

Failure of science, death of nature¹

Harry F. Recher

School of Natural Sciences, Edith Cowan University, Joondalup, WA 6027, and School of Veterinary and Life Sciences, Murdoch University, Murdoch, WA 6150, and Australian Museum Research Institute, The Australian Museum, College Street, Sydney, NSW 2000, Australia.
Email: hfrecher@gmail.com

Abstract. As a people, Australians have lost contact with the world of nature, risking the collapse of civilisation. One factor in the alienation of nature in Australia is the failure of the scientific community to take responsibility for the technology created by the knowledge generated from scientific research. Science has failed to protect Australia's flora and fauna. Scientists must communicate more widely with society, but need to be educated on how to communicate and on their ethical responsibilities to others and other species. Government needs to show leadership in environmental management and nature conservation, while conservationists need to 'invert the paradigm', taking a new, less anthropocentric approach to conservation. None of this is possible in a market-place economy and Australians must move to an economic system that is ecocentric. This will not be easy as it requires a reduction in the consumption of resources and a smaller population.

Received 28 December 2014, accepted 27 January 2015, published online 21 April 2015

Introduction

Some years ago I had the opportunity to present a paper at a Royal Zoological Society (NSW) Forum on why I was a grumpy old scientist (Recher 2013). I explained that I was grumpy with my academic colleagues and with the environment movement. I was grumpy with both long before I achieved senior citizen status. If I was giving my grumpy paper today, I would add a group that in the last 12 months has made me extraordinarily grumpy – Australia's politicians.

I am annoyed with all because they each threaten the world of nature that I cherish and the world of my children and grandchildren. To borrow from the words of Paul Collins (1995; p. 2)²,

'The environment is the central issue facing the contemporary world and if we do not face up to the environmental crisis we will have no future.'

We will be hated by our children's children and all those who come after them for having destroyed the world of nature, leaving them without choice, opportunity, or freedom.

Our actions threaten civilisation, with senior environmental scientists such as Paul Ehrlich giving us less than 1 chance in 10 of reversing the course of environmental degradation, mass extinction, and the collapse of civilisation (Ehrlich and Tobias

2014). As Paul and Anne Ehrlich once asked me, 'why isn't everybody as scared as we are?'. We live in a world of denial. Although the last few years have seen a rising level of concern for our environmental future, we do too little to change the path we follow, with Australia's decision-makers choosing to return to the past, as, for example, by seeking to reverse World Heritage status of 74 000 ha of forest in Tasmania (Ogilvie 2014).

Our politicians do not see what is happening to Earth. If they do see, they do not understand or care. To Australia's politicians, and most of its people, it seems as if the environment is not important; the future is not important. There is no other way that I can explain the undoing since 2008 and the Global Financial Crisis of 50 and more years of progress in protecting our environment; a reversal accelerating without precedent since the election of the Australian Liberal/National Party Coalition and the installation of Tony Abbott as Prime Minister in 2013. Today it is as if nothing matters but financial security, with the threats of terrorism and boat people used to blind the public to the government's economic policies and the reversal of protection for Australia's environment. In the eyes of government, protecting the environment has become 'green tape'.

¹This paper is based on the 2014 Keith Roby Memorial Lecture that I delivered at Murdoch University on 23 October, 2014. The Keith Roby Memorial Lecture in Community Science is a lecture sponsored by the Keith Roby Trust, established in memory of Dr Roby, a foundation member of Murdoch University. The spoken paper and illustrations used in the talk are available on the Murdoch University web site for the Roby Lectures (<http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-speeches-and-articles/Keith-Roby-Memorial-Lecture/>).

²Where I 'quote' an individual, I have mostly changed words to shorten the quote and fit it to the theme presented, so as to make the meaning clearer in the context of the paper. However, I do not believe that I have changed any author's meaning or intent.

A sustainable society

Charles Birch, who gave the inaugural Roby Lecture, spoke on ‘Born again science and technology’ (Birch 1982). Charles was an ecologist, a humanitarian, and had strong religious feelings, not unlike Keith Roby. Birch said ‘scientists are among the most destructive people in the world, which explains why the public is disenchanted with science’. Others who presented a Roby Lecture made similar comments, referring to the science and technology of war, nuclear war in particular. Birch developed the theme of the role of science in society, echoing Keith Roby’s concept of community science, as ‘science and technology for a sustainable society’. Birch asked, ‘what is a sustainable society?’ – a core theme of the lecture series. He said ‘a sustainable society is not the one we have’; we live in a finite world and unlimited growth and consumption is not sustainable. In Birch’s view, the world needed to adopt Zero Population Growth (ZPG)³ and ‘zero growth’ in consumption. Birch also said that if we were to have a sustainable society, then scientists needed to be better at communication.

What Birch said over 30 years ago, pertains as much, if not more so, today. Our political, social, and economic systems are not sustainable and are ‘not conducive to the long-term survival of humanity’ (Birch 1982). We need to be realistic and not assume that there is always going to be a technological fix just around the corner. Nor should we believe in miracles.

Paul Ehrlich, who delivered the 3rd Roby Lecture, spoke on the accelerating increase in the rates of extinction of the world’s flora and fauna, expressing concern for the future of humanity. Ehrlich (1985) pointed out ‘that the bell that tolls for the Mountain Gorilla also tolls for *Homo sapiens*’. Little has changed since Ehrlich spoke in 1985, with global and Australian extinction rates continuing to increase, with little, if any, action being taken to reverse the trend. De Vos *et al.* (2015) report that extinctions are currently 1000 times greater than the background rate of extinction seen in the fossil record, greater than the 100–1000 greater extinction rate estimated when Ehrlich spoke, and likely to accelerate to 10 000 times the background rate.

Unlike some Australian politicians, such as Senator Bob Katter of Queensland, who would like us to believe otherwise (Anon. 2010; www.bobkatter.com.au/issues/bradfield-scheme.html, accessed 12 December 2014), there are no unused resources. The water that flows from the land into the ocean, for example, is not wasted. It is used and needed by countless other species and sustains important fisheries. Whenever we take those resources, we diminish the capacity of other species to survive. Ultimately, populations are lost and species proceed to extinction.

In ‘Hope on Earth’, Ehrlich and Tobias (2014) quote the consensus statement of more than 500 scientists on maintaining humanity’s life-support systems:

‘based on the best scientific information available, human quality of life will suffer substantial degradation by the year 2050 if we continue on our current path’. (<http://mahb.stanford.edu/consensus-statement-from-global-scientists/>)

The reasons given in the consensus statement for the rapid collapse of the quality of life are climate change, mass extinction

of species, the loss of entire ecosystems, pollution of land, water, and air, human population growth, and unsustainable patterns of resource consumption. These are concerns voiced by presenters of the Roby Lecture from 1982 onwards.

The conclusions of Collins, Birch, and Ehrlich, as well as the consensus statement, do not differ from those of Jared Diamond, who has written extensively on the collapse of human societies, such as Easter Island and the Mayan civilisation, and the failure of generations of humans to act. Diamond’s analyses show that all civilisations bring on their own collapse through unsustainable growth and resource exploitation (Diamond 1992, 1997, 2005).

We need to ask why we persist in following social, cultural, and economic paths to environmental collapse that risk the future of our children and all children after them. The more we alienate ourselves from nature the less likely we can move to an ecologically sustainable society. We need an economy that does not rely on the exploitation of nature and human population growth.

Failure of science

I said I was grumpy with my scientific colleagues. I am grumpy with them because scientists do not take responsibility for the knowledge and technology they generate. Brian Easlea, who presented the 2nd Roby Lecture, attributed the world’s problems to the destructive nature of science and a cultural view that people were not part of the natural world (Easlea 1984). Easlea said that people do not see, do not care, do not know.

Despite all the advances in science over the millennia, science and scientists have failed to protect the world of nature. If this is to change, we need to know why.

Foremost is an inability, an unwillingness, by scientists to communicate widely. Scientists are taught only to present facts, not to advocate or express opinions (Nelson and Vucetich 2009; Wilhere 2012). Thus, we have a world replete with weapons of mass destruction and suffering the consequences of global heating. As Ehrlich (1985) and De Vos *et al.* (2015) make clear, we are in the midst of an extinction episode to rival that of the Permian, 250 million years ago, during which 70% of terrestrial species and 90–95% of marine species became extinct (Hecht 2014), an extinction event that dwarfs the loss of the dinosaurs. Lack of appreciation of this comes down to the way we teach science and educate scientists.

Birch (1982) called for scientists to communicate better and more widely – to work across disciplines. Barry Jones, Minister for Science in the Hawke government, repeated Birch’s call for scientists to communicate better and more widely (Jones 1988). Birch called for the need to have ‘experts’ who could cross boundaries, while Jones commented that the scientific community was singularly ineffective as a lobby. If Australia’s current Chief Scientist, Ian Chubb, is correct, not much has changed since Birch and Jones spoke. Chubb thinks scientists are getting better at lobbying, although they could do better (Australian Broadcasting Commission Q & A, 15 September 2014). I disagree; too few scientists speak and almost all avoid controversy.

³ZPG is achieved when each person has no more than two children, irrespective of the number of partners they may have.

Australian scientists are poor communicators. Despite the efforts of a few, such as Tim Flannery, Lesley Hughes, David Lindenmayer and Ian Lowe, the majority disdain communicating with the wider community and shun the media. This is especially so if an issue is contentious, as matters of the environment often are. A common excuse is that ‘the media always gets it wrong’, when in fact the problem is the inability of scientists to explain in simple English what it is that the public should know⁴. I have long held the view that scientists are poor communicators because we do not teach English and other languages to science students at university (Ehrlich 1993; Recher 1992a,b, 1994, 1998, 2008, 2013; Recher and Ehrlich 1999). Neither do we teach them how to speak in simple English using words non-scientists can understand. Because they cannot communicate, scientists tell you that good written and oral expression is not important.

Barry Jones (1988) said that people, including politicians, downplay the things they do not understand; what you cannot do or understand is unimportant. No one admits ignorance nor, in my view, can people admit that someone else may be brighter than they are. Australians happily accept that Sally Pearson runs faster, Ian Thorpe swims faster, and Danny Green hits harder than they can, but no one is smarter. Hence the prevalence in our society, including at university, of ‘dumbing down’, lowering expectations and promoting mediocrity.

According to a 1984 survey by the Organization for Economic Cooperation and Development (OECD) referred to by Barry Jones (1988), there was little agreement in Australia about the importance of science, with science seen as ‘external to national life’. The decision of the current Commonwealth government (elected 2013) to abolish a dedicated science portfolio in the Cabinet reflects their disregard for science. The OECD noted a strong anti-intellectual mood in Australia, which I extend to include a disdain of ‘education’. The views of the OECD were, according to Jones, ignored by government. They also appear to have been ignored by the scientific establishment, and by science educators, who have done little to improve the communication skills of the scientific community. Perhaps this is why Australian governments since the Whitlam era have degraded higher education and research.

Barry Jones (1988) said education, especially early specialisation, had much to answer for and that the need for disciplines to work together had never been greater. Charles Birch (1982) also called for individuals capable of communicating with other, disparate, disciplines, but this has not eventuated, contributing to the dominance of environmental sceptics among decision-makers in Australia.

How do we resolve the problem of science communication? I suggest making the Bachelor of Science a four-year degree, abandoning the anachronistic Honours year, and teaching science students how to communicate. It is also essential that academic institutions abandon the use of citation indices to measure the worth of journals and individual researchers. Citation indices were never designed for these purposes and are widely misused (Calver and Bradley 2009; Wall 2009; Cooper and Poletti 2011).

A sustainable economy

The way we educate scientists and the way they communicate with the public is only one of the challenges confronting us as we seek to address Australia’s environmental problems.

In his 2003 Roby Lecture, Peter Underwood said Earth’s exploitation was based on a greedy, devouring system that placed the riches of a few over the needs of the many. According to Underwood, we needed to develop a different attitude and respect for our fellow humans and the natural world. Others have used different words to express their condemnation of the global economy. In ‘Guns, Germs, and Steel’, Diamond (1997) described the role of government as facilitating the transfer of wealth from the poor and needy to the rich and greedy. In his novel ‘The Sigma Protocol’, Robert Ludlum (2001), speaking through the novel’s hero, Ben Hartman, commented in relation to treatments prolonging life: ‘The rich and powerful get to live twice as long as the poor and powerless! It’s a goddamned conspiracy of the elite’ – different words from Diamond’s, same conclusion.

Underwood said that to achieve a more equitable and sustainable society we needed to develop our social and human capital. This is the answer to a different economy – one that values personal achievement, education, art, and creativity over an obscene accumulation of material wealth. With such an economy, the world can grow without destroying the world of nature and the future of our children. Fred Jevons (1989), concluded that ‘We can afford to live for things other than making a living’. Easlea (1984) was another who wanted a more equitable world.

Not all speakers in the Roby Lecture series were sympathetic to the concerns of environmentalists for the future. Jevons (1989) commented that the ‘limits to growth debate’ of the early ‘70s was a false start, as the concerns raised had not happened. As with a host of deniers who misunderstood Ehrlich’s (1968) predictions of mass famine, there is a risk of a Type I error in taking predictions of the future too literally. An analysis by Graham Turner and Cath Alexander of the University of Melbourne of ‘Limits to Growth’ (Meadows *et al.* 1972) finds the predictions of the Meadow’s ‘business as usual’ model remarkably accurate through 2010 (Turner 2007, 2014; Turner and Alexander 2014). Meadows *et al.* (1972) concluded:

‘If the present growth trends in world population, industrialisation, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years. The most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity’.

According to Turner (2014) and Turner and Alexander (2014), there is little to indicate that ‘Limits to Growth’ got it wrong, although they do not say that the future will unfold precisely as predicted by Meadows *et al.* (1972). It is always possible, as happened with the Green Revolution, that technological advances will slow what most of the world’s peak scientific bodies consider inevitable – resource depletion,

⁴There are journalists who distort the truth in the pursuit of making a story sensational or to promote their own views and of those who pay their salaries. Working with such individuals is a challenge, but not an excuse for shunning all media and public communication.

intensifying resource competition, resource conflict, and falling *per capita* food and industrial production as resources are depleted and diverted to non-productive activities, such as conflict. The pollution of land, sea, and air will increase with the accelerating loss of ecosystem services and declining global productivity. All of this will lead to the cuts in social services and goods accompanied by increased death rates and a fairly sharp decline in population predicted by [Meadows *et al.* \(1972\)](#).

[Meadows *et al.* \(1972\)](#) predicted population to begin falling by ~500 000 million per decade from ~2030, which would eventually take the world's population to about half of today's 7+ billion – still too many for ecological sustainability, which will happen only if death rates increase. If you think the 'Limits to Growth' predictions are extreme and are concerned by the prospect of an increase in death rates, consider the prediction of James [Lovelock \(2006\)](#) of 'Gaia' fame that accelerating environmental degradation and climate change accompanying uncontrolled human population growth will end with environmental collapse and a world population of less than one billion by 2100. Lovelock is not alone in his views. Jared [Diamond \(2005\)](#) considered that global collapse was possible within the next few decades due to the world's growing environmental, social, and economic (resource competition) problems. As [Diamond \(2005\)](#) describes, this would not be the first time a human society collapses by destroying its resource base. The difference is only the scale, with collapse threatening all people, not just individual civilisations. It is not only *Homo sapiens* at risk, but all species.

It appears to me that the Australian biota is already in terminal decline as overall continental productivity falls; as Australians take more from the land and waters of the continent, there is less for other species. Well beyond the infamous loss of Australia's mammal fauna during the latter part of the 18th century and first half of the 19th century, Australia has suffered massive losses of biodiversity, almost none of which is documented. Reports from northern Australia suggest declines in the biota similar to those that occurred decades ago in southern Australia ([Burbidge and McKenzie 1989](#); [Woinarski *et al.*, 2014a](#); [Lewis 2014](#)), while bird populations across the continent wink out, like lights on a Christmas tree, one after the other ([Recher and Lim 1990](#); [Recher 1999](#); [Ford 2011, 2013](#)). As I said to a forester about the need to ensure the survival of native rats in a commercial forest – 'if the rats cannot survive, how can the trees?'. If there are no birds, what does this tell us about the viability of ecosystems we depend on for clean air and water, soil fertility and agricultural production, and health – points made by [Underwood \(2003\)](#), who linked human health with a healthy environment.

Underwood regarded the dream of endlessly rising wealth (material goods, money, power) and consumption as impossible, dangerous, and empty. Humanity needs to shift away from developing natural resources to developing our social and human capital (culture, arts, and education). I first heard this vision expressed by an Indonesian Minister for the Environment, Sarwono Kusumaatmaja, who said in essence that Indonesia needed to develop the wealth of its people and its culture

and not simply seek material wealth blindly following the West (www.culturalsurvival.org/ourpublications/csq/article/developing-appropriate-environmental-conflict-management-procedures-into, accessed 7 January 2015).

[Underwood \(2003\)](#) also said that we needed to develop a different attitude and respect for our fellow humans and the natural world, and concluded that 'we are on thin ice and need to dance'. The views of Underwood, like those of Birch, Ehrlich, Jones, and other Roby speakers contrasts sharply with those of [Jevons \(1989\)](#), who at one stage referred to greenies as 'unkempt weirdos'. He did acknowledge, however, that by the 1980s the environmental movement had matured and the environment should not be seen as a brake on development, but an opportunity for growth, a view currently promoted in the media and by economists ([Friedman 2008](#), [Winston 2010](#), [UNEP 2012⁵](#)).

Economic development and growth figured importantly in Jevons' presentation and in Penny Wensley's 1992 Roby Lecture ([Wensley 1992](#)). Both Jevons and Wensley picked up the conclusions and recommendations of the 1987 Brundtland Report, 'Our Common Future', where the notion of sustainable development gained prominence ([WCED 1987](#)). Jevons and Wesley agreed with the conclusion of the Brundtland Report that development was necessary to alleviate world poverty. That report defined sustainable development as:

'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.

It also recognised that the world is a system and that what happens in one place affects all people and places. The report argued the world needed a 'different kind of growth, one integrated with the environment' but, nonetheless, if the world was to get rid of poverty growth needed to be accelerated.

The concept of 'sustainable development' is an 'oxymoron'. In a finite world, continued development and the relentless exploitation of world resources, is not sustainable regardless of technology. It is possible to have ecologically sustainable economies, but these need to be modelled after natural ecosystems where over the long term the amounts of energy and resources entering the system equal the amounts used or are lost. Cities, for example, require vast amounts of energy and resources sourced from outside the city. As such, any significant disruption to supplies of energy, water or food would rapidly lead to urban collapse. We can live in cities and avoid the famines predicted by [Ehrlich \(1968\)](#) and [Malthus \(1798\)](#) only because we burn vast quantities of fossil fuels, including that required to provide cities with food and water. This is not ecologically sustainable and is the foundation of climate change and global heating.

Jevons' and Wensley's presentations, like the Brundtland Report, were essentially 'anthropocentric'. Clive Hamilton in his 1998 Roby Lecture described conventional economics as anthropocentric and contrasted this with ecocentric economics in which everything, including clean air and solitude, has intrinsic value even if it cannot be bought and sold. Unfortunately, despite the hopes of environmentalists, ecocentric

⁵Perhaps this is why the Australian government decided to cut its funding to UNEP by 80% (J. Sturmer, 2 December 2014, www.abc.net.au/news/2014-12-02/government-cuts-un-environment-group-funding-by-over-80pc/5932278).

economics has yet to replace the marketplace. Nowhere was this more evident than at the November 2014 G20 meeting in Brisbane. The concluding communiqué of the meeting called for a 2% increase in global Gross Domestic Product by 2018 without once mentioning the environment or the need for ecological sustainability; growth was mentioned 28 times, with sustainable growth or development used four times (www.mofa.go.jp/files/000059841.pdf, accessed 15 November 2014).

Hamilton (1998) noted that the marketplace does not do a good job of protecting the environment, with a need for greater regulation if an ecologically sustainable society was to be achieved. One proposal put forth in his lecture was for a carbon tax, and we all know that the Liberal/National Party government of Tony Abbott was, in large part, swept to power in Australia on a campaign of fear of escalating energy costs as a result of the carbon tax introduced in 2012 by the previous Labor government.

In 2009, the Roby Lecture was presented by Jules Petty, who addressed issues of sustainability. He concluded that poverty could be eliminated and everyone on Earth could enjoy an Australian lifestyle, but it would require the resources of 6–8 planet Earths. Petty argued that technology deceived us into thinking that civilisation could only exist with technology and technological progress. Instead, we can achieve sustainability only by changing patterns of consumption and living differently; an Australian lifestyle is not ecologically sustainable even in the context of ‘meeting the needs of the present, without compromising the needs of the future’ (WCED 1987). Petty (2009) asserted that consumption comes at a cost to nature and quoted the American naturalist and philosopher, Aldo Leopold (1949), who wrote:

‘We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect’.

This parallels my call to invert the conservation paradigm and view all of Australia as a place of nature, a conservation reserve, within which there are nodes of human activity, all of which is managed with ecological sustainability and nature conservation as the goals (Recher 1994, 2003).

David Rapport (2012) stressed, as had speakers before him, that humans were part of, not separate from, their ecosystems. Quoting the 1992 world scientists’ warning to humanity (UCS 1992), Rapport said we had to change the way we lived if vast human misery was to be avoided and Earth not irretrievably mutilated. Using a United Nations report on ‘food security’, Rapport noted that although there was no immediate risk of mass famines there were no grounds for complacency. In 1900, there were 8 ha of agricultural land in the world per person, but by 2005 that had fallen through population increase and land degradation to 2 ha per person. On current trends there would only be 1.6 ha per person by 2050, falling to less than 1 ha per person if the population grows to the 9.6–12.3 billion in 2100 projected by the latest United Nations models (United Nations 2013; Gerland *et al.* 2014). Coupled with climate change and continuing land degradation this places medium-term food security at high risk.

It is clear from the presentations in the Roby Lecture series that, for the past several generations, humanity and the scientific

community have been aware of the risks to Earth and the survival of civilisation in the way people use the world’s resources. It is not simply a matter of waste and inefficient use, nor even excessive consumption, but one of unsustainable population growth. Despite abundant scientific evidence and increasing concern from the scientific community, humanity continues to embrace market place economics that promote endless, unsustainable growth. I have no need to review the myriad environmental, social, and cultural issues assailing humanity – they are available daily in the media, yet Australian governments continue to act as if we are not part of the environment and that nature is simply an impediment to development. Climate change, or at least our burning of fossil fuels as the cause, is denied by the Prime Minister and his government, the loss of Australia’s biota is ignored or seen as inconsequential, while a bigger Australia is promoted in the interests of national security, jobs, and a better life. But is life better? Is the nation more secure? And, do people have the jobs they want? – jobs that allow them to develop as individuals.

Petty (2009) pointed to the absurdity of thinking we could continue to increase the human population and have everyone living at an Australian standard of living. Petty also said that technology does not ensure a better life or make people happier.

The things of nature that I cherish and know are essential for ecological sustainability are disappearing. Wherever I go there is less wildlife – fewer birds. Their loss is the result of our ‘greedy and devouring’ system of resource exploitation that puts our wants above the needs of all other living organisms.

Death of nature

Australians have lost whatever contact they had with nature. As a society we do not value the natural world nor understand the dependence of humanity and civilisation on the life-support systems provided by global and regional ecosystems. Easlea (1984) said humanity sees itself as separate from nature, not dependent on nature. People see nature as an impediment to growth and development, to be exploited and subdued.

Arnae Naess, who presented the Roby Lecture in 1986, said ‘as a species we were the first that could appreciate the richness of nature, but we do not’. Instead, nature is seen a threat. Naess (1986) claimed that if people were not taught the benefits of nature conservation, they would reject it. This is not easy when people know nothing of the natural world.

Australians are not alone in being divorced from nature. The world accepts economic and social systems encouraging the accumulation of obscene wealth by a few while sacrificing the rights of others, including other species, to life’s necessities – clean air and water, food and shelter, freedom of movement, and opportunity to evolve and adapt to a changing world. For many of us, the relentless growth of humanity and economy denies us the basic human rights of individual expression and solitude. We embrace an evolutionary imperative of ‘survival of the fittest’ and see no wrong in exploiting resources to the detriment of other people and of other species that require those same resources for survival. Too often we are not aware of how we affect others or other species; our society is anthropocentric and fixated on the individual.

The Earth's environmental challenges are legion and there is the risk that discussion of the world's environmental ills will be seen as 'doom saying' and that the effect on people will be negative. In 1994, I presented the inaugural Alan Sefton Memorial Lecture at the University of Wollongong and wrote (Recher 1994, p.149):

'I am reminded of the words of E. F. Schumacher of 'small is beautiful' fame', who said:

"People ask 'Will we survive the present age?' If I should answer 'Yes', they will lapse into complacency. If I should answer 'No', then they will be filled with despondency. It is better for now that we leave the question unanswered whilst we all set to work to resolve the problems of survival".

Schumacher's words hung besides those of Bill Mollison at Amery Acres in the Shire of Dowerin in the wheatbelt of Western Australia. Mollison's words were:

'all of us are concerned that we leave a continent in which our children and grandchildren can survive and exist and have a good life, a healthy life'.

Mollison's words are the words that drive my life, and I know they drive the lives of Paul and Anne Ehrlich and others who take strong positions on the state of the world's environment and our responsibilities to others and other species. Schumacher's words echo those of many scientists who say 'scientists should not advocate or take a position on issues'. I disagree with Schumacher that we should leave the question unanswered. We may not like the future, and we probably do not like the choices confronting us. However, if we don't answer the question, we risk following the same path to the future that led us here and has placed the survival of civilisation at risk.

There are no simple cures to Australia's environmental problems, much less those confronting the world, but we should have hope. We can achieve an ecologically sustainable society; we have the knowledge, we lack only the will to act. We lack the will to act because a majority, including the majority of decision-makers, do not understand and therefore deny the need to change. If we are to guarantee the needs of future generations, then we need to ensure that people understand the bond between themselves and their environment, and their responsibility to other species. To achieve this, we must be aware of the reasons behind our lack of care and understanding of the natural world. Education is a key and we need to change our education system to develop communication and understanding between the scientific community, the public, and decision makers. This means learning about nature; education needs to embrace the teaching of natural history, ecology, and environmental sciences as central to the development of sustainable societies and ecosystems.

In September 2014, the Office of the Chief Scientist of Australia released a report on the importance of science, technology, engineering, and mathematics to Australia's future (Office of the Chief Scientist 2014). It was effectively a call to boost science education at all levels of education and cannot be faulted in that regard. Ben Eltham, of *The Guardian* newspaper (theguardian.com, 3 September 2014) was critical of the report, saying it placed too much emphasis on the economy and put 'economic growth at the very top of its agenda'. I, too,

was disappointed on reading the report to find that neither 'environment' nor 'ecology', much less 'natural history', were mentioned either as core subjects of science and science education or as essential for an understanding of our relationship with the world around us and with other species. To me, as to Eltham, the report focused too much on economic development through technology. This is the same path that created the myriad environmental, social, and cultural problems the world already faces. It showed how deeply entrenched society is in marketplace economics and how difficult it will be to shift to the ecocentric economy – an ecologically sustainable economy – advocated by Clive Hamilton (1998).

The Chief Scientist, Ian Chubb, did attempt to explain the apparent emphasis on the economy in the report by saying that our children should expect more than a 'balanced budget' (Ian Chubb, theguardian.com, 8 September 2014). They should also expect clean air, good food, and oceans to swim in, as well as being able to raise a family and grow old. Nonetheless, when Chubb then says 'Science builds industries, boosts productivity and drives human progress. It is critical to national growth', all I see is the tired, failed mantra of growth and jobs, which if we continue on that path will deny our children and their children the clean air, good food, and oceans Chubb says are important.

Science must provide direction, not just technology. We need to change from economies exploiting the world's resources unsustainably to ones emphasising personal achievement and quality of life above material wealth. As Charles Birch (1982) pointed out 33 years ago, unending and ever-expanding development in a finite world is not possible. The sooner we move to ecological sustainability the sooner we can ensure better lives for our children's children.

People need to accept that we have a moral responsibility to share resources with other species, thus ensuring their right to life. This will not happen if we see science only as technology and business, and science education as only engineering and mathematics, as presented in the Office of the Chief Scientist (2014) report. We must educate children (and their parents) on how they are part of, and dependent on, global and regional ecosystems. Only then can education put science and technology in a context ensuring clean air, good food, and swimmable oceans for the future.

Below I suggest why Australians are divorced from nature and discuss options available to the community and science whereby humanity can begin to address Earth's environmental problems in a meaningful way. The options will challenge most, offend many, and be seen as difficult to implement by politicians, economists, conservationists, and business. Regardless of the challenges, we no longer have a choice; we must change the way we live, and the way we live with nature.

Natural history: its role in society

Prominent in the scientific and educational literature are analyses and discussions of the importance of natural history as a science and its role in informing us of our relationship with our environment and our dependence on other species for our well being (Cheeseman and Key 2007; Leather and Quicke 2009, 2010; Adam 2010; Beehler 2010; Tewksbury *et al.* 2014). Although there is far from unanimous agreement, there is

consensus that the increasing urbanisation of Western society has contributed to a decline in the study of nature and the teaching of natural history.

Unfortunately, when natural history was a subject of education and a larger proportion of the population was in contact with the land and nature it did not stop environmental destruction nor prevent extinctions. The epidemic of extinctions in Australia and across the Pacific Ocean islands began with the arrival of humans: first Aborigines, then Polynesians, and lastly Europeans (Johnson 2006; Steadman 2006). It is often said that First Nation People lived in harmony with their environment. This is not true. It is true that many First Nation People today have deep feelings for their land and deep respect for the life they share that land with. However, the image of harmony is a false one created by not understanding the relationship between animals and their environment. If First Nation People were in 'balance with nature', it was because they lacked the technology to subdue nature. There is abundant evidence of First Nation People contributing significantly to the extinction of the megafauna in the Americas, the Pacific, and Australia (Merrilees 1968; Martin 1973, 1984; Johnson 2006; Steadman 2006). The advent of agriculture some 10 000 years ago allowed changes to human society that marked the separation of people from nature, and of people from each other. As science and technology grew and cities prospered, people became increasingly distant from nature and more fearful of the non-human world.

Nevertheless, I would like to see ecology, the environment, and natural history as core subjects of education from preschool through university and beyond. We cannot rely on David Attenborough documentaries to teach society about the world of nature and where we, as humans, fit into it. However, integrating the ecological sciences into education is not sufficient to guarantee the survival of nature in Australia. There would be a stronger basis for conservation if people understood how they personally benefit from the natural world and the importance to themselves of nature conservation (Naess 1986). Naess was critical of the extensive 'moralising' of environmentalists that gave the public the false impression that in conserving nature they were being asked to sacrifice personal interests with no benefits. That is, the public and the politicians they elect do not see the self-interest inherent in conservation, but consider nature conservation as an impediment to development and jobs.

Failure of science

Charles Birch (1982) said scientists were among the most destructive people on Earth and were the reason the public distrusted science. This was a view endorsed by Brian Easlea (1984) and Barry Jones (1988), with Jones describing science as 'dirty business'. It is not the science itself that is destructive, but how it is used – through technology. Where science and scientists have failed is in not taking responsibility for how the technology developing from science is applied (Recher 2013). Science education in Australia is antiquated, narrow, and divorced from society. Although not expressed so emphatically, I think this is what Birch, Easlea, and Jones were speaking about. It is also implicit in the guidance that Ian Chubb is attempting to

give to government when he speaks of the importance of science to society and need for better and more comprehensive science education in Australia.

When I wrote about being grumpy with my scientific colleagues, I expressed my concerns as follows (Recher 2013):

- scientists are conservative and do not challenge authority or conventional norms
- scientists in Australia lack training in the arts and humanities
- scientists lack communication skills – English and communication are not regarded as important in educating scientists
- scientists avoid working with the media, thus making it difficult to communicate with the public and decision-makers alike; they avoid the media because they cannot communicate in simple English
- scientists adhere to a philosophy that they should not be advocates; they should only present facts, not opinions⁶; few scientists understand how public opinion works or is moulded; the public does not understand shades of grey, so when scientists claim that more data are needed or offer probabilities rather than certainties, this creates confusion and ambiguity, a situation that is exploited by science deniers
- the technology developed from the advances of science is often incompatible with an ecologically sustainable and ethical society, but scientists fail to give moral direction in how the knowledge they generate is used
- too much emphasis in science is placed on death control, prolonging life, and enhancing fertility, and not enough on sustainability and personal fulfilment
- science and technology are too concerned with the generation of material wealth and insufficiently concerned with the generation of knowledge and culture
- scientists need to assume responsibility for science and technology, and not allow politicians and multinationals to dictate science policy or interfere with science communication.

Scientists in the public service and any who have had the benefit of a publicly funded education or research grant should be required to communicate with the community. Science should be open and free; public service regulations prohibiting public discourse should be rejected. This requires fundamental changes in the way we teach scientists.

Scientists need to be taught how to communicate, and taught that communication with the wider community is as important as communication among peers. Scientists have a moral responsibility to other people and species to ensure that the technology developed from scientific enquiry is compatible with an ecologically sustainable and ethical society and economy. By not communicating with the public scientists abrogate their responsibilities to society and nature. There is no greater condemnation of the inability of scientists to communicate with the public than seeing a Hollywood star (Leonardo DiCaprio) leading the debate at the United Nations to reverse climate change. As put by Nelson and Vucetich (2009, p. 1090):

'... scientists, by virtue of being citizens first and scientists second, have a responsibility to advocate to the best of their

⁶Note that in law experts are entitled to have opinions.

abilities, to improve their advocacy abilities, and to be advocates in a justified and transparent manner’.

Science in particular, but academics in general, have lost control of how knowledge is communicated (Recher 2013). The worth of a scientist and science cannot be measured by an arbitrary set of citation indices (Calver and Bradley 2009; Wall 2009; Cooper and Poletti 2011; Calver 2013). The current addiction among academic and research institutions with citation indices distorts the way in which knowledge is communicated, making free and open communication difficult (Andersen *et al.* 2008). In my opinion, citation indices have been used by multinational publishing houses to gain control of scientific publication. By allowing multinational cartels of publishers to assume control of peer to peer publication, the academic community has allowed the communication of knowledge to become a commercial industry, when in fact it should be free and freely available. At the very least, all science receiving public funding should be available at no cost to anyone needing or wanting to use it (Calver and Bradley 2010; Fuller *et al.* 2014). The scientific community needs to revert to an earlier era and accept the necessity of tithing time and resources in the service of scientific societies, journals, and the organisation of conferences (Saunders *et al.* 1987). A good scientist, a complete scientist, supports science and society by assuming personal responsibility for fair, impartial and prompt peer review, journal production, and conferences (Recher *et al.* 2009).

Achieving this revolution in science requires fundamental changes in science education in Australia. Thus, I recommend the following:

- science should be a four-year degree, with the first year providing a broad foundation in the humanities; you cannot be a responsible scientist without understanding how human society works
- an Honours year is archaic and must be abandoned in the interests of broadening the education and communication skills of all undergraduates and postgraduates, not just an elite few
- scientists need to be instructed in their ethical responsibilities to all people and all life on Earth, and to science itself.

Only when scientists understand their responsibilities to science and society and learn how to communicate in simple English will we begin to see science and people working together to achieve an ecologically sustainable society and economy.

The challenge to conservationists

Science and scientists are not the only ones to bear responsibility for the failure of society to protect the natural world. Previously, I’ve been critical of the environmental movement and green groups, including ‘Green’ politicians, for failing to understand ecology and the needs of other species (Recher 1994, 2002a,b, 2013). Despite professing a love of nature, green groups are anthropocentric, lacking a basic understanding of ecology and the scientific basis of nature conservation. Conservation action is driven more by emotion and ideology than good science and the needs of other species. Australian conservation groups place

too much emphasis on wilderness and a conservation reserve system that provides escape and recreation for people, but cannot conserve continental biodiversity. Additionally, there is an unedifying and hypocritical disdain of any species deemed to be ‘alien’ or ‘not native’ to Australia.

Australian nature conservation is ‘reactive’, not proactive; the emphasis on threatened and iconic species prevents conservation and management of most continental biodiversity. As is true globally, Australia’s conservation reserve system is fragmented and unrepresentative (Joppa and Pfaff 2009; Watson *et al.* 2010; Craigie *et al.* 2014). Reserves are too small and isolated, meaning the end of evolution. Nomadic and migratory species are at immediate risk of extinction as habitats continue to be cleared and degraded (Ford 2013). The thousands of honeyeaters that I had on my study plots near Sydney in the 1970s are gone (Recher, unpubl.). By and large, conservation reserves are poorly managed, with an emphasis on people, including protecting people and their property off-reserve (author’s obs.). In my opinion, too many conservationists, conservation groups, and resource managers lack the basic ecological understanding required for planning, developing, implementing, and monitoring management for conserving biodiversity.

Inverting the paradigm

What is needed is a whole-of-landscape approach to conservation, with the emphasis on other species, not people. Wild-Country in Australia and Wild Lands in America are examples of the approach that should be taken (Recher 2003). Woinarski *et al.* (2014b) call for the entire Australian ‘Outback’, an area of 5.6m km² (73% of the continent) to be managed as a single ecosystem, arguing that this is necessary not only to conserve the region’s biota, but to ensure its productivity and capacity to sustain human life. We need to invert the conservation paradigm so that all of Australia and its waters are seen as a nature conservation reserve with nodes of human activity within that matrix managed with nature conservation as a priority. This will be the only way to achieve an ecologically sustainable society.

The goal of nature conservation should be to conserve entire ecosystems not just individuals or individual species. If dispersive species are taken into account, as they must be, an ecosystem may span continental-scale landscapes. Conservation success can only be measured by the extent to which populations and taxa are lost or conserved. Conservation success should not be measured against some mythical ‘natural’, ‘pre-European’, or even ‘pre-human’ condition, but by the absence of extinction and the self-sustainability of ecosystems. Thus, there is scope for integrating so-called ‘alien’ or ‘exotic’ species within otherwise ‘natural’ landscapes to the benefit of the indigenous (native) flora and fauna. This does not mean that there are no exotic species (including species indigenous to Australia) requiring control or eradication. Nor does it mean that new species should be introduced to Australia or that indigenous species can be moved from one part of Australia to another without careful consideration of how the native biota will be affected. My view is that Australia is already a transformed and highly degraded continent as a result of human activities. This includes the introduction of exotic species of plants and animals beginning with the introduction of the Dingo (*Canis lupus dingo*) by

Aborigines more than 4000 years ago. Some of these species, however, have significant benefits for remnant native species and their integration into the landscape may prove more cost effective and beneficial than attempting control or eradication (Date *et al.* 1991, 1996; Visser *et al.* 2009).

Whatever efforts are made to conserve nature in Australia they will ultimately fail without reducing the impact of people on the land and water. This requires limits on the consumption of resources and a reduction in the size of Australia's population. Based on the extent of environmental degradation across the continent and the accelerating loss of biodiversity there is a strong ecological argument that Australia is overpopulated. Yet it is only recently that Australian green groups have begun to address issues of population size, rate of growth, and distribution. Simply saying that population policies are needed, as the Australian Conservation Foundation did in its submission to the development of a Sustainable Population Strategy for Australia (Australian Conservation Foundation 2011), is inadequate. Groups concerned about the conservation of nature in Australia and the future well being of Australian society need to set clear targets for the size of Australia's population and explain precisely how those targets can be achieved. None currently attempt this, although Australia's 'Sustainable Population Party' advocates stabilising the nation's population as rapidly as possible, with a stable population of 23–26 million by 2050 (www.populationparty.org.au; accessed 3 October 2014).

Population: the human dilemma

The latest projections from the United Nations (2013) suggest that the world's population could exceed 15 billion by 2100, although I agree with James Lovelock that escalating environmental degradation and cultural collapse, with attendant increases in mortality, will prevent that from happening. There is a pattern to population growth that should not be ignored. Initially, populations grow as resources are exploited, only to crash when the resources available have been diminished to the point when numbers can no longer be sustained. Because resources have been overexploited, the carrying capacity of the environment is less than when growth began, and may never recover fully. All animals, including humans, follow the same pattern of boom and bust; because we see ourselves as different does not mean that nature will treat us any differently from sheep, deer, or microbes. Australians see Koalas (*Phascolarctos cinereus*) on Kangaroo Island killing their food trees and conclude there are too many koalas and their numbers need to be reduced (SA Department of Environment and Natural Resources [undated]; Masters *et al.* 2004). Strange then, when Australians look across Australia and see landscapes dominated by dead and dying trees as a result of our exploitation of the land and its resources, we conclude 'we need more people'. This is the ignorance and insanity that threatens the survival of civilisation.

Limiting the size and rate of change of the human population are the key issues in achieving an ecologically sustainable society and conserving biodiversity, but this will not be easy

for cultural, social, and demographic reasons (Bradshaw and Brook 2014). Limiting population size is made difficult by the fact that we do not discuss the need for population control nor the means by which limiting growth could be achieved in humane and socially responsible ways. Australian governments do not have population policies other than to encourage growth. We need to ask why – because we need to know why such a critical issue for human and planetary survival is not a subject of discussion, debate, and action.

It is my view that reproduction is not a right; it is a privilege. There are costs to reproduction that affect other people, future generations, and other species, and for that reason I argue that reproduction is not a right. The costs are measured in the use and depletion of resources, including space (solitude) and opportunity that others may need and are entitled to share equitably. Whether you consider reproduction a right or a privilege, having children carries with it significant responsibilities beyond the simple caring for your offspring. Key to those responsibilities is ensuring that by having children you do not deny future generations their needs for survival.

As judged by the scale of environmental degradation across Australia, the numbers of people in Australia exceed the continent's carrying capacity. Priority must be given to ecological sustainability and healing the land, and not to development and population growth. Population limits are not discussed because of concerns that anyone advocating limits to population growth and size will be branded a misanthrope or racist. For many scientists and conservationists these are legitimate concerns and prevent free and open discussion of this critical issue. There are numerous examples of advocates of population control being branded as misanthropic, genocidal, and racist. These include Paul Ehrlich (e.g. www.stevengoddard.wordpress.com/2012/07/14/paul-ehrlich-the-racist/; accessed 4 October 2014) and Australia's Sustainable Population Party (King 2013, www.onlineopinion.com.au/view.asp?article=15382, accessed 4 October 2014).⁷ The Wilderness Society was described as 'fascist' and 'misanthropic' for saying that the environment (in this instance, Cape York's wild rivers) was more important than people (local Aborigines wanting development of the rivers) (Sarah Hudson, *The Australian*, 6 August 2009, <http://www.theaustralian.com.au/opinion/rivers-hijacked-by-green-fascists/story-e6frg6zo-1225758369377>, accessed 4 October 2014).

Given that every person, and all species, depend on a common environment, I find it difficult to understand how a person or group advocating environmental protection above development and environmental destruction can be described as racist, fascist or misanthropic. Paul Ehrlich, for example, has argued against racism for his entire academic career (Ehrlich and Feldman 1977, 2003, Ehrlich and Ehrlich 2009) and is the last person I would describe as misanthropic. Branding individuals fighting to protect our environment as misanthropic or racist is no more than 'yellow journalism' intended to intimidate and thwart free and open discussion. Ehrlich suggested a maximum population for Australia of less than 10 million, while Tim Flannery considers a population of 6–12 million appropriate (NSW Nature Conservation Council 2012). Speaking at the

⁷For an informative discussion of the reasons population limitation is not widely discussed visit www.motherjones.com/blue-marble/2010/05/population-forum (accessed 4 October 2014).

University of Tasmania on 4 March 2011 in his final public address as Secretary of the Treasury, Ken Henry expressed the view that Australia's population growth was unsustainable. Henry thought a sustainable population for Australia might be around 15 million. He based his views on the extent of Australia's environmental degradation, species extinction, and the loss of biodiversity (www.abc.net.au/am/content/2011/s3155979.htm, accessed 26 December 2014). These are numbers far below the current population of 23 million and less than the 25 million suggested by Dick Smith in his Press Club address earlier in the year (<http://www.abc.net.au/news/2014-08-13/national-press-club-dick-smith-and-graham-turner/5668522>, accessed 26 December 2014) or by the Sustainable Population Party (SPP). Without the checks on population growth advocated by Smith, Australia's population is predicted to reach 37.6 million by 2050 (Christopher Joye, *Financial Review*, 30 November 2050, http://www.afr.com/p/national/why_australia_needs_to_get_real_7hEC3IX0RZWitSkELPcJEI, accessed 4 October 2014), while the 2010 Intergenerational Report predicted a population for Australia of 35.9 million by 2050 (Commonwealth of Australia 2010). There was a time when I would have been content if Australia's population stabilised at 50 million (Talbot *et al.* 1969; Recher and Talbot 1970). This was when government advocated a population of 100 million for Australia and 50 million seemed small in comparison, but we were wrong in thinking Australia could sustain a population of 50 m and continue to exploit the land as Australians have since colonisation by Europeans in the 18th century. Even the 20–25 million advocated by Dick Smith and the SPP exceeds the continent's carrying capacity when allowance is made for the 50–70+ million people, including the more than 6 m tourists visiting Australia each year, for which Australia provides food and fibre, but who do not live in Australia. However, I suspect Smith and the SPP would prefer a much smaller number and, as Talbot *et al.* (1969) did, put up a number that while not desirable was at least better than what government was promoting. My own view agrees with those of Ehrlich and Flannery that an ecologically sustainable population for Australia, that is, a population that does not degrade the land, rob future generations of opportunity, nor deny other species the right to evolve, is less than 10 million, and probably less than 8 million.

To achieve Charles Birch's call for Zero Population Growth and zero growth in consumption was never going to be easy. But unless we change the way we live and address population growth, it is unlikely that civilisation will survive this century. Australia needs to cease encouraging high birth and immigration rates. As I advocated in a lecture more than 20 years ago, Australia needs to adopt a one child policy, but even that may no longer be adequate (Bradshaw and Brook 2014).

Setting a limit to Australia's population requires open, frank, and free discussion. The issue is too important to ignore and is one that the scientific community needs to lead. Although individual scientists, such as Ehrlich and Flannery, have spoken on the need for population limits, most have remained silent. Spike Milligan, noted as a comedian and for his roles on the Goon Show, had more to say about the need for controlling the human population than Australia's scientific community. In a 1970 letter responding to concerns in 'World

Wildlife News' regarding farming and wildlife (Farnes 2013), Milligan wrote:

'There is only one answer, and always has been one answer, and that is population control. Nobody can compromise with ever expanding population, to try and compromise with that is sheer madness, and at the moment madness is at the helm ... there must be a crash birth control programme at once'.

Regrettably, madness has prevailed since 1970 and more than the wildlife and wild vegetation that Milligan was concerned about has been lost. It is likely that humanity, in exceeding Earth's carrying capacity, will experience the kind of population crash predicted by Lovelock (2006) and endlessly documented with other 'boom and bust' species. Having so degraded planetary ecosystems it is probable that Earth's carrying capacity will require millennia, if not longer, to recover. The option of Milligan's 'crash birth control programme' may no longer be available, even if one could be humanely implemented.

Science provided the knowledge that allowed the development of technologies that give us unprecedented control over the future, but enabling technology is not enough. The scientific community must also provide direction on how the knowledge and technology it generates are used. So far, it has failed to do that and the advances of science have created an unsustainable civilisation. There is nothing new in this. Throughout human history civilisations have come and gone, but we now have a global society, a global marketplace: one that is destroying the resources and life-support systems essential for sustainability and survival – for civilisation.

Unless we change the way we live, it is unlikely that civilisation will survive this century, and to paraphrase the words of Paul Collins (1995, p. 2), 'we will be hated by our children and all children after them for having denied them the right to a world of nature' and the opportunity to determine their own destiny.

The choice is ours.

Acknowledgements

My thanks to the Roby Memorial Lecture committee who invited me to present the 2014 Roby Lecture. I am also indebted to Murdoch University for granting me access to the university online library. Mike Calver was a gracious and generous host during my time at Murdoch and made helpful comments on a draft of the paper. He also provided references that I would not otherwise have found; who else besides Denis Saunders searches for the pronouncements of Spike Milligan? My wife, Judy, and my brother, Paul, read and commented on the paper as it evolved. Mike Calver, Mark O'Connor, Irina Dunn, Paul Ehrlich, Rod Fletcher, Pat Hutchings, and Denis Saunders kindly read and commented on near final drafts. Their collective efforts improved the paper and helped me avoid being too angry with the state of Australia's environment and the efforts of Australia's ruling class to destroy the lives of my children's children.

References

- Adam, P. (2010). The study of natural history – a PPP. In 'The Natural History of Sydney'. (Eds D. Lunney, P. Hutchings, and D. Hochuli.) pp. 1–15. (Royal Zoological Society of New South Wales: Sydney.)
- Andersen, H., *et al.* (2008). Editorial – Journals under threat: a joint response from history of science, technology and medicine editors. *Historical Records of Australian Science* **19**, ii–iv. doi:10.1071/HRV19N2_ED

- Anon. (2010). Bradfield Scheme would end MDB controversy: Katter. *Agribusiness*, 23 October 2010. Available at <http://www.northqueenslandregister.com.au/news/agriculture/agribusiness/general-news/bradfield-scheme-would-end-mdb-controversy-katter/1976567.aspx> [verified 31 March 2015].
- Australian Conservation Foundation (2011). Submission to a Sustainable Population Strategy for Australia. Australian Conservation Foundation, Melbourne.
- Beehler, B. M. (2010). The forgotten science: a role for natural history in the twenty-first century? *Journal of Field Ornithology* **81**, 1–4. doi:10.1111/J.1557-9263.2009.00253.X
- Birch, C. (1982). Born Again Science and Technology. Available at <http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-and-speeches/Keith-Roby-Memorial-Lecture> [verified 31 March 2015].
- Bradshaw, C. J. A., and Brook, B. W. (2014). Human population is not a quick fix for environmental problems. *Proceedings National Academy of Sciences* **111**, 16610–16615. doi:10.1073/PNAS.1410465111
- Burbidge, A. A., and McKenzie, N. L. (1989). Patterns in the decline of the mammal fauna of Western Australia: causes and implications for future conservation. *Biological Conservation* **50**, 143–198. doi:10.1016/0006-3207(89)90009-8
- Calver, M. C. (2013). RAM the PI-BETA, C3PO – what the H-STAR happened to my promotion application? Or: The pros and cons of bibliometric evaluations of researchers. In 'Grumpy Scientists: The Ecological Conscience of a Nation'. (Eds D. Lunney, P. Hutchings, and H. F. Recher.) pp. 106–121. (Royal Zoological Society of NSW: Sydney.)
- Calver, M. C., and Bradley, J. S. (2009). Should we use the mean citations per paper to summarize a journal's impact or to rank journals in the same field? *Scientometrics* **81**, 611–615. doi:10.1007/S11192-008-2229-Y
- Calver, M. C., and Bradley, J. S. (2010). Patterns of citations of open access and non-open access conservation biology journal papers and book chapters. *Conservation Biology* **19**, 574–577.
- Cheeseman, O. D., and Key, R. S. (2007). The extinction of experience: a threat to insect conservation? In 'Insect Conservation Biology'. (Eds A. J. Stewart, T. R. New, and O. T. Lewis.) pp. 322–348. (CABI: Watlington, UK.)
- Collins, P. (1995). 'God's Earth: Religion as if Matter Really Mattered.' (Dove: Melbourne.)
- Commonwealth of Australia (2010). Australia to 2050: future challenges. (Commonwealth of Australia: Canberra.)
- Cooper, S., and Poletti, A. (2011). The new ERA of journal ranking: the consequences of Australia's fraught encounter with 'quality'. *Australian Universities Review* **53**, 66–72.
- Craigie, I. D., Pressey, R. L., and Barnes, M. (2014). Remote regions – the last places where conservation efforts should be intensified. A reply to McCauley *et al.* (2013). *Biological Conservation* **172**, 221–222. doi:10.1016/J.BIOCON.2014.02.032
- Date, E. M., Ford, H. A., and Recher, H. F. (1991). Frugivorous pigeons, stepping stones and weeds in northern New South Wales. In 'Nature Conservation 2: The Role of Corridors'. (Eds D. A. Saunders and R. J. Hobbs.) pp. 241–245. (Surrey Beatty: Sydney.)
- Date, E. M., Recher, H. F., Ford, H. A., and Stewart, D. A. (1996). Conservation biology of rainforest pigeons in northern New South Wales. *Pacific Conservation Biology* **2**, 299–308.
- De Vos, J. M., Joppa, L. N., Gittleman, J. L., Stephens, P. R., and Pimm, S. L. (2015). Estimating the normal background rates of species extinction. *Conservation Biology* **29**, 452–462. doi:10.1111/COBI.12380
- Diamond, J. (1992). 'The Third Chimpanzee: The Evolution and Future of the Human Animal.' (HarperCollins: New York.)
- Diamond, J. (1997). 'Guns, Germs, and Steel: The Fates of Human Societies.' (W.W. Norton: New York.)
- Diamond, J. (2005). 'Collapse: How Societies Choose to Fail or Succeed.' (Viking: New York.)
- Easlea, B. (1984). Conflict, science and the Garden of Eden. Available at <http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-and-speeches/Keith-Roby-Memorial-Lecture> [verified 31 March 2015].
- Ehrlich, P. R. (1968). 'The Population Bomb.' (Ballantine Books: New York.)
- Ehrlich, P. R. (1985). Extinction: the implications of loss of our biological heritage. Available at <http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-and-speeches/Keith-Roby-Memorial-Lecture> [verified 31 March 2015].
- Ehrlich, P. R. (1993). Communication: how can ecologists get their message out? In 'Nature Conservation 3: The Reconstruction of Fragmented Ecosystems'. (Eds D. A. Saunders, R. J. Hobbs, and P. R. Ehrlich.) pp. 295–301. (Surrey Beatty: Sydney.)
- Ehrlich, P. R., and Ehrlich, A. H. (2009). 'The Dominant Animal: Human Evolution and the Environment.' 2nd edn. (Island Press: Washington, DC.)
- Ehrlich, P. R., and Feldman, M. (2003). What creates our behavioral phenotype? *Current Anthropology* **44**, 87–107.
- Ehrlich, P. R., and Feldman, S. S. (1977). 'The Race Bomb: Skin Color, Prejudice, and Intelligence.' (New York Times Book Co.: New York.)
- Ehrlich, P. R., and Tobias, M. C. (2014). 'Hope on Earth: A Conversation.' (University of Chicago Press: Chicago.)
- Farnes, N. (Ed.) (2013). 'Spike Milligan: Man of Letters.' (Penguin Books: London.)
- Ford, H. A. (2011). The causes of decline of birds of eucalypt woodlands: advances in our knowledge over the last 10 years. *Emu* **111**, 1–9.
- Ford, H. A. (2013). Are we underestimating the threat to Australia's migratory land birds. *Pacific Conservation Biology* **19**, 303–311.
- Friedman, T. L. (2008). 'Hot, Flat, and Crowded: Why We Need a Green Revolution.' (Macmillan: New York.)
- Fuller, R. H., Lee, J. R., and Watson, J. E. M. (2014). Achieving open access to conservation sciences. *Conservation Biology* **28**, 1550–1557. doi:10.1111/COBI.12346
- Gerland, P., Raftery, A. E., Sevckova, H., Li, N., Gu, D., Spoorenberg, T., Alkema, L., Fosdick, B. K., Chunn, J., Lalic, N., Bay, G., Buettner, T., Heilig, G. K., and Wilmoth, J. (2014). World population stabilization unlikely this century. *Science* **346**, 234–237. doi:10.1126/SCIENCE.1257469
- Hamilton, C. (1998). Using economics to protect the environment. Available at <http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-and-speeches/Keith-Roby-Memorial-Lecture> [verified 31 March 2015].
- Hecht, J. (2014). 'Missing' disaster led to all-time worst extinction. *New Scientist* **2992**, 23.
- Jevons, F. (1989). A science policy for the 1990s: globalisation and localisation. Available at <http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-and-speeches/Keith-Roby-Memorial-Lecture> [verified 31 March 2015].
- Johnson, C. (2006). 'Australia's Mammal Extinctions.' (Cambridge University Press: Cambridge.)
- Jones, B. (1988). Politics, choice and long-term thinking in an age of technological revolution. Available at <http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-and-speeches/Keith-Roby-Memorial-Lecture> [verified 31 March 2015].
- Joppa, L. N., and Pfaff, A. (2009). High and far: biases in the location of protected areas. *PLoS ONE* **4**, e8273. doi:10.1371/JOURNAL.PONE.0008273
- Leather, S. R., and Quicke, D. J. L. (2009). Where would Darwin have been without taxonomy? *Journal of Biological Education* **43**, 51–52. doi:10.1080/00219266.2009.9656151
- Leather, S. R., and Quicke, D. J. L. (2010). Do shifting baselines in natural history knowledge threaten the environment? *The Environmentalist* **30**, 1–2. doi:10.1007/S10669-009-9246-0

- Leopold, A. (1949). 'A Sand County Almanac.' (Oxford University Press: Oxford.)
- Lewis, D. (2014). Small mammals vanish in northern Australia. *Science* **345**, 1109–1110. doi:10.1126/SCIENCE.345.6201.1109
- Lovelock, J. (2006). Controversial scientist predicts planetary wipeout. *Daily Mail Australia*, 29 November 2006.
- Ludlum, R. (2001). 'The Sigma Protocol.' (St. Martin's Press: New York, NY.)
- Malthus, T. R. (1798). 'An Essay on the Principle of Population.' (J. Johnson: London.)
- Martin, P. S. (1973). The discovery of America. *Science* **179**, 969–974. doi:10.1126/SCIENCE.179.4077.969
- Martin, P. S. (1984). Prehistoric overkill: the global model. In 'Quaternary Extinctions'. (Eds P. S. Martin and R. G. Klein.) pp. 354–403. (University of Arizona Press: Tucson.)
- Masters, P., Duka, T., and Moss, G. (2004). Koalas on Kangaroo Island: from introduction to pest status in less than a century. *Wildlife Research* **31**, 267–272. doi:10.1071/WR03007
- Meadows, D. H., Meadows, D. L., Rander, J., and Behrens, W. W. III (1972). 'The Limits to Growth: A Report to the Club of Rome Project on the Predicament of Mankind.' (Earthscan: London.)
- Merrilees, D. (1968). Man the destroyer: late Quaternary changes in the Australian marsupial fauna. *Journal of the Royal Society of Western Australia* **51**, 1–24.
- Naess, A. (1986). Self-realization – an ecological approach to being in the world. Available at <http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-and-speeches/Keith-Roby-Memorial-Lecture> [verified 31 March 2015].
- Nelson, M. P., and Vucetich, J. A. (2009). On advocacy by environmental scientists: what, whether, and how. *Conservation Biology* **23**, 1090–1101. doi:10.1111/J.1523-1739.2009.01250.X
- NSW Nature Conservation Council (2012). The population policy of the NSW Nature Conservation Council. (NSW Nature Conservation Council: Sydney.)
- Office of the Chief Scientist (2014). Science, technology, engineering and mathematics: Australia's future. (Australian Government: Canberra.)
- Ogilvie, F. (2014). Government stands firm on bid to reduce Tasmanian forest World Heritage listing. Available at www.abc.net.au/news/2014-05-15/senate-world-heritage-forests-tasmania/5456214 [verified 30 March 2015].
- Petty, J. (2009). Sustainability and surviving the Perfect Storm: will it be convergence or divergence? Available at <http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-and-speeches/Keith-Roby-Memorial-Lecture> [verified 31 March 2015].
- Rapport, D. J. (2012). Ecocultural health for a Sustainable Future. Available at <http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-and-speeches/Keith-Roby-Memorial-Lecture> [verified 31 March 2015].
- Recher, H. F. (1992a). Simple journalists or simple scientists?: Are environmental issues too complex for the media? *Australian Zoologist* **28**, 19–23. doi:10.7882/AZ.1992.005
- Recher, H. F. (1992b). Ecology on trial. In 'Zoology in Court'. (Ed. D. Lunney.) pp. 25–34. (Royal Zoological Society of New South Wales: Sydney.)
- Recher, H. F. (1994). Science and conservation, towards alternative strategies for protecting Australia's biological resources. *Australian Zoologist* **29**, 148–156. doi:10.7882/AZ.1994.002
- Recher, H. F. (1998). Public and political: the challenge for ecologists. In 'Ecology for Everyone: Communicating Ecology to Scientists, the Public and the Politicians'. (Eds R. Wills and R. Hobbs.) pp. 9–15. (Surrey Beatty: Sydney.)
- Recher, H. F. (1999). The state of Australia's avifauna: a personal opinion and prediction for the next millennium. *Australian Zoologist* **31**, 11–27. doi:10.7882/AZ.1999.003
- Recher, H. F. (2002a). Challenges for nature conservation. *Australian Zoologist* **32**, 112–116. doi:10.7882/AZ.2002.010
- Recher, H. F. (2002b). Scientists in the wilderness. *Australian Zoologist* **32**, 139–149. doi:10.7882/AZ.2002.011
- Recher, H. F. (2003). WildCountry. *Pacific Conservation Biology* **8**, 221–222.
- Recher, H. F. (2008). Good English, God's Nature: Science Education. *Pacific Conservation Biology* **14**, 3–4.
- Recher, H. F. (2013). What makes this old scientist grumpy. In 'Grumpy Scientists: The Ecological Conscience of a Nation'. (Eds D. Lunney, P. Hutchings, and H. F. Recher.) pp. 1–8. (Royal Zoological Society of New South Wales: Sydney.)
- Recher, H. F., and Ehrlich, P. R. (1999). The essence of science: the social responsibility of communicating. *Pacific Conservation Biology* **5**, 161–162.
- Recher, H. F., and Lim, L. (1990). A review of the status of Australia's terrestrial vertebrate fauna. *Proceedings of the Ecological Society Australia* **16**, 287–301.
- Recher, H. F. and Talbot, F. H. (1970). Australia in 2030. *Walkabout* **36**, 7–10.
- Recher, H. F., Calver, M. C., and Saunders, D. A. (2009). Communication and the publication process. *Pacific Conservation Biology* **15**, 77–79.
- Saunders, D. A., Arnold, G. W., Burbidge, A. A., and Hopkins, A. J. M. (1987). The role of remnants of native vegetation in nature conservation: future directions. In 'Nature Conservation: The Role of Remnants of Native Vegetation'. (Eds D. A. Saunders, G. W. Arnold, A. A. Burbidge, and A. J. M. Hopkins.) pp. 387–392. (Surrey Beatty: Sydney.)
- South Australian Department of Environment and Natural Resources (undated). Kangaroo Island Koala Management Program: How and Why. South Australian Government, Adelaide.
- Steadman, D. W. (2006). 'Extinction and Biogeography of Tropical Pacific Birds.' (University of Chicago Press: Chicago.)
- Talbot, F. H., Recher, H. F., and McMichael, D. F. (1969). Planning for population stability in Australia. *Australian Journal of Science* **31**, 406.
- Tewksbury, J. J., Anderson, J. G. T., Bakker, J. D., Billo, T. J., Dunwiddie, P. W., Groom, M. J., Hampton, S. E., Herman, S. G., Levey, D. J., Machnicki, N. J., Del Rio, C. M., Power, M. E., Rowell, K., Salomon, A. K., Stacey, L., Trombulak, S. C., and Wheeler, T. A. (2014). Natural history's place in science and society. *Bioscience* **64**, 300–310. doi:10.1093/BIOSCI/BIU032
- Turner, G. (2007). A comparison of the Limits to Growth with 30 years of reality. SEED Working Paper Series 2008–09. CSIRO, Canberra.
- Turner, G. (2014). Is Global Collapse Imminent. MSSI Research Paper No. 4. Melbourne Sustainability Institute, University of Melbourne.
- Turner, G., and Alexander, C. (2014). Limits to growth was right. New research shows we're nearing collapse. *The Guardian*, 2 September 2014.
- Underwood, P. (2003). Beating nature? Reflections on human and global health. Available at <http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-and-speeches/Keith-Roby-Memorial-Lecture> [verified 31 March 2015].
- Union of Concerned Scientist (UCS) (1992). World scientists' warning to humanity. Available at www.ucsusa.org/about/1992-world-scientists.html#.VHPleauUcao [verified 31 March 2015].
- United Nations (2013). World population prospects: the 2012 revision, key findings and advance tables. Working Paper No. ESA/P/WP.227. United Nations, Department of Economic and Social Affairs, Population Division, New York.
- United Nations Environment Program (UNEP) (2012). The business case for the green economy: sustainable return on investment. UNEP.
- Visser, R. L., Watson, J. E. M., Dickman, C. R., Southgate, R., Jenkins, D., and Johnson, C. N. (2009). A national framework for research on trophic regulation by the Dingo in Australia. *Pacific Conservation Biology* **15**, 209–216.

- Wall, H. J. (2009). Don't get skewed over by journal rankings. *The B.E. Journal of Economic Analysis & Policy* **9**, 1–10. doi:[10.2202/1935-1682.2280](https://doi.org/10.2202/1935-1682.2280)
- Watson, J. R., Evans, M. C., Carwardine, J., Fuller, R. A., Joseph, L. N., Segan, D. B., Taylor, M. F. J., Fensham, R. J., and Possingham, H. P. (2010). The capacity of Australia's protected-area system to represent threatened species. *Conservation Biology* **25**, 324–332.
- Wensley, P. (1992). Rio and beyond – global environmental issues: Australia's role and interests. Available at <http://our.murdoch.edu.au/University-Secretarys-Office/University-history/Lectures-and-speeches/Keith-Roby-Memorial-Lecture> [verified 31 March 2015].
- Wilhere, G. F. (2012). Inadvertent advocacy. *Conservation Biology* **26**, 39–46. doi:[10.1111/j.1523-1739.2011.01805.x](https://doi.org/10.1111/j.1523-1739.2011.01805.x)
- Winston, A. (2010). Going green for the economy. *Harvard Business Review*, August 17 2010. Available at: <https://hbr.org/2010/08/going-green-for-the-economy.html> [verified 31 March 2015].
- Woinarski, J., Burbidge, A., and Harrison, P. (2014a). 'The Action Plan for Australian Mammals 2012.' (CSIRO Publishing: Melbourne.)
- Woinarski, J., Trail, B., and Booth, C. (2014b). 'The Modern Outback: Nature, People, and the Future of Remote Australia.' (Pew Charitable Trusts: Sydney.)
- World Commission on Environment and Development (1987). 'Our Common Future.' (Oxford University Press: Oxford.)