Biodiversity, traditional management systems, and cultural landscapes: examples from the boreal forest of Canada

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Introduction

Many discussions implicitly or explicitly assume that biodiversity conservation is possible only within protected areas. Yet most of the world's biodiversity is in areas used by people. Hence, to conserve biodiversity, we need to understand how human cultures interact with landscapes and shape them into cultural landscapes. In fact, to a large extent, the world's biodiversity depends on maintaining patterns of resource use that facilitate the continued renewal of ecosystems. Many traditional systems of forest use do this, showing subtle understandings of how forest ecosystems work. The study of cultural landscapes and indigenous use of non-timber forest products (NTFPs) provides an arena in which discussions of biodiversity, traditional management systems and cultural landscapes can be brought together.

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The use of many NTFPs is linked to the ecological processes of disturbance and succession. Various species of trees and shrubs are distributed in space and time relative to disturbance. For example, in the lands of the Anishnaabe (Ojibwa) people of Shoal Lake, north-western Ontario, fireweed (*Epilobium angustifolium* L.) occurs in the early years following a disturbance, ginseng (*Panax quinquefolius* L.) is found under mature forest canopies, while highbush cranberry (*Viburnum trilobum* L.) often occurs along riverbanks disturbed periodically by spring flooding. Fireweed and ginseng are utilised as medicinal plants while highbush cranberry is an edible berry (Davidson-Hunt and Berkes 2001). However, the dominant use of the forest in this geographic area has been large-scale timber production, a use that has made little allowance for these ecological processes that produce NTFPs.

Can forests be managed sustainably – in a way that permits these processes to continue, while at the same time providing for timber production and other services? Over the last few decades there has been a shift in the idea of how forests should be managed (Worster 1977). Instead of merely as a source of timber, forests are increasingly viewed as providing a range of values and benefits. This shift is in part related to understanding traditional practices (Dove 2002) and how human activities can be made consistent with biodiversity and landscape conservation (Berkes 2004; Ghimire and Pimbert 1997). The acceptance of the idea that forest ecosystems provide a range of ecosystem goods and services is related to such recent interdisciplinary, international efforts as the Millennium Ecosystem Assessment (MA 2005), UNDP's Equator Initiative programme (UNDP 2006), and *World resources 2005* (UNDP/UNEP/World Bank/WRI 2005). These efforts aim for

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the integration of ecosystem management with human well-being, and recognise that the long-term health of forest ecosystems and livelihood needs are complementary, rather than opposing, goals.

In exploring the relationship between biodiversity conservation and cultural practices of land use in forest ecosystems, our objectives are to examine the significance of traditional knowledge and management systems and their implications for biodiversity conservation (Posey and Balee 1989; Ramakrishnan *et al*. 1998). We start with a section to provide a context on indigenous systems of forest use. Then we turn to the detailed example of the indigenous use of boreal forest ecosystems of northern Canada, discussing traditional practices and cultural landscapes that provide temporal and spatial biodiversity, and examining the mechanisms by which biodiversity can be conserved. We conclude by discussing broader definitions of conservation and integrated objectives for sustainable management that can accommodate the livelihood needs of local people while protecting biodiversity.

Succession management in traditional systems: use of fire

A diversity of traditional practices exists that resemble contemporary scientific practices for ecosystem-based management. They include succession management, landscape patchiness management, resource rotation, and multiple species management (Berkes *et al*. 2000). Among these, succession management is a particularly common practice, often used in combination with the other practices. Table 1 provides a sample of traditional ecosystem-based management systems that use fire as a way to clear land and initiate ecological cycles that provide food and other materials. This practice is best known from systems of shifting cultivation (swidden or slash-and-burn) from the humid tropics. But tropical agriculturalists are not alone in practising succession management by the use of fire.

Conventional wisdom used to hold that hunter–gatherers did not practise habitat management. Lewis's seminal work and cross-cultural comparative studies showed that many different groups in diverse geographic areas of the world practised fire management. There were remarkable similarities in the functional strategies used by these groups in such diverse areas as the Pacific northwest of the USA, northern Alberta in the west-central boreal zone of Canada, and in Tasmania and the various parts of Australia (Lewis and Ferguson 1988).

Table 1 is restricted to examples from the Americas. They range from a classical study of Amazonian shifting cultivation (Denevan *et al*. 1984) and the *kumerachi* system of the temperate forests of northern Mexican highlands (Davidson-Hunt 2003a), to boreal forest examples. One of these is the Lewis and Ferguson (1988) study of habitat management of northern

Table 1. Examples of the use of fire for succession management in the Americas

Society/area	Description	Reference
Bora, Peru Amazon	Multi-stage, multi-crop tropical shifting cultivation system	Denevan *et al*. 1984
Ralamuli, Northern Mexico	*Kumerachi:* oak-pine forest management for corn and beans cultivated in patches	Davidson-Hunt 2003a
Prairie Region, Canada	Anishnaabe burning of aspen parkland and riverbanks to expand prairie habitat for bison	Davidson-Hunt 2003a
Northern interior British Columbia, Canada	Burning of patches to maintain production of berries, mainly mountain huckleberry and lowbush blueberry	Johnson 1999
Southern coastal British Columbia, Canada	Burning of garry oak savannah landscape to prepare habitat for root crops, mainly camas	Turner 1999
Northern Alberta, Canada	Boreal forest burning to produce yards, corridors, mosaics, and habitat attractive for wildlife	Lewis and Ferguson 1988
Northwest Ontario, Canada	Boreal forest burning for berry production and small-scale cultivation	Davidson-Hunt 2003b

boreal hunters and the other, Davidson-Hunt's (2003b) work on Anishnaabe berry management that will be described in some detail in this article.

Ecologically speaking, what these succession management systems have in common is that they all involve ecological renewal cycles and they all start with a disturbance event. The disturbance could be a natural fire, a pest infestation, or a blowdown following a storm, or it could be a human-made fire or a patch of forest cut and cleared. A typical renewal cycle, also called the adaptive renewal cycle (Gunderson and Holling 2002), starts with an early succession phase of rapidly growing herbaceous plants. Gradually, bushy plants take over, shading out the grasses and other pioneer species. Larger trees gradually take over, leading to a climax phase. In the Denevan *et al.* (1984) example, the Bora people burned a forest patch and planted a succession of crops from annuals and root crops to bananas to tree crops, mimicking natural succession. Some 30 years later, the patch had grown to look similar to the original forest but still yielded useful products for the Bora.

In the classical ecology of the 1930s, it used to be thought that terrestrial vegetation developed in a unidirectional way, toward greater species diversity, until it reached a balanced stage referred to as climax. This notion has been largely criticised and abandoned because it is known that climax is often not an end point but a stage (Worster 1977). The "balance of nature" idea has been replaced by multi-equilibrium thinking (Scoones 1999). The adaptive renewal cycle does not stop at the climax phase but proceeds through a disturbance event, such as the use of fire in a patch of mature forest which serves to restart the cycle. In boreal forest ecosystems, as in some other forest ecosystems, a disturbance event is needed to release the nutrients and start the cycle over again. Frequent small disturbance events actually help with ecosystem functioning (Berkes *et al.* 2000). Conversely, the prevention of small disturbances makes a forest ecosystem increasingly vulnerable to large and potentially disastrous disturbances. The classical example is the Yellowstone National Park in the USA – a century of fire prevention eventually resulted in a giant fire in 1988 that burned down about half the park.

In resilient ecological systems, small disturbances precipitate the release phase that helps system renewal by leading to a reorganisation phase in which the memory of the system enables ecological cycles to start over (Gunderson and Holling 2002). The memory can consist of pine cones in a boreal forest, for example, anything that helps the forest ecosystem to perpetuate itself; it could also include the social memory of traditional practices such as those of the Bora or the Anishnaabe that help renew forest ecosystems.

Canada's boreal forest ecosystem and people

The boreal forest dominates large parts of North America and Eurasia. Canada's boreal region covers some 6 million square km, or 58 per cent of Canada's land mass. It forms a broad green belt across the centre of the country from Newfoundland to the Yukon, bounded by the tundra to the north and temperate forests and prairies to the south. By some calculations, the boreal forest contains some 90 per cent of the country's remaining large intact forests. Wetlands and an estimated 1.5 million lakes cover some 30 per cent of the boreal zone. It receives year-round precipitation and contains some of the country's largest river systems.

Canada's boreal region is home to more than four million people, including many First Nations communities. Indigenous peoples of the boreal forest include the Cree, and the Anishnaabe (Ojibwa), both of whom speak languages belonging to the Algonquian family, and the Dene (Athapascan) who include groups such as the Gwich'in. The boreal forest, with its wetlands, lakes and rivers, is a source of livelihood for these groups. Boreal indigenous people have developed lifestyles and local economies that are based on hunting, fishing and gathering, with small-scale agriculture practised only in limited areas.

The forest is a source of big game such as moose and small game such as snowshoe hares. Wetlands produce ducks and geese, and lakes and rivers produce fish. Indigenous traditional economies used timber mainly for construction, firewood, and to make wood implements such as

sledges, snowshoes, and ice shovels. Berries and medicinal plants were the main NTFPs used (Andre and Fehr 2001; Marles *et al*. 2000). Other NTFPs included household goods and crafts such as birch bark baskets, other woven containers and mats, and food items such as sugar from maple and other tree sap.

The use of the forest by Canadian indigenous people is probably not as well known internationally, for example, as the practices of the indigenous peoples of the Amazon. There is extensive information on land use and wildlife hunting in the Canadian boreal forest and some on forestry planning (Natcher and Hickey 2002), but the use of plants and NTFPs is relatively less studied. In this article we concentrate mainly on the use of berries as a way of illustrating the relationship of boreal indigenous peoples with the plant resources of their environment.

The discussion is based on the Anishnaabe of Shoal Lake (Iskatewizaagegan No. 39 Independent First Nation), a small community in north-western Ontario straddling the Manitoba border. In the two sections that follow, we first discuss a traditional boreal forest management system of the Shoal Lake Anishnaabe that provides temporal biodiversity. Second, we discuss their notions of spatial biodiversity. We make cross-reference to a second Anishnaabe community, Pikangikum First Nation, also in north-western Ontario, and a Dene group, the Teetl'it Gwich'in of Fort McPherson, the Northwest Territories, who live near the Mackenzie Delta.

A traditional knowledge and management system of the Shoal Lake Anishnaabe

The central portion of the Canadian boreal zone is a fire-driven forest ecosystem. It depends on periodic natural fires to renew itself, and there are a number of fire-dependent species, as one also finds in other fire-dependent forest ecosystems from around the world. In the past, the Shoal Lake Anishnaabe used fires to create disturbances in the forest canopy. This practice was banned in the first half of the twentieth century as wasteful and dangerous. However, the Anishnaabe still use disturbance as a forest management tool, relying on naturally occurring fires (Box 1) and other kinds of disturbances such as clear-cutting that in some cases mimic the ecological effects of fire (Davidson-Hunt 2003b).

The cycle starts with "forest", called *Nopoming* in Anishinaabe (Fig. 1). The elders use the word *Ishkote* to refer to the action of burning. The first year or two following a fire is described as *Ishkwaakite*, "newly burned trees" (the English term in each case is a gloss of the Anishnaabe term). At this stage, following a fire disturbance, herbaceous vegetation is absent or just beginning to emerge. What is present in abundance is standing dead wood suitable for firewood. *Ishkote* is used to refer to both those fires set by people and those that occur naturally. Historically, a fire could be set to clear an area for a planting, for example a garden on islands on Shoal Lake. In this case, *Ishkote* is used to convert *Nopoming* into *Ishkwaakite* and then into *Gitigaan*, meaning planting or gardening. Some of the islands in the region, those with deep, loamy soils and with a mixed hardwood forest cover, are known as *Gitigaan Minis*, "gardening islands".

Once a garden is established by clearing the standing dead wood, it is burned each spring to prepare it for planting. The process of burning and planting eventually leads to an area that was free of roots and easily planted. When it is no longer utilised as a garden, the annual burning would stop but the long-term imprint of the cultural modification could remain for more than 50 years. Figure 2 shows the soil profile for two sites on one of these gardening islands, Potato Island. The control site in the forested area has A and B soil horizons. The site that

Box 1. Anishnaabe elder, Walter Redsky (Shoal Lake, Ontario, 2001) on the relationship of naturally occurring fires and blueberries

I am going to talk about where they used to pick berries. They picked all over. Across the lake in the river there was a big fire. And over there, there is a river, that river is long. Its about three miles in the bush. And here it was burnt black. The fire burnt a long way, almost to the Manitoba boundary where the big border cut is, that is as far as it went. After the fire, that was when the berries came. There were berries all over. There were about three seasons after the fire that is when the berries grew. After that fire they didn't have to go to other places. They could pick all the berries here on Shoal Lake and sell them.

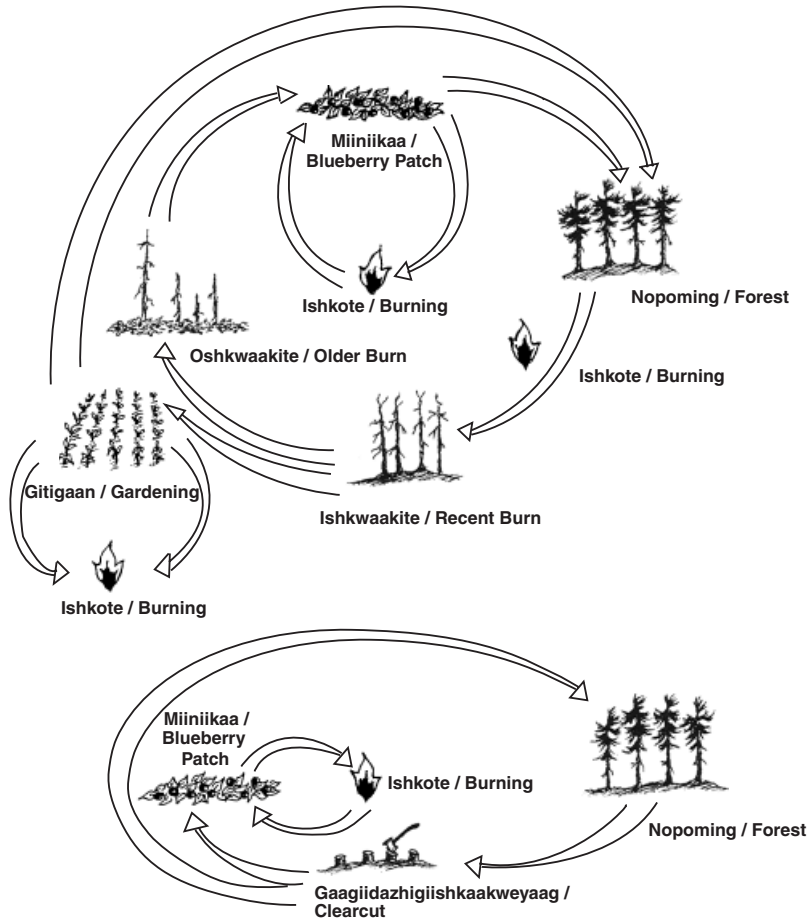

FIGURE 1. An Anishinaabe perception of forest succession following disturbance. The top cycle refers to fire as disturbance. The bottom cycle refers to foresty clearcuts as disturbance.

corresponds to the planted area does not have a B horizon, resulting in a soil profile signature for the site due to the process of working the soil for gardening. There is also a noticeable impact of gardening on the soil chemistry and on the mix of plant species found at the site (Roberts 2005).

When a fire occurred on sandy or rocky sites with little soil, these sites were not used for gardening. In these places, *Ishkwaakite* changed to *Oshkwaakite*, "older burnt trees". The standing dead wood could be harvested for firewood. In such areas, three to five years after the disturbance, a blueberry heath would develop. Several years after the establishment of the blueberry heath, bush honeysuckle (*Diervilla lonicera*) would begin to shade out the blueberry plants. In order to prevent this from occurring, some people burned the blueberry heath every couple of years to renew the blueberry plants and control succession. This led, over time, to a *Miiniikaa*, a "blueberry patch". If the blueberry patch was not burned, then succession would proceed and the patch would revert back to forest.

The elders described a similar cycle for a logging disturbance, also shown in Fig. 1. In this case, the stage that followed logging was described as *Gaagiidazhigiishkaakweyag*, "there the trees were cut down". A blueberry heath would be established following a clear-cut that occurred on sandy soils. However, this appears

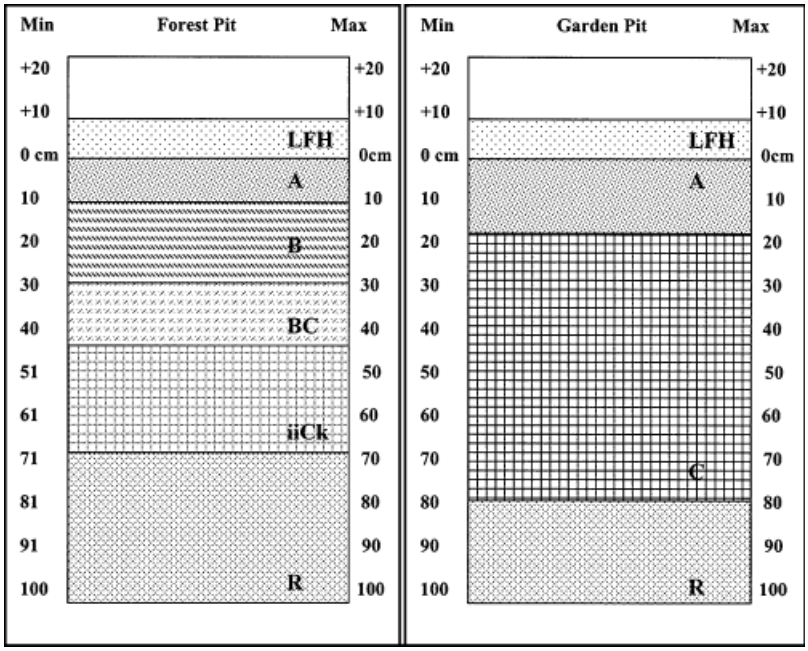

FIGURE 2. A comparison of soil pit profiles from a garden island on Shoal Lake. The forest pit serves as the control, with distinct A and B soil horizons. The garden pit shows a soil profile signature due to the process of working the soil for gardening that perists long after the garden is abandoned. Legend: LFH – Organic horizons; A – Mineral soil layer close to surface; B – Sub-surface mineral soil layer; BC – Soil layer in which horizons B and C are intergraded; C – Parent material soil layer; iiCk – Parent material soil layer with a different deposition event (prefix ii) and presence of carbonates (suffix k); R – Bedrock.

to be dependent on post-harvest site preparation. Some methods of silviculture lead to a full and productive blueberry heath. Others result in a patchy heath with poor production. Elders suggested that the timing of the cycle was similar to that which followed forest fires. A blueberry patch established itself three to five years after a clear-cut and lasted for another three to five years.

We have also documented the use of fire to control vegetation underneath oak trees (probably to help fertilise and protect oak trees); on points and high areas (probably to help visibility for hunting); and to keep campsites free of brush (as elders note, this allows the wind to blow and reduce mosquito nuisance). The diversity of uses of fire documented here has something in common: the Anishnaabe used disturbance in a variety of ways to maintain habitats in early stages of succession. The actual practices in the use of disturbance no doubt varied with the indigenous group and the type of boreal forest ecosystem. Management for berries seems to be common in many parts of the boreal forest. Others have documented additional practices. For example, Lewis and Ferguson (1988) have shown that, in addition to creating and maintaining blueberry patches, fire has been used to maintain grassy areas along rivers and wetlands to provide food in spring for large mammals and other species, to clear trails, and to renew dead patches of forest.

Spatial biodiversity and Shoal Lake Anishnaabe boreal forest knowledge

Many plant species important to the Anishinaabe people occur across a variety of boreal forest habitats. In the four kinds of habitats (called ecosites in the Ontario ecological land classification system) investigated by Ruta

Aurora borealis above the boreal forest of Northern Canada. Hachette/Hoaqui/Marales

(2002), there were plants that were named and utilised by the Anishinaabe. Some of these species were specialists and occupied only a narrow range of habitats. Others were generalists found in most of the habitats. While the generalists were widely distributed, they were often found in greater abundance in a narrower range of habitats (Ruta 2002).

After documenting the distribution and abundance of important plant species within four habitat types, a workshop was held with Shoal Lake Anishnaabe elders to discuss whether these findings could suggest that some habitats were more important than others. Could the diversity of habitat types at a landscape scale be shifted in a direction that would maximise habitats that generate local values? The context of this question was the ongoing discussions on the forest management policy of the Province of Ontario. There has been the suggestion that productive forest lands should be intensively managed as plantations for a single value (timber), while conserving other lands as protected areas. Such a shift in forest management practice would change the abundance of different types of habitats at the landscape scale, as well as their distribution across the landscape. This was the issue we posed to the elders in the jointly organised university–First Nations workshops.

To approach the larger question, the elders were asked whether some plants were more important than others, with the related understanding that this may indicate that some habitats are more important than others to keep in the landscape at higher abundance. This question generated a rich discussion regarding the relationship between forest management and biodiversity, and led to an articulation of the principles that the elders began to formulate. The basic principle from Shoal Lake Anishnaabe elders is that some plants are not more important than others, and there should not be an effort to protect some species and not other species. Rather, what is important is the protection of the full suite of plant species. Habitats at the landscape scale, as well as plants at the scale of sites, should be maintained through forest management practices. Of course, the elders do

Box 2. A narrative by Ella Dawn Green (Shoal Lake, Ontario, 2002) on why all plants are important and how medicinal knowledge comes to the Anishnaabe

And there are people too that come to you. Sometimes you are sick, they see you are not feeling well, and then they pass that medicine on, they give you that medicine, or they tell you about these plants to go and pick. And that's yours now because it was given to you by that person who felt sorry for you . . . so you can get healed from medicine. So I keep that too, I take it because it was already passed on by another elder. And that's how I remember all these things and I keep them and I use them when people come to me. And I do the same thing, especially for young people, when they come to me for healing or anything like that, then I pass that thing on to them, I give it to them. I tell them and I show them what to do. I take them out in the bush and show them where that plant is because I won't be taking that with me. I like to leave it with the young people. That's what I do. I think that's how the teaching of our elders, a long time ago, that's how they did these things. It was passed on, passed on, generation to generation; whoever keeps it will take care of it and learn more about it. You never stop learning . . . right to the end. So, who are we to say what plants we need and those we don't. All of them should be kept for young people so they can go on learning.

And then some of them I received through dreams. Like, I would dream about something, you know. Especially an old lady or an old man would be in my dreams telling me all kinds of things. But after talking to me, like you know, it would be a bird or a four-legged, you know those animals that run around and around, that's how they turn when they leave. Dreams, visions . . . visions would be like seeing a bear coming to me and telling me what the purpose of a plant is, you know, giving me that medicine.. . . That is how I learned to make medicines for anyone. Another thing I learned, when they have shaking tents, the people in there, the spirits, when they give you medicine, and you are supposed to keep that medicine, it is for you, eh, for you to heal. I keep that too because it has already been given to me through shaking tents. That's how I received all these things that I carry, that I carry on, from my aunties, my mom and dad, through dreams and through shaking tents. You asked me whether some bush is more important for plants we use than others. But you see, the Creator put everything on the earth for a reason, even if we don't know that reason. How can we decide which bush should stay and which should go? You need to understand how we learn about plants. The way I started learning plants is my aunties, they used to take me out in the bush to show me what kind of plants there are and what kind of plants that we can use for medicine. My mom too, she used to take me out on the lake along the shoreline, and she used to tell me all kinds of plant which I can't remember, and she showed me where to find them. And that was passed on and a lot of these medicines that they showed me and how they are used, they used to tell me that I would be carrying on to the next generation. And it was so important to them for me to learn all this and to keep in mind which plants I am supposed to pick, and there are some poisonous plants that I can't touch.

not express themselves using the terms biodiversity, habitat, and site. Box 2 provides a narrative from the Shoal Lake elder, Ella Dawn Green, talking about why it is important to retain biodiversity, in the context of medicinal plants. Since one receives knowledge through many different pathways, one does not always know what a given plant may be useful for. The narrative captures an example of elders' voices speaking about what we would call biodiversity.

As we further probed the idea of maintaining the full suite of species during a series of workshops, we came to the following understanding. In the Anishinaabe perspective, the Creator placed the people in Iskatewizaagegan (Shoal Lake) and provided everything that they would need for their survival in that place. In return, the Anishinaabe hold the responsibility to maintain these gifts. Practices that harm these gifts can lead to consequences for an individual or the individual's family. At the landscape scale, there is a basic duty upon the Anishinaabe not to influence abundance or distribution of habitats. In a workshop with elders in Pikangikum, the same principle emerged and was concisely translated into English as, "as was, as is".

The creation of blueberry patches through repeated burning was not seen as a contradiction of this principle. Burning or other disturbance simply reveals the different combinations of plants that are naturally present in the landscape. The idea is related to the statement in Box 2. "As was, as is" means that all that was on the land before should still be there today and also tomorrow. While a fire may destroy a forest, it also follows a known pattern in that blueberries follow fire on sandy soils; it takes a few years before they can be picked, they can then be picked for a few years, then other plants follow the blueberries, and then again you have forest. The cycle can be modified by humans but should not be disrupted, so that when the burning ceases, the forest comes back.

At the site-specific scale, there is another argument for maintaining the full suite of biodiversity. There exists a general body of knowledge about plants that can be referred to as survival knowledge and is widely distributed through the Anishinaabe population. However, there is another body of knowledge – in this case, specialised knowledge – that is accessed during the healing process. A healer may receive

a vision during a dream in which a plant, or other being, offers itself for the healing process. A healer does not know ahead of time what that plant might be; it might even be a plant that the healer has never used before. One must hold an attitude of humility for the mysteries of nature, as one never knows the real value of a plant ahead of time. Given that the Creator provided everything that the Anishinaabe need to survive, there must be a reason for the existence of every plant, animal, and other being (Davidson-Hunt *et al*. 2005).

The Shoal Lake Anishnaabe principle of maintaining the full suite of biodiversity is similar to scientific views on multifunctional landscape management, but it is from a different angle. Rather than tying biodiversity to the known functional properties of a habitat or species, the Anishinaabe principle considers that every habitat and species has a reason to be there, known or unknown, and for that reason the full suite of plant species should be maintained into the future.

Conserving biodiversity in cultural landscapes

Anishinaabe principles and practices contradict much of current forest management strategies. Anishinaabe people seem to manage diversity at both the site scale and the landscape scale, to obtain multiple values at both. By contrast, much of current scientific management aims to obtain a single dominant value from a given landscape. For example, protected areas are managed to maximise conservation, while forest lands are managed to maximise timber production. Neither appears to be doing a particularly good job of conserving biodiversity.

In both cases, there is a tendency to "freeze", or fix the ecosystem in a particular configuration to manage for the dominant value (Holling and Meffe 1996). In the Anishnaabe system, the land reveals itself in its multiple manifestations, and the Anishnaabe people are part of the natural order of the land. This is a recurring notion in many indigenous groups (Berkes *et al*. 1998). A disturbance is created or welcomed as the necessary force to drive renewal cycles and give rise to both spatial and temporal diversity. That is, the landscape is allowed to be dynamic so that it generates values ("Creator's gifts"), rather than trying to control the ecosystem to generate a particular commodity, such as industrial wood.

This idea of the forest providing gifts is pervasive among the indigenous peoples of the boreal forest. For example, the Gwich'in say "the Creator made this land for us"; and resources such as berries are sacred gifts that are part of the spiritual connection of the Gwich'in to their land (Parlee *et al*. 2005). This is not to say they do not harvest resources or change the land in any way. The Creator allows them to harvest the land if they follow the correct rules of respect (Preston 2002). This also goes for maintaining trails and cutting back invasive species such as willows to "take care of the land" to increase berry production, as practised by the Gwich'in (Parlee *et al*. 2005); the use of fire for landscape management by a number of Dene groups (Lewis and Ferguson 1988), and a range of plant management techniques used by the indigenous groups of the Pacific coast of North America (Deur and Turner 2005; Turner 1999).

The Anishnaabe landscape is multifunctional; it produces all that is needed by the people, as long as biodiversity is maintained throughout the landscape. This does not mean that Anishinaabe people do not undertake practices that change the landscape. However, it does mean that such practices are in line with natural processes (such as succession) and help maintain spatial and temporal diversity at both the landscape and the site level. How do Anishnaabe and other indigenous principles of diversity protection get translated into practice? Are there specific mechanisms by which biodiversity is conserved and created in these multifunctional, dynamic, cultural landscapes? There seem to be at least three possible mechanisms in the case of Anishnaabe fire and other kinds of disturbance management.

The first is conserving and enhancing biodiversity by the maintenance of all successional stages. Each stage in succession represents a unique community of plants, animals, and human uses. A land use regime that maintains forest patches at different successional stages therefore helps maintain biodiversity. At the same time, such a pattern of land use contributes to the continued renewal of ecosystems by conserving the system memory for renewal and reorganisation (Berkes and Folke 2002).

The second is the creation of patches, gaps and mosaics. These are well known in landscape ecology as ways in which biodiversity may be enhanced in a given area. Another way of stating this is that low and intermediate levels of disturbance often increase biodiversity as compared to non-disturbed areas. Not only boreal NTFP harvesters but also boreal hunters know this mechanism well and use it effectively, for example, through the creation of meadows and yards (e.g. moose yards) by the use of fire (Lewis and Ferguson 1988).

The third is the creation of edges (ecotones). Edges exist in nature but new edges can also be created by disturbance. Boundaries between ecological zones are characterised by high diversity, both ecologically and culturally (Turner *et al*. 2003). Overlaps, mixing and diversity of plant and animal species and human cultures make for dynamic landscapes (Boyd 1999).

A fourth mechanism, not observed in Anishnaabe cultural landscapes but found elsewhere (Boyd 1999), is the conservation and enhancement of vertical diversity. Resource use can help create structural complexity with layers of tree, shrub and ground vegetation. For example, some of the indigenous-inspired alternatives to clear-cutting being practised in British Columbia involve the maintenance of species and age diversity of forest as well as its architecture (Pinkerton 1998).

In summary, the practice of Anishnaabe site-specific burning, in combination with landscape-scale natural fires, would increase the temporal diversity of the boreal forest. The combined outcome is a landscape that is diverse spatially, and within that spatial diversity there are habitats at different temporal stages that increase the overall landscape biodiversity. It is possible that this pattern may help fireproof the landscape. The large patches of young vegetation from natural fires, as well as the ribbons of green along the rivers and patches of green scattered throughout, would provide firebreaks. Frequent small fires would reduce the fuel load on the forest floor, an example of small disturbances staving off a Yellowstone National Park kind of catastrophic disturbance (Lewis and Ferguson 1988). More generally, in ecosystems in which the natural rate of decomposition is slow (as in the boreal forest), fires would speed up nutrient cycling, help increase biological productivity, and maintain ecosystem resilience by lubricating adaptive renewal cycles.

Conclusions: towards integrated objectives of biodiversity conservation and livelihoods

Human activities modify ecosystems. ''Pristine areas'' are not as pristine as the purists think, and ''wilderness'' is largely a myth, even in apparently untouched tropical forests (Gómez-Pompa and Kaus 1992). In many areas, human activities have caused the degradation of ecosystems and loss of biodiversity. But this is not necessarily the case everywhere. Even in heavily populated biodiversity hot spots such as the Western Ghats, India, researchers have found high levels of biodiversity, comparable to protected areas, in sacred groves and in multispecies plantations (Bhagwat *et al*. 2005). As these authors observe, sacred groves maintained by tradition, and the multifunctional cultural landscapes produced by centuries-old systems of agroforestry, can be as important as formal protected areas in conservation strategies. As the Anishnaabe example shows, there are habitats that emerge from the activities of people on the land.

Local people have incentives to conserve biodiversity when their livelihoods depend on a multitude of products and values produced by biodiversity. This is the case for many rural peoples of the world whose livelihoods depend on NTFPs. It is also the case for the indigenous groups of Canada's boreal forest ecosystems who obtain much of their protein from hunting and who use NTFPs such as medicinal plants and berries. Hence, biodiversity conservation strategies that work in the long term need to take into account those who use the products of the ecosystem in which they live and who are active agents in producing cultural landscapes.

Recent approaches such as the Millennium Ecosystem Assessment (MA 2005) and *World resources 2005* (UNDP/UNEP/World Bank/WRI 2005) promote the integration of ecosystem management with human well-being. They recognise that biodiversity conservation and livelihood needs are, or should be, complementary goals. But these two objectives are not necessarily

congruent in a given situation and rarely coexist as equals.

More common are situations in which one objective or the other dominates (Brown 2002). For example, involving local communities in conservation is often used as a means of making conservation measures less likely to meet local resistance. But the ultimate objective is one of conservation. Conversely, protecting the productivity of a resource may be a means to enhance local livelihoods and development options, but the main objective remains development. Management approaches that explicitly have more than one objective are far less common than those that have only one.

The Millennium Ecosystem Assessment terms this multiple objectives approach, ''integrated responses''. They are those responses that explicitly and purposely state that their objectives address more than one ecosystem service(s) and human well-being simultaneously. Integrated responses may be seen as a way of moving from problem-solving in simple systems to problem-solving in complex adaptive systems (Berkes 2004). As appropriate to that task, integrated responses tend to involve networks and partnerships of various levels of government, the private sector and civil society. In cases such as the management of boreal forest ecosystems, effective integrated responses need to take into account traditional knowledge systems and alternative ways of understanding and interacting with forest ecosystems.

Learning from traditional management systems, such as those of the Anishnaabe, is important for broadening conservation objectives and approaches. The use of local and traditional ecological knowledge is an effective mechanism for the empowerment of indigenous communities for joint decision-making. The lens of cultural landscapes provides a mechanism for understanding how multiple objectives (timber production, NTFPs, protected areas, tourism) are central to sustainable forest management in landscapes that conserve heritage values and support the livelihood needs of local people. Developing a broader, cross-cultural, pluralistic definition of conservation is a major challenge. Our definition of conservation has been western-centric and elitist. Accommodating livelihood needs and recognising local and traditional knowledge built over centuries to deal with cultural landscapes is one way to build more inclusive, robust constituencies for conservation.

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References

Andre, A., and Fehr, A. 2001. *Gwich'in ethnobotany: plants used by the Gwich'in for food, medicine, shelter and tools*. Tsiigehtchic, Northwest Territories: Gwich'in Social and Cultural Institute and Aurora Research Institute.

Berkes, F. 2004. ''Rethinking community-based conservation'', *Conservation Biology*, 18 (3), 621–630.

Berkes, F., and Folke, C. 2002. "Back to the future: ecosystem dynamics and local knowledge", *In*: Gunderson, L. H. and Holling, C. S., eds *Panarchy*. Washington, DC: Island Press, 121–146.

Berkes, F., Colding, J., and Folke, C. 2000. "Rediscovery of traditional ecological knowledge as adaptive management", *Ecological Applications*, 10 (5), 1251–1262.

Berkes, F., Kislalioglu, M., Folke, C., and Gadgil, M. 1998. "Exploring the basic ecological unit: ecosystem-like concepts in traditional societies", *Ecosystems*, 1 (5), 409–415.

Bhagwat, S., Kushalappa, C. P., Williams, P., and Brown, N. 2005. "The role of informal protected areas in maintaining biodiversity in the Western Ghats of India", *Ecology and Society*, 10 (1), 8. [online] URL: http://www.ecologyandsociety.org/vol10/iss1/art8/.

Boyd, R. 1999. "Conclusion", *In*: Boyd, R., ed. *Indians, fire and the land in the Pacific northwest*. Corvallis, OR: Oregon State University Press, pp. 292–297.

Brown, K. 2002. "Innovations for conservation and development", *The Geographical Journal*, 168 (1), 6–17.

Davidson-Hunt, I. J. 2003a. *Journeys, plants and dreams: adaptive learning and social-ecological resilience*. Thesis (PhD) Winnipeg: University of Manitoba.

Davidson-Hunt, I. J. 2003b. "Indigenous lands management, cultural landscapes and Anishinaabe people of Shoal Lake, North-western Ontario, Canada", *Environments*, 31 (1), 21–42.

Davidson-Hunt, I. J., Jack, P., Mandamin, E., and Wapioke, B. 2005. "Iskatewizaagegan (Shoal Lake) plant knowledge: an Anishinaabe (Ojibway) ethnobotany of north-western Ontario", *Journal of Ethnobiology*, 25 (2), 189–227.

Davidson-Hunt, I., and Berkes, F. 2001. "Changing resource management paradigms, traditional ecological knowledge, and non-timber forest products", *In*: Davidson-Hunt, I., Duchesne, L. C., and Zasada, J. C., eds *Forest communities in the third millennium*. St Paul: USDA Forest Service, 78–92.

Denevan, W. M., Treacy, J. M., Alcorn, J. B., Padoch, C., Denslow, J., and Paitan, S. F. 1984. "Indigenous agroforestry in the Peruvian Amazon: Bora Indian management of swidden fallows", *Interciencia*, 9 (6), 346–357.

Deur, D., and Turner, N. J., eds 2005. *"Keeping it living": traditions of plant use and cultivation on the Northwest Coast of North America*. Seattle, WA: University of Washington Press and Vancouver: University of British Columbia Press.

Dove, M. R. 2002. "Hybrid histories and indigenous knowledge among Asian rubber smallholders", *International Social Science Journal*, 173, 349–359.

Ghimire, K. B. and Pimbert, M. P., eds 1997. *Social change and conservation*. London: Earthscan.

Gómez-Pompa, A., and Kaus, A. 1992. "Taming the wilderness myth", *BioScience*, 42 (4), 271–279.

Gunderson, L. H., and Holling, C. S., eds 2002. *Panarchy: understanding transformations in human and natural systems*. Washington, DC: Island Press.

Holling, C. S., and Meffe, G. K. 1996. "Command and control and the pathology of natural resource management", *Conservation Biology*, 10 (2), 328–337.

Johnson, L. M. 1999. "Aboriginal burning for vegetation management in northwest British Columbia", *In*: Boyd, R., ed. *Indians, fire and the land in the Pacific Northwest*. Corvallis, OR: Oregon State University Press, 238–254.

Lewis, H. T., and Ferguson, T. A. 1988. "Yards, corridors and mosaics: how to burn a boreal forest", *Human Ecology*, 16 (1), 57–77.

MA 2005. *Millennium ecosystem assessment synthesis report*. Chicago, IL: Island Press.

Marles, R., Clavelle, C., Monteleone, L., Tays, N., and Burns, D. 2000. *Aboriginal plant use in Canada's northwest boreal forest*. Vancouver: University of British Columbia Press.

Natcher, D., and Hickey, C. 2002. "Putting the community back into community-based resource management: a criteria and indicators approach to sustainability", *Human Organization*, 61 (4), 350–363.

Parlee, B., and Berkes, F. and the Teetl'it Gwich'in Renewable Resources Council 2005. "Health of the land, health of the people: a case study on berry harvesting from northern Canada", *EcoHealth*, 2 (2), 127–137.

Pinkerton, E. 1998. "Integrated management of a temperate montane forest ecosystem through holistic forestry: a British Columbia example", *In*: Berkes, F., and Folke, C., eds *Linking social and ecological systems*. Cambridge: Cambridge University Press, 363–389.

Posey, D. A., and Balee, W. L., eds 1989. *Resource management in Amazonia: indigenous and folk strategies*. New York: New York Botanical Garden.

Preston, R. J. 2002. *Cree narrative: expressing the personal meanings of events*. Revised edn. Montreal and Kingston: McGill-Queen's University Press.

Ramakrishnan, P. S., Saxena, K. G. and Chandrashekara, U. M., eds 1998. *Conserving the sacred for biodiversity management*. New Delhi: Oxford and IBH.

Roberts, W. 2005. "Restoring aboriginal cultural landscapes with Iskatewizaagegan No. 39 Independent First Nation, Shoal Lake, Ontario". Thesis (Master of Natural Resources Management). Winnipeg: University of Manitoba.

Ruta, T. 2002. "Forest patches and non-timber forest products in the boreal forest: a case study from the Shoal Lake watershed, north-western Ontario". Thesis (Master of Natural Resources Management). Winnipeg: University of Manitoba.

Scoones, I. 1999. "New ecology and the social sciences: what prospects for fruitful engagement?", *Annual Review of Anthropology*, 28, 479–507.

Turner, N. J. 1994. "Burning mountain sides for better crops: aboriginal landscape burning in British Columbia", *International Journal of Ecoforestry*, 10, 116–122.

Turner, N. J. 1999. " 'Time to burn'. Traditional use of fire to enhance resource production by aboriginal peoples in British Columbia", *In*: Boyd, R., ed. *Indians, fire and the land in the Pacific Northwest*. Corvallis, OR: Oregon State University Press, 185–218.

Turner, N. J., Davidson-Hunt, I. J., and O'flaherty, M. 2003. "Living on the edge: ecological and cultural edges as sources of diversity for social-ecological resilience", *Human Ecology*, 31 (3), 439–463.

Undp 2006. The Equator initiative [online] URL: http://www.undp.org/equatorinitiative.htm United Nations Development Programme.

Undp/Unep/World Bank/Wri 2005. *World resources 2005. The wealth of the poor: managing ecosystems to fight poverty*. Washington, DC: United Nations Development Programme/United Nations Environment Programme/World Bank/World Resources Institute.

Worster, D. 1977. *Nature's economy: a history of ecological ideas*. Cambridge: Cambridge University Press.