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Environment and Society through the Lens of Resilience: Toward a Human-in-Ecosystem Perspective

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Abstract

The study of the commons has provided an interdisciplinary approach for understanding the relationship between humans and the environment. The commons emerges through the interaction of social and ecological processes. As such, the commons acts as an organizing concept through which the interactions between social and ecological processes can be examined within a set of spatial and temporal parameters. The commons approach has differed from other approaches in western theory which have maintained a clear separation between the environment and society. Many of these latter models have provided sophisticated accounts of how the environment and the social articulate and mutually influence each other. However, an emerging body of literature has begun to appear which provides support for the interdisciplinary approach pursued by commons scholars. This body of research emphasizes that systems are often characterized by non-linear processes and multiple equilibria instead of stability, unpredictability, threshold effects and system change. Furthermore, this literature has begun to move toward a human-in-environment instead of a human and environment perspective. These ecological models suggest that more emphasis should be placed upon the relationships and processes at given spatial and temporal scales as well as cross-scale dynamics.

One concept which has proved useful at moving toward a "dwelling" or human-in-ecosystem perspective has been resilience. This paper extends the work of Holling and Sanderson (1996), Berkes and Folke (1998) and others to explore the contribution of the concept of resilience for understanding environment-society linkages. Resilience has been utilized by commons, and other scholars, to explore the linkages among ecological, social and institutional processes. A focus on ecological and social processes is also being utilized in practical approaches to resource conservation and economic development. Through an examination of four such projects it has been found that common property institutions, at multiple scales, are important for maintaining the linkages between ecological and social processes. Both theoretical developments and practical applications of a human-in-ecosystem perspective have drawn attention to the processes which link environment and society, and how such processes drive beneficial and detrimental change.

1. Introduction

There is a long history in several disciplines in trying to understand the relationship between ecological and social systems. The issue is often glossed as the nature/culture and environment/society dichotomies. Glacken (1967) has provided an extensive and wide ranging survey of the ways in which the relationship between environment and society have been conceptualized within Western thought up to the 18th century. With the Age of Enligtenment, humans were extracted from the environment. The separation of environment and society became a foundational principle of Western thought and provided the organizational structure for academic departments. Since that time, Western thought has oscillated between positions in which environment and society were treated as distinct entities, and one in which articulations between environment and society were examined.

One of the early attempts to provide a model of environment and society articulation was that constructed by Karl Marx in the 19th century (Ingold 1980; Harvey 1996; Wolf 1982). Marx's model, while firmly Cartesian, was a sophisticated approach in trying to understand the relationship between environment and society, on the one hand, and the individual producer and society, on the other. Marx recognized that by transforming the environment, humans also transformed their society (Wolf 1982). This was not a deterministic model but one which recognized that the relationship between environment and society was made up of complex processes and multiple causality. However, the model emphasized the opposition between both environment and society and between individual and society, thus maintaining Cartesian duality.

The discussion on the relationship between environment and society has been carried on during the 20th century in many different disciplines. There has been the human ecology of Thomas Park 1936), the cultural ecology of Julian Steward (1955), the ecological anthropology of Gregory Bateson (1973; 1979), Netting (1974; 1986; 1993), Vayda and McCay (1975), the population school represented by Paul Ehrlich (1968), the ideas of Carl Sauer (1956) and other human geographers, the environmental history of William Cronon (1983) and Donald Worster (1977;1988), the ethnoecology of Conklin (1957) and others (Toledo 1992; Nazarea 1999) and the emerging political ecology (Greenberg and Park 1994; Peet and Watts 1996). The literature

pertaining to the environment and society relationship spans many disciplines and contains much theoretical discussion.

Recently, an emerging body of literature is emphasizing that ecological systems are characterized by non-linear processes and multiple equilibria instead of stability; surprises (perceived reality departing qualitatively from expectation, in the sense of Holling 1986); threshold effects; and system flips. Implications of this perspective are being explored for understanding the relationship between environment and society (Biersack 1999; Kottak 1999; Scoones 1999; Vayda and McCay 1975; Zimmerer 1994; Zimmerer and Young 1998). Following Berkes and Folke (1998), institutions are a key link between social systems and ecosystems. To the extent that much of the environment is used as a shared resource, common-property institutions are an important consideration for this body of literature. To the extent that resources and human uses occur across a variety of scales, both spatial and temporal, linking social and ecological systems is a cross-scale problem (Holling et. al. 1998).

Taken as a whole this body of thinking questions the utility of Cartesian models which maintain the separation between environment and society. Such a position reverses Descartes' c*ogito ergo sum* (I think therefore I am), to *sum ergo cogito* (I am therefore I think) which may be called a human-in-ecosystem, or "dwelling", perspective (Descola and Palsson 1996; Ingold 1998; Ingold, forthcoming). One line of thought which has been woven throughout this broader literature is the idea of resilience as reformulated by the ecologist C.S. Holling (1973). Holling's resilience is utilized as a way to think about the relationship between environment and society and about the boundary between the two. This paper extends the work of Holling and Sanderson (1996), Berkes and Folke (1998) and others to explore the contribution of the concept of resilience for understanding environment-society linkages.

The chapter begins with a broad overview of different ways in which Western thought has conceptualized the relationship between environment and society (Section 2). It then traces the sources of a systems approach for understanding environment and society interactions (Section 3). The paper then turns to an examination of three different approaches which have drawn on the resilience concept (Section 4). We then examine four recent and practical applications of the human-in-ecosystem approach (Section 5) for an insight into emerging

syntheses which are proving useful for understanding environment/society linkages.

2. Environmental Determinism, Possibilism and Cultural Ecology

Cultural ecology and ecological anthropology emerged from the tension between two contending "grand" theories which have been termed "anthropogeography" and "historical possibilism" (Geertz 1963; Moran 1979). Anthropogeography is a variant of environmental determinism which has its origins in human geography. It proposes that the environment is the causal agent for the behavior of social systems. According to environmental determinism, "a 'temperate' or 'balanced' climate, ethnocentrically defined, was responsible for the virtuous qualities of the area's inhabitants. As a result, they were destined to rule and control the 'lesser' domains where populations were more lethargic, less courageous, and less intelligent" (Moran 1979: 24).

Although not politically correct today, environmental determinism was often used by many societies to explain the relationship between their own society and other people. The early Greek, Roman and Arab empires, along with the dominant European countries of the eighteenth and nineteenth centuries, all utilized environmentally deterministic theories in this manner (Moran 1979).

Anthropogeography was a particular manifestation of environmental determinism, developed by Friedrich Ratzel in the late 1800s, which suggested that the interrelation of groups with their habitats produced specific kinds of cultural traits. Following Moran (1979), Ratzel's main thesis included the following propositions: habitat was primary in bringing about cultural diversity; similarities between cultural groups were explained as occurring due to the diffusion of traits by migrating groups; and, human cultural evolution emerged out of the territorial competition between migrating groups. Ratzel's theory began a trend that viewed human beings as limited by their habitat in their range of responses, and human culture as shaped by environmental conditions. According to this view, environment was postulated to cause change in human societies, thereby accounting for human evolution through a process of trait selection by the environment.

Historical Possibilism was developed by Franz Boas in the early 1900's as an alternative theory to explain the interactions between humans and the environment. Historical Possibilism suggested that "nature circumscribes the possibilities for humans, but historical and cultural factors explain what possibility is actually chosen" (Moran 1979: 34). In Boas's view, humans chose what they want to use in nature, and it is those cultural decisions, not nature, which influence the trajectory of human societies and cultural change. In order to refute environmental determinism, historical possibilism constructed the concept of culture as the basis of human adaptation. Boas emphasized inductive studies which focused on the empirical cultural traits of different human groups as a means to counterbalance the deductive theories of environmental determinism.

Through studies carried out in the early and mid-twentieth century, anthropologists were able to demonstrate that many different cultural traits were found in areas sharing similar biophysical environments. It was culture, and not geography, which led to differences between human groups. Traits shared by groups were explained by diffusion from one culture area to another. How far a cultural trait had diffused from its origin was believed to demonstrate the antiquity of a trait. Although this approach corrected for environmentally deterministic theories, it led to another problem because of its emphasis on the idea of culture. Culture became a "superorganic" entity which subordinated individual humans to its patterns. The causal agent shifted from the environment to culture; change emerged from historical and cultural forces while the environment acted as the setting in which these forces were played out.

The cultural ecology of Julian Steward emerged out of the debate between these two opposing theories as another perspective to understand the relationship between nature and society. One of Steward's objectives was to move anthropology back toward a consideration of the evolutionary or adaptive relationship between human society and nature (Steward 1955). To return to the question of how societies change, the purpose of cultural ecology was to "develop a methodology for determining regularities of form, function and process which recur cross-culturally among societies found in different cultural areas" (Steward 1955: 3).

Whereas other writers sought to formulate cultural development in terms of supposed universal stages, Steward's objective was to seek causes of cultural change. Cross-cultural

comparisons were made through an examination of the "cultural core" which was defined as the "recurrent constellations of basic features ... which have similar functional interrelationships resulting from local ecological adaptations and similar levels of sociocultural integration" (Steward 1955: 6). The basis of Steward's evolutionary theory was "multilinear evolution" which he defined as "the methodological position [which] assumes that certain basic types of culture may develop in similar ways under similar conditions but that few concrete aspects of culture will appear among all groups of mankind in regular sequence" (Steward 1955: 4).

Steward's cultural ecology, by focusing on empirical features, rather than deductive and universal theories, was an important reframing of understanding the relationship between cultural change and the environment. First, he pushed the focus towards the relationship between the environment and cultural features, and how adaptation or change emerged out of the relationship over time. Second, he emphasized empirical cases by which similarities could be found across cultures and theories of process could be built. Third, he recognized that human perception of the environment played a role in the environment/human relationship and adaptation.

3. Ecological Anthropology and the Rise of Systems Approaches

Geertz (1963) in his book, *Agricultural Involution*, provided a new challenge to the model of cultural ecology. He suggested that an ecological approach should utilize an ecosystem model, whereby humans were one component of an ecological system. As Geertz put it, "the ecological approach attempts to achieve a more exact specification of the relations between selected human activities, biological transactions, and physical processes by including them within a single analytical system, an ecosystem" (Geertz 1963: 3). This mode of analysis is of a sort which trains attention on the pervasive properties of systems *qua* systems (system structure, system equilibrium, system change) rather than on the point-to-point relationships between paired variables of the "culture" and "nature" variety (Geertz 1963). One significant aspect of Geertz's (1963) approach is that he suggested a unified systems model which would include both biological and social entities and processes, an idea which would not be fully explored again until the 1990's. His main criticisms of Steward's (1955) cultural ecology model were that it still

perpetuated the nature/society dichotomy, and reduced the number of variables which might be considered in understanding cultural change to those emerging from the adaptive relationship between environment and society.

Geertz showed in *Agricultural Involution* that changes in Indonesian society were not attributable to ecological processes but emerged from political, commercial, and intellectual developments. The features of society do not change only as a result of changes in the cultural core, as those features adapt to the environment, but may also change for reasons which are unrelated to subsistence technology. Geertz's (1963) ecosystem approach attempted to put humans into a unified system, while insisting that the system account for social and political structures, functions and processes along with the biological.

The application of the systems approach and use of ecological concepts moved the field into what was termed the new ecological anthropology (Moran 1979; 1990; Vayda and McCay 1975). While Geertz (1963) recognized that social, political and biological variables should be included in a systems approach, it proved difficult to operationalize such an ecosystem approach. Rather, ecological anthropology turned toward the study of human adaptation by utilizing the principles of biological ecology (Vayda and Rappaport 1968).

A number of different approaches were utilized to study human adaptation within an ecosystem framework. The most notable of these has been the use of energy flows and the use of cybernetics, or information flows, along with a study of rituals (Rappaport 1967). The systems approach was not without its critics. Some of the most glaring problems included the teleological fallacy which attributed goal-seeking behavior to levels of organization higher than the individual; an overemphasis on the role of energy; a focus which emphasized equilibrium and functional behavior at the expense of historic change; lack of consideration of the role of the individual; and lack of attention to boundary and scale (Alland and McCay 1973; Borofsky 1994; Keesing 1976; Moran 1979,1990; Vayda and McCay 1975).

Many of these criticism emerged out of the renewed emphasis on the primacy of the individual in the theory of biological evolution (Alland and McCay 1973; Richerson 1977). However, the challenge for both the systems and the evolutionary approaches have been to account for Geertz's (1963) early observation that changes in societies cannot solely be explained

either by the adaptation of cultures or of individuals. The environment/society dichotomy, and the location of causality for societal adaptation within this dichotomy, has remained a continuing tension within ecological anthropology.

Evolution, as a biological process, and history, as a social process, both influence human adaptation and societal change; however, our understanding of the processes by which this occurs is still unfolding (Geertz 1963; Netting 1974; 1986; McCay and Jentoft 1998). The relationship between human perception and the environment emerged into a new area, ethnoecology, which has provided an arena for an ongoing debate regarding the role of perception in adaptation (Conklin 1957; Nazarea 1998; Ingold 1998). The role of perception and political processes in the relationship between humans and the environment emerged into a new line of inquiry, political ecology, which combines political economy with an ecological approach. Political ecology "expands ecological concepts to respond to this inclusion of cultural and political activity within an analysis of ecosystems that are significantly but not always entirely socially constructed" (Greenberg and Park 1994: 1).

These new developments in ecological anthropology, ethnoecology and political ecology have largely resolved the old culture/individual dichotomy. The main area of interest at this point is to break down the environment/society dichotomy (Descola and Pálsson 1996; Escobar 1999; Ingold 1998). The challenge for these new disciplines and other approaches to understanding the relationship between humans and the environment has been to build a new kind of ecological model of humans in the environment. Resolving the environment/society dichotomy may require incorporating evolutionary and historical processes into a model, and creating ecological concepts which are sensitive to both (Holling et al. 1998). One such concept which was developed in the ecological literature and utilized in the analysis of the linkages between ecological systems and social systems is resilience.

4. Resilience for Environment - Society Linkages

While the concepts of single vs. multiple equilibrium systems, stability, change, resistance and resilience have been developed in the ecological literature, they are concepts

which are not unfamiliar to social scientists. In 1975 Andrew Vayda and Bonnie McCay drew from the work of Holling and Goldberg (1971) and Holling (1973) to suggest that resilience may be a more useful concept to understand human adaptation then stability and resistance. Vayda and McCay (1975: 298) stated, "ecological systems that have survived are 'those that have evolved tactics to keep the domain of stability, or resilience, broad enough to absorb the consequences of change.'" The consequence for social systems is that resilience means "...remaining flexible enough to change in response to whatever hazards or perturbations come along" (Vayda and McCay 1975: 299). Resilience, in this sense, is coterminous with flexibility, and stresses the ability of individuals, households or groups to adapt to disturbances and survive (McCay 1981; Lamson 1986).

The concept of resilience appeared in the ecological literature at a time when culture was held to be the force by which humans confronted nature and shaped it to their purposes, as well as the super-organic entity which constrained individual human behavior (Anderson 1973; Moran 1979, 1990; Wolf 1982). In a similar vein, Rappaport (1967) had published his study which suggested the use of ritual acted to translate complex ecological processes into binary switches. This process allowed humans to make the appropriate decision, in Rappaport's analysis, to maintain an ecological equilibrium. The assumption behind this functionalist approach was that culture was an equilibrium-based system, whereby the equilibrium was near the carrying capacity of the environment. A culture, in this perspective, was analogous to a climax forest. The function of systems processes were to maintain a society at a specific balance, and to move it back towards the equilibrium point after a disturbance.

Utilizing Holling and Goldberg (1971) and Holling (1973), Vayda and McCay (1975) challenged Rappaport's concept of culture as an equilibrium-based system. What Rappaport saw as a stability-maintaining mechanism could be interpreted instead as a resilience-building mechanism. To Vayda and McCay resilience, as a property of social systems, allows individuals and societies to change in the face of environmental challenges such as hazards. The resilience concept requires "investigating possible relationships between such characteristics of hazards as their magnitude, duration, and novelty, and the temporal and other properties of people's responses; abandoning an equilibrium centered view and asking instead about change in relation

to homeostasis; and studying how hazards are responded to not only by groups but also by individuals" (Vayda and McCay 1975: 302).

The concept of resilience helped to move ecological anthropology toward a dynamic, ecological perspective which investigated processes of change and equilibrium and disequilibrium, through an examination of the relationships between the environment, individuals and groups. Subsequent literature used to concept of resilience to explore three related themes:(1) generalist and specialist strategies; (2) uncertainty and surprise; and (3) adaptation ability and degree of centralization.

4.1 Generalist and Specialist Strategies

The Africanist literature on hunter-gatherers and pastoralists parallels the above-cited work but differs from it in that it uses Holling's ideas about resilient and stable systems in a comparative fashion. The basic premise of this optimal foraging strategy thesis is that in locations where resources are unpredictable (referred to as "resilient system") a generalist strategy is pursued, whereas in areas with predictable resources ("stable system") a specialist strategy emerges. Yellen (1977) utilizes Holling's view as part of what he calls the stability-time hypothesis. "Holling (1973) draws the useful distinction between stability and resilience. Stable systems are those which tend to return quickly to equilibrium after a temporary disturbance and can be best described with equilibrium models. In resilient systems, there may be no single point of equilibrium. Individual components may be subject to rapid, unpredictable change; however, basic relationships between components or populations remain the same" (Yellen 1977: 264).

Yellen (1977:270) goes on to suggest that, in reference to hunter and gatherers who live in desert environments characterized by unpredictability, "in relatively severe, variable environments of low predictability, populations exhibit resilience and the ability to persist over time. One of the ways in which hunter and gatherers have adapted to these unpredictable resource fluctuations is through flexible forms of social organization in which the composition of groups can change readily:

> In an environment subject to severe and unpredictable change, it is obviously advantageous for a population to be able to alter its distribution rapidly in order to put the most people in places where the most resources are available. Among the

> !Kung, for example, the ability for rapid movement in a number of possible directions is provided primarily through kin ties and the obligations generated by them... Other social patterns such as the belief that people with the same name have special obligations toward each other, and their system or inheritance in which individuals may have rights in scattered places, also *increase the number of possible residence locales and permit rapid changes in residence, if need be*" (Yellen 1977: 270-271, emphasis added).

Brooks et al. (1984) developed this idea into a comparative approach by contrasting African hunter-gatherers ("generalists") with African pastoralists ("specialists"). The "generalist" strategy was characterized by the following features of social organization: "...small social groups, absence of rights to property, emphasis on bilateral kin relations, and egalitarian social structure with minimal formal political and legal structures" (Fratkin 1986: 270). In contrast, the "specialist" strategy was characterized by "...longer occupation of settlements, cooperative herding, corporate ownership and lineal inheritance, increased value of children's labor, formal political and legal structures, the emergence of material accumulation and differential wealth, and increased birth rates" (Fratkin 1986: 270). He contrasted two pastoralist societies of northern Kenya, the Arial who live in a unpredictable environment, and the Rendille who reside in a more predictable environment.

> The Ariaal differ from the cattle-keeping Rendille in their production of two major types of livestock, camels and cattle, in the marginal and variable environment of the Ndoto Mountain-Kaisut Desert interface. Their subsistence strategy is more generalist than the Rendille, allowing them to emphasize either cattle, camels, or small stock production when conditions drastically change, such as in the nineteenth century during the Rinderpest epidemic that destroyed Ariaal and Samburu cattle. The Rendille, wholly dependent on their camels and small stock in the constant but limited resources of the desert, have a specialized subsistence strategy that is less resilient to sharp changes (Fratkin 1986: 284, 283).

The relationship between resilience and social organization is also explored by Dyson-Hudson et al. (1998) who suggest that the Turkana follow a generalist strategy to cope with environmental diversity and stochasticity. The characteristic structure of social organization is a residential and production unit called a camp. Camps are composed of temporary shelters and corrals, a nuclear family, and a herd. The herd moves many times a year and may subdivide and undertake independent movements. In order to undertake this activity, a herd owner "...needs

several skilled and responsible herder managers with a detailed knowledge of livestock and of the South Turkana environment" (Dyson-Hudson et al. 1998: 22). An individual production unit with fluctuating herd size and a loose system of social organization, such as the Turkana, also requires a network of kin and friends who act as supporters in disputes and provide insurance during bad years.

Dyson-Hudson and colleagues suggest that one of the mechanisms by which resilience is built into the Turkana social system is through marriage rules. It is the marriage rules which "prevent the society from fragmenting into tiny, independently operating human/livestock units, which would lack the adequate resources to provide the diversity of labor and management skills to cope with a harsh, severely fluctuating environment" (Dyson-Hudson et al. 1998: 42).

4.2 Uncertainty and Surprise

In discussing the concept of resilience, Holling (1973) distinguishes between ecological systems which are characterized by high levels of fluctuation versus low. He suggests that the property of resilience is found in those ecosystems where climatic fluctuations are extreme and are characterized by unpredictable and widely fluctuating populations of organisms. The property of stability, or the ability to maintain an equilibrium, is found in less fluctuating climates whereby populations are more constant but less able to absorb chance climatic events. In the former, the system tends to have a high degree of resilience but low stability, whereas in the latter, the system is characterized by a high degree of stability but low resilience. "The balance between resilience and stability is clearly a product of the evolutionary history of these systems in the face of the range of random fluctuations they have experienced" (Holling 1973:18).

A number of authors have used the resilience idea to explain how societies deal with resource uncertainties. For example, Winterhalder (1983), writing about Cree-Ojibwa moose hunting in Northern Ontario, pointed out the importance of resilience in adjusting hunting strategies in a patchy and uncertain environment. One author who has used the resilience idea in some detail is McCay, who discussed the relationship between resource uncertainty and fisherfolk in Fogo Island, Newfoundland:

> Variability in the size of year-classes is inherent in Atlantic cod populations...Temporal and spatial variations in wind, currents, and other factors generate changes in cod migratory behavior and availability...Unpredictable variability in cod is compounded by the effects of storms, high winds, and Arctic ice on the ability of fishermen to get out to the grounds and use their gear. The result is a highly uncertain and fluctuating resource. Codfish production figures on Fogo Island vary as much as two-fold from year to year...In addition, in any given year cod may be abundant on some fishing grounds but scarce on others (McCay 1978: 405**)**.

Fisherfolk perception of resource cycles across time (seasons) and space provides them with the means to formulate goals and strategies (coping mechanisms) which over time develop into adaptive strategies (in the sense of Bennett 1969). Fisherfolk perceive the environment as the textured seascape of patterns and rhythms in which they dwell and make their livelihood. Technology, knowledge and social organization are forged within the patterns and rhythms of the seascape and help the fisherfolk make a livelihood from a fish population which fluctuates widely over time and space. Resilience is reflected in the technology, knowledge and social organization. The particularities of such a livelihood can be seen in the Fogo Island fishing strategies.

> Cod fishing crews ... maintained two or three traps, placed in widely spaced "berths", or fishing spots. If fish were scarce in one berth, they might be abundant in another. Similarly, crews used or kept on hand a wide variety of fishing gear, and often two or more different kinds of boats, which permitted a rapid switch from one technology to another. If cod failed to come into shallow inshore waters where the "trap" fishery took place, the crew might set gill-nets or use hook-and-line gear in deeper near-shore waters. In addition, family firms maintained the capital equipment and recruitment process necessary for engaging in a "fall fishery," which they relied upon as insurance against the failure of the more intensive and normally more productive "summer fishery." Seasonally available salmon and lobster also provided buffers against the failure of cod. Moreover, a long tradition of being "fisherman-farmers," and more recently "jacks of all trade," provide yet another means of coping. When fishing was poor, lumbering, construction work, subsistence farming, and the use of government transfer payments (unemployment insurance since 1959 and welfare assistance) provided alternative or supplemental sources of income (McCay 1978: 405-406).

Resource uncertainty and unpredictability need to distinguished from truly novel or unexpected change, a"surprise" in Holling’s (1986) terminology. McCay (1978) suggests that

there are two possible responses when a resource departs from the expected cycle: diversification and intensification. Occupational pluralism, or diversification, referring to a "general ‘spreading of the risk’ and expanding alternative modes of coping with environmental problems" is relevant to both general uncertainty and surprise (McCay 1978: 410). During an unexpected resource event, the first response is to diversify into minimal, less costly and more reversible alternatives. This is a "wait and see" or a "weather the storm" strategy, whereby an individual or group undertakes alternative activities to see if the resource cycle returns to the expected pattern: "... minimal responses to perturbation may be valuable in providing a built-in time lag for evaluating the magnitude, duration, and other characteristics of problems, as well as the effectiveness of solutions. They thereby minimize the chance that costly and irreversible responses are activated for what might turn out to be trivial or transient problems" (McCay 1978: 415-414).

If the expected pattern does not reemerge, then an "intensification" strategy may be adopted, whereby people will make an "increased commitment to an investment in one or another mode of resource procurement [which are] ‘deeper’, more costly, and less reversible" (McCay 1978:410). If these new strategies are adaptive, they may provide a long-term solution which restores flexibility to social actors and units. Diversification is the appropriate strategy if the ecological system has remained within the previous domain of stability.

In some cases, it is difficult to distinguish between a cycle of long periodicity and a true surprise. Resource cycles of 50 to 100 years may not be within the memory of a group of people and their institutions. If surprise is a result of long-term cycles, then it may be possible to return to the previous livelihood cycle at some future point. There is some evidence that traditional societies may be able to deal with certain classes of long cycles such as once-in-a-generation tropical hurricanes (Lees and Bates 1990) and caribou population cycles which may be on the scale of a century (Berkes 1999). The mechanisms that provide resilience seem to be those that help start up the reorganization phase of the adaptive renewal cycle, such as elders and the use of oral histories (Berkes and Folke 2000).

Whether elders or oral history can help in the case of real surprises and "large, infrequent disturbances" or LIDs (Turner and Dale 1998), is an open question. As well, system flips from one stability domain to another, as in the potential case of climate change (Holling 1986), creates

a unique set of adaptation and resilience problems. Folke et al. (1998) have pointed out that one way traditional societies and other groups seem to have dealt with surprises is to create small disturbances that would help forestall much larger disturbances and surprises. They point out several cases in *Linking Social and Ecological Systems* which indicate that disturbance management is an adaptive response of many groups. Nurturing sources of ecosystem disturbance and renewal maintains the capacity of an ecosystem to absorb perturbations, thus preventing flips.

4.3 Adaptation Ability and Degree of Centralization

Another class of uses of the stability/ resilience idea deals with the question of why some societies (groups, companies) may have failed to adapt and "went out of the evolutionary game" (Hurst 1995; King 1995; King 1997; Lamson 1986; McGovern 1980). One of the commonalities to these approaches is that flexibility of social organization allows societies to adapt to resource cycles and surprises more effectively than do rigid hierarchies. This is the essential message of McGovern's examination of the Norse colony in Greenland during A.D. 985-1500:

> There is little doubt that the Greenlandic Norse economy, as established in the little climatic optimum, faced serious if not fatal challenges in the 14th century. With full inner-fjord resource space, heavy investment in ceremonial architecture, and strong linkages to distant and increasingly disinterested European markets, Norse society of ca A.D. 1300 showed a *dangerous lack of resilience (in the sense of Holling 1973)* in the face of waning extractive efficiency, fluctuating resources, and Inuit competition (McGovern 1980: 270, emphasis added)

McGovern (1980:272) identifies three characteristics which he suggests may reduce resilience in societies: (1) treating innovation as inherently dangerous to elites; (2) controlling social ideology, in this case through the medieval church, to punish deviance and reinforce orthodoxy; and (3) centralizing decision-making powers. In his view, the suppression of innovation, adherence to orthodoxy and centralized decision-making, in face of environmental change impair adaptive response. In the case of the Norse colony, the movement to utilize coastal resources by poor farmers threatened the land holding elite of the colony, and was prevented through social controls. The later work of McGovern and colleagues continues to use the resilience concept to deal with the question of environmental degradation in North Atlantic offshore islands colonized by medieval Scandinavians:

> Modern climatic data indicate that it is the resilience and stress-resistance of pasture communities that would be most altered as Norse farmers sailed north and west - not gross species composition or initial resistance to grazing pressure. As modern experience suggests, it is not easy to judge pasture resilience until damaging overgrazing has already occurred. Stocking levels appropriate to wind-sheltered areas may be disastrous on nearby exposed slopes, as small holes in the groundcover are rapidly widened , soon turning into a swiftly advancing erosion front that is difficult to halt (McGovern et al. 1988: 125).

Much of the literature on the question of adaptation ability and centralization deals with institutions. King (1995) reviewed the common features of four societies (referred to as "surprise-avoiding communities") that seem to have survived for a long time without reducing the natural environment's ability to support life, and concluded that the critical point was the communal use of resources. Common property resource management institutions in these four societies allowed the natural spatial and temporal variability in the environment "to a degree almost unimaginable today" (King 1995: 976). Because resources were held in common, King argues, human-made boundaries did not place an artificial grid on the landscape to impede natural flows and cycles.

Although common property is no guarantee of prudent ecological practice, one of the ways in which common property institutions are supportive of resilience is through locally adapted practices based on ecological knowledge and understanding (Folke et al. 1998). It has been documented by many cases in *Linking Social and Ecological Systems*, as well as elsewhere, that local-level institutions learn and develop the capability to respond to environmental feedbacks faster than do centralized agencies. Being "on the ground" they are physically closer to the resources, there is no separation of the user from the manager, and there is more learning-by-doing in accumulating a base of practical ecological knowledge (Berkes and Folke 1998).

Another way of looking at this issue is that large, centralized resource management agencies are susceptible to making large mistakes -- which by itself is not a bad thing because making mistakes is the primary means by which institutions learn (Gunderson et al. 1995). But by the same token, it is less risky for managers and users alike to make smaller mistakes and to learn from those smaller mistakes. Local-level common property institutions help decentralize environmental decision-making and diffuse the risk. As well, to reflect on McGovern (1980),

they produce opportunities for innovation -- innovation that is important for the integrity of adaptive renewal cycles. One of the most striking aspects of common property institutions is their diversity. This is in sharp contrast to conventional resource management which has reduced, since the middle of the twentieth century, diversity in and experimentation of the ways in which environment and resources are managed (Berkes and Folke 1998).

The concept of resilience and the centralization of power become increasingly important for the intentional management of resources. For example, people are able to intentionally change the temporal and spatial characteristics of terrestrial resource cycles through technologies such as fire (Lewis and Ferguson 1999; Johnson 1999). By changing the range of oscillation of the resource cycle and the spatial characteristics of the system people attempt to gain stability at the expense of resilience. The reduction of resilience, in order to gain stability, is an intentional act and can exist along a continuum from burning a berry patch to producing berries in an industrial monoculture. The trade off is between resilient, but fluctuating resource cycles and stable resource production increasingly vulnerable to surprise (Finlayson and McCay 1998). As production becomes more stable, in the short term, it can attract investment to maintain or increase stability. For example, there is a dramatic difference in the investment made by a harvester of wild berries versus the industrial production of such berries. As people and industries specialize and invest in a resource there is also a centralization of resource management power at a higher scale. The priority of resource management becomes the maintenance of stability and not resilience. McCay has summarized this process in the following manner:

> with centralization of power and control, there is a greater likelihood that inappropriate responses or errors in the scale of response will occur...or that centralization will itself worsen the initiating environmental problem...In addition, it becomes difficult for individuals and local communities to maintain their own flexibility, or ability to respond effectively to an uncertain and changing environment, because of their increased dependency, and the specialization attendant upon political development. It is also politically difficult for them to regain responsibility over the management of their local environments when the nature of their environmental problems is such that a lower level of regulation might be more appropriate. One reason for this is the public policy comes to serve the special purposes of certain powerful groups or individuals through the process of usurpation...Accordingly, it may not be in their interests to allow

> regulations which have come to attain values other than environmental control to be changed in favor of local communities. (1981:372)

5. Operationalizing Resilience: Dwelling in the Eco-Commons

Resolving the environment/society dichotomy has required a stroll through a vast literature spanning several disciplines and sub-disciplines. In this section, we turn to a consideration of some recent practical applications of a human-in-ecosystem approach. These conceptualizations essentially use an ecological perspective which attempts to move beyond the individual/culture and nature/culture oppositions through a focus on **processes**. As such, they are consistent with the resilience concept and provide ways of operationalizing resilience.

Dwelling is a perspective which begins with the premise of the integrated concept of humans-in-nature (Berkes and Folke 1998). It is the practical and perceptual engagement of humans with others of the dwelt-in-ecosystem which generates the forms and holds them in place (Ingold 1996). Knowledge, in a dwelling perspective, can be defined as skill, or "...the experience gained through direct, 'hands on' engagement in particular tasks - experience that both enables one to make sense of spoken or written instructions, and that is augmented in the process of following them" (Ingold 1997: 31-32). Learning, or enskilling, is a process which may be described as the "education of attention" as elders create structured contexts through which the novice can build her own perceptual skills in relation to the total environment, biophysical and social (Ingold 1998). What are the practical applications of a dwelling perspective which takes into account the ecological and social cycles which occur within an ecosystem? One way to examine this question is to look at initiatives which have applied human-in-ecosystem approaches through "on the ground" projects. Four projects are chosen for discussion, each one reflecting a dwelling or humans-in-ecosystem perspective: (1) the sense of place project directed by Gary Nabhan of the Arizona Sonora Desert Museum in Tucson, Arizona; (2) the people's biodiversity registers programme in India initiated by Madhav Gadgil; (3) the Kagiwiosa-manomin project of the Wabigoon First Nation in Canada

initiated by Joe Pitchenese and Andrew Chapeskie; and (4) the citizen's science programme directed by Steve Light in Minnesota. All four projects share the twin emphasis on the importance of access to resources and the processes of knowing-learning-remembering ecosystem components and processes through livelihood activities. This can be seen through a brief summary of the four projects and their foundational statements.

The **Sense of Place** (SoP) project has worked in collaboration with local organizations to explore the unique natural and cultural resources, place names and vocabularies, songs, foods and other traditions of the Sonora watershed. The project works with both indigenous and non-indigenous communities in the southwestern United States and northwestern Mexico to build a strong sense of identity, heritage and relationship to the surrounding terrain.

> When a culture remembers and incorporates particular springs, sacred mountains, fields, buildings, marketplaces and ceremonial grounds as "places of the heart", these places are less likely to be unnecessarily exposed to external threats that diminish them. We believe that strong community institutions such as museums, libraries, historical societies, cultural centers and gardens can help nurture and support the unique features of a place and its peoples, acculturate newcomers and slow detrimental change. (http://www.desertmuseum.org/place/launch.html:1)

The **People's Biodiversity Registers** (PBR) program was initiated by the Foundation for Revitalization of Local Health Traditions with the initial purpose of documenting community based knowledge of medicinal plants and their uses for 52 communities spread across India. The scope of the project has since been expanded to examine all elements of biodiversity by recording the knowledge and perceptions of lay people, primarily rural and forest dwelling communities, of living organisms and their ecological setting across an expanded geographic region.

> All knowledge and wisdom ultimately flow from practices. But their organization differs amongst the different streams of knowledge. Folk knowledge is maintained, transmitted, augmented almost entirely in the course of applying it in practice; it lacks a formal, institutionalized process of handling it...[Folk knowledge and wisdom] must therefore be supported in two ways; through creating more formal institutions for their maintenance, and most importantly, by creating new contexts for their continued practice. (Gadgil n.d.)

Kagiwiosa-Manomin (KM) was an initiative started by Joe Pitchenese of Wabigoon First Nation to establish Ojibway tenure for manomin (*Zizania aquatica* L.), an Ojibway harvesters' cooperative, a manomin processing facility based on historic Ojibway processing methods and organic, and bulk, markets in North America and Europe. The project emerged from the realization that the retention, transmission and adaptation of knowledge about manomin was linked to the practice of manomin harvesting, the Ojibway identity in northwestern Ontario, Canada and the need for supplemental income.

> The Anishinaabeg of the Wabigoon Lake Ojibway Nation are continuing to struggle to retain an indigenous management regime pertaining to the growing and harvesting of wild rice. Indeed they have begun to reclaim control over the processing of the product through the establishment of a wild rice processing business in the community which is seeking to work within the customary rule-making framework of the community itself which regulates the utilization of the resource." (Chapeskie 1986:131-132)

The **Citizen's Science** (CS) program emerged from the idea that sustainability of natural resources can only be achieved through citizen-led democratic action working with nature, the way nature works. The emphasis of the project has been to bring together the citizens, scientists, government agency personnel and politicians of Minnesota, U.S.A. in an attempt to cooperatively define problems and find solutions through joint experiments carried out by citizens and scientists.

> The project was born of beliefs founded on the understanding that sustainability of natural resources can only be achieved through citizen-led democratic action working with nature, the way nature works. This requires developing partnerships among stakeholders with multiple and diverse perspectives who are willing to tackle complex problems, working together to create innovative science-based approaches. The challenge is finding ways to make decisions in the present-based on incomplete scientific knowledge-that remain open to improvement and reframing in the future. (Light et al. 1999:5)

The four projects demonstrate that a human-in-ecosystem perspective can be applied in many different contexts, although each project emphasizes different approaches. One of the main differences among the four projects is the degree to which the participants derive their livelihood from a direct use of the products of their local ecosystem. Table 1 summarizes an attempt to capture the core components of a human-in-ecosystem approach. Six themes emerge

out of the grouping of these core components: (1) use of spatially bounded management units; (2) relational networks; (3) embeddedness; (4) knowing-learning-remembering; (5) cultural identity and sense of place; (6) institution building; and, (7) livelihood activities.

(1) Spatially bounded management units

Two of the four initiatives, SoP and CS projects, both emphasized the importance of recognizing nested ecological and institutional units. However, they also noted that the boundaries or scale of an ecological unit did not always match social or institutional units. Institutions representing different class or ethnic groups may be found within one ecological unit. This situation becomes increasingly apparant as the ecological unit is scaled up. The solution pursued by the SoP and the CS projects regarding this problem of fit between ecological and institutional units was to work at multiple scales. The projects worked intensively with ethnic or other local communities while also encouraging events which brought people together within a regional watershed. Over time it is hoped that these "communities of interest" may form into larger representative institutions which can cope with larger scale ecological units.

(2) *Relational networks*

Understanding the networks of relationships among people and among people and other species was seen, to varying degress, as an important element by all four projects. The existence, or creation, of networks was seen as the basis of communication among the inhabitants of an ecosystem. Such communication was seen to provide a system of feedbacks among the inhabitants and allow for the appropriate adjustments in behaviour. Events as simple as annual picnics which brought together different communities sharing food, crafts, stories and song; school field trips in which elder members of the community could share knowledge with youth about places in the landscape; or workshops where people could learn how to make things from local species were all seen to contribute to building communication and feedback loops within an ecosystem.

(3) Embeddedness and behaviour

All four initiatives concurred that the individual behaviour of individuals and institutions was embedded within social strutures and cultural values. Behaviour toward other humans and

other species can not be explained solely through an analysis based on aggregating the economizing or rational choice preferences of individuals. This is especially evident in the SoP project which has supported creative writing and other artistic endeavors to express the relationship among people and among people and other species of the Sonora watershed. The assumption is that the values which embed economizing preferences and rational choices will influence the contours of such preferences and choices.

(4) Knowing-learning-remembering

The SoP, PBR and KM projects reflect an emphasis on the importance of supporting , or re-engaging, people in the processes of knowing, learning and remembering an ecosystem through practical activities. Such activities allow people to build their own perceptions of an ecosystem and to share their perceptions within and between generations. The dwellers of an ecosystem were brought into, or initiated, these three projects as active participants in the documentation, creation and communication of knowledge, institutions, technologies, and values.

(5) Cultural Identity and sense of place

Cultural identity and sense of place were explicitly mentioned by the SoP, KM and CS initiatives. Identity and sense of place are complex concepts but were considered to be linked to the practical activities of people, people's perceptions of an ecosystem and the relational networks that people build within an ecosystem. The projects supported activities which allowed for the creation and strengthening of both individual and collective identities. Individual and collective identities and senses of place appear to be emergent properties of particular ecosystems and relational networks as built through on-going practical experiences and communication.

(6) Institution building

The PBR and the KM project both place an emphasis on institutions at the scale of collective property-rights and specific livelihood activities. Larger scale common-property institutions are considered to be the mechanism by which people continue adapting livelihoods dependent upon the goods of local ecosystems (Alcorn and Toledo 1998). Access allows people to carry out the practical activities which create the contexts for knowing, learning and remembering. It is this practical engagement with resource harvesting that allows harvesters to

collectively codify and reformulate the specific rules of resource harvesting at the scale where resource harvesting occurs. Dwelling requires access to resources through some form of property-rights shells while allowing people the flexibility to generate specific institutions out of their practical engagements with the ecosystem. However, the case of KM, in particular, emphasizes that such an approach should recognize that periods of stability and change are inherent to common property institutions at both scales. Institutions should not be frozen in time, the traditional should not be traditionalized, but should be generated out of the processes of knowing-learning-remembering.

(7) Livelihood activities

All four of the initiatives recognize that practical activities which create linkages among humans and other constituents of an ecosystem are the foundation upon which a human-in-ecosystem approach is built. The PBR and KM work with people who already have a strong linkage to the ecosystem through their livelihood activities. Practical activities which link people to other humans and other constituents of the ecosystem are already in place. The main challenge for these initiatives is whether people who already dwell in the eco-commons can continue to do so while their livelihoods become increasingly integrated into global markets and cultural processes. The SoP and CS initiative work with a variety of people with diverse relationships to other inhabitants of the ecosystems. These initiatives have tended to create new organizational contexts for practical activities. However, a major challenge in both contexts has been the disjuncture in the intergenerational learning of practical activities as instructional time has become dominated by a schooling paradigm. The SoP project, in particular, has focused on linking practical activities and inter-generational communication within a schooling context. The creation of organizations which promote horizontal communication networks within ecosystems is considered to be a major goal of these projects.

In sum, the consideration of the four case studies points toward two practical applications: (1) Rather than extracting people from the eco-commons in order to create nature, we need to ensure that people who are attentive to the land are able to continue making a living in a landscape; we need to break down the opposition between livelihood and nature; and, (2) For people whose livelihoods are no longer closely connected to the land, we need to create learning

contexts. These are situations in which people learn representations about the land by becoming attentive to the land and building their own memories and skills in relationship with the land. The former will require public policy that supports a dwelling perspective; the co-evolution of skills, memories, institutions, property rights, organizations and landscapes as they emerge out of people's livelihoods. The latter is a path which will require public policy to support organizations which focus less on heritage and more on experimental activities that enskill people to be attentive to humans, other animals and life processes of the landscape within which they dwell.

6. Conclusion

The relationship between environment and society has been examined through a number of different models within Western thought. The concept of resilience has provided a means to uncover new insights for our understanding of environment and society linkages. Resilience moves the emphasis away from a focus on form to a focus on process; from simplistic models of cause and effect to that of complex systems and relationships. These insights contribute to a more appropriate focus for understanding how changes occur within complex systems.

A dwelling, or human-in-ecosystem, approach explicitly recognizes that there are dynamics of complex systems to be considered. Processes, and the forms that emerge from processes, pertain to different spatial scales. For instance, the ecological processes which lead to a change in vegetative form within a patch of land in the boreal forest from fireweed, to blueberries, to pin cherries to a jack pine stand pertain to a patch of land which may be 100 square meters. However, climatic processes which results in a warmer and drier conditions for the boreal forest and an increase in fire frequency and intensity, effects thousands of square kilometers. Likewise, the institutions which govern the harvest of blueberries from a patch of land, may pertain only to a limited region, whereas the institutions which govern the tenure of a forest may influence a whole province. Resilience focuses attention on the dynamic of spatial scales.

Resilience also focuses attention on the characteristics of the temporal dynamics of a human-in-ecosystem perspective. History and evolution reveal that processes are often cyclical in that they lead to periods of stable forms, followed by periods of rapid change or adaptive lurches. Processes not only pertain to different chunks of geographic space but also to different

periods of time. A maple tree sheds and grows its leaves yearly while a maple forest may give way to a birch forest over a five hundred year period. Cyclical processes are occurring in both cases, but we often do not recognize change when time has "slowed down". Time may also slow down at different periods of a cycle. In the case of institutions, for example, institutions during periods of stability may last hundreds of years, while those during periods of instability may only exist for decades. This shift in rates of change tends to divert our attention away from processes and create the illusion that causality is attributable to stable forms such as long-enduring institutions and landscapes.

A resilience emphasis raises the question of whether there are clusters of cyclical processes which occupy different spatial scales and speeds of change. Holling (1992) has observed that nature is "lumpy", with the key variables clustering around different spatial and temporal scales. For instance, common-property institutions which specify the property-rights of a community to a resource, may not change very much over a hundred year period. However, this very property-right may allow the community to negotiate and change common-property institutions which pertain to the harvest of a specific resource over a shorter period. Rules of resource use likewise change to accommodate changes in population, technology and resource availability. The persistence of common-property institutions pertaining to a small geographic area may depend upon the existence of larger-scale institutions with slow rates of change. This cross-scale dynamic allows the processes of small-scale institutional change to continue at a faster rate. If there are clusters of processes around a small set of spatial and temporal scales, this may suggest that there are a limited set of processes which drive system change. Resilience moves our attention away from whether it is the environment or society which drives change, to a consideration of how the **processes** linking environment and society, across different spatial and temporal scales, drive change.

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Table 1. Core Components of a dwelling, or human-in-ecosystem perspective.

Component / Initiative	Sense of Place (SoP)	People's Biodiversity Register (PBR)	Kagiwiosa-Manomin (KM)	Citizen's Science (CS)
1.1 Spatial boundaries - organizing principle for ecosystem based projects	XXX	X	X	XXX
1.2 Emphasis on cross-scales, as in nested watersheds	XXX	XX	X	XX
1.3 Importance of the local scale, larger scale efforts bringing together local efforts	XXX	XX	XX	X
2.1 Emphasis on understanding relationships between people and other species	XXX	XX	XX	X
2.2 Emphasis on understanding relationships among people	XXX	X	XXX	XX
2.3 Emphasis on communication, relational networks and cross-scale institutions	XXX	XX	XX	XXX
3.1 Actor behaviour (individuals, organizations) embedded in social structures and cultural processes	XXX	XXX	XXX	XXX
4.1 Knowledge transmission (spatial diffusion) among groups	XXX	XX	XX	XX
4.2 Knowledge transmission (temporal diffusion) between generations	XXX	X	XX	X
4.3 People's participation in documentation and mapping of local ecosystem	XXX	XXX	XX	X
5.1 Cultural identity and sense of place	XXX	X	XXX	XX
6.1 Institution Building	XXX	XX	XXX	X
6.2 Emphasis on commons institutions	XX	XX	XXX	X
7.1 Livelihood activities in the ecosystem	XXX	XXX	XXX	X