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Part I

Setting the scene

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1 Protecting beyond the protected

Tim O'Riordan

Biodiversity and the fraying web of life

This planet is unique, at least as far as we will probably ever know. It contains life, which is maintained through self-regulating flows of energy and chemical connections, the science of which is well described by Tim Lenton (1998). We also know that these webs of life are frayed (World Resources Institute 2000). We are by no means clear as to how much these life-maintaining flows and fluxes are damaged. An assessment by the World Resources Institute (2000: 9) entitled Pilot Analysis of Global Ecosystems (PAGE) indicates that there is still a fundamental ignorance of how this web joins, and of what it consists at any scale of analysis, or of human action. The Board on Sustainable Development of the US National Research Council (1999: 208, 220–1) points out that this ignorance is all the more worrying because of the complex multiple causes and consequences of this disruption. One of the major threats to ecosystem goods and services is our lack of understanding about how specific ecosystem functions may change with ecosystem transformations. Another cause for concern is our hesitation about deciding on options for coping with and ameliorating these fundamental changes. A third limitation is lack of knowledge about, or incorrect valuation of, the 'worth' of ecosystem functioning for social well-being and economic advantage.

A study attempting to calculate the 'worth' of ecosystem services (Costanza *et al.* 1997) came up with a range of estimates on the basis of heroic estimates and ingenious assumptions. These estimates all exceeded the current value of total economic activity for the globe, on an annual basis, by a factor of up to threefold. Frankly there is no way of knowing how accurate this calculation is. What is revealing is that a clever monetary estimate indicates our scale of dependency or 'free riding' on the web of interconnected life. More relevant, perhaps, is the danger of trying to place a market-equivalent value on a mystery for which we should be more in awe than in arithmetic.

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The World Resources Institute study of global ecosystem services (World Resources Institute 2000: 12–15) summarises some of the vital, life-maintaining, roles of water, plants and soils.

1.7 billion people lack access to clean water, while $42 billion is spent world-wide on buying bottled water.

$52 million annually is spent on the kerosene that households in Jakarta must buy to boil water before use.

Thirteen national parks in Venezuela provide fresh water for urban water supplies that would otherwise cost some $200 million to cleanse.

Between 30 and 90 per cent of US soft fruit and horticulture production depends on pollination by honey bees. The total value of this service is estimated to be around $54 billion annually. Eighty-eight per cent of all the world's flowering plants rely on beetles for their pollination.

Extracts from plants and animals for medicinal drugs are worth $75–150 billion annually, while 76 per cent of the world's population uses traditional medicines for health care.

Some 60 per cent of the annual excess production of carbon is absorbed by oceans and vegetation. The long-term value of this role is incalculable.

We live in an unusually significant period in the interactive history of humanity and nature. The capability of humans to alter and to interfere with the life-maintaining processes of the globe has never been more comprehensive or interdependent. According to the World Resources Institute (2000: 6), 'the current rate of decline in the long term productive capacity of ecosystems could have devastating implications for human development and the welfare of our species'. Yet our ability to know the scale of what we are doing, and what fundamentally needs to be done to move us towards a sustainable outcome, has never been so well analysed. According to the Board on Sustainable Development of the US National Research Council:

> a successful transition to sustainability is possible over the next two generations. This transition could be achieved without miraculous techniques or dramatic transformations of human societies. What will be required are significant advances in basic knowledge, in the social capacity and technological capabilities to utilise it, and in the political will to turn this knowledge and know-how into action. (US National Research Council 1999: 276)

We may not know the full picture, but we do know enough to change our ways and our moral framework. We have no excuse, except the comfort of looking the other way, or claiming that the mountains of reform and reconstruction are too steep to climb. To shelter behind the façade of indecision or inaction would be acts of reprehensible folly. Protecting

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beyond the protected is, therefore, the replacing of folly by conscious and co-operative transformation.

We cannot escape. According to an influential report by the UN Environment Programme, the US National Aeronautics and Space Administration and the World Bank (1998: xx), 'the Earth currently is approaching the point where its physical and biological systems may not be able to meet human demands for environmental goods and services, threatening the ability of nations to meet their populations' needs for adequate food and clean water, energy supplies, safe shelter and a healthy environment'. The PAGE report referred to above produced the most comprehensive account of this weakening of the capability of natural ecosystems to maintain life.

Half the world's wetlands have been lost in the past century.

Logging and conversion of woodland ecosystems have shrunk the world's forests by as much as half, and another quarter is being fragmented by roads, farms and residences.

About one in ten of all tree species is at risk of extinction.

Some 58 per cent of coral reefs are threatened by destructive fishing practices, tourism pressures and pollution.

Fishing fleets are 40 per cent larger than the ocean can sustain, with 75 per cent of global fish stocks either depleted or overharvested and a further 44 per cent at the point of depletion.

Most freshwater and coastal ecosystems no longer have the capacity to maintain healthy water quality. The poor are especially exposed to declines in drinkable and reliable water. Poverty is an outcome of environmental degradation as well as a cause of it. Over-pumping for agriculture exceeds natural replenishment by over 160 million cubic metres annually.

Introduced species, transmission of pathogens and incurable damage to natural immune protection are leading to a chaotic reduction in species numbers and densities. The consequences for ecosystems, within which these species play a critical part, are unfathomable.

All of these outcomes breed on each other. Not only do ecosystems reach out across space. They also retain, up to a critical point, their capacity to absorb and respond to changed circumstances, and variations in species mix, through their flows of mutual support. The richness of populations and species interactions provides the basis for creative evolution. It is this evolutionary drive that in turn creates the capacity for resilience, or buffering against the unanticipated. But, as Tom Lovejoy reminds us in the next chapter, biological diversity is the ultimate integrator of environmental change. Losses of such diversity are clarion calls for humanity that their own well-being is in peril.

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On biodiversity and resilience

Holling *et al.* (1998: 349) suggest that ecological resilience has two interpretations. One is based on the capacity to absorb or to repair ecosystem functions in the wake of a shock or damaging activity. This perspective assumes an in-built capacity to restore to the original condition. This is basically a rational, linear model of action and response. It finds its way in resource management into such concepts as sustainable intervention, sustained yield, allowable catches and various extractive quotas. As Berkes and Folke (1998a: 12) put it: 'discrete yield levels, such as maximum sustained yields of fish or timber, can be calculated, and perturbations (such as fire or pest outbreaks) can be controlled or excluded'.

This interpretation of ecological resilience is part of the cause of ecosystem fraying. Analysing 'allowability' in resource management does not take into account the critical interconnections between resources and ecosystems. Ecosystems are flows of support and nurture with assimilative buffers to cope with waste matter and unexpected perturbations. Resources mingle within ecosystems, so that removal is often disruptive and stressful, operating beyond these in-built absorptive capabilities. The very presumption of calculated removal is part of the cause of ecosystem disintegration.

A part-way position within this perspective is the practice of selective removal, through which individual trees, or other plants, are harvested by supposedly ecologically forensic measures. The aim is to extract on the basis of maturity, with minimal damage to surrounding vegetation and their ecological linkages, and to replant. This practice is recommended for the Forest Stewardship Council (FSC) qualifications. FSC is an international arrangement for ensuring the renewability of tree removal and abstraction as well as the well-being of forest inhabitants. Selective removal, coupled to non-extractive use of forest resources to benefit local economies, is becoming attractive as a 'half-way house' in ecological resilience. It is being promoted as a way forward in Brazil, as we shall see in chapter 10. It is necessary to include the 'people well-being dimension' before such an approach can be relied upon for maintaining sustainability. As for enhancing biodiversity, well, this is not always guaranteed. Yet what is biodiversity? If forest management can retain reliable species mix, ensure robust ecosystem functioning, and maintain local livelihoods, is this not a laudable objective? We shall see that as we reach out to protect beyond the protected, the concept of biodiversity will embrace a mosaic of objectives and management approaches.

The second notion of resilience is based on the proposition that ecosystems may evolve and respond chaotically, in a non-linear fashion, without clear trajectories of adjustment. The important test for resilience is the

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degree of disturbance that can be absorbed before an unpredictable and convulsive change in system functioning occurs. An example would be the removal of species diversity as 'islands' of biodiversity become more isolated. Ecosystems are seen as permeated by an unknown capacity for self-organisation, flows may be unpredictably discontinuous, and adaptive learning based on sensitive monitoring and 'environmental' knowledge may hold the keys to appropriate management action.

David Tilman (2000: 208–9) summarises the results of a vast range of ecological analysis as to the relationship between biological diversity and the efficiency and resilience (or stability) of ecosystem functioning. He reviews the growing body of ecological evidence that the richer and more heterogeneous the species mix, the more robust the ecosystem as a whole. The shifts towards more diverse ecosystems may be due to three main processes.

- Species are so varied that they respond very differently to changes in environmental circumstances. The more species that environmental change is averaged across, the less variable is the total species mix.
- Species in a similar trophic level tend to compete, so as one declines in abundance, another will increase. Overall, this 'negative covariance' tends to reduce variability.
- Community abundance tends to increase as species diversity grows, giving rise to greater total productivity and resilience.

Tilman concludes that 'resilient biodiversity' may well be the consequence of a variety of trade offs between competitiveness and co-operation leading to advantage and cohabitation. Society is simplifying species connections to the peril of the survival of ecological complexities. There is no evolution in ethics or management as scientific understanding progresses.

> The loss of biodiversity will diminish the capacity of ecosystems to provide society with a stable and sustainable supply of essential goods and services. It seems likely that environmental policy that is optimal from societal perspective would be remarkably different now from that of 250 years ago. However, we still use environmental and landuse ethics codified in law that were articulated during an era when the human population, at one tenth of its present size, tamed wilderness with axe and ox. (Tilman 2000: 210)

Ecological resilience is enhanced by linkages across ecosystems in space and over time. To understand how humans can damage or repair, therefore, requires a profound knowledge of the interrelationships between ecosystems as ecosystems, and their combined interrelationships with society. In the absence of reliable observational evidence we may have to rely on what residents know through experience and social understanding.

Tilman (2000: 211) offers an even more profound insight as to the future of biodiversity. This is that any future for biodiversity will be

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the outcome of human choice, and, for the most part, intervention. In essence, our future biodiversity will be designed and created, as in tending a garden, rather than exclusively placed in 'hotspot' museums to be observed and recorded from afar. The phrase 'hotspot museums' applies to the strict protection of mega-diverse sites as identified by Myers and his colleagues and explained more fully in chapter 3. So the biodiversity of the future will depend on a science of intervention that is informed by creative scientific explorative analysis and ingenious experiments with resilience. This is why this chapter is entitled 'protecting beyond the protected'.

> The earth will retain its most striking feature, its biodiversity, only if humans have the prescience to [establish an ethic as long lasting as a constitutional bill of rights or as religious commandments]. This will occur, it seems, only if we realise the extent to which we use biodiversity. (Tilman 2000: 211)

The Tilman message is given priority in this section on resilience because he suggests that biodiversity can be created as much as it is destroyed, by the application of co-operative science and management. He is not indicating that overall biodiversity can be regained. But he is commenting that co-ordinated and progressive management of sites and connecting zones of sympathetic human and ecological activity may achieve a more robust global biodiversity in the future. This is the message for Costa Rica, Namibia, South Africa and Europe in the chapters that follow. It is also the guiding theme for the title of the book.

Berkes and Folke (1998a: 12–20) point to the advantages of incorporating cultural traditions and norms into resource management so as to combine the learning practices of social and ecological sustenance. Not all customary practices act to sustain and restore. It is dangerous to presume that 'tradition' is somehow 'good' for ecosystem maintenance. Yet established practices are customary and valued by those who cherish them, partly because they bind and provide a sense of community identity. To ignore or degrade them without clearly creating communal acceptance of an alternative set of practices would be an act of folly (as identified above), a discourtesy, and profoundly unhelpful in achieving the kind of interactive management sought for ecosystems by integrative ecologists (Stoll-Kleemann 2001: 382). We shall see in chapters 5 and 13 that this notion of social resilience involves a more open use of scientific methodology, a mix of quantitative and qualitative techniques, awareness and empathy to feelings and instincts, and a wide range of monitoring and communicative skills and assessments. Such approaches not only are interactive with ecosystem resilience; they also require a form of management which regards society and nature as constantly revealing themselves through direct engagement and negotiation.

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For example, we shall learn from the South African case (chapter 8) that the management of plant-rich 'fynbos', a particularly endemic mix of plants in a unique climatic and geological setting, will succeed when neighbouring human communities actually depend for their income on a restored and enhanced biodiversity, the establishment of which they actively contribute to. Effective biodiversity in South Africa can provide income through crafts and products, and services of eco-friendly tourism and local recreational pleasure. To make the whole relationship work, the social support services have to be responsive to the possibility of disruption and failure, as much as the natural resource management organisations are. Experience of wildlife management from Namibia (chapter 9) suggests that by bringing local people into partnerships of trophy, recreational and nutritional roles for wild animals, it is possible to devise agreed and communally protected schemes of game use that serve the needs of hunting, viewing and eating, all in the same ecological-economic zone. Yet the integrity of the ecosystem must always be given priority as this is the routeway to the integrity of local economies. The same lesson is painfully being learned via the accommodation to the Habitats Directive in the European Union (chapter 6). Protecting beyond the protected means ensuring that the capacity to absorb, to learn and to repair is incorporated into both the social and the natural worlds so as to create an adapting and self-organising unity, so long as the natural world remains essentially intact.

On the loss of biodiversity

Biological diversity, or biodiversity in its shorthand, means the variety of living organisms on earth, the range of species, the genetic variability within each species, and the varied characteristics of ecosystems. We shall see in the two chapters that follow that only about one tenth of all species are known, and that loss rates are possibly fifty to a hundred times greater than ever experienced in recorded history. Already the threat of extinction hangs over 10 per cent of known bird species, 20 per cent of known mammal species, 5 per cent of known fish species and 8 per cent of all recorded plant species (Chapin *et al.* 2000: 234). Yet genetic variability establishes the primary form of evolution, the adaptability of wild species to human-induced change, including cultivation and domestication, and the basis of special breeds of animals and plants that provide the fundamental basis for modern food production. This is part of natural protective functions that need to be protected.

Reducing biodiversity further will mean that additional alterations to ecosystems, especially in unpredictable combinations, could result in a much more devastating weakening of ecological absorptive capabilities.

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Furthermore, well-meaning but limited attempts to restore ecosystems or reintroduce species will have less and less influence on the depleted restorative capacity of species and their habitats. Decreased biodiversity interferes with all manner of essential ecosystem functions such as pollination, the maintenance of soil health, water cleanliness, the assimilation of wastes, especially toxic wastes, and the cycling of carbon, nitrogen and sulphur. In short, biodiversity loss means, at the very least, contributing to undermining the capability of life to survive and reproduce itself with vigour and reliability.

Pimm and his colleagues (2001: 207) conclude, after extensive analysis, that the destruction of biodiversity has contributed, surprisingly and sadly, very little to overall human welfare. The humid tropical forest, once covering 14 per cent of the global land surface, yet housing 67 per cent of terrestrial species, is now cleared to about half of its original size. Much of this cleared land is unusable for agriculture. About a third of species-rich waterways are being diverted for irrigation that is almost always unsuitable for crop growing owing to desalination and toxification. Biodiversity loss is a double blow. Protecting beyond the protected means ensuring future well-being of life support to avoid senseless degradation of both human and ecological resilience.

To preserve biodiversity we choose to protect it. We cannot do this everywhere, so we protect in special places. The aim is to safeguard a sufficient range of species and habitats through protected areas management in order that the essence of biodiversity is preserved. Pimm and Raven (2000: 843) observe that many species found in a given habitat are found only in smaller areas within that habitat. So early phases of widening habitat alteration may not result in much noticeable species loss. Peak extinction rates may only occur decades later as habitat alteration continues. The rate of extinctions depends on how much of the habitat is altered, while the actual percentage of species removed is based on how much habitat is actually lost. Pimm and Raven (2000: 844) summarise research to show that, even if 5 per cent of tropical moist forest areas were safeguarded, 50 per cent of all species could remain. How long such an ephemeral state might continue to harbour those species without reservoirs of species nearby remains a matter for ecological speculation. Here is where Tilman's comments on biodiversity gardening become apposite.

As Norman Myers argues in chapter 3, species are particularly vulnerable to the damage to habitats in their range of survival. Because as much as 30–50 per cent of plant and animal species occur in 'hotspots' occupying only 1.4 per cent (but originally 12 per cent) of the land surface, what happens to these highly species-rich areas is vital to the totality of species availability. But random destruction of habitats outside of these

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areas, and especially linked to them, could create centres of extinction that match the hotspots (Pimm and Raven 2000: 844). We do not know enough about biodiversity to know what and where to protect. Even where we do protect, we may not be able to stop the continual reduction in survival capacity. Protecting does not necessarily mean protected. In any case, safeguarded zones need reservoirs of species and ecosystem functions beyond their artificial boundaries for their continuance as biological reserves. Tom Lovejoy in the chapter that follows reminds us that while restricting a habitat does not linearly remove species, fragmenting and disrupting habitats is much more likely to undermine species resilience.

Margules and Pressey (2000: 243) argue persuasively for the maintenance of safeguarding reserves as integral units of biodiversity. But the selection of reserves is often arbitrary, based on conflicting objectives or agency missions, or dependent on ownership. This means that most reserves are in economically marginal territory, while biodiversity as a whole is not protected. As a consequence, many species occurring in productive landscapes or landscapes with development potential are not protected, even though disturbance, transformation to intensive uses and fragmentation continue (Margules and Pressey 2000: 243). Box 1.1

BOX 1.1 STAGES IN SYSTEMATIC CONSERVATION PLANNING

Systematic conservation planning can be separated into six stages, with some examples of tasks and decisions.

1 **Compile data on the biodiversity of the planning region**
   Review existing data and decide on which data sets are sufficiently consistent to serve as surrogates for biodiversity across the planning region.
   If time allows, collect new data to augment or replace some existing data sets.
   Collect information on the localities of species considered to be rare and/or threatened in the region (these are likely to be missed or underrepresented in conservation areas selected only on the basis of land classes such as vegetation types).

2 **Identify conservation goals for the planning region**
   Set quantitative conservation targets for species, vegetation types or other features (for example, at least three occurrences of each species, 1,500 ha of each vegetation type, or specific targets tailored to the conservation needs of individual features). Despite inevitable subjectivity in their formulation, the value of such goals is their explicitness.
   Set quantitative targets for minimum size, connectivity or other design criteria.
   Identify qualitative targets or preferences (for example, as far as possible, new conservation areas should have minimal previous disturbance from grazing or logging).

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