

science. *vs* superstition

the case for a new scientific enlightenment

Edited by

James Panton
and Oliver Marc Hartwich

policy
exchange



University of Buckingham Press

First published in December 2006 by Policy Exchange Limited
and University of Buckingham Press Limited

Policy Exchange
Clutha House
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London SW1P 3AY
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www.policyexchange.org.uk

Distributed by
The University of Buckingham Press
Buckingham MK18 1EG
+44 1280 828338
www.ubpl.co.uk

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ISBN 0-9551909-8-3
Printed by University of Buckingham Press

The cover picture was provided by the National Cancer Institute,
<http://visualsonline.cancer.gov>.

Printed by Heron Dawson and Sawyer
Designed by John Schwartz, john@thefrontline.net

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Science vs. Superstition is distributed to the book trade by:



University of Buckingham Press

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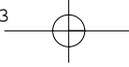


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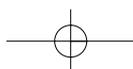
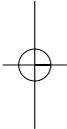
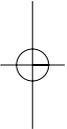
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2: The problem of the precautionary principle: the paternalism of the precautionary coalition

Jaap C. Hanekamp and S. Wybren Versteegen

In recent years, the traditional wisdom that ‘one can never be too careful’ has been formalized as a dominant legal doctrine, enshrined in international law as the Precautionary Principle. The first international endorsement of the precautionary principle was the acceptance in 1982 by the United Nations General Assembly of The World Charter for Nature, and it first appeared in an international treaty in the 1987 Montreal Protocol. It can now be found in a host of diverse national and international legislative treaties.¹ In terms of international policy-making, the most influential enshrinement of the precautionary principle was its insertion into the 1992 Rio Declaration on Environment and Development.

Although the principle has been defined in a host of different ways, leading to a variety of interpretations², its essence is expressed quite clearly in the Rio Declaration, which states that in relation to a given action or state of affairs:

“Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”³

In other words, the precautionary principle suggests that if the result of a given action may be to cause irreversible damage of some sort, in the absence of scientific consensus that such harm will not ensue, we must proceed as if there is evidence that such harm will indeed ensue. The result is that the burden of proof falls not on the regulator, but on those who advocate taking the action.

The precautionary principle has arguably had an enormous impact in the areas of scientific and, particularly, environmental law and regulation. It has been the subject of innumerable publications and appraisals, fluctuating between sycophantic and derogatory. For its most vociferous proponents, the precautionary principle is seen as the foundation upon which a new universally applicable (environmental) legal system can be built that can protect present and future generations against the environmental and health risks associated with contemporary society's technological methods of production and high rates of consumption. To its critics, the precautionary principle has served to formalise a climate of fear around scientific development which places unreasonable burdens upon scientists and which, if carried out in full, can only seek to prevent a wide range of scientific developments and breakthroughs.

The extent to which the precautionary principle has become enshrined within the European Union is expressed by the fact that in 2001, the European Environment Agency, the EU body which claims to be "dedicated to providing sound, independent information on the environment", published the now well known and much cited report, *Late Lessons from Early Warnings*.⁴ According to the European Environment Agency this report,

*"is about gathering information on the hazards raised by human economic activities and its use in taking action to protect better the environment and the health of the species and ecosystems that are dependent on it. The study aims to contribute to better and more accessible science-based information and more effective stakeholder participation in the governance of economic activity so as to help minimise environmental and health costs and maximise innovation."*⁵

In reality, however, the report *assumes* the perspective of the precautionary principle as its starting point. The report is organised around 14 case studies involving "a range of well known hazards to the public, to workers and to the environment, where sufficient is now known about their

impacts to enable conclusions to be drawn about how well they were dealt with by governments and by civil society”.⁶ Beginning with the precautionary principle as its unquestioned premise, it proceeds to argue that a host of previous environmental problems and scientific accidents could have been prevented if only the precautionary principle had been understood and actionable prior to those problems and events. *Late Lessons* is worth considering in some detail precisely because it seeks to extrapolate back from the contemporary social and scientific climate, in which the precautionary principle is often simply *assumed*, and in so doing to demonstrate that *precautionary* measures have always been at the heart of sensible scientific practice. However, the report reveals far more about our contemporary mindset and obsessions than it teaches us about the history of particular scientific events.

An example from the introduction can serve to illustrate this point. In recounting events surrounding the cholera epidemic in London in the 19th century, *Late Lessons* takes the actions of John Snow who, having noticed a correlation between individuals infected with cholera and their use of a water pump on Broad Street, proposed removing the handle of the pump to prevent people using it. According to the authors of *Late Lessons* this demonstrates a “classic case of precautionary prevention”.⁷ However, a more accurate interpretation of Snow’s actions would be to point out that he was relying upon the basic scientific method of induction: having noticed a correlation, he set out to test whether or not there was a causal connection between the water pump and the infection of individuals with cholera. Rather than *precaution* as the guiding principle underlying his actions (“we don’t know the consequences of our actions, so we’d better not do anything”), it seems to us that this example illustrates perfectly the attempt to develop scientific knowledge through a process of trial and error in which the results of a particular action are not known in advance.

This is precisely the kind of attitude that we believe is at the heart of the scientific endeavour, and it is an attitude which we believe the precautionary principle stands opposed to. Because this principle has become such an unquestioned premise of contemporary regulation, we

believe it is important to subject it to some serious questioning. Because *Late Lessons* stands as such a well known and influential report which seeks to demonstrate the importance of the precautionary principle, published by the EU's own Environmental Agency tasked with providing "sound, independent advice on the Environment", we believe that interrogating the arguments of *Late Lessons* is a particularly important task for anyone who wishes to understand the limits of the precautionary principle.

Late Lessons from Early Warnings

In *Late Lessons*, fourteen historical case studies are presented and twelve lessons formulated on environmental and health issues. The examples considered range from halocarbons and the ozone layer, acid rain and forest dieback, to hormones in beef. It is argued that these problems have all created (or will create) great harm that could have been (or will be) prevented through the application of the precautionary principle.

One thing that is clearly revealed is the extent to which the precautionary principle is as much a political tool as it is a method of sensible scientific practice. The first case study, on fish stock depletion, makes this fact very clear indeed.

As far back as the Middle Ages, human beings have been aware that fish stocks could be overexploited. The abundance of many fish species fluctuates markedly as a result of a range of natural and environmental processes; but clearly the rate at which fish are caught by humans can have a marked effect upon such 'natural' cycles. In recent years, marine biologists have attempted to establish what level of fishing is possible at sustainable levels without causing the degradation of fish stocks; what are called 'maximal sustainable yields'. The setting of such limits, however, is not a purely 'scientific' question. One problem is that the predictions of marine biologists as to the capacity of fish stocks to replenish themselves are not definitive. A second is that the imposition of limits has to take into account not only the actual number of fish that will be caught, and the predictions of the implications of the number of fish caught for the overall capacity of the stock to regenerate. It also involves the livelihoods

of fishermen and the provision of fish that consumers wish to eat. There are important questions of economics, of local economies, and human livelihoods at stake. In reality, prolonged political debate between scientists, fishermen, lobbyists and politicians, has not tended to result in any consensus on acceptable fishing levels for all parties concerned.

Examples of the depletion of a host of fish stocks over a number of centuries suggest a real uncertainty in our capacity to determine a maximal sustainable yield. So the historical lesson drawn from this is that the precautionary principle must be fully employed. This would mean a 'temporary halting' of fishing activities through the establishment of 'no-take zones'. Such an approach employs what the report authors euphemistically term the "error-resilient concept"; or in other words, given that there is uncertainty about the optimum levels of fishing that will maintain fish stocks, the only safe, error-free course of action is to call a halt to fishing in these areas altogether for a certain period of time.⁸

However, there are a number of obvious problems with this approach. First, there is the question of its implications for both consumers and fishermen. The precautionary principle would seem to suggest that their interests simply have to be over-ridden. Second, there is the definitional problem of what is to count as a 'temporary' halt to fishing activities. Precisely because the call for this measure is the result of uncertainty as to the impact that a particular level of fishing will have upon a particular fish stock, the question of how 'temporary' the closure should be, much as the question of what constitutes a 'maximal sustainable yield', is a question of political debate, not scientific fact. According to the EU's communication on the precautionary principle, the provisional nature of precautionary measures "is not bound up with a time limit but with the development of scientific knowledge".⁹ Here we enter a problematic circle: it is the fact of scientific uncertainty which has led to the call for the precautionary principle to be enacted leading to a 'temporary' halt to fishing activities, yet the temporary nature of such a halt is to be determined by the development of scientific certainty on a particular issue. But the possibility of scientific certainty is precisely the thing that is here under dispute: what level of 'certainty' is required to satisfy the propo-

nents of the precautionary principle? A precautionary ban will most likely have an “enduring temporality”.

A second example of a case-study employed in *Late Lessons* gives further illustration of the political underpinnings of the precautionary principle. ‘Knocking’ is the name given to the process where petrol ignites too early in a four stroke combustion engine; it causes a knocking sound, reduces the engine’s performance, and increases wear and tear. In the 1970s, MTBE (methyl tert-butyl ether) was introduced as an anti-knocking agent to replace lead, which had previously been used, because rising concentrations of airborne lead had been deemed undesirable. However, *Late Lessons* draws attention to the fact that MTBE has, or may have, its own set of environmental costs; and indeed that all anti-knocking agents which could be used as an alternative to lead have, or at least may have, environmentally undesirable consequences. The solution proposed is therefore that the best option would be “questioning the basic need for a mass transit system”.

In the logic of the argument, we move from the recognition that rising concentrations of air-borne lead are undesirable, through the claim that alternatives to lead have, or may have, undesirable implications, to the solution that we ought, therefore, to adopt “a policy to discourage citizens from driving personal vehicles”.¹⁰ We move, in other words, from a demonstrable scientific problem (the use of lead as an anti-knocking agent in combustion engines), to the raising of uncertainty about alternative practices (the uncertainty about the impact of alternative anti-knocking agents), to a call for cutting back citizens’ use of personal vehicles.

These two examples illustrate the underlying thrust of *Late Lessons*: the use of the logic of the precautionary principle as an attempt to trump each side of the political debate, and in so doing, to locate the problem as that of consumers and producers who are unable and unwilling to ‘restrict’ their self-interest.

On smoking guns

There is good reason to believe that there is no necessary conflict between self-interest and environmentally better practices. An example

is the discovery of the 'hole' in the ozone layer above Antarctica in 1985, and the development of scientific data indicating that the use of CFCs may be the problem. The result was the rapid development of a consensus amongst the international community that the use of halocarbons must be quickly phased out.¹¹ What is most interesting in this example, however, is that the movement from discovering the cause of an environmental problem and acting upon it was in no way the result of a precautionary approach. The discovery of ozone depletion caused by halocarbon emissions was a 'smoking gun', direct proof of the effect of halocarbons on the atmosphere: there was no uncertainty.

The environmental movement has been quick to grasp that it is such 'smoking guns', not the vagaries of the precautionary principle, that in fact lead to swift action. The discovery of 'natural disasters', such as floods and hurricanes, which are often interpreted, rather crudely, as evidence of man's impact upon global temperatures, are employed as a (quasi-) 'proof beyond reasonable doubt' that will satisfy public opinion and politicians who, though often in an oversimplified manner, keep thinking in terms of the authority of 'scientific proof'. Society does not accept precautionary action, but relies on what it conceives as 'scientific proof'.

This is precisely the structure of events that lead to the introduction of policies around SO₂ (sulphur dioxide) emissions, which *Late Lessons* takes as a further case study.

In the early 1980s, as a result of lobbying, public opinion in Europe became convinced that acid rain (especially caused by SO₂) threatened to cause forest dieback. This fear of 'forest death' – *Waldsterben* – was a major factor in the development of anti-air pollution measures. In November 1981, the German news magazine *Der Spiegel* triggered a wave of public interest with three successive articles on acid rain. On the 14th of February 1983, *Der Spiegel* dubbed *Waldsterben* 'an ecological Hiroshima'. From the start, however, scientists had been critical of the association of *Waldsterben* with acid rain.¹² In 1990, a ten-year, \$500 million National Acid Precipitation Assessment Program (NAPAP) concluded that there was no widespread forest damage caused by acid rain in the United States.¹³ A later report on European forests concluded that

the effects of air pollutants were small compared with other stresses affecting tree conditions (such as abnormal weather conditions and insect damage). Indeed, it pointed out that overall forest productivity had increased in Europe since the 19th century.¹⁴ Kandler, in 1993, exposed the discussion of *Waldsterben* as a hoax,¹⁵ and in 1995 one of the key scientists who had proposed the relationship between sulphur dioxide emissions and forest dieback himself explained that the hypothesis of “large-scale forest dieback in the near future is not backed by data and can be discarded.”¹⁶

In spite of this scientific evidence, the introduction of policies limiting SO₂ emissions is understood to have been a great victory for the environmental lobby. The introduction of such policies was the result of public opinion and resultant political pressures premised upon the false belief that there was a serious threat of forest dieback, and that SO₂ emissions were to blame. The perception of forest dieback, in other words, supplied the ‘smoking gun’ which led to the introduction of anti-SO₂ emissions policies. What is most interesting is that here we again have an example of the ‘success’ of environmental legislation being the result not of the precautionary principle, but of (in this instance) the fabrication of a smoking gun which circumvents the need for precautionary measures by making what are taken to be demonstrable scientific facts. The existence of scientific certainty, real or imagined, makes the far more ambiguous claims to uncertainty upon which the precautionary principle is founded, effectively impotent.

The ‘Conclusion’ of *Late Lessons* makes a call for the inclusion of “lay and local knowledge” in any scientific appraisal.¹⁷ Yet the example above, on the construction of the false problem of forest dieback, gives good reason to be wary of this. In situations of scientific uncertainty, the inclusion of lay knowledge in the decision making process is actually a call for the greater propensity to manipulate the public with idiosyncratic reference to scientific data. This conclusion should also be reached if we consider the case of growth promoter hormones, another case study considered in *Late Lessons*. The authors admit that the infamous Delaney Clause in the United States, which prohibits the use of carcinogenic substances in food for human con-

sumption, cannot be applied in practice. Food literally consists of hundreds of thousands of chemicals, including carcinogenic compounds. These cannot be eliminated. Nevertheless, *public opinion* has ensured that “the clause remained on the statute books”.¹⁸ The problematic nature of ‘public scrutiny’ is well illustrated here. *Late Lessons* makes clear that the risks of exposure to food additives hormones, such as growth promoters, despite thorough research, are non-existent.¹⁹ The introduction of an EU ban on such additives was in reality, a “*political risk assessment*”.²⁰ The assessment of the Lamming Committee that hormonal growth promoters were safe “was clearly unpopular with the EU officials.”²¹ It was *fear* among bureaucrats redefined as ‘public concern’, rather than any scientific evidence or knowledge, which paved the way for a ban. Risk aversion, distrust of scientific research, and ultimately the precautionary culture *itself* caused the problem.

A False Utopia

As with many studies about environmental issues, *Late Lessons* laments the optimism and scientific ‘hubris’ which dominated Western society from the 18th century onwards. Precautionary thinking is urgently looking for an alternative framework from Enlightenment scientism, and it seeks it in a call for the replacement of ‘knowledge’ by ‘wisdom’. Aristotle, for example, is introduced as an authority and Socrates is presented as a precautionary thinker *avant la lettre* “when he acknowledged ignorance as a source of wisdom. Our report shows that this is a lesson from history that many people have forgotten”.²²

As a biblical triptych, paradise – fall – salvation, *Late Lessons* extols the wisdom of the past, bemoans the abhorrent technocratic present, and looks forward to a technological eco-efficient ‘third’ industrial revolution. This triptych is a typical example of the false utopianism of precautionary thinking: a future which can be made viable only when contemporary society is sketched in dark colours of crisis, against the background of a paradisiacal past that serves as a guide to a bright future.²³ Subsequently, this bright future can only be inaugurated by the precautionary wise, who have risen above the limitations of scientific knowledge and in so doing, have developed a ‘truer’ grasp of what society needs.

Claiming that the world lacks (ancient) wisdom and, therefore, is in crisis, underlines the romanticism we are confronted with in precautionary thinking. Romanticism is the ideological motive behind the precautionary urge for bans on an increasingly broad range of technologies, especially chemical technologies (which are discussed in two of *Late Lessons*' chapters). It is the romantic idea that modern technology spoils or pollutes an otherwise 'clean earth'. This comes down to the wish that mankind must leave as little trace of its existence as possible. Ideologically, it is a way of denying factual history and the influence history has on the present and the future.²⁴ Banning certain technologies is a way of banning history by trying to create a world in which coming generations will be set free of what we are doing now, to give them 'clean earth to till' as Gandalf states in *The Lord of the Rings*.

The distrust in science caused by precautionary thinking is already backfiring on society. In the case study on BSE, *Late Lessons* insists that the whole issue was a *political*, not a scientific, mess, although this seems an overstatement.²⁵ The most interesting aspect of this case is that the precautionary culture *itself* caused the trouble. The government was faced with a conundrum, as it feared that *any* regulatory response would be a disclosure that there was something wrong, undermining worldwide consumer confidence. So, it is the risk aversion of modern society, fuelled by lay knowledge and technophobia, which has fallen victim to 'doubt beyond reasonable proof', that lies at the heart of the *political* row over BSE, not scientific hubris. As Forbes remarks: "Pessimism about structures – and a generally negative view of political actors as a group – can be entirely consistent with high expectations about what governments can and will do."²⁶ To state that 'public scrutiny' would have been a way of checking the BSE row, as the authors of *Late Lessons* do, is to turn the whole issue upside down.²⁷

The precautionary coalition

Since the precautionary principle presents itself as counterbalancing the hubris of scientism and 'greed' of business interests, we might ask exact-

ly who are the promulgators of this principle, and why their motives are promoted as more trustworthy?

We first note that mistrust has become an important source for scientific investigations themselves. Scientists nowadays build a career on technophobia within society. They are the first group who form the scientific core of the precautionary coalition. The authors of *Late Lessons* are an example. A second group who have been central to pushing the precautionary principle are environmental and consumer organisations. Precautionary-inspired environmental legislation has given NGOs a weapon to subdue corporations²⁸; while consumer organisations are, by their very nature, obliged to find potential harm caused by technology. A third party are supranational political bodies. Through the politicisation of the European consumer, with the introduction of accountability as the market was deregulated in the 1980s, which resulted in the concomitant loss of political power of the nation state, EU governments were able to (re)-establish their legitimacy.²⁹ Through the institutionalisation of mistrust, the regulation of a principally deregulated market was established. The insistence on *ex-ante* proof that products are safe, rather than reassuring the public as to the safety of their commodities and consumables, serves in reality to further promote consumer suspicion. Fourth, the mass media is a key coalition partner as it is well-equipped to find stories of harm, guilt and blame. As Forbes states in relation to BSE: "Fears about the safety of beef bloomed like so much algae under the heat of *The Sun* and other media exposure."³⁰

When confronted with the power of the precautionary coalition, politicians have begun to move in a cautious way. Public authorities might be blamed for any suffering caused by technological failures. Authorities will not quickly be held responsible for traffic accidents or lung cancer, but they will be when a problem is uncovered with food additives. How can they avoid this, and what are the most common strategies the authorities will use to avoid responsibility?

A first strategy is the call for 'safer' technology. The result is that non-sensical levels of safety regulation are derived from scientific results that

are generated by cooperative scientists who themselves distrust the blessings of the modern world, or because our fearsome and rich society is ready to spoil enormous sums on increasing amounts of research on ever-decreasing risks.³¹ This is the obvious consequence of “promoting more robust, diverse and adaptable technologies to minimize the costs of surprises and maximise the benefits of innovation”.³² One wonders what the *hubris* is behind precautionary thinking!

A second strategy is to involve the public in decision-making because then the public can no longer claim that ‘technology’ is a realm outside its responsibility. The public seems to be offered a chance to speak out, although on issues on which it has no great expertise and often little understanding. Nonetheless, when problems arise politicians appear less blameworthy if they have simply been enacting the will of the public. Of course, this means an intrusion into the realm of science by the laity. The justification is that science and scientists can no longer be trusted considering the environmental havoc wrought over the last century. A report like *Late Lessons* makes great play of this point. Yet exactly why laymen and politicians are *better* equipped than scientists to foresee the future is never made clear. Could the laity have seen the risks of BSE or ponder on the potential threats of MTBE or other anti-knocking alternatives? We doubt it.

To understand this we need to remember that the precautionary principle is in reality not about science, but about politics and the (transfer) of political responsibilities. Once lay knowledge is introduced into the arena of political decision-making about science, everybody becomes responsible for any future disaster that was overlooked. It is not surprising that, from a position of relative ignorance, faced with the question of what risks are acceptable, the decision of the public should be conservative. The coupling of the precautionary principle with the introduction of lay-knowledge results in a call for *safety in stasis*.³³ The precautionary principle is turned into an ultimately reactionary political tool. As *Late Lessons* points out about the introduction of any new technology “their very novelty might be taken as a warning sign”.³⁴

A paternalistic future?

This remark, as a final observation, suggests that the precautionary coalition has a paternalistic, even anti-humanist, perspective on society, its citizens and its economies. The perspective is one that assumes that once we have begun to engage in a direction that *might* lead to undesirable outcomes, we will be unable to stop, or to make choices between good and bad outcomes.³⁵ It is the possibility of human action in the world for human betterment that the precautionary principle throws into doubt. It is scientific activity itself about which the principle calls upon us to be precautionary.

The supporters of the precautionary principle are moving on a slippery slope by trying to impose the ancient ‘wisdom’ – better to be safe than sorry – over scientific knowledge, as the guide to our actions. This is really a call to move away from conscious knowledge, information, education, ethics of responsibility and the capability for judging freely, towards the unconscious and the ultimately uncontrollable. Its prohibitions, moreover, suppress freedom of choice, since this suppression of freedom is thought to be the only way to prevent future wrong uses of freedom.

The precautionary coalition believes itself to have the capacity to protect us against any concatenation of events. When precautionary policies are devised, all for the benefit of European citizens, then a ‘true value’ of human and environmental wellbeing is assumed. This ‘true value’ carries utopian overtones. Resisting precautionary regulation is branded as irresponsible. This means certain parts of society define and impose on others their conception of human health and environmental quality and the maintenance thereof. Precaution thereby tends to empower supranational bureaucratic organisations. It resembles enlightened absolutism. It uses ‘lay knowledge’ as a political tool to circumvent science, but is nevertheless only weakly attached to democratic scrutiny. The only way out of this conundrum is to reiterate the values of knowledge, information, education, ethics of responsibility and the individual capability of judging freely. That is why we oppose the precautionary principle.

Endnotes

Foreword

- 1 The sociologist Anthony Giddens is one proponent of this view. Giddens draws a distinction between “external risks”, which are “risk experienced as coming from the outside, from the fixities of tradition or nature”, and “manufactured risks”, which are “risk[s] created by the very impact of our developing knowledge upon the world.” For Giddens, contemporary society can be characterised by the predominance of “manufactured risks” which are the result of human action upon the world, and about which “we simply don't know what the level of risk is, and in many cases we won't know for sure until it is too late.” Anthony Giddens, Lecture 2 of the 1999 Reith Lectures 1999, *Runaway World*, available at: http://news.bbc.co.uk/hi/english/static/events/reith_99/default.htm.
- 2 The sociologist Ulrich Beck has contributed most to the development of these arguments. See for example his *Risk Society - Towards a new Modernity* (Sage, London, 1992) and *World Risk Society* (Polity Press, Cambridge, 1998).

Chapter 1

- * Translated from the German by Oliver Marc Hartwich.
- 1 Interview with Carl Djerassi http://www.makingthemodernworld.org.uk/everyday_life/personal_accounts/PA.0009/.
 - 2 Interview with Carl Djerassi, <http://abc.net.au/rn/talks/8.30/helthrp/stories/s214672.htm>.
 - 3 Ellie Lee, *The Pill, politics and Litigation*, <http://www.prochoiceforum.org.uk/ri7.asp>.
 - 4 Interview with Carl Djerassi, *Financial Times*, 14 August 1999, available from <http://www.djerassi.com/news6/index.html>.

- 5 http://www.ileperu.org/contenido/Articulos/ecologismo_mcrishton.htm.
- 6 Dirk Maxeiner and Michael Miersch, The Urban Jungle, in: Jesse Norman (ed.), *Living for the city – A new agenda for green cities*, Policy Exchange, London, 2006, pp. 52-67.
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- 8 A typical example is Dave Foreman's statement "Our environmental problems originate in the hubris of imagining ourselves as the central nervous system or the brain of nature. We're not the brain, we are a cancer on nature." in an interview with *Harper's Magazine*, April 1990, pp. 40-46.
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- 10 *Stern* magazine, Interview with Erwin Chargaff, 15 November 2001.
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- 12 Interview with Christiane Nüsslein-Vollhard in *Der Tagesspiegel*, 26 September 1999, <http://archiv.tagesspiegel.de/archiv/26.09.1999/ak-ws-me-47621.html>.
- 13 See, for example, *The Stanford Daily*, Poll reveals environmental pessimism, 6 April 2006, <http://daily.stanford.edu/article/2006/4/6/pollRevealsEnvironmentalPessimism>.
- 14 Gregg Easterbrook, *The Progress Paradox: How Life Gets Better While People Feel Worse*, Random House, New York, 2003.

Chapter 2

- 1 The precautionary principle has been incorporated in more than 50 multilateral agreements. See: Arie Trouwborst, Evolution and Status of the PP in International Law, *American Journal of International Law* 96(4) (2002): 1016-1018.

- 2 See, for example, the article by Kenneth R. Foster, Paolo Vecchia and Michael H. Repacholi, *Science and the Precautionary Principle*, which cites 14 different formulations of the principle in treaties and nontreaty declarations'. Available at: http://www.biotech-info.net/science_and_PP.html.
- 3 See <http://www.unep.org/Documents.multilingual/Default.asp?DocumentID=78&ArticleID=1163&l=en> (last accessed on the 7 November 2006).
- 4 Paul Harremoës et al. (ed.), *Late Lessons from early warnings: the Precautionary Principle 1896–2000*, European Environment Agency, Copenhagen, 2001. Available at: http://reports.eea.europa.eu/environmental_issue_report_2001_22/en
- 5 See http://reports.eea.europa.eu/environmental_issue_report_2001_22/en
- 6 Harremoës et al. (ed.), *op. cit.*, p. 11.
- 7 *Ibid.*, p. 14.
- 8 *Ibid.*, p. 26.
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- 10 *Ibid.*, p. 118.
- 11 *Ibid.*, pp. 80–81.
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- 16 Bernhard Ulrich, *The history and possible causes of forest decline in central Europe, with particular attention to the German situation*. *Environmental Reviews* 3 (1995): 262–276.

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- 18 *Ibid.*, p. 149.
- 19 *Ibid.*, pp. 152-153.
- 20 *Ibid.*, p. 154.
- 21 *Ibid.*, p. 150.
- 22 *Ibid.*, p. ii.
- 23 Hans Achterhuis, *De erfenis van de Utopie [The Legacy of Utopia]*, Ambo, Amsterdam, 1998; Meredith Veldman, *Fantasy, the Bomb and the Greening of Britain. Romantic Protest, 1945-1980*, Cambridge University Press, Cambridge, 1994.
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- 26 Forbes, *op. cit.*
- 27 Harremoës *et al.* (ed.), *op. cit.*, p. 165.
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Chapter 3

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