play a role today in wildlife and fisheries management in the ISR. The data from such studies have also provided valuable input to social scientists and resource economists who quantified the role of subsistence harvesting in the overall economy of the region (Smith and Wright, 1989; Wein and Freeman, 1992; Environment Canada, 2003; Usher et al., 2003).

Going a Step Further: Harvest-Based Monitoring

In the 1980s, harvest enumeration studies gave rise to another approach. The FJMC recognized that the subsistence harvest of fish and marine mammals provided an untapped opportunity to obtain long-term data sets and monitor wildlife populations. Biological samples, measurements and field observations obtained from harvests (Berkes, 1990) yield detailed and pertinent information that otherwise would not be readily obtainable. Such an approach also provides a direct opportunity to collaborate with harvesters and to benefit from their field expertise and store of acquired knowledge about the resource.

An example of the evolution of a harvest enumeration study into a harvest-based monitoring study, the latter designed to answer scientific questions, is the harvest of Beaufort Sea beluga in the Mackenzie River estuary. Harvest data were collected by the government from 1973 to 1975 (Hunt, 1979), by industry-sponsored consultants in 1977–80 (e.g., Fraker and Fraker, 1979), and eventually by government again in 1981–86 (Strong, 1990; Weaver,

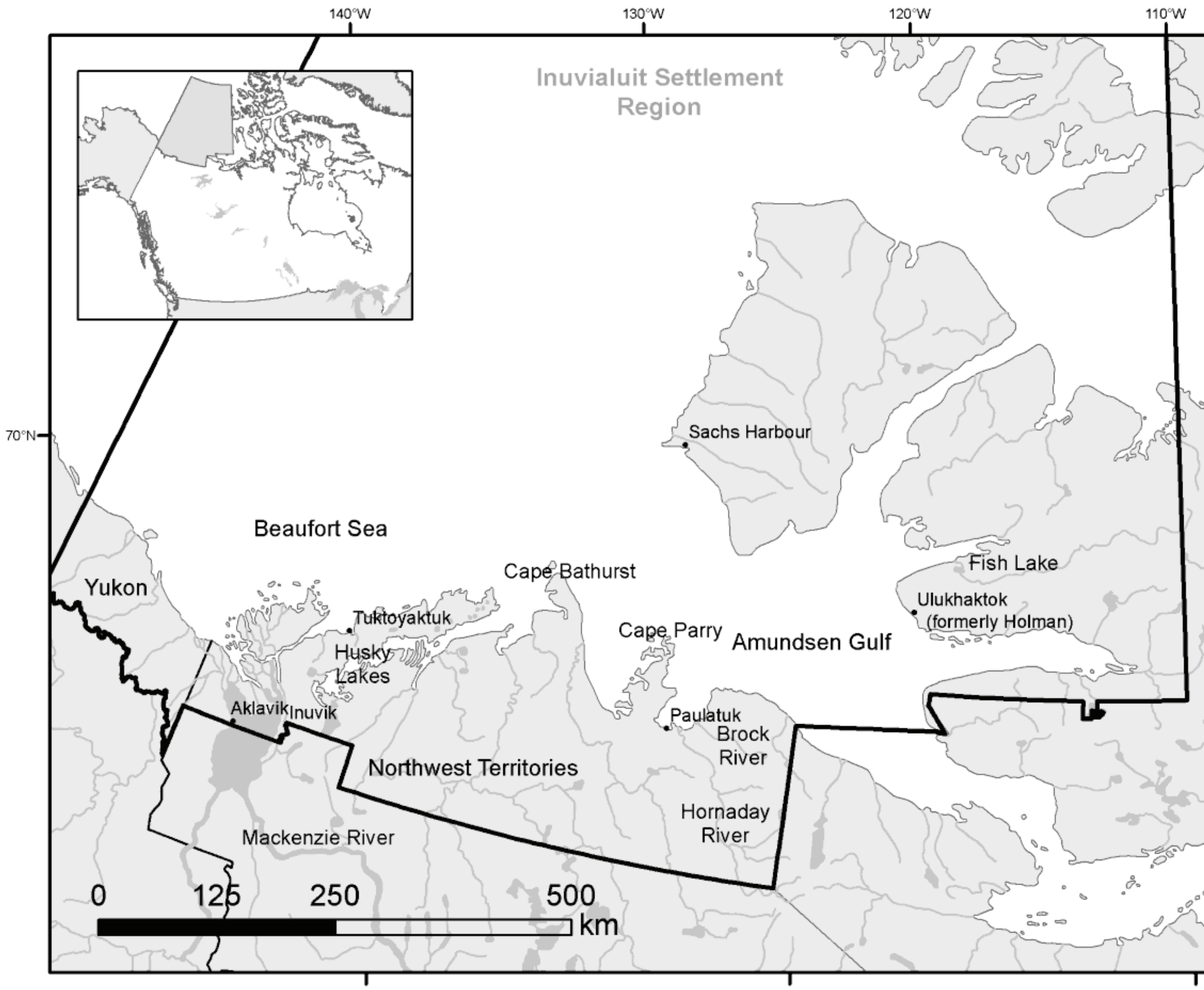

FIG. 1. The Inuvialuit Settlement Region boundary and communities and other locations mentioned in the text.

1991). In 1980, the method was standardized with regard to biological data and samples collected. The FJMC, with its approach of fostering close working relationships with beneficiary monitors, took over responsibility for the program's funding and coordination in 1987. The FJMC was better positioned to provide a longer-term funding vision than had been possible with government or industry up to that point (Harwood et al., 2002). The scope of the program continued to evolve and expand in the 1990s to include the collection of samples to examine diet, productivity, contaminants, genetic relationships, and the incidence of disease (Lockhart et al., 2004; Loseto et al., 2008a, b).

One of the main reasons the FJMC took over the program was that, in the late 1980s, ISR beneficiaries and scientists anticipated that further study of the beluga and the beluga harvest was prudent to protect and ensure continued subsistence harvesting opportunities. Inuvialuit hunters, with generations of observational data to draw from, were confident that they were harvesting from a stable or increasing population, yet scientific advice of the day, based on a paucity of available data, had a somewhat different interpretation (Cosens et al., 1998). In addition, subsistence hunting activities were coming under increasing scrutiny by international management forums, such as the International Whaling Commission. This underscored the importance of obtaining a long-term, blended, credible record of indigenous and scientific information, should hunters have to defend their beluga harvesting practices or levels in the future.

The FJMC continued to deliver the program with this collaborative approach, which came to be regarded as its flagship monitoring program, for the next 22 years (Harwood et al., 2002). Similar collaborative harvest-based monitoring programs are, or were, conducted concurrently, directed toward stocks of arctic charr (*Salvelinus alpinus*), Dolly Varden charr (*Salvelinus malma*), ringed seal (*Phoca hispida*), arctic cisco (*Coregonus autumnalis*), and lake trout (*Salvelinus namaycush*) (see www.fjmc.ca for citations, descriptions, photos). All these studies were based on the traditional, long-term subsistence harvesting activities of beneficiaries, capitalized on the land-based knowledge of the harvesters, and were designed cooperatively by harvesters and researchers. The best understanding of Arctic animals is obtained when both traditional and scientific approaches supplement each other (Stirling, 2012), and below we provide examples and steps to illustrate how we have achieved this goal in the ISR over the past two decades.

THE FIVE STEPS

The suitability and success of collaborative harvest-based monitoring depends on five key steps: (1) formulating the question, (2) designing the program, (3) determining roles for field work, (4) conducting the field work, and (5) analyzing data and reporting the results.

Step One: Formulating the Question

The community and the researcher or manager must formulate their interest or concern as a question that can reasonably be answered in an unbiased way through field investigation. Then they must decide whether long-term, harvest-based monitoring is an appropriate tool to use in answering that question. After hearing local concerns and perspectives about the issue through community consultation, a researcher may then formulate a specific study question for which an answer could be illuminated by harvest samples, through studies of harvest timing or catch effort.

The researcher or the local hunters and trappers organization then identifies experienced harvesters who are familiar with the stock or population in question. This identification can take place in a meeting setting or take the form of a more defined process, such as establishing a working group. The meetings and planning may involve many specialists, both indigenous and scientific, discussing the details of the problem and the sources of available indigenous and scientific information pertinent to the subject. This might occur over a period of days, or even years. Often public input is sought during the process, as was the case with studies recommended in the Hornaday Charr Management Plan (www.fjmc.ca; Harwood, 2009).

It is important to formulate a question that can be answered by a carefully designed study. Poorly planned harvest-based monitoring can be just as alluring to communities and politicians as well planned programs. But aside from short-term employment for those involved in program delivery, poorly planned programs bring little or nothing in the way of outcomes that can be used to enact change or to advance science. Such efforts have negative connotations and will have the added effect of creating disillusionment with the whole collaborative management effort.

Several types of concerns have been raised by communities in the ISR and addressed through harvest-based monitoring studies: (1) concern about stock trends and abundance, and therefore, harvest sustainability (Fig. 2) (Paylor et al., 1998; Harwood, 2009; Roux et al., 2011a); (2) concern for species health and well-being, mainly due to changing habitats (Fig. 3) (Harwood et al., 2000; Smith and Harwood, 2001; Lockhart et al., 2004; Evans et al., 2005; Stern et al., 2005; Addison et al., 2009; Gaden et al., 2009); (3) concern for disturbance of fish and marine mammals by activity and its impact on subsistence harvesting opportunities and resource (food) quality (Harwood et al., 2007, 2009; Roux et al., 2011b; Quakenbush et al., 2010); and (4) concern about the impact of external pressures (e.g., anti-harvesting campaigns), political pressures, and scientific findings on subsistence lifestyles and harvesting opportunities (Adams et al., 1993; Harwood et al., 2000; www.fjmc.ca).

The harvest-based monitoring approach has been applied to or used across a range of species to address a number of different questions relating to resources and habitats in the ISR. Usually the harvester-monitor, in collaboration with the researcher, collects a set of measurements, specimens, and notes, using standard techniques, from the harvested animals, or reports on hunting or fishing effort. The harvester might also collect supplementary biological specimens in addition to the subsistence-harvested ones, under a protocol agreed upon by the harvester, the researcher, and the community hunters and trappers committee (HTC). For example, supplementary specimens were gathered during our 2003–07 study of ringed seals offshore of the Mackenzie Estuary because seal tissue and stomach content samples were required from an area and a time at which subsistence harvesting did not normally take place (Harwood et al., 2007). The collection of the additional requested specimens was first approved at the community HTC level, and then the Department of Fisheries and Oceans (DFO) issued a license. Seal carcasses were returned to the monitor's families for subsistence use after monitoring.

Managers and politicians often favour the conduct of studies that involve harvest-based monitoring because they are visible and well liked by the communities, but monitoring of harvests is not always the right tool to investigate the research question at hand. Not all questions can be answered through harvest-based monitoring, just as not all stock-size questions can be practically answered with mark-recapture methods, for example. Often, more than one line of evidence is best for obtaining an answer to a scientific question, and in such cases, harvest-based monitoring might be undertaken at the same time as a more typical style of scientific study, such as one involving test netting or marking (tagging) of individuals (Carmack and Macdonald, 2008; Harwood et al., 2000, 2008; Roux et al., 2011a, b). Harvest monitoring alone, without frequent analysis and the addition of the latest local information and use of the latest scientific tools, cannot expect to contribute answers to complicated questions such as possible impacts of anthropogenic noise or global climate change on the stocks being studied.

FIG. 2. Community monitor preparing to measure the fluke width of a beluga whale landed in the subsistence harvest near Tuktoyaktuk, Northwest Territories, Canada. (Photo: DFO)

Step Two: Designing the Program

Open and respectful meetings that include community harvesters, managers, and science staff are required to define the research options and design an appropriate study. This definition and design must occur well before decisions on program delivery are taken. The science staff must have knowledge of the sample size and timing that would be required to address the question, so that the eventual product will be credible to scientific peers, and thus usable by leaders, managers, and policy makers to enact change or regulation.

Similarly, in the design stage, the local experts have to consider and communicate to the scientists whether the collection of such data or samples is practical (because of timing, location of harvesting, sample size expected), and if so, if such collections would be acceptable to the harvesters. While each group will likely not fully appreciate the constraints facing the other groups, the participants must act with mutual respect and disclose their knowledge so that the project can be planned, refined, and eventually moved forward (or not) in a credible way.

Working together, the scientist and the harvesters can discuss and determine the expected sample size and sample composition (by sex or age class, for example) for a range of appropriate parameters (e.g., fish length, weight, fishing effort). Measurement of biotic and abiotic factors that are meaningful can be included as "value added"; however, care must be taken that the time, equipment, and resources needed to collect the 'extra' samples or measurements do not overshadow collection of the primary samples, tissues, or information. For example, it is sometimes possible to collect water level data using a simple staff gauge and record water levels daily along with water temperature, without compromising the basic data collection tasks (e.g., Sandstrom and Harwood, 2002).

FIG. 3. Community technicians from Tuktoyaktuk, Northwest Territories, pulling a live-captured ringed seal from a net set in a breathing hole. This seal was instrumented with a satellite-linked transmitter and released at the same location, and its movements were tracked for three months. (Photo: L. Harwood)

This consideration of focusing on the primary data is most important in the first years of a harvest-based monitoring program, and value-added data requests can gradually be included as the program matures and new questions arise. Scientific colleagues, for example, may request collection of certain tissues that require complex preservation or handling methods, or unrealistic sample sizes. In these circumstances, the harvest monitor doing the field sampling may be overextended by such requirements, to the detriment of time and effort allocated to the core program. The team must accept add-ons only if they are not likely to compromise the basic program and must be prepared to suspend the collection of add-on data if it compromises the basic data in any way. Further, the requesters of add-ons must be able to contribute financial resources toward the project to compensate for increasing the sample load of the harvester (Stern et al., 2005).

The design stage of the program involves frequent compromise and discussion. Both the scientific staff and the harvesters have to decide for themselves on which points they can be flexible, and on which points they cannot. For example, seal harvesters may be willing to allow the reproductive tracts of their harvested female seals to be removed, but they do not want the seal pelt disfigured as this would defeat one of the main reasons for harvesting the seal in the first place. Thus the cooperating project planners must devise a solution. One solution might be to rule out the collection of this particular sample altogether. Another solution, devised and practiced for two decades by our veteran seal monitor John Alikamik, was to access the body cavity of the seal to obtain samples in such a way that the pelt was not compromised. Laboratory work, types of samples collected, and preservation methods for samples required can also be adjusted as necessary if the researcher so advises on the basis of his or her knowledge.

In the ISR ringed seal monitoring study, the same data sheet, protocols, procedures, partners, and funding support have been in place since the study's inception in 1992. The successful design of the study in year one did not happen by chance—valuable input and assistance in designing the study and data sheet in 1992 were provided by a community elder and a scientist who had worked on seals for 20+ years in this area in the 1970s and 1980s (Smith, 1987). This design ensured we were positioned in the early years of the program to obtain the appropriate data on seal fatness and reproduction in as consistent a manner as possible (Harwood et al., 2000).

Step Three: Determine Respective Roles for Field Work

The delivery of the field component of the project is as important as the design. It must be executed according to protocol, ensuring acceptability at the local level. For example, is it acceptable to local people to capture and tag fish, or to establish a monitoring field camp in the vicinity of harvesters waiting for the arrival of ducks? Scientific protocol, which includes adequate sample size, careful measurements, and meticulous note taking, must be understood and strictly followed by the monitors to ensure a valid data set. No series of meetings will change the former, and no amount of statistical manipulation of data will change the latter. The project planners have to get it right at the outset.

The study design must ensure that the collection and input of indigenous observations beyond the core-monitoring sample or data collection process are embraced. The harvester/monitor draws upon his or her experience and accumulated knowledge of the species and habitats in question to monitor for (and record) the unusual. An illustration of this occurred in 1991, when the tip of a narwhal tusk was found embedded in the melon of a harvested beluga whale (Orr and Harwood, 1998). This finding provided a record of range overlap and an aggressive encounter between a narwhal and beluga, neither of which had previously been documented in the scientific literature for the ISR.

Another example of an unexpected finding occurred in 1998 at Ulukhaktok, when the veteran seal hunter and sampler there noticed and collected starveling seal pups and reported that he had never before seen pups in this condition in his 40+ years of harvesting experience. This finding ultimately became the premise for a better understanding of how the timing of spring break-up (which was six weeks early that year) affects seal fatness and reproduction (Smith and Harwood, 2001). Another example from Tuktoyaktuk Harbour involved subsistence capture of two rare species, the nine-spine prickleback (*Pungitius laevis*) and the wolf fish (*Hoplias malabaricus*), during regular subsistence fishing (Harwood et al., 2008). Short-term, biological test netting by management staff, for example, would not likely have picked up such vagrant catches or occurrences, but the spatial and temporal coverage offered by subsistence harvesters (at least in some areas, for some species) allows for a much broader view of a resource. The combination of information from indigenous observations, fishing effort data, and harvest-based monitoring samples adds to our collective understanding of the resources, their habitats, and the inherent ecological relationships.

It is paramount to strive for consistency in samples, often by using the same samplers. Without this effort, unnecessary error and bias can be introduced that will be difficult to detect or control. The preference of a scientist to hire the same individual as the sampler/monitor may not necessarily be consistent with community wishes, since communities have an understandable tendency to share employment opportunities in an equitable manner. It is also important to include Aboriginal youth as trainees (Harwood et al., 2002) so they can learn from the experienced hunters who have important knowledge and skills to pass on. Since these studies run many years, if not decades, it is prudent to train for future replacements while instilling interest and pride in the younger generation. It is also important not to underestimate the contribution of the project participants' social and interpersonal skills to the smooth delivery of a field program (Huntington et al., 2011).

A division of labour is needed in the actual conduct of the fieldwork. The planners must recognize and allow for partners to bring their own special skills and knowledge to bear on the work. Each must recognize the contributions, constraints, and successes of their counterparts. There will be both fieldwork specialists (likely led by the harvesters, with their lifetime knowledge of where, when, and how to access harvested resources) and technical-reporting and analytical specialists (likely led by the scientific staff). Each must trust the judgement, planning, and field delivery skills of the other. If both come with experience, mutual respect, and a willingness to seek assistance and advice as needed, the project will have the best chance to be successful (Paylor et al., 1998). If the experience and skills of both the harvesters and scientific staff are not valued and respected, then the outcome of the project will almost certainly be compromised.

Step Four: Program Delivery

With the question set, the design and protocols established and agreed to, and the partners ready to start on the collection of the data, the fieldwork component of the study will begin. Contingency, safety, and back-up plans must be built into the design of all programs. Careful recording of data and preservation and shipping of samples are essential.

However, because so many aspects of Arctic field work are essentially beyond control (e.g., weather, flight schedules for shipping samples, tides, ice, fuel availability), it is especially important to anticipate and plan for unexpected situations and pitfalls (e.g., have a freezer, a satellite phone in camp, ship frozen samples early in the week so they do not become stranded over a weekend, take extra fuel to camp) and to solve problems regularly as unforeseen situations arise.

Even when the field program unfolds according to carefully planned protocols, study design adjustments may be necessary for a variety of reasons, both foreseen (e.g., change of the harvest or science partner working on a program) and unforeseen (change in timing of a fish migration, change in timing of sea ice breakup). Even the simplest changes to a monitoring plan (for example, changing the location on a seal carcass where blubber thickness is measured) will complicate or compromise the utility of data collected prior to that point. If additional measurements or samples are deemed necessary, it is preferable to add them to the existing sample roster, rather than substitute one measurement or sample type for another part way through the study.

Just as in the previous steps, the scientific and Aboriginal partners must work together to address issues and problems as they arise, and together agree to any necessary adjustments to the program. In some cases, it may even be necessary to suspend or conclude monitoring, if the partners discern that the program-question cannot be answered because of an unforeseen outcome or situation. The scientific and harvester partners must work together, respect each other's knowledge and positions, and at times, make hard decisions together. If any changes are deemed necessary and agreed to, the partners have to consider the implications of those changes for protocols, outcomes, and the answer to the question established at the outset.

Step Five: Analyze Data and Disseminate Results

The harvester and the scientific staff must both take responsibility to bring the results to fruition in a form that is useful, be it as a poster for a community, a newsletter, or eventually, a peer-reviewed publication or article. In the early stages of a long-term study, presenting results first takes the form of annual progress reports to community and funding agencies, school visits, or talks at community and HTC meetings, along with preliminary analysis each year of the data and samples as they are being generated. If the data and samples have been collected carefully, consistently, and in adequate numbers, the project partners can move on to the final stage: collating, interpreting, and communicating the results. This communication can take very different forms depending on the intended audience, and the partners must use their skills to select the format that is appropriate. The step of presenting results to the community may be done jointly, while preparation of a journal article may be led by one of the scientific partners on the project, likely with co-authorship of the indigenous knowledge holders and any other main contributors to the study (Huntington, 2006; Harwood et al., 2002, 2005, 2008).

Project partners all work toward the same goal, that is, defensible, credible conclusions from a study that can be used to address concerns, bring about political or regulatory change, inform management, and understand resources and their habitats. The step of analysis and dissemination of results from each study is crucial, but often it is not given adequate emphasis in the planning and budgeting process. A monitoring study that does not include both steps of reporting back to the communities and publication of results in a peer-reviewed format cannot be counted on to change policy or regulations. There are instances from the ISR in which an official, peer-reviewed Stock Status Report was required to change harvesting regulations (DFO, 2000). The peer review process in these instances (www.dfo-mpo.gc.ca/csas-sccs) has included both harvesters and scientists at the peer review table.

At the local level, results must be communicated back to the harvesters and community harvest entities that were involved in the study and may be affected by its outcome. The peer-reviewed and published documents that ensue from the scientific side are also useful to the community, for example, to formulate terms and conditions of industry operations (Harwood et al., 2007), adjust safe harvest levels, realize commercial fishing opportunities (Roux et al., 2011a), or establish a sport fishing lodge (Roux et al., 2011b). The cost of sponsoring this usually time-consuming and arduous final task in the process can be significant, and those proposing or planning present-day community-based studies must fully embrace the importance of this step.

DISCUSSION

The harvesting of wildlife in Aboriginal subsistence economies can provide a long-term source of scientific data (Berkes, 1990). Collecting harvest data is an ideal way to include and benefit from indigenous knowledge in a scientific study (Huntington, 2011). The costs of such programs are relatively small, and the benefits of long-term studies are well recognized by the scientific community. Outcomes of such collaborative programs, and any associated management decisions or recommendations, have a better chance of being ratified at the community level.

The results from a scientific project in which scientists arrive from the south, conduct the work, and leave at the end of the field study are often (and understandably) not viewed favourably or understood by the communities affected by them. Another strength of the harvest-based monitoring approach is that retroactive comparisons and calculations may be possible because of the long-term nature of the studies. For many species in the Arctic, such as seals, the harvests are much reduced from the 20th century and getting smaller every year. The archived samples, tissues, and information available from harvest-based programs since the 1980s may become critical baseline data for future assessments and study.

There are some limitations in harvest-based monitoring studies. Most harvests target mature individuals, which underrepresents the younger age classes (Harwood et al., 2000). Therefore, a harvest-based study may be unable to address certain questions, such as the age of sexual maturity or body condition of juveniles. This limitation underscores the importance of planning and setting the question at the outset, as a simple broad-based monitoring scheme is definitely not the appropriate approach for all research questions.

Harvest-based monitoring programs may run for years or decades; in fact, this duration is likely necessary to elucidate change (Smith, 1987; Stirling, 2002). Still, funding for harvest-based monitoring, even though the costs are relatively modest, must often be applied for annually. Not only does this mean that partners will have to allocate time and resources to rework the proposal each year, but it also leaves the community partners uncertain about whether the project will go ahead in a given year or at all.

The support received for the programs cited in this paper was continuous, these programs being a cornerstone approach in the ISR. Nonetheless, interruption of funding is a fiscal reality and a threat to the success of even the most modest monitoring program. Funding agencies that embark on long-term monitoring types of studies should acknowledge this point and make all possible provisions for funding to be in place for the number of years that are needed to produce credible results. Most science projects tend to be better positioned than harvest-based monitoring projects to secure funding through to fruition, since they typically last for fewer years (e.g., 3–5 years, compared with the decades that are required for monitoring).

As in most contemporary land-claim areas, most of the Aboriginal partners that have worked on various research and monitoring projects in the ISR have done so on a project-specific, contract basis. At present, more secure and longer-term employment opportunities in the field of natural science seem to require formal "Western science" credentials. At the same time, the delivery of the programs requires that the Aboriginal harvest monitors work as an integral part of a scientific team while still maintaining and using local skills and knowledge—in fact, often the success of the program and the safety of the project team likely depends on their role. The importance of fairly recognizing and justly compensating Aboriginal partners for their contributions to program design and delivery "at par" with science partners cannot be overstated.

ACKNOWLEDGEMENTS

Past and present FJMC members, staff, and DFO liaison were instrumental and supportive in moving the harvest-based approach forward: in particular, the late Alex Aviugana, the late Billy Day, the late Nelson Green, the late Donovan Dowler, Pat Ekpakhoak, Max Kotokak Sr., Dr. Burton Ayles, Ron Allen, Larry Dow, Vic Gillman, and Dr. Michael Papst. That support was based on equal parts of practicality and IFA philosophy. It originally arose in the late 1980s during discussions regarding how the FJMC could better understand the Prince Albert Sound/Minto Inlet arctic charr complex. Michael Papst (FJMC member, 1991–96; 2010–12) advocated a shift in the research question from assessing stock size at one point in time, to longer-term studies of stock trends through monitoring, and with that, smaller-scale community-based projects which incorporated indigenous knowledge. This became, and continues to be, the FJMC's main approach, and subsequent successes have vastly outweighed failures.

We gratefully acknowledge the skilled and dedicated Inuvialuit harvesters that have worked on delivery of harvest-based and other projects in the ISR (1988–2010). In alphabetical order, Isaac Aleekuk, Buddy Alikamik, John and Emma Alikamik, the late Titus Allen, Angus Alunik, Alex Angasuk, Billy Archie, Dennis Arey, Larry Arey, the late Alex Aviguana, the late Billy Day, Forrest Day, Catharine Dick, John Dick, Pat Ekpakhoak, Walter and Maureen Elias, Lennie Emahok, Earl Esau, the late Eric Ettagiak, Raymond Ettagiak, Christopher Felix, Joseph Felix Jr., the late Danny A. Gordon, Danny C. Gordon, Ian Green, the late Nelson Green, Noel Green, Tony Green, Chucky Gruben, Joseph Haluksit, Joseph Illasiak, the late Roy Ipana, the late Darrell Joe, Alan Joss, Pat Kasook, John Keevik, David Kuptana, Jeff Kuptana, Clarence Mangelana, the late Jimmy Memogana, Roger Memogana, David Nasogaluak, Joe Nasogaluak Jr., Morris Nigiyok, Douglas Panaktalok, Charles Pokiak, James Pokiak, Frank Pokiak, Nellie Pokiak, James Rogers, Jerry Rogers, Bobby Ruben, the late Charlie Ruben, Nelson Ruben, Ruben Ruben, and the late John Voudrach. We sincerely apologize to anyone we may have missed. We also gratefully acknowledge the skilled and dedicated efforts of our longest-term science partners: Harold Wright, Paul Sparling, Steve Sandstrom, Dr. Thomas G. Smith (EMC Ecomarine Corp), Don MacDonell, and John Moran. Finally, we also thank Dr. Smith for his helpful review of this manuscript and for sharing his perspective on working in the ISR for four decades. This manuscript was written in response to a request by the FJMC members, while on their annual community tour to the Inuvialuit community of Holman (now known as Ulukhaktok) in fall 2001.

REFERENCES

AANDC (Aboriginal Affairs and Northern Development Canada). 2010. Inuvialuit Settlement Region. http://www.aadnc-aandc.gc.ca/eng/1100100027701/1100100027705.

Adams, M., Frost, K.J., and Harwood, L.A. 1993. Alaska and Inuvialuit Beluga Whale Committee (AIBWC) – An initiative in "at home management." Arctic 46(2):134–137.

Addison, R.F., Muir, D.C.G., Ikonomou, M.G., Harwood, L.A., and Smith, T.G. 2009. Hexachlorocyclohexanes (HCH) in ringed seal (*Phoca hispida*) from Ulukhaktok (Holman), NT: Trends from 1978 to 2006. Science of the Total Environment 407(18):5139–5146, http://dx.doi.org/10.1016/j.scitotenv.2009.05.049.

Bell, R.K. 1994. Indigenous knowledge, sustainable development and cooperative management: The FJMC Experience. In: Hansen, B.V., ed. Arctic Environmental Protection Strategy, Report on Seminar on Integration of Indigenous Peoples Knowledge. Reykjavik, Iceland: Ministry for the Environment. 186–199.

Berkes, F. 1990. Native subsistence fisheries: A synthesis of harvest studies in Canada. Arctic 43(1):35–42.

———. 1999. Sacred ecology. Philadelphia, Pennsylvania: Taylor & Francis. 209 p.

Berkes, F., and Fast, H. 2005. Introduction. In: Berkes, F., Huebert, R., Fast, H., Manseau, M., and Diduck, A., eds. Breaking ice: Renewable resource and ocean management in the Canadian North. Northern Lights Series 7. Calgary, Alberta: University of Calgary Press and the Arctic Institute of North America. 1–19.

Berkes, F., Berkes, M.K., and Fast, H. 2007. Collaborative integrated management in Canada's North: The role of local and traditional knowledge and community-based monitoring. Coastal Management 35(1):143–162.

Byers, T., and Roberts, L.W. 1995. Harpoons and ulus: Collective wisdom and traditions of the Inuvialuit regarding the beluga ("qilalugaq") in the Mackenzie River estuary. Report by Byers Environmental Studies and Sciometrix Inc. for the Department of Indian Affairs and Northern Development and the Fisheries Joint Management Committee. Available at FJMC, Box 2120, Inuvik, Northwest Territories X0E 0T0.

Carmack, E., and Macdonald, R. 2008. Water and ice-related phenomena in the coastal region of the Beaufort Sea: Some parallels between Native experience and Western science. Arctic 61(3):265–280.

Cosens, S.E., de March, B.G.E., Innes, S., Mathias, J., and Shortt, T.A. 1998. Report of the Arctic Fisheries Scientific Advisory Committee for 1993/94, 1994/95 and 1995/96. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2473. 87 p.

Day, B. 2002. Renewable resources of the Beaufort Sea for our children: Perspectives from an Inuvialuit elder. Arctic 55(Supp. 1):1–3.

DFO (Department of Fisheries and Oceans). 2000. Eastern Beaufort Sea beluga whales. DFO Science Stock Status Report E5-38. 14 p.

Donaldson, J. 1984. 1982 wildlife harvest statistics for the Baffin Region, Northwest Territories. Technical Report No. 2. Baffin Region Inuit Association (BRIA) unpubl. report. 64 p. Available from BRIA, Iqaluit, Nunavut X0A 0H0.

Dowler, D. 1996. The use of traditional knowledge by the Fisheries Joint Management Committee in the Inuvialuit Settlement Region. In: Fehr, A., and Hurst, W., eds. A seminar on two ways of knowing: Indigenous and scientific knowledge. Inuvik, Northwest Territories: Aurora Research Institute. 62–63.

Environment Canada. 2003. Improving local decision-making through community based monitoring: Toward a Canadian Community Monitoring Network. Prepared by the Ecological Monitoring and Assessment Network Coordinating Office and the Canadian Nature Federation. Ottawa: Environment Canada.

Evans, M., Muir, D., Kwan, M., Harwood, L., Dick, T., Keating, J., and Wang, X. 2005. Persistent organic contaminants in char and seals consumed by coastal Arctic communities. Poster presented at the Society of Environmental Toxicology and Contaminants, 13–17 November 2004, Baltimore Maryland.

Fehr, A., and Hurst, W. 1996. A seminar on two ways of knowing: Indigenous and scientific knowledge. Inuvik, Northwest Territories: Aurora Research Institute.

Fraker, M.A., and Fraker, P.N. 1979. The 1979 whale monitoring program, Mackenzie Estuary. Report by LGL Limited, Sidney, British Columbia. Available at the Department of Fisheries and Oceans Library, 501 University Crescent, Winnipeg, Manitoba R3T 2N6. 51 p.

Gaden, A., Ferguson, S.H., Harwood, L., Melling, H., and Stern, G.A. 2009. Mercury trends in ringed seals (*Phoca hispida*) from the Western Canadian Arctic since 1973: Associations with length of ice-free season. Environmental Science and Technology 43(10):3646–3651, doi:10.1021/es803293z.

Gamble, R.L. 1988. Native harvest of wildlife in the Keewatin Region, Northwest Territories, for the period October 1985 to March 1986 and a summary for the entire period of the harvest study from October 1981 to March 1986. Canadian Data Reports of Fisheries and Aquatic Sciences 688. Winnipeg: Department of Fisheries and Oceans.

Government of Canada. 1984. Western Arctic (Inuvialuit) Claims Settlement Act. S.C. 1984, c. 24. Ottawa: Department of Justice. http://laws-lois.justice.gc.ca/eng/acts/W-6.7/index.html.

Gwich'in Elders. 1997. Gwich'in words about the Land. Inuvik, Northwest Territories: Gwich'in Renewable Resources Board.

Harwood, L.A. 2009. Status of anadromous arctic charr (*Salvelinus alpinus*) of the Hornaday River, Northwest Territories, as assessed through harvest-based sampling of the subsistence fishery, August–September 1990–2007. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2890. Yellowknife: Fisheries and Oceans Canada. viii + 33 p.

Harwood, L.A., Smith, T.G., and Melling, H. 2000. Variation in reproduction and body condition of the ringed seal (*Phoca hispida*) in western Prince Albert Sound, NT, Canada, as assessed through a harvest-based sampling program. Arctic 53(4):422–431.

Harwood, L.A., Norton, P., Day, B., and Hall, P.A. 2002. The harvest of beluga whales in Canada's Western Arctic: Hunter-based monitoring of the size and composition of the catch. Arctic 55(1):10–20.

Harwood, L.A., McLaughlin, F., Allen, R.M., Illasiak J., and Alikamik, J. 2005. First-ever marine mammal and bird observations in the deep Canada Basin and Beaufort/Chukchi Seas: Expeditions during 2002. Polar Biology 28(3):250–253.

Harwood, L.A., Smith, T.G., and Melling, H. 2007. Assessing the potential effects of near shore hydrocarbon exploration on ringed seals in the Beaufort Sea Region 2003–2006. Environmental Studies Research Funds 162. 103 p.

Harwood, L.A., Pokiak, F., and Walker-Larsen, J. 2008. Assessment of the subsistence fishery and biological data for arctic cisco in Tuktoyaktuk Harbour, NT, Canada, 1997–1999. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2845. ix + 31 p. Winnipeg: Fisheries and Oceans Canada.

Harwood, L., Joynt, A., Kennedy, D., Pitt, R., and Moore, S. 2009. Spatial restrictions and temporal planning as measures to mitigate potential effects of seismic noise on cetaceans: A working example from the Canadian Beaufort Sea, 2007–2008. DFO Canadian Science Advisory Secretariat Research Document 2009/040. iv + 14 p.

Hunt, W.J. 1979. Domestic whaling in the Mackenzie Estuary, Northwest Territories. Technical Report 769. Winnipeg: Canada Fisheries and Marine Service, Western Region, Department of Fisheries and the Environment.

Huntington, H.P. 1998. Traditional ecological knowledge and beluga whales. http://www.culturalsurvival.org/ourpublications/csq/article/traditional-ecological-knowledge-and-beluga-whales.

———. 2000. Using traditional ecological knowledge in science: Methods and applications. Ecological Applications 10(5):1270–1274.

———. 2006. Who are the "authors" when traditional knowledge is documented? Arctic 59(3):iii–iv.

———. 2011. The local perspective. Nature 478:182–183.

Huntington, H.P., and the Communities of Buckland, Elim, Koyuk, Point Lay, and Shaktoolik. 1999. Traditional knowledge of the ecology of beluga whales (*Delphinapterus leucas*) in the eastern Chukchi and northern Bering Seas, Alaska. Arctic 52(1):49–61.

Huntington, H.P., Gearheard, S., Mahoney, A.R., and Salomon, A.K. 2011. Integrating traditional and scientific knowledge through collaborative natural science field research: Identifying elements for success. Arctic 64(4):437–445.

Jingfors, K. 1986. Inuit harvesting levels of caribou in the Kitikmeot Region, Northwest Territories, Canada, 1982–1984. Rangifer 6(2), Special Issue 1:167–172.

Joint Secretariat. 2003. Inuvialuit Harvest Study: Data and methods report 1988–1997. The Joint Secretariat. vi + 202 p.

Kingsley, M.C.S., and Byers, T.J. 1998. Failure of reproduction in ringed seals (*Phoca hispida*) in Amundsen Gulf, Northwest Territories in 1984–1987. In: Heide-Jørgensen, M.P., and Lydersen, C., eds. Ringed seals in the North Atlantic. NAMMCO Scientific Publication 1. Tromsø, Norway: The North Atlantic Marine Mammal Commission. 197–210.

Kofinas, G., with the Communities of Aklavik, Arctic Village, Old Crow, and Fort McPherson. 2002. Community contributions to ecological monitoring: Knowledge co-production in the U.S.-Canada Arctic Borderlands. In: Krupnik, I., and Jolly, D., eds. The earth is faster now: Indigenous observations of Arctic environmental change. Fairbanks: ARCUS. 54–91.

Lockhart, W.L., Stern, G.A., Wagemann, R., Hunt, R.V., Metner, D.A., DeLaronde, J., Dunn, B., et al. 2005. Concentrations of mercury in liver of beluga whales (*Delphinapterus leucas*) from the Canadian Arctic from 1981 to 2002. Science of the Total Environment 351-352:391–412. http://dx.doi.org/10.1016/j.bbr.2011.03.031.

Loseto, L.L., Stern, G.A., Deibel, D., Connelly, T.L., Prokopowicz, A., Lean, D.R.S., Fortier, L., and Ferguson, S.H. 2008a. Linking mercury exposure to habitat and feeding behaviour in Beaufort Sea beluga whales. Journal of Marine Systems 74(3-4):1012–1024.

Loseto, L.L., Stern, G.A., and Ferguson, S.H. 2008b. Size and biomagnification: How habitat selection explains beluga mercury levels. Environmental Science and Technology 42(11):3982–3988.

Manseau, M., Parlee, B., and Ayles, G.B. 2005. A place for traditional ecological knowledge in resource management. In: Berkes, F., Huebert, R., Fast, H., Manseau, M., and Diduck, A., eds. Breaking ice: Renewable resource and ocean management in the Canadian North. Northern Lights Series 7. Calgary, Alberta: University of Calgary Press and the Arctic Institute of North America. 141–164.

Mymrin, N.I., the Communities of Novoe Chaplino, Sireniki, Uelen, and Yanrakinnot, and Huntington, H.P. 1999. Traditional knowledge of the ecology of beluga whales (*Delphinapterus leucas*) in the northern Bering Sea, Chukotka, Russia. Arctic 52(1):62–70.

Nuligak. 1966. I, Nuligak: The autobiography of a Canadian Eskimo. Edited and translated by Maurice Metayer. Richmond Hill, Ontario: Pocket Book. 191 p.

Orr, J.R., and Harwood, L.A. 1998. Possible aggressive behaviour between a narwhal (*Monodon monoceros*) and a beluga (*Delphinapterus leucas*). Marine Mammal Science 14(1):182–185.

Paylor, A.D., Papst, M.H., and Harwood, L.A. 1998. Community household survey on the Holman subsistence arctic char (*Salvelinus alpinus*) fishery: Priorities, needs and traditions. Canadian Technical Report of Fisheries and Aquatic Sciences 2234. vi + 16 p.

Quakenbush, L.T., Citta, J.J., George, J.C., Small, R.J., and Heide-Jørgensen, M.P. 2010. Fall and winter movements of bowhead whales (*Balaena mysticetus*) in the Chukchi Sea and within a potential petroleum development area. Arctic 63(3):289–307.

Remnant, R.A., and Thomas, M.L. 1992. Inuit traditional knowledge of the distribution and biology of High Arctic narwhal and beluga. Available from North/South Consultants Inc., 83 Scurfield Blvd., Winnipeg, Manitoba R3Y 1G4.

Roux, M.-J., Harwood, L.A., Illasiak, J., Babaluk, J., and de Graff, N. 2011a. Fishery resources and habitats in a headwater lake of the Brock River, NT, 2003–2005. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2932. Winnipeg: Fisheries and Oceans Canada.

Roux, M.-J., Harwood, L.A., Zhu, X., Sparling, P., and Tallman, R. 2011b. Fish assemblage structure and species diversity with relationships to environmental variables in an Arctic estuary: The Husky Lakes ecosystem, Canada. 2011 Fisheries Society of the British Isles Annual International Conference: Fish Diversity and Conservation: Current State of Knowledge, 18–22 July 2011, Bournemouth, England.

Sandstrom, S.J., and Harwood, L.A. 2002. Studies of anadromous Dolly Varden (*Salvelinus malma*) (W.) of the Big Fish River, NT, Canada, 1972–1994. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2603. Winnipeg: Fisheries and Oceans Canada.

Smith, T.G. 1987. The ringed seal, *Phoca hispida*, of the Canadian western Arctic. Canadian Bulletin of Fisheries and Aquatic Sciences 216. 81 p.

Smith, T.G., and Harwood, L.A. 2001. Observations of neonate ringed seals, *Phoca hispida*, after early break-up of the sea ice in Prince Albert Sound, Northwest Territories, Canada, spring 1998. Polar Biology 24(3):215–219.

Smith, T.G., and Taylor, D. 1977. Notes on marine mammal, fox and polar bear harvests in the Northwest Territories 1940 to 1972. Technical Report 694. Ste. Anne de Bellevue, Quebec: Arctic Biological Station, Fisheries and Marine Service, Department of Fisheries and the Environment. 37 p.

Smith, T.G., and Wright, H. 1989. Economic status and role of hunters in a modern Inuit village. Polar Record 25(153):93–98.

Statistics Canada. 2012. 2006 census of population. Ottawa: Statistics Canada. http://www12.statcan.gc.ca/census-recensement/2006/index-eng.cfm.

Stern, G.A., Macdonald, C.R., Armstrong, D., Dunn, B., Fuchs, C., Harwood, L., Muir, D.C.G., and Rosenberg, B. 2005. Spatial trends and factors affecting variation of organochlorine contaminants levels in Canadian Arctic beluga (*Delphinapterus leucas*). Science of the Total Environment 351-352:344–368, http://dx.doi.org/10.1016%2fj.scitotenv.2004.10.033.

Stirling, I. 2002. Polar bears and seals in the eastern Beaufort Sea and Amundsen Gulf: A synthesis of population trends and ecological relationships over three decades. Arctic 55(Supp. 1):59–76.

———. 2012. Review of “Polar bears in Northwest Greenland: An interview survey about the catch and climate,” by E.W. Born, A. Heilmann, L.K. Holm, and K.L. Laidre. Polar Biology 35(1):155–157.

Strong, J.T. 1990. The domestic beluga (*Delphinapterus leucas*) fishery in the Mackenzie River Estuary, Northwest Territories, 1981–1986. Canadian Data Reports of Fisheries and Aquatic Sciences 800. Winnipeg: Fisheries and Oceans Canada. 52 p.

Usher, P.J. 1975. Historical statistics approximating fur, fish and game harvests within Inuit lands of the N.W.T. and Yukon 1915–1974, with text. Renewable Resources Project Vol. 3. Ottawa: Inuit Tapirisat of Canada. 71 p.

———. 2000. Traditional ecological knowledge in environmental assessment and management. Arctic 53(2):183–193.

———. 2002. Inuvialuit use of the Beaufort Sea and its resources, 1960–2000. Arctic 55(Supp. 1):18–28.

Usher, P.J., and Wenzel, G. 1987. Native harvest surveys and statistics: A critique of their construction and use. Arctic 40(2):145–160.

Usher, P.J., Wysocki, W., and Larcombe, P. 1996. Evaluation of the Inuvialuit Harvest Study. Report prepared by P.J. Usher Consulting Services and Symbion Consultants for the Joint Secretariat, Box 2120, Inuvik, Northwest Territories X0E 0T0.

Usher, P.J., Duhaime, G., and Searles, E. 2003. The household as an economic unit in Arctic Aboriginal communities, and its measurement by means of a comprehensive survey. Social Indicators Research 61(2):175–202.

Weaver, P.A. 1991. The 1987 beluga (*Delphinapterus leucas*) harvest in the Mackenzie River Estuary, NWT. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2097. Winnipeg: Department of Fisheries and Oceans. 18 p.

Wein, E., and Freeman, M.M.R. 1992. Inuvialuit food use and food preferences in Aklavik, Northwest Territories, Canada. Arctic Medical Research 51(4):159–172.

Wenzel, G.W. 1999. Traditional ecological knowledge and Inuit: Reflections on TEK research and ethics. Arctic 52(2):113–124.