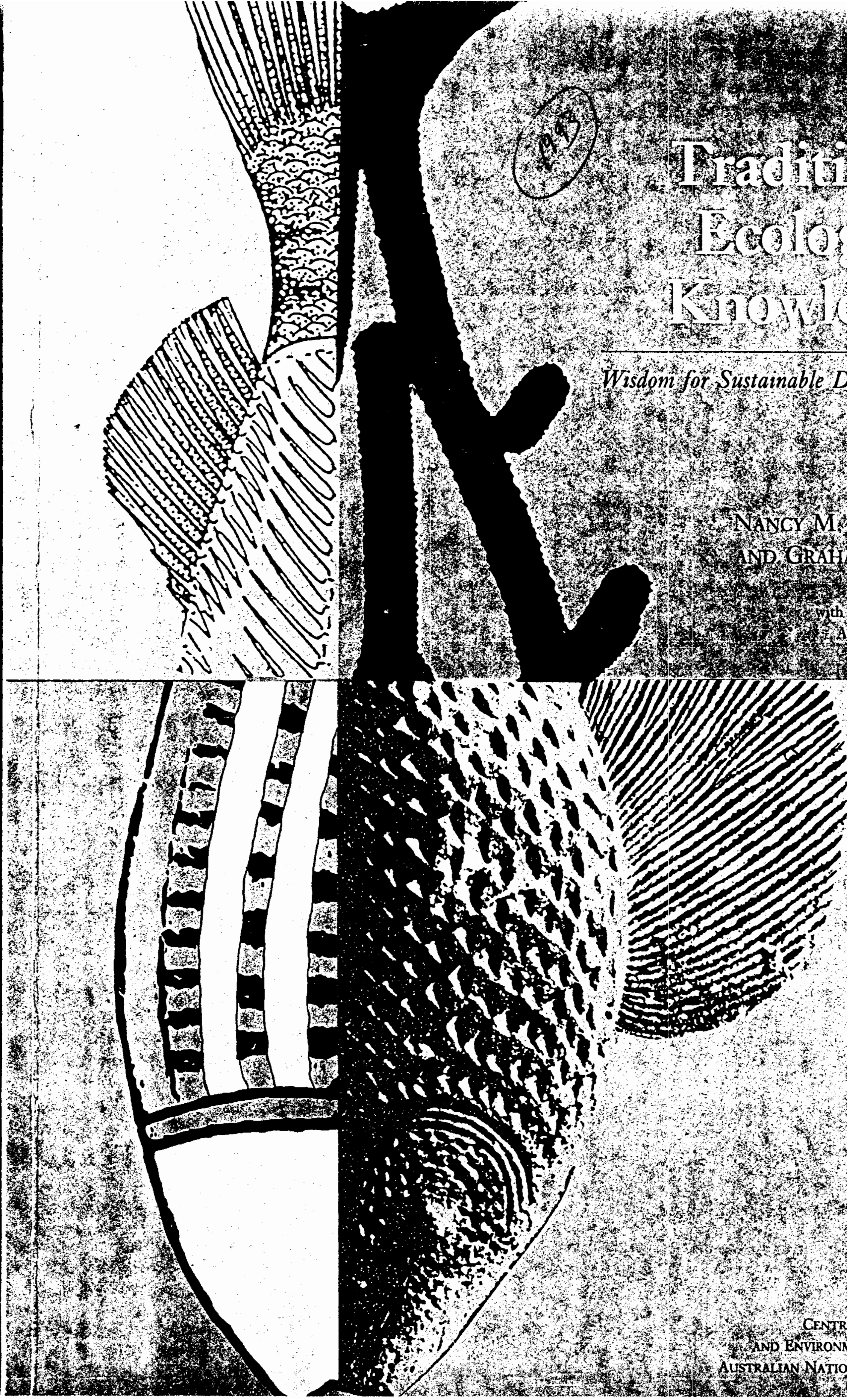

Traditional Ecological Knowledge

Wisdom for Sustainable Development

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What is traditional ecological knowledge?

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What is TEK? Traditional Ecological Knowledge. Traditional Ecological Knowledge contrasts with Modern Scientific Knowledge, better known as Science with a capital "S". I will argue that traditional ecological knowledge is a valuable source of information relevant to natural resource conservation and the preservation of ecological integrity in many parts of the world today. Systems of traditional ecological knowledge provide insight into human-environment relationships, i.e., human ecology, that modern science does not, and perhaps cannot, provide.

TEK is first of all *traditional*. Traditions evolve – usually over many centuries – within a given locality, habitat, or place. Traditions are transmitted from one generation to the next generation of people who live in, and by means of, the local environment. New ideas and techniques may be incorporated into a given tradition, but only if they fit into the complex fabric of existing traditional practices and understandings. Thus traditions are enduring adaptations to specific places. Modern science by contrast is a system of knowledge in rapid flux that seeks universal rather than local understanding. For some, the opposite of Science is Ignorance. For such people, tradition is a form of ignorance representing a perspective that is out-of-date, unchanging, and of purely antiquarian interest. That view is wrong. Traditions are the products of generations of intelligent reflection tested in the rigorous laboratory of survival. That they have endured is proof of their power.

TEK is *ecological* knowledge. As we have noted, traditions are specific to particular places. For example, the foraging tradition of the Arrernte (Aranda) of central Australia reflects at least several thousand years of occupation of this local region. The agricultural tradition of the Maya Indians of the state of Quintana Roo of south-eastern Mexico evolved in the tropical forests of this region during a period of at least 3,000 years. These two examples – one relating to foraging and one to agriculture – are alike in that in each case the local communities depend for all, or virtually all, of their material necessities – food, shelter, and medicine – upon the plants and animals of their immediate surroundings, and have done so for millennia. In each case the traditions include detailed knowledge of several hundred plants and as many animal species with which the people share their habitat. This knowledge of the natural environment – of the species it contains and how it functions, as well as their understandings of their own place within it – was learned over the course of more than 100 human generations. By contrast, modern science is less than ten generations old; the modern science of ecology no more than two.

Many aspects of a given tradition may seem to be unrelated to ecology as we define the modern scientific specialty. Traditions include ideas of religion, patterns of artistic expression, and familial relationships, for example, in addition to knowledge of economically valuable resources. However, closer examination will reveal that it is not possible to divorce the ecological aspects of a tradition from the religious, the aesthetic, or the social. For example, among Native American people of the Columbia Plateau of north-western North America, moral precepts are inculcated by means of a body of "Coyote stories". A Columbia Plateau Indian elder may know more than 60 such stories, each constituting a full evening's performance. To appreciate the meanings these stories convey requires an intimate knowledge of the local natural environment, local animals and plants being the main characters and local places the stage on which they act out the human drama. Children learn the moral precepts that will guide them in their social and ecological relationships by listening to their elders tell these stories. Thus religion, art and ecology are one. Traditions are thus ecological in the sense that they represent a complex and integrated system of practices and beliefs.

TEK is *knowledge*. The essence of a tradition is not its material by-products; that is, it is not the tools, crafts, or works of art, nor the customary dress, ritual songs or dances, nor the local foods. All these things are embodiments of the shared ideas of a people. Traditions include a great sum of knowledge about the local environment – about its plant and animal species, about its soils and weather, and a detailed map of the local topography. However, traditions also incorporate values and beliefs that provide a basis for traditional understanding of the things of the world in which they live. How people use their knowledge of the things of the world is guided and motivated by their values and beliefs about the world and their place within it. As knowledge, TEK may be transmitted from person to person, as it has been transmitted for generations in the maintenance of tradition. The medium of its transmission is, to a great extent, linguistic. Thus the study of traditional ecological knowledge requires use of the native language of the bearers of each tradition. Accurate translation from the native language of the particular traditional ecological knowledge system into the language of modern ecological scientists is critical if the traditional ecological knowledge system is not to be misunderstood by the scientists. Wilkins (in this volume) uses Arrernte examples to explain in detail why this is so.

"Knowledge is power" is a popular aphorism. It is often used to justify a policy of secrecy, of withholding information from competitors or other outsiders. With this in mind, some traditional leaders -- and other supporters of traditional rights have agreed – have sought to keep traditional knowledge (including TEK) from enquiring scholars, in particular, anthropologists. Traditional leaders may fear that to share that knowledge is tantamount to the knowledge losing its power.

I would like to argue, to the contrary, that the power of TEK is enhanced by being shared with the outside world. Knowledge that is kept secret can benefit only the few who are privy to it, generally at the expense of others excluded from it. Knowledge that is widely shared has the potential to grow and bear more abundant fruit. This is the most fundamental moral principle of modern science. The power of modern science, which not even its strongest detractors fail to acknowledge, derives in large measure from the fact that it is a co-operative intellectual effort, engaging some of the best minds of each generation and of people from throughout the world. I believe that traditional ecological knowledge should take its rightful place alongside modern scientific knowledge. Modern scientists and scholars and the bearers of traditional knowledge should work together, thereby enhancing the power of both bodies of knowledge as tools to conserve the world's resources and as a means to develop all communities in an ecologically viable manner.

Sharing TEK also ensures its survival. Many local traditions have already been driven to extinction by the drastic pace of cultural change of the past few centuries and by the destructive effects of conflict between diverse cultural groups. This extinction represents a great loss to humanity. Just as the extinction of biological species represents a loss of genetic diversity and thus a restriction of future evolutionary options, so also does the loss of traditional ecological knowledge (and the traditional cultures that generated such systems) represent a reduction in the range of choices available to future human generations. TEK is powerless if it is unknown, if it goes to the grave of the last elder without having been transmitted to a new generation (whether by indigenous means or not) willing and able to appreciate its value. This includes, of course, future generations of traditional people whose parents may have lost contact with their own traditions. It also includes those who might be unwitting agents of its destruction.

An important step in defining TEK is to examine what TEK is not. Traditional ecological knowledge is not a panacea. Systems of TEK are by definition local, not global. If we are faced with a problem of resource management in a locality where an indigenous tradition exists, we may seek to learn what that tradition can tell us about the local ecological reality. In many parts of the world, such traditions no longer exist. They have been destroyed by the expansion of colonial peoples. In other cases indigenous traditions may still exist, but may be of quite limited utility for dealing with contemporary resource management problems because of rapid increases in population density and/or transformation of the production system.

Secondly, systems of TEK are not final solutions: traditions as we have defined them are evolving knowledge systems. Particular traditions may not have achieved an enduring, self-sustaining adaptive balance. Some traditional systems may radically alter or seriously degrade their natural environments before a stable adaptive solution is achieved. Others may be unsuccessful in controlling the growth of their populations. Systems of TEK provide alternatives to those of modern science; their value should be assessed impartially on the basis of a careful and comprehensive analysis. If we ignore these traditions on the assumption that we already have all the answers we need, we will never know what more we might have learned.

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The ethnobiological foundation for traditional ecological knowledge

Eugene Hunn

TEK begins with two strikes against it. Most educated people today – except for those trained in sociocultural anthropology or related disciplines – believe that traditional cultures are unscientific because they are based on magical beliefs and/or because they lack the benefit of the western scientific method of empirical observation and experiment. Ironically, many sociocultural anthropologists also believe that traditional cultures are unscientific. This follows from the anthropological dictum that every culture has a unique world view. Thus, modern science, as a product of western culture, represents but one cultural perspective, different from but no better than, any other. The first group believes that Science (with a capital "S") is a recent invention of European culture. The second group professes that there can be no Science (with a capital "S") because there is no Reality (with a capital "R"), only unique cultural definitions of reality. Neither perspective leaves room for TEK and modern science to join forces to the end of achieving an understanding of reality superior to both. I believe, however, that there is a common foundation for TEK and modern science that allows for mutual communication of information and insight about local ecological systems and the human role in those systems. On that foundation we may reach a better understanding of how to conserve our natural resources and to manage them for the future.

The common foundation of traditional ecological knowledge and modern science is the strong tendency of people of all cultures to recognise and name biological species. Research in many traditional cultures around the world has shown a close agreement between the *basic categories of plants and animals* recognised in each traditional culture and modern scientific biology. Traditional cultures typically recognise and name between 200 and 800 basic categories of plants and about as many again of animals. As might be expected, societies located in species-rich environments tend to have the largest inventories. The vast majority of these categories correspond referentially to a scientific species (or, less often, to a subspecies, genus, family or higher scientific taxon). The first task for an outsider in coming to know a system of traditional ecological knowledge is to learn the native names for plants and animals – at least those relevant to the specific resource management or research task at hand – and to determine precisely their referential correspondence(s) to scientific plant and animal names. Once these correspondences are learned (and documented scientifically), indigenous and western "scientists" may begin to communicate with some confidence that they are at least talking about the same things.

To establish the referential correspondence between a traditional biological nomenclature and that of modern science requires combining *linguistic*, *biological*, and *ethnographic* skills and insights.

Linguistic Requirements

The researcher must first be able to ask this fundamental question in the native language: "What is the name of X?" (while pointing to some individual organism). And he/she must be able to transcribe the answers accurately in that language. It is also necessary to know the difference between a name and the other possible responses to that key question, e.g., "I don't know," "Yankee, go home!" or, "The big, black, noisy bird that craps on your head."

Learning a foreign language is a tall order. It will often be the case that a researcher will not have time or resources to gain fluency in the indigenous language of the traditional community in question. One should not therefore abandon the attempt to learn the local system of traditional ecological knowledge (or some particularly relevant aspects of it). In most instances at least some, if not all, of the local people will be bilingual in a national language. This may be the same as the researcher's native language or it may be a second language for both the researcher and the native consultant. A researcher may converse with consultants in the contact language, frame questions and record considerable useful information in that language. However, it is essential that the indigenous language names for specific plants and animals be recorded to avoid the confusion that results from mistranslation.

For example, consider the case of "camas", a lily of north-western North America with an edible bulb that was a staple food of local Indian groups. A noted local ethnographer – who shall remain unnamed – published an account of the native food plants of one local group, a Salish-speaking group in the northern portion of the Columbia Plateau. He listed five species of "camas" as important in their diet, distinguishing "black camas" as *Camassia quamash* (the scientific name of the only species of camas known from the area), but listing several species of "white camas" also as *Camassia* species. These latter species were described as being harvested on extensive dry rocky flats south of the Columbia River. A generation of anthropologists searched for these camas digging grounds unsuccessfully. Subsequent ethnobotanical research exposed the original ethnographic error: the term "camas" was borrowed originally from the Nez Perce Indian language (not a Salish language) by the explorers Lewis and Clark. The term was then appropriated by botanists for both the Latinate genus and species names. The term also entered the local English vernacular, but was generalised by English-speaking settlers to refer to most, if not all, Indian root foods. The Salish Indians described these plants to the ethnographer in the local English vernacular, in which "camas" has a much wider referential range than it had in the original Nez Perce (and related Sahaptin) language. "White camas" is not camas at all, in the Nez Perce or the botanical sense, but is used to refer to several species of "desert parsleys", members of the genus Lomatium of the parsley/celery/carrot family. There is no camas in this part of the Columbia Basin, but plenty of desert parsley. The two types of Indian foods are alike only in that the edible part of the plant is underground. They are found in quite different habitats, are harvested at different times, and are cooked and/or dried for storage in quite distinct ways. To confuse them is to miss a large part of the sophistication of local traditional ecological knowledge.

If the researcher has no knowledge of the local language, he or she must seek the assistance of linguists expert in the local language who are willing to help. It may require months of practice before one's transcriptions are totally reliable, so tape recording each name, spoken in isolation and in the context of a sentence, is important. Such tape recordings may be sent to co-operating linguists to verify the accuracy of one's transcriptions. Consider the confusion that would result if a researcher studying contemporary British TEK (say a native speaker of Polynesian) were to transcribe "oak" incorrectly as "auk" or as "oat". Expert linguistic help is also essential to distinguish a *compound name* such as "blackbird" (primary accent on "black") from a *descriptive* *phrase* such as "black bird" (primary accent on "bird"). Not all blackbirds are black (at least not all black), nor are all black birds blackbirds.

Biological Requirements

The researcher must be able to identify scientifically (preferably at the level of species) all those organisms named by the traditional consultants. If the researcher is well trained in the scientific classification and identification of the local flora and fauna he/she may directly note that an organism called A in the native language is called X by the scientist. However, it is not yet established that A "means" X in terms of referential equivalence. The native term A may be used to refer to the scientist's species Y as well as X (a case of *underdifferentiation*: frequently in such cases X and Y are closely related in the scientific system, but not invariably so), or a second native term B may be used to refer to the next example of species X encountered (for example, if the native terminology *overdifferentiates* with respect to sex, age, or cultivar, etc.). Repeated questioning should allow the researcher to map the correspondence of most native terms to scientific species (or other scientific taxa) without ambiguity.

Few researchers will have sufficient scientific knowledge of a local flora and fauna to name on sight each individual plant or animal encountered. Here the collaboration of one or more biological experts is essential. As it is difficult and often impossible to arrange to work directly in the field with collaborating botanists or zoologists, it is necessary (and advisable in most cases anyway) to collect voucher specimens to which may be appended relevant biological, linguistic, and ethnographic data. Such vouchers – if properly prepared – may be sent to scientific experts for subsequent identification. Furthermore, the voucher specimen (one or more copies thereof) should be deposited permanently in a scientific collection. This allows future researchers to verify or correct one's work.

The collection of plant specimens is relatively straightforward. It is essential, however, to consult beforehand with botanists to learn how they wish specimens to be prepared. A formal agreement regarding the curating of voucher specimens by herbaria may be advisable, especially if collecting or export permits are required. Similar documentation for animals is much more difficult to obtain. Special techniques and equipment must be employed for each different animal group, such as insects, aquatic organisms or the various classes of vertebrates. Many vertebrate animals are large and distinctive. These may be identified and verified descriptively, by means of photographs, drawings and/or verbal descriptions of the organisms named. In this context it is also very helpful to request that one's TEK consultants describe each animal (or plant) in the indigenous language: these descriptions should include a discussion of the appearance and behaviour of the species in question, where and when it may be found and what role it plays in the local ecosystem, including its direct cultural utility. One may also request that consultants draw or paint pictures of the species in question. When this information is compared with what is known by western scientists of the natural history of local species, it is often possible to establish referential equivalence by a process of elimination. Furthermore, consultants' descriptions of the natural history of local species often prove of great interest to biologists, not infrequently extending their knowledge of the natural history, biology, and ecology of little known species.

Ethnographic Requirements

Ethnographic expertise comes into play throughout the process of documenting traditional ecological knowledge. The ethnographic researcher enters (or should enter) a community motivated by respect for the value of traditional knowledge and the desire to record faithfully that knowledge for future generations. The ethnographic researcher may be a member of the community who has been trained in ethnographic methods, or more often, an outsider well versed in the academic literature relevant to the traditional culture in question. Ethnographic skills are essential to establish rapport with consultants so that the work may proceed on a basis of mutual respect and understanding. It is also the ethnographer's responsibility to come to a mutually agreeable understanding with local consultants and local community leaders as to the disposition of the data gathered by the researcher. The researcher must return to the community some benefit that is just compensation for the time and trust that members of that community have invested in the research work.

The end product of this initial phase of TEK research is a specialised dictionary (a "technical dictionary") of the flora and/or fauna (or some portion thereof) known to the traditional community, cross-indexed to the Linnaean classification system of western science. It may be assumed that traditional ecological knowledge is organised by reference to these basic indigenous categories of flora and fauna, and that people use these categories to think and talk about their environment, just as the western scientists' knowledge of natural history, biochemistry, and ecological and evolutionary processes is organised by reference to Linnaean categories, most notably at the species level. A carefully documented and comprehensive indigenous language-Latinate dictionary thus brings these two bodies of environmental knowledge together.

Some cautions are in order, however. While in the majority of cases there will be a one-to-one correspondence between the referential meanings of native and scientific names for plants and animals, in some cases there will be no such simple equivalence. Thus the following cautions should be kept in mind:

1. Native classification systems are usually less comprehensive than those of western scientists. In general, the gap between the two systems of classification increases as the size of the organism and/or its cultural significance decreases. Thus, virtually all large mammal species will be named in traditional systems, but only a small fraction of the insects or other invertebrates will be specifically recognised. As an illustration, in the Tzeltal Mayan language of southern Mexico, the numerous species of bats known by western scientists that occur locally are all "lumped" together under a single term. Bats are difficult to observe and are associated with evil forces in Mayan belief. Columbia River Indians of north-western North America specifically name over a dozen species of "desert parsleys" (*Lomatium* spp., family *Umbelliferae*), which are important as foods or medicines or which are considered to be poisonous. However, they label other common species of this genus for which they have no use as "just flowers", a catch-all or residual category that includes dozens of species of often colourful "wild flowers". Such residual categories may include a number of related species (of a single genus or family, for example) or they may include an odd assortment of species with little in common other than their lack of cultural relevance in the traditional system in question. The use of such residual categories in traditional systems is in no way an indication of inability to distinguish species on a par with that of a western scientific expert. Rather, it reflects a principle of mental economy in traditional cultures whereby attention is focussed on a few hundred species that have proven most useful as tools for living in the traditional homeland.

2. The opposite situation is also frequently encountered. Species of great import to particular cultures may be overdifferentiated with respect to the scientific system. The Hanunoo of the Philippine Islands have named over 90 varieties of rice while several hundred named varieties of potatoes have been recorded in the Quechuan languages of the Peruvian Andes. In some cases, overdifferentiation reflects strong sexual dimorphism or developmental metamorphism in culturally important species. For example, English lacks a general term for the scientific species *Bos taurus*. Instead, English speakers use the term "cattle" to refer to a collectivity of that species: "cow" for the adult female, "bull", "steer" or "ox" for adult males (variously employed in the cattle economy), and "heifer" and "calf" for subadult stages. The Maring of the highlands of Papua New Guinea, who hunt male birds of paradise for their plumes, give distinctive names to the males of each of the species they hunt but use a separate term to refer to all the females.

3. Basic categories of plants and animals in traditional systems may also have two senses; a *core* reference to a particularly interesting or conspicuous species, and an *extended* reference to one or more similar species of less central importance. Whether the term is being used more or less precisely will depend on context.

4. Binomial nomenclature was not *invented* by Linnaeus, the "father" of modern scientific taxonomic nomenclature. Linnaeus simply codified a practice that was already in use. In fact, most languages of the world make some use of this nomenclature principle. The Tzeltal Mayans call all robins (a group of thrushes of the genus *Turdus*) "*toht*", a name imitative of the voices of these birds. However, they distinguish up to five

species by modifying the generic name, e.g., "*ch'ish toht*" (thorn robin) for the rufous-collared robin (*Turdus rufitorques*) and "*k'an toht*" (yellow robin) for the clay-coloured robin (*T. grayi*). Frequently, however, the most important species of a folk genus will be called by the unmodified generic name. One must be careful to determine whether such a term is thus being used in a generic or a specific sense.

5. Traditional biological classification systems may be hierarchically organised much as is the scientific taxonomy. To illustrate this point, in Tzeltal Mayan any tree may be called "*te'*", while an oak tree is "*hih-te'*" and one group of closely related species of oaks is called "*sak-yok hih-te'*" (white-bark oak). One must be careful to distinguish the taxonomic level to which an indigenous name applies. Higher level terms in folk systems will not, as a general rule, correspond closely with the higher level terms of the scientific system. In traditional systems, such terms are often based on some one aspect of growth habit, on preferred habitat, or on cultural use, e.g., Columbia River Indians have no single term for "grass", but rather use one term for edible, forage grasses and another for grasses and grass-like plants that are "useless". By contrast, higher level scientific taxa are supposed to reflect the evolutionary processes that generate species.

6. One further caution involves the fact that names for plants and animals in traditional systems have not been standardised. Thus, numerous cases of synonymy and homonymy will be encountered. Terminology may vary by context, by dialect, even idiosyncratically. Cultural practices can greatly complicate the task of establishing equivalences between traditional and scientific names. Some traditional cultures in Australasia and the South Pacific avoid using the name of a recently deceased person or of any word that may resemble or call to mind the name of the deceased. This can lead to frequent substitution of alternative names or circumlocutions in referring to plants and animals. This creates no ambiguity within the traditional community but can confound the outside researcher.

So far we have confined our discussion of the "meanings" of plant and animal names to their referential meanings. It must be borne in mind that referential meaning is but one aspect of the meaning of a term. To say that "dog" means the same thing as *Canis familiaris* (the scientific name for the species) is to ignore other aspects of meaning, for example, that "dog" means "man's best friend" in one culture, "sled-puller" in another, and "dinner" in a third. The study of traditional ecological knowledge begins with the referential meanings of plants and animals, but certainly should not end there. Once the referential meaning has been established a whole world of other cultural meanings is accessible to the student of that system of traditional ecological knowledge.

6

The current status of TEK: Papua New Guinea and North America

Chris Healey and Eugene Hunn

Intact Systems

Traditional systems of knowledge are still largely intact in societies that maintain substantially or wholly self-sufficient subsistence-based economies. Generally, such communities are relatively remote from major commercial centres, or lack natural resources of a commercial value which might otherwise draw the communities into greater involvement in modern market systems in which traditional ecological knowledge has usually been accorded little significance. In geographically and economically "marginal" areas, traditional subsistence strategies provide the most viable or socially desirable means of making a living. Nonetheless, most traditional systems have been modified to some extent to accommodate introduced factors such as cash cropping, labour migration, or the production of handicrafts for cash sales.

Thus, for example, while most Kalahari San have adopted a semi-sedentary lifestyle associated with wage-labour, agriculture or herding, traditional hunter-gatherer skills and knowledge are still integral elements in their mixed subsistence strategies. Similarly, many indigenous peoples living as minorities within developed nations (those, for example, in Australia and Canada) who are partially dependent upon employment or welfare for survival, also maintain a modified hunting and gathering economy (Altman 1987; Tanner 1979). In such circumstances, frequently a very considerable amount of traditional ecological knowledge is nevertheless retained as an integral aspect of contemporary livelihood, even where that knowledge is applied to different ends. Thus, for example, traditional ecological knowledge is now employed by some Canadian Cree Indians to trap animals for the commercial fur trade and only incidentally for food.

While hunter-gatherer societies have proved particularly vulnerable to the disintegrative impact of larger scale, economically more differentiated social systems, subsistence agriculture-based societies have been more resilient and adaptable.

The Status of TEK in Papua New Guinea

An example of the importance of TEK as a continuing basis for survival is provided by societies in Papua New Guinea. More than 85% of the nation's population live in rural areas, and over 80% are engaged in subsistence horticulture and/or fishing. Many also earn some cash from the sale of agricultural produce, whether of

Table 1: Cultigens of important crops in three Papua New Guinea Highland Communities

Crop	Number of Cultigens		
	Maring[1]	Wola[2]	Enga[3]
Sweet Potato	27	64	35
Dioscorea Yam	30	1	12
Colocasia Taro	35	43	23
Banana	35	10	9
Sugar Cane	27	12	8
Rungia "Spinach"	5	3	2
Marita (Fruit) Pandanus	28	4	–[4]

1. Healey (unpublished data).
2. Sillitoe (1983).
3. Waddell (1972).
4. Apparently not important.

introduced cash crops, such as coffee or cocoa, or of food crops mostly grown under essentially traditional conditions. The importance of agriculture as a source of income is highly variable, averaging around K55 per capita (approximately $60 Australian or $55 U.S. on 1980 figures; Goodman et al. 1985:79).

The Papua New Guinea region is environmentally diverse, ranging from tropical coral atolls and lowland swamps to permanent snow on the highest peaks of the great mountain spine of the main island. Permanent human occupation extends from temperate highland regions to almost 3,000 metres above sea level. Environmental diversity has enabled considerable variation in subsistence strategies. There is also great cultural variability, so that traditional ecological knowledge, though showing much continuity in time and space, may nonetheless be contained within larger conceptual schemes of world view that may be quite different from one area to another.

Although the major staple food crops are relatively few in number – mainly sweet potato, taro, yams, bananas, and sago – there is, in many parts of the country, a great diversity of subsidiary crops. Further, domesticated animals – mostly pigs and fowls – and wild plants, game animals, and marine resources are widely exploited for food and a whole range of technological, medicinal and magical purposes. (For a partial list of plants exploited for food and other uses see Powell 1976; Sillitoe 1983.)

Some important domesticates, such as bananas, sugar cane, and taro are of considerable antiquity. Other crops are of relatively recent introduction. Notable among the latter is the sweet potato, which became established as an important staple in much of the highlands only about 300 years ago.

Papua New Guinea horticulturalists have proved themselves generally to be keen experimenters with new and old crops, readily discovering the best kinds of crops and varieties to grow on different soil types, and under differing cultivation regimes. Although the number of staples is relatively small, there is a sometimes bewildering number of locally recognised cultivars, as the examples in Table 1 indicate. This kind of diversity is by no means unusual, and represents a very considerable body of detailed local knowledge by which varieties may be recognised and perpetuated through consideration of their specific environmental requirements. Furthermore, new varieties are continually being discovered, perpetuated through selective propagation, and disseminated to other communities.

The emphasis on experimentation with new crops and their varieties is an important aspect of traditional ecological knowledge in Papua New Guinea and elsewhere. It shows that "tradition" does not consist of slavish adherence to unchanging custom, but rather, encompasses a genuine sense of enquiry and determination to learn from personal experience and the collective experience of others. Experimentation may lack western-defined scientific rigour, but it is no less effective in discovering the tolerances and requirements of crops, and is thus crucial to the adaptation of contemporary subsistence horticulturalists to their environments.

Much traditional ecological knowledge is under threat through sometimes misguided attempts to introduce new agricultural techniques or settlement patterns, sometimes with grave unforeseen environmental and social consequences (as in the case of Kaluli agriculture; see Chapter 22 in this volume). Development projects aimed at replacing subsistence agriculture with cash-earning ventures also threaten to undermine the continuing practical utility of traditional ecological knowledge in everyday affairs. Nonetheless, throughout much of the less accessible parts of Papua New Guinea, this knowledge is likely to remain an essential resource for maintaining subsistence. While it is generally of quite local application, having evolved in response to sometimes limited regional, physical, and social conditions, it may nonetheless prove, with careful research, to be applicable in other areas. As such, traditional ecological knowledge is a valuable resource for the future of rural-based Third World countries, where a measure of community self-sufficiency helps reduce dependence upon international markets.

The Status of TEK in North America

Native North American societies were devastated by diseases introduced from Eurasia beginning in the sixteenth century. The first well documented pandemic of smallpox swept through the most densely populated heartland of the American continent beginning in 1519. Where indigenous systems of intensive agriculture supported very large populations before Eurasian contact, aspects of local indigenous traditions survived more or less intact. Thousands of peasant communities in Mexico, Peru, and other parts of Latin America characterised by a high proportion of predominantly Indian populations are still close to the land, their livelihood depending in large measure on their traditional ecological knowledge. These communities cultivate a great variety of native plant species for food, medicine, and manufacturing materials. Traditional markets facilitate now, as they did in the past, the exchange of resources among local communities with access to a diversity of microhabitats. As of 1992, interest in recording and evaluating traditional ecological knowledge is well established and growing vigorously in Mexico. Of particular interest to Mexican students of traditional ecological knowledge are traditional medicinal plants, local cultivars, the role of "weeds" ("*quelites*") in traditional diets and the management of shifting cultivation systems in tropical forests. An objective motivating much recent research in traditional ecological knowledge in Mexico is the goal of local, regional and national self-sufficiency, especially in food production (see Toledo et al. 1985).

An excellent example of the potential of TEK in this part of the world is the recent rediscovery of a diploid perennial maize (*Zea diploperennis*) by a Tarascan Indian botany student. This and other Old World relatives of maize – one of the world's top three grain crops – are well known and valued in local systems of traditional ecological knowledge. Diploid perennial maize has proved to be resistant to six of the seven major pathogens of annual maize and is interfertile with it. The development of disease-resistant hybrid strains could save corn farmers billions of dollars.

Unfortunately, mature tropical forests in Central America and Amazonia are being converted at a high rate to pasture for beef cattle production for export to the United States and other developed countries. This process – driven by Third World debt – is destroying the ability of many Latin American countries to feed themselves. The Mexican campaign of developing TEK-based self-sufficiency in food production could retard or reverse the current trend toward conversion of tropical rain forests to pasture.

In most of North America north of Mexico, indigenous American populations were less dense, often by several orders of magnitude than in Central and highland South America. Though in most cases the first Eurasian epidemics came much later in the north, they brought a deeper, more destructive impact – demographically, socially, and culturally. North of Mexico, Eurasian colonisation was more intense. Only in the far north – in Alaska and northern Canada (e.g., Feit 1978; Freeman and Carbyn 1988; Nelson 1969, 1983) – and to a lesser degree in the southwestern deserts of the United States have indigenous systems of traditional ecological knowledge continued to be viable, if drastically modified, to the present.

More typical is the situation of the Columbia River Indians with whom Hunn works (Hunn 1990). As of 1988, a few dozen elders aged over 60, fluent native speakers of the local Indian language and raised in traditional homes, kept the local traditional ecological knowledge alive. Traditional foods continued to have great symbolic value as indicators of Indian ethnic identity and are considered sacred. Thanksgiving feasts for these foods are still the focus of a powerful native religious practice in the Columbia Plateau. Treaties protect the rights of tribal members to harvest traditional foods in "usual and accustomed places ... in common with citizens of the Territory", which wording has been interpreted by U.S. federal courts to mean in the case of the key salmon fisheries a 50% allocation of fish returning to inshore and riverine waters. More recently these rights have been extended to include a right to intervene when development projects that affect traditional resource stocks are proposed. Tribal representatives on fisheries management bodies and tribal involvement in decisions affecting environmental quality throughout the region covered by treaty brings a diversity of perspectives to resource management previously lacking. Indian representatives have been outspoken in placing a higher value on managing resources which they see as sacred in perpetuity than have non-Indians.

Though in this and other cases the local people's actual use of traditional ecological knowledge for subsistence has been inoperative for nearly two generations and has been seriously disrupted for three to four generations, much can still be learned about how these systems functioned by recording in the indigenous language what traditional elders recall having learned as children. This information may be compared with evidence in early historical documents (in the Columbia River area dating to 1805), and in the archaeological record, to assess the early impact of contact on traditional ecological knowledge.

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