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Diversity as if Nature and Culture Matter: Bio-Cultural Diversity and Indigenous Peoples

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Abstract: Discussion of diversity tends to be myopic. It is confined either to conservation of the variety of biological life or to the normative agenda of sustaining the myriad cultural mosaics of human societies. Little effort has been made to engage both biological and cultural diversity, and their mutual relationship remains even less explored. Nature and culture have been seen as mutually exclusive. However, most indigenous communities do not perceive such a division between their culture and the environment that they inhabit, and increasingly, the scholars who work with them are beginning to share their view. Furthermore, significant challenges of the 21st century, such as environmental conflict resolution, resource extraction, indigenous land claims and rights, climate change, sustainable livelihoods, food sovereignty, and dramatic socio-cultural change, require an integrated perspective that is sensitive to both ecological and cultural diversity. Using three case studies of indigenous human ecological relations in the Circumpolar Arctic, this paper illustrates that (1) conservation of ecological and cultural diversity are intertwined, especially where indigenous communities are concerned; (2) conservation of ecological and cultural diversity requires transcending of national boundaries; (3) conservation necessitates an interdisciplinary perspective embracing the physical, biological, and social sciences, as well as the humanities; and (4) the notion of "interdisciplinarity" extends to indigenous knowledge holders. Specifically, the three case studies examine (a) how at the turn of the 20th century, during the demise of the Soviet Union, Arctic communities acted globally across national boundaries in applying indigenous knowledge of ecological diversity to achieve food sovereignty; (b) how Sami people of the Kola peninsula in Russia used their traditional livelihood, reindeer herding, to prevent ecological damage to the tundra from mining activities; and (c) how Iñupiat knowledge of sea ice is important to assessing the nature and impact of climate change.

Keywords: Biocultural Diversity, Biological Diversity, Cultural Diversity, Indigenous Knowledge, Traditional Ecological Knowledge, Human Ecology, Nature and Culture

Introduction [1]

CONSERVING DIVERSITY IS fundamentally an act of caring: an act of love. It has been described as *biophilia* (Fromm 1964; Harmon 2007; Nabhan 1997; Wilson 1984). It is an ethical act that goes beyond the evolutionary calculus of saving all the parts to facilitate adaptation to change, and it has a time orientation because it is intergenerational and future-focused. One of the most passionate articulations of conservation was made by Aldo Leopold in *A Sand County Almanac* (1949): "We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.…That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics. That land yields a cultural harvest is a fact long known, but latterly often forgotten" (viii-ix). The concept of the individual cannot exist without the related notion of community: each depends on the other for its identity. In its original sense, the word "individual" implied indivisibility and connectivity (Williams 1989) to a network of relations. While in current usage this meaning may seem paradoxical, the fact remains it is not possible to speak meaningfully of the single part without understanding its relation to the whole. Similarly, conservation, as described by Leopold, is more than the mere impulse of individuals for self-preservation: it is recognition of the ecological character of their socio-cultural community.

Recent articulation of the relationship between biological diversity and cultural diversity can be viewed as a process driven largely by crisis and urgency.[2] The phrase "the death of birth" captures the idea that the rate of human perturbation is increasing too fast to allow evolution to replenish lost diversity. The loss of diversity is not an unusual part of the ecological process. Rather, the problem is the dimensions of this loss (Dasmann 1991; Wilson 1999). The source of alarm is not change in itself, which is a

[1] This article is adapted from a plenary address given on November 30, 2006, at the "Conservation Science in Practice" conference sponsored by The Nature Conservancy in Tucson, Arizona (27–30 November 2006). The case studies are drawn from *Bio-cultural Diversity and Indigenous Ways of Knowing: Re-Framing Human Ecology in the Arctic and Sub-Arctic* (unpublished manuscript).
[2] For a history of how the notion of biodiversity developed, see Maffi (2005).

necessary part of the ecological process, but the dramatic pace of change and the ability of organisms and the ecosystem to absorb and adapt to change. Currently, there is no established way to measure loss of cultural diversity, but using linguistic diversity as a proxy, it is estimated that 50%–90% of the more than 6000 currently spoken languages are now endangered and may be lost by 2100 (Maffi 2005: 602). Furthermore, there is no way to measure the absolute loss of biodiversity in rain forests globally, but conservative estimates suggest that 27,000 species are lost each year, or 74 each day, or three each hour (Wilson 1999: 280). Although the time frames of change and adaptation for human and ecological systems are very different,[3] the current losses in both cultural and biological diversity are staggering. Innovation, both cultural and ecological, requires a foundation: it is necessary to keep all the parts, as change has to work with what already exists, transforming and combining several systems to produce a complex whole (Jacob 1982). This endless tinkering underlies diversity. Environmental stress through loss of ecological habitats affects not only species diversity, but also cultures. Recent attempts to express the relationship between biological diversity and cultural diversity have arisen largely from the twin aims of conservation and sustainable development.

A brief critical review of the discussion in the literature about the relationship between biological and cultural diversity will examine the value of using species and languages as proxies for understanding the complex relationships of human communities and their habitats. Three case studies of indigenous communities will illustrate this complex connectivity.

Languages and Species as Proxies for Diversity

The relation between cultural and biological diversity has been discussed in two phases: first the articulation of the hypothesis and then testing of that hypothesis. The role of indigenous cultures and the application of their knowledge to ecosystems in conserving biodiversity have been central to this discussion. In the late 1980s and 1990s, discussion was largely devoted to examining the linkage between cultural diversity and biological diversity. At this stage, there was little consensus on the connectivity between biological and cultural diversity through its relationship to conservation practices by indigenous peoples. While some scholars maintained that the linkage between biological and cultural diversity was merely coincidental to the habitats of indigenous peoples (Hames 1991), others conceded that indigenous peoples had specialized knowledge of their ecosystems (Dasman 1991), and still others argued that indigenous knowledge and practice are indeed examples of adaptation to local contexts (or niche formation) and contribute to conservation of biodiversity (Alcorn 1996; Durning 1992; Gadgil 1985, 1987; McNeely 1995). This debate gave rise to a number of quantitative case studies, discussed below, that attempted to illustrate the relationship between biological and cultural diversity. Such studies rested on the hypothesis that language density is an indicator of cultural diversity and species richness an indicator of biological diversity.

Hotspots and Hotbeds of Diversity

The connection between biological and cultural diversity has been illustrated largely as the correlation between species richness and language density (Maffi 2001, 2002; Harmon 2001, 2002). Like conservation biologists who speak of "hotspots" of species diversity, linguists talk of "hotbeds" of languages. Nettle and Romaine (2000: 27) argue that there are "remarkable overlaps between the areas of greatest biological diversity around the world and greatest linguistic/cultural diversity around the world, allowing us to speak of a common repository of biolinguistic diversity." Quantitative studies based on linguistic atlases, which categorize culture as language in comparison to species, have been replicated several times (Collard and Foley 2002; Moore et al. 2002; Pagel and Mace 2004). These studies have shown a strong correlation between species concentration and language richness at lower latitudes. Nettle and Romaine (2000) make a case for a pattern of high linguistic density in the tropics that diminishes closer to the poles.

One outcome of the language-species model is a policy of trying to conserve the "hotspots" and "hotbeds" of diversity (Wilson 1999; Dasmann 1991; McNeely 1997). However, what about the "coldspots"? Although these tend to be ignored, they are equally valuable in providing benefit to the planet's ecological systems as a whole (Bridgewater 2002; Kareiva and Marvier 2003; Myers et al. 2000). In the Arctic, there are fewer endemic species than in the tropics, but this comparison misses the point of conservation of diversity. Conservation cannot be entirely species-focused; rather, it must be based on the whole system that sustains a variety of life. Furthermore, concentration on "hotspots" ignores the overall importance of relations between biological and cultural diversity. "Coldspots" like the Arctic and sub-Arctic have significant relations between the biological and cultural that are not visible through

[3] The time frame of evolution in a biological sense is very long (millions of years), whereas adaptation of human cultures to change can occur much more quickly (Graddol 2004; Maffi 2002, 2005).

the prism of the languages-species model. For instance, Smith (2001) compared biological diversity to cultural and linguistic diversity, considering "cultural areas," "ethnolinguistic groups," and "species richness." The study found a correlation between linguistic, cultural, and biological diversity problematic. Smith found that some Native North American groups are culturally diverse and linguistically similar, whereas others are linguistically diverse and culturally similar. Also, cultural and linguistic diversity were strongly correlated with tree species, but not with various mammal species. There are methodological constraints: for example, we do not have the ability to measure the absolute biodiversity of even the smallest landscape unit if all five biological kingdoms (monera, protista, fungi, plants, and animals) are taken into account (Callicott et al. 2007).

Defining Boundaries

Defining the boundaries of species is problematic (Dobzhansky 1961), and similarly, drawing borders around languages is difficult. Genetic characteristics and language change through different mechanisms, even though they may interact in the process of evolution (Pennisi 2004a). Recent evidence not only indicates diversity among the click languages of Africa, which Pennisi (2004b) refers to as the original languages of humanity, but has called into question their classification into one Khoisan language family.

This raises the question: is language a sufficient proxy for culture? The example of the Iñupiat in Alaska is informative. Up to the mid-1800s, according to Burch (2005), cultural diversity was supported by rich biological diversity of the sea and land in Northwest Alaska. In this Arctic region of 40,000 square miles (104,000 km^2), an area slightly larger than South Korea, ten different Iñupiaq nations engaged in trade, warfare, and peace. Their cultural diversity is not identifiable at the level of language. Societal boundaries and territorial borders were determined on the basis of cultural and ecological resources that defined their relationship to the land and sea. One of the elements through which these Arctic communities derived their identity was their speech: the intonation contours, rhythm, and speed of speech were the basis of striking differences. Other factors contributing to identification of a culture included territoriality, hunting of migratory animals, and differences in craftsmanship of apparel (Burch, 2005). While there was linguistic similarity, there was also tremendous cultural diversity.

Taxonomy and the Standardization of Diversity

The above discussion demonstrates that a taxonomic approach to defining biodiversity and cultural diversity, through the analogues of species richness and language density, is problematic and may not yield helpful insights. It relies on categorizations and approximations that are limiting. If we map the characteristics of the individuals comprising a species, or the species comprising a genus (or languages, or language families), we will find that their distribution is normal. A species or a language is a conglomerate of qualities, defined by their average or central tendencies, upon which there can be consensus. The central tendency is an approximation, and comparing languages and species is comparing approximates. However, focusing on the central tendencies may cause us to overlook the outliers. The correlation between language density and species richness is, at best, only an indicator of the presence of diversity: it tells us little about how to conserve diversity. Relationships form with discrete events, not averages. Interconnectivity is not between averages, but between the discrete elements along the continuum of variance among different organisms.

There is a profound weakness inherent in viewing species or languages only as part of a typology.[4] Classification results in a tendency to ignore the exceptions that do not fit neatly into a category. But the exceptions cannot be ignored, because they are relevant: they are the basis of diversity and the stepping-stone to discovering the connectivity of parts within a whole.

The species-language link lacks the forcefulness of a specific context and is therefore a vacant overgeneralization. Conservation of diversity leads to the preservation of species, but the reverse (that preservation of species will lead to conservation of diversity) does not hold true. The notion of habitat fragmentation in island biogeography illustrates that once ecosystem decay has set in, no amount of species preservation will help (Quammen 1997). As noted in the introduction, the individual is defined by connectivity: by its network of relations to other organisms and habitat features. If a habitat ceases to be viable, all individual species are affected and di-

[4] This approach is reminiscent of the Aristotelian mode of thought in physics, where frequency determines lawfulness and the essential nature of events. Aristotelian physics depended on regularity of occurrence to determine whether to classify an object as "natural" or "not natural." Yet diversity takes place in a specific circumstance; it is the specific event that makes it significant. In Galilean physics, an object was not assigned a value; rather, substance was replaced by function. An object does not operate in binary (on-off) mode, but in a continuum. This does not mean that Galilean modes of thought, by concentrating on the particular, ignore the greater or whole. Rather rigid and abstractly defined classes that determine the physical nature of things were simply not relevant, according to Galileo (Lewin 1935). The idea that an understanding of the greater or whole can be approached by recognising diversity is characteristic of both Galilean thinking and evolutionary thought as described by Darwin (1996).

versity is threatened. Diversity is dynamic, not static. There are multiple layers of interaction between culture and its ecological environment. These interactions are best described by relationships—by meaning, rather than by a mean.

Complex Connectivity

The methodological constraints on examining diversity described above suggest that conservation efforts may be advanced by employing notions of the complex connectivity of cultures and societies to ecological systems. The linkage of ecological and cultural diversity through the proxies of species and languages is an example of instrumental connectivity. This approach, based on taxonomic categories, tends to be detached from context. Recent quantitative studies of diversity have alluded to the significance of other environmental factors beyond just climate (Collard and Foley 2002; Moore et al. 2002). Using vascular plants and languages as proxies, one such study found significant correlation of biological and cultural diversity in montane regions with varied climates throughout the world (Stepp et al. 2005). This result suggests that the discussion of biological and cultural diversity must necessary be holistic, taking into account the ecological context. Diversity occurs in time and space. For cultural and biological diversity to have meaning, connectivity must be at the level of local life. This type of connectivity is complex in that its multidimensional character confounds taxonomy. In this sense the instrumental connectivity is impoverished of insights because it is a one-dimensional account of the relationship. Unlike instrumental connectivity, complex connectivity does not give conceptual privilege to the indicators such as languages and species. Complex connectivity is empirically demanding as well as empirically rich. This type of connectivity gives a strong sense of the consequences arising from actions (Tomlinson 1999). It implies the ability to act for change—and therefore is relevant to the conservation of diversity.

Three case studies of indigenous communities in the circumpolar Arctic, described below, illustrate the complex connectivity that lies beneath the relationship between biological and cultural diversity. The idea that "man does not live by bread alone" has particular significance for complex connectivity, as the case studies will illustrate. Material relations are only one aspect of complex connectivity. These material relations may include a portion of food, fodder, water, building sites and materials, medicines, and other natural resources and ecosystem services derived from the local environment. In addition, complex connectivity goes beyond material needs, linking relations based on cultural and ethical values, concepts of sacred spaces, aesthetic experience, and personal or group identity (or both) derived from the local environment. Biocultural diversity fundamentally underlies both the material and the spiritual aspects of complex connectivity (Callicott et al. 2007). The case studies illustrate that conservation of diversity is difficult to achieve without recognition of indigenous human ecological relations. This complex connectivity describes the relationships between people and their environment, which include relations between humans and other animals, plants, and their habitat. It is a narrative of how human beings develop a socio-cultural system on the foundation of nature. It is not a linearly determined, genealogical notion of *relatedness* (or kinship), but rather the progenerative idea of an all-encompassing connectedness of *relationships* (or kindred).

Case 1: Significance of Different Ways of Knowing

Knowledge, from a human ecological point of view, does not lie in the heads of individuals, but in the relations between them and their environment. This first case study (Robinson and Kassam 1998) illustrates that at the dawn of the third millennium, subsistence hunting and gathering are not relics of an earlier era, but rather remain essential to both cultural diversity and human survival. Arctic ecosystems continue to provide the basis for human existence, bridging biological and cultural diversity. In the mid-1990s, after the collapse of the Soviet Union's centralized economy, the world's most industrialized and densely populated polar region found itself facing shortages of food and fuel. On the Kola Peninsula and the Chukotka Peninsula, these shortages threatened to starve and freeze entire communities. In Lovozero, on Russia's Kola Peninsula, the prices of essential food items (if available) fluctuated hourly as the ruble plummeted. Doctors could diagnose illness, but lacked the medicines they needed to treat patients. Hospitals, under the best of conditions, could offer patients only one meal a day, if that. Help was not widely available from Russian government institutions; instead, it arrived from other circumpolar indigenous communities and civil society institutions. The diverse Sami cultural groups from Norway, Sweden, and Finland came to the aid of the Sami in Russia. Similarly, various Iñupiaq, Inuit, Inuvialuit, and Yupik groups came to the assistance of the Chukchi and Yupik in the Chukotka Peninsula (Kassam 2005).

While sharing some similarities with other international emergency relief efforts, these indigenous responses were otherwise unique because they involved transfer of tools and knowledge to facilitate subsistence hunting and gathering. The ability to

hunt and fish was not a question of sport, but an essential need for feeding members of one's community and household. A university degree was irrelevant to meeting one's immediate needs. A different kind of knowledge was necessary: knowing *how* to live off the land and sea. Although this ability to maintain a subsistence lifestyle was present in some individuals, it had been largely neglected and devalued during decades of industrialization and collectivization. The Russian Arctic was one of the most industrialized among the circumpolar nations, with intensive mining activities and an extensive military complex. To offset decades of Soviet discouragement of sustainable local resource use, for example, Alaska's Iñupiat found it necessary to send supplies and weapons to their neighbours across the Bering Sea. But before Chukotka's communities could effectively hunt marine mammals, the Iñupiat also found it necessary to pressure the International Whaling Commission to extend quotas to enable subsistence hunting. Moreover, for several years they invited community leaders, hunters, and scientists from the Chukotka Peninsula to Alaska's North Slope Borough to facilitate transfer of knowledge and the strengthening of local institutions that would become stewards of hunters' rights and capacities to use local resources effectively (Kassam 2005).

The collapse of the Soviet Union and the dogma associated with its industrial complex provides important lessons for humanity. First, not only is there a compelling link between biological and cultural diversity, but this link supports a different way of knowing. Indigenous knowledge is relevant in the 21st century. Second, diversity, both cultural and ecological, while not commonly associated with "coldspots" such as the Arctic and sub-Arctic, is in fact a reality of the circumpolar North. Third, these events illustrate that indigenous organizations have integrated modern transportation and communication methods (telephone, e-mail, Internet) into their subsistence lifestyle and used them to act transnationally in providing support.

Case 2: Cultures Conserve Ecological Diversity

Between 1995 and 1998, the Sami made land- and marine-use maps for the region of Lovozero on the Kola Peninsula (Robinson and Kassam 1998). These maps depicted diverse information, such as the reindeer herding process according to the seasons; bird, fish, terrestrial and marine mammal harvesting sites; and the location of sacred places. In the spring of 1998, the development of a gold mine in the Voronya tundra, including a bridge across the Voronya River, was proposed by Voronya Minerals, a joint venture of the Swedish mining company Boliden Ltd. and the Murmansk County Administration. The development would have opened up the tundra to widespread access, and the mine would have devastated essential reindeer herding grounds. Local Russian, Nenets, and Komi, along with the Sami, protested the bridge and the gold mine development. The human ecological maps prepared by the Sami were used to illustrate the potential impacts of the development on the ecology of the region and the livelihoods of its people. As a result of a campaign undertaken by the local Sami with the participation of the Sami Parliament in Finno-Scandinavia, the sponsoring Swedish company withdrew its investment from the development initiative, thus averting an impending environmental catastrophe (pers. comm. Larisa Avdeeva, 2000).

Conservation of the Sami way of life and livelihood (reindeer herding) also resulted in conservation of ecological diversity. The human ecological maps that illustrated Sami knowledge, relations, and connectivity with their environment were central to their effort in communicating the potential ecological impacts of development. The lens of the language-species model would not have revealed the complex relations based on indigenous knowledge. The community cannot be separated from its ecological context; discussion of conservation of its culture necessitates engagement with the environment in which it lives. Again, indigenous communities used their specific ecological knowledge to act transnationally.

Case 3: Sea Ice and Climate Change

In 1999, during interviews for a participatory human ecological research project intended to document the impact of chemical pollutants in Wainwright, Alaska, community members identified significant changes to sea ice (Kassam and the Wainwright Traditional Council 2001). They observed that over a period of 15 to 25 years, shore-fast ice was forming later and later. Previously, slush ice used to be present in September, and shore-fast ice would begin to form in October; increasingly, however, shore-fast ice formation was taking place as late as December, or even January. Furthermore, late freeze-up resulted in stranded and starving polar bears in the vicinity of the town of Wainwright. Hunters also reported shorter guard hair among some fur-bearing animals (wolf, wolverine, and fox) because of warmer fall seasons. There was concern that the less robust sea ice was making subsistence hunting of marine mammals more dangerous. The Iñupiat hunt marine mammals out at sea, butcher the harvest on the sea ice, and transport it back to land, so these safety concerns warrant further investigation of climatic variation.

Asking *how* the Iñupiat of Wainwright are interacting with the sea ice provides an empirically rich way of determining that climate change is taking place. Iñupiat interaction with their habitat involves subsistence hunting. Hunting involves complex knowledge of, and relation with, sea ice. Because sea ice is such a visible entity and is interwoven into the daily lives of polar communities, personal observation of ice phenology can help researchers understand climatic change.[5] Therefore, understanding climatic change involved understanding Iñupiat knowledge of sea-ice morphology and phenology. The geophysical location of Wainwright, compared to other communities on the North Slope of Alaska, speaks to context-dependent knowledge. The village is located on a peninsula on the east side of the mouth of the Kuk River. Unlike Barrow or Point Hope, Wainwright is not located on a point. Therefore, ice movement in this region is different because it the ice forms a concave arc moving from NNE to SSW, bounded by Point Belcher (*Nunaġiaq*) 15 miles (24 km) to the northeast and Icy Cape (*Qayiaqsiġivik*) approximately 50 miles (80 km) to the southwest. As Wainwright is located on a shallow bight where the bottom drops gradually into the Chukchi Sea, land-fast ice extends steadily to several miles out as the winter progresses (Nelson 1969). Because of Wainwright's unique location, ice movement in the area is affected equally by both the wind and current, whereas near other coastal communities on the North Slope it is affected primarily by wind. To paraphrase Iñupiat hunters, the life of the ice is different here than in Barrow or Point Hope: the ice is alive in a different way at Wainwright. Therefore, the Wainwright hunters' knowledge of sea-ice movement is distinctive of the community's coastal geography and must be gained through direct experience.

Further interviews with individual traditional whaling captains and crews, analysis of the results, and collective validation of these results with the community members produced growing evidence that sea ice had increasingly been forming later, decaying faster, and becoming thinner or less robust (Kassam 2005). Respondents explained that the ice not only forms late, but also "rots" easily in the spring season. They characterized the ice as "damp." Monthly Satellite Aperture Radar (SAR) images over a period of five years (1996–2000) indicated that pack ice was forming along with shorefast ice in mid-December or later, and the two types of ice were linking. Small leads (channels of water through the ice) occurred in April, and larger ones by June. Open water was present by July, indicating swift decay of the sea ice. The SAR images corroborated Iñupiat observations. While corroboration with SAR images was important, the SAR data were episodic, while Iñupiat information was robust and therefore highly relevant: it was thick, it was grounded, and it was cumulative over time. Iñupiat knowledge involved subtleties associated with the nature and different types of ice. It is a richer knowledge. Indigenous knowledge in this sense completed our understanding of climate change.

The implication of these changes is that deteriorating ice conditions affect safety, resulting in increasing accidents and potential loss of life. In terms of food sovereignty, loss of ability to hunt marine mammals would put greater pressure on terrestrial mammals. Furthermore, irregularity in weather makes prediction very difficult resulting in anxiety. These changes have a tremendous impact on the survival of the Iñupiat because of deep inter-connectivity between the ecological and the cultural. Human ecological relations are dependent on a cultural system of symbols, values, and beliefs. Sharing is a fundamental value that is manifested in various social contexts. One example is the *Nalukataq* festival after a successful spring whale hunt, when the hunters share out their catch. The remainder of whale is stored after the festival, to be shared again with the community later in the year. It is necessary to reiterate that even though the hunt is carried out by a small group of hunters, the value of sharing in the Iñupiat cultural system is manifested in Wainwright's social structure through community-wide celebrations, such as the *Nalukataq*, Thanksgiving, and Christmas (Kassam and the Wainwright Traditional Council 2001). If sea-ice conditions continue to deteriorate to the point where subsistence activities can no longer be carried out in the way they have been, the socio-cultural impact on the fabric of the community may be devastating.

Furthermore, indigenous insights are indispensable for understanding not only climate change, but also other issues that affect conservation of biodiversity. The hunters' knowledge about sea ice, gained through subsistence harvesting of marine mammals, establishes a baseline for research that uses sea ice as an indicator of local climate change. In Wainwright, we have an unusual condition, in that this knowledge is relatively well documented (Nelson 1969; 1982). A subsistence lifestyle inherently connects people to their environment, allowing them to observe discernible change. Researchers in the Arctic

[5] Sea ice is a useful indicator of climatic trends because temperature variations create immediate impacts on its seasonal growth and decay patterns. A relatively thin (average 2–3 m thick) floating layer of ice with a saltwater origin, located in the polar regions, it covers approximately 7% of the world's oceans: an area greater than Europe and North America combined. A product of the earth's very complex climate system, sea ice is extremely sensitive to any alterations in the surface energy balance: slight warming trends can have a tremendous impact on its growth and ablation patterns. Sea-ice phenomena are not static; they are part of a dynamic process that inherently records climatic variability occurring at a larger scale. Ice morphology, formation, and melting dates can point to global cooling or warming patterns.

have repeatedly pointed out that the use of indigenous knowledge has the potential to enrich and expand our collective understanding of climate change in the Arctic (Berkes 1999; Cruikshank 2001; Nelson 1969; Norton 2002; Reidlinger and Berkes 2001; Wenzel 1999). Recent studies using documented personal observations by holders of indigenous knowledge indicate climatic variations on a larger (regional) scale (Krupnik and Jolly 2002; Magnuson 2000; Nichols et al. 2004; Reidlinger and Berkes 2001). Subsistence activities provide a practical starting point from which to undertake a study on climate change using both indigenous and scientific knowledge systems.

Discussion

The aim has been to illustrate the point that when we speak of conservation of diversity, both nature and culture matter. The two are intertwined in a complex connectivity. Complex connectivity to natural systems is characterized by a combination of material needs and culturally driven relations, which are not mutually exclusive. The three case studies illustrate that human socio-cultural systems are in dynamic engagement with their habitat. Separation between nature and culture is not relevant to conservation.

Understanding of this complex connectivity requires first an interdisciplinary perspective that includes the humanities, physical, biological, and social sciences. Interdisciplinarity is demanding because it engenders a particular type of maturity: not only excellence in one's own field, but also the ability to transcend one's own understanding to see value in the work of others in different fields. Second, and equally important, this acknowledgement of multiple ways of knowing necessarily extends to indigenous knowledge. Recognition of the relationship between biological diversity and cultural diversity speaks to intellectual pluralism.

Studies illustrating the correlation between language density and species richness have been very useful in drawing attention to the link between cultural and biological diversity and the importance of conservation. However, this type of connectivity is merely instrumental. It is not robust enough to provide insights into the complex relations that reinforce both cultural and biological diversity. For instance, the species-language model does not inform us of the connectivity between the Iñupiat, sea ice, and marine mammals like the bowhead whale. To uncover these relations, we need another approach that allows us to appreciate the underlying unity of biological and cultural diversity and consider the multifaceted nature of "biocultural" diversity holistically.

The case studies emphasize that relations between biological and cultural diversity are context-specific. Specific subsistence practices were compatible with conservation of biological diversity. The implication of this relationship is that recognition of indigenous knowledge[6] can help us to achieve conservation of both biological and cultural diversity. This process does not need to take place in a vacuum; there is value in linkage with management systems and the best available scientific knowledge.

As the case studies show, indigenous ways of knowing are informed not only by socio-cultural systems and the presence of other living organisms, but also by the physical elements of the ecological system, such as sea ice. Therefore, conservation must occur in this holistic sense of ecology. Continuous human presence in the Americas indicates a historical dimension to indigenous knowledge. The European settlers of North America, driven by ideas of "manifest destiny" and "empty lands," understood biodiversity as separate from social structures and cultural systems in the New World. The myth of a wilderness free of human impact justified colonial political development. However, this myth has been largely debunked by evidence that demonstrates the historical dimensions of human impact on the habitat. Considering the cultural history of specific historical interactions of humans with the combined flora, fauna, and microorganisms of a given region along with their biological aspect provides an important dimension of understanding for biodiversity preservation in the future (Callicott et al. 2007). Other sciences can contribute to and complement the historical dimensions of this knowledge through long-term ecological studies (Willis et al. 2007a; 2007b).

This article began with the contention that conservation is an ethical act. An interdisciplinary approach is fundamentally ethical because it acknowledges the dimensions of what one does not know and seeks to learn from others. This shared ethic is combined with biophilia: the love of life in all its varieties and forms. Research that links biological and cultural diversity has been driven by a sense of urgency. These case studies emerged from focusing attention on problem solving. Whether that was food sovereignty and livelihoods or addressing climatic change, the agenda was driven by practical problems facing human communities. Each case study speaks to the power of human agency. Culture has a changeability that solely biological processes do not have. While paths of biological evolution cannot be reversed, cultures can visit unexplored paths, by re-examination of values and beliefs, to make changes and adapt

[6] While these case studies show the linkage between biological and cultural diversity among indigenous peoples, such linkages also exist with other communities that engage their habitats (Cocks 2007; Kassam 2007; NAMA 2006).

to their habitat. The time scale of cultural change is more rapid than that of most chemical and biological processes.This is a hopeful note for humanity only if we understand it and act upon it.

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Dr. Karim-Aly Kassam holds a PhD in Natural Resource Policy and Management from Cornell University (USA), an MSc in Social Policy and Planning in Developing Countries from the London School of Economics (UK), an MPhil in Islamic Studies from University of Cambridge (UK), and a BA in Economics from University of Calgary (Canada). His objective is to seamlessly merge teaching with applied research in the service of communities. The focus of this applied research is on the complex connectivity of human and environmental relations addressing issues such as indigenous rights, sustainable development, and climate change. In partnership with indigenous communities, he undertakes this research in the Alaskan, Canadian and Russian Arctic and Sub-Arctic; the Pamir Mountains in Afghanistan and Tajikistan; and the rainforest in the south of India. By investigating the relationship between biological and cultural diversity, Dr. Kassam is seeking to expand the foundations of the notion of pluralism.

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