Culturally Defined Keystone Species[1]

Sergio Cristancho[2] and Joanne Vining[3]

Department of Natural Resources and Environmental Sciences
University of Illinois at Urbana/Champaign
Urbana, IL 61801
USA

Abstract

The concept of "keystone species" has been widely used in biology and ecology to better understand certain biological dynamics at the ecosystem level of analysis. It illustrates the complexity of ecosystem interactions and the dependency of the entire web on certain species that are critical to its stability. While great effort has been put into studying those species that are central to the functioning of the natural ecosystem where they are embedded, not enough is known about the importance of certain plant and animal species for the cultural stability of human communities.

Historically, some animal and plant species have been attributed tremendous spiritual or symbolic value by different cultures. Some of these species are so important that a cultural group may define them as critical elements in their relationship with and adaptation to the environment. In this paper we propose the concept of Culturally Defined Keystone Species (CKS) *to designate those plant and animal species whose existence and symbolic value are essential to the stability of a culture over time. We use examples from research conducted among indigenous communities from the Amazon to illustrate the relevance of the CKS concept and propose criteria to define which species may be labeled as such.*

Important implications for environmental policy and social sciences are discussed and we propose further lines of research on CKS. The CKS concept has special relevance as a parameter of evaluation within the Cultural Impact Assessment framework since the United Nations Environmental Programme has emphasized the strong connection between ecological and cultural preservation in the context of indigenous communities.

Keywords: *keystone species, culture, Amazon region, indigenous communities, cultural impact assessment, psychological and cultural value of plants and animals*

Introduction

Together with biodiversity, the concept of keystone species in biology and ecology has gained standing for its usefulness in understanding biological cycles and ecological niches. In this paper we will suggest that some species of plants and animals may be indispensable to a culture in the same manner as keystone species are crucial to the structure and function of an ecosystem.

Keystone Species in the Context of Natural Sciences

Keystone species, a concept coined by Paine, refers to those species that "are the keystone of the [biological] community structure" meaning that "the integrity of the community and its unaltered persistence through time . . . are determined by their activities and abundances" (1969, 92). In other words, keystone species have a disproportionate effect on the persistence of other species to the extent that their removal may lead indirectly to the loss of such other species in the community (Vogt et al. 1997).

The concept of keystone species is derived from the assumption that different species are not equal in their importance for the functioning of communities. There are some species whose functional role is more important than that of others. Those species that can be considered most important to the structure and function of a community deserve the keystone species label. Moreover, the importance of keystone species to the dynamics of a community is unrelated to their abundance at equilibrium. Thus it is possible for rare species to have a greater impact on the food and energy webs of the ecosystem than more common ones (Tanner, Hughes and Connell 1994). These species "exert influences on the associated assemblage, often including numerous indirect effects, out of proportion to the keystone's abundance or biomass" (Paine 1995, 962).

The starfish (*Pisaster ochraceus*) in the Pacific coast of North America is the classic example of a keystone species (Paine 1966). This species is a carnivore that maintains a balance in the exposed rocky intertidal zone by influencing the food chains of other predators whose abundant presence would otherwise decrease the general biodiversity. Likewise, the triton (*Charona sp.*) and another starfish (*Acanthaster planci*) perform critical roles in the Great Barrier Reef along the northeast coast of Australia (Paine 1969). *Acanthaster* eats stony corals, whereas *Charona* is a predator of

Acanthaster. This web helps preserve the balance in the ecosystem but if (as has been the case) *Charona* disappears from that context, the increase of *Acanthaster* is uncontrollable and may lead to massive coral disappearance.

Although the keystone species concept has been criticized for its poor definition and breadth (Kotliar 2000; Hulbert 1997), we believe that the concept helps to better understand the complexity of ecosystem interactions at the biological level and the dependency of the entire web on certain species that are critical to its stability.

Keystone Species in the Context of Social Sciences: A Proposal

Although great effort has been put into studying those species that are central to the functioning of their natural ecosystem, not enough is known about the importance of certain plant and animal species for the cultural stability of human communities. In this paper we will present a working definition of the culturally defined keystone species, emphasizing the psychological and cultural meanings attached to certain species. Then, we will briefly discuss criteria to be taken into account in defining which species may be considered as keystone species from a cultural standpoint. Next, we will use specific examples, some of which were drawn from research based in the Colombian Amazon, to better illustrate the concept. Finally, we will discuss some implications for social sciences as well as for environmental policy.

Some of our earliest historical references to culturally meaningful species are the "tree of life" for the Celtic culture, often represented by a single living tree in the community, usually an oak (Freeman 1999); and the "trees of life and knowledge" for Christians as portrayed by Genesis 2:9-10. We should note that evidence that these trees referred to only one species is limited. However, if we take a broader historical look, it is not difficult to find certain specific species closely tied to the political and social stability of cultures in both symbolic and substantive ways. Some examples are the laurel (*Laurus nobilis*) in ancient Rome and Greece; the *fleur-de-lis* (*Iris graminea*) in France; the cow (*Bos taurus*) in India; the poppy (*Papaver sp.*) in China; the hemp (*Cannabis sativa*) in India; the betel (*Piper betle*) in all Asia; the belladonna (*Hippeastrum sp.*), the peyote (*Lophophora williamsii*) and the date (*Phoenix dactylifera*) in Central America; and the coca (*Erythroxylum coca*) in South America (Janick 1992; Saenz 1938).

Most pre-industrial societies privilege some species over others when it comes to giving them cultural meaning. Examples of animal and plant species that are attributed tremendous spiritual and, therefore, cultural value include pigs for the Tsembaga of New Guinea (Rappaport 1968), the Chilean wine palm (*Jubalea chilensis*) for earlier Easter Islanders (Bahn and Flenley 1992), the *ayahuasca* vine (*Banisteriopsis Caapi*) for the Quichua from Ecuador and Peru (Whitten 1976; Villoldo and Jendresen 1990), the corn (*Zea mays*) for the Maya or for the Hopi, and the plants used to produce *ebene* (*Anadenanthera sp.*) for the Yanomamo Indians from Venezuela (Chagnon 1968). Each of these cultural groups considers the associated species to be a critical element in their relationship with and adaptation to the environment. We argue that the concept of keystone species, so widely used in biology and ecology, will be useful for describing the psychological and cultural importance of a species for the social (human) context in which it is embedded.

The natural science model of the keystone species has been criticized for being dichotomous — that is, a species either is or isn't key (Mills, Soule and Doak 1993; Power et al. 1996). We recognize that the CKS concept is better represented in terms of each species' interaction strength relative to its cultural ecosystem — that is, as a continuum from least to most crucial species. The keystone species concept has also been criticized because of the difficulty in operationalizing the term and because a species may perform a variety of different functions (Mills, Soule and Doak 1993; Power et al. 1996). We hope to mitigate this concern with respect to the CKS by offering a definition and criteria for its designation.

Moreover, because cultures are dynamic and adaptive, keystone species may develop, persist, and then be retired for a variety of reasons. We need to maintain a historical context, locating a CKS not only culturally, but historically as well.

We also recognize that cultures are not always homogeneous (Romney, Weller and Batchelder 1986) and that there may or may not be a cultural consensus regarding a keystone species. Although it is normal to see within-culture variations in values, beliefs, and practices, we should speak of a predominant cultural trait only when there is certain cultural consensus regarding that issue or practice. Thus, in keeping with cultural consensus theory, a species should only be considered for CKS status if there is a consensus among the members of the culture as to its critical role. Some methods to assess cultural consensus will be discussed later.

Toward a Definition of Culturally Defined Keystone Species (CKS)

In order to move from the concept of Keystone Species (KS) to the concept of CKS it would be useful to briefly examine current literature on the field of folkbiology. Atran et al. (1999) evaluated the attributed ecological centrality of plant and animal species in two Maya-descendant groups (Itza' and Q'eqchi') and a non-indigenous one (Ladino) living in the Peten forest of Guatemala. They found that a plant called "ramon" (*Brosimum alicastrum*) was cited by respon-

dents across the three cultures as the most necessary plant for the forest to thrive. Ramon is valued in the Maya lowlands mostly due to its perceived positive role for the ecosystem because it provides food for a variety of animals. Although there may be a relationship between perceived and empirically based ecological centrality (the importance of a species for the stability of its surrounding natural environment or ecosystem), "ramon" would be something similar to a KS. However, "ramon" is also defined by the community through the understood value of the plant to the people and it is that value that we want to highlight here more than its biological value *per se*.

In a similar vein, Atran et al. reported that perceived "ecological importance and combined utility . . . predicted which plants the Itza' seek to protect" (2002, 432). Should we assume that plants that are attributed ecological centrality are also attributed cultural centrality? We believe that ecological centrality may contribute to cultural centrality but it does not define it. We must make the distinction between the perceived ecological or utilitarian value of a species and its perceived cultural value. It is precisely in the latter aspect that we focus on here.

It is important to acknowledge here that both ecological and cultural centrality are derived from assessments of perceptions, whether these assessments are made by individuals inside or outside of the culture. In other words, it is more useful to think of judgments about ecological and cultural centrality as psychological entities rather than real ones. In other words, both are more usefully referred to as constructed entities rather than as reifications of constructs. As we note later, this distinction is an important one for cross-disciplinary conversations, in which the ecological centrality may be treated as a fact of nature rather than a construct created by nature's observers.

As a first attempt at a definition, we wish to propose that the concept of the *Culturally Defined Keystone Species (CKS) designates those plant and animal species whose existence and symbolic value are essential to the stability of a cultural group over time*. CKS perform functions that are so important for the culture that their withdrawal from the culture's context would entail significant cultural disruptions. We will elaborate more on this definition later when we suggest definitional criteria for a species to be assessed as a CKS.

Paine's (1969) original definition of keystone species was based on three elements: species activity, species abundance, and the strategic place of species within the community's structure. Because we are referring to the importance of plant and animal species to human social groups, we tailor these definitional elements by converting them into: species use by humans, species presence/abundance in the human community, and species function in the psycho-socio-cultural structure. As for the KS, the importance of a CKS is not only determined by its abundance, but by its critical role to the human community.

To illustrate these concepts, we examine the results of several studies suggesting that the use of coca facilitates cultural transmission of knowledge from elderly individuals to young adults in various indigenous communities from the Amazon: the Barasana and the Desana (Reichel-Dolmatoff 1975, 1978, 1996, 1997); the Uitoto (Candre and Echeverri 1996; Urbina 1992); the Tanimuka (Von Hildebrand 1987); the Yukuna (Reichel 1987; Van der Hammen 1992); and the Letuama (Cristancho and Vining 2004; Palma 1984). By "mambeing" (the traditional action of chewing the powdered coca leaves), sages and apprentices attempt to please the Masters of Nature (semi-deities in their cosmology) with a valued gift. The Masters, in turn, reveal the knowledge to the sage who enlightens the apprentices.

Moreover, it is through coca that indigenous groups such as the Letuama ask the Masters for permission to use the natural resources they need to thrive (Cristancho 2001). This illustrates their particular conception of the coca plant as a mediator in their communication with the supernatural beings who control nature. Thus, the coca plant, becomes so indispensable that people from these communities are unable to conceive of their culture should they suffer from a shortage or a lack of this plant. Were the coca plants to disappear completely, their culture would face a major adaptation.

Using the three definitional elements of keystone species from biology (species activity, species abundance, and the strategic place of species within the community's structure), we could say that the use of coca is critical to these cultures, it is rather abundant in the environment, and it serves various important functional roles within these human communities. Therefore, coca can be considered as a CKS in this cultural context. However, because biological keystone species and CKS differ in nature, it is necessary to go beyond these criteria to refine the issue of whether a species should or should not be considered as a CKS.

We wish to highlight the point that keystone species, both cultural and ecological, are supported by the existence of and interaction with other species. For example, a plant that may be key to a culture is probably pollinated by bees or bats. Thus, those species are key indirectly. We suggest that such species that are indirectly important for a culture are secondary CKS, whereas the species that is directly recognized by the culture is the primary keystone species. In this paper we refine the primary CKS concept while recognizing that secondary CKS should also be recognized and assessed.

Here also lies a more fundamental issue that we want to address by proposing this concept. The CKS concept is derived from acknowledgment of the crucial roles that humans play preserving their environments. Moreover, we

suggest that social scientists need to appeal to culturally grounded concepts and issues, hence increasing their sensitivity towards the local despite their search for the universals of human behavior. Designating a CKS answers these two issues by including the human dimension as a critical one in the preservation of natural resources and by stressing the unique role each culture has in determining the species on which they rely the most.

CKS Among Indigenous Cultures in the Amazon

The close interdependency that hunter-gatherers and other pre-industrial societies (which we will now refer to as "indigenous") have had with the natural environment is a useful domain in which to illustrate the CKS concept. Virtually all of the existing literature about Amazon indigenous communities mentions the key role that certain species have for cultural subsistence. In fact, one of the broadest cultural divisions of indigenous groups in the Colombian Amazon is based on the cultural centrality of certain products derived from their most valued plant species. For instance, in the Central region we find the "people of *ambil*" or licked tobacco (*Nicotiana tabacum*), comprising groups such as the Uitoto and the Andoque. In the Northwestern region we find the "people of snuffed tobacco," comprising groups such as the Makuna and the Letuama. And in the Southern region we find the "people of *huito* and *achiote*,"[4] (*Genipa Americana* and *Bixa orellan*, respectively) comprising groups such as the Tikuna and the Yagua (Vieco, Franky and Echeverri 2000).

Similarly, individual indigenous communities often refer to themselves as descendants from animal species. For example, the Tanimuka claim to be descendants from the jaguar (Von Hildebrand 1987), the Letuama from the Boa (Palma 1984), and the Uitoto from the monkey (Urbina 1982). In short, we could say that totemic animals are the center of their cultural identity, their social organization, and their relationship with other groups. Although these totemic species are certainly central to these cultures, it is yet to be determined whether they are CKS and their existence required for the survival of the culture.

In his study of the Tukano Indians, Reichel-Dolmatoff (1996) described the important role that certain species such as a legume called *uacú* (*Monopteryx Angustifolia*), and the jaguar (*Panthera onça*) played in their shamanic practices. The uacú represents the principle of procreation, and the jaguar, spiritual power. Interesting psychological implications emerge here. Shamans, for instance, are thought to have the ability to transform themselves into jaguars. These beliefs in ontological transformations, or transformations of essence, demonstrate the strong imagined connection between those animal species and Tukano people and help us better understand their privileged position within the culture.

Among the Tukano and among several other indigenous communities from the Amazon, these key species sometimes coincide with plants that also have a psychoactive effect and there may be confusion about the two functions. Moreover, the importance of psychoactive plants could easily be interpreted as merely serving to facilitate altered states of consciousness through which shamans offer spiritual mediation between supernatural and lay beings. Instead, these plants are crucial to the existence of the community. This misinterpretation may be the result of industrialized cultures' conceptions of mythic plants as recreational psychoactive drugs, a tendency that has developed primarily in the second half of the 20th century. Such a tendency has impeded researchers from examining more holistically the role of these species beyond their mere psychoactive or physical effects. The first studies conducted by Reichel-Dolmatoff (1975, 1978) among the Desana of Colombia showed the same trend. Likewise, the classical studies of South American coca have been devoted almost exclusively to its psychoactive effects (e.g., Saenz 1938) and little has been said about the role it plays in maintaining society and culture. Disciplines such as ethnobotany have also paid major attention to the medicinal use of certain plants and their cultural role has been only tangentially mentioned (Schultes 1987; Schultes and Raffauf 1990).

A few authors have examined dimensions other than the psychophysiological impact of important plant species. A good example is the work of Antonil (1978), who discusses his personal experiences with and observations of the social and cultural dimensions of coca use among the Paez Indians of Cauca, Colombia. Another seminal work in this regard is that of Candré and Echeverri (1996) who draw on a series of Uitoto traditional stories to demonstrate the crucial role that coca and tobacco (among other plants and animals) play in this group's sense of spirituality, self-discipline, health, education, dream symbolism and social norms. Likewise, Cristancho (2001) found that coca, tobacco and pineapple were the three most important plant species in the context of the Letuama people from the Colombian Amazon primarily due to their spiritual and cultural meaning. Even though there may be a relationship between certain plant species' psychoactive properties and the cultural value that some groups attach to them, our point is that their cultural value goes far beyond their physical effect on human beings. We now turn to an analysis that may help define coca as a CKS for the Letuama.

Coca: A Plant CKS for the Letuama People?

The complexity of the CKS concept is illustrated by our work with the Letuama culture of the Colombian Amazon.

Through this example we wish to distinguish CKS from species that have only ecological centrality, or cultural significance that is not key to the survival of the culture.

We will now explore the example of coca as a CKS for the Letuama people and analyze it in more detail. Cristancho (2001) and Cristancho and Vining (2004) explored the cultural importance of plant and animal species for the Letuama[5] through qualitative analysis of the responses to the following questions: What is the most important plant/animal species for you and your community and why? In regard to plants, coca, tobacco and pineapple were consistently mentioned in the qualitative response to this question. Consistently, frequency analyses showed that coca, tobacco and a native palm called "cananguchо" (*Mauritia flexuosa*) were mentioned more often than any other plant species on all the ethnographic material. The analysis for the latter was, for example, the number of times that "cananguchо" was mentioned over the total number of times that any plant species was mentioned. Therefore, note that these frequencies do not refer to the number of people of the community mentioning the species but to the number of times each species was uttered by anyone during any portion of the in-depth interviews that were recorded. As is illustrated in Figure 1, coca was mentioned almost twice more frequently (29.0%) than any other plant species, followed by tobacco (15.2%) and "cananguchо" (13.1%).

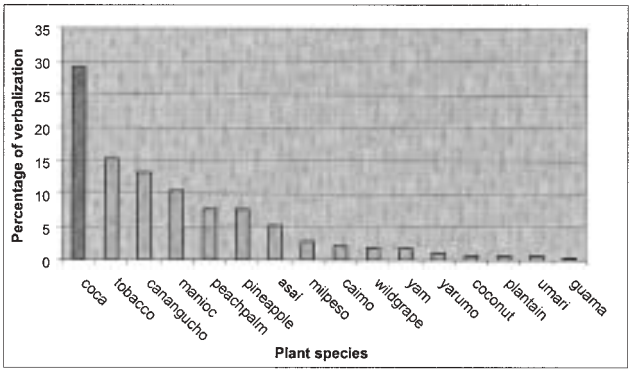

Figure 1. Plant species frequencies of verbalization.

In regard to animals, the boa and jaguar (which they refer to as tiger and that is how it appears in our figure) were the wild species most frequently mentioned, with the domesticated dog also mentioned frequently. Figure 2 shows that the boa was mentioned 2.3 times more frequently (28.2%) than the next animal species, the dog (12.0%), and the jaguar (11.6%).

However, a species may be mentioned frequently without being crucial to the culture and that is the reason why we should not rely exclusively on this kind of analysis to identify CKSs. Let us go back to the case of coca and analyze it in more detail. Coca is within easy reach of the Letuama community. It is cultivated in their local *chagras* or community gardens. The physical presence of the plant in this case is critical insofar as it guarantees its daily use and other traditional activities in which it is indispensable. At a basic level, for example, coca is used in activities intended to supply the basic needs of the community (e.g., for hunting or gathering food, building shelters and housing, retrieving firewood, weaving hammocks, etc). By chewing the coca powder, indigenous people offer to their Masters of Nature something that pleases them in order to get their permission to extract plants or animals. Their offerings also serve to prevent negative consequences.

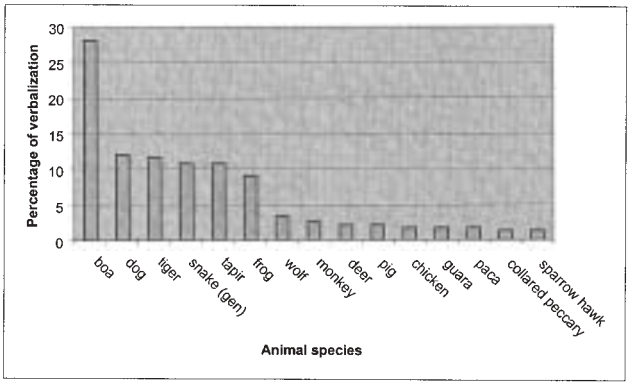

Figure 2. Animal species frequencies of verbalization.

At a more complex level, coca is a crucial element in the cultural transmission of knowledge. Sacred knowledge is only discussed or transmitted when sages and apprentices are *mambeing* coca. The sage also receives knowledge from higher powers while mambeing coca. Because the sage is the conduit by which sacred knowledge is transmitted among generations and community members, coca is a crucial vehicle for such transmission for the entire community. Coca is also indispensable in major rituals such as the ritual of world healing and illness prevention (Yuruparí), the seasonal feasts offered by the community to the Masters of Nature to thank them for particular harvests, and the healing ceremonies led by the sage. The story of the origin of coca is closely tied to the ancestors and origins of the Letuama culture and hence to their myths and beliefs. Furthermore, coca is given different symbolic meanings as we show in our analyses. For example, coca is thought of as both a person and a tool given by the people of the old Letuama world to the people of the new world in order for them to negotiate goods with the Masters of Nature.

Given the extent to which coca is interwoven in their culture, it is not surprising that the Letuama refer to it as not only an important species, but also a crucial one. We now

turn to empirical observations that support and complement what we have described. Coca is represented as having at least five critical uses for the Letuama culture, as is demonstrated by the following quotes from the narrative data:

• As CURRENCY for negotiating with nature:

*When we are going to clear-cut the chagra, we don't do it simply because we want to finish the forest. We have a limit that help us to think "until here it is useful, and until here it is not useful." Then we do spells for the nature not to harm us and ask the owner, through **Coca**, Tobacco... We give him the most we can... This is like a business in which we pay something. Same as the whites have their currency and say, "Take this and I can use that piece of land." It is the same but we pay with Coca and Tobacco.*

• As a DEFENSE from natural threats:

...When there are bad signals, men ought to do prevention with Coca, that is, to raise a defense for his wife not to fall in the animals traps and weapons such as the snake, the scorpion, or any other evil thing.

• As an ENHANCER of the power of thought:

***Coca** is sacred because it manages and directs our thoughts. It is with this thought that nature is managed for purposes of world healing. With this one [he points out the **Mambe**] we do so... Because this is the principal power of our thought, the power of **Coca**.*

• As MEDIATOR in learning and socialization:

*...But if you want to ask him [the sage] for advice, you **Mambe** yourself and you start asking him with which thought you should do the things... until you fully understand. In other words, when you start **Mambeing** and you go to the **Mambeadero** [place where people mambe coca], you start learning slowly in order to understand everything.*

• As a PARTNER (anthropomorphism of Coca):

***Coca** and Tobacco come from this world [they are not trees], they are our partners... **Coca** himself was a person that transformed himself for good, so it is too sacred...*

Even in these few excerpts, the variety and depth of the different meanings given to coca among the Letuama (as well as other indigenous Amazon communities) illustrate the importance of this species for their psychological, social, and cultural well-being. Consequently, any disruption of their traditional coca related practices caused by external groups may lead the Letuama to a cultural catastrophe. For example, lack of awareness among government officials of the role played by coca among the Letuama could easily lead to plans to eradicate coca fields cultivated by the Letuama. This would have serious consequences for the community. The Letuama thus perceive potential threats for the coca as threats to their culture:

• From non-indigenous people in general:

For white people, the environment has an economic value because of the money that it represents... Because we know the history of Coca, we know how to manage it, whereas they manage it based on an economic interest, that is, as an economic resource... That's the reason why they have so much trouble with it. For us instead this is sacred...

• From miners and drug dealers:

What if we find a gold mine here within our territory? It is only us that would suffer the bad consequences because, behind it, what would there be? ...The same kind of thing happens with Coca. It is through Coca that war comes.

• From institutions of drug-control:

Please tell them [white people] that this is too sacred for us. We won't allow any institution entering here to clear-cut our Coca crops as they have done close to Leticia with [another indigenous community].

In conclusion, coca plays an important role in the Letuama culture, a role that may be crucial. This is evident in the frequency with which they mention the plant in conversations concerning nature, in the meanings they attach to it, and in their call for outsiders to respect it. It is clear at this point that the withdrawal of the species could bring seriously negative consequences to the community. Thus, we suggest that coca is a CKS for the Letuama.

The next step is to delineate definitional criteria from the analyses. What are the psychological, social, and cultural criteria that define a CKS? We suggest that a plant or animal species that meets most of the following seven indicator conditions relative to a specific cultural context may be considered a CKS:

- The story of the species' origin is tied to the myths, the ancestors, or the origin of the culture.
- The species is central to the transmission of cultural knowledge.

- The species is indispensable in the major rituals on which the community's stability depends.
- The species is either related to or used in activities intended to supply the basic needs of the community such as getting food, constructing shelters, curing illnesses, etc.
- The species has significant spiritual or religious value for the culture in which it is embedded.
- The species exists physically within the territory that the cultural group inhabits or to which it has access.
- The cultural group refers to the species as one of the most important species.

Some of these conditions may result when a human community values a particular species, while others may help to explain why a certain species has garnered so much psychological and socio-cultural value in a community. However, if a species satisfies most of these criteria it is likely to be a CKS. As we have noted, the abundance or scarcity of a CKS *per se* does not necessarily determine its effect. Likewise, the frequency of its use does not necessarily determine the key role a CKS plays in the cultural stability of the human community. Finally, although it is probably that only a few species in each culture meet these criteria, we believe there is no reason why a culture may not have more than one CKS.

Now, let us use these criteria to assess the importance of a plant species in several different cultural contexts. Archeological findings have suggested that, for the inhabitants of Easter Island, a palm species known as the Chilean wine palm (*Jubaea chilensis*) was indispensable in moving and erecting the *moai*, huge stone statues that played a major cultural role in their society. It is believed that the disappearance of *Jubaea chilensis*, which was probably due to drought, the overpopulation of rats brought to the island, and a rapid process of deforestation led to the culture's progressive collapse from 1500 to 1722 (Bahn and Flenley 1992).

Jubaea chilensis was:

- Indispensable in the major rituals on which the community's stability depended, such as erecting the *moai*.
- Used in activities intended to supply the basic needs of the community. The wine palm nuts were used as a source of food.
- Spiritually valuable for the Easter Island culture in which it was embedded.
- Present physically within the territories occupied by Easter Islanders.
- Referred to by the inhabitants of the Island as one of the most important species. (Evidence for this is provided in carvings and historical documents.)

In this example, the Chilean wine palm meets five out of the seven criteria we proposed and therefore could be called a CKS in the context of earlier Easter Island cultures.

Other plant and animal species mentioned in the introduction also play (or played) roles similar to coca or the wine palm, yet in different cultural contexts. For example, the Hopi use corn not only to make a flatbread that is a staple of their diet but also to bless special places and *kachinas* (spirits said to mediate between humans and ancient spirits). They have several *kachinas* that specifically bless the corn crop. For example, the "Corn kachina" blesses the harvest. The "Speckled Corn kachina" represents the different colors of corn, and the "Seed kachina" brings the seed for planting. The "Yellow Corn Maiden kachina" is used to bring rain (McManis 2000). Moreover, corn and cornhusks and stalks are used in ceremonies and as part of ceremonial clothing, which are landmarks of their culture. Corn is exchanged as a sign of friendship or peace. Corn dances are performed to celebrate and encourage planting, germination, growth, and harvest (Dutton 1975; James 1979). In this example, we can see how six CKS criteria are met:

- The corn story of origin is tied to the Hopi myth of the origin of rain.
- Corn is indispensable in their major rituals including traditional dances, clothing, and ceremonies to bless places and *kachinas*.
- Corn is used in activities intended to supply the basic needs of the community, in this case to make flatbread, which is a staple of their diet.
- Corn has a significant spiritual value for the Hopi as it is thought to be a mediator between humans and ancient spirits and to bless the harvests.
- Corn plants can be found within the territory inhabited by the Hopi.
- If asked, the Hopi would probably refer to corn as one of the most important plant species for their culture.

The laurel (*Laurus nobilis*) is another example. This plant was probably a CKS for Roman and Greek cultures. Laurel was Apollo's tree. It symbolized merit and victory. Governors, nobles and sages wore laurel crowns to portray an image of intellectual superiority. In Rome, as a divinatory tool, laurel also played an important role in mysteries and religious rites. In sacrifices, assistants were sprinkled with branches of laurel soaked in holy water. In Greece, Pythia, the soothsayers chewed and burned its leaves to prophecy. Those who obtained a favorable reply returned crowned with laurel. The cultural importance of laurel to Rome and Greece has become known to us through most artworks produced in the eras when these cultures flourished. Moreover, derived from its original meanings in these cultures, laurel was widely used to praise the scholarship of graduates and poets later on in the Middle Ages. Here, we see how laurel meets four of the CKS criteria:

- The story of laurel's origin is tied to Apollo, considered as one of the greatest ancestors of Roman and Greek cultures.
- Laurel was indispensable in major rituals mostly of artwork production but also of healing and divination, all of which were central cultural rituals with implications for their social stability.
- Evidently, laurel had significant spiritual value for these cultures as it was used to celebrate religious rites and also to symbolize their deities (e.g., Apollo) and the intellectual superiority they would obtain when enlightened by such deities.
- Laurel plants existed all over the Roman and Greek territory.

Similarly, the Celts viewed a kind of pig, the boar, as central to their culture. The boar symbolized warriors' skill and prowess. It also represented fertility, wealth, courage, and strength, all of which were the basic survival traits for them. Its meat was also offered in "Otherworld feasts" to their deities. The heads of sacrificed animals were preserved as oracular fetishes. The boar was sacred to the Goddess Arduinna, patroness of the forests of the Ardennes (Cooper 1992; Walker 1991). The Boar meets four CKS criteria:

- The boar was indispensable in major Celtic rituals such as the "Otherworld feast" and the elaboration of oracular fetishes.
- The boar was used in activities intended to supply the basic needs of the community, in this case, the need for survival in warfare. This animal was a symbol to encourage their warriors' prowess, which was critical for them to win the war with their neighbors, thus protecting their own lives.
- The boar had significant spiritual value for the culture because it was offered to the Goddess Arduinna and to other deities.
- The boar existed within the Celtics' territory.

There are several ways to assess whether a species is CKS or not. We believe that a grounded approach that relies on the members of the community speaking for themselves (Charmaz 2000) is called for in the initial identification of a CKS. Through such a process, an external observer might identify a CKS with the questions above in mind by conducting participant observation or interviews with members of the culture in question or by developing and applying culturally tailored instruments to assess each species' potential as a CKS. Nonetheless, we also acknowledge that other scientific methods could be developed to determine a species' condition as a CKS or not. Scientific discourse matters here mostly in cases in which the community may not be aware of the importance of a species because they take the presence and the cultural function of the species for granted. We believe though, that in order to be well-founded, external observers' judgments of a species as a CKS should be endorsed at some point by the community itself. As mentioned earlier, it is also important to establish consensus around the key role that a species plays in a certain culture.

Cultural consensus can be assessed qualitatively or quantitatively. One option, for example, is to qualitatively analyze peoples' expressions about the importance of certain species for their group, highlighting those that seem to be crucial culturally. Also, one could use the term consensus when there is a minimum acceptable percentage of agreement among the members of the group about the cultural importance of such species (e.g., > 60%). Finally, cultural consensus can be assessed in a more reliable manner using Romney, Weller, and Batchelder's (1986) operational criteria. These authors argue that cultural consensus is reached when the principal-components analysis of a subject-by-subject matrix of responses (in this case about the cultural importance of different species) shows: 1) the ratio of the latent root of the first to the second factor is high, 2) the first eigenvalue larger than the second and accounts for most of the variance, and 3) all individual first factor scores are positive and relatively high. In this case, agreement between members of the culture can be explained by a single factor solution, which represents their "consensus." Under this model, the level of agreement of an individual with the consensual model can also be assessed (see also Atran et al. 1999, 2002; Medin et al. 1997 for examples).

CKS vs. Other Species Playing Key Subsistence, Ecological, Economic or Psychoactive Roles

It is important to avoid confusion in the use of the CKS concept in three situations. First, a distinction must be made between species that are central to the physical survival of individuals within a cultural group (e.g., species solely used for food and shelter) and species, such as CKSs, that are crucial to the survival of the culture (e.g., species used for collective rituals that are pivotal to the culture). For example, physical survival of individuals might be jeopardized by the scarcity of food species, but food species are substitutable for the most part. When we detect a potential CKS species that has utilitarian importance for the culture we need to ask whether the species also meets the other criteria for a CKS.

Second, some psychoactive plant species can confound determination of CKS status. Although it is true that some CKS have psychoactive effects, it is not necessarily true that all psychoactive species are CKS.

Third, as suggested by Atran et al. (1999, 2002), there are species that are attributed ecological or economic central-

ity in certain cultures (e.g., the "ramon" or the "chicle" for the Itza' Maya). We suggest that besides ecologically and economically central species there are others that also become or are culturally central. In other words, we argue that some CKS may be important from an ecological or economic standpoint but not all ecologically or economically central species are CKS, at least in the sense we use the CKS concept here. There may be a relationship between ecological, economical and cultural centrality but this relationship has not been explored yet. However, Atran et al.'s (1999, 2002) studies suggest that this relationship may vary greatly across cultures depending on a series of historical, cultural, and environmental factors that are unique to each culture.

Although it is always easier to see things in black and white, we do not want to suggest that these three distinctions necessarily form dichotomies. The extent to which a species is physically, psychologically, ecologically, economically, or culturally central is unclear at this point and needs to be better framed through evidence from studies of other cultures. At this point, we believe a continuum would better represent the different strengths of various species in each of these dimensions.

Implications

We have proposed the CKS concept in order to raise awareness of species that are critical to the cultural stability of human communities. Our empirical analyses are limited to one in-depth example (the Letuama of the Colombian Amazon) at this point, but we are confident about the depth of the information collected there. We believe our data offer a good beginning to the discussion about the conceptual usefulness and practical applicability of the term. Moreover, there are indications in the literature that other cultures may also have culturally defined keystone species. We believe that in addition to having merit of its own, the CKS concept is heuristic of studies into human ecosystems.

We assume herein that cultural stability is beneficial to the communities in question. We recognize, however, that as is the case with ecological systems, cultural systems are dynamic entities that change over time in response to the environment and to changes in their internal structures. The CKS concept is therefore restricted conceptually to species whose loss may cause irretrievable and catastrophic damage to a culture. The distinction between such disastrous consequences and more gradual, natural change is one of degree, of course. As shown in Figure 3, the identification of a CKS may be oriented more as a continuum of importance rather than a dichotomous judgment.

Traditionally, natural sciences have focused their efforts on maintaining keystone species alive and functioning well within the ecosystem in which they are embedded. Now we may examine the human ecosystem in a similar way and suggest that natural and social scientists work together to determine cultural keystone species as well as natural ecological keystone species. The study of CKS could be a convergence point for interdisciplinary collaboration. We should note, however, that there are differences in philosophy or inquiry between disciplines that may hinder such collaboration. Culturally defined keystone species do not exist in nature — they are constructed by humans. There is a perception among many in the natural and physical sciences that ecological keystone species are real, that they are in no sense constructed by a human psyche. Many, if not most, social scientists would argue that a keystone species is a human construction, whether biologically or culturally defined. Nonetheless, the notion that an ecologically defined keystone species is somehow more real than a culturally defined species could hinder interactions among disciplines on this important topic. As we stated earlier, we borrowed a concept from the natural sciences as a model to explain social and cultural phenomena because we believe in the usefulness of such conceptual analogies for the purposes of clarity.

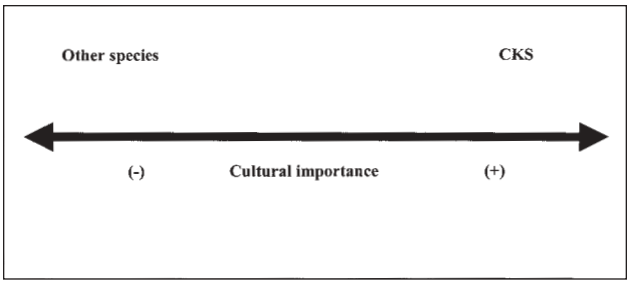

Figure 3. CKS in the continuum of cultural importance.

It is also necessary for social scientists and managers of government organizations to join efforts in preserving CKS in order to prevent significant cultural and environmental disruptions. Social scientists in emerging fields such as conservation psychology and folkbiology should lead efforts to theorize about and guide CKS preservation efforts just as researchers in conservation biology have done in promoting biodiversity and keystone species protection. Ecological anthropology and ethno-botany would also benefit from using the CKS concept given their keen interest in the human meanings given to natural species.

For ecological anthropology, psychological anthropology, cross-cultural psychology, and indigenous psychologies a new challenge emerges. We might frame questions such as: What makes a species a cultural keystone? Or, in other words, what historical, ecological, social, and psychological factors lead a cultural group to give keen importance to a certain species? What are the mechanisms for a culture to des-

ignate a species as keystone? What are the cross-cultural differences in the conception and definition of CKS? How does socialization of the cultural knowledge about CKS occur? What is the functional role of CKS in indigenous communities' ritual practices? How do the symbolism and analogies attached to each CKS (through the use of myths or stories) constitute models of social and ecological behavior? The answers to these questions may provide a better understanding of human-nature interactions at the human-species level and on the mediation of psychological processes in environmental ethics.

It would be also interesting to know whether species seen as ecologically central (such as the "ramon" and the "chicle" in the Maya lowlands) are also seen as culturally central. In other words, future research may explore the relationship between perceived ecological centrality and perceived cultural centrality of both plant and animal species. We also believe that study of the process by which a CKS is gained or lost would be interesting.

Other questions remain to be answered about the existence and nature of culturally defined keystone species. Our examples of CKS come primarily from examination of preindustrial and rather homogeneous cultures. Although we have not done the research to determine a keystone species of any cultures within industrialized countries, we believe that it is possible for such cultures to have species that are key to their existence. Agricultural communities, for example, may depend on certain species as both crops, for their subsistence value, and as symbols celebrated in festivals. Although CKS seems to be more salient to cultures living relatively "closer to nature" such as those we have discussed here, we believe that cultures living in environments dramatically altered by humans or "far from nature" (i.e., urban cultures) may still develop the notion and thus turn certain species into CKS. It is important to examine a greater variety of cultures in detail to determine whether the CKS concept also applies to these types of cultures. Furthermore, the applicability of CKS to other types of cultures largely depends on what definition of culture one takes (e.g., national, organizational, professional, local) but discussion of this point is well beyond the scope of this paper. We hope that our work here stimulates study of CKS in industrialized and developing, urban and rural, indigenous and non-indigenous cultures.

In the applied arena, the identification and assessment of CKS should be a priority in all governmental and non-governmental plans for development in or near indigenous communities. The disappearance of a CKS may have tremendous social and ecological implications. First, it may endanger the stability of a culture by seriously jeopardizing the transmission of knowledge and other vital processes that have allowed the community to thrive over time. Second (in cases such as the Amazon indigenous communities), by affecting the human group that is effectively caring for local natural resources, the disappearance of a CKS may indirectly affect the stability of critical ecosystems.

Furthermore, we argue that conservation of CKS should be included in integrated resource management plans of regions with indigenous or other communities with shared cultural beliefs. Likewise, environmental policy should address the protection of CKS by ensuring that: 1) these species are respected by outsiders, 2) their commercialization is under control, and 3) their use outside of the traditional cultural practices is prevented.

Recently, the United Nations Environmental Programme (UNEP 2002) emphasized the existing link between environmental sustainability and preservation of indigenous communities' traditional knowledge and practices in those regions. Assessment of CKS on indigenous lands may be one out of several important parameters to evaluate in the Cultural Impact Assessments that UNEP promotes prior to any developmental project in such ecologically sensitive territories. More research is needed, though, to assess the applicability of the concept in different scientific and applied domains. Moreover, designation of CKS may be useful in establishing UNESCO cultural heritage. In the current designation criteria there are cultural landscapes, natural sacred sites, oral traditions, traditional medicine and other types of cultural heritage, but none of them includes species as cultural keystones.

In summary, we have proposed the concept of a culturally defined keystone species as an analogue to that of an ecological keystone species. We have offered a definition, criteria for designation, and an example of a keystone species from our own study of an indigenous Amazonian culture. We believe that the CKS concept is worthy of further basic research as well as consideration for management and policy.

Endnotes

1. The evolution of idea of the culturally defined keystone species (CKS) originated in a paper by Cristancho and Vining (2000), given at the International Symposium for Society and Resource Management. Cristancho (2001) published for the first time the CKS concept in his Master's thesis, and was invited to give a more definitive presentation of the idea at the first International Young Scientists' Global Change Conference (2003) in Trieste, Italy. Our work on culturally defined keystone species has already attracted the attention of other scholars (Garibaldi and Turner 2004).
2. Author to whom correspondence should be directed. E-mail: cristanc@uiuc.edu
3. E-mail: jvining@uiuc.edu
4. Huito and achiote are used by Tikuna people to paint their bodies with black and red tinctures, respectively, during the main rituals held

at their communities such as the *pelazon* through which young girls make transition to womanhood. These tinctures are attributed the property of preventing ailments from sorcery in community vulnerable periods such as those of ritual.

5. As part of an ethnography that took place during Summer 2000, we obtained tape-recorded material from in-depth interviews and informal conversations with the headman and the adult people with most important traditional roles in the community. Interviews addressed issues regarding human-nature interactions including the concept and classification of nature, importance of plant and animal species, mental representations of the natural world, values, norms, and perceived threats. These interviews were conducted by the first author and took place in the main community house known as 'maloka.' Informal conversations took place while the respondents were performing daily activities either in their household, or in community gardens, or in forest pathways.

Acknowledgements

We would like to thank the University of Illinois Human Dimensions of Environmental Systems program and Center for Latin American and Caribbean Studies for their support of this research. We are also grateful to three anonymous reviewers for their thoughtful and constructive comments on this paper.

References

Antonil. 1978. *Mama Coca*. London: Hassle Free Press.

Atran, S., D. Medin, N. Ross, E. Lynch, J. Coley, E. Ucan Ek' and V. Vapnarsky. 1999. Folkecology and commons management in the Maya Lowlands. *Proceedings of the National Academy of Sciences USA* 96, 7598-7603.

Atran, S., D. Medin, N. Ross, E. Lynch, V. Vapnarsky, E. Ucan Ek', J. Coley, C. Timura and M. Baran. 2002. Folkecology, cultural epidemiology, and the spirit of the commons. *Current Anthropology* 43, 3, 421-450.

Bahn, P. and J. Flenley. 1992. *Easter Island, Earth Island*. New York: Thames and Hudson.

Candre H. and J.A. Echeverri. 1996. *Cool Tobacco, Sweet Coca: Teachings of an Indian Sage from the Colombian Amazon*. London: Themis.

Chagnon, N.A. 1968. *Yanomamö, the Fierce People*. New York: Holt, Rinehart and Winston.

Charmaz, K. 2000. Grounded theory: Objectivist and constructivist methods. In N.K. Denzin and Y.S. Lincoln (eds.), *Handbook of Qualitative Research*, 2nd Edition. Thousand Oaks, CA: Sage Publications.

Cooper, J.C. 1992. *Symbolic and Mythological Animals*. London: Aquarian/Thorsons.

Cristancho, S. 2001. *Letuama Psychological Representations of Nature and Human-Nature Interactions*. Unpublished M.S. thesis. Champaign, IL: University of Illinois.

Cristancho, S. and J. Vining. 2000. *Natural Justice Among the Letuama People*. Paper presented at the International Symposium for Society and Resource Management, Bellingham, WA.

Cristancho, S. and J. Vining. 2003. Culturally defined keystone species: A proposal, *Proceedings of the First International Young Scientists' Global Change Conference*, Trieste, Italy, 78.

Cristancho, S. and J. Vining. 2004. Reciprocity as principled argument: The ethics of human-nature interactions for the Letuama. *Human Ecology Review* 11, 36-50.

Dutton, B.P. 1975. *American Indians of the Southwest*. Albuquerque, NM: University of New Mexico Press.

Freeman, M. 1999. The Celtic tree of life: A sacred ecology. *Parabola* 24, 59-64.

Garibaldi, A. and N. Turner. 2004. Cultural keystone species: Implications for ecological conservation and restoration. *Ecology and Society* 9, 1.

Hulbert, S.H. 1997. Functional importance vs. keystoneness: Reformulating some questions in theoretical biocenology. *Australian Journal of Ecology* 22, 369-382.

James, H.C. 1979. *Pages from Hopi History*. Tucson, AZ: University of Arizona Press.

Janick, J. 1992. Horticulture and human culture. In D. Relf (ed.). *The Role of Horticulture in Human Well-Being*. Portland, OR: Timber Press.

Kotliar, B.N. 2000. Application of the New Keystone-Species concept to praire dogs: How well does it work? *Conservation Biology* 14, 1715-1721.

McManis, K. 2000. *A Guide to Hopi Katsina Dolls*. Tucson, AZ: Rio Nuevo.

Medin, D.L., E.B. Lynch, J.D. Coley and S. Atran. 1997. Categorization and reasoning among tree experts: Do all roads lead to Rome? *Cognitive Psychology* 32, 49-96.

Mills, L.S., M.E. Soule and D.F. Doak. 1993. The keystone-species concept in ecology and conservation. *BioScience* 43, 219-224.

Paine, R.T. 1966. Food web complexity and species diversity. *The American Naturalist* 100, 65-75.

Paine, R.T. 1969. A note on trophic complexity and community stability. *The American Naturalist* 103, 91-93.

Paine, R.T. 1995. A conversation on refining the concept of keystone species. *Conservation Biology* 9, 962-964.

Palma, M. 1984. *Los Viajeros de la Gran Anaconda*. Managua: Editorial America Nuestra.

Power, M.E., D. Tilma, J.A. Estes, B.A.Menge, W.J. Bond, L.S. Mills, G. Daily, J.C. Castilla, J. Lubchenco and R.T. Paine. 1996. Challenges in the quest for keystones. *BioScience* 46, 609-620.

Rappaport, R.A. 1968. *Pigs for the ancestors: Ritual in the Ecology of a New Guinea People*. New Haven, CT: Yale University Press.

Reichel, E. 1987. Astronomía Yukuna-Matapí. In J. Arias and E. Reichel (eds.). *Etnoastronomías Americanas*. 45th Congreso de Americanistas en la Universidad de Los Andes. Bogotá: Universidad Nacional de Colombia.

Reichel-Dolmatoff, G. 1975. *The Shaman and the Jaguar: A Study of Narcotic Drugs Among the Indians from Colombia*. Philadelphia, PA: Temple University Press.

Reichel-Dolmatoff, G. 1978. *Beyond the Milky Way: Hallucinatory Imagery of the Tukano Indians*. Los Angeles: UCLA Latin American Center Publications.

Reichel-Dolmatoff, G. 1996. *The Forest Within*. London: Themis.

Reichel-Dolmatoff, G. 1997. *Rainforest Shamans*. London: Themis.

Romney, A.K., S.C. Weller and W.H. Batchelder. 1986. Culture as consensus: A theory of culture and informant accuracy. *American Anthropologist* 88, 313-338.

Saenz, L.N. 1938. *La Coca*. Lima.

Schultes, R.E. 1987. Coca and other psychoactive plants: Magico-Religious roles in primitive societies of the new world. In S. Fisher, A. Raskin and E.H. Uhlenhuth (eds.). *Cocaine: Clinical and Biobehavioral Aspects*. New York: Oxford University Press.

Schultes, R.E. and R.F. Raffauf. 1990. *The Healing Forest: Medicinal and Toxic Plants of the Northwest Amazonia*. Portland, OR: Dioscorides Press.

Tanner, J.E., T.P. Hughes and J.H. Connell. 1994. Species coexistence, keystone species, and succession: A sensibility analysis. *Ecology* 75, 2204-2219.

United Nations Environmental Programme. 2002. *News Release 2002/82: Big Developmental Projects Need Cultural Impact Assessments*. Nairobi: UNEP.

Urbina, F. 1982. *Mitología Amazónica: Cuatro Mitos de los Murui-Muinanes*. Bogotá: Universidad Nacional de Colombia.

Urbina, F. 1992. *Las Hojas del Poder: Relatos Sobre la Coca entre los Uitotos y Muinanes de la Amazonia Colombiana*. Bogotá: Centro Editorial Universidad Nacional de Colombia.

Van der Hammen, M.C. 1992. *El Manejo del Mundo: Naturaleza y Sociadad entre los Yukuna de la Amazonía Colombiana. Estudios en la Amazonía Colombiana, IV*. Bogotá: Tropenbos Colombia.

Vieco, J.J., C.E. Franky and J.A. Echeverri. 2000. *Territorialidad Indígena y Ordenamiento en la Amazonía*. Bogotá: Universidad Nacional de Colombia.

Villoldo, A. and E. Jendresen. 1990. *The Four Winds: A Shaman's Odyssey into the Amazon.* San Francisco, CA: Harper and Row.

Vogt, K.A., J.C. Gordon, J.P. Wargo, D.J. Vogt, H. Asbjornsen, P.A. Palmiotto, H.J. Clark, J.L. O'Hara, T. Patel-Weynand, B. Larson, D. Tortoriello, J. Perez, A. Marsh, M. Corbett, K. Kaneda, F. Meyerson and D. Smith. 1997. Ecosystems: Balancing Science with Management. New York: Springer.

Von Hildebrand, M. 1987. Datos etnográficos sobre la astronomía de los indígenas Tanimuka del noroeste Amazónico. In J. Arias and E. Reichel (eds.). *Etnoastronomías Americanas*. 45th Congreso de Americanistas en la Universidad de Los Andes. Bogotá: Universidad Nacional de Colombia.

Walker, B.G. 1991. *The Woman's Dictionary of Symbol and Sacred Objects.* San Francisco, CA: Harper Collins.

Whitten, N.E. 1976. *Sacha Runa: Ethnicity and Adaptation of Ecuadorian Jungle Quichua.* Urbana, IL: University of Illinois Press.