Part III

Social–ecological learning and adaptation

Introduction

Given that some level of uncertainty always exists in complex systems, decision makers need to continuously monitor and integrate appropriate ecological, social, and economic information into management. Such adaptive management, whereby policy making is seen as an iterative experiment, acknowledges uncertainty, rather than assuming it away. Carrying out adaptive management requires a great deal of information to provide feedback to the manager regarding the consequences of the policy experiment. In addition to some of the conventional kinds of ecological and economic data, adaptive management requires qualitative information in the form of feedback from the social–ecological system to indicate the direction in which management should proceed.

Where does the information for adaptive management come from? Some of it comes from conventional science and social science, but some of it can also come from the knowledge held by the resource users themselves. Many local and traditional knowledge systems are characterized by the use of local ecological knowledge to interpret and respond to environmental feedback to guide the direction of resource management. These local management systems have something in common with adaptive management – they emphasize feedback learning and address uncertainty that is intrinsic to all systems. How do we access and use local and traditional knowledge, and what kinds of arrangements are necessary to bring together the full spectrum of knowledge pertinent to a problem?

The three chapters in this section provide insights into these questions. Chapter 8 explores the role of local ecological knowledge in complex systems management, and concludes that a key issue is to share knowledge in the form of 'adaptive co-management.' Chapter 9 explores resource management as problem solving in which the solutions are not technical but require stakeholder

participation in a collaborative effort; adaptive management does not provide a set recipe but a collaborative process for learning-based and negotiated problem solving. The context of Chapter 10 is cross-cultural: co-management is based on mutual learning and, once again, on joint problem solving in a kind of adaptive dance as in Gunderson's Chapter 2.

8

Exploring the role of local ecological knowledge in ecosystem management: three case studies

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8.1 Introduction

Local resource users have come to play an increasingly significant role in the ecosystem approach to resource and environmental management. The way it is being organized, its relationship to the institutionalized, professional science, and its role in catalyzing new ways of managing environmental resources have all become important subjects (Kellert *et al*., 2000; Gadgil *et al*., 2000; Olsson and Folke, 2001). Local ecological knowledge is a central component of such management regimes, and in this chapter we present three case studies in an attempt to explore its role. These case studies deal with three contrasting socio-economic, cultural, and political settings: that of Sweden, a relatively equitable and homogeneous society; of Canada, a society with a gulf between the Euro-Canadians and the indigenous people; and of India, a highly stratified society but with strong traditions of learning and democracy conducive to the development of participation in resource management.

The development of local knowledge in management appears to have been motivated in two distinctive ways. On the one hand, it may attempt to complement the more general knowledge developed by professional science, with site-specific, contextualized knowledge generated by local users through local observations and experiments. On the other hand, local ecological knowledge may be an attempt to challenge those manifestations of professional science that tend to serve relatively narrow, vested interests. The first motivation dominates in the Swedish case study, where different levels of governance collaborate in a relatively smooth fashion and with similar value systems. The second is significant in the divided societies of Canada and India, where the professional scientific establishment does not share the economic interests and cultural values of the subordinate classes of the society. In particular, the knowledge system of the citizens from subordinate classes comes from a stream where empirically

validated knowledge and beliefs commingle and that professional scientists therefore view with great skepticism. As a result, developing a mutually supportive relationship between citizen knowledge and establishment science poses a more difficult challenge in these countries.

Using three case studies from diverse cultures and environments, this chapter explores the quality of that local knowledge and how it is used (if at all) in management practices, and whether such knowledge is recognized by authorities and used in co-management. In particular, we explore the role of local knowledge to deal with change, and how it can improve the knowledge base to respond to change adaptively. We refer to this as adaptive co-management because it combines the adaptive management perspective of Holling (1978) with the idea of co-management or the sharing of management power and responsibility between government and local resource users (e.g., Pinkerton, 1989). In the Swedish case, the issue is lake acidification caused by long-range transport of anthropogenic emissions of sulfur and nitrogen. In the Canadian case, it is oceanographic change related to large-scale hydroelectric development; and in the Indian case, it is the loss of biological diversity in rural areas. The Swedish case focuses on a local fishing association that has the legal right to manage fish and crayfish populations. Here, local ecological knowledge was mobilized to respond to a need for improved management. Consequently, local resource users' institutions for fish and crayfish management and watershed management were formed. The Canadian case is the Hudson Bay Bioregion project, organized by the Inuit community of Sanikiluaq, involving 28 Inuit and Cree communities scattered around the vast region. This project aimed to build an integrated regional-scale knowledge base of environmental change from the point of view of aboriginal people, drawing upon the observations of hunters and fishers. In India, a group of ecologists, science teachers, and students in undergraduate colleges and workers from non-governmental organizations (NGOs) has worked with local communities in 52 clusters of villages distributed in different ecological zones of the country to document people's ecological knowledge, perceptions of ongoing ecological changes, forces driving these changes, and prescriptions for prudent management of environmental resources. The exercise has generated many valuable insights into these issues and in some cases promoted community-based initiatives at good resource management.

8.2 Crayfish management in Lake Racken

Acidification of lakes adversely affects recreational fisheries. Coping with this environmental challenge promotes a whole series of information and ecosystem management initiatives in the Lake Racken watershed in the municipality of

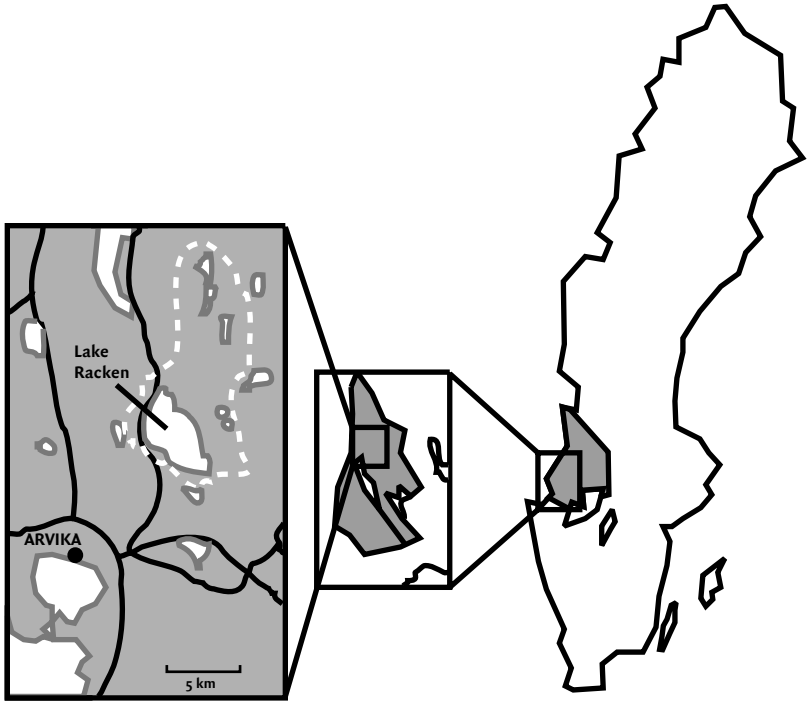

Figure 8.1 To the right, a map of Sweden with Värmland County in gray; in the middle the municipality of Arvika; and to the left Lake Racken, where the watershed is indicated by a dotted line.

Arvika, Värmland County, Western Sweden (Fig. 8.1; see Olsson and Folke, 2001).

In Sweden, governmental resource management agencies have progressively created an arena for the involvement of local people in liming programs to counteract acidification and in the management of fish and crayfish. Local fishing associations commonly play such a role in involving people in many parts of Sweden, managing vast numbers of lakes, rivers, and streams. In the early 1980s, the area for management by local fishing associations was extended from lakes and rivers to include whole watersheds. This extension was founded on a decision at the national level and carried out by the Swedish Land Survey. At this time, fishing associations were only involved in management through communication by developing proposals and requests about management to authorities. Decisions were still taken at the national level of authority. In 1994, fishing associations were provided the right to make decisions concerning fishing and fish conservation. However, some decisions are still taken at the national level, such as a ban on certain fishing methods, and permission is required

for the stocking and transfer of fish and shellfish between different water bodies.

The fishing association currently managing Lake Racken watershed was initiated in the early 1980s by a few individuals with the common goal to address the problem of acidification arising in the tributaries of Lake Racken. This environmental change triggered a joint effort by these individuals of sharing, combining, and developing their individual experience and knowledge. At this time there were no locally coordinated management practices incorporating ecological knowledge about species or ecosystem dynamics. This group, with the goal to counteract the acidification process by liming the lake, later moved toward communal fish and crayfish management in a watershed context and today they manage several different species, including noble crayfish (*Astacus astacus*) and brown trout (*Salmo trutta*). The development of the local fishing association enhanced the potential to deal with a diversity of environmental variability, including situations never before experienced.

The crayfish population of the lake declined drastically within a 20-year period, between the mid-1960s and the late 1980s. During the last decade, the local fishing association has taken various measures to respond to this decline. The crayfish of Lake Racken are not currently a source of income for the local community, but crayfishing is an important and highly regarded social event and the main reason why many are fishing. It is a ritual repeated annually, and the whole event contributes to the enjoyment of consuming the locally caught shellfish, which are considered a delicacy.

8.2.1 Deploying ecological knowledge

Olsson and Folke (2001) studied the ecological knowledge among members of Lake Racken fishing association related to crayfish and crayfish management. Their study revealed that they possess knowledge and understanding about species and their biology as well as knowledge of specific ecological processes and functions and how these affect crayfish. The knowledge ranges from the level of individual crayfish to the watershed and is related to complex dynamic ecosystems and cross-scale interactions.

For example, people are aware of the problems of acidification in the area and its temporal and spatial variation. Some infer that crayfish suffer greater acid shock in the parts of the lake where tributaries join it because of the sudden influx of acidic water following spring snowmelt. There is also knowledge of how acidification affects different species and their freshwater habitat. For example, there is an awareness of how acidification affects water quality, including calcium levels, alkalinity, and metals, and local people are engaged

in measurements of the water quality throughout the watershed. There is also awareness that the strings that attach the eggs to the female crayfish are broken off in more acidic waters. Locals have observed declines in other species sensitive to acidification, such as roach and trout, and increases of species more tolerant of acidic conditions, such as perch. They dissect the stomachs of fish such as perch to identify crayfish predators and also observe predation by other species, which in combination with knowledge about crayfish feeding habits results in a local awareness of interactions between trophic levels.

Knowledge varies among local users, with two people being particularly knowledgeable. These two individuals play a key role in systematic monitoring, including pH, alkalinity, metals, and several indicator species such as insects, mollusks, and fish. One of them is a biology teacher and the other is a technician at the Lake Racken waterworks where drinking water is treated and distributed to the citizens of Arvika. These individuals are key stewards in the sense of systematic monitoring and various management initiatives, but others in the community also play important roles. Some contribute with knowledge and experience concerning organizational and institutional response in relation to social, economic, or ecological change. Individuals might have contacts with key individuals in other similar local organizations or at other organizational levels (e.g., municipalities, county, national) that facilitate co-management and information sharing. Individuals involved in fishing and hunting contribute with knowledge and experience from almost daily observations of the area and provide information such as the kind of species preying on crayfish, fluctuations in the populations of these predators, algae growth, and other changes in the crayfish habitat.

The occasional observations and systematic monitoring at the local level are complemented with information from scientific studies and from surveys of the area carried out by authorities at the municipality and county levels. Specific studies also include those on mercury levels conducted by a high school in Arvika. The two key stewards represent the key link in transferring such information and knowledge to the local decision-making process of the fishing association. Information is communicated to the other members of the fishing association both informally and during formal meetings.

In addition, there is also an exchange of information and knowledge among similar groups. When acidification was discovered in Lake Racken area by one of the stewards, people of a neighboring watershed were consulted to help the Lake Racken community to form a liming group. Fishing associations often share information during formal meetings of the Arvika Fishing Circle, which includes fishing associations within the municipality of Arvika. Sometimes representatives from authorities and companies participate in these meetings.

This implies that there is not only an input to the local communities from outside sources, but also a feedback of practical implementation of ecological knowledge to stakeholders at other institutional and organizational scales. Most fishing associations are members of the Värmland County Fishing Association, which is a branch of the Swedish Association for Owners of Fishing Rights. Decisions about fishing and fish management can only be made at the local level by the fishing associations, and organizations at other levels function as information facilitators, organizers, and lobbyists.

Knowledge about resource and ecosystem dynamics in relation to the crayfish population among local resource users in the Lake Racken area is thus a mix of external knowledge from various governmental and NGOs and from scientific findings and knowledge generated through occasional observation and systematic monitoring at the local level. In the Lake Racken area, scientific and formal information is contextualized and combined with locally generated knowledge. In this sense, scientific and local knowledge intermingle.

8.2.2 Management practices and institutional dynamics

The responsibility for fish and crayfish management has been shared among local fishing associations, municipality, and national government since 1994 (Olsson and Folke, 2001). Thus, management practices for fish and crayfish management observed locally are embedded in institutions at different organizational levels, which constitute a nested set of institutions. Members of the Lake Racken fishing association monitor ecosystem change through a bundle of indicators and respond to nature's dynamics to secure and enhance the productivity of fish and crayfish populations. This is an ongoing process in which local ecological knowledge is used to re-evaluate and reshape management practices and the rules they are embedded in for improved performance.

For example, the local fishing association has tried different management practices to increase the crayfish stock. As a first effort to do something about the low crayfish catches, the association proposed a 3-year closure of fishing. The authority granted the application and there was no fishing between 1990 and 1993. This was just before the devolution of management rights to local fishing associations in 1994. Since then, the local fishing association has changed the size regulation from 9 cm to 10 cm, and has changed the harvesting time from 2 consecutive days in early August to 2 widely separated days at the beginning and end of the month. The reason for having 2 days of crayfishing with a couple of weeks in between is to provide an opportunity to estimate the population size. The process involves catch and release, with marking of crayfish with a white dot on the carapace, a practice performed by a limited number of people.

The local fishing association is still involved in liming of the watershed. However, since the grants for liming have been subject to a VAT tax, the municipality of Arvika has taken over the application and administration because they can deduct this tax. The fishing association and the municipality of Arvika also cooperate in rewarding people for catching mink, but decisions regarding hunting are not decentralized to the same extent as fishing. For instance, the regulations for hunting mink are controlled at the national level. National law also requires people to be careful with and clean fishing gear, boats, and other equipment that is moved between different waters. This is to prevent the spread of a fungal disease among crayfish that since 1907 has taken a heavy toll on the native noble crayfish population (*Astacus astacus*) in Sweden.

Olsson and Folke (2001) also identify individual practices, encouraged by the local fishing association for improved crayfish management, which are not embedded in formal institutions. These are only recommendations and a person will not be sanctioned for not following them. They include improving habitat to provide shelter, increasing food availability, increasing crayfish aggregation, moving crayfish between localities to prevent inbreeding, and enhancing the crayfish stock by selective fishing, for which people are advised to remove large males and throw back females.

8.2.3 Possible pathways

A crisis or major change like the acidification and decrease of the crayfish population triggers an opportunity to reorganize, i.e., to create, re-evaluate, and reshape management practices, rules, and organizational structure. Decisions in times of reorganization will direct the linked social–ecological systems into a certain trajectory or pathway. Some decisions can reduce flexibility and limit future options, whereas others may do the reverse.

The institutional and organizational changes and the efforts of key individuals in the Lake Racken area have led to an increased capacity to cope with the acidification threat. They have also led into a trajectory of developing an ecosystem management approach, generating knowledge about cross-scale interactions ranging from the watershed level to the individual crayfish. However, some people have the opinion that the recovery rate of the crayfish population is too slow, which has resulted in members of the fishing association discussing alternative management strategies. These involve (a) stocking with reared noble crayfish from a commercial hatchery, and (b) members of the local fishing association running a hatchery with the purpose to stock with noble crayfish reared from the egg-bearing females of Lake Racken. These alternative options are believed by some to fulfill the goal of attaining a large crayfish

population more quickly, but they may also counteract the process of being alert in responding to environmental feedback and further alienate people from their ecosystems (Olsson and Folke, 2001).

The Swedish case shows how a local organization and its members that are given a chance, organize themselves, monitor and observe changes in their social–ecological environment, and use their knowledge to create, re-evaluate, and reshape local institutions. The devolution of management rights in 1994 was a step in the direction of co-management, using existing organizational structures and the potential of local fishing associations to manage fish resources. It provides an arena where local and scientific knowledge can complement each other.

8.3 Hudson Bay bioregion

The second case study, from the Hudson Bay area of Canada, was triggered by concern over the environmental impact of large-scale power generation, in this case through strings of hydroelectric dams in northern parts of three Canadian provinces, Quebec, Ontario, and Manitoba. The officially sanctioned environmental impact studies focused on one project at a time. For example, the Government of Quebec's environmental assessment, completed in 1993, addressed only the specific impacts of the Great Whale or James Bay II project. The indigenous people of the region, with extensive dependence on hunting, were concerned that there were cumulative impacts of the network of hydro projects on the environment of the region as a whole that were being ignored. Some sporadic initiatives by government departments and university researchers to assess cumulative impacts did not progress very far. Moreover, governments were reluctant to authorize studies of cumulative impacts of existing and proposed development. It is in this context that local people have assumed the role of challenging the biases of the establishment resource management by generating ecological information based on detailed local-level observations, combined across the region to provide a regional level of understanding.

8.3.1 Initiating the community-based project

The process was initiated by the hunters in the area affected by the huge (15 000 MW) James Bay I project in the belief that they were already seeing impacts that had been ignored. The tiny Inuit (Eskimo) community of Sanikiluaq on the Belcher Islands in eastern Hudson Bay, which is downstream from the coastal currents generated by the plume of the La Grande River on which four dams are located (Martini, 1986), complained about changes in sea-ice

pattern and currents. These, in turn, were affecting marine mammal and seabird populations.

Receiving little satisfaction from the government but getting good support from its neighbors, Sanikiluaq took the lead to organize a project involving 28 Inuit and Cree communities around Hudson Bay. Carried out between 1992 and 1995, the project aimed to build an integrated regional-scale picture of environmental change from the point of view of aboriginal people, drawing upon the day-to-day and year-to-year observations of hunters and fishers. The project was supported by a northern-oriented national NGO, the Canadian Arctic Resources Committee, which did the fund raising and helped with the logistic support for the project. Aboriginal leaders provided the intellectual direction of the work, and back-up was provided by a number of leading northern scientists with both government and university affiliations.

The study was carried out through six regional meetings that brought together hunters and other knowledgeable people from the six regions of Hudson/James bays. Much of the information was collected on maps and digitized for Geographic Information Systems (GIS) analysis. A second series of meetings helped to verify the information and fill the gaps. Two workshops with scientists helped consolidate the information and formulate ways of presenting the material. Progress reports were issued in 1995 and the final report in 1997 (McDonald, Arragutainaq, and Novalinga, 1997).

8.3.2 Compiling local ecological knowledge

Some of the findings were related to the effects of hydroelectric development (e.g., the strings of reservoirs attracting migratory geese inland), but other findings may have been related to climate change (Fast and Berkes, 1998). On Southampton Island, for example, local people reported that snow was arriving before the freshwater freeze up, creating a different kind of lake ice. Whale Cove reported that snow had increased but that it melted earlier than it did in the past. Chesterfield Inlet, Southampton Island, and Arviat all reported increasingly more erratic weather, such as snow melting in May but blizzards occurring as late as June (McDonald *et al.*, 1997). Sanikiluaq hunters reported recent changes in currents, sea ice and winterkill of common eiders (*Somateria mollissima*). The work of the biologists Robertson and Gilchrist (1998) provided cross-verification by corroborating Inuit observations of changes in regional sea-ice conditions in eastern Hudson Bay as related to eider winterkill.

The overall picture that emerged from the Hudson Bay bioregion study was an accelerated pace of environmental change in Hudson Bay, with large-scale changes in goose migration patterns and in the sea ice and currents of the bay.

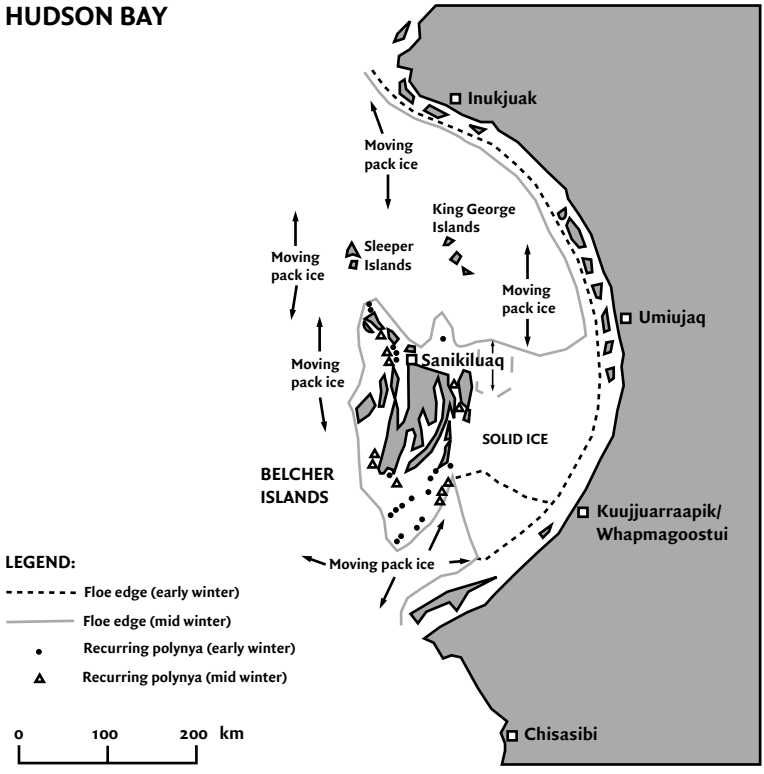

Figure 8.2 Eastern Hudson Bay sea-ice conditions in the period about 1920–70. Adapted from McDonald *et al.*, (1997).

The changes were narrated in quotations and through maps, which provided details of changes based on indicators monitored by indigenous experts but rarely measured by Western scientists, thus showing how traditional knowledge can complement scientific data (Fenge, 1997).

It is generally thought that traditional knowledge complements scientific data by providing local information. However, one of the significant aspects of the Hudson Bay bioregion case was the use of traditional knowledge for the assessment of impacts and environmental change over a large area. Figures 8.2 and 8.3 show the details of changes in the ice pattern before and after the 1970s when the plume of water from the hydro development project started to change the oceanography of the region of Sanikiluaq.

The figures show that the few hundred Inuit residents of the area have knowledge of the distribution of ice and current features of an area of some $600 \times 600\ km^2$. They know where the ice floe edge is in winter (because that is where people hunt seals) and how it changes from early winter to mid-winter

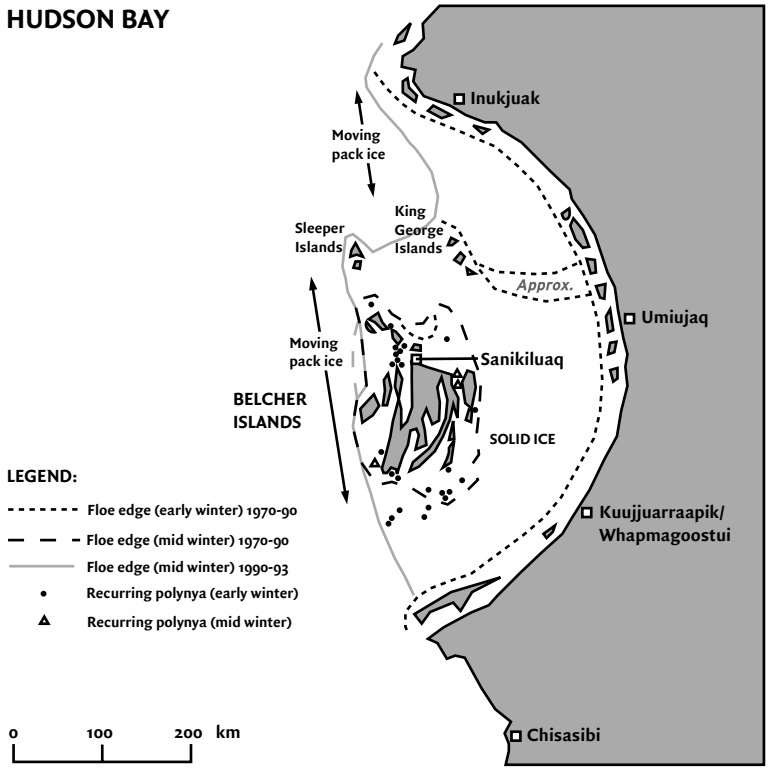

Figure 8.3 Eastern Hudson Bay sea-ice conditions in the period 1970–93. Adapted from McDonald *et al.*, (1997).

They know where the polynyas are. These are the permanent open-water areas (surrounded by solid ice) where various species, such as the eider ducks, congregate. The figure of the earlier period shows that people, as interviewed in 1993, had no trouble reconstructing the environment, as known in the period, 1920–70. Also, by constructing pre-impact and post-impact maps of ice and currents, they were able to show the major changes. Note, for example, the reduction in the number of mid-winter polynyas, constricting the critical habitat of species such as the eider and resulting in winterkills.

Figures 8.2 and 8.3 show the details of only one community out of the 28 involved in the study. The region-wide maps in the study report were compiled by putting together six area maps, each of which aggregated the overlapping knowledge of adjacent communities (McDonald, *et al.*, 1997). The resulting maps are more detailed than the ice maps produced by oceanographers, not only for the local areas, such as around the Belcher Islands as shown in the figures, but also for the Hudson and James bays as a whole.

8.3.3 The integration of local ecological knowledge

Even though many authors regard traditional knowledge to be merely locally relevant because it is locally developed, the case shows the feasibility of the use of local and traditional knowledge synoptically over a large area. This is not an isolated finding; as the book *Sacred Ecology* documents, many traditional knowledge and management practices are in fact common enough to be considered as principles. For example, many groups of arctic and subarctic indigenous peoples, from Labrador to Alaska, monitor the fat content of the caribou that they hunt (a major food species across the north). This provides them with a readily observable qualitative index of the health of the animal and of the caribou herd, an index that can be monitored over time to help decide on hunting strategies (Berkes, 1999).

The Canadian case shows that, in addition to generating information to supplement scientific data, local environmental knowledge can provide several additional benefits: (a) selecting critical variables not covered in scientific surveys (e.g., inshore currents and ice characteristics); (b) generating hypotheses that can lead to further scientific studies (e.g., the relationship between environmental change and eider duck winterkill); and (c) compiling a synoptic picture of large-scale change by building and combining regional maps of local knowledge. Even though the report of the project itself did not result in tangible changes in government policy, the findings have been used for resource and environmental management purposes, and to provide insights into how to deal with uncertainty and surprise, as in climate change (Fast and Berkes, 1998). Perhaps more significant for policy making, the knowledge of the indigenous groups has been used by the co-management boards set up by previous land claims agreements, the *James Bay and Northern Quebec Agreement* of 1975 and the *Nunavut Agreement* of 1993. These agreements recognize the right of Cree and Inuit peoples to participate in the management of their living resources, conservation planning, land use planning, and impact assessment. Indigenous groups won these rights, not because they were able to show the legitimacy of their knowledge, but because of legal challenges to the authority of Canadian federal, provincial, and territorial governments as sole authority on resource and environmental matters.

The use of peoples' knowledge in the co-management bodies created by these native land claims agreements is significant. As Kendrick discusses in Chapter 10 of this volume, 'co-managing knowledge' within these bodies may be characterized as a mutual learning system. How the two kinds of knowledge can be used together is a matter of mutual education, respect, and trust building. The particular caribou co-management board described by Kendrick is the

oldest such board in Canada, and it has a longer track record than the co-management institutions under the *Nunavut Agreement*, which covers most of Kendrick's case study area. What generalizations can be offered regarding the co-management of different kinds of knowledge in the northern Canadian experience?

One conclusion from the Canadian experience is that indigenous knowledge holders and scientists can grow to appreciate one another's knowledge. However, there are limits to the acceptability of each kind of knowledge by the other. Scientists require empirical validation of traditional knowledge and have well-articulated rules of evidence. They tend to be skeptical of knowledge generated without scientific measurements and quantification. Also, scientists are uncomfortable with the belief component of traditional knowledge, which can be characterized as a knowledge–practice–belief complex (e.g., Gadgil, Berkes, and Folke, 1993). For their part, holders of traditional knowledge do not consider that science is capable of verifying their knowledge. In the case of conflicts between the two kinds of knowledge (e.g., whether hunting should be allowed for a particular species), they consider their knowledge to be superior because it is grounded in local observations. They have a profound skepticism of the 'book knowledge' of scientists and regard claims of (scientific) expertise with disdain, unless the individual scientist is personally known to have studied that particular area for years.

8.4 People's science movements in India

India – a relatively poor, highly stratified society, yet with a strong democratic system and rich traditions of learning – has a vibrant participation in resource management movement, commonly called PSM or People's Science Movement, organized as an All India People's Science Network. The movement first took root in the early 1960s in the state of Kerala, where the statewide PSM, known as KSSP, has over 40 000 individual members. Its initial motivation was to wean people away from the traditional cultures that were viewed as mired in superstitions and responsible for the continued depressed status of the subordinate classes. Its mission was thus to communicate professional science to all citizens, especially the poor and uneducated, and to eradicate superstitions. It did not consider local ecological knowledge to be of any value. It saw traditional practices of nature conservation, such as the protection of sacred groves or sacred fig trees (*Ficus* spp.), as superstitions that needed to be eradicated (Zachariah and Sooryamoorthy, 1994).

These PSMs began to re-examine their wholehearted championship of professional science in the early 1970s when confronted with environmental issues

such as water pollution emanating from the Mavur Rayon factory or the submersion of Silent Valley, a biodiversity-rich, hilly region by a hydroelectric project. In these cases the assessments of environmental impacts by the scientific establishment were clearly inadequate and biased. PSMs then added independent, professionally unbiased evaluations of the environmental, social, and economic impacts of such activities as an additional significant concern (Gadgil and Chandran, 2000). Initially, these assessments were undertaken primarily by scientists from academic institutions and communicated to the broader public, but did not involve any element of local ecological knowledge.

8.4.1 Co-management of forest resources

Independently of these activities of the PSMs, but prompted by the broader awareness of environmental challenges, resource management agencies began to set up in the 1970s systems of co-management of forest and water resources. These systems assigned to local people some additional share in the resource in return for assistance in guarding the resources. The local people, however, had little role in planning and decision making; nor was their local ecological knowledge put to any use. However, the setting up of these systems of co-management triggered the spontaneous establishment of thousands of village forest committees (VFCs) in many parts of the country, especially in the state of Orissa with a large concentration of tribal population (Poffenberger and McGean, 1996; Saxena, 1997).

One such VFC was set up in the Dhani Panchayat (the equivalent of a village council) in 1987 in response to large-scale commercial felling. The VFC organized complete protection of a forest area of 840 ha in extent. However, this protection was not exercised as a rigid prescription. It was relaxed to permit some cattle grazing after 3 years of good regeneration; at the same time some of the poorest households were permitted limited levels of harvest of fuelwood. Thus local ecological observations were being employed to organize a regime of adaptive management. There was, however, no involvement of professional scientists and their scientific information and that of professional resource managers in this system (Panigrahi and Rao Giri, 1996; Nayak, Rao Giri, and Singh Neera, 1996).

8.4.2 Intellectual property

In the 1990s there were important developments, which began to change the attitude of professional scientists toward knowledge held by people with no contact with formal science. Thus scientists at the Tropical Botanical Garden

and Research Institute in Thiruvantapuram in Kerala developed a new drug called Jeevani from a rain-forest herb, *Trichopus zeylanicus*, on the basis of information supplied by two members of the Kani tribe. In light of the provisions for benefit sharing embodied in the Convention on Biological Diversity, they shared half the royalty received from a drug company with a trust set up by the tribe to which the informants belonged (Pushpangadan, Rajasekharan, and George, 1998).

With such examples of effective management of natural resources by ordinary, mostly illiterate citizens, as well as proven commercial value of their knowledge, PSMs began to re-evaluate their perceptions of local knowledge. While they remain committed to the eradication of superstitions, they now acknowledge that some practices such as the conservation of sacred groves may serve a very useful social purpose, even though they had originally been implemented through the belief that a forest deity would punish any violators of taboos to remove wood from the grove. In fact, PSMs as well as professional scientists began to survey and document such refugia (Ramakrishnan, Saxena, and Chandrashekara, 1998). Their rationale was also examined further and shown to include secular motivations as well (Gadgil, Hemam, and Reddy, 1998).

8.4.3 Local-level resource mapping

With the PSMs' interest in reaching large masses of people, they became involved in a major literacy drive that was launched in the late 1980s against the backdrop of about 50 percent of the Indian population remaining illiterate 40 years after independence. Amongst their objectives was to reach 100 percent literacy in parts of the already highly literate state of Kerala, and in this KSSP achieved a considerable measure of success. In general, the literacy campaign was notable for inducting substantial local voluntary effort to supplement the usual highly centralized bureaucratic development projects commonly prevalent in India.

A significant fallout of the literacy campaign and the interest in generating literature for neoliterates was the Panchayat Level Resonance Mapping (PLRM) program, again initiated by KSSP. Panchayat denotes the lowest tier of self-government in India, and PLRM was an exercise involving citizens, primarily villagers, many of them newly literate, in mapping the land and water use in their localities. The program was guided by scientists from the Centre for Earth Science Studies, Thiruvananthapuram, and the citizens' own knowledge was not a matter of interest to the program. However, its relevance was gradually realized during the course of the PLRM exercises. A well-known example of this was the experience in Kaliassery Panchayat in Kannur district. Here there were

recurring flood problems that often claimed human lives. The participatory mapping exercise revealed an old drainage channel that had been blocked. The mapping exercise prompted people to take voluntary action to restore the structure, which has subsequently mitigated the flood problem (Gadgil and Chandran, 2000).

8.4.4 Peoples' Biodiversity Registers

All these developments led in 1995 to a serious attempt to examine whether local ecological knowledge can be combined effectively with professional scientific knowledge and then deployed to support systems of adaptive co-management throughout the country. This is being attempted through a program called 'People's Biodiversity Registers' (PBRs). It is a program of documenting the understanding of lay people, primarily rural and forest-dwelling communities, of living organisms and their ecological setting. The information recorded relates to present status as well as changes over recent years in distribution and abundance, factors affecting distribution and abundance including habitat transformations and harvests, known uses, and economic transactions involving these organisms. The document also records the perceptions of local people concerning ongoing ecological changes, their own development aspirations, and finally their preferences as to how they would like the living resources and habitats to be managed. The experience of preparation of these 50-odd PBRs has been most positive, with considerable enthusiasm generated amongst teachers and students in educational institutions, amongst NGO activists, as well as among members of local communities (Gadgil *et al*., 2000).

Some very interesting developments have been triggered in the course of preparation of the PBRs. One such happy experience comes from Himachal Pradesh. Nanj, a village on the bank of the River Sutlej, witnessed a novel community initiative during the course of study. The village was an active participant in the literacy movement during 1992–3 and the people were exposed to a variety of issues relating to natural resource management. As a consequence, a heavily degraded patch of forest was enclosed by consensus to prevent harvesting. The regeneration has been extremely good and promising. During the literacy campaign, a blackboard had been painted on a wall at a public place in the village for open classes and dissemination of information. Between 1994 and 1996, the blackboard had fallen into disuse. It was revived again during the PBR documentation to display the gist of information collected. This resulted in public debates on the issues raised by the information and in turn on conservation actions. One such debate centered on the species *Kambal*. This is a multipurpose tree found up to the mid-Himalayas. It is considered to be a good

fuelwood and its leaves are used as green manure in ginger cultivation. It was pointed out on the blackboard that due to excessive pressure of both fuelwood and manure collection, the *Kambal* had been reduced to a bush in the forest, leading to declining availability of both fuelwood and manure. After many days of discussion in front of the blackboard, it was decided that leaf manure for ginger was a higher priority. As other fuelwood species were available in the forest, the extraction of *Kambal* would be restricted to leaves for green leaf manure and the bushes would be pruned in such a way that one or two shoots would be permitted to grow. At the same time, a few progressive farmers decided to experiment with agricultural crop residues as a substitute for *Kambal* leaves for manure. Over 1 year, they demonstrated that there was no difference in the yields from the two kinds of manure and subsequently more farmers turned to crop residues as this meant lower labor inputs. As a consequence, *Kambal* is now flourishing in the forest and, due to careful pruning and good rootstock, will grow back to trees in a few years time (Gadgil *et al*., 1998).

An account of the experience appeared in the Annual Survey of Environment for 1998 published by Hindu, one of the leading English language newspapers of south India. A large number of people from all over India have expressed an interest in undertaking PBR exercises in their own area as a result of this exposure. Similar interest has been expressed from Brazil and South Africa as well. More concretely, the government of India, in the Biological Diversity Bill tabled in the parliament in June 2000, has specifically entrusted to the village councils the responsibility of documenting biodiversity resources, knowledge, and conservation efforts. Further, the bill provides for direct sharing of the royalties from the commercial application of these efforts with individuals or groups of people. Although the bill does not specifically mention the village documents as the basis for benefit sharing, it would become eventually imperative for the government to do so.

8.5 Co-managing knowledge

These three experiences from Sweden, Canada, and India point to a great challenge for the scientific community. The ecological knowledge of tribal, peasant, herder, or any other resource-user group is of relevance in the context of systems of adaptive co-management. In particular, it incorporates knowledge derived from historical observations of 'natural experiments' and their dynamics (e.g., succession following a fire event) of these systems. Because it is difficult to systematically conduct properly planned and replicated experiments in complex systems, local observations of such experiments can be of significant value. This is particularly true for situations of change and

dealing with change in an adaptive fashion. Hence, the incorporation of local and traditional knowledge into adaptive co-management becomes particularly important.

However, co-managing different kinds of knowledge is fraught with pitfalls. It is true that both local knowledge and scientific knowledge are based on empirical observations and the need to interpret and understand the world. But there are major differences in these two kinds of knowledge. Western science has very specific rules about the admissibility of evidence and turning observations into hypotheses. By contrast, local knowledge can be broadly characterized as knowledge–practice–belief systems (Gadgil *et al.*, 1993; Berkes, 1999). Local knowledge often blends knowledge and belief without clear distinction. Given the strong tradition of skepticism of Western science, it is difficult for those trained in this stream to deal with local knowledge. Often the tendency is to try to tease the knowledge and belief components apart, and then to try to assimilate into science that which is empirically valid (e.g., Mackinson and Nøttestad, 1998; Colding and Folke, 2001).

From one point of view, it is important to identify and use the empirically valid component of local knowledge. From another point of view, however, to do so is to miss the point. Is local knowledge merely marginalized knowledge? Can it overcome its marginalization only by 'fitting' into the framework of 'establishment science?' Teasing apart knowledge and belief undermines the very process by which local knowledge is practiced. Local knowledge, without its belief component, is out of context. Some people who work closely with local and traditional knowledge systems have commented that Western science has a tendency to try to reduce traditional knowledge to either 'myth' or 'data.' The alternative view is to respect the integrity of each knowledge system within its own framework and worldview, and to bring together knowledge systems by treating them as equal but different (Berkes, 1999).

Further problems arise because of the acceptance of so-called post-modernist critiques of science. This critique rejects the claims of modern science to be a special knowledge system with far stronger links to objective reality than any other knowledge system. In fact, some post-modernists view science as just another belief system. We believe this critique not to be valid; modern science is indeed a far better organized system of elaborating knowledge of the world, and the exercise of bringing local knowledge together with scientific knowledge must acknowledge the significance of this aspect. At the same time, it needs to be acknowledged that modern science has little of the wealth of detailed context-specific observations of the dynamics of complex ecological systems. Knowledge of how to respond to disturbance and how to build resilience for enhancing adaptive capacity is still in its infancy. Such knowledge, site specific

and often embedded in management practices of local resource users, exists as a part of the knowledge systems of tribal peoples, peasants, herders, and fishers in many parts of the world (Berkes and Folke, 2002).

This chapter explores the potential of combining scientific knowledge with local knowledge in a process of adaptive co-management. In the Swedish case study, adaptive co-management manifests itself in the establishment of local fishing organizations that blend scientific and local ecological knowledge, which is supported by governmental institutions. In the Canadian case study, such adaptive co-management is achieved by the use of indigenous knowledge in the formal land claims agreements between Cree and Inuit peoples of the North and governmental agencies. In the Indian case study, adaptive co-management is expressed through joint forest management programs, the recognition of the intellectual property rights of local people, and local-level resource mapping with the intent of protecting biodiversity hot spots such as sacred groves.

These case studies and others indicate that involving local people and designing an institutional and organizational structure for incorporating local ecological knowledge in ecosystem management are desirable. Local institutions need to be integrated or nested within institutions at other organizational levels to be able to match social and ecological processes at various scales. For example, the institutional and organizational structure observed in the Swedish case makes possible the process of constant testing of rules in relation to ecological and socio-economic factors at different scales. This in turn creates feedback loops at different scales, and a cross-scale institutional dynamic that we argue is necessary to consider in adaptive co-management.

An important part of adaptive co-management is to stimulate further the possibility for local organizations to interact with each other and with organizations at other levels. That is, we argue that adaptive co-management would be enhanced by linking institutions both horizontally (across space) and vertically (across levels of organization), using the terminology of Ostrom *et al*. (2002). Information sharing and conflict resolution across scales are important for ecosystem management. The flow of information, interactions, and other linkages between and among organizations for adaptive co-management are areas that should be investigated further. For example, the Swedish case pinpoints the functional role of different individuals to facilitate the flow of information. Different individuals at different organizational levels play various key roles in the processes of creating, re-evaluating, and reshaping management practices, rules, and organizational structure in relation to ecological and social dynamics. The quality of the knowledge and understanding that these stewards possess is of crucial importance for which trajectory is chosen for the linked social–ecological system.

As explored at the workshop on the role of local and regional assessments in an international ecosystem assessment (Winnipeg, September 1999), ecosystem assessments by local people can fulfill several important objectives. These objectives include promoting participatory processes; creating new information to share across scales; making optimal use of existing knowledge; developing indicators of change and resilience to monitor ecosystem dynamics; and transforming existing institutions toward ecosystem management. Such ecosystem assessments by local people can create alliances between owners of formal and informal knowledge, as in the India case. They can establish links among governments, local users, and scientists, as in the Swedish case. They can create new information about local ecosystem conditions, to be shared vertically (from local to national levels) and horizontally (among regional groups of indigenous peoples), as in the Canadian case. Such exercises can build on pluralistic approaches, help monitor change, and create a vision of desirable environmental futures, through a process of adaptive co-management.

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9

Facing the adaptive challenge: practitioners' insights from negotiating resource crises in Minnesota[1]

KRISTEN BLANN, STEVE LIGHT, AND JO ANN MUSUMECI

9.1 Introduction

The chapter draws lessons and insights from interviews with practicing resource managers involved in leading diverse groups of primary interest groups through resource management crises and change. Each of these management efforts was perceived by the interviewed practitioners and others as experimenting with new ways to recouple and renew social–ecological systems. They represent a nested set of local and regional experiments within one organizational context, a state resource management agency that was intentionally trying to reorganize through novel approaches to management and citizen involvement (Fig. 9.1). All of the cases profiled were characterized by involvement of multiple stakeholders with competing interpretations, values, and goals for the resource system, and reflected a conscious design to engage citizens in creating alternative platforms for resource negotiation (Woodhill and Röling, 1998). In each case, practitioners were experimenting with learning to function differently, outside traditional norms of leadership.

The goal of this study was to identify management practices and frameworks that are founded on knowledge and understanding of dynamics in both human and ecological systems, and to identify the key elements contributing to adaptive response. In this chapter, we develop a matrix based on the release and reorganization phases of the Holling adaptive cycle in an attempt to classify the 'tacit understanding,' or intuitive guiding principles, which emerged in interviews. Practitioners articulated principles loosely, drawing metaphors from systems theory and chaos theory, organization and change management, and ecosystem management. The chapter explores whether and how practices based on these guiding principles contributed to creating adaptive capacity and resilience in social–ecological systems.

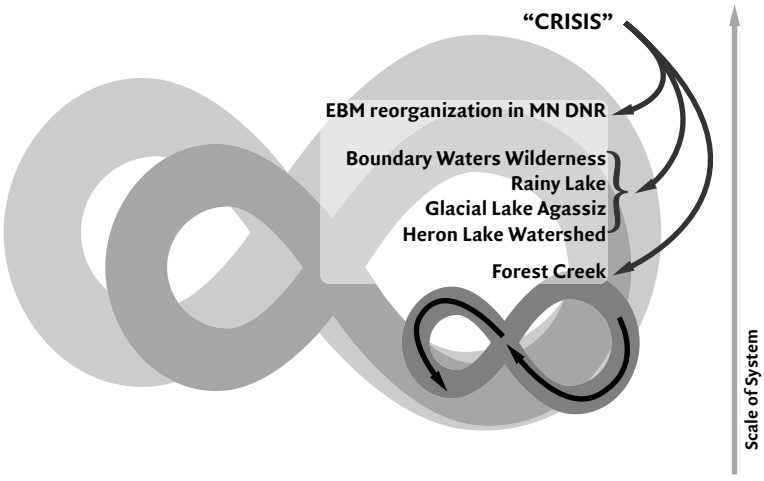

Figure 9.1 Department of Natural Resources ecosystem management case studies at multiple scales.

9.1.1 Rationale

Conventional resource management has been characterized as a crisis-response model, because in constraining a managed system to optimize for a few narrow targets, it often invites larger and larger external feedbacks that ultimately compromise the resilience of the system. Over time this can lead to the collapse or near-collapse of the resource system itself, generating 'crisis' in the social, political, and economic system as well. The resilience of social and ecological systems is therefore linked and co-evolutionary in nature (Gunderson, Holling, and Light, 1995; Perrings *et al.*, 1995; Holling and Sanderson, 1996; Berkes and Folke, 1998; Levin, 1999).

The failures of conventional management have led to a widespread search for new approaches able to anticipate and cope with multiscale demands and stresses while maintaining ecological and social resilience. Increasingly, the search for new approaches has been manifested by a broadening of management paradigms – beyond expert-based, control-oriented management and instrumentalist, reductionist science – to include greater emphasis on community-based, participatory approaches to management (Webler, Kastenholz, and Renn, 1995; Knight and Meffe, 1997; VanNijnatten, 1999; Pimbert *et al.*, 2000; Wondolleck and Yaffee, 2000), and re-examination and revaluation of the diverse spectrum of resource systems based on local and traditional ecological knowledge (Anderson and Grove, 1987; Kloppenburg, 1991; Holmberg, 1992;

Pimbert, 1993; Reichhardt *et al*., 1994; Rocheleau, Tomas-Slayter, and Wangari 1996; Sarin, 1996; Berkes *et al*., 1998; Posey, 1999). Increasingly, strategies for incorporating such practices into agency resource management are being pursued within modern pluralist democracies in an attempt to manage conflicts between competing users, negotiate through and out of social and ecological crisis situations, and avoid or pre-empt future conflicts and crises (Wondolleck and Yaffee, 2000).

Many authors have argued that human individuals and groups appear to do the majority of 'out-of-the-box learning,' or breakthrough thinking, in response to crisis (Kingdon, 1984; Holling, 1986; Lee, 1993; Light and Dineen, 1994). In the adaptive cycle heuristic developed by Holling (1986), 'crisis' can serve as a source of renewal, the Schumpeterian 'creative destruction' which allows re-ordering and reorganization of system 'capital.' Such 'capital' may be present, for example, in the form of the resource base (ecological systems or natural capital), knowledge, relationships, and values (social systems), or available financial capital (economic systems). The organizational or ecological response to crisis depends both on the 'capital' present in the existing system as well as on the unfolding of events that lead to reorganization (Kingdon, 1984; Lee, 1993; Westley, 1995). In the relatively short periods of rapid change which follow in the wake of creative destruction, reorganization of component relationships can occur such that the new system that emerges is fundamentally different from the old one (Holling, 1986). At this stage, individuals, small influences, and/or random events – 'novelty' – can have a major impact on the configuration of the new system that emerges. Control strategies and management skills that are effective in traditional bureaucracies and agencies may be inappropriate or counterproductive in this period from creative destruction to reorganization, or 'the backloop.' Facilitating radical reorientation in resource management, therefore, may require development of skill sets and management principles that differ from those that have served conventional resource management.

As in traditional resource management systems, which have been shown to avoid over-harvest by codifying management 'rules of thumb' in social and religious belief systems (Gadgil, Hemam, and Reddy, 1998), modern resource management practitioners may develop 'tacit understanding' – intuitive, context-specific understanding based on practical experience and observation over a career or a lifetime. Such knowledge contributes in particular to resilience because (a) it is based on a long-term, qualitative understanding of the system and therefore incorporates understanding of long-term change, or 'slow variables,' (b) it includes insight derived from experiences with rare events, or surprise, and thus may aid recognition of thresholds in order to avoid flips,

and (c) it complements quantitative monitoring by helping recognize when a system has shifted from being driven by key processes which are essentially linear (such as those occurring from exploitation to conservation) to being driven by nonlinear processes (disturbance, release, and renewal).

In practice, 'experts' do not operate by deriving general rules from case-by-case experience. Rather, they may begin by applying rules, but they gradually begin to rely on intuitive knowledge without applying explicit rules as their experience grows (Dreyfus and Dreyfus, 1986, quoted in Capra, 1996: 278). When asked to articulate such understanding, however, experts translate their knowledge as heuristics and abstract 'rules,' using language, which is in itself an abstraction. These 'rules,' therefore, are presented not as substitutes for experience, but rather as guidelines for experimentation, inquiry, and dialogue. A major characteristic of adaptive, participatory, and indigenous resource management systems is a focus on learning-by-doing (Walters and Holling, 1990; Bawden, 1992; Allen *et al*., 1998; Berkes, 1998; Borrini-Feyerabend *et al*., 2000). Experiential learning and reflection are essential because the ecosystems under management are constantly changing. There are no 'cookie cutter' approaches that will work for more than one system or for more than brief periods of time.

Furthermore, the observation that local-level organizations often develop the capability to respond to feedbacks faster than do centralized agencies implies a need for greater decentralization of management learning and decision making (Westley, 1995; Berkes and Folke, 1998). Multiple, modest experiments may yield more new learning about a problem than one general design applied widely (Brunner and Clark, 1997). At the same time, the cross-scale nature of many social, ecological, and economic problems, particularly in the modern global economy, creates a need to find effective strategies to address linkages across scales (Holling, 1986; Grumbine, 1994; Gunderson *et al*., 1995; Folke *et al*., 1998; Woodhill and Röling, 1998). For this reason, we have selected a set of diverse cases representing local and regional experiments in watershed management, forestry, and fisheries within the Minnesota Department of Natural Resources (DNR) for a comparative approach to the examination of management practices applied to specific complex problems at nested scales.

9.1.2 Objectives and methods

The goals of this study were (a) to identify the key elements contributing to adaptive or novel responses to natural resource crises in a set of spatially and temporally nested local and regional examples, and (b) to identify and investigate

management practices and principles deriving from resource practitioners' direct experience in facilitating organizational renewal in the Minnesota DNR. The DNR is a state agency charged with the management of Minnesota's wildlife, fisheries, water, mineral, forest, and recreational resources, and, in more recent language, its ecosystems and ecological services. The case studies are based on interviews conducted with the practitioners who were primarily responsible for implementation on-the-ground. The case studies were selected on the basis of testimony by peers and participants that consistently suggested a major shift in approach or understanding had been achieved through the project. Interviews were conducted one-on-one over a 2-month period during the fall of 1998. The interviews were centered around 16 questions developed to investigate how practitioners identified and implemented innovative strategies in cases where traditional strategies were no longer working. Each interview lasted 2–3 hours and all were taped and transcribed. Case study research was based on methods outlined in Yin (1994). Follow-up interviews with two practitioners were conducted for the Forest Creek[2] case study in the spring of 1999 to obtain additional factual information pertaining to the case. Five of the six managers interviewed for the cases were trained as scientists in the fields of biology, fisheries and wildlife, watershed management, and forestry; one was trained as an educator. Five were men, one a woman. All six worked for the state natural resource management agency. Years of experience ranged from 5 to 31. Notably, practitioners interviewed were widely respected and noted for their passion and commitment to the natural resource itself.

The case studies are profiled in Box 9.1. In interpreting interviews with practitioners, we focus in particular on practices developed explicitly to deal with productively negotiating through crisis and change, the release and reorganization phases, or the 'backloop' of the adaptive cycle. We evaluated interviews qualitatively to identify themes that were consistently emphasized (Babbie, 1992; Miles and Huberman, 1994). We then located these 'rules of thumb' in a matrix based on the release and reorganization phases of the Holling adaptive cycle (Table 9.1). We address several hypotheses proposed in the challenge of understanding dynamics between ecosystems and institutions: (a) that there are ecological and management practices that contribute to resilience and adaptive response in linked social–ecological systems; (b) that such practices serve to 'put the brakes on release' or 'conserve memory and opportunity for renewal' during reorganization; (c) that processes are nested at multiple scales; (d) that self-organization plays a critical role during renewal; and (e) that qualitative knowledge complements conventional quantitative data in helping to assess the status of systems and to determine appropriate context-contingent responses during reorganization and renewal.

Box 9.1 Case studies for practitioner interviews

Forest Creek

The issue Angling groups wanted a popular trout stream in a local state park in the Mississippi blufflands to be managed for trophy fishing, but many other stakeholders were concerned about the potential impacts of habitat improvement projects on other uses and values for the park. Habitat improvement has been used successfully for 30 years to satisfy public demands for quality trout fishing. It serves as a single-use, 'bandaid' approach – stabilizing banks and engineering cover for fish (primarily introduced brown trout) – given managers' limited ability to address the ultimate causes of stream degradation in the watershed. Over the years, however, as uses and values for the park had broadened, concerns had been raised by other users regarding the impact of trout habitat improvement projects. Concerns pertained to the broader local ecology, particularly state and federally listed threatened plants and animals, as well as to cultural values such as archaeological sites and artifacts present in state park lands.

The challenge DNR staff wanted to avoid a repeat of a contentious battle which had occurred a few years earlier over a similar stream. When several trout associations approached DNR with a proposal for a habitat improvement project in the popular state park, managers knew they needed to do things differently. A new temporary acting manager, with the aid of the new regional management team, created a facilitated process that was fair, open, and flexible. A critical change was devolving the authority and accountability for the final decision making to the local managers and to the process.

The outcome After only 8 months, an agreement was reached that satisfied all parties and soothed residual community tensions. 'Memory,' in the form of working relationships and information about system hydrology gained in resource assessments, persisted long enough to defeat a quarrying operation subsequently proposed at a nearby farm which would have severely affected the hydrology and water quality of the stream in question.

Rainy Lake fishing roundtable

The issue Rainy Lake and Rainy River straddle the USA–Canadian border, and present special problems of international coordination and management. The Rainy Lake resort economy on both sides of the border depends on good fishing to attract tourists/anglers. Although regulations in the 1980s had put an end to commercial fishing in the lake, total catch and average size

had continued to decline in the years leading up to the roundtable process, displaying the classic signs of an overexploited fishery. Around the same time, DNR had cut back on stocking in natural walleye lakes based on internal research showing annual stocking was a waste. Resort owners and anglers, convinced DNR was the problem, demanded more stocking.

The challenge To develop science-based consensus with stakeholders and resort owners that catch limitations, rather than stocking, were necessary to improve fishing, along with mitigation of water quality and water level impacts caused by the operations of two paper mills.

The outcome DNR built support for experimental catch regulations by involving stakeholders in research, modeling, and experimental design. Involvement in the research and modeling processes and in the final management decisions built broad-based support for the policy. Catch rates and sizes improved after experimental regulations based on roundtable recommendations were implemented. Subsequently, the recreational fishery showed signs of a healthy recovery, and anglers praised the slot limits. Negotiations with stakeholders from both sides of the border over water level issues were ongoing.

The Boundary Waters Canoe Area Wilderness controversy: from extensive harvest to intensive forestry

The crisis The forestry profession and lumber industry were completely in agreement that it was necessary to manage the wilderness area for timber, despite strong public opposition at the state and national levels. They were still building roads, using herbicides, and taking other actions that were inconsistent with wilderness law and public opinion, despite data showing there was abundant timber available outside of the BWCAW.

The challenge How to break through the rigid, conventional forestry paradigm carried by commercial and government foresters to accept their own data showing that a shift from extensive exploitation to intensive forestry practices could provide an adequate volume of timber without the need to harvest timber in the wilderness area.

The outcome Public opposition and convincing testimony from state foresters using the Forest Service's own data countered the federal agency testimony that harvesting in the wilderness was scientifically or economically necessary. A Congressional mandate ended harvesting and road building in the BWCAW. The timber industry and professional foresters began shifting from extensive to more intensive forestry practices, longer rotations, and adoption of best management practices, with minimal job losses and positive economic impacts. In forestry and tourism, several

state parks in historically fire-dependent ecosystems have reintroduced fire management. The Forest Resources Council, a 13-member board representing commercial, recreational, scientific, and conservation interests, was created to provide sound management advice to federal, local, state, and county governments.

Agriculture

Heron Lake Watershed Project

The issue Various stakeholders were concerned about the decline of the watershed, historically one of the richest wildlife and waterfowl areas in southwestern Minnesota. Various recreational goals and single-target management strategies, such as fishing, public access, and waterfowl habitat, were perceived to be in conflict.

The challenge To find a way to resolve multiple, sometimes conflicting goals for a limited resource. The project moved over time to embrace a whole system or watershed approach.

The outcome Dozens of public and private groups and individuals, including sportsmen's organizations, farmers, local and national conservation organizations, and local, state, and federal government, formed a watershed project in 1989 to develop a comprehensive watershed plan, restore wetlands, acquire easement lands, improve water level management, and address nonpoint source pollution. DNR voluntarily assisted the watershed project leadership in an advisory role. Ecosystem management efforts were continued.

Preserving prairie remnants in the Glacial Lake Agassiz region

The issue Development of land for agriculture had eliminated 99 percent of the original extent of prairie ecosystems; DNR and other conservationists sought a strategy to protect remaining prairie remnants.

The challenge Conventional agricultural systems in the midwest rely on extensive inputs and extensive hydrological modifications that have severely impacted and permanently altered the original prairie, savanna, stream, and wetland ecosystems. The challenge in the Glacial Lake Agassiz area was how to envision a future which could preserve remaining prairie remnants as well as honor the strong agricultural identity of the region, in a time of social and economic crisis in agriculture and rural agricultural identity, declining agricultural profitability, and low international commodity prices.

The outcome The DNR helped spearhead and then participated in a successful visioning process through a series of facilitated dialogues. Local communities took ownership of their needs and concerns and developed strategies for preservation and stewardship of remaining prairie resources.

Table 9.1 *Matrix of practitioners' 'rules of thumb'*

	Local → Watershed → State/regional				
'Rules of Thumb'	Forest Creek	Heron Lake Watershed Project	Rainy Lake fishing roundtable	Glacial Lake Agassiz citizen forum	BWCA forests and MN DNR ecosystem-based management
Looking outward and inward					
Double-loop learning: identify governing values and paradigms; key driving variables; use of metaphor	•	•	•	•	•
Drawing on memory: remembering the past	•	•	•	•	•
Protecting and nurturing capital					
Thorough resource assessment, inventory, and monitoring	•	•	•		•
Valuing diversity of perspectives and experience	•	•	•	•	•
Fair, open, honest process to build trust	•	•	•	•	•
Sense of place, connection to land Relationship building through shared experience	•	•	•	•	•
Detecting and fostering novelty					
Mobilizing capacity for inquiry Engaging all stakeholders	•	•	•	•	•
Open process and information flow, listening	•	•	•	•	•
Developing shared language and understanding	•	•	•	•	•
Coping with surprise Disturbance, crisis, and conflict as change agent	•	•	•	•	•
Encouraging and amplifying experimentation Devolved decision-making, self-organization	•	•	•	•	•
Dampening barriers to renewal and learning Creating 'safe spaces' for experimentation; tolerance of mistakes	•	•	•	•	•
Minimizing learner's sense of vulnerability; 'respect' for process and individuals	•	•	•	•	•
Proactive negotiated consensus process; avoiding charged, polarized settings	•	•	•	•	•
Speeding the contagion					
Cultivation of networks	•	•	•	•	•
Metaphor, shared language and understanding	•	•	•	•	•
Developing readiness at multiple levels – replication of efforts at local, regional, and state scales	•	•	•	•	•
Cross-scale interactions	•	•	•	•	•
Vision, leadership, passion, and commitment	•	•	•	•	•

9.2 Background and organizational history

What do resource managers manage? Resource management agencies have at best only limited control over the interactions between society and nature (Fig. 9.2). In a complex democratic society with private ownership of land and capital governing the production of public and private goods, interactions between society and local ecosystems are driven by the structure and scale of the social–economic system as a whole. Most of the structuring linkages occur well outside the sphere of government or bureaucratic regulation. Consequently, few 'resource managers' in the USA today actively manage resources, and are instead engaged in managing organizations, staff, and human use. More than ever, as others have observed, resource management is people management (Gerlach and Bengston, 1994; Berkes and Folke, 1998).

In the late 1970s, resource management theory began to shift from control of the resource to regulation of human demand (Gerlach and Bengston, 1994). Changes in the orientation of federal agency programs paralleled changes in state agency programs in many parts of the USA as well as grassroots efforts at the local level to incorporate ecosystem management principles and greater public participation in resource management decision making (Grumbine, 1994). In Minnesota, the shift to ecosystem-based management began officially

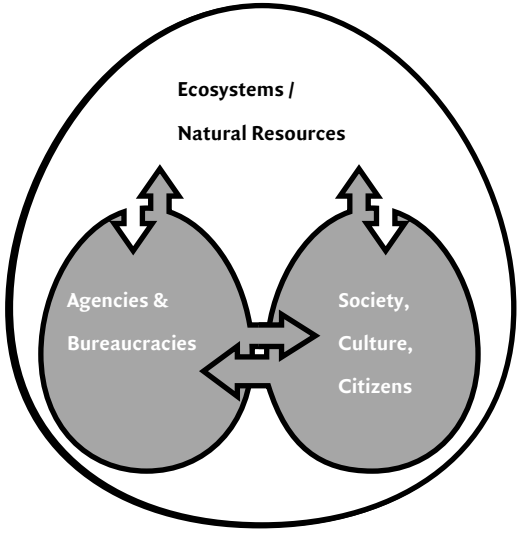

Figure 9.2 The Resource Management Practitioner's Context: limited control or relative influence over resources and public, and two-way flow of linkages between resources, institutions, and society.

in 1995, but the groundwork for such a shift had been in the works for decades. As at the federal level, the impetus for change had come both from outside the agency, in the form of pressure exerted in the political arena by adversaries, and from the internal contradictions that tend to surface in linearly evolving bureaucracies as they seek to implement a growing list of mandates that may be in direct conflict (Peltzman, 1976; Yaffee, 1997).

In Minnesota, state agency resource management had its roots in a long political struggle to end the rapacious commercial and private exploitation that in less than 100 years had resulted in widespread deforestation, driven dozens of fish and game species to commercial or local extinction, and drained and channelized wetlands and streams extensively (Breining, 1981). The Minnesota Department of Conservation was created in 1931 when four units of state government – forestry, game and fish, drainage and waters, and lands and timber – were combined. These early commissions and departments, set up in the late 1800s to deal with rapid settlement and exploitation, had performed unevenly, and had at times exacerbated the destruction of the state's natural resources. The new Department of Conservation was marked by ambitious attempts to stem the tide of resource losses and to foster a growing conservation ethic. In 1971, the name of the agency was changed to better reflect the DNR's broadening responsibilities.

Over the years, each of the various departments of the DNR had evolved close working relationships with their primary constituent groups, resulting in internal fragmentation of DNR's goals and activities and lack of communication among and between the different divisions of the agency. Tight coupling of stakeholder groups with their respective agency counterparts based on shared agendas – section of fisheries with angling groups, wildlife management with sportsmen's organizations, Division of Waters with lake associations, forestry with timber interests, and parks with recreational users – led to poor coordination of messages and activities and often pitted divisions against each other (Yaffee, 1997). This fragmentation was also evident at a larger scale, between the DNR as a whole versus other state agencies such as the Minnesota Pollution Control Agency (MPCA) or the Minnesota Department of Agriculture (MDA). The agency was often a magnet for conflict, both internally between departments working at cross-purposes and externally with various stakeholders (Anderson, 1995). Although public opinion surveys showed that the 'silent majority' of state residents essentially approved of the agency (Kelly and Sushak, 1996), the DNR suffered from a serious erosion of trust and downright hostility among specific constituent groups, particularly farmers and loggers in the rural areas of the state.

In the 1970s and 1980s, agency initiatives had focused on resource assessments and planning initiatives, in addition to the traditional single-target management activities. In the late 1980s, managers and other individuals interested in planning approaches began experimenting with roundtables on various resource issues and the first wave of public and private watershed partnerships. It was not until the early 1990s, under a new administration, that the agency began seriously to study alternatives for fundamental reorganization. The agency developed a hierarchical system for classifying the state's ecosystems and ecological communities, and initiated strategic planning efforts based on these ecological units. In 1995, DNR outlined a plan to adopt the ecosystem approach as a way to redesign its basic organizational structure and operating principles. 'Ecosystem-based management' encompassed a set of strategies for developing integrated planning processes and building teamwork at all organizational levels, greater budget flexibility to foster shared responsibility for common goals, and increased use of partnerships to foster interdisciplinary collaboration within the agency, between the DNR and other state agencies, and with citizens and communities (MNDNR, 1996). The agency initiated pilot projects for multiple-use, ecosystem-based natural resource management in two of the ecologically defined regions; consolidated integrated planning and budgeting activities and ecological support services; developed statewide natural resource forums to convene citizens, agencies, and other organizations for sustainability dialogues organized around forestry and agriculture; and created Regional Environmental Assessment Teams to facilitate coordination and collaborative decision making earlier in project planning to develop better working relationships with local units of government (MNDNR, 2000). The agency also continued and expanded a roundtable process it had used to resolve contentious issues as they arose, including experimental game and fish regulations, de-listing the wolf as an endangered species, and old-growth forest management. The roundtable process brought stakeholder representatives from all sides of an issue together at regular intervals for facilitated meetings to review the science of an issue, discuss policy, and develop consensus or compromise recommendations for working through the issue.

These changes form the context for the case studies outlined in Box 9.1. They represent forestry, fishery, and agricultural issues and cover a range of scales and ecological areas of the state. At the state and federal level, strong leadership by state foresters helped to resolve the controversy over logging and road building in the Boundary Waters Canoe Area Wilderness (BWCAW) in the late 1970s. The resulting changes in forest management and forestry paradigms, from extensive harvest to intensive forest management, have been accelerated through

a series of public-input processes which led to improvements in forest management, attracted economic investment in forestry and tourism, and stemmed the tide of conflict. At regional scales, the Rainy Lake fishing roundtable and the Heron Lake Watershed-Project highlighted the ability of diverse groups of constituents to reach innovative, science-based decisions for resource management based on negotiated consensus. Because such decisions involved a broad base of stakeholder participation and perspectives, they proved to be more resilient in the face of attacks in the political arena that had frequently derailed decisions made by DNR scientists in isolation. At the local level, the Forest Creek trout habitat improvement project highlights how a facilitated public-input process that is committed to being open, fair, and respectful can resolve long-standing community conflicts, develop consensus on a detailed resource management plan, and generate a shift in focus from single-use, single-species management to balanced multiple-use management.

9.3 Practitioners' rules of thumb

Despite practitioners' emphasis on the contextual, improvisational nature of managing resource crises and change, many principles or guidelines emerged repeatedly in interviews. In contrast with conventional paradigms characterized by instrumentalist methodologies for targeted problem solving, practitioners presented insights as loose guidelines for managing an organic process while not being overly directive. Direct control in such systems is, in fact, not possible given the multitude of interacting, independent agents and the role of chance events. 'Rules' are geared more at maintaining the parameters and conditions for learning – the conditions for meaningful dialogue, communication, and innovation – than at producing particular outcomes (Table 9.1). We categorized the principles in relation to the backloop of the adaptive cycle as follows:

1. Looking outward and inward for understanding.
2. Protecting social and natural capital.
3. Detecting and fostering novelty.
4. Speeding the contagion.

9.3.1 Looking outward and inward for understanding

Practitioners identified being sensitive to initial conditions, focusing on slow variables, and facilitating learning as important practices in leading change.

Such practices, drawing both from memory and visioning, served to stimulate reflection on the internal and external sources of current dilemmas and to expand the temporal frame of reference beyond the immediate present. Rather than directing a process, practitioners focused on creating safe spaces for dialogue among diverse players to stimulate learning at multiple levels – both single-loop and double-loop learning. Single-loop learning generally refers to learning within a framework or paradigm. It is often viewed as basic 'how-to' knowledge acquisition, for example learning about rules and regulations to achieve set goals (Pimbert *et al*., 2000). Double-loop learning involves learning at a deeper, more fundamental level. It involves examining assumptions, identifying not just the immediate, proximate mechanisms behind current structures and problems, but also the governing values, underlying frameworks, and paradigms that structured the previous problem-solving response (Argyris, 1990). Double-loop learning is about reorganizing conceptual models and behavior based on a revised understanding of the system or problem. It concerns the diagnosis and treatment of causes, rather than the symptoms.

At Forest Creek, the need to be 'sensitive to initial conditions' was provided by the lingering conflict over previous habitat improvement projects. DNR staff wanted to avoid a repeat of a contentious battle over another state park stream, Trout Creek, that had occurred a few years earlier. That battle had led to significant and lingering controversy, negative publicity for the DNR, internal conflict within the agency, enormous costs in terms of time and attention, and an outcome not widely perceived to have been positive. The Trout Creek experience had set much of the tone. Relationships – some positive, but many negative – had already been formed among individuals in the various agency and stakeholder groups. Initial decisions about the process – internal communication and meetings, setting ground rules for respect in the public meetings, solicitation of informal, one-on-one feedback from key players in advance of meetings, and an open-door policy of DNR managers toward inquiries from the public and participants – were all based on this understanding.

'Slow' variables, or variables that change over longer time scales, such as cultural history, governing values and paradigms, and economic structures, were identified both as sources of memory and as barriers constraining bureaucratic options and social imagination. The agrarian traditions of northern and central European settlers who largely settled Minnesota conditioned attitudes toward resources. Conservation philosophies and local knowledge passed down from small farmers of the Depression era blended elements of Christian stewardship ethics with elements reminiscent of Leopold's land ethic (1949). Many

second-generation and third-generation farmers recall being raised with strong stewardship values, and many continue specific farming practices linked to that ethic, such as the maintenance of fencerows, woodlots, and wetlands as refuges for on-farm biological diversity (Blann *et al*., 1998). At the same time, these traditions structured rigid paradigms for the management of forestry, fish, and game, combining an agrarian view of human management and control and an entitlement view of the rights of Western culture to fully exploit natural resources wherever and whenever they could (R. Sando, personal interview, October, 1998, former Commissioner of Minnesota DNR). The agrarian view saw fish stocking and wildlife feeding programs as a DNR mandate. Monitoring data showing such programs to be ineffective at best were to be ignored or mistrusted. The pro-development view saw the efficient liquidation of natural capital on both public and private lands as an economic and moral imperative to sustain growth that was being thwarted by naïve preservationists.

At Glacial Lake Agassiz, dialogues began with facilitated discussions drawing the historical picture of commodity agriculture in the local and global economy. The paradigms, economic incentive structures, information flows, and federal policies which influenced conventional agricultural decision making were seen as the factors driving prairie loss, as well as farm consolidation, rural depopulation, and political pressure on agriculture from urban environmentalists. The state natural resource agency's long-term focus on hiring technically and scientifically trained staff to fill primarily technical job descriptions, despite a need for communication skills and significant public interaction in many of these jobs, has continued to influence agency 'capital' in terms of its relationships with its public 'customers.' A long history of extensive timber exploitation in Minnesota, leading to tight economic and social coupling of state and federal agency foresters with the timber industry, yielded fierce resistance to the wilderness movement's attempt to bring an end to timber exploitation in the BWCAW. Such observations lend support to the caricature of the perversely resilient bureaucracy (Gunderson, 1999) or the Kuhnian notion of nonlinear cycles in dominant scientific paradigms. During the exploitation phase of the adaptive cycle, the success of linear thinking and control strategies leads to stable configurations of paradigms, management rules, and relationships. Scientists, managers, and other players who have experienced success in this system are likely to resist risking fundamentally new approaches, and to systematically ignore accumulating evidence of impending crisis or failure of the current policy or approach. Past success becomes the motivation for persisting in conservative behaviors. The rigidity of this configuration serves

to thwart efforts at renewal, and underscores the observation that the impetus for reorganization generally comes from the 'fringe' (Kuhn, 1970; Holling, 1995).

9.3.2 Protecting social and natural capital

In the adaptive cycle, the period from reorganization to renewal is rapid, chaotic, and subject to chance events. Events occurring in this phase often lay the foundation for the order that emerges, while innovation emerges from novel combinations of existing social and natural capital. It is critical in this phase to protect and retain the 'raw ingredients,' or social and natural capital – whether in the form of soil fertility or experience-based knowledge and wisdom. Managers expressed a conscious framework for protecting such 'capital', with practices such as:

- thorough resource assessment, inventory, and monitoring;
- valuing diversity of input, perspectives, and experience;
- developing trust through fair, open, honest process;
- building on sense of place: developing local knowledge, emotional commitment, shared experience, and relationship.

One of the most significant examples of identifying and protecting capital – conserving memory and opportunity – is provided in the form of a threat to the resource at Forest Creek that did not materialize. Once the habitat improvement plan was completed and approved, the decision-making platform at Forest Creek had achieved its purpose and had therefore been dissolved – freeing capital while retaining memory in the form of skills, relationships, and knowledge. In the fall of that year, a quarry operation was proposed on a property near the creek. Due to the resource survey that had been conducted, it was known that that land was part of the recharge area for the creek. A quarry operation on the land would have undoubtedly posed a threat to the spring and to the entire resource through alterations of groundwater hydrology or contamination of water quality from the quarrying process. Individuals responded quickly through the informal communication network that the Forest Creek project had spawned. They managed to get the property designated fairly rapidly as an important 'Scientific and Natural Area', a state land acquisition and management program. In a memo to a colleague, the practitioner involved in the Forest Creek event commented:

The value of a facilitated stakeholder involvement process is sometimes found in the costly things that don't happen, such as the time and energy that is not spent because the

situation does not spin out of control, or the extra meetings that do not happen because the initial processes work effectively. However, it is hard to measure things that don't happen.

Capital is often unrecognized until it is eroded. When facilitation is working, it is often invisible. Likewise, when community capital is in place – e.g., civil society or community institutions are able to perform essential social services and cope with small-scale shocks and disturbances – avoided crises, or crises that never materialize, may never be perceived at all. A linear problem-solving approach is unlikely to recognize those crises that do not materialize. Because we lack measures and means of identifying when capital is functioning to maintain resilience, a problem-solving orientation is likely to prevail, identifying problems and proposing radical solutions to small-scale, fast-variable problems that may result in cures that are worse than the disease. A focus on what is working, and what resources are in place and functioning, may play a key role in generating solutions to perceived problems.

9.3.2.1 Thorough resource assessment, inventory, and monitoring

Practitioners emphasized the importance of having as thorough as possible a baseline understanding of the system. Scientific surveys played a key role in inventorying existing natural capital. Thorough inventory and assessment of ecological resources as well as careful monitoring of the fit between agency activities, financial outlays, and outcomes were key to the success of the reorganization efforts in the DNR at all levels. Statewide, federal and state forestry inventory data provided the justification needed to cease the harvest of old-growth timber in the BWCAW. At Rainy Lake, long-term data on exploitation rates and catch sizes provided input to models assessing the impact of catch regulations on the fishery. The Minnesota County Biological Survey (MCBS), a statewide natural resource inventory which had been initiated in 1987 in order to identify, map, and facilitate land acquisition to protect rare ecological features and communities, helped practitioners to communicate with citizens at Forest Creek and in other outreach efforts.

At Forest Creek, project leaders augmented MCBS data with detailed resource inventory and mapping of the archaeological and biological resources of the riparian area. An interdisciplinary team of DNR scientists was assembled and worked closely to develop a Geographic Information Systems (GIS) depicting the precise locations of each valued resource. These maps were then used to develop the proposed locations for habitat improvement so as to be unlikely to undermine other resource values for the creek. A key benefit of the resource surveys conducted as part of the Forest Creek project was not just the expanded

ecological knowledge base, but the working relationships forged between the biologists in different disciplines, the stakeholder groups, and the agency managers. Fisheries staff organized a series of walking tours for the benefit of any and all interested stakeholders, as a new component of all habitat improvement projects. The park supervisor played a key coordination role throughout the project, working closely with interested parties and participating in walking tours. The walking tours formed the basis for developing a shared understanding of the diverse values people held for the creek. On one tour, for example, a botanist led the group away from the creek in search of a rare fern that grew only in small patches characterized by a cool microclimate. For the regional fisheries manager, experiencing the collective search for this rare, little-known fern in its unique microhabitat helped to enlarge his own appreciation for the diversity of ecological conditions and values for the park.

9.3.2.2 Valuing diversity of input, perspectives, and experiences

Creating adaptive capacity requires valuing diversity and individual experiences for what each can contribute to the process in the form of knowledge capital. By honoring each individual's right to participate and creating a climate of respect for differing perspectives and opinions, positive-feedback loops are created in which participants move from tolerating diversity to valuing and enjoying it for the role it plays in their own learning process. While many resource managers may go through the motions of facilitating public participation, these managers expressed a strong belief that working with stakeholders as partners was vital to addressing the resource issue. As the manager of the Heron Lake Watershed Project stated: '. . . the plan they asked me to write . . . it was their ideas I had listened to . . . I carried those plans everywhere with me. Anybody could have a copy of the plan. It was very available.' The manager of the Glacial Lake Agassiz described his own epiphany: 'We had been approaching [the problem] as saving the prairie *from* the farmer instead of *with* the farmer.'

Protecting capital was embodied in a focus during Forest Creek on helping people to perform at the peak of their individual abilities. Part of what had eroded the public's lack of trust in the agency during the Trout Creek controversy was the obvious conflict and disagreement, both about facts and uncertainties, present among agency staff – the non-game biologists versus the fisheries staff in particular. In order for each biologist and manager to present his or her best work at public meetings, it was necessary to develop consensus within the agency about what was known, what was unknown, and what were the likely uncertainties, as well as to anticipate as much as possible the likely criticisms and concerns that would arise in the meetings. Public meetings regarding the

Forest Creek habitat improvement plan were characterized by a well-planned agenda that laid out careful time limits, ground rules for respectful interaction, a coordinated and consistent message for the state resource agency, and an inclusive process for assessment, decision making, and accountability. Agency agreement with respect to the science and the process had been carefully crafted through a series of internal formal and informal meetings and one-on-one conversations carried out in advance of the public meetings. Careful attention to process in advance allowed the process to become invisible. The knowledge and skills of the agency scientists could then emerge, while the knowledge and concerns of the various nonagency participants would also be honored, heard, and addressed without major damage to relationships.

9.3.2.3 Fair, open, honest process to establish trust

Woven through all the discussions about protecting capital was an emphasis on the necessity of building trust by maintaining a consistently fair, open, and honest process. In complex systems, relationships form the basis for all communication, motivation, and action. Trust is critical (Nelson, 1994; Faast and Simon-Brown, 1999). Practitioners emphasized creating opportunities for people involved in an issue to meet and interact socially in the resource environment, sharing food, stories, experience, collective learning, and work. They stressed the need to allow time and space for relationships and ideas to incubate, and to resist assuming that just because they were not doing anything, nothing was happening. Once the conditions for learning and dialogue were in place, their role was to step back and allow events to unfold.

9.3.2.4 Building on sense of place: developing local knowledge, emotional commitment, shared experience, and relationships

Without exception, practitioners stressed the need for decision makers to have regular and direct experience of the resource. Such experiences served to build context-specific knowledge and passion. The role of science was to serve this process of building connections and local knowledge, rather than the reverse. It was not the knowledge *per se* that developed commitment to stewardship, but the sense of ownership behind that knowledge, the connection to place embodied in the range of knowledge acquired about a place. Knowledge about the uniqueness of a resource or a place helped individuals to enlarge their appreciation for ecological knowledge in general, by helping them both to recognize and value diversity and to connect with others' feelings of stewardship and pride for unique resources in other places.

9.3.3 Detecting and fostering novelty

As the introduction to this volume suggests, self-organization plays an important role both in ordering ecological knowledge and in emergent organizations. Ideas and heuristics emerge over time through dialectic between individuals in a group as well as through the group's interactions with the ecological system. Individuals within stakeholder groups 'co-evolve' with the ecological system they have formed to address – 'self-organization through mutual entrainment' (Folke *et al*., 1998). Stakeholders and planners reframe their understanding of a situation through a kind of dialogue (like those practitioners described), but may be unaware that this is happening (Innes, 1998). Self-organization may also play a role in the emergence of 'novelty' in terms of non linear shifts in understanding. Numerous practitioners suggested that their own ideas as well as those of others had evolved as a result of a collaborative process.

Strategies for creating the conditions for novelty to emerge in the ecological or social system included mobilizing capacity for inquiry, anticipating and capitalizing on surprise and uncertainty, encouraging and amplifying experimentation, and dampening barriers to renewal and learning.

9.3.3.1 Mobilizing capacity for inquiry

Mobilizing capacity for inquiry is a process of identifying and freeing capital. In each case, this involved engaging all stakeholders in an inclusive process and developing shared language and understanding. Inclusive dialogue was seen as bringing more capacity for innovation to the process. According to one member of a regional DNR interdisciplinary team: 'Ecosystems are not only more complex than we think, they're more complex than we *can* think. So the more brains you have working on the problem, the better chance you have of coming out with something that's acceptable to everyone or successful.'

Developing shared language to communicate system metaphors, ecological processes, and community vision is a gradual process that occurs hand in hand with developing relationships and understanding. Collective science-based dialogue, experiential learning, and modeling were used to develop a shared knowledge base. Practitioners stressed the need to be aware of and avoid the use of overly narrow language, such as scientific jargon, especially in the initial stages. At Rainy Lake, a fishing roundtable composed of lay persons, resort owners, and fishermen gradually developed a firm grasp of the terminology and theory used by fisheries scientists. According to the fisheries manager on the project, the roundtable's final report issuing management recommendations for Rainy Lake 'could have been written by a biologist.'

9.3.3.2 Coping with surprise and uncertainty

Practitioners and participants tended to characterize the 'time being ripe' in terms of the existence of a threshold level of concern or frustration and the willingness of key people to begin actively searching for new approaches to dealing with a problem. 'Crisis' was frequently cited as playing a necessary or sufficient role in spurring action, but was rarely defined. At what scale must crisis occur in order for meaningful learning to occur? Crises shared elements of being both real and perceived or socially constructed, both social and ecological. Glacial Lake Agassiz highlighted economic crisis in agriculture as well as loss of remaining prairie remnants. At Heron Lake, concerns focused on the loss of waterfowl habitat and degraded water quality. At Rainy Lake, concerns focused on the deterioration of the walleye fishery and the impact this might have on the tourism economy. Forest Creek was primarily characterized by a perception of crisis in the social arena, where desire to avoid repetition of a difficult and negative process at Trout Creek led to internal reorganization and rethinking of the agency's approach to habitat improvement in state parks. In other cases, concerned groups responded to the perception of impending crisis. The impetus for reorganization of the DNR at the state level emerged from the convergence of small, medium, and large-scale contradictions and conflicts, none of which individually might have precipitated action.

The differing nature and role of 'crisis' may lie in the structure of land tenure and management as well as in existing social capital. Where such capital exists in the form of strong local or grassroots community ties, an individual motivated to act is more likely to find and 'plug in' to an active support network, or a 'shadow network' working at multiple scales. By contrast, where people's lives are relatively isolated at the level of the nuclear family, decoupled from place and community, as was the case in several of the case studies related to a specific issue such as recreation, more immediate crises are required to spur collective action and generate novelty. The impetus for such collective efforts – the perception of crisis – may arise out of fears about being subject to larger uncontrollable forces of globalization and rapid change, out of a historical and cultural context of values and political empowerment, via the enabling institutions which support directly or respond to civic action, and/or via the articulation of vision by practitioners involved in leading change regarding the inadequacy of traditional approaches.

Practitioners were generally philosophical about the role of surprise and uncertainty, recognizing that not everything could be anticipated. A diversity of perspectives was credited with conferring a level of insurance against the type

of unintended consequences generated by narrow thinking: 'Keep your eyes open and watch for the unexpected . . . you just have to be careful about linear tracking on all of this stuff. Having the bigger group . . . really helps to avoid a lot of the problems.' The conflicts that arose in the case of the earlier situation at Trout Creek had come as a complete surprise to the DNR fisheries and park managers. The defensive reaction to surprise allowed the issue to spiral out of control. In broadening input, practitioners were able to better anticipate surprise and take it in stride when it materialized. In this sense, commitment to honoring diverse perspectives serves both to break open renewal cycles as well as to 'put the brakes on' release.

In several cases, surprise provided the opportunity for re-evaluating views. At Forest Creek, an unusually severe summer flash flood occurred at a time when resource assessors, in the process of thoroughly mapping the 1.5-mile stream, had begun to get bogged down in specific, single-purpose plans for each segment of the stream. The flood literally washed away several areas of contention. In so doing, it created a more flexible climate for negotiation, and served as a reminder of the pitfalls of micromanagement.

9.3.3.3 Encouraging and amplifying experimentation

Practitioners saw the involvement of the public as both a challenge and an opportunity. Reorganization and renewal in particular require a faster pace of learning and organizational change than agencies typically achieve on their own. Mistrust of government, lack of scientific literacy and/or of a common language for speaking about ecology, and poor communication between agencies and the public serve as obstacles to the implementation of management plans. Narrow interest groups of citizens sometimes serve to co-opt and corrupt processes of public involvement. Agencies often feel that they are being hijacked and hamstrung by political controversy. However, loose networks of activist citizens and non-governmental organizations (NGOs) can play the role of change agent by regularly lighting fires under the slower-moving, task-oriented bureaucracies. Thus, ironically, 'slowing down' to broaden the process of planning input, if done correctly, serves to facilitate more rapid fundamental change.

Several practitioners experimented with devolution of the actual decision-making authority, or 'leadership from behind' as it has been termed within the agency, but continued to pay close attention to the dynamics of helping people to work through the process collectively. Devolution of decision making explicitly recognizes the inability of an agency or a manager to truly 'manage' a complex system itself. The manager cannot direct change or control change, and therefore must focus instead on creating the conditions for learning and for

self-organized contagion. Practitioners often felt the need to articulate a vision or a set of ground rules, but then stepped back to 'let self-directed discussions nourish themselves.' At Forest Creek, the regional manager supervised the process at a distance, but devolved decision making and clear accountability for the final decision on the outcome to the park manager. The park manager, in turn, coordinated communication between biologists involved in the resource mapping and surveys as well as with the public. The practitioner involved most intimately with the Heron Lake Watershed Project gave the following prescription: (1) listen, (2) contribute information, (3) sit back and be patient, and (4) expect your partners to make good decisions. He added 'I can remember thinking: "I'm the resource person, I have the training and the experience, *I'm* the only one who is going to be qualified to make the correct decision" . . . [but] actually, if you trust in the process, your partners will make better decisions than you will.' Prescribed burning to reintroduce historic disturbance in one of Minnesota's largest and most beloved state parks was planned and carried out entirely at the local level in a public process led by the park superintendent. In each case of devolved authority, practitioners admitted to having made a leap of faith – and to feeling pleasantly surprised by the quality and the scientific soundness of the decision reached.

Practitioners emphasized the improvisational style, the lack of a 'master plan,' as a way to encourage experimentation. The primary focus was on 'discovery learning,' engaging people in dialogue, observation, and in some cases monitoring in such a way as to allow them to draw their own conclusions.

9.3.3.4 Dampening barriers to renewal and learning

Because learning and experimenting with new ways entail risk, an important strategy for dampening barriers to renewal is to create space where participants are free to experiment, the learners' sense of vulnerability is minimized, and mistakes are actively tolerated or even rewarded. At Forest Creek, an active 'open-door policy' for communication between the agency and the various stakeholder groups sought to 'create safe places where conflict could be managed and learning could take place.' 'Safety' in this case refers to regular opportunities for informal or one-on-one communication with process participants via phone, office visits, and field visits. Agency decision makers regularly contacted key leaders of stakeholder organizations to discuss concerns and convey information regarding the status of the process.

Many practitioners focused on the importance of 'active listening,' or listening for ideas that emerge from the different ways in which people frame problems. Some brought up the paradoxical value of extremists. While extremists can be barriers in the sense of creating strained relationships, gridlock, and

barriers to communication, they can also be sources of novelty as the sparks for inducing 'crisis' (as opportunity), as the parameters for enlarging the range of options considered, as a source of passion for energizing a process, or even as a common 'enemy' helping to unite others. The Trout Creek experience, for example, had taken such a toll in terms of stress, mental energy, and broken relationships that individuals explicitly expressed a 'readiness to do things a different way' at the outset.

A major concern of practitioners was how to handle individuals who were particularly charismatic, powerful, and/or disruptive to the collaborative process. Several members of stakeholder groups at Heron Lake and Forest Creek were known for their tendency to be vocal and disruptive at public meetings, to be manipulative of the agenda, to interrupt when other individuals were speaking, and to go outside of the process to achieve their ends. Such negative tactics were dampened via a kind of 'Tao' of facilitation: individuals who tended to disrupt discussion were encouraged to speak up within their allotted period. Ground rules agreed upon at the beginning of each public meeting helped to diffuse the tension and anxiety experienced by participants who tended to hijack the conversation out of fear that their concerns might not be aired otherwise. Skilled facilitation helped to maintain ground rules, to ease anxieties about the fairness of the process, and at times to transform the passionate but negative energy these individuals brought to the table into a force for constructive change.Practitioners confirmed that an open process that respectfully honors diverse input will be self-censoring. The group itself becomes the arbiter of the rules, and the group will sanction individuals who consistently violate the established norms of respectful input.

9.3.4 Speeding the contagion

Practitioners worked to ensure that processes of change occurred at multiple scales, from local to regional to organizational. They recognized the need to operate at multiple readiness levels – not just scaling up from the local or imposing top-down processes from the state level. Lessons learned from DNR's early experiments with ecosystem-based management were shared across scales through internal and external publications within the agency, links with the state university, media coverage, informal communication, and formal exchanges at events and conferences. Organizational changes in the DNR have occurred to capture the memories from Forest Creek and Trout Creek and to scale up the learning (Fig. 9.3). The regional environmental review teams and process are in place to replicate the planning process that occurred at Forest Creek in any future settings. During the Forest Creek planning process, the regional

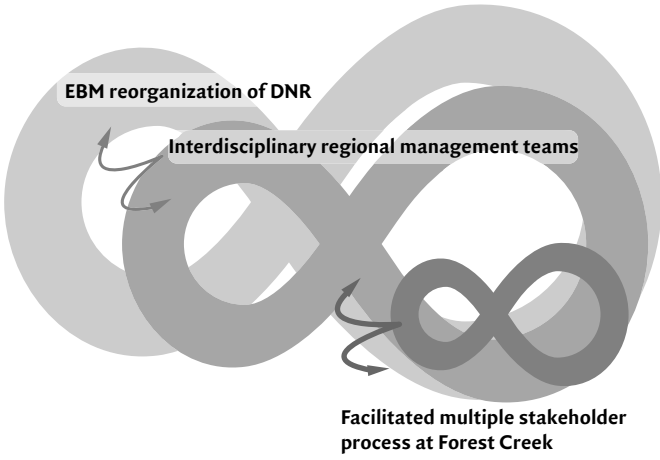

Figure 9.3 Nested interactions at Forest Creek.

coordinator and the regional managers met informally several times to review the process.

Several practitioners knew each other or were familiar with one another's published work and drew parallels in their own work. Novelty in the social system emerges as an organic property of collective work, and is facilitated by lateral diffusion of successful models through informal networks. As one practitioner phrased it 'you can't say that one idea came from here and then it was picked up over here . . . it's more like a cloud taking shape. Everyone's ideas are like little nudges, they're constantly nudging themselves and others. Some nudges made a bigger difference than others.'

The commitment and passion of specific key individuals, especially, play a critical role in generating enthusiasm, maintaining momentum, and speeding the contagion of a process. Practitioners recognized an opportunity to act on behalf of the resource and capitalized upon it. Their own passion and commitment to a successful outcome were evident in interviews. Many emphasized the need for patience and understanding of the lag times that follow legwork that has been in the works for decades. One practitioner said: 'You can only go as fast as local people want to go or can go. If you try to go faster it doesn't work. We're almost 20 years later [now] and we really are talking about wetland restoration, riparian buffers, feeder streams, and erosion control' (having moved from a focus on in-lake restoration). This may have problematic implications in terms of measuring and reporting on outcomes, especially from the point of view of a task-oriented bureaucracy. Nonprofit organizations, which can afford to be more patient with these kinds of informal development processes, play a valuable support role.

The process of negotiating resource use conflicts is often intrinsically rewarding in itself. Participants regularly express a profound sense of satisfaction resulting from learning about the environment or others and the relationships they developed both with others and with the natural world, particularly relationships that evolved from adversarial to cooperative. At Forest Creek, participants were extremely positive about the learning embodied in the respectful process. Handling small steps well, especially in the initial stages, laid the groundwork for success. With Trout Creek in mind, participants at the initial, well-coordinated public meeting about Forest Creek went away pleasantly surprised by how smoothly it had been conducted. Early small successes created a snowball effect, helping to reinforce the positive feelings participants retained after the plan was developed.

9.4 Synthesis: adaptive practices for navigating through the 'backloop'

9.4.1 Against prescriptions: resource management as jazz

The management of complex social–ecological systems is highly context specific. There are no formulas for 'technology transfer' that can be bottled and applied to other resource management problems with assurances of success. Management, especially the management of change, is as much an art as a science, and requires continuous re-evaluation and monitoring. Fostering change requires 'institutional leaders' who have particular personal qualities and abilities as well as opportunities for influence (Stein, 1997). The 'new' practitioners, as facilitators of learning and change, need different skill sets, including the ability to articulate vision and metaphor for double-loop learning and to create safe, open, and respectful platforms for dialogue, learning, relationship building, and experimentation. Looking outward and inward to understand the roots of crisis, protecting and conserving human and natural capital – the 'memory' of the system – through release and reorganization, detecting and nurturing novelty to generate renewal, and speeding the contagion by which adaptive capacity can be replicated and transferred across scales, lead to new configurations of social and ecological capital (Fig. 9.4).

Facilitating adaptive learning and renewal involves an explicit recognition of a fundamentally adaptive, iterative paradigm, rather than one of a linear planning and implementation process geared toward efficient reaching of targets specified at the outset. Practitioners do not subscribe to an instrumental view of public participation as a means to broaden the base of public support to counter challenges to bureaucratic power and to liberate themselves from demands of special interests. They view the construction of alternative processes for

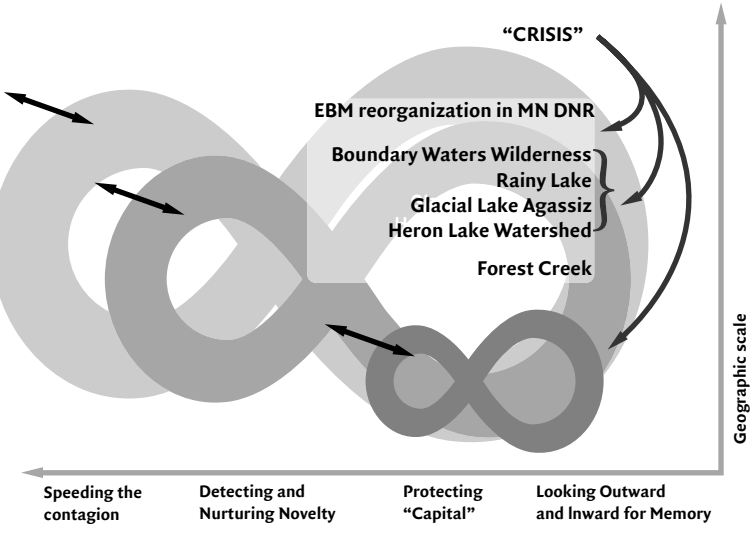

Figure 9.4 Facilitating adaptive renewal at multiple scales.

devolved or shared decision making as a process valuable as an end in itself insomuch as it promotes learning and experimentation. They stress the importance of orchestrating diverse, interdisciplinary working groups of scientists, field staff, managers, landowners, and other stakeholders to build platforms for learning about specific issues that can be scaled up to broader problems. Such platforms are a necessary alternative to the formalized processes by which most public agencies make decisions. As temporary learning systems, they retain flexibility without additional bureaucratic costs. They generate self-organized adaptive capacity, allowing diverse communities of interest and place to strengthen or renew social, economic, and ecological resilience. Practitioners recognized the role of these broad networks as antidotes to the pattern of increasing conservatism that develops in permanent, specialized, fragmented communities.

Facilitating adaptive renewal also requires complementing quantitative knowledge with qualitative understanding of social and ecological dynamics. It requires balancing soft systems with the hard systems; scientific understanding with human values; the instrumentally rational, goal-oriented, problem-solving approach with the organic, emergent, self-organized process of facilitated learning and human resource development. Managers focused as much on the human dynamic as on the ecological in seeking to produce adaptive capacity. According to one, 'We understand adaptive management as a way of looking at ecology, but the other factors for how we proceed are driven by social, political, and

economic forces that need to be looked at in an adaptive way.' In each of these cases, scientific resource data were being obtained and balanced day by day, side by side, hand in hand with a platform for negotiating resource use outcomes contingent upon values, beliefs, and learning. Thorough resource assessment helped to lay the groundwork for science-based discussion of options, trends, and key driving forces shaping the ecological, economic, and social system at local and regional scales. Open communication, information flow, and information quality played a key role in building solid working relationships and mutual trust. By establishing a safe, open climate for dialogue, practitioners were able to facilitate double-loop learning and to begin building capacity for making long-term, fundamental change. The development of networks operating at multiple levels of readiness enabled cross-scale transfer of knowledge and learning. Together, these principles encompass strategies for navigating through crisis in ways that lead to renewal and resilience.

Notes

1. The cost of this study was underwritten by a grant from the Resilience Network.
2. Real name changed.

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10

Caribou co-management in northern Canada: fostering multiple ways of knowing

ANNE KENDRICK

10.1 Introduction

The links between social and ecological systems are represented by diverse ways of looking at human–environment relations. The continuing exchange between different ways of knowing may be crucial to integrative thought about social–ecological linkages. For many indigenous societies, the separation of social and ecological systems does not make sense. A 'human–environment' divide is especially absent from many arctic and subarctic cultures. How does this fundamental ideological difference play out in resource management systems that incorporate stakeholders both from 'the West' (Euro-American) and from indigenous cultures for whom a human–environment or social–ecological divide is a relatively new and foreign concept?

This chapter looks at the differences that exist in the perceptions of indigenous caribou-using communities, caribou managers, and scientists in co-management processes in arctic and subarctic North America. It is contended that these differences represent potentials to expand how we think about human–*Rangifer* (caribou) systems as much as they represent obstacles to caribou research, monitoring, and management decision-making. The process of negotiating cross-cultural differences in the co-management of caribou herds indicates the potential for the growth of alternative resource management systems capable of accommodating varied ways of knowing and learning.

The question of how humans learn to respect other ways of knowing is represented here as an examination of humility, a respect for diverse realities. There are multiple epistemologies outlining ethical positions of human–environment relations and human perceptions of nature (Folke, Berkes, and Colding, 1998). Attempts to develop resource management systems in balance with resource dynamics must address the suite of alternatives available to 'navigate nature's dynamics.' However, a fundamental issue in social sciences with respect to

resource management is the mistrust that can occur among stakeholders. This mistrust may stem from one thought system's domination or outright dismissal of alternative ways of knowing. An appreciation of coexisting but different ways of knowing may improve the chances of developing sustainable resource management systems. At the same time, the options at hand for interpreting and adapting to ecological change are broadened.

Increased conceptual diversity alone does not lead to the increased resilience of social–ecological systems. However, building the adaptive capacity for change may hinge on the existence of varied tools for change. This chapter is an attempt to promote discussion of the mechanisms supporting conceptual diversity that may develop within co-management regimes. It is postulated that the trust, respect, and feedback internal to co-management regimes play a role in building the capacity to deal with change in social–ecological systems. Co-management is defined here as '[a] blending of [indigenous and government[1]] systems of management in such a way that the advantages of both are optimized and the domination of one over the other is avoided' (Royal Commission on Aboriginal Peoples, 1996: 665–6).

There are discrepancies between the attitudes and beliefs of government caribou managers, biologists, and traditional caribou users within co-management regimes (Kruse *et al*., 1998). Do these differences represent fundamental obstacles to resource management decision-making or the respect for multiple ways of knowing? What are the differences in how and what caribou managers, biologists, and users learn and think about caribou? The lingering differences between the beliefs and attitudes of indigenous resource users and government managers may reveal much about humility. For instance, continued differences in perceptions of caribou population dynamics (Kruse *et al*., 1998) represent a significant epistemological problem. How can different ways of thinking about social–ecological realities be reconciled within resource management systems? Epistemologically speaking, co-management may contain clues about how to overcome the human deficit of *what* we are able to know and think ecologically (Bateson, 1991), and an increasing tendency to homogenize *how* we are able to know and think about ecological systems. The role of narrative and the larger potential to understand the mismatch between human behavior and ecological processes may be best reconciled in co-management settings. As one caribou biologist phrases it, through involvement in co-management, he has:

> . . . come to realize that there is a very different method of storing this knowledge and of examining what's going on with the caribou that's not related in the numerical sense or in written words
>
> *(Kruse* et al.*, 1998).*

Dominant global ideologies emphasize the 'one-sided divorce, not only from nature but also from our own biology, and thus of course from our very selves' (Livingston, 1981: 82) leading to a mismatch between human behavior and natural processes. This mismatch has strong implications for the human capacity to think about living processes and to act on our knowledge of living systems. In other words, *how* we learn about social–ecological linkages is as important as *what* we learn about these links. The sustained recognition that there exist discrepancies between the thought and belief systems of traditional caribou users and government caribou managers may lead to significant integrative and complex learning about human–environment relations.

10.1.1 Objective and method

This chapter attempts to broadly answer the question: where attempts have been made to create a dialogue between government scientists/managers and indigenous caribou-hunting communities, what is the nature of the cross-cultural information exchange? Findings are based on conversations with caribou users (the term 'users' is employed here to encompass not only those individuals who hunt caribou, but those who process and consume the animals as well) in three traditional caribou-hunting communities, and an analysis of caribou co-management systems in North America. First, the issue of the trust necessary for the maintenance of diverse conceptual constructs is discussed along with the limitations of knowledge systems. The re-awakening of thought about the integrative nature of belief systems that may shape the relationship between sustainable resource use and human values is then explored. Finally, the chapter looks at the suggestion that the learning occurring in cross-cultural co-management settings may lead to the conditions necessary for the formulation of resource management systems encompassing alternative and diverse ways of knowing.

10.2 Caribou co-management in the Canadian North

Caribou co-management systems provide unique opportunities to explore the learning necessary for the respect of diverse systems of thought. A Man and Biosphere research project completed an extensive comparative study of the influence of caribou management history and beliefs on current caribou management systems (Kruse *et al*., 1998). The two management systems examined were those established for the Beverly-Qamanirjuaq (of northern Canada, hereafter the Canadian system) and western Arctic (of Alaska, hereafter the

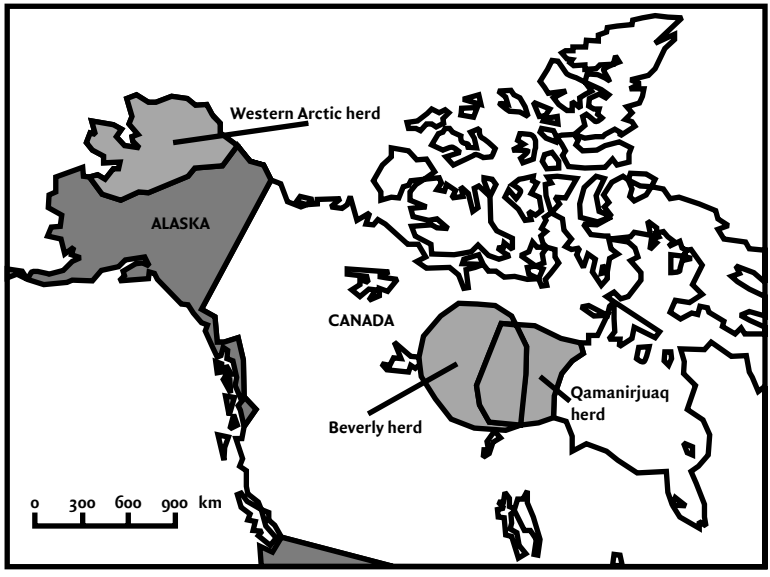

Figure 10.1 Ranges of the three Alaskan and Canadian caribou herds mentioned in the chapter.

Alaskan system) caribou herds (Fig. 10.1). These management bodies were initiated because the caribou populations involved seemed to be encountering population declines in the 1970s. These herds were subsequently shown to have recovered quickly or not to have declined to the extent first assumed following the perceived 'crisis' episodes of the 1970s (Kruse *et al*., 1998: 449).

There is a high level of uncertainty regarding barren-ground caribou (*Rangifer tarandus*) population dynamics and the interpretation of aerial survey data for population estimations. A 1993 census survey of the Beverly herd suggested that the population had fallen well below the co-management board's ascribed critical threshold. However, a census completed the following year showed three times as many animals (Anon, 1995). The increase in numbers between the 1993 and 1994 surveys could not be explained by population growth alone. The complexity and variability of caribou population dynamics are vast (Klein, 1991). Such variation and survey data uncertainty exacerbates the questions of who interprets changes in caribou behavior and dynamics and subsequently makes management decisions, and how this is done.

The legacy of caribou population 'crises' continues to reverberate in the Canadian and Alaskan management systems (Freeman, 1989). It is extremely difficult to separate differences in the belief structures between and among

communities and government. In addition, there are schisms between government and indigenous communities, created by the uncertainties of population survey techniques (Usher, 2000). It is in this history that the complexity of the issues surrounding the 'who, what, and why' of the definition of resource crises can be illustrated. The history of the Canadian system is a unique example of an ongoing conversation about resource crises and their real or socially constructed nature. This history also illustrates the enigma of assessing co-management achievements. For instance, co-management institutions are examples of social interactions where 'what you don't see is as important as what you do see.' The lack of protracted legal battles over monitoring and enforcement methods and increased environmental literacy enabled by 'cross-checking' knowledge of herd dynamics (including population numbers, behaviors, and health) among co-management participants is as important to the definition of co-management achievements as any listing of the 'outcomes' of the process (Singleton, 1998).

A survey of acceptable harvest practices reveals that in both the Alaskan and the Canadian caribou management cases, consensus between caribou users and managers exists for only half of the harvest practices discussed (Kruse *et al*., 1998: 453). There is much less agreement on acceptable population monitoring practices (Klein *et al*., 1999). The comparative Alaskan and Canadian study shows that whereas a majority of caribou managers find aerial cow-calf counts and radio collaring of caribou acceptable, only a minority of indigenous caribou users find these practices acceptable (Fig. 10.2). Moreover, there are considerable differences between the cultural beliefs held by the various user communities represented by the Canadian and Alaskan systems (Kendrick, 1994; Kruse *et al*., 1998).

Despite co-management efforts, managers believe that their knowledge is clearer to users than it was during the 'crises' of the 1970s, whereas users do not agree (Fig. 10.3). A majority of government managers in Alaska and Canada believe indigenous caribou users are more likely to trust their knowledge now compared to the situation in the 1970s. In contrast, only a minority of indigenous caribou users find the knowledge of government caribou biologists believable. What are the reasons for this discrepancy? One suggestion is that indigenous caribou users interpret changes in the prevalence of caribou as a matter of location, not changes in herd size (Ferguson and Messier, 1997). Other suggestions include misunderstandings about changes in survey methods as they were refined from early efforts (in the late 1950s) to present-day techniques, and changes in information needs complicated by changing herd dynamics as well as management goals. An example of such changes includes the switch from visual aerial surveys (caribou counts made by human observers flying overhead) to photographic aerial surveys of the herds, first carried out in the

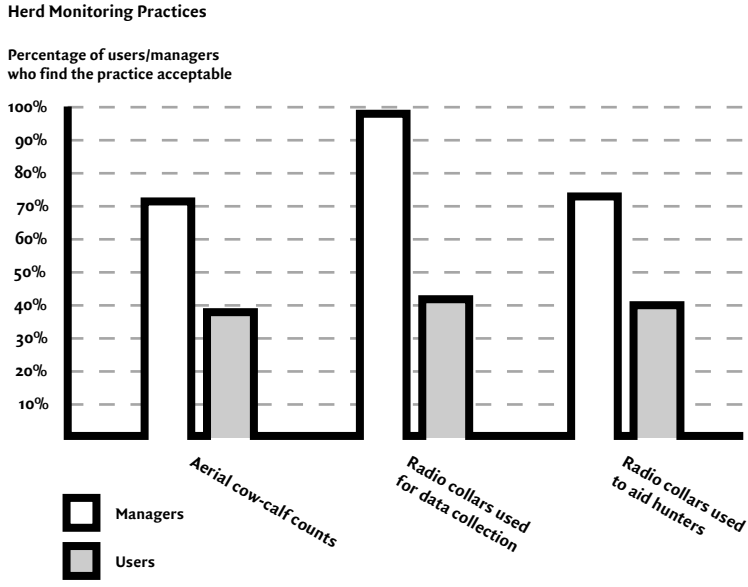

Figure 10.2 Attitudes of caribou managers and users toward herd-monitoring practices Adapted from Klein *et al*. (1999: 495).

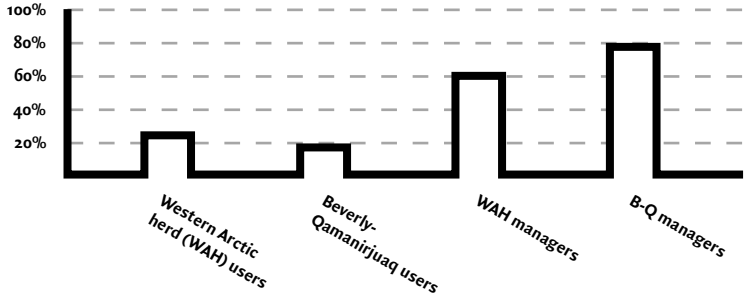

Figure 10.3 Proportion of caribou users more likely to believe biologists now than in the 1970s. From Kruse *et al*. (1998: 454).

early 1980s (caribou counts estimated from photographs of the caribou range taken from the air). Results of a survey of the Beverly caribou herd released in 1984 showed that the new aerial photographic technique revealed *twice* as many animals as the visual aerial survey technique.

The explanation and meaning given to population changes often differ between indigenous caribou users and government managers. The connection between Chipewyan observations of caribou population declines in the 1950s

and 1960s, and some of the first caribou population surveys by government biologists and Chipewyan traditional beliefs is illustrated below:

> A wide-spread tradition holds that caribou never die, unless killed, but if one is captured or mistreated his spirit will go to the others and warn them to remain away from the area . . . [t]he decline in caribou numbers in the 1950s and 1960s coincided with the onset of serious caribou studies by the Canadian Wildlife Service. The Chipewyan attributed the decrease in caribou in this area to the capture and tagging, which caused the caribou to avoid the area, rather than to any real decline in numbers
>
> *(Smith, 1978: 72).*

This is not to imply that indigenous belief systems exist in isolation from quantitative observations of change. The contribution of indigenous caribou-hunting communities to empirical knowledge of caribou population dynamics cannot be dismissed. It is not unusual to find, especially in the north where research costs are expensive, that biologists collect data on relatively few variables within specific geographical areas for short periods of time. However, it is very difficult to generalize findings at short time and small spatial scales to the variable and fluctuating environments of boreal ecosystems (Ferguson, Williamson, and Messier, 1998). An increased appreciation of the uncertainty involved in understanding fluctuations in caribou populations is also playing a role in increasing academic interest in the contributions of local knowledge to understandings of caribou ecology (Klein *et al.*, 1999). Similarly, the field of ecology does not solely focus on the description of reductionist quantitative patterns to the exclusion of integrative and qualitative thought (Holling, 1998). The differences between indigenous and government knowledge systems are not black and white. However, it is interesting to contemplate whether traditional caribou-hunting peoples, caribou biologists, and managers gather, interpret, and take action on their knowledge of caribou in fundamentally different ways.

10.3 Human thought and ecological processes

Not only are there cultural differences in human perceptions of nature; there are mismatches between natural processes and human thought in many societies (Bateson and Bateson, 1987). Gregory Bateson, a leading thinker on this issue, was concerned that the materialist framework of knowledge dominating ecological science leads to interpretive error, and as a result helps to deepen ecological crises. Attempting to correct for such interpretive error, he partially developed a theory of an integrative biological dimension of experience.

Bateson used a model of 'mental process' (where nature has a mentality – similar in some ways to animism) to describe the interaction of structure and

process by abduction, a widespread phenomenon of human thought. Abduction is a term adopted from philosophy to describe a qualitative method of knowledge construction. It is evident in metaphor, dream, parable, allegory, comparative anatomy, etc. (Bateson, 1979: 142). Abduction permits a 'lateral extension of abstract components of description,' allowing formal comparisons through 'contrasts, ratios, divergences of form, and convergences' (Harries-Jones, 1995: 177). Unlike deduction or induction, abduction is a process of modeling information characteristic of both humans and other living organisms in their own environments. 'Mental process' is a model Bateson created in part as a tool for comparative study, bridging the gap between epistemology and ethics, and in part because he felt that occidental (Western) languages do not lend themselves easily to the discussion of process versus structure. Bateson metaphorically described 'mental process' as very large mental systems of ecological size or larger. He saw the mentality of a single human being as a subsystem characterized by constraints in the transmission of information (information is defined as communicated knowledge or news of a difference from one state to another) between the parts of the larger mental system (Bateson and Bateson, 1987).

This body of thinking acknowledges that every individual and every cultural, religious, and scientific system has particular habits governing knowledge creation. However, Bateson contended that most epistemologies confuse 'map' (the domain of distinctions and differences) with 'territory' (the physical domain that we can never perceive in its entirety). Local epistemologies usually assume that the rules for drawing maps (receiving information) are inherent in the nature of that which is being represented in the map (Bateson and Bateson, 1987). This epistemological confusion of map with territory is the equivalent of believing that the 'name is the thing named.' However, while we cannot 'know' an individual 'thing,' we can know something about the *relations* between things.

For Bateson, *metaphor, not classification, is the logic upon which the biological world is built*. The logic of metaphor identifies and connects all living processes. In contrast, classical logic is ultimately limited because of its dependence on language, unavoidably structured by the discontinuous nature of description or 'naming.' One of the first steps to new ways of thinking about nature is to look at the limitations of any act of description (Bateson and Bateson, 1987).

Consistent with Bateson, the Dene concept of *inkonze* (Ridington, 1990; Sharp, 1997; Smith, 1998), loosely translated as 'little bit know something,' emphasizes the inferiority of human knowledge and power in comparison to nature. The Dene are the indigenous Athabascan peoples of the Canadian subarctic. It is the Gwich'in, Dogrib, Slavey, and Chipewyan subgroups of the Dene that hunt the caribou populations of the Canadian subarctic and arctic. *Inkonze* is a complex concept that is echoed in Bateson's thinking about the difficulties of human

attempts to describe and understand living processes. *Inkonze* emphasizes the experiential nature of life. Living and learning are intertwined and nature is the source of knowledge and power. As expressed by Tuan (1979), 'knowing is an engagement with the world, rather than a reflection of the world.'

Description is a 'spinoff of our perceptions and thought' and the name is never the thing named. The *Ding an sich*, or 'the thing itself,' is equivalent to an 'infinitude of details' we can never fully describe or comprehend (Bateson and Bateson, 1987: 164). Our descriptions of the world around us will always be marked by 'gaps' so that descriptions, 'form,' or 'structure' are human constructs that are discontinuous or digital in character, whereas process or the world of flux is continuous or analogic. The Dene concept of *inkonze* emphasizes the limitations and uncertainty involved in human understandings of reality. The knowledge of traditional caribou users 'tends to reserve a place for phenomena which are basically and fundamentally unsuitable for research and the unknowable core gives strength to the knowledge system' (Roots, 1998).

Description is obviously necessary if humans are to communicate their knowledge of living systems. Extended metaphor (such as that of a vast 'mental process') is a way to classify statements of description consistently without denying the primary nature of process (Bateson's 'territory:' Bateson and Bateson, 1987: 193). By studying human descriptions, and human nature as information-processing creatures, we may learn much about the mismatch between human actions and natural processes and therefore about sustainable resource use. The connections between language and human reliance on learning and teaching are adaptive mechanisms of crucial significance in human efforts to avoid ecologically disastrous behavior (Bateson and Bateson, 1987). Until we understand the necessary limits of language and, by extension, the limits of science, we will continue to ignore unavoidable epistemological problems (Bateson and Bateson, 1987). Regarding the limitations to conscious human knowledge, Bateson firmly believed that the correctives for errors implicit in human language and science lie in metaphor or narrative. Bateson was frustrated by so-called solutions to 'environmental problems' that fail to understand the limitations of description and fail to use metaphor to achieve integrative and complex thought. Humankind's resource and environmental problems path may be based on a systemic, epistemological problem because of:

> … a destructive mismatch between human behavior and the characteristics of the biosphere within which human beings live and on which we depend. This is a mismatch rooted, not in the mistakes of particular chemists or the wastefulness of hunters or farmers, but in the human capacity to think about natural systems and act on that knowledge *(Bateson, 1991:* x*).*

10.4 Co-management: the potential for institutional transformation?

Co-management may be an arena where the human capacity to think about natural systems is remembered and innovated. This can be achieved by respecting the metaphors or beliefs of indigenous communities that inform the technical aspects of traditional knowledge and practice. Caribou co-management institutions constantly negotiate fundamental resource management concepts, including those summarized in Table 10.1. Terms like 'conservation' and 'management effectiveness' are culturally derived. Indigenous caribou-using communities are often not homogeneous collective units, depending upon the manner in which people's seasonal movements on the land changed to permanent year-round settlement less than 50 years ago. The needs of community representation and resource use and allocation are constantly shifting as human and caribou occupation of the land changes through time. This constant negotiation of meaning makes caribou co-management a dynamic process. Co-management is a discourse in which interactive and mutual learning takes place. For example,

Table 10.1 *Caribou co-management: areas of negotiation*

Concept	Contrast of meaning
Conservation	Caribou as a depletable bank of resources versus a 'partner' in a reciprocal relationship feeding not only economic needs, but spiritual, cultural, and intellectual life and playing fundamental roles in social organization, kinship relations, and cultural transmission
Management effectiveness	Marked by a disparity between traditional caribou users and state management's perceptions of acceptable monitoring, harvesting practices, and notions of expert knowledge
Caribou-using community	A homogeneous collective voice versus heterogeneous settlement of people that moved seasonally; social and ecological contexts changed throughout the year until less than 50 years ago
Resource crisis	Who defines a caribou crisis? How is it defined? Why are crises defined?
Community representation	What is the adequacy of representation? What is the shifting nature of representation needs as caribou herd ranges expand and shrink?
Resource use/allocation	If all uses are not given equal priority, how are commercial, recreational, and subsistence uses prioritized so that uses recognize that often subsistence harvesting depends upon the wages earned through commercial uses?

in many resource management settings, there are long-standing questions not only about who has the authority to define when a resource crisis has been reached, but also about how resource crises are defined, and the equity behind the decisions made to pronounce a perceived resource crisis.

Co-management embodies a tension between government-mandated wildlife management regimes, the expertise of indigenous resource users, and the 'social and political questions about how practices of recognition occur in contexts of power, dominance and resistance' (Feit, 1998: 124). Most of the co-management literature establishes and discusses the power dynamics that are central to the linking of government and indigenous knowledge systems (Berkes, George, and Preston, 1991; Campbell, 1996). The problems of power imbalances are well illustrated in the 'us–other' cycle where the knowledge of 'other' marginalized societies is compared and measured against 'our' mainstream thinking as illustrated in Figure 10.4. The 'other' (indigenous communities)

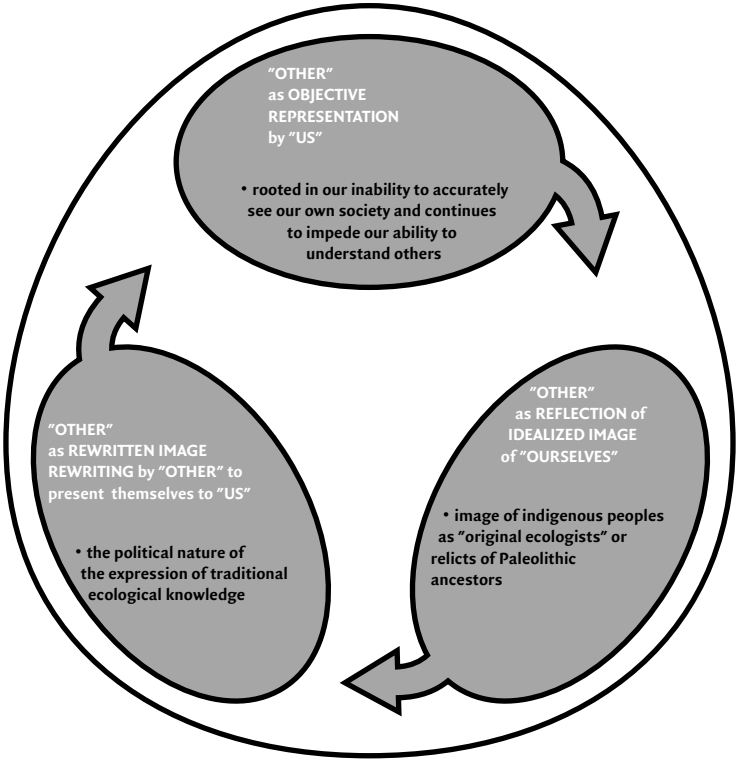

Figure 10.4 The 'us–other' comparison of knowledge systems. Adapted from Fienup-Riordan (1990).

are often represented as idealized images of 'ourselves' (mainstream society), forcing the politicization of this image in order to allow indigenous communities to represent themselves to us in a more realistic and empowered fashion. Fienup-Riordan (1990) speculates this cycle of image making stems from 'our' inability to understand our own society, leading to objective representations of 'other' societies that are essentially images mirroring ourselves.

Perhaps because of this 'us–other' dynamic, co-management is pictured in a number of different manners in the literature. Some describe it as a process of management devolution from government to indigenous responsibility. Others see it as one of convergence between government and indigenous management systems. Co-management is also depicted as an act of compromise and, finally, especially in the case of caribou co-management, as a model of community burden where the risks to communities of participating in co-management processes can be high. These burdens include community concerns that indigenous rights and titles may be undermined through participation in co-management (Kofinas, 1998). Co-management is not a formula for the resolution of long-standing resource management conflicts. There are considerable transaction costs endured by the indigenous societies that participate in these processes (Caulfield, 1997; Kofinas, 1998). However, while not denying that power dynamics are central to co-management decision-making processes, this discussion is an attempt to expand upon the concept of 'trust between actors.'

The conditions necessary for trust will be unfolded here by examining evidence of *learning*. Cross-cultural co-management learning is dependent on the mutual recognition of the belief systems, metaphor, and alternative narratives of the parties involved in co-management. Co-management analyses have largely ignored the potential development of innovative learning processes within co-management arrangements. Most analyses have almost completely focused on political power dynamics. In an analogous manner, ecology largely focused on the competitive aspects of ecological relationships while marginalizing the study of the cooperative aspects of living relations, such as mutualisms, until relatively recently (see Berkes, 1989; Rybczynski, 1997). *Informal* and *flexible* conditions allowing double-loop learning ('learning about the ultimate or underlying factors behind a response, in addition to the immediate or proximate causes;' see Chapter 9) or frame-shifts where the negotiation of the meaning of resource management can occur are possibly critical components of caribou co-management dynamics. The trust necessary for co-management involves the mutual recognition of the learning patterns of the cultures participating in caribou co-management processes.

10.5 Resource management, belief systems, and societal aspirations

There are dangers laden in any analysis of resource management systems that does not acknowledge differences in cultural values and societal aspirations. Northern indigenous groups in Canada are negotiating self-government in some form or another. It is often politically risky for indigenous communities who have not completed these negotiations to participate in resource management processes that may later undermine their efforts to achieve political autonomy. For instance, co-management can become a process reflecting the conformity of traditional caribou-using communities to existing government management systems, rather than a shared perception of fairness and respect of diverse cultural values among participants.

The majority of Alaskan and Canadian indigenous caribou users involved in the aforementioned Man and Biosphere research project see formal government management regimes as mechanisms to control hunting in the event of caribou herds experiencing a decline (Kruse *et al*., 1998). However, in the face of herd declines, it is difficult to imagine that conventional contingency plans will be workable. The communication occurring between government and indigenous institutions can be fraught with difficulties, including: (1) historical conflicts between caribou users and managers, (2) differences in cross-cultural ecological knowledge, (3) jurisdictional differences between communities, and (4) low levels of community identification with government institutions (Kendrick, 2000).

There is also a lack of recognition of the 'customary practices' of caribou-using communities among government institutions. This lack of understanding of customary practices may be couched in a lack of understanding of the changing history of human–caribou relationships. Just as wildlife population dynamics change, the human–caribou dynamic has shifted dramatically in the last century. In a comparison of human–*Rangifer* (the genus *Rangifer* includes the caribou of North America and the reindeer of Eurasia) relationships across the circumpolar North, Anderson (2000: 169) asks, 'when we know that the history of human communities has changed, is it not reasonable to assume that the identity and quality of *Rangifer* populations has also changed?'

There are problems inherent in caribou research that attempts to understand the very complex and unpredictable ecology of caribou through methodologies that simplify human–*Rangifer* relations. In a description of historical Dene movements, Smith relates that:

> Visiting between local and regional bands was common . . . information on shifting herd movements would be widely known. The distribution of hunting groups may be viewed in terms of the anticipated dispersal of caribou . . . The apparent breakdown of

the network about 1950 was a consequence of a new phase in the late contact-traditional era . . . indicative of a greater degree of sedentism

(Smith, 1978: 82).

Communities are very conscious of the dramatic changes in their relationship with caribou. The caribou of today are not the same as the caribou at the turn of the twentieth century, any more than today's caribou hunters are the same as the hunters of the early twentieth century (Anderson, 2000). There is an intimate and long-standing shared history between caribou and traditional caribou-hunting communities. External forces can profoundly influence the relationships between these communities and the caribou populations they hunt.

The connection between indigenous self-determination and resource management in the Canadian North (Caulfield, 1997; Nuttall, 1998) cannot be over-emphasized. Harvest controls are potentially as devastating to community identity and self-determination as any other process of acculturation (Ames, 1979; Bussidor and Bilgen-Reinart, 1997).

In the light of the discussion above, how do indigenous communities perceive co-management arrangements? Among Canadian managers, 87 percent feel that co-management has increased users' sense of control, whereas *only 27 percent* of users have an increased sense of control. Two-thirds of Canadian managers think that user involvement is as great as it needs to be, whereas *less than one-third* of users feel the same. In the Alaskan case, almost all (94 percent) managers and a majority of users (two-thirds) would like to see increased user involvement (Kruse *et al*., 1998). Evidently, users and managers have different perceptions of the appropriate level of caribou user participation in co-management processes.

Neither the Canadian nor the Alaskan systems have found effective mechanisms for incorporating user and manager observations in management decision-making (Kruse *et al*., 1998). Managers comment that user observations are often difficult to interpret. Such communication difficulties are not uncommon in many other efforts to include traditional ecological knowledge (TEK) in resource management decision-making. The crux of this problem is described by one indigenous scholar in the following manner:

By reducing processes into factual data, much of the power of Indigenous Knowledge is lost. The dominant society is willing to use Indigenous generated factual data in co-management agreements, but they are not willing to use the *process* of Indigenous management. Instead of strengthening and using Indigenous processes, the dominant society inserts factual knowledge into its own processes, models and management plans. The ability of Aboriginal [indigenous] peoples to affect change in environmental management then becomes greatly reduced

(Simpson, 1999: 74).

Despite the formal co-management arrangement, Canadian government managers do not seem to be placing a higher value on indigenous knowledge than Alaskan managers who are not party to a co-management regime. In another twist, when queried, a higher proportion of Alaskan users said they would cooperate with managers compared to the Canadian case. This may be related to the amount of time that Alaskan users and managers spend together on a day-to-day basis (Kruse *et al*., 1998). Is it the informal social relations between government and community that lead to real, but informal institutional change that includes processes of indigenous management?

Fienup-Riordan's (1999) work with Yup'ik communities in Alaska confirms the importance of the social connections between government and community. Without the development of personal connections, collaborative work between communities and government remains limited in scope. As expressed by one Yup'ik elder (Fienup-Riordan, 1999: 19): 'There are different kinds of biologists. Some stick with what they know, they don't try to expand their knowledge. There are the others who want to learn more and expand their knowledge to help us.'

It is important to note, however, that in the comparison of the Alaskan and Canadian systems, Canadian indigenous users have achieved governmental recognition of indigenous rights to resource use and management that Alaskan users do not hold to the same extent. In contrast, Alaskan indigenous users are recognized as 'rural people' under a federal law that has provided the means for rural subsistence harvesters to protect their use rights from commercial interests through allocation preferences (Wolfe, 1998). However, the 1980 Alaskan Subsistence Law is out of step with the 1971 Alaska Native Claims Settlement Act that requires protection of the subsistence needs of *indigenous* Alaskans. As a result, an uneasy tension exists between federal and state laws where the federal government regulates subsistence on federal lands (60 percent of Alaska) and Alaska maintains authority over the majority of the rest of state lands (Thornton, 1998).

It is not as incumbent on Canadian users to cooperate with managers as it is in the Alaskan case. In Alaska, managers *and* users do recognize the *potential* of reformed management regimes. However, government managers and traditional users may *recognize different potentials*. The clash of perceptions of users and government managers during the caribou 'crises' of the 1970s may be more fundamental than we have even begun to realize. *Formal* co-management institutions still treat community-based thinking as something so unfamiliar as to be essentially nonexistent in formal decision-making. For example, users may see co-management as a place to secure a voice in government resource management decision-making. Managers may recognize that both the

enforcement of hunting restrictions in the face of a decline in caribou populations and the monitoring of animals are impossible without community involvement.

10.6 Cognitive commitments

Little work exists documenting indigenous cognition of caribou population dynamics. Attempts include work with Inuit, James Bay Cree, and Gwich'in communities (Gunn, Arlooktoo, and Kaomayok, 1988; Berkes, 1995; Kofinas, 1998). When scientific survey results conflict with community observations, conventional management measures (i.e., limitations placed on harvest activities) may be achieved only at the expense of significant short-term and long-term social costs (for example community distrust and noncompliance with harvest quotas). Very little has been documented about the ways that caribou users share (and shared before year-round settlement patterns) information about the location and movements of caribou (Smith 1978; Speiss, 1979; Burch, 1991). Pre-contact indigenous harvesting levels were probably *not* limited *solely* by low population numbers and inefficient technologies. There were local rules, behavioral norms, beliefs, tribal territories, and other social mechanisms of harvest control (Csonka, 1991; Berkes, 1999). It is possible that the hesitancy of communities to accept the methods and technology of caribou population surveys is also related to the ways that such research may threaten the authority of indigenous knowledge and management systems. For example, Dene elders have expressed concerns about past caribou programs by biologists that targeted animals at river crossings, perhaps causing a change in their movements (Smith, 1978; Kendrick, 1994).

Hunters in some settlements use citizen's band (CB) and high-frequency (HF) radios to communicate with people on the land or in communities hundreds of miles away about wildlife movements (Nakashima, 1991; Kendrick, 1994). It could be argued that the way knowledge of caribou movements is now spread by people with home-operated, two-way radios helps to replicate the manner that information was exchanged in the past. Before settling year-round in one location, people moved on the land, visiting neighboring hunting camps and occasionally gathering in large numbers for caribou group hunts in which they shared knowledge of caribou movements.

There are remarkable parallels in caribou-hunting techniques across the circumpolar region, including mass traps such as corrals with drive fences and drives of animals into water bodies (Speiss, 1979). These techniques indicate that the indigenous knowledge of caribou movements and distribution of societies even marginally dependent on caribou was extensive. Ethnohistorical

records show that 'regional bands' of between 200 and 400 people (of 'Caribou Eater Chipewyan' and Yellowknife Dene) gathered for the sole purpose of communal hunts at drive fences in the fall and winter (Speiss, 1979: 115). Even brief consideration of the complexity involved in coordinating these hunts should give us pause about the level of knowledge, communication, and cooperation involved.

What kind of relations, relevant to increasing trust and respect, are driven by co-management efforts? State managers increase their awareness of the sharing and kinship relations involved in hunting and food distribution. Co-management also increases awareness of the knowledge exchange occurring at the local level. Notions of sharing, equity, and reciprocity are very different in traditional caribou-hunting societies versus government bureaucracies. This is especially apparent when these principles are applied to the negotiation of resource use rights. For instance, in the 1980s, the Beverly-Qamanirjuaq caribou co-management board, with its majority of indigenous members, recommended the removal of barriers to the shipment of meat to community members hospitalized in southern cities. Government regulations had prohibited the shipment of wild meat to cities. In a further example, user representatives on the same board initiated research that documented community-identified critical caribou habitat that subsequently led to changes in one political jurisdiction's fire-fighting policy. Canada's Northwest Territories have a fire-management plan that now includes caribou habitat protection as well as commercial timber areas for fire control.

The examples listed in Table 10.2 further illustrate the depth of the concepts currently negotiated in co-management contexts. Biologists, government managers, and indigenous communities may not only define caribou herds and land differently, they may also relate to caribou and the land differently. There are therefore difficulties inherent in translating across these linguistic as well as conceptual barriers. In some Dene communities, it is said that time and space join in ways understandable only from the standpoint of a five-dimensional or six-dimensional model (Sharp, 1997: 97). The reality of *time* created in such a conceptual model is more similar to Western concepts of *space*. Time is a variable rather than a fixed point, so that 'history is not past, history is; future is not maybe, future is; both are equally real' (Sharp, 1997: 97). This concept of time is in sharp contrast to Western thinking in which time is organized in a linear sequence and causality is an implied part of this sequence (the classical definition of logic). Time moves in a direction from a determined past to an undetermined future so that only 'now' is real (Sharp, 1997: 97). It is obvious that if Dene conceptions of time are more closely related to Western ideas of space, there are huge differences between these conceptions.

Table 10.2 *Blurred conceptual realities: Dene caribou users, managers, biologists, and caribou*

On one hand . . .	Concept	On the other hand . . .
A discrete population of animals displaying long-term fidelity to a definable calving area and subject to abundance and scarcity	A caribou herd . . .	Groupings of animals whose behavior and discreteness are responsive to human–caribou interactions or a relationship of collaborative reciprocity
A resource that is a biophysical component of habitat that supports populations	Land . . .	Nde – a Dogrib (Dene) term describing land as a living entity encompassing a holistic notion of living; a landscape complete with animals, plants, and other living processes with spiritual lives
Time is linear/space is three-dimensional and impersonal	Time and space . . .	For the Bearlake Dene, time and space join in a five-dimensional or six-dimensional model (Sharp 1997: 97) Time is a variable rather than a fixed point so that the past, present, and future are current
Caribou as a 'resource' that can be managed and belief in control and rational explanation; belief that population dynamics can be manipulated	Management . . .	The word is nonexistent in Dene languages; however, *inkonze* illustrates the fundamental differences between the scientific human–nature split and *inkonze*'s recognition of human dependence and place 'in' nature Human–nature relationship is one characterized by ethics, and reciprocity, but not by 'management;' acceptance of uncertainty, uncontrollability, and unknowability

The realization of such differences makes cross-cultural caribou management a huge challenge, especially when the word 'management' itself is a word that has no equivalent in Dene languages and characterizes a human–environment divide that is antithetical to Dene cultural values. Moreover, it may be detrimental to communities to fully engage themselves with government institutions or to try to achieve a synthesis of knowledge and concepts (Kofinas, 1998). Mainstream influences may decontextualize community structures and knowledge to such an extent that they are no longer meaningful or viable (Weinstein, 1996).

10.7 Learning to recognize diverse knowledge systems

In recent years, there have been efforts to complement the TEK of resource users with the science of resource managers. Comparisons are often made between Western science and TEK. There are dangers inherent in this comparison because it is easy to forget that 'what we know' is framed by 'how we know.' Comparing TEK as knowledge associated with human values and ethics to 'Western scientific' knowledge – seemingly differentiated from human value systems – is an almost self-defeating task when the multidimensional nature of knowledge is forgotten.

Since Cartesian times, Western society has marginalized the science of the integration of the parts in favor of the prescriptiveness offered by the science of the parts (Bateson, 1991; Capra, 1996; Holling, 1998). The science of the parts gives an incomplete and misleading picture of social–ecological systems (Chapter 1). The '. . . inherent unknowability, as well as unpredictability, concerning ecosystems and the societies with which they are linked . . . [and the] inherent unknowability and unpredictability to sustaining the foundations for functioning systems of people and nature [is forgotten]' (Holling, 1998).

However, other scientists point beyond the *imbalances* in the *application* of the 'two cultures of biological ecology.' Bateson (1991: 199–201) outlined the *misleading orthodoxies* of the natural sciences. Namely, (1) the artificial isolation of the observer from the object observed, (2) the false sense that time is independent of process, when in fact time is a consequence of process, and (3) the misapplied logical typing that makes structure primary and process secondary.

Many thinkers have outlined the pitfalls of seeing Western science as an objective, value-free practice (Longino, 1990; Latour, 1999). Comparisons made between TEK and Western science tend to construct TEK as a sounding board for Western science, true to the 'us–other' comparison described in Figure 10.4. The troublesome aspect of such comparisons is that diverse knowledge systems boxed as TEK or indigenous knowledge are heavily generalized or stereotyped, often in the effort to redress the imbalances, misleading orthodoxies, or forgotten presuppositions of Western science (Agrawal, 1995; Cruikshank, 1998). There is a responsibility to understand the cultural context of TEK *and* Western knowledge in order to avoid untenable comparisons:

> Some of the people using TEK do so on the false basis of a comparison between a selected part of Western societies' knowledge, i.e. 'science,' and the whole of a culture which is regarded as knowledge . . . Such opinions are stated when it is quite clear that science without intuition would be nothing; that many scientists were strictly moral and religious; that the discoveries of Einstein would not have been made had Einstein not believed in a principle of divine harmony; that Indigenous people have hierarchical classification;

and that the same people always, and I say always from my own experience, count the number of fish or whatever they catch in a season, and that they are not merely qualifiers of nature but also quantifiers

(Clément, 1998: 12).

In this way, the TEK–Western science dichotomy can be an illusion that co-management regimes may or may not identify and avoid.

10.8 How something is known is as important as what is known

Real innovation and progress in thought may be discovered in resource management approaches that concentrate on recognizing cultural differences in learning patterns. The manner in which knowledge is learned is as important as the ways it is shared. Animism and shamanism, 'described as among the most significant characteristics of northern cultures . . . [and the] least analyzed . . .' (Yamada and Irimoto, 1997), may be viewed as systems of thought and practice articulating the associations between human will and environmental potential (Ridington, 1990: 96; Irimoto, 1997). Anthropologists working in northern Canada have explored this idea (Bielawski, 1992; Cruikshank, 1998). Mythic beliefs and practices are forms of technology – a system of knowledge representing living practices. They are the means for sharing and interpreting knowledge and often provocative tools for problem solving (Cruikshank, 1998). Myths and stories are powerful agents for thinking, not simply for entertainment. Separating the technical knowledge of a culture from its place within a system of belief can lead to misleading conclusions about the relevance and reliability of that knowledge.

Mythic thinking, story telling, dreaming, and ceremonies are activities that members of Western society might refer to as artistic or ritualistic. However, indigenous story tellers have used narratives to raise significant epistemological issues about Western classificatory practice and contemporary theoretical constructions (Cruikshank, 1998). For example, government resource management regulations in one part of the north allow the hunting of swans for subsistence purposes only. The subsistence classification prompted a Dene elder to ask, 'So, if "subsistence" means "food," and "nonsubsistence" means "culture," how do you get a swan bone for a ceremony?' (Cruikshank, 1998: 17). Fundamental questions are being asked: how do Dene continue to observe hunting practices that respect the reciprocity inherent in human–environment relations? Western resource management defines acceptable harvesting practices in a utilitarian manner: hunting for food is legitimate use, but hunting to maintain a relationship of mutual obligation between the hunter and the animal is another matter.

Stories and ceremonies play a role in linking human history (of human–environment relations) to a sense of place, so that when '[o]ld people they tell

you a story, you've got to listen. When you don't listen, you're going to be crazy. You're going to be crazy, and you're not going to live long' (Cruikshank 1998: 19). Should we be concerned that mainstream resource management ignores and marginalizes the integrative learning offered by narrative and metaphor? By narrowing the kind of knowledge and learning that is relevant to resource management decision-making, are we helping to sever the feedback between human actions and the environment?

10.9 Conceptual diversity: the wisdom to respect what we may not understand?

The cross-cultural translation of knowledge, regardless of the rationale behind human actions, is a big task. What happens, for instance within caribou co-management regimes, when the policies of northern governments require the inclusion of TEK within management decision-making and monitoring activities? A biologist or social scientist speaking to indigenous elders about their knowledge of wildlife may sideline the dances, songs, or stories accompanying such knowledge sharing. An academically trained scientist may not have the knowledge of the metaphor or context that these expressions represent. Aspects of learning or of respecting another way of knowing are therefore lost or at the very least forgotten. Western cultures often ignore the 'background' or context that is in fact the 'operator' in an interaction, and selectively place the 'operands' in the foreground, believing that these parts can be understood distinct from their contexts (Bateson, 1991: 66).

In a series of films recording the thoughts of Inuit hunters and caribou biologists in the Keewatin region (west coast of Hudson Bay) in the late 1970s, one hunter stated:

> I think that they [Inuit hunters, government managers, and biologists] would stop disagreeing with each other if they both started showing things in a way that doesn't make the other person look bad but so that the other person or party understands what the other is trying to do about the caribou
>
> *(National Film Board, 1982, video tape #8[1]).*

In this statement there lies a plea to recognize the difference in the contexts from which caribou hunters and government managers speak.

10.10 Conclusions

Not only are we more aware that space and time are not conceptualized by all cultures in the same way, but we are beginning to understand that language plays

a large role in the way we learn about the world around us. This chapter looked at the discrepancies between the attitudes and belief systems of caribou-using communities and government caribou managers and the ways these differences can frustrate caribou co-management efforts. No doubt, cooperative management *action* is difficult because of the continued differences between government managers and caribou users despite almost two decades of direct dialogue in Canada. However, it is here that encouraging conditions for the learning of resilient thought processes lie. Co-management may be the path to an expanded capacity to recognize the diversity of what we can know about *ourselves* as biological beings, as well as *how* we can know and understand natural processes. The creation of resource management systems that include stakeholders with fundamental perceptual differences – such as caribou co-management boards – may lead to profound and important insights into human–environment relations.

The fact that caribou-using communities have significantly different notions of caribou population phenomena from caribou biologists has the potential to stimulate rather than stall co-management decision-making. Caribou biologists are still coming to grips with issues such as herd discreteness, range use, the periodicity of population cycles, and the effects of human disturbance activities on caribou behavior and viability. Inuit and Dene elders question the reality of population 'crises' and the necessity of handling wild animals outside of the respect and reciprocity of harvesting relationships. Are we seeing evidence of a consciousness that emphasizes the primariness of relations over structure or something similar to Bateson's 'mental process'?

Caribou co-management has enabled an exchange of ideas between resource users and government managers and biologists about research approaches (Urquhart, 1996; Ferguson *et al.*, 1998; Kofinas, 1998). Co-management as a mutual education process involves a fundamental reform of attitudes, both of government and community representatives (Thomas and Schaefer, 1991). As a consequence, co-management is a dynamic process and its outcomes are difficult to describe. There is evidence that slow learning is taking place in caribou co-management settings, but not yet necessarily in a way that ensures that both community and government equally share the costs of this process. It is suggested that indigenous communities run the risk of undermining their aspirations for political autonomy by participating in co-management arrangements that represent partnerships with outside government institutions (Caulfield, 1997; Feit, 1998; Kofinas, 1998). Indigenous communities also diminish their capacity to participate in other land-use planning processes when they take on the enormous burden of translating co-management discussions (conceptually and

linguistically) to community members. There is a large amount of time and effort involved in enabling collective community participation in co-management decision-making.

Caribou co-management may represent an emerging dialectic of conceptual diversity in practice. However, the trust and humility involved are complex. These elements are fostered in arenas beyond the rigid frameworks of formal co-management board meetings. The differences in the knowledge of caribou biologists, managers, and users may involve more than the spatial or temporal contexts of the knowledge (i.e., synchronic versus diachronic observations). The resilience of human abilities to think about natural processes may lie in learning how to challenge mainstream orthodoxies. To do this we must better understand social (human) and ecological linkages. Without mechanisms allowing the respect and support of knowledge systems based upon precepts that are fundamentally different from mainstream resource management thinking, future resource management systems may not only distort or ignore viable ways of thinking, but altogether destroy them.

Learning to respect differences does not lie in the codification of knowledge (Cruikshank, 1998). If we are to think and learn in an adaptive manner, then world views or metaphors that add to the range of human integrative and complex thinking need to be supported rather than ignored. By focusing *only* on the codification of marginalized knowledge, we risk eliminating the resilience of the human capacity to know in integrative and complex ways.

This chapter looks at caribou co-management as a case study of the accommodation of different views of human aims and perceptions of the environment, and illustrates the potential co-management has to provide the space for intellectual discourse between mainstream thinking and marginalized indigenous thought on human–environment relations. Resource management systems tend to fragment the meaning and values inherent in indigenous knowledge in the search for technical explanations of resource dynamics that fit into current ecological models and theories. Co-management may be the place where these problems will be overcome. There is also a relatively unexplored role for indigenous narratives within mainstream resource management systems. These narratives represent ways of looking at social and ecological systems and the links between them that could both complement and challenge established thinking. Co-management is fundamentally a process of joint problem solving with positive outcomes for all parties. All stakeholders lose when knowledge of 'the other' is mystified. Narrative may play a more fundamental role in the way human beings learn and promote resilient, integrative, and complex social–ecological thought than mainstream resource management yet recognizes.

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Note

1. The use of the term 'government' in this chapter denotes nonindigenous government structures. Many indigenous groups in Canada consider their negotiations with Canadian government structures as a nation-to-nation or government-to-government process.

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