



The ethics of human impacts and the future of the earth's ecosystems: Introduction

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ABSTRACT: In this Theme Section, a selection of the International Ecology Institute Prize laureates and authors of the Excellence in Ecology books present their thoughts on the ethics of our impact on, and the future of, the earth's ecosystems. The 5 essays address various issues: (1) the longer-term role of humans on the earth and (2) the earth's capacity for supporting humans; (3) the diversity of microbes surrounding us and the allergic desensitization they provide and (4) our need for respecting the world around us; (5) which is gradually being compromised by our inability to act as reasonable stewards of the earth. In addition, the ethics of overfishing as well as new issues and questions raised are briefly discussed.

KEY WORDS: Bioethics · Microbes · Biodiversity · Overfishing · Stewardship

INTRODUCTION

An important contribution of the International Ecology Institute (ECI; www.int-res.com/ecology-institute/eci-home/) to science is the publication of the Excellence in Ecology book series authored by the ECI Prize laureates (www.int-res.com/ecology-institute/eci-prize/). The ECI prize is awarded to ecologists who are distinguished by outstanding and sustained scientific achievement, and are therefore some of the most important marine, terrestrial, and limnetic ecologists of our time. In each book, the author is encouraged to present personal insights, freely criticize, and formulate new scientific concepts.

In this Theme Section, a selection of these authors present their thoughts on the ethics of our impact on, and the future of, the earth's ecosystems, each con-

tributing an essay either from their own field of specialization, or on wider issues they encountered in the course of their careers.

ETHICS AND SCIENCE

Ethics and science do not necessarily mix well, and a collection of essays devoted to how these 2 realms interact could be called 'transgressive' if the term had not been abused (Sokal 2008). Scientists, young and old alike, are still uncomfortable with ethics, even though they are often involved in research whose products may have profound effects, including some very negative to the well-being of people; for example, chemists involved in enhancing the taste of nutritionally worthless quasi-food products. Yet, we must deal with ethical issues, notably

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because the applications alluded to above are becoming ever-more powerful, and their consequences, unintended or not, are impacting increasingly more people. Because we are scientists, however, we will start our reflection with empirical data. The empirical data we will use here should answer the question: How much concern is there about the issue of ethics in science?

A search of the relative frequencies of ethics-related 1-, 2-, or 3-word sequences in the corpus of digitized books, such as 'bioethics,' 'ethics in science,' 'ecoethics' (Fig. 1a), 'ethics in law,' 'ethics in politics,' and 'ethics in medicine' (not shown here) reveals that bioethics clearly dominates the frequencies by more than 2 orders of magnitude, with its frequency of use exponentially increasing after 1970 (Fig. 1a). The relative frequencies of 'ethics in science' and 'ecoethics' also increase exponentially after 1960 and the late 1980s, respectively (Fig. 1a).

In addition, the relative frequencies of 'biodiversity conservation' (all forms) and 'human impact' also increased exponentially after 1990 and 1950, respectively, whereas 'planetary capacity' and 'human overpopulation' were 1 or 2 orders of magnitude smaller (Fig. 1b).

Overall, however, what the 2 panels of Fig. 1 illustrate is that there is indeed increasing concern about the nexus of ethics and science, notably regarding human interactions with the earth's natural systems and their biodiversity. Discussions about these issues are taking place, and the important question for scientists is whether they feel comfortable with everybody except themselves having and expressing opinions about ethics and science, and particularly about the 'ethics of trashing the earth' (the only one we will have for a long time, notwithstanding the possible discovery of a second Earth in outer space).

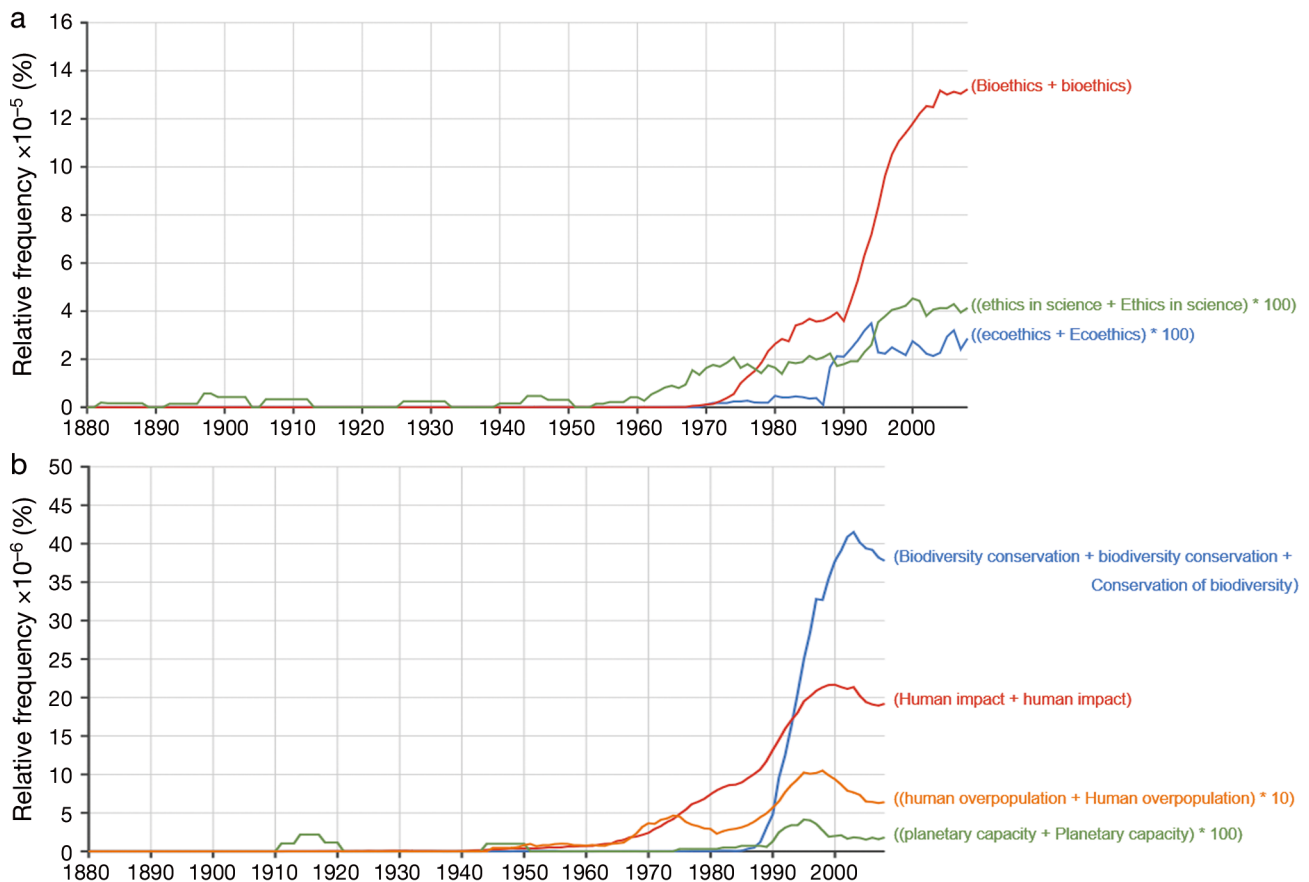


Fig. 1. Relative frequencies of different terms in the corpus of English digitized books, extracted using the Ngram Google tool (available online at <http://books.google.com/ngrams>). (a) All forms of 'bioethics,' 'ecoethics,' and 'ethics in science,' (b) all forms of 'biodiversity conservation,' 'human impact,' 'human overpopulation,' and 'planetary capacity.' A detailed account of the Ngram technique is provided by Michel et al. (2011) and Lin et al. (2012), whereas a step-by-step guide for its application using examples is available online at <http://books.google.com/ngrams/info#advanced>

FROM ALLERGIC DESENSITIZATION TO THE CAPACITY OF EARTH TO SUPPORT HUMANS: IDEAS PUT FORWARD IN THIS THEME SECTION

The 5 essays in this theme section address some of these issues: the longer-term role of humans on the earth (Pauly 2014) and the earth's capacity for supporting humans (Ehrlich 2014), the diversity of microbes surrounding us and the allergic desensitization they provide (Hanski 2014), and our need for respecting and loving the world around us (Loreau 2014), which is gradually being compromised by our inability to act as reasonable stewards of the earth (Reynolds 2014).

In particular, Pauly (2014) argues that humans are not 'part of the ecosystem,' as the phrase goes, but rather threaten to become 'a cancer on the Earth,' and he concludes that humans' longer-term ecological role on Earth should instead resemble that of a 'co-evolved parasite' of the earth's systems. Ehrlich (2014) discusses various ethical issues (e.g. consumption, overpopulation) associated with the $I = PAT$ equation, in which I is the impact of a human society on its environment, P is society's population size, A is its per capita consumption, and T is the 'technology' which includes the processes used to service the consumption as well as the political, social, and economic arrangements involved. Hanski (2014) discusses a special case of the biodiversity hypothesis showing a significant negative relationship between allergic sensitization in adolescents and the amount of forest and agricultural land in their surroundings, a fact clearly revealing that environmental microbial diversity is a vital health-related 'ecosystem service.' Loreau (2014) argues that human nature is neither fundamentally selfish and utilitarian nor fundamentally altruistic and non-utilitarian; humans simply have a set of fundamental needs that they perceive as needing to be satisfied. Thus, to the extent that their needs include respecting and loving the world around them, they may be motivated to act toward maintaining its biodiversity and natural ecosystems. Finally, Reynolds (2014) discusses the limited capacity of the planet to support humans, under various scenarios and assumptions and stresses that new social structures and new, cleaner, more resource-efficient technologies are required that must be directed towards solving inequities in the use of food, energy, and, especially so, water.

Several forms of human impact that have major ethical implications are not handled here, for example climate change, deforestation, soil erosion, pollution and overfishing, and all have major impacts on the delivery of services by an ecosystem, e.g. soils for

farming (see Montgomery 2012), or marine fisheries. Given our fisheries background, below we take this opportunity to briefly elaborate on ethical issues regarding the last of these.

OVERFISHING AND ETHICS

Several studies have documented that many fisheries of the world are in the process of collapsing (e.g. Pauly et al. 1998, 2002, Stergiou 2002, Beddington et al. 2007, Christensen et al. 2014, Vasilakopoulos et al. 2014), despite some local fisheries, e.g. in the USA, being managed successfully. Fishing is an extractive activity that has a history going back at least 90 000 yr, as demonstrated by harpoons associated with the remains of giant catfishes (Yellen et al. 1995). Fishing remained tied to muscle and wind power until the 1880s, when the first steam trawlers were deployed around the British Isles (Roberts 2007). Given their enormous power, they quickly depleted inshore stocks of fishes and had to move offshore, into the wider North Sea and beyond. This expansion of industrial fisheries, first interrupted by World War (WW) I, then by WWII, characterizes marine fisheries development since the post-WWII period. This expansion is clearly profit-driven and mediated by rapid technological development.

Officially, marine fisheries remove around 80 million t annually (FAO 2014). However, recent 'catch reconstructions' (see e.g. Zeller et al. 2011, 2014) have documented that total removals (i.e. including those of the small-scale recreational and subsistence fisheries, as well as discards, and illegal, unreported, and unregulated catches, IUUs) are well over 120 million t annually, but are declining rapidly due to overfishing. There is little doubt that such a large-scale removal of biomass from our oceans drastically affects the structure and function of marine ecosystems and thus their ability to provide us with (sea)food, as well as aesthetic and cultural services (Pauly et al. 2006, Halpern et al. 2012). The detrimental effects of fishing were very illustratively expressed by Lord Perry of Walton several years ago: 'Fifty years ago, a single cod was large enough to feed a family of four or five. Today, it is barely enough for one' (Anonymous 1997, p. 110).

Such a huge removal of biomass from our oceans not only raises ethical issues related to the fate of our oceans and the right of future generations to enjoy them as their ancestors did, but also raises ethical issues at the governmental/political level related to the intended (or unintended) underreporting of official landings.

Mariculture, seen by many as the future of seafood provisioning, will not be able to fulfill its potential if it continues to shift toward the production of carnivorous fishes, which require smaller fishes for their feed (Pauly et al. 2001, Stergiou et al. 2009, Tsikliras et al. 2014). In fact, mariculture, and aquaculture as a whole, when it shifts from raising mussels, oysters, and other plankton feeders toward the farming of carnivorous fish such as salmon, changes from being part of the solution to feeding the world, to generating new socioeconomic and ethical concerns. This is because large quantities of fishes suitable for direct human consumption are turned into animal feed, used for the production of relatively small quantities of fishes destined for affluent consumers (Naylor et al. 2000).

EPILOGUE

This Theme Section also raises new issues and questions that will have to be answered in the near future. For instance, resolving inequities in resource use requires strong political will at the global level. Yet, it is well accepted that there is a lack of political will (Cardinale & Svedäng 2008), with politics being the weak link in management (Browman & Stergiou 2005). In addition, the recent imposed globalization (Friedman 2005), liberalization, and marketization of all aspects of our lives, from markets, agriculture, and fisheries to the last 'public fortress' of our societies, i.e. our educational system (Lynch 2014, Stergiou & Tsikliras 2014), also raise the question of whether equities in resource use can be achieved, rather than increasing the chasm in resource use between north and south, and within each country, between its rich and poor citizens.

Unquestionably, changing our consumption patterns and resolving the issues presented in this Theme Section, and others, will take many generations and will require the education of new generations of scientists and informed citizens. Also, public servants and politicians will need to be sensitized to environmental problems and the ethical issues they raise. However, one has to wonder whether this can be achieved within the new global landscape of declining academic freedom arising from the marketization of education (Stergiou & Tsikliras 2014).

Finally, economic crises are confronted with drastic, severe measures, as is clearly exemplified by the recent economic crisis in southern European countries. In contrast, global ecological crises, such as those described here, are not taken as seriously as economic crises, despite their many similarities, a

fact that might lead to ecosystem/resource crises, and thus to ecosystem bankruptcy with severe side effects on global economy (Tsikliras et al. 2013). The question is still open of whether ecological crimes (i.e. pollution, IUU fishing; sensu Österblom et al. 2011) leading to ecological crises should be confronted with measures of similar severity (Tsikliras et al. 2013). The International Monitoring, Control, and Surveillance network and the INTERPOL Environmental Crime Committee (with permanent Fisheries, Wildlife and Pollution Crime working groups; Österblom 2014) represent a step in the right direction.

Maybe the best way to close this essay is with the well-known ancient Greek phrase 'metron ariston' ('everything in moderation'), since the extravagant ways we have used to despoil our planet have made it a subversive adage.

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