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USING TRADITIONAL ECOLOGICAL KNOWLEDGE IN SCIENCE: METHODS AND APPLICATIONS

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Abstract. Advocates of Traditional Ecological Knowledge (TEK) have promoted its use in scientific research, impact assessment, and ecological understanding. While several examples illustrate the utility of applying TEK in these contexts, wider application of TEK-derived information remains elusive. In part, this is due to continued inertia in favor of established scientific practices and the need to describe TEK in Western scientific terms. In part, it is also due to the difficulty of accessing TEK, which is rarely written down and must in most cases be documented as a project on its own prior to its incorporation into another scientific undertaking. This formidable practical obstacle is exacerbated by the need to use social science methods to gather biological data, so that TEK research and application becomes a multidisciplinary undertaking. By examining case studies involving bowhead whales, beluga whales, and herring, this paper describes some of the benefits of using TEK in scientific and management contexts. It also reviews some of the methods that are available to do so, including semi-directive interviews, questionnaires, facilitated workshops, and collaborative field projects.

Key words: beluga whales; bowhead whales; collaborative field work; herring; impact assessment; semi-directive interview; social science; Traditional Ecological Knowledge.

INTRODUCTION

Various advocates of Traditional Ecological Knowledge (TEK) promote its benefits on one or more of several fronts: improvements to scientific research and management through more and sometimes better information (Freeman and Carbyn 1988, Johnson 1992, Brooke 1993, Inglis 1993, Mailhot 1993, Hansen 1994); identification of new paradigms by which we can understand the natural world and our relation to it (Colorado 1988, Kawagley 1995, Deloria 1996); and broad societal change away from the positivist and amoral and toward the holistic and ethical (Colorado 1996, Kremer 1996). Amid the rhetoric, there are opportunities for practical and productive collaboration (Agrawal 1995).

For the purposes of this paper, I use TEK to mean the knowledge and insights acquired through extensive observation of an area or a species. This may include knowledge passed down in an oral tradition, or shared among users of a resource. The holders of TEK need not be indigenous, as shown below in the example on herring. While there are important differences between the structure and purpose of TEK and those of scientific knowledge (e.g., Berkes 1993, Deloria 1996, Stevenson 1996), we must recognize that TEK has an empirical basis and is used to understand and predict environmental events upon which the livelihood or even survival of the individual depends.

For ecologists, TEK offers a means to improve research and also to improve resource management and environmental impact assessment (Brooke 1993, Inglis 1993, Stevenson 1996). Much has been written about the potential benefits of documenting and applying TEK, but it is frequently in the future tense: ''TEK *will* be of use,'' somewhere, sometime. This tendency is unfortunate in that it often obscures real and practical contributions made by TEK in various fields and areas. In this paper, I review four methods by which TEK can be documented and otherwise accessed, three cases from Alaska in which I have been involved to some degree, and possible reasons that TEK has not been used or credited more widely. The paper is not intended as a review of TEK, but as an introduction to the topic and some of the important issues surrounding it.

METHODS FOR DOCUMENTING TEK

The methods for documenting TEK derive from the social sciences. Ecologists may prefer to engage social scientists to conduct actual research documenting TEK, but they should be aware of the variety of methods available and their strengths and weaknesses for promoting substantive interchange between local experts and outside scientists.

The four methods described below are not mutually exclusive, but are starting points from which a particular method can be developed that best meets the needs

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of the researchers and communities and best fits the circumstances of the research. These methods may involve the use of maps and other items to spur the memory or upon which to locate observations. Tape and video recordings can also be useful, in addition to accurate note taking. When designing a research project and selecting methods for gathering data, it is especially important to consider the cultural context in which the interactions take place (Briggs 1986, Johnson and Ruttan 1993). In addition, appropriate ethical principles must be followed in the conduct of TEK research so that community and individual rights are respected (IARPC 1992).

An additional consideration that applies to all four methods is the selection of participants. In the absence of personal experience with the pool of potential participants in a community or an area, the most practical option is peer selection. In nearly all cases of TEK research, the researcher will want to identify key informants rather than select a random sampling of the community. If appropriate, the community council can be asked to help select the most knowledgeable persons. Chain referrals, with each participant suggesting the name or names of further experts, are also a useful technique, and allow the researcher to evaluate the completeness of the selections since eventually few or no new names will come up. While evaluations of the reliability of a particular participant will depend in part on the judgment of the researcher, group reviews and other sources of local feedback can help minimize the role of the researcher in resolving conflicting statements from different participants.

Semi-directive interview

In this method (see Nakashima and Murray 1988, Nakashima 1990, Huntington 1998), participants are guided in the discussions by the interviewer, but the direction and scope of the interview are allowed to follow the participants' train of thought. There is neither a fixed questionnaire, nor a preset limit on the time for discussions or the topics to be covered. The interviewer may have a list of topics to discuss, which can be useful for prompting further discussions when there is a lull, but the interviewer must also be prepared for unanticipated associations made by the participants.

The semi-directive interview is more a conversation than a question-and-answer session. This is especially useful in cases where the participants are not comfortable with direct questions, or in which the researcher cannot be sure that the questions are understood as intended. Even simple questions often include assumptions that may not be universally valid, such as equating ''north'' with ''up,'' or that do not take into account local idioms. In a conversation about herring, one might ask the question, ''Where do the fish enter the bay?'' In the local idiom, ''fish'' may mean ''salmon'' rather than ''herring,'' and so the answer may appear valid but actually be referring to a different species than the researcher believes (see also Briggs 1986).

An example of the power of this method comes from my research on beluga TEK. Discussions in one group interview suddenly turned to the increasing population of beaver in the region. I was caught off guard, and as I listened to the conversation, I wondered whether it was time to exercise the ''directive'' part of the method. Seeing my confusion, one of the elders then explained why beaver were relevant to beluga: the beaver dam streams where some salmon spawn, reducing salmon habitat, and thus potentially affecting the abundance and distribution of the salmon on which beluga feed. This type of information is unlikely to be anticipated in advance, and the strength of the semi-directive interview method lies in providing an opportunity for such information to be discussed, while still providing enough structure that other useful information is not missed.

Questionnaire

This method is useful when the interviewer knows in advance what he or she is seeking, and also simplifies comparisons between respondents. Quantification, if desired and appropriate, is often simpler with a well-designed questionnaire. Depending on the cultural context, this may be more comfortable to some respondents than the more free-form semi-directive interview. When quantification is not necessary for all responses, some questions can be left open-ended, giving the respondent a chance to add more detail or make associations beyond those anticipated in the questions. While this is unlikely to produce as thorough a discussion as the semi-directive interview, it can be useful in providing new ideas and insights beyond the scope of the initial inquiry.

Analytical workshop

In some cases, collecting additional data is not as desirable as trying to interpret what is already known. Just as a workshop among scientists can help spur new ideas and challenge old assumptions, a workshop that brings together scientists and the holders of TEK can allow both groups to better understand the other's perspective, and to offer fresh insights. By cooperating in the analysis of data, the two groups may also find common understanding and jointly develop priorities for management and future research. Comanagement settings like the Alaska Beluga Whale Committee (ABWC) are examples of de facto analytical workshops. In the absence of a formal cooperative body, ad hoc workshops can be convened to address particular topics of interest.

Collaborative field work

Applying TEK to scientific research need not take place exclusively in an interview or meeting room. Collaborative field work offers an excellent means of interacting for an extended period. As shown by the examples of the use of TEK below, TEK has often been used to locate study sites, obtain specimens, and interpret field results. Locally hired field assistants have often contributed far more to research than mere logistical support (e.g., Dowler 1996), though this contribution is often not acknowledged.

Examples of the Use of TEK

The bowhead whale census

In 1977, the International Whaling Commission imposed a ban on the harvest of bowhead whales (*Balaena mysticetus*), curtailing a traditional activity of Alaska Eskimos (this section is based on Huntington [1989, 1992], Albert [1996, 1997], and T. Albert *personal communication*). In response, the whalers formed the Alaska Eskimo Whaling Commission (AEWC), composed of one representative of each bowhead-hunting community in Alaska. The eventually successful fight against the ban was a political one, and led to the creation of a quota for the harvest. Establishing the quota and getting it increased to a more tolerable level became a scientific battle, centered on the bowhead whale census conducted along the north coast of Alaska.

The census started with visual counts of migrating bowheads, made from sites on high cliffs or pressure ridges in the shorefast ice along the open lead through which the migratory path led. Early census counts produced population estimates of 2000–3000 bowheads. The Eskimo whalers felt that this was not an accurate figure, and that the assumptions upon which the census count was based were not valid. In particular, the visual census assumed that all migrating bowheads passed within sight of the census location, and also that when the lead was closed (i.e., the pack ice had moved in toward shore and no lane of open water remained) the bowheads stopped migrating past. The whalers, however, travel on the ice when the lead is closed and go by boat to the pack ice across the lead. At these times and in these places they see whales.

In the early 1980s, as a result of interactions between whalers and scientists similar to collaborative field work and analytical workshops, the census was expanded to include both acoustic and aerial components. The acoustic component allowed the researchers to detect bowheads migrating when the lead was closed (during which times the whales breathed through cracks in the pack ice or forced their blowholes through relatively thinner ice), and to provide a check on the completeness of the visual count. The aerial component, by flying transects perpendicular to shore and well beyond the visual range of the surface location, showed that the bowheads do in fact migrate on a front broader than the confines of the nearshore lead. Thus, in both instances the Eskimo whalers' knowledge proved accurate. The use of this knowledge had the tangible and, to the whalers, beneficial result that the population estimates increased to 6000–8000 bowheads.

The Alaska Beluga Whale Committee

In 1988, Alaska Native American hunters of beluga whales (*Delphinapterus leucas*) and government agency biologists and managers established the Alaska Beluga Whale Committee (this section is based on Huntington [1992, 1998], Adams et al. [1993], Frost [1996], Huntington and Mymrin [1996], and K. Frost, *personal communication*). The ABWC's founders reasoned that good information on beluga populations, stock identity, and harvest levels together with a sound management plan would forestall, or at least minimize the impact of, sudden action by the International Whaling Commission like that taken on the bowhead hunt.

Unlike the AEWC with its hunter-only representation, the ABWC members include government agency personnel as well as beluga hunters from around the state. (The one limitation to the government role is that only hunters can vote on hunting matters.) These biologists and managers also conduct or assist with much of the current research on belugas. Thus, the ABWC plays a substantial role in identifying data needs and in establishing research priorities and methods. In addition to allowing hunters to bring TEK into these discussions, the ABWC has established broad support for research including studies on mitochondrial DNA, studies to determine stock identity and discreteness, and satellite tagging of belugas to determine migratory and behavioral patterns.

Similarly designed studies using intrusive or invasive techniques such as satellite tag implants or radio collars have in other parts of Alaska generated considerable opposition from Native American residents who view such procedures as cruel or disrespectful (T. Brelsford 1996, *personal communication*; J. Spaeder 1997, *personal communication*). The ABWC's research, developed at meetings similar to an analytical workshop and including collaborative field work, has avoided such opposition by establishing close collaboration between hunters and scientists, based on common understanding of the ecological problems to be addressed, and mutual respect for each other's expertise.

In 1995, I began a research project to document TEK about belugas in three areas of Alaska and four areas in Chukotka, Russia, using the semi-directive interview method. The ABWC was supportive of this effort, and at the conclusion of the field work participated in a seminar to review current understanding about the documentation and application of TEK. While the TEK information documented was for the most part already known to them, the ABWC's members felt that it was valuable to have it recorded in an accessible form and identified as the knowledge of the hunters. The ABWC continues to promote the coordinated development of

TEK and biological research to better understand beluga ecology and to better manage Alaska's stocks of belugas.

Herring and the Exxon Valdez oil spill

The 1989 Exxon Valdez oil spill in Prince William Sound, Alaska, released 41.6×10^6 L of crude oil, which flowed through the sound and the Gulf of Alaska, reaching as far as Kodiak Island and the Alaska Peninsula (this section is based on Exxon Valdez Oil Spill Trustee Council 1993–1999, Brown et al. 1996, Holloway 1996; J. Seitz 1997, *personal communication*; see also Lethcoe and Nurnberger 1989, Piper 1993). Currently, the Exxon Valdez Oil Spill Trustee Council administers settlement funds from the civil lawsuit against Exxon, some of which are used for a restoration science program to study injured resources.

Among these resources is the Pacific herring (*Clupea pallasi*), which has been harvested commercially in Prince William Sound for much of this century. In 1993, the herring population crashed due to viral hemorrhagic septicemia. Whether an indirect result of the oil spill or part of a natural fluctuation, the crash has had severe economic repercussions. Residents of the area believe that the crash has also affected the distribution of predators such as seabirds and seals. Current research on herring includes examination of its life history and ecology throughout the sound and Gulf of Alaska.

This effort is hindered to an extent by the lack of documented historical data concerning distribution of herring in the region, particularly for spawn, juveniles, and the winter distribution of adults. Promoted by a researcher familiar with the communities of the Sound and one of the herring researchers, a study of the local knowledge of the region's fishermen and pilots and the TEK of native residents is currently underway to record long-time residents' observations and understanding of herring ecology. This study uses a questionnaire as well as some aspects of a semi-directive interview. The results to date include geographically and temporally extensive observations of juvenile herring and other forage fish, dating from the 1930s to the present, adding a great deal of information to the documented record on distribution of juvenile herring and the significance of certain areas as nurseries.

Discussion and Conclusions

As noted above, TEK has made a demonstrable difference in many research projects and management strategies. Why, then, does it not enjoy broader acceptance, and why is it not used more often and in more places? McDonald (1988), Johannes (1993), Nakashima (1993), and others have offered various critiques and explanations in which two factors predominate: inertia and inflexibility. The former, inertia, is merely a general resistance to change because it upsets the familiar and comfortable. Working within an established paradigm is simpler than adapting to a new one. With continued pressure from advocates and holders of TEK, more collaborative research, and a growing mass of evidence from studies documenting and incorporating TEK, this resistance may be overcome.

Inflexibility, on the other hand, is resistance specifically to TEK and the changes required by its use. It relies on more subtle arguments, questioning the reliability of TEK, or expressing concern about ''political correctness'' replacing scientific rigor. Such resistance may be due to concerns about funding priorities and about power over management decisions. Inflexibility may also include an unwillingness to work with nonscientists, indigenous or otherwise. While one would hope that evidence of the utility of TEK would help overcome this resistance as well as inertia, the positions here are more entrenched.

There are, of course, more than two reasons why TEK has not been more widely accepted. Many wildlife managers and researchers are unfamiliar with social science methods and are not prepared to attempt to use these methods to gain access to information that otherwise remains out of reach. They may also be uncomfortable in cross-cultural interactions. The holders of TEK, for their part, are sometimes reluctant to share information, and issues of ownership and control over use of TEK sometimes arise. The combination of obstacles presents a more complex problem than a simple lack of recognition of the merit of TEK.

While the validity and relevance of the reasons behind the various forms of resistance are perhaps debatable, they are an appropriate caution against the overselling of TEK. TEK, like other forms of knowledge (including science), is sometimes wrong. Such errors may be due to misinterpretations made both by observers (e.g., informants) or by collectors of information (e.g., managers and researchers). Documenting TEK can be a long process, and the effort is not always justifiable by either the applicability of the results or by the involvement of residents from the area of the study in question. Insistence on a TEK component of every ecological research and management activity will only succeed in reducing TEK to a token, to be included in a paragraph or two, and then ignored. Unquestioning acceptance of TEK is as foolish as its unquestioning rejection.

Instead, TEK should be promoted on its merits, scrutinized as other information is scrutinized, and applied in those instances where it makes a difference in the quality of research, the effectiveness of management, and the involvement of resource users in decisions that affect them. On this basis, there is ample evidence of the utility of TEK. What is needed is a broader willingness to consider its relevance, to attend to the information it offers, and to incorporate the expertise that is available.

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