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Integration or co-optation? Traditional knowledge and science in the Alaska Beluga Whale Committee

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SUMMARY

Traditional ecological knowledge (TEK) has become a focus of increasing attention by natural resource managers over the past decade, particularly in the context of the shared management authority between resource users and government agencies (co-management). Little work has been done on how TEK can be successfully integrated with science and applied in contemporary science-based resource management institutions, and the efficacy and legitimacy of co-management and associated attempts to document TEK or integrate it with science have recently been questioned. The cooperative research programme of one co-management group, the Alaska Beluga Whale Committee (ABWC), was studied to describe how TEK and science are integrated and applied in the research process, document perceptions and attitudes of native hunters and scientists towards TEK and science, and identify organizational characteristics that facilitate knowledge integration. Hunters and TEK played a variety of roles in ABWC's research programme, including hypothesis generation, sample collection and data interpretation. Hunters and scientists defined TEK similarly, but differed in their views of science, which hunters often perceived as a tool of state control. Despite political undercurrents, the ABWC displayed several indicators of successful knowledge integration. Organizational characteristics that facilitated integration included a membership structure fostering genuine power-sharing and a range of opportunities for formal and informal interactions among hunters and scientists leading to long-term relationships and an organizational culture of open communication and transparency in decision-making. Given the importance of long-term relationships between scientists and hunters for successful knowledge integration, this study raises questions about (1) the potential for meaningful integration in short-term projects such as environmental impact assessment and (2) the use of TEK documentation studies in the absence of other forms of active participation by TEK-holders.

Keywords: co-management, common property, common pool resources, cooperative research, environmental impact assessment, indigenous knowledge, traditional ecological knowledge

INTRODUCTION

Traditional ecological knowledge (TEK) has become a popular topic in natural resource management over the past decade (Berkes 1999; Ford & Martinez 2000; Armitage 2003), yet progress in understanding and applying TEK in contemporary science-based management institutions has been slow, particularly in the state-sponsored management regimes of the global North. In this paper, we report the results of a study of the Alaska Beluga Whale Committee (ABWC), a co-management organization comprising Alaska Native beluga hunters and government agency personnel, and its use of TEK. The ABWC's work to date has focused largely on generating knowledge, through research, that informs beluga management. Beluga hunters have participated in that research, and in doing so implicitly and explicitly contributed their knowledge and expertise. Our study examined the ways in which TEK has been included in management-oriented research, the perceptions and attitudes of ABWC members concerning TEK and scientific research, and the organizational characteristics that have facilitated knowledge integration.

We define TEK as a 'system of experiential knowledge gained by continual observation and transmitted among members of a community' (Huntington 1998), acknowledging also its intergenerational character (Berkes 1999). TEK consists of biophysical observations, skills and technologies, as well as the social and cultural values, norms and institutions that guide human-environment interactions (Berkes 1999; Fernandez-Gimenez 2000). Like other types of knowledge, the kind and quality of TEK vary within communities depending on the gender, age, social class and position, occupation and interests of the individual (Davis & Wagner 2003). Most research on TEK continues to be dominated by documentation of TEK through interviews and sometimes participant observation, and often comparison of TEK with scientific knowledge (Nakashima & Murray 1988; Ferguson

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& Messier 1997; Huntington *et al.* 1999; Roue & Nakashima 2002; Erickson & Ardon 2003; Zuercher *et al.* 2003; Verlinden & Dayot 2005). The role of TEK in traditional resource management systems has also been described (Niamir 1995; Warren *et al.* 1995; Berkes & Folke 1998; Berkes 1999). Despite frequent allusions to the importance of TEK in the design of contemporary management institutions for common pool resources (Osherenko 1988; Ostrom 1990), there is relatively little documentation of how it is incorporated into these arrangements, particularly in the science-based state management systems of the North (Berkes & Folke 1998; Nadasdy 2003*b*; Aswani & Hamilton 2004; Phuthego & Chanda 2004).

Co-management is defined here as a formal or informal arrangement through which natural resource decision-making authority is shared by resource users and government management agencies (Pinkerton 1989). Much of the scholarship on co-management has focused on formal legal arrangements, but co-management can also refer to more informal emergent power-sharing arrangements (Olsson *et al.* 2004; Plummer & Fitzgibbon 2004). Various functions of co-management have been identified, including roles typically associated with natural resource management (Pinkerton 1989), community-oriented roles such as cultural integrity (Berkes 1991) and harvest efficiency (Pinkerton 1994), and those associated with process and equity (Plummer & Fitzgibbon 2004). Pinkerton (1989, p. 15) identified 'data gathering and analysis for understanding the state of the resource,' as one of the seven key functions of co-management. Folke *et al.* (2005, p. 463) likewise recognized 'knowledge building and understanding of resource and ecosystem dynamics' as an important component of adaptive governance of complex social-ecological systems. While reliable information about beluga whale populations does not necessarily ensure sound management or the conservation of beluga populations (see Huitric 2005), we share the assumption that reliable and credible information on resource condition is a necessary foundation for successful management.

Both co-management and TEK are subject to criticism. Critics of devolution in natural resource management question the legitimacy of granting local resource users a disproportionate (in their view) voice in management decisions over publicly-owned resources (McCloskey 1996; Coggins 2001). Similarly, some doubt the quality or validity of TEK and question its utility for natural resource management, in part because of the spiritual beliefs that comprise one aspect of it (Howard & Widdowson 1996). Others caution that TEK, by definition knowledge about specific localities, should not be extrapolated and applied beyond the local areas to which it pertains (Duerden & Kuhn 1998). On the other side of the debate are scholars who perceive co-management as a means of promoting the expansion of state authority (rather than sharing power more equitably with local people) and placating communities that might otherwise challenge the state's rights to valuable resources (Cruikshank 1998; Nadasdy 1999).

Similarly, these critics question the motives and efficacy of integrating TEK and science, contending that TEK documentation projects isolate TEK from its social and cultural contexts and interpret it through a Western science lens, constituting another form of exploitation (Cruikshank 1998, 2001; Nadasdy 1999, 2003*a*). In the middle of the debate over the application of TEK to management are those who assert that documentation is one of several approaches to incorporating TEK, and is preferable to excluding indigenous perspectives (Stevenson 1996). Kaplan and McCay (2004), for example, concede that co-management of fisheries has been fraught with controversy and mistrust, but assert that cooperative research involving fisherfolk and government researchers can improve the quality of science by drawing on the expertise of different stakeholders and increasing the transparency of the research process.

Missing from these debates and the literature on co-management and traditional knowledge are detailed accounts of the ways in which TEK is applied in co-management settings, and the organizational characteristics that promote or impede the use of this knowledge (Huntington *et al.* 2002; Ross & Pickering 2002; Sherry & Myers 2002). Our aim is to provide such an account, focused on the role of native hunters and their TEK in the research activities carried out by the ABWC. Our objectives were two-fold. First, we sought to describe the roles of TEK and science in ABWC's research and ABWC members' perceptions of and attitudes towards TEK and science. Second, we aimed to analyse the ways in which TEK and science have been integrated in this co-management group, and identify the organizational characteristics that foster this integration.

The ABWC is a co-management group comprising Alaska Native hunters, scientists and agency managers created in 1988 with the goals of maintaining healthy beluga populations, providing for adequate subsistence harvest of beluga whales and protecting hunting practices of Alaskan subsistence hunters (Adams *et al.* 1993; Alaska Beluga Whale Committee 1995). The ABWC was formed in the wake of the bowhead whaling moratorium crisis of 1977 (Huntington 1992; Freeman *et al.* 1998) to gather data on belugas and demonstrate local management capacity so as to avoid regulation of beluga hunting by outside parties such as the International Whaling Commission. To date, the ABWC's efforts have focused primarily on research about beluga stocks and harvest levels, one of Pinkerton's (1989) seven potential management functions.

METHODS

The study is based on participant observation, semi-structured interviews, document reviews and focus groups with Alaska Native hunters and community members from seven beluga-hunting native villages in three different regions

of the state. Meeting minutes, newsletters, and existing management plans and co-management agreements were reviewed. The authors have attended annual ABWC meetings since 1997, 1989 and 1988, respectively, M. E. Fernandez-Gimenez and H. P. Huntingdon as participant observers, and K. J. Frost as an active member of the group. In addition, M. E. Fernandez-Gimenez made two trips to ABWC member communities to interview ABWC participants and other local beluga hunters and community leaders. Most of the founding members and early leaders of the organization were interviewed, as well as agency managers and scientists who have participated actively in ABWC. In 2002, community focus groups were conducted in three communities in the North Slope Borough (NSB), Kotzebue Sound and Norton Bay regions, respectively. The NSB focus group was held in Point Lay, where a large proportion of the community participates in an annual beluga drive hunt. The Kotzebue Sound and Norton Bay focus groups each included participants from at least three different communities within each of these regions. In all, 12 native hunters and nine non-native agency scientists or managers were interviewed individually, and a total of 36 native hunters and community members participated in the three focus groups.

Interview and focus group data were transcribed, imported into N*VIVO (QSR International 2000) and coded along with documents such as meeting minutes. Both deductive and inductive coding were used. The deductive coding applied pre-determined categories to analyse text, while inductive coding applied categories that represented emergent themes that arose through the iterative process of analysis (Miles & Huberman 1994; Bernard 2002). Deductive codes related to our initial research objectives, namely the roles of hunters and their TEK in each of the ABWC research initiatives, hunter and scientist views of TEK and science, and indicators of TEK integration. Inductive codes related to emergent themes such as validation (the use of science to validate TEK and vice versa), relationship-building and communication. Our analysis took a grounded theory approach (Strauss & Corbin 1998), whereby the research was approached without a preconceived hypothesis in mind. Instead, the data were used to generate theory through an iterative process of identifying emergent themes, assembling themes into working hypotheses, testing these hypotheses against the data and reformulating the theory until it was consistent with the evidence. Our preliminary findings were presented to ABWC participants during two annual meetings, to help validate our initial results and interpretations and elicit additional feedback. Drafts of the manuscript were also reviewed by ABWC members for accuracy.

In keeping with the exploratory and inductive nature of our research, our research objectives were primarily descriptive. We sought to understand how TEK and native hunters are incorporated into ABWC's research, document hunters' and scientists' perceptions of and attitudes towards TEK and science, determine how and whether science and TEK were integrated into the ABWC, and identify factors that helped facilitate such integration.

RESULTS

TEK and research

The ABWC has undertaken or encouraged research to advance knowledge in five areas important to management, namely population estimates and trends, harvest levels, migratory behaviour, stock identity and TEK studies. Hunters and scientists have played roles in each research activity, as has TEK (Table 1).

Population estimates and trends

Native hunters have often made observations about trends in abundance, but providing point-in-time estimates of actual population size had been more challenging. Because of the importance of population data for management, and the role that the lack of reliable population estimates played in the bowhead hunting moratorium in the late 1970s (Huntington 1992), gathering accurate population data was one of the first areas of research pursued by ABWC.

Starting with the limited data available from earlier studies, ABWC scientists worked with native villagers to learn from them when and where belugas usually appeared in their areas and when they were hunted. A rotating series of aerial surveys was conducted to cover each provisional management stock of belugas. Hunters often accompanied the survey team and provided advice on when and where to fly in order to locate belugas. Some hunters interviewed felt that their advice had not been heeded, in part because the logistics of scheduling the aircraft or the maintenance of a statistically valid research design constrained the flexibility of the surveyors.

Reports of the survey results, the population estimates, and stock assessments were provided to ABWC members at their annual meeting. Hunter representatives often asked questions and provided additional reflections about the survey process and results, sometimes challenging the conclusions. Hunters who were aware of the estimates generally felt it was useful information and that the estimates to date largely supported their contention that beluga stocks in northern and western Alaska were healthy. The population estimates were used by the National Marine Fisheries Service (NMFS) to develop stock assessment reports, on which management decisions were based, and in which ABWC was credited with providing essential information.

Harvest levels

Another important contribution to stock assessments was the annual harvest reporting by village representatives to the ABWC. These reports included the number of belugas harvested, the number struck and lost, the timing of the hunt(s), and often additional information on the technology used (rifles versus nets), the conditions under which hunting occurred, observations on local beluga behaviour and health,

Table 1 Summary of ABWC research and the roles played by hunters and scientists in these projects. In addition to the roles specified here, all ABWC members participate in making decisions on research priorities and funding. For details see text.

	Aerial surveys	*Harvest reports*	*Satellite telemetry*	*Genetic research*	*TEK studies*
Purpose	Population estimates. Stock assessments	Document harvest levels, struck and lost. Document other observations. Stock assessments	Identify which stocks go where. Seasonal distribution of stocks. Document dive duration	Distinguish stocks and populations	Document traditional knowledge about belugas
Hunter roles	Direct surveyors to areas where belugas likely to be found. Accompany flights. Data interpretation. Report results to communities	Report harvest levels, struck and lost, conditions, observations, hunting methods. Report results to communities	Hypothesis generation. Tagging. Data interpretation. Report results to communities	Hypothesis generation. Sample collection. Data interpretation. Report results to communities	Provide knowledge. Review and validate draft report
Scientist roles	Conduct aerial surveys. Analyse data. Report results	Use harvest reports to develop stock assessments. Report results	Hypothesis generation. Tagging. Data analysis and interpretation. Report results	Hypothesis generation. Data analysis and interpretation. Report results	Document knowledge on tapes and maps. Report results. Compare TEK with existing literature
TEK contribution	Where and when belugas are seen	Observations on hunting practices and beluga health and behaviour	Knowledge of how to capture belugas. Observations on distribution	Observations of different groups of belugas	All types of observations about belugas and related species and ecosystem functions
Learning	Current population size	Current rates of harvest appear sustainable. Rates of struck and lost declining	Belugas go far north	Five distinct stocks in Alaska	Insights into beluga ecology and relation to other species and terrestrial ecosystems

and other village concerns regarding belugas and their management.

The hunters' role in the harvest reports has been key, since hunters gathered the information and reported it to the Committee. In reporting hunters also often provided a first level of analysis and interpretation of the data. Harvest data were often viewed as 'sensitive information', especially when they had been gathered for an agency or other outside entity, and when they might have revealed practices that might not reflect well on an individual hunter or a village, such as a large number of struck and lost animals. Early in the ABWC's history, hunters often feared that harvest data would be used against them. Rather than attempting to allay these fears, one agency scientist reported telling hunters: 'Of course they're going to use it against you. You can never guarantee. But if it's your data, if it has your name on it as the source, and if it's as good as you can possibly make it, people are at least going to have to come to you and ask about it.' The scientist went on to explain that, 'It's an issue of control.' If hunter data were not available, decision-makers might use other data, potentially of questionable quality and validity, which hunters would be unable to contest. By this reasoning, it was better for the hunters to provide their own data, albeit scrutinized.

Over the years, hunters on the Committee have also developed a sense of collective ownership of and pride in the data they have provided. Their contributions have been formally acknowledged when agencies such as NMFS cited the ABWC as the source of harvest and population data in their published stock assessments. This formal recognition, has in turn lent credibility to the ABWC in its dealings with other agencies and entities such as the International Whaling Commission.

Migratory behaviour

The ABWC has sponsored satellite telemetry projects on beluga whales since 1996. Early satellite telemetry was initiated in part to document the amount of time belugas spent submerged in a given dive. This information improved population estimates by providing a correction factor to be applied to raw counts made during aerial surveys. The main focus of current telemetry efforts has been to document the seasonal migration patterns of different beluga stocks. Hunters have provided much valuable information about beluga behaviour and distribution when belugas have been in near-shore waters, but little was known about where belugas went when they left these areas, whether multiple villages and regions hunted from a given stock, and whether the stocks were in fact distinct.

In Point Lay, where in 1998 the ABWC team first tagged belugas, hunters have played a vital role in the project. There, tagging has taken place in conjunction with the annual hunt, in which the migrating animals are herded into a long narrow

lagoon by a flotilla of skiffs and trapped in an area of shallow water. After the villagers had taken the animals needed for food, the scientists tagged whales remaining in the shallows, usually with local assistance. Once the tags were placed on the whales, the locations were tracked on a map, and weekly updates of the belugas' routes were transmitted to the village and posted in a public location. At the annual ABWC meeting, the results of the year's telemetry project were formally presented and discussed, with hunters participating avidly in the interpretation of the findings, which have been of great interest to hunters and scientists alike (see Suydam *et al.* 2001).

Other telemetry efforts were made in Norton Sound, Bristol Bay and Cook Inlet, with assistance from ABWC and its member hunters. One hunter, who was also an officer of the ABWC, was certified by NMFS as a tagger; he could capture and place tags on animals without scientists present. This formal acknowledgement both facilitated the research, by allowing it to continue in the absence of the scientists, and officially recognized his contribution to beluga science. Other hunters have been included as co-authors on scientific papers publishing the results of the telemetry research (Suydam *et al.* 2001). When asked about future research priorities, interviewed hunters often requested additional satellite telemetry studies in other regions of Alaska. Each group of communities using a specific stock wanted to know where 'their' belugas went during the rest of the year. Hunter support for satellite telemetry was especially noteworthy in light of cultural beliefs among many Alaska native groups that manipulation or invasive procedures on animals for purposes other than subsistence hunting are disrespectful at minimum, and at worst threaten the success of future harvests (Fienup-Riordan 1999).

Stock identification

ABWC has been involved in genetic research on belugas since 1992, leading to the identification of five distinct beluga stocks in Alaska (O'Corry-Crowe *et al.* 1997). Like population estimates, information on the distinctness of stocks has been important to management because it has helped managers and hunters to determine which communities (and countries) hunt from the same stocks and whether a particular stock is at risk of depletion. For example, genetic research by ABWC helped to confirm that the Cook Inlet beluga population was genetically distinct from other Alaska stocks, indicating that the recent decline in that local population was reason for concern. This information ultimately led to agency actions and recognition by hunters that past levels of harvest were no longer sustainable.

Hunters made essential contributions to this research by providing the tissue samples for genetic and biological sampling. According to one ABWC officer, tissue samples were provided from about half of all the belugas harvested in Alaska, a high level of cooperation leading to a uniquely complete data set on the genetics of this species (600–700 samples).

In addition to providing the samples, hunters made significant contributions to the development of research hypotheses and the interpretation of genetic research results. Among the former was the question of whether the spring and fall migrations of belugas through Norton Sound might be from different stocks. Hunters' concern for the fate of the belugas that once migrated through Kotzebue Sound, but largely disappeared in the mid-1980s, also stimulated investigation.

TEK studies

Two studies focusing on beluga TEK in Alaska were conducted. The first involved five communities that had participated in the ABWC, was funded by the National Science Foundation and conducted by an interdisciplinary researcher with close ties to but not a voting member of the ABWC (Huntington *et al.* 1999). The second study was funded and organized by the ABWC during the Cook Inlet beluga 'crisis'. In this instance, the same researcher was contracted to interview hunters in the Anchorage area and document their knowledge of beluga whale biology and ecology (Huntington 2000). While these studies have been faulted by some social scientists for their emphasis on biophysical knowledge and failure to include the larger cultural context of the knowledge (Cruikshank 1998, 2001), they have been valued by both hunters and scientists on the ABWC, and provided some new insights into the relationship between belugas and nearshore terrestrial and freshwater ecosystems (Huntington 1998).

Hunters were generally pleased that their knowledge was documented and made more accessible to scientists and others through the documentation process. Documentation of their knowledge in written form seemed to put it on a more equal footing with science, which they equated with written knowledge. Several researchers noted that they appreciated having an organized compendium of beluga TEK to refer to, in part because it enabled them to cite a written source for this observational information. Other scientists included native observations in their work and were comfortable citing their original sources directly as personal communication.

ABWC member perceptions of science and TEK

TEK and science

In individual interviews and focus groups, we asked hunters and scientists to define TEK and science, to determine whether and how the meanings of these two terms differed between groups. Natives and scientists interviewed shared the perception that TEK is experiential knowledge. Natives ultimately found TEK the most credible 'true' information about belugas, while scientists found it valuable, but sometimes difficult to deal with given their process for creating, and criteria for validating, knowledge. Natives valued scientific knowledge, particularly when it validated TEK, but perceived science as a power structure as well as a knowledge system, whereas scientists either did not perceive the power

dynamics associated with use and negotiations over different types of knowledge, or de-emphasized them. Scientists viewed science as a process or method that yields a special type of knowledge.

Conflicts between TEK and science

The descriptions of hunter and TEK involvement in ABWC's research programme highlighted the complementary role that traditional knowledge has played in the research process. There were several instances, however, where hunters' knowledge conflicted with science. One case involved hunters' assertions that belugas feed in a particular coastal lagoon. To test this proposition, scientists examined the stomach contents and liver condition of belugas harvested from the lagoon and concluded that while belugas are found in the lagoon, there was no food in their stomachs and their livers indicated that the animals were fasting (R. Suydam, personal communication 2004). Another ongoing tension between science and TEK has been the method used to survey beluga populations. Aerial survey timing has not not always coincided with the advice of local hunters and the flight pattern required for statistically valid sampling may have undersampled areas that hunters said held higher concentrations of belugas.

Indicators of integration

Four indicators of knowledge integration were observed among ABWC members: use of hunters' knowledge as a basis for scientific hypothesis generation and data interpretation, hunters' sense of ownership over research projects and products, hunters' assimilation and dissemination of scientific knowledge, and scientists' increased understanding and appreciation of the socio-cultural context and implications of TEK. Having already described the role of hunters' knowledge in ABWC's various research programmes, focus here is on the other three indicators.

One result of hunter participation in all phases of research, including setting the research agenda, is that hunters expressed ownership of the products of research. One long-term agency scientist noted that a prominent hunter and ABWC officer used the pronoun 'we' when referring to ABWC satellite tagging efforts. Because this individual had not personally participated in those efforts, the scientist considered his statement a strong indication of ownership of the activity and the resulting data.

A further indicator of integration is hunters' assimilation of scientific research into their overall understanding of belugas and dissemination of their new knowledge within and among hunting villages. Scientific knowledge about belugas was communicated among hunters and within communities, and has become part of the local knowledge base. Knowledge assimilation was revealed in the village focus groups, where ABWC hunters discussed the merits and results of different ABWC research projects with other hunters, demonstrating a strong understanding of the research and its management implications.

In another instance, information that originated with a scientist's observation about beluga deaths in an ice entrapment was reported in a traditional knowledge interview with hunters (Huntington *et al.* 1999). Observational information originating from the scientist had been incorporated into local knowledge. Hunter dissemination of sophisticated scientific information, such as results of genetic studies and population estimates, was especially noteworthy given the constraints on community dissemination in many community-based monitoring and civic science studies (Vaughan *et al.* 2003; Whitelaw *et al.* 2003).

An indicator of integration displayed by the scientists was their increased understanding and appreciation of the socio-cultural implications and context of their research. Through participation in ABWC and its research programmes, scientists came to value and apply knowledge that did not arise from the scientific methodologies they were trained to use. As several scientists emphasized, the research would have been far less fruitful and in some cases impossible without the research questions posed by hunters and their contributions to sampling. Further, scientists who began their work with the ABWC with a narrow focus came to appreciate the broader cultural context and implications of their work and the impact that it had on a subsistence culture. Hunters observed and appreciated these transformations in their scientist colleagues, noting that, 'Scientists are beginning to think like us'.

Facilitating factors: organizational structure and process

The salient structural features of the ABWC included its membership, with representatives from over 40 native beluga-hunting villages and from federal, state and local agencies. Native hunters and the mostly non-native agency staff had equal membership status, except that hunters alone voted on hunting matters. Village hunter representatives far outnumbered agency representatives on the Committee, although agency staff held disproportionate power because of their positions as agency decision-makers and researchers. Nevertheless, this structure meant that hunters had significant influence over research priorities and funding. A second significant means of power-sharing was the credit given to Native hunters' knowledge, data and other research contributions. Both hunters' influence over the research agenda, and the official acknowledgement of their contributions, contributed to their sense of ownership of the products of research, one of the integration indicators.

ABWC facilitated communication among hunters and between hunters and scientists in both formal and informal settings, in annual meetings and in the field. These patterns of interaction, and the environment of mutual respect and learning in which they occurred, have contributed to the long-standing relationships of trust, respect and reciprocity that characterize ABWC.

ABWC's annual meetings appeared to be more successful at achieving knowledge integration (and perhaps other goals) than meetings of some other co-management groups (see Morrow & Hensel 1992), with discourse and dialogue rather

than unidirectional presentations, and were greatly valued by all ABWC members.

The direct involvement of hunters in all phases of research facilitated the integration of TEK and science through more informal interactions and helped build relationships based on personal and professional exchanges. For example, scientists working in Point Lay earned the respect and appreciation of local residents by helping with the hard work of cutting up harvested animals.

In the view of one native ABWC member, both hunters and scientists benefited when scientists participated in village life and began to understand the impact of their science on matters of profound importance to villagers: 'Researchers don't view themselves as being part of this thing that is in front of them. They are part of it. When they see themselves as part of it and not separate from it . . . there are gains on both sides'.

The integration of science and TEK in ABWC has been a continuous process that has resulted from long-term relationships and interactions between researchers and hunters about a topic that interested both. As a result, some scientists resisted labelling traditional knowledge and distinguishing it from other forms of information. This approach to integration contrasts with others that, intentionally or otherwise, sustain the distinction between traditional and scientific knowledge. At the same time, ABWC also participated in and supported TEK documentation studies, which hunters viewed as giving credibility to their knowledge and scientists appreciated because such studies enabled them to cite a written document as the source of TEK used in their research. The iteration between the two approaches was also a key to the ABWC's success. Documentation gave TEK credibility in the eyes of scientists and hunters alike, clearing the way for both groups to use available knowledge as appropriate, regardless of source.

DISCUSSION

Hunters and others from beluga hunting communities were involved in a variety of roles in research projects undertaken by the ABWC. In some of these roles, TEK was explicitly sought and acknowledged. In others, TEK was less visible, though it has rarely been far from the surface, as hunters incorporated their knowledge in their interactions with researchers and managers. Evidence for the integration of TEK and science included use of hunters' knowledge as a basis for scientific hypothesis generation and data interpretation, hunters' ownership of research, their assimilation and dissemination of scientific knowledge, and scientists' increased understanding of the social and cultural contexts and implications of TEK. Both structural and process characteristics of ABWC facilitated this integration.

The information provided by the blend of TEK and science in the ABWC's research has influenced beluga management. The ABWC population surveys and harvest reports were used to develop NMFS stock assessments, which in turn formed the basis for management decisions. Research on stock identities, for which hunters provided tissue samples and research questions, revealed that the Cook Inlet belugas belonged to a genetically distinct population. As a result of this information, managers took action and hunters agreed to a significant reduction in beluga hunting in Cook Inlet waters. Members of the ABWC expected that ongoing satellite telemetry and genetic research would help further clarify which villages hunt from which stocks, as well as what other regions or countries might hunt the same stocks, informing future beluga management and conservation.

It is important, however, not to overlook the potential for co-optation in an apparently successful co-management group such as ABWC, since co-management and the projects of documenting and integrating TEK and science have the potential to exploit native participants (Nadasdy 1999, 2003*b*). Our results showed that interactions of science and TEK within ABWC have not been without tensions. Hunters viewed some scientific interpretations as incorrect, some methodologies as flawed and some research projects as unimportant. Some scientific findings conflicted with TEK, and some TEK was perceived as irrelevant to science. More important perhaps, was the awareness, particularly acute on the native side, of the underlying power dynamics of native involvement in research and co-management. Native ABWC members and village hunters often associated science and scientific management with loss of native control over subsistence resources. When science was used to 'validate' or confirm hunters' traditional knowledge, a use of science that several hunters held in a positive light, scientific knowledge was a benchmark against which TEK was compared, and held power over the credibility of TEK.

Hunter perceptions of science as a means of state control reflect the historical supremacy of western scientific knowledge over traditional and indigenous knowledge, as well as the contemporary political environment in which the State of Alaska has not recognized the sovereignty of Alaska Native tribes and has refused to grant a preference in hunting and fishing rights to native or even rural subsistence users. Although the Federal government has recognized Alaska tribes, it has maintained ultimate authority over tribes and Federal trust lands under the policy by which tribes are recognized as sovereign, but dependent, nations (Case 1984). In the ABWC, the struggle for sovereignty has been played out at a fairly low level of intensity, both in assertions of and negotiations over knowledge, and in early negotiations over the structure of the organization. Although native ABWC members openly discussed the use of science as a tool of state control generally, they were supportive of ABWC's research programme and perceived benefits to belugas and beluga hunters from the knowledge it has generated. Even though some hunters welcomed the use of science to validate TEK, it is unlikely that they would easily dismiss their own long-held understandings of belugas and the ecosystem on the basis of scientific research alone.

Despite individual and cultural differences and political undercurrents, the ABWC has evolved an organizational

culture characterized by open and respectful interactions among all participants, leading to authentic dialogue over conflicting and converging knowledge and research priorities. This organizational culture may be attributed both to structural and process features of the group, including the equal voting rights for native and non-native members, the large number of native members in comparison with non-native agency staff and scientists, and the multiple venues for formal and informal communication and relationship-building. These characteristics of ABWC have helped ensure genuine power sharing, transparency in setting the research agenda, and effective communication among all members. Huntington *et al*. (2002) explored in more detail some of the factors that made ABWC annual meetings successful, including accountability, preparation and continuity over time.

As Pinkerton (1989, p. 8) noted, 'Comanagement is not only about new institutions, but more fundamentally, about the new relationships resulting from them. Institutions and legal incentives can only permit, support and create incentives for new relationships; it is the new relationships which generate the communication, trust, and willingness to risk innovation which make the benefits of comanagement actually materialize'. The ABWC appears to be a strong example of the way in which a co-management organization can provide opportunities for relationship-building and joint action, particularly joint inquiry about beluga populations. These joint research activities in turn have reinforced communication and trust among participants leading to increased commitment to and involvement in research by hunters, and increased appreciation for and use of TEK by scientists and managers. These findings lend support to Kaplan and McCay's (2004) claims that cooperative research is key to improving relationships among stakeholders. Further, they provide an illustration of the ways in which joint research can lead both to increased transparency in the research process and greater awareness of and accountability for the social and cultural consequences of science and management on the part of non-native agency staff and scientists. The importance in the ABWC of multiple venues for communication between hunters and scientists also confirms earlier findings about the importance of face-to-face interactions between biologists and native community members for the success of co-management (Kruse *et al.* 1998).

CONCLUSIONS

TEK and hunters can make contributions throughout the research process. This study has demonstrated the potential for successful cooperative research in co-management that draws on local skills and knowledge not only to provide samples, but more importantly to offer observations and insights that lead to testable hypotheses and help to interpret results. Further, native researchers found value in science, incorporated it into their own knowledge systems and contributed to its success when they shared control of the research agenda and process. Similarly, when scientists worked shoulder-to-shoulder with hunters doing research and participating in village life, their understanding of the potential impacts of their work grew, as did their appreciation of the knowledge and skills of native researchers. The outcome of ABWC research has been shared learning to serve shared goals.

The TEK documentation studies sponsored by ABWC were valued by both native community members and scientists, yet such studies are less useful for the integration and application of knowledge than direct involvement by TEK holders (in this case hunters) in research and management. The ABWC case emphasizes the importance of interactions among the knowledge holders, not just the importance of the knowledge, in research and management. The success of the ABWC's cooperative research programme is the result of long-standing personal relationships between hunters and scientists that emerged from the variety of different settings for interaction and an organizational culture that allowed for candid exchanges in a mutually respectful environment. The contributions of TEK to the ABWC's research programme could not have arisen from documentation studies alone. They required the dialogue between hunters and scientists, the active exchange of knowledge and ideas, the challenges to each others' beliefs and world views. The result has been increased knowledge of beluga whales, improved understanding and valuing of each others' knowledge, and a greater appreciation of the significance belugas hold for both hunters and scientists.

This study points to at least two issues regarding knowledge integration that deserve further consideration. First, if the ABWC's successful integration of TEK and science has been owing in large measure to long-term multi-faceted relationships between hunters and scientists, can meaningful integration be achieved in the much shorter time frame of, for example, an environmental impact assessment? Some native ABWC members were adamant about the need to incorporate TEK into environmental impact statements. What would successful integration of TEK into environmental impact assessment require, from both the native and the agency points of view?

Second, what are the distinct roles, merits and drawbacks of TEK documentation studies versus processes that incorporate TEK by making native resource users active members of management or research teams? In the ABWC, the active involvement of many hunters in diverse aspects of research and management has been an effective means of incorporating TEK. But is having one native representative on a management board sufficient? Is documentation in the absence of active participation acceptable? How effective is active participation without some form of documentation or other preparatory work (for example see Huntington *et al.* 2002)? These questions also deserve further inquiry.

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