Tasks for Future Ecologists

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ABSTRACT: Apparent conflicts between human jobs and welfare and the interests of wildlife can frequently be resolved if man is perceived as *part* of Nature rather than in opposition to it. However, social and scientific paradigms emphasize individuality at the expense of connectedness, and competition at the expense of co-operation. Ecologists are well placed to address the important questions of how fast human societies can adapt to change; which cultures are most adaptable, and how satisfactory given adaptations are likely to prove in the longer term. A new perception of time is needed, with serious questioning of such practices as discounting the future. Ecologists may be able to help predict the long term effects of climate change, not only on the environment, but also on human social systems.

KEYWORDS: Evolutionary change, human ecology, scientific paradigms.

THE PARABLE OF THE LOGGER AND THE OWL

About once a month someone asks me, rather belligerently, "So what's more important? The spotted owl or the livelihoods of loggers and the survival of the small towns of the Pacific Northwest?" The question is posed in terms of a confrontation, a war of sorts, between owls and certain groups of people. It is cast in moral tones, like one of those problems one finds ready-made in textbooks intended to teach children ethics. You know the sort of dilemmas I mean: Mr Smith's wife is sick and desperately needs antibiotics. Mr Smith, however, is broke, and cannot afford the prescription. What should he do? Steal the drug or let his wife die? This same sort of simplistic either/or dichotomy is applied to the spotted owl/logger debate. It turns up over and over again in almost *all* discussions about the environment: one must choose between 'man' and 'Nature'. If one 'wins', the other must 'lose'.

Now most children beyond the age of 12 immediately see through the narrowness of Mr Smith's dilemma as it is posed to them. He has a whole lot of options besides stealing or letting his wife die. He can ask the druggist for credit, borrow from a friend, leave a promissory note (if the druggist is not there to ask),

Environmental Values **1** (1992): 35-46

or go to a free clinic if he is truly penniless. Imaginative children come up with dozens of reasonable possibilities. But almost no-one – not even college graduates, lawyers or politicians – can see any way to save the logger *and* the owl, or on a larger scale, to save man *and* Nature. Yet without owls – and the living environment they symbolize – there can be no people, whether loggers or others. Both owls *and* humans depend on a healthy ecosystem. Owls are like the coal-miners' canaries, signallers of danger; they are friends, not adversaries. Their potential demise serves to warn us of the magnitude of our own self-destructiveness.

Let me develop this a bit further. Anyone who has flown over the Northwest's logged areas knows the ugly starkness of huge rectangular patches of ground clear-cut of their trees. Only a few felled trunks, looking like broken matchsticks from the air, are left lying among the useless brush; seldom is reforestation undertaken. The loggers, having moved on, now want to cut into stands of virgin 'old growth' forest, where the spotted owls live – and where there are still big trees. But when those forests are gone, along with the owls, then what? The loggers will be out of business 30 years from now; the problem will merely have been postponed. *Irreplaceable* species and habitats will have been 'disappeared', all for the sake of pushing on to our children a problem we should be solving today. A similar argument can be made for almost every question of 'environment versus people'. Failure to halt destruction and begin to restore our living support system only postpones and usually exacerbates the problem that ultimately *will be solved*: either we restore the environment, or we die off or move away.

What is the solution? Step one is to realize that neither loggers nor owls are the problem: *we all* are the problem! We buy the wood that is logged at as low a price as possible – too low to make 'sustainable' logging on second growth forests 'economical'; and we obtain *our* livelihood by selling the loggers cars, refrigerators, and so forth. Clearly, the free-market system is not signalling to us the real costs of decimating our forests – of using up environmental capital, of living beyond our means.

There are two ways to 'solve' the problem: both proscribe logging 'old' forests. The loggers reforest clear-cut areas and develop a sustainable *managed* section of forest. This will mean placing tariffs on imported timber produced cheaply elsewhere by unsustainable logging. The cost of living will go up, but loggers will still have jobs and we shall have wood indefinitely. The other solution is to let people buy cheaper imported wood (and 'so what' to the rest of the global ecosystem). The loggers put out of work become a community responsibility, and society as a whole shares the costs of retraining them into new niches in the work force. (This is an exactly parallel principle to that underlying the process of 'economic conversion', when communities *as a whole* assist in shifting from a defence-based economy to a 'peacetime' economy.) Note that this same cost will accrue 30 or so years from now if old growth forests are cut

down as a one time, non-renewable resource: loggers will then be out of work for good.

The idea that *society as a whole* is responsible for solving socio-economic problems is, for Americans, a new one, which does not fit easily into our individualistic style of thinking. Yet I think it is going to become quite widespread during this decade – *if* we are to make any headway in solving environmental (and many other) problems. Bringing about this change in our social thinking means getting *people as a whole* to accept their shared responsibility, and this will require, among other things, their being educated about environmental matters by – who else? – ecologists!

This brings me to my central subject. What should ecologists be doing? What is their social task, their job? In what follows, I shall draw an admittedly oversimplified picture of how ecological concepts are interpreted by the public, and I shall argue that both concepts *and* interpretations are often misleading. It is the 'task' of ecologists to develop a more correct image of how Nature works, and to make it known to all.

PRESUMPTIONS ABOUT ECOSYSTEMS

"The fragile tundra!" "The fragile rainforests!" "The fragile deserts!" That idea, of the 'fragility of Nature', pronounced breathlessly in a sonorous baritone voice, turns up with depressing regularity on TV nature films. Fragility is a word that should not be in the ecologists' lexicon at all. It implies that an ecosystem 'breaks', and is thereby destroyed. What happens, of course, is that it is *changed* – what lived there before may be gone, and sooner or later other life forms will migrate in. When motorcyclists gouge through the crisp surface of the California desert they lay the loose soil beneath open to wind and water erosion. The swathes left on the desert floor remain devoid of larger plants for decades. But the desert is not 'broken': it is made rather less productive (in the ecologists' sense) and less aesthetically attractive. But long before humans evolved and long after we are extinct, Nature will continue to experience cataclysms – out of which new ecosystems, new combinations of life forms emerge, and sometimes new species 'suddenly' appear. What we *really* mean in speaking of 'fragile' ecosystems is that they are *made less useful to humans*. A forest fire started by lightning destroys X "millions of dollars worth" of valuable timber! Our species depends on predictable ecosystems, ones that change imperceptibly slowly, so that our institutions can adapt without social disruption and chaos. Thus a major 'task' for ecologists is to make very clear how ecosystems remain stable and how they change – so we can learn to avoid sudden changes and prepare (as best we may) for those already set in motion.

There is another 'spin-off' from this understanding, that will become clear later. In particular I have in mind the models from Nature that people

unconsciously use to pattern their own thinking. Such ideas as evolutionary 'progress', 'survival through competition' and so forth, are used to justify certain assumptions about human nature and, thence, about human institutions.

But I want to begin by noticing how our vision as scientists is influenced by our prior cultural assumptions. What we 'see' in Nature is not exactly 'wrong', but it is always *selected*, *partial*, and therefore unavoidably *misleading* – sometimes dangerously so!

THE 'BILLIARD BALL' UNIVERSE

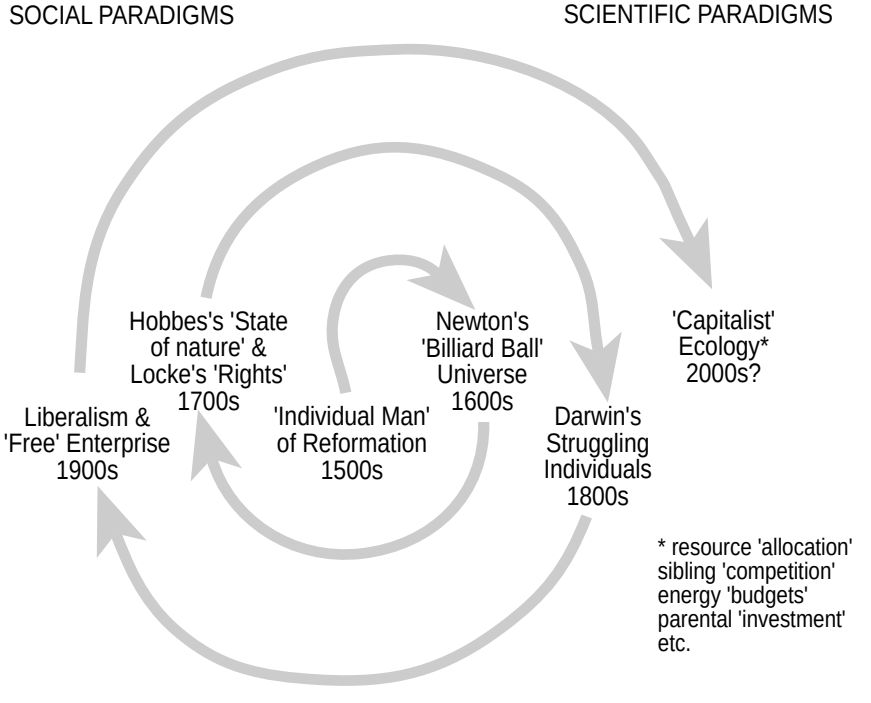
I begin, then, with how Westerners generally see the world. Physics has long since modified the Newtonian image of the universe – first with statistical mechanics, then with quantum theory, and finally with relativity; and maybe next with concepts of a residual order in chaos that confound the meaning of 'entropy'. Newton's was a universe of discrete, isolated particles of momentum-bearing matter, each located for a given instant at an identifiable address located in three dimensional space. The interactions between these isolated, energized billiard balls became the describable, even predictable, 'causes' and 'effects' of observable events. Thus was science born. Although the balls interact, and may even join or separate, their essential discreteness was always presumed.

This discreteness of objects remains the underlying assumption for most evolutionists and ecologists. Each individual organism is surrounded by a host of other discrete entities, some living, some not, that collectively are its 'environment'; to this collectivity, it is 'adapted'. The multiple billiard balls of the external environment impinge upon the organism, which, however, retains a discrete and separate 'identity'. This image envisions an identifiable boundary where organism *stops* and environment *begins*.

This mentally created boundary raises some philosophical problems. For example, it places the normal bacteria in my gut 'outside' me – they are part of my 'environment'; any latent herpes virus particles fused to the DNA of a patch of my epithelial cells are 'not really me'; but the parasitic DNA of my mitochondria, which has been part of my maternal lineage for around a billion or so years, *is* me! Going outward, 'me' stops at my skin; Siamese twins notwithstanding, families and societies are assemblages of independent billiard balls, not functional entities at another level of organization, having emergent characteristics of their own. Scientists persist in 'explaining' the existence of societies and of ecosystems from the point of view of the individual billiard balls – either they are or are not adapted – and not from the point of view of a functional whole system, one that has its own history and complex structure.

Now this image of sharply-bounded organisms has greatly simplified our scientific studies, but it has also led us to place too much emphasis on the particular individual on which our attention is focused, and to fail to observe the

details of its embeddedness in a total, functioning system. The Gaia hypothesis and other systems paradigms notwithstanding, we have largely failed to keep an eye open for connectedness. Furthermore, this habit of seeing the individual, not the whole, has a strong parallel in Western *social* thinking – particularly that of Anglo-Americans, for whom the individual is the central focus, the very *raison d'être*, of socio-economic reasoning. Which of these visionings – the ecologists' or the social philosophers' – came first? Certainly the philosophers', beginning in the Renaissance. But today it is tacitly, yet deeply reinforced by the basic assumptions of evolution and ecology. The world-view of the West is thus self-consistent: natural science and social theory are mutually reinforcing.



EVOLUTION: SELECTION AS ADAPTATION

It is commonplace to observe how so much in Nature seems to be 'well adapted' to its purpose. The long bill, longer tongue and tiny size of hummingbirds! How uniquely suited they are to hovering before nectar-bearing flowers! The amazing

skill of mountain goats as they leap from ledge to ledge always causes a gasp of wonder. We cannot believe how perfectly stick insects 'disappear' against the branch they are sitting on. So attuned are we to seeing 'perfect' adaptation – underscored by photos in every introductory biology textbook of the amazing mimicry of dark and light forms of the British peppered moth to their respective backgrounds – that we scarcely notice Nature's numerous klutzes. Caterpillars which are painfully inefficient crawlers; pandas whose 'thumb' is a clumsy outgrowth of a wrist bone; and of course human beings whose upright gait leads to the almost universal presence of chronic back problems.

Yet, although there might indeed be 'room for improvement' in Nature, few people think like this. Rather, there is widespread public belief that we inhabit a biologically more or less 'completed' world. If things could have improved, then surely they would have done so by now. Thus, future improvements will be those brought about by us humans, through our science, technology and cultural advancement.

Not only is the biological world 'complete', but it reached its present state of adaptation through a severe winnowing process: resources on the planet are *scarce*; siblings must *compete*; and Nature then *selects* the most efficient variants: it is 'survival of the fittest'. One cannot overemphasize how prevalent among the public at large are these assumptions and their logical consequences. In the popular Western mind, competition among isolated individuals is the basis for survival, and *it is therefore natural for humans to compete*. Furthermore, although biological evolution is pretty much 'complete', we humans continue to evolve through our special attribute, namely culture. And in assessing our cultural adaptiveness we use the same yardstick: the fact of 'surviving' – read *winning* – in a cultural competition implies 'fitness'. Finally, all evolution, including cultural evolution, is viewed in terms of a linear progression: past to present; lower to higher; inferior to superior. What is most recent and most dominant is *ipso facto* 'best adapted'.

The implications of all of this in terms of the mind-set and thrust of Western industrial society are profound. There is widespread intellectual confusion. If the dominant group (Americans, etc.) is indeed 'better adapted' than other, less developed peoples with whom we 'compete', then why are we creating so many environmental problems – far out of proportion to our numbers? If the kind of power-based competition we have set up between 'sibling' cultures threatens the entire species, either through nuclear annihilation or global environmental destruction, how can we say competition leads to adaptiveness? What is missing from the abstract equations by which we model the universe, and hence ourselves?

I think there are two misapprehensions here. One has to do with the nature of human beings, who surely did *not* evolve as competitive self-centred animals. (I have written about this at length elsewhere and will not pursue it here.) The other misapprehension, which ecologists are to some degree responsible for, has

to do with the notion of a 'static' biosphere, one that is more or less complete. Now although ecologists are intellectually aware of the notion of an ongoing evolutionary process, in general that process is too slow to be readily reflected in the questions they ask in their research, and hence in the image their work transmits to the public. The notion that evolution is *in progress* is certainly not purveyed to the public by most of the environmental science popularized in the mass media. Although extinctions are mentioned frequently, adaptations to changed circumstances seldom are. While we hear a lot about endangered species, we hear next to nothing about *Salmonella* (typhoid-causing bacteria) that are now resistant to antibiotics fed to chickens and cattle, nor about corn pathogens resistant to fungicides, nor about mosquitoes resistant to DDT – i.e. those species which are *right now* evolving to survive in the new environment we have created. Clearly, what is needed is a clear picture of the various time frames in which natural selection occurs and how these are affected by the rate and magnitude of our current impacts on the environment.

Going one step further, we have to ask: how fast can human societies adapt to the changes we humans are now bringing about in our own support system? How fast does cultural adaptation occur? Are all cultures equally adaptable? Do we even have a good definition of 'adaptive fitness' for human societies? These I believe are highly critical questions for ecologists to address. How do we know whether a culture is adapting well, or is rapidly driving itself into an evolutionary cul-de-sac vis-à-vis the environment? Sheer economic, political and military 'success' may be a poor indicator of adaptiveness over any extended period into the future.

STABILITY AND CHANGE

This brings us to our assumptions about stability and change in ecosystems, and to the meaning of adjectives like 'fragile' and 'delicate'. During the first half-century of its existence, ecology came up with such terms as 'equilibrium' and 'climax' and 'stability'; intended to explain what the palaeontological record indicated were long periods of fairly stable communities. The search was on for the factors that create stability. Why do ecosystems not continually change? Is natural selection inoperative because indeed everything is virtually perfectly adapted? Is almost every new variant that comes along in fact less fit?

Although no one suggested that evolution is over, the presumption was that the rates of evolution are extremely slow, and further, that feedbacks exist among species that cause the whole ecosystem to return to a 'preferred' equilibrium state whenever it is disturbed. This became popularly translated into 'Nature's delicate balance' – again, breathlessly spoken about on TV nature programmes – where, however, mention is seldom made of the ecologically well known and quite robust phenomenon of succession in disturbed habitats that was the basis

for conceptualizing an equilibrium state.

A kind of homeostatic feedback among species was envisioned for ecosystems, analogous to the feedbacks discovered by physiologists that maintain the 'constant internal environment' of organisms. All kinds of interactions were examined – from competition for scarce resources, both within and between species, to predation and parasitism (and defences against them) – that would explain the approximate constancies of populations and of community composition. The more numerous the feedbacks, the more stable the system: 'diversity ensures stability'.

As many people are well aware, these explanatory ideas are not nearly so sound as they first seemed. For example, populations – such as those of lemmings or desert locusts – often seem to bounce about in a chaotic fashion that apparently arises from intrinsic instabilities in the reproductive pattern rather than from external forces, such as starvation or predation. The highest diversity of species tends to occur not in the most stable systems, but in those subject to constant disturbance, e.g. rainforests subject to destruction by storm, and rocky intertidal regions buffeted by heavy surf. Finally, the equilibrium state of an ecosystem seems not to be determined by the total mix of species present, but by the presence – or absence – of a very few 'keystone' species. In the scrub of the high desert, for instance, removal of two or three heteromyid species changes the climax vegetation within the exclosure dramatically, while removal of other rodent species has virtually no effect. Thus, the presence or absence of but one or two species may determine the texture of an entire ecosystem. Our whole understanding of what forces shape ecosystems and create what appears to be 'stability' is far less certain than it seemed but a decade ago. It is clear, however, that the simple 'billiard ball' model with which we started this discussion is far from satisfactory, and our ability to predict what are wise and unwise approaches to environmental management, or perhaps we should say 'stewardship', is more tentative than we thought.

SOME ECOLOGICAL RE-VISIONING

Whenever one is as blunt as I have been about the concepts of a discipline, many hackles are raised. So I hasten to point out that the data collected by ecologists are not 'wrong', nor are the interpretations put on them 'incorrect'. There *is* competition, there *are* identifiable feedbacks, disturbed ecosystems usually *do* return to fairly stable climax states, and so on. Rather, what I am suggesting is that this is not *all* that is going on: we have been developing a highly selected and skewed picture of Nature. There are also numerous cooperative interactions, within and between species, which are much more difficult to study and require a quite different underlying imagery than that provided by the 'billiard ball universe' with its simple mathematical relationships. Furthermore, as I have just

noted, the logical explanations of Nature we had deduced starting from those original assumptions are not holding up. Every few months, a new 'surprise' seems to come along to discredit our model. As an old friend – an ecologist – in San Diego said to me last year, "Ecology has lost its guiding theory".

I have no big, new guiding theory to propose, nor even a small one – only a few suggestions that may help the process of re-visioning. Clearly, we need a much better sense of what we mean by such terms as 'adaptation' and 'fitness', and even 'ecosystem'. These are not esoteric issues. The survival of our species may depend on knowing better how to think about these abstractions. We need a much clearer idea of how to judge the 'adaptive fitness within an ecosystem' of human societies. What are the *measures of sustainability*? Ecologists need to enter the mainstream of decision making, collaborating with – and correcting the misapprehensions of – their colleagues from economics, political theory, psychology, engineering, sociology and the rest. To enter the mainstream, however, ecologists will need to reconstruct for the public mind a more appropriate vision of Nature – one that makes it crystal clear why spotted owls matter!

A NEW MODEL FOR RELATIONSHIPS

As I said, I do not know what this new vision will look like in detail. Certainly, it will no longer be based on notions of competition and scarcity. Although these exist, there is much, much else that contributes to 'fitness' and survival. Terms like 'community' and 'cooperation' will begin to take on physical meaning as a different imagery of relations among organisms begins to emerge – including the relationship of humans to other species. The old billiard ball universe will, I believe, give way to one looking far more like Indra's net, where foreground and background, small and large, and past and future are all intertwined in a complex, undulating, always changing meshwork. The old attempts at linear mathematical modelling may – despite our giant computers – prove quite incapable of providing us a way to do such holistic thinking.

Precisely how this new model will evolve, and what it will look like are still unclear. What is likely, however, is that it will help to reshape Western ideas of the relations between humans and the rest of he biosphere. In the absence of any 'scientific' ability to predict precise outcomes of this or that specific impact on the environment, a general sense of embeddedness *in* rather than dominance *over* Nature may become essential. (We already see the need for this in the United States today in the unwillingness of the Bush Administration to move toward reduction of greenhouse gas emissions because of uncertainty in their predicted effects.) The existence of alternative attitudes toward Nature in certain other cultures has led to their ability – without the necessity of a detailed scientific understanding – to maintain a sustainable resource base for generations. Some-

how, ecologists need to construct a new image of Nature based on arguments that will be acceptable to and received by the modern Western mind. This is no mean task!

An important secondary outcome of this effort is likely to be a reshaping of Western ideas of human nature – shifting from today's acceptance of competitive individualism as 'natural' and hence inevitable, to a more complex vision of ourselves as highly bonded, intensely social beings with a fundamental need for acceptance into a meaningful group. Obvious though such a description of the human animal may seem, it is virtually absent from the assumptions underlying almost all our major social institutions.

A NEW PERCEPTION OF TIME

Another area of Western thought where ecologists and evolutionists can offer significant new insights is in the Western perception of time. The time frame for human action varies from culture to culture. In the cosmology of the East, time is cyclic and never-ending, with the lifespan of a single universe being reckoned in trillions of years, during which the spirits of living beings reappear many, many times. Among the Iroquois nations, ancestors are remembered back through seven generations, and future time extends ahead seven generations. In contemporary Western society, however, time frames are much shorter. Whereas Japanese firms make plans one hundred years ahead, American firms scarcely think beyond a decade, and individuals seldom beyond a single generation (25 years).

Nowhere is this ability to 'discount the future' more prevalent than in economics, where the value of the future is approximately halved every ten years. (The $1000 I borrow at 7% compound interest a year I will pay back in 10 years as $2000). This calculus is applied not only to the exchange of goods and services, but also to the value placed on the resource base in which the economy is embedded. A major difficulty with attempts to 'commoditize' the environment, to internalize today's externalities, is this very process of 'discounting'. In calculating whether or not to cut down a rainforest and how much to compensate its residents for their 'loss', modern economics prices the forest at its one-time value as a source of commercial timber, not as a piece of self-renewing capital capable of supplying usufruct for centuries to come.

Besides this problem of essentially dismissing the future – which, after all, eventually becomes 'now' – contemporary society seems unable to evaluate the true impact of *rates* and *degrees* of change. Here I think ecologists and evolutionists can help enormously. We need a new theory for predicting how these parameters of change affect the various members of a complex system. Systems analysts can help, but I think biologists bring special insights into the nature of the interactions and the kinds of constraint faced by individual

members or populations within a community: which are 'key' species? what are the ranges of physical tolerance of various species? how much redundancy of function is built into the system? (i.e. how many species share similar 'tasks', such as decomposing, or pollinating, or controlling herbivorous insects?) and perhaps most important of all, which species are likely to tolerate rapid change and which are not?

A couple of brief examples might help. Take the impact of global warming on temperate forest biomes. These are known to have migrated north and south with past climate changes, sometimes without apparent major loss of species or overall productivity. But the *rates* of those climate changes were about ten times slower than those predicted for the next century. Trees neither evolve rapidly nor migrate rapidly; hence, those now existing at the southern limits of their climate range may well die off before new immigrant species replace them. The impact of this on local climate, on water storage, on soil erosion and nutrient loss, and on habitat availability for those great insectivores, birds and anurans, is difficult to predict from present theory and knowledge.

My second example asks not about ecosystems but about human social systems, which must also adapt to rapid changes in their environment in coming years. But it seems to me that the principles emerging from a good theory for ecosystem change might well find close parallels in social system change. Here the question is what kinds of human systems are most robust in face of major environmental change? Are they kinship based societies such as are still found in many less developed nations, or the technologically sophisticated societies of the industrialized North? I have my suspicions, but we need hard, data-based arguments if we are to influence the 'scientifically trained' Western mind, with its continuing faith in the 'technological fix'. There are, right now, plenty of catastrophes to study and analyse, both natural and human-caused. Perhaps the most important question of all to answer as we examine and compare various cases is, once again, what do we mean by 'survival' and 'adaptation'? Do we use (as the media and many scientists now do) simply the number dead or saved? Or do we look at the longer impact on cultural integrity, and the ability to cohere once the first brunt of the crisis has passed? Might not the social structure of the peoples of, say, Bangladesh, be more resilient than that of, say, North Americans, in the face of continuous change? This is an aspect of human ecology that seems to me to have had too little theoretical attention paid to it. Surely, it, like the study of change in ecosystems, is a highly appropriate area of inquiry for the next generation of ecologists.

In conclusion, what the human species seems to need to know as soon as possible are the following:

1. How might we better predict the robustness of ecosystems under various kinds and rates of human-applied stress (including increased storms as a

likely result of global climate change)? Which will remain stable? Which will change? How fast? In what direction? What key information is needed to begin to answer these questions?

2. How can we predict the stability of different types of human societies faced with oncoming environmental change? What social patterns and institutions are most resilient? Which are most fragile? How can the latter begin *now* to prepare themselves to adapt to a new set of conditions?

The central question we are asking in each case is *what are the intrinsic rates of adaptation* of a given system? It seems to me that ecologists have much to offer here. I cannot think who else is better placed than they to tackle these essential questions. The experiments are already going on, all over the planet. They are not tidily 'controlled'; they are messy and 'unscientific'. But they *are* there – a reality against which to test theory, and come up with the best policy recommendations for the leaders and peoples of the future.

This paper is based on an address read at the University of Minnesota, Minneapolis, on 15 May 1991.

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