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Insight

Cultural Keystone Species: Implications for Ecological Conservation and Restoration

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ABSTRACT. Ecologists have long recognized that some species, by virtue of the key roles they play in the overall structure and functioning of an ecosystem, are essential to its integrity; these are known as keystone species. Similarly, in human cultures everywhere, there are plants and animals that form the contextual underpinnings of a culture, as reflected in their fundamental roles in diet, as materials, or in medicine. In addition, these species often feature prominently in the language, ceremonies, and narratives of native peoples and can be considered cultural icons. Without these "cultural keystone species," the societies they support would be completely different. An obvious example is western red-cedar (*Thuja plicata*) for Northwest Coast cultures of North America. Often prominent elements of local ecosystems, cultural keystone species may be used and harvested in large quantities and intensively managed for quality and productivity. Given that biological conservation and ecological restoration embody human cultures as crucial components, one approach that may improve success in overall conservation or restoration efforts is to recognize and focus on cultural keystone species. In this paper, we explore the concept of cultural keystone species, describe similarities to and differences from ecological keystone species, present examples from First Nations cultures of British Columbia, and discuss the application of this concept in ecological restoration and conservation initiatives.

INTRODUCTION

"People of the Deer," "Town of the Wild Plums," "People of the Wild Rice" ... all around the globe, humans identify themselves and each other by their cultural and economic affiliations with particular species of plants and animals. The reliance of humans on other life-forms in their environments is unquestioned. However, although all life-forms in some way influence human survival and the diversity of species used in any given region is immense, some species have more direct relevance and recognition in peoples' life ways and have developed a primary, overriding importance. These significant species play a unique role in shaping and characterizing the identity of the people who rely on them.

The species that play these special cultural roles vary widely from one region to another and from one culture to another. In general, however, the species most closely associated with indigenous and local peoples, wherever they reside, are the ones they depend upon most extensively to meet their needs for food, clothing, shelter, fuel, medicine, and other necessities of life. These are the species that become embedded in a people's cultural traditions and narratives, their ceremonies, dances, songs, and discourse. These are also the species for which a people will have developed the most detailed names and associated vocabulary, and the ones on which they focus in their immediate activities and conversations.

In this paper, we discuss these culturally salient species and propose to identify them as "cultural keystone species," a metaphorical parallel with ecological keystone species (see also R. Ellen, *unpublished manuscript*; Nabhan and Carr 1994; G. Nabhan, L. Monti, and L. Classen, *unpublished manuscript*). In keeping with the growing body of research and thinking in which ecological systems and social systems are conceptually linked (cf. Cavalli-Sforza and Feldman 1981, Folke et al. 1998, Fracchia and Lewontin 1999, Dove 2001, Berkes et al. 2003), we see a number of benefits to identifying and focusing on culturally prominent species in research on environmental, economic, and cultural change and restructuring, as well as in ecological restoration and biodiversity conservation efforts. In developing this

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concept, we first provide a characterization of the original concept of the ecological keystone species, including a brief discussion of some of the potential and perceived problems and shortcomings of the idea. We then elaborate on the inextricable linkages between ecological systems and cultural systems, and suggest how our cultural keystone concept might be situated within the current theoretical approaches in the area of ethnobotany and ethnoecology. We also explore the contributions of this concept in the partnership between social science and natural science, and more specifically between indigenous knowledge and Western knowledge, sometimes referred to as integrative science (see University College of Cape Breton 2003).

In the next section, we develop the cultural keystone concept more fully, providing three examples of cultural keystone species from our work with First Nations in British Columbia. Finally, we discuss the implications and applications of the concept of the cultural keystone species for understanding environmental change and in ecological restoration and habitat conservation.

CONCEPT OF THE ECOLOGICAL KEYSTONE SPECIES

Robert Paine coined the term “keystone species” in the late 1960s following his study of the rocky intertidal zone of the Pacific Ocean (Paine 1969). Among his findings was the fact that, through predation, the ochre starfish (*Pisaster ochraceus*) kept a population of mussels (*Mytilus californianus*) to a size that allowed the rest of the species in the ecosystem to coexist and thrive in this coastal community. Once the starfish were removed from the system, a reduction in biodiversity of eight to 15 species was observed (Paine 1966). Based on these findings, Paine (1969) originally postulated that a species is considered keystone to a community if it holds the system in check and preferentially consumes species that would otherwise dominate the system (Power et al. 1996). This concept has since been studied, critiqued, and modified as well as cited in more than 92 publications from 1970 to 1989 (Mills et al. 1993).

Like any metaphorical concept of this magnitude, this one is not without its shortcomings. One major criticism of the keystone species concept stemmed from the ambiguous nature of its definition (Mills et al. 1993). This made it hard to identify exactly which species should be designated as having a keystone role in a community (Mills et al. 1993). According to Power et al. (1996), among the obstacles to such a determination are:

1. cost. It is an expensive and detailed task to gather sufficient data to determine if a species plays a keystone role;
2. controls. It is difficult to measure data from in situ experiments because of the many variables, known and unknown, in the field;
3. time. Long-term studies are required to determine patterns in species behavior;
4. ethical constraints. Certain tests to determine the extent of its influence on an ecosystem, e.g., removing a species from its environment, may eliminate the very species or habitat that conservation biologists are trying to save; and
5. context dependency. A species may play a keystone role in some parts of its range, at specific times of the year, or under certain conditions. Therefore, the determination of a species as keystone varies both temporally and spatially, and a strong understanding of the context specific interactions is required.

However, despite these problems, many ecologists still see value in the concept of the ecological keystone species as a whole and believe that modifying rather than dismissing the idea may be a useful approach (deMaynadier and Hunter 1994, Power et al. 1996). A meeting of ecologists with expertise in the keystone species concept resulted in a publication that expanded the definition of keystone to mean “... a species whose impact on its community or ecosystem is large, and disproportionately large relative to its abundance ...” (Power et al. 1996:609). More recently it has been proposed that adding the caveat that keystone species “... perform roles not performed by other species or processes ...” may increase the applicability of the keystone concept to conservation (Kotliar 2000). The debate about exactly what is and what is not a keystone species continues. Menge and Freidenburg (2001) propose limiting keystone species to consumers, in keeping with the original definition proposed by Paine (1969), to separate bottom-up effects such as primary production from top-down effects such as keystone predation. Rather than disregard the importance of bottom-up effects, Menge and Freidenburg (2001) see them as linked but separate concepts. As shown above, delineating the boundaries between keystone and nonkeystone species

may be difficult at best. The term “foundation species” was recently put forth by Soulé et al. (2003) to classify those species that are very abundant or dominant, and therefore fall outside the criteria of keystone according to Power et al. (1996), yet are highly interactive in an ecosystem. However, the discussion of the keystone species concept is ongoing, and the concept will undoubtedly undergo further revisions.

Species have been proposed as ecological keystones in ecosystems all over the world (Power et al. 1996). One notable example is the Canadian beaver (*Castor canadensis*), which is referred to as a “keystone modifier” by Mills et al. (1993) and identified as a mutualist rather than as a keystone by Soulé et al. 2003. The beaver's damming of streams creates ponds, which in turn serve as habitat for numerous other species from ducks to aquatic plants and insects (Naiman et al. 1986, Pollock et al. 1995). Although originally reserved only for those species at the higher trophic levels, keystones, as they are now identified, may be found at any trophic level and exert influence on ecosystems through a number of mechanisms such as dispersal, disease, pollination, mutualism, and competition (Power et al. 1996). Other species that have been referred to as keystones include the sea otter *Enhydra lutris* (Duggins 1980), the red-naped sapsucker *Sphyrapicus nuchalis* (Ehrlich and Daily 1988), and the sea urchin (Fletcher 1987). Although plant products such as palm nuts, figs and nectar have been identified as keystone (Terborgh 1986), the vast majority of observed keystone species have been animals. Although the importance of these plants to the ecosystem is undisputed, their role as keystones has been questioned (Menge and Freidenburg 2001) based on the separation of bottom-up and top-down effects. Therefore, plants are presently considered tentative keystone species at best.

CONNECTING CULTURAL AND ECOLOGICAL SYSTEMS

It has been proposed that, just as there is a biosphere, i.e., the region of the earth's crust and atmosphere occupied by living organisms, there is an ethnosphere, defined as “... the sum total of all thoughts, beliefs, myths and institutions made manifest today by the myriad cultures of the world ...” (Davis 2001:8). The exploration of this concept has many implications for those interested in both the natural and social spheres of study. On a broad level, it is an application of an ecological concept modified to describe cultural systems. Examined further, it becomes a tool to understand the complex web of human-ecosystem connections. The ethnosphere is born out of the biosphere within which it is situated, but it has its own particular features, history, and development. In its turn, the ethnosphere modifies, manages, and therefore influences the biosphere.

Many people have begun to see similar processes that permeate the social and biophysical worlds as not just reflections of an interesting metaphor, but as concrete parallels between social and ecological systems (see Cavalli-Sforza and Feldman 1981, Berkes and Folke 1998, Fracchia and Lewontin 1999, Dove 2001, Seixas 2002, Berkes et al. 2003). The role of the “edge effect” in both ecological and cultural spheres, the similarities and parallels between biological and genetic refugia and cultural refugia, the relationships between biological diversity and cultural diversity, the importance of resilience and adaptive response in ecological and human communities, and the concept of “health” for ecosystems as well as for communities and individuals, are all examples of work currently underway in which links between ecological and social systems are being investigated (Colding and Folke 2001, Vasseur et al. 2002, Berkes et al. 2003, Davidson-Hunt 2003, Garibaldi 2003, Turner et al. 2003).

Currently, the very ecosystems that have supported the earth's diverse complex of social systems are facing unprecedented changes. What happens to a culture when landscapes and ecosystems are modified? Both social and ecological systems have co-evolved with a fine-tuned network of checks and balances. In fact, the management practices used by indigenous Americans for thousands of years have helped to produce the very image of “wilderness” that many non-native settlers saw upon their arrival in the Americas (Anderson 1996; Deur and Turner, *in press*). The maintenance of biodiversity by aboriginal peoples has been well documented (Blackburn and Anderson 1993, Anderson 1996, Gadgil et al. 1998, Turner 1999, Deur 2000, Minnis and Elisens 2000), and a decline in biological diversity often means a loss of cultural diversity. The implications of arctic environmental change are acutely felt in circumpolar communities; as such, more attention has been given to the value of indigenous observations of these changes (see Krupnik and Jolly 2002). It is imperative that we address the fact that the changes taking place in ecosystems at a range of scales are mirrored in human cultures, and

that the strengthening of the cultural knowledge and practices of indigenous and local peoples may spur us toward a strengthening of ecological systems. Although the preservation or conservation of recognized ecosystems may be possible in some locations, restoration and reclamation may be the only option in others.

Our current aim is to highlight the parallels between what we refer to as ecological keystone species and cultural keystone species. In some cases, the same species that could be considered ecological keystones are also identifiable as cultural keystones, such as beaver for the Dene and baleen whales for the Inuit. However, the distinction of these as cultural keystones highlights their importance to the ethnosphere, the cultural component of the earth's systems. This designation has implications for understanding the conservation and restoration of both social and ecological systems. Currently, although most researchers recognize the contributions of community partnerships in conservation efforts, successful models and methods for establishing those relationships are just being developed. Additional practical approaches for addressing social and ecological concerns in restoration and conservation are needed.

CULTURAL KEYSTONE SPECIES

Just as certain species of plants or animals appear to exhibit a particularly large influence on the ecosystem they inhabit, the same is true in social systems. We have termed these organisms “cultural keystone species” and define them as the culturally salient species that shape in a major way the cultural identity of a people, as reflected in the fundamental roles these species have in diet, materials, medicine, and/or spiritual practices. Recently, others have denoted culturally significant species as “keystone,” such as the sago palm *Metroxylon sagu* (R. Ellen, *unpublished manuscript*) in eastern Indonesia and mesquite (*Prosopis* spp.) in the American Southwest (Nabhan and Carr 1994; G. Nabhan, L. Monti, and L. Classen, *unpublished manuscript*). These designations underscore the value of further developing a concept of cultural keystone species that articulates some of the defining characteristics of these organisms.

Keystone species may serve a particular culture materially in a host of different ways: as a staple food or a crucial emergency food, in technology, or as an important medicine. As well, such a cultural keystone species may be featured in narratives or have important ceremonial or spiritual roles. It would also likely be highly represented in a culture's language and vocabulary. As will be described in greater detail, although the specific role a particular species plays in a culture may vary considerably, its designation as a cultural keystone species lies in its high cultural significance.

The connection between the concepts of ecological keystone species and cultural keystone species is in the defining influence a species exerts within its respective “sphere.” Unlike ecological keystones, whose identity hinges on the expected ecological influence of a species relative to its biomass, the main criterion for a cultural keystone species is its key role in defining cultural identity; it may or may not be considered ecologically dominant. In this regard, cultural keystone species are not unlike “foundation species,” which have recently been defined as “... highly interactive species that are often extremely abundant or ecologically dominant ...” (Soulé et al. 2003:1239). For example, trees, grasses, and large mammals such as bison may be designated as cultural keystones in given situations. Although some of these species may be excluded under the current accepted definition of ecological keystone species, they may neatly fit the cultural keystone definition for one or more cultural groups. If we extend the concept of “interaction” to include social or cultural interactions, then the term “cultural foundation species” may also be appropriate in keeping with the definition of “foundation species” by Soulé et al. (2003). The primary characteristics of cultural keystone species are presented in Appendix 1.

The identification and characterization of cultural keystone species is complex because peoples' cultural relationships with plants vary with environmental factors such as climate, natural disturbance, and fluctuations in populations and productivity unrelated to human causes. These relationships are also affected by social factors such as economic systems, social organization, access to land and resources, and knowledge transmission. The difficulty associated with identifying ecological keystone species has been one of the largest obstacles to its acceptance and application in conservation efforts (Mills et al. 1993). The concept of cultural keystone species could face similar challenges if the criteria for evaluating the designation of culturally “key” species are not explicitly outlined. We propose a quantitative aid to assess the overall influence a particular species exerts

within a culture, an index based on its identified cultural influence. The different elements that must be considered when identifying a cultural keystone include the following:

1. intensity, type, and multiplicity of use;
2. naming and terminology in a language, including the use as seasonal or phenological indicators;
3. role in narratives, ceremonies, or symbolism;
4. persistence and memory of use in relationship to cultural change;
5. level of unique position in culture, e.g., it is difficult to replace with other available native species; and
6. extent to which it provides opportunities for resource acquisition from beyond the territory.

Obviously, these factors are relative, contextual, and difficult to quantify, but we propose using a series of questions associated with each of the six identified elements to extract a quantitative indicator of species "keystone-ness" (Table 1). As seen in Table 1, the more cultural significance a species has, the higher the score assigned to it. This calculated indicator provides a quantitative value for comparison with other species.

It is not difficult to pick out some of the most predominant keystone species without even going through a systematic evaluation. Perhaps the best test of all, a practice not possible with ecological keystone species, is to ask the people themselves which species they feel are key to their identity and survival. For the Gitga'at, a Tsimshian community in Hartley Bay, British Columbia, edible red laver seaweed (*Porphyra abbottiae*) is one of these, as is western red-cedar (*Thuja plicata*), according to the Gitga'at elders. Animal species that would be considered cultural keystones to the Gitga'at are the five species of salmon (*Oncorhynchus* spp.) as well as cockles (*Clinocardium nuttallii*) and abalone (*Haliotis kamtschatkana*). These are the species for which the Gitga'at are renowned, and with which they themselves identify. Two of these, western red-cedar and red laver, are described later as examples. Many examples exist outside of British Columbia, such as rue (*Ruta* spp.), which is used as an important medicinal and spiritual plant in many parts of traditional Spain (San Miguel 2003).

Among the logistical problems faced in the identification of an ecological keystone species is that manipulative field experiments are expensive and time-consuming at best and unethical at worst, e.g., the experimental removal of the very species and ecosystems that may be at risk (Power et al.1996). Although cultural keystone species may be more readily identified, a loss or change in their availability can be equally drastic to the human communities that depend on them. Alterations in the abundance or productivity of cultural keystones have occurred in many cases, and there are also many instances of people losing access to their keystone species. Losses of this type have been brought about both intentionally and unintentionally as a product of development. The upheaval faced by aboriginal communities when their ecosystems have been altered and their cultural keystone species eliminated is unfortunately well documented (e.g., Turner et al., *in press*). Simultaneously, practices that cultures may have used to encourage and support the abundance of particular keystone species may have been interrupted during periods of large ecosystem changes. For example, abalone are no longer available to the Gitga'at due to overharvesting by commercial interests and subsequent closure of the fishery.

Issues of scale

Cultural keystone species vary over temporal, geographic, and social scales. For discussion purposes, we will treat these as isolated dimensions, but in reality they are a continuum. A species can act at any location within an interactive matrix that combines these axes, simultaneously affected by season or history, location, and personal cultural or societal standing.

Temporal scale

Both seasonal markers, such as phenological cues, and longer-term historical markers, such as ceremonies or other rituals that strengthen cultural cohesiveness, facilitate the cultural continuity of landscape use and management. "The People of the Wild Rice" mentioned in the introduction, also known as the Menominee, are highly attuned to the timing or phenological markers associated with rice (*Zizania aquatica*) cultivation (University of Wisconsin 2003). Their connection to rice is annually solidified through both harvesting and associated management practices for this critical cultural plant. This knowledge has been so imbued in the Menominee culture that it has become a key part of their identity. It is integral to

Table 1. Index of the identified cultural influence of cultural keystone species. The ratings for western red-cedar (*Thuja plicata*) in the Pacific Northwest are derived from Stewart (1995) and Turner (1998); those for red laver seaweed (*Porphyra abbottiae*) for the Coast Tsimshian, from Turner (2003); and those for wapato (*Sagittaria* spp.) for the Katzie before 1900, from Suttles (1955), Spurgeon (2001), and Garibaldi (2003). Although a scale with more increments could be used, in this case a rating of 5 represents the answer "yes, very high"; 4, "yes, high"; 3, "yes, moderate"; 2, "yes, low"; 1, "yes, although low or infrequent"; and 0, "no, not used." The higher the sum total for all the questions, the more likely that the species is a cultural keystone. The highest possible rating is 35.

Elements that indicate a cultural keystone	Rating		
	Red-cedar	Red laver	Wapato
Intensity, type and multiplicity of use			
- Is the species used intensively (routinely, and/or in large quantities)	5	5	5
- Does the species have multiple uses?	5	4	3
Naming and terminology in a language, including use as seasonal or phenological indicators, names of months or seasons, place names			
- Does the language incorporate names and specialized vocabulary relating to the species?	5	5	4
Role in narratives, ceremonies, or symbolism			
- Is it prominently featured in narratives and/or ceremonies, dances, songs, or as a major crest, totem, or symbol?	5	4	3
Persistence and memory of use in relationship to cultural change			
- Is the species ubiquitous in the collective cultural consciousness and frequently discussed?	5	4	5
Level of unique position in culture			
- Would it be hard to replace this species with another available native species?	4	5	3
Extent to which it provides opportunities for resource acquisition from beyond the territory			
- Is this species used as a trade item for other groups?	5	5	5
TOTAL	34	32	28

their ceremonies, oral traditions, and community structure (University of Wisconsin 2003). There are countless other examples in which people renew their cultural identity on a short-term seasonal scale and on a longer time scale spanning multiple generations, such as ceremonial observances for births, marriages, and funerals that identify people with a particular species such as tobacco (*Nicotiana* spp.) for the Karuk of California (Harrington 1932) or *ti* (*Corydaline terminalis*) for the indigenous people of Hawaii (Ehrlich 1999).

Table 2. Index of the Identified Cultural Influence (ICI) of cultural keystone species. The higher the sum total for all questions the more likely a species is a cultural keystone.

Elements that indicate a cultural keystone	Rating*		
	Western red-cedar in the Pacific NW (1) (2)	Red laver for the Coast Tsimshian (3)	Wapato for the Katzie (pre-1900) (4) (5) (6)
Intensity, type and multiplicity of use - Is the species used intensively (routinely, and/or in large quantities) - Does the species have multiple uses?	5 5	5 4	5 3
Naming and terminology in a language, including use as seasonal or phenological indicators, names of months or seasons, place names - Does the language incorporate names and specialized vocabulary relating to the species?	5	5	4
Role in narratives, ceremonies, or symbolism - Is it prominently featured in narratives and/or ceremonies, dances, songs, or as a major crest, totem, or symbol?	5	4	3
Persistence and memory of use in relationship to cultural change - Is the species ubiquitous in the collective cultural consciousness and frequently discussed?	5	4	5
Level of unique position in culture (i.e. it is difficult to replace with other available native species)	4	5	3
Extent to which it provides opportunities for resource acquisition from beyond the territory - Is it used as a trade item for other groups?	5	5	5
TOTAL (ICI rating) out of 35	34	32	28

* We suggest rating question responses based on the following: 5 [yes, very high], 4 [yes, high], 3 [yes, moderate], 2 [yes, low] 1 [yes, though very low or infrequent], 0 [no, not used]; a different scale may be used if necessary (i.e. a scale that has more increments).

(1) Turner 1998 (2) Stewart 1995 (3) Turner 2003 (4) Garibaldi 2003 (5) Spurgeon 2001 (6) Suttles 1955

Spatial scale

Like ecological keystone species, cultural keystone species are dependent on context. What is a keystone species to one group may not be keystone to another. Factors such as the availability of resources, plant community structure, and proximity to other keystone species all affect the significance a community places

on a particular organism. These species may be ubiquitous throughout a nation's territory, such as soapberry (*Shepherdia canadensis*) among the Secwepemc or Shuswap Nation of British Columbia. Conversely, some species may be used or depended upon by just one group within a broader culture or tribe. For example, in the Secwepemc Nation, the keystone species of the Neskonlith and Skeetchestn Bands are highbush cranberry (*Viburnum opulus*) and choke cherry (*Prunus virginiana*), respectively.

Furthermore, a keystone species is not bound by traditional territories. For example, devil's club (*Oplopanax horridus*) is a salient species in most coastal communities of the Pacific Northwest from Oregon to south central Alaska (Lantz 2001). It has high spiritual and medicinal value and is featured in many narratives and ceremonies. It is one of the more easily identifiable keystone species. Other obvious examples include western red-cedar and salmon for Pacific Northwest Coast peoples, wild crabapples (*Pyrus fusca*) for Pacific North Coast peoples such as the Tsimshian and Haida, and Saskatoon berries (*Amelanchier alnifolia*) for the Stl'atl'imx (Lillooet) and other Interior Salish peoples of southern British Columbia.

Other cultural keystones may be viewed on joint temporal and geographic scales. Some species are significant at particular times of the year at certain locations such as fish camps, ceremonial sites, and hunting routes. These plants may have particular meaning to an individual such as a shaman or to a small group, e.g., a family, or they may be important to an entire band. This social differentiation provides another axis by which cultural keystone species may be viewed.

Social scale

As noted, one particular family member, healer, or leader may have a strong connection to a specific type of plant because of childhood experiences or information received in a dream. A plant may also have particular prominence as a family or clan crest, e.g., frog, raven, fireweed (*Epilobium angustifolium*), spiny wood fern (*Dryopteris expansa*); play a role in the spiritual regalia of a particular dance society; or be featured in a personal story owned by an individual. This type of “small-scale” keystone species will vary from one individual or one social group to another. However, this does not undermine the importance of such a species in maintaining and reflecting well-being and identity within that context.

Cultural keystones can extend in their influence beyond families or social groups within a community to an ever-widening range of communities and cultural groups. At wider social scales, it is difficult to distinguish between the social and geographic dimensions of cultural keystones, because both dimensions may define them simultaneously.

Understanding the associated scales for a particular keystone species is critical. Spatial, temporal, and social scales define the applicability of this concept in a specific conservation and restoration effort. For example, identifying one or even a few cultural keystone species may not be possible in a socially diverse and possibly transient Western community in the Pacific Northwest where multiple cultural communities reside. This concept may best be applied in indigenous communities in which long-term direct contact with an ecosystem has been possible. Recognition of scale reduces the possibility of a species being misapplied for conservation or restoration purposes in a given context.

LIMITATIONS OF THE CONCEPT OF THE CULTURAL KEYSTONE SPECIES

One of the key advantages in the identification of cultural keystone species is that it provides an effective starting point for conservation and restoration of what Fikret Berkes refers to as “social-ecological systems” (Berkes 2002:335). Practical methods for simultaneously addressing community needs and those of researchers, industry, or government are not always readily available. However, although this concept may highly beneficial, it is important to be judicious in its application.

We have identified three potential limiting factors of this concept. First, the ecological status of the keystone species may restrict suggestions for its future use. A threatened, endangered, or red-listed species may not be able to tolerate additional reduction in its population through harvesting. It may be necessary to modify harvesting techniques (see Johannes 1998), severely restrict gathering, or cease harvesting altogether in such cases. Another option may be to explore the potential of another species to fill the role of the cultural keystone. For example, on southern Vancouver Island, *Camassia quamash* is more

common than *C. leichtlinii*, and therefore the former could be featured in cultural restoration efforts in preference to the latter, although both could qualify as cultural keystone species for Central Coast Salish (Beckwith 2002). However, the substitution of a cultural keystone species may not always be possible because of the unique cultural niche the species fills. A recovery program should be assessed for each species based on its particular biological constitution. At the same time, regardless of the status of the species, social-ecological studies provide an opportunity to research baseline species information before the species was compromised, to educate project participants and local resource users, and to better understand traditional techniques for resource management.

Second, even if a species is not officially listed as "threatened," it may be at risk from environmental change or habitat loss. Cultural keystone species may be affected by large-scale disturbances such as climate change and introduced species. The Garry Oak Ecosystem found in British Columbia formerly supported large populations of *Camassia* spp., which, along with other important traditional species, have been severely affected by introduced species such as orchard grass (*Dactylis glomerata*) and Scotch broom (*Cytisus scoparius*). As well, many large-scale vegetative changes resulting from climate change are taking place and projected to increase. These include the redistribution of forest patterns and major shifts in wetland habitat, particularly those that rest on permafrost (Watson et al. 1997). Many cultural keystones species may be affected by these habitat modifications. Therefore, as with "listed species," alternatives to the traditional practices for harvesting cultural keystone species that are otherwise threatened may need to be put in place.

Third, an absolute quantification of the significance of a particular cultural keystone species, which we refer to as the identified cultural influence, is not possible. However, the complexity of assigning this indicator should not negate the value of the analysis that seeks to understand the association between a community and its resources. Discussing Arctic environmental change and indigenous knowledge, Berkes (2002:335) states that "...conventional disciplines in the sciences and social sciences are inadequate to deal with problems involving the interaction of humans with the environment. These coupled social and ecological systems (social-ecological systems for short) need to be understood and approached as complex adaptive systems." We believe the same is true in the investigation of any environmental change.

CULTURAL KEYSTONE SPECIES: EXAMPLES

Western red-cedar (*Thuja plicata*)

Western red-cedar is a tree that is an ideal candidate as a "cultural keystone" for the coastal First Peoples of British Columbia, who are sometimes known as the People of the Cedar (see Table 1). As "the cornerstone of Northwest Coast Aboriginal culture" (Turner 1998), its wood is lightweight yet strong, rot-resistant, and easily split; in addition, when steamed or wet, it can be shaped, molded, and even bent at a 90° angle under the proper conditions. Its bark, especially the inner layers, is tough and fibrous, and, at the right season, it can be pulled off the tree in long strips. The roots and branches are also very tough, yet flexible, and can be readily split into long segments. These qualities, combined with the tree's abundance on the Pacific coast of North America, make it a tree of high cultural significance throughout its range.

Red-cedar wood is valued by First Peoples everywhere along the coast for its extremely important and varied use in technology, e.g., it is a prized wood for making dugout canoes (Fig. 1). Perhaps because of its immense role in material technology, western red-cedar is known as a sacred tree. It is considered a gift from the Creator to the people and has ceremonial importance in the winter dances and potlatches of the Kwakwaka'wakw and other coastal peoples. It is treated with special respect through rituals and harvesting practices. It also features in origin stories, such as that of Daisy Sewid-Smith's Kwakwaka'wakw ancestor c'eqamey', who, according to Daisy's family narrative, survived the Great Flood thousands of years ago with his family, sealed within a colossal cedar tree (Sewid-Smith et al. 1998).

Given its important roles to the people of the Pacific Northwest Coast, it is not surprising that their vocabulary contains many words related to red-cedar (cf. Compton 1993; Turner, *in press*). Traditional use of cedar has changed over roughly the past hundred years. Its prominence in Northwest Coast culture is still very high, but many of its uses have notably diminished. Coupled with an escalating demand for western red-cedar as a timber species, the quantity of

cedar available to First Peoples is only a fraction of its former amount. Alienation from their former landbase because of factors such as tree farm licenses and the creation of parks and protected areas has further reduced the availability and accessibility of cedar. In response to limitations on their access to this highly valued resource, some Nations, like the Gitga'at and Haida, are currently developing their own strategies to manage and protect the cedar remaining within their traditional territories. In ongoing treaty and land rights negotiations between First Nations and federal and provincial governments, the availability of cedar features prominently (Heiltsuk First Nation and Greenpeace 2003). Thus, despite all the changes in peoples' life ways, the culture is still resilient enough to retain its focus on western red-cedar.

Fig. 1. Western red-cedar (*Thuja plicata*) from Gitga'at territory, showing where a cedarbark sheet was removed many years ago.

Edible red laver seaweed (*Porphyra abbottiae*)

Another species that meets our criteria for a cultural keystone species is the marine red alga *Porphyra abbottiae* of the Northwest Coast (see Table 1). These algae are relatively abundant primary producers and an important component of the food web in coastal ecosystems. A highly nutritious food, *P. abbottiae* is still gathered in quantity today by the Coast Tsimshian, Haida, Heiltsuk, Kwakwaka'wakw, and other coastal peoples (Boas 1921, Turner 1995, 2003). The harvesting and preparation of this seaweed is exacting and time-intensive. It necessitates a wide range of knowledge and skills, including an understanding of weather patterns, tides and currents; an appreciation of the growth and usable life stages of the seaweed; and a knowledge of the optimum drying locations and techniques and of the procedures for secondary moistening, chopping, and drying to achieve the best flavors and greatest nutritional value. *P. abbottiae* is generally harvested in May, and

many coastal dialects name that "month" after this important resource. Phenological cues given by the stinging nettles (*Urtica dioica*) at the seaweed camp indicate the harvesting time of seaweed. Gitga'at elder Helen Clifton gauges the growth rate of the seaweed and predicts its readiness by watching the stalks of the stinging nettle mature and elongate; as they grow, so do the seaweed fronds.

Helen Clifton has described specific management techniques for this seaweed and believes it benefits from harvesting (Helen Clifton, *personal communication*). Though formerly a women's activity, both genders now participate in seaweed gathering. The postharvest preparation and handling of the seaweed (Fig. 2) is fairly labor-intensive and detailed. Once processed, seaweed is considered "an expensive and prestigious food" (Norton 1981:438) and is valued as a gift or trade item that is often exchanged for equally valuable products from other groups.

Fig. 2. Colleen Robinson, Gitga'at elder of Hartley Bay, sprays salt water on her edible seaweed before pressing it into a cedar-wood box to "get its flavor." After three days, it will be taken out, chopped, and redried.

As well as its various food and trade uses, *P. abbottiae* is valued for its medicinal properties (Turner 2003) and is featured in a number of stories, including one that specifically refers to the origins of its use as medicine (Davis et al. 1995). There are a several temporal and habitat taboos (Colding and Folke 2001)

associated with seaweed picking. The Gitga'at never pick seaweed in rainy weather; it is too dangerous, and the seaweed does not taste good (a temporal taboo). Also, the seaweed is picked only from the rocks above the level of the tide, never while it is floating in the water (a habitat taboo). Another temporal taboo is that, during the time of the seaweed harvest, the Gitga'at never harvest giant mussels (*Mytilus californianus*) or cedar bark for basketry, or it will rain (Port Simpson Curriculum Committee 1983; Helen Clifton, *personal communication*).

Fig. 3. Camas bulbs (*Camassia quamash*) on left and wapato tubers (*Sagittaria latifolia*) on right, prepared for a pit cook.

Today, as in the past, the seaweed is an important component of peoples' diets and traditional life ways. Seaweed harvesting and processing bring families and communities together, thus providing opportunities for learning and teaching stories, songs, survival knowledge, and language. However, elders and others agree that people are not harvesting as much seaweed as they did in the past, and they worry that, without a knowledge of such traditions as seaweed gathering, the youth will be less healthy and more at risk of accidents resulting from environmental hazards. Additionally, elders have noted the excessive rain during the month of May over the past few years, which has made it hard to harvest and process the seaweed.

Wapato (*Sagittaria* spp.)

The last two examples depicted species that are still an available and important cultural resource even though their traditional use patterns are changing. However, there are many situations in which species have been extirpated or the habitat has been severely modified. In situations such as these, cultural keystone species may be needed for restoration, not conservation. For example, the introduction of the potato (*Solanum tuberosum*) by settlers into the Fraser River Valley of British Columbia tremendously modified the harvesting, use, management, and trading of the tubers of a staple traditional root vegetable, wapato (*Sagittaria latifolia*), also known as Indian swamp potato, by the Katzie and other Sto:lo peoples of British Columbia (see Table 1). Wapato was formerly among the four most important underground starch sources of the Coast Salish. The Northern Straits tribes relied on camas (*Camassia* spp.), the Musqueam used bracken fern (*Pteridium aquilinum*), the Nooksack depended on wild carrots (*Perideridia gairdneri*), and the Katzie intensively harvested wapato (Suttles 1990, Garibaldi 2003). The removal of this last species through wetland alteration and the replacement of this

starch source significantly altered the Katzie life-style. Coupled with the changes in other traditionally used species such as bog cranberry (*Vaccinium oxycoccus*), ducks, and geese, a keystone guild for the Katzie was eliminated.

The subsequent alteration of the wetlands of the Fraser River Valley for European-style agriculture solidified this shift in the primary carbohydrate source for the Katzie. Changes took place on two basic levels. On a cultural level, wapato patches were formerly maintained by certain families and were an important trade item. With the introduction of the table potato, whose tubers took on a similar dietary function, many families lost their community structure. This was coupled with many other concurrent changes to life-styles, local economies, belief systems, education, and material culture.

There were also profound changes to the local environment when the Fraser Valley wetlands were converted to agricultural fields. Some loss of the use of wapato was by choice, in that the Katzie chose to use the table potato in preference to wapato. However, at the same time, traditionally used wetlands were being altered by filling, draining, and development, leaving little opportunity to cultivate wapato or to use the other wetland resources. This environmental change was not intentionally directed toward wapato, but had the effect of reducing and, in some cases, virtually eliminating wapato growth, which futher limited the use of this cultural resource. By identifying wapato as a keystone species for the Katzie, we acknowledge the significant cultural role this plant has had, and this recognition may subsequently help in cultural and ecological wetland restoration. We may begin to study the autecology of this plant and the roles it plays in ecosystem functions and processes as well as in maintaining cultural identity and integrity. Done in conjunction with local First Nations communities, this process has long-term impacts for the true restoration of the species, its habitat, and the peoples who live there (see Garibaldi 2003).

IMPLICATIONS OF CULTURAL KEYSTONE SPECIES FOR ECOLOGICAL CONSERVATION AND RESTORATION

We need to restore not only landscapes but also the diversity-enhancing capabilities of the human communities inhabiting those landscapes. “To truly restore these landscapes, we must also begin to re-story them, to make them the lessons of our legends, festivals, and seasonal rites ...” (Nabhan 1991:3).

Researchers have paid increasing attention to the role of humans in landscape restoration (Geist and Galatowitsch 1999, Gobster and Hull 1999, Higgs 2003) and have sought to develop methodologies that incorporate these relationships into restoration efforts (see Nabhan 1991, Naveh 1998). Additionally, as the profound influence of aboriginal people on the landscapes of North America is recognized, the role of the human component in ecosystems becomes increasingly significant in ecological conservation efforts (see Lubchenco 1998, Colding and Folke 2001). We have identified four major contributions of the cultural keystone model to conservation and restoration.

First, the concept of the cultural keystone species provides an opportunity to begin to reinforce and study the relationship of local communities to place. Despite a rising awareness of culture in these efforts, available methods and approaches that actively address both ecological and cultural concerns are still sparse. This concept targets a finite number of species and is therefore more manageable both financially and logistically. Starting small and directing attention to a limited number of species will favor success (Johannes 1998). The identification and appreciation of the complex relationships of cultural keystones to each other and to their habitat may be their most valuable contribution to conservation and restoration efforts. Although ecologically influential species must also be conserved, it is the dynamic association between cultures and the organisms they rely on most heavily that may see the most immediate reward of conservation or preservation efforts.

Second, the identification and analysis of cultural keystone species, both those that have experienced decline and those that have not, may provide a starting point for further analysis of environmental change and community resilience in the face of such change. For example, the former abundance of wapato in many areas along Shuswap Lake in interior British Columbia is apparently known today solely because of one Secwepemc (Shuswap) elder, Mary Thomas, who remembers harvesting it as a child (Garibaldi 2003). Her memories of its habitat and its management made herbivory studies and reintroduction successful (Garibaldi 2003). Through the participation of many

aboriginal peoples, a more complete reference system may be identified for both restoration and conservation efforts.

Third, a better understanding of the interactions between keystone species and other species may be gained. Cultural keystone species play more than one role, and often this role is supported and enabled by other nonkeystone species. This relationship is paramount to understanding the role of cultural keystone species in restoration, because often the restoration of an entire system's structure and function is the ultimate goal.

Finally, the communities who consider these plants to be keystones have the most obvious reason for wanting to see their sustainable return. They may also have the most direct influence on those species and their habitats. Therefore, a partnership between researchers and community members may be the most successful way to achieve conservation or restoration goals.

If we begin our conservation and restoration efforts by focusing on cultural keystone species, both social and ecological integrity may be enhanced. Once local people begin to reconnect to their landscape through the conduit of species that have high importance to them, they will play a much more active role in ecosystem conservation and restoration, including the conservation of ecological keystone species. We anticipate that linking conservation and restoration to cultural concerns will result in an upward spiral of increasing effectiveness in maintaining and restoring both human and ecosystem health.

CONCLUSION

Indigenous and local people occupying a particular landbase and depending upon it for survival almost invariably identify with a relatively limited complex of species that they consider exceptionally important to their daily lives. The concept of cultural keystone species provides us with a focus for considering the impacts of economic and environmental change on a particular group of people and their life ways, just as the concept of ecological keystones has provided a lens through which conservation biologists can identify important elements that influence the dynamic processes and balances within an ecosystem.

As described above, a cultural keystone species such as red laver seaweed or wapato, once identified, can serve as a starting point from which to assess the effects of environmental disturbance or stress on a culture and whether it is able to withstand change without losing its identity. A group's responses to such stress are often readily reflected in their use of and focus on the species around them that are the most meaningful. If they are able to continue to use and relate to their most prominent and culturally significant species, they will be better equipped to retain their cultural identity. Conversely, losing access to such species, or moving away from the knowledge about them, can foreshadow or symbolize a more drastic loss of language and culture.

Conservation initiatives whose intention is to account for the social and cultural considerations of ecosystem use may benefit especially from identifying and focusing on cultural keystone species. The detailed traditional ecological knowledge surrounding such species can bring to ecologists and conservation biologists a better appreciation of and respect for traditional knowledge systems in general, and can serve as a window through which such understandings are realized.

In short, recognizing a socially oriented concept such as cultural keystone species that aligns itself with a concept already in common usage in ecological discourse allows more effective communication among all those with interests in “biocultural” conservation and restoration. Furthermore, it contributes to the development of a more holistic perspective of ecosystems and provides us with one more avenue through which to emphasize the importance of species and habitats to particular peoples and to all humanity.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol9/iss3/art1/responses/index.html

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APPENDIX 1. CULTURAL KEYSTONE SPECIES

Definition

Cultural keystone species are culturally salient species that shape in a major way the cultural identity of a people. Their importance is reflected in the fundamental roles these species play in diet, materials, medicine, and/or spiritual practices.

Main traits

Like ecological keystone species, cultural keystone species are dependent on context, i.e., the same species does not have the same value to all indigenous groups in all areas. Changes in diversity or species composition may push another species toward a keystone role, e.g., the potato replaced wapato (*Sagittaria* spp.) for the Secwepemc of Salmon Arm, British Columbia. Therefore, cultural keystone species are fluid and may change based on community needs or the availability of species. The cultural value of a cultural keystone depends on the community's ability to use it for food, material, or technology or in narratives or spiritual practices. Cultural keystone species are expressed along temporal, spatial, and social axes, varying from one culture to another and from one region to another. Some may play key social roles within a restricted time, space, or social context, whereas others may be more widely recognized for a longer period and in a broader social context. Cultural keystone species frequently interact with each other, forming a cultural grouping similar to a keystone guild (Power et al. 1996).

Indicators

Based on their complex, qualitative nature, cultural keystone species may best be identified using a quantitative index of the following five elements of indicators of cultural influence:

1. intensity, type, and multiplicity of use;
2. naming and terminology in a language, including use as a seasonal or phenological indicator;
3. role in narratives, ceremonies, or symbolism;
4. persistence and memory of use in relationship to cultural change; and
5. extent to which its role can be replaced or substituted.

Usefulness

Cultural keystone species may often be grouped into keystone guilds that reflect the collective impact of several species used together at one time of the year or in one location, e.g., wapato, water parsnip, coot eggs, and cattail among the Secwepemc. These species may help to highlight land use patterns, traditional ecological knowledge, and cultural values. They provide valuable information on the ecological characteristics of an area with considerable historical accuracy that has been passed down from generation to generation.

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