

The missing voice: a zoologist on the consequences of feeding the world

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ABSTRACT

Food is central to our existence. We are keen to know about it as we are vulnerable to its lack. Biodiversity is directly affected by the human need for food. Foley, in a lead paper in *National Geographic*, identifies that agriculture accelerates the loss of biodiversity and that agriculture is a major driver of wildlife extinction. In the increasing concern for the animals raised and slaughtered for human food on an industrial scale, the question of the number of species, rather than the number of individuals, hardly ever enters the debate. Yet this is a point of considerable zoological interest. The lack of diversity of food options strikes a zoologist as basis for concern about how we can manage the future of our food supplies. Zooarchaeologist Juliet Clutton-Brock adds a new dimension to the debate by looking at the arrival of animals as domesticates. In Europe, she says, the driving force of domesticating animals for agriculture may have been the increasing human population. The grim story of famine in Ethiopia will repeat across the globe as the human population rises, and food crises will become the ethical flashpoint of a larger problem of too many people for the earth to sustain. We need to face the converse of the food shortage more squarely, and that is the issue of the overabundance of people. An underlying concern for zoologists is that the subject areas of zoology, such as species survival, ecosystem management and conserving biodiversity, are poorly covered, or not even mentioned, in so many writings on food, food ethics, agriculture and economic growth, yet zoology needs to be on the table at every discussion. The zoologist has been a missing voice and now must be heard.

Key words: agriculture, beef, biodiversity, ethics, extinction, famine, Foodtopia, green revolution, human population, kangaroos, milk, wildlife.

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Introduction

Food is central to our existence. We are keen to know about it as we are vulnerable to its lack. The same vulnerability applies to all animals. As agriculture expands to feed the growing human population of the world, there is a corresponding adverse impact on the native animal life of the planet. For example, the UK Government's Foresight report (UK 2011) on 'The Future of Food and Farming: Challenges and Choices for Global Sustainability' recognises the importance of food security and highlights five key challenges: balancing future supply and demand; ensuring adequate stability in food supplies; achieving global access to food and ending hunger; managing the contribution of the food system to the mitigation of climate change, and maintaining biodiversity and ecosystem services while feeding the world.' As the authors point out, in England, for example, where over 70% of land is farmed (DEFRA 2011), the viability of ecosystems, maintenance of biodiversity and delivery of wide ecosystem services are directly affected by the way agricultural land is used and managed.

In their paper, 'Priority research questions for the UK food system', Ingram *et al.* (2013) capture where zoology, or more broadly biodiversity, fits into the international

picture: 'Food is a fundamental human need and access to food is a universal human right' (UN General Assembly 1966). Biodiversity is directly affected by this bold, startling declaration. Even if one does not take up the legal aspect of the human right to food, we cannot deny the more basic equation that more people will need more food. To the extent that agriculture increasingly takes up more of the world's resources, the world's wildlife will disappear. The conservation of biodiversity is very much a central subject in zoology. Consequently, food, politics and the science of zoology are inextricably intertwined. Thus, the aim of this paper is to help highlight these connections and thereby avoid isolating such debates as those on the ethics of food we eat from the subject of managing wildlife populations, preventing extinction and conserving all the elements of biodiversity.

¹ Universal Declaration of Human Rights. Article 25 1. Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control. http://www.ohchr.org/EN/UDHR/Documents/UDHR_Translations/eng.pdf last accessed 6.11.17

A zoological outlook on our diet

The subject of the ethics of the food we eat is explored in other forums and publications (e.g. Singer and Mason 2006; Sandler 2015; Chignell *et al.* 2016), and while my aim here is to acknowledge this philosophical debate, it is not to canvass it. Rather, my focus is on animals as a zoologist. The increasing concern for animals raised and slaughtered for human food on an industrial scale is always concerned with the number of individual animals slaughtered. The question of the number of species facing death, more gently called extinction, hardly ever enters the debate, yet this is a key point of zoological interest, concern and warning. A parallel matter of zoological concern is the narrow base of our food supply, and this goes to the issue its sustainability, including the areas of land and sea we use to grow or extract our food.

Herzog (2010, 183), in his engaging book ‘Some we love, some we hate, some we eat’, asks why the list of edible animals is so long, but the list of creatures whose flesh we regularly eat is so short? Herzog draws on Jared Diamond’s (1997) book ‘Guns, germs and steel’, who points out that while most animals are edible, few are good prospects for large-scale agricultural production.

Of the 5,096 mammal species world-wide (McDonald 2009 p xii), only three dominate as food for humans: cattle *Bos taurus*; sheep *Ovis aries*, and pigs *Sus scrofa*. There are other species that are handled commercially, such as *Bos indicus*, a tropical cattle breed, goats *Capra hircus*, and kangaroos (Grigg 2002; Lunney 2010), but the first three overwhelmingly dominate numerically. Of the birds, domestic chickens *Gallus domesticus* dominate numerically, although other species, such as turkeys, ducks and geese are raised commercially, but nowhere near the number of chickens. The LEAD-FAO report (2006, p 1842), considers that breeds are part of the picture, and notes that from just 9 of the 14 most important species (cattle, horse, ass, pig, sheep, buffalo, goat, chicken and duck) as many as 4000 breeds have been developed and used worldwide. There is also a long list of fish species that are eaten by humans, but so many populations have been overfished to the extent that they no longer provide a food source for our increasing human population (Roberts 2007). Further, as Ward *et al.* (2017) note, besides the pervasive decline in commercial fish catch in most jurisdictions, there is also a dominance of commercial interests in environmental management decisions.

In the terrestrial world, four species – three mammals and a bird – dominate those animals that are raised on farms. For land animals, when it is realised that three mammal and one bird species lie at the centre of our debate on food security, land use, eating patterns and the ethical use of animals as food, it is evident that zoologically it is a tiny base for supporting a huge and growing world population of people. This lack of diversity of food options strikes me as a zoologist as basis

2 <ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e.pdf>

for concern about how we can manage the future of our food supplies, both in Australia and across the world, as well as how we can best manage our land to stop the loss of native species and degradation of the landscape.

Archer and Beale (2004, p 1), in their engaging book *Going Native: living in the Australian Environment*, open with the sentence: “Let’s start by being blunt: despite good intentions, the way we Australians make our living from an ancient and fragile land is seriously damaging and unsustainable.” Not far into their introduction (p9), they state that most agricultural systems have been irrational and destructive. Agriculture, they point out, is the major land use in Australia, covering about 60 per cent of the continent and consuming about 70 percent of the water used nationally. Archer and Beale have a solution; they call it ‘going native’. They posit that Australia’s precious heritage of plants and animals hold the potential for not only just a few new crops, but whole new industries and new ways of sustainably using the land. Instead (p 16), they say, of riding to an illusory prosperity on the sheep’s back, Australia could be growing its way to a far more secure future on the back of gum trees and kangaroos. This point on kangaroos is zoological, and Grigg (2017) takes up this issue, while identifying some of the setbacks to the concept.

Grigg has been a long-term advocate of a change in policy on kangaroo management, and he has played a pivotal role in recognising the value of kangaroos (Lunney 2010). His proposal, first published in 1987, was to substitute kangaroo harvesting for sheep farming on the sheep rangelands as an answer to both widespread land degradation and sustainable kangaroo management. Grigg later gave it the epigrammatic description of “sheep replacement therapy”. Grigg (2017) reflects he has been seeking an economically productive alternative in which the value of kangaroo meat could be increased enough, such as through marketing, to encourage wool growers to see kangaroos as a resource rather than a pest, and to reduce sheep numbers and, thus, total grazing pressure. The implication was that kangaroo meat would be marketed for human consumption, relying on its low fat, high protein characteristics, making it a healthier alternative to traditional livestock. Now, says Grigg (2017), almost 30 years since the idea was first published, kangaroos are still regarded as pests, kangaroo meat is still undervalued, and rangeland degradation continues apace. There has indeed been ‘sheep replacement’, Grigg (2017) laments, but in many areas it has been by goats. The goat meat industry is booming and as Grigg points out, the rangelands will suffer further and, as a consequence, the future of the rangelands remains bleak.

A more general point emerges from this enlightened thinking, championed by Grigg, Archer and Beale, and that is we are not using our zoological imagination. The result is that great tracks of country deteriorate, and we miss the considerable value of new food sources. We are

stubbornly sticking to European animals, indeed animals of the biblical lands, as our food, despite that fact that they did not evolve in our drastically different Australian ecosystems, and are ill-suited to them (Lunney and Dickman 2002; Lunney 2012a,b).

Livestock's Long Shadow

The Livestock, Environment and Development (LEAD) Initiative, supported by a raft of international organisations, including the Food and Agriculture Organisation of the United Nations (FAO), produced a dramatically entitled report (LEAD-FAO 2006)³, *Livestock's Long Shadow: environmental issues and options*. It makes a forthright assessment of the livestock sector. In its summary, it concluded that the sector is one of the top two or three most significant contributors to the most serious environmental problems, at every scale from local to global and that it should be a major policy focus when dealing with problems of land degradation, climate change and air pollution, water shortage and water pollution and loss of biodiversity. The reason being is that the livestock sector is by far the single largest anthropogenic user of land. The figures produced are arresting: the total area occupied by grazing is equivalent to 26 percent of the ice-free, terrestrial surface of the planet and the total area dedicated to feed-crop production amounts to 33 percent of total arable land. In all, the report states, livestock production accounts for 70 percent of all agricultural land and 30 percent of the land surface of the planet. Of particular interest for zoologists concerned about the consequences of agriculture for conserving biodiversity is that many of livestock's threats to biodiversity arise from their impact on the main resource sectors (climate, air and water pollution, land degradation and deforestation). The reports considers that there is scope for improving pastoralists' interactions with wildlife and parks and raising wildlife species in livestock enterprises, that reduction of the wildlife area pre-empted by livestock can be achieved by intensification and that protection of wild areas, buffer zones, conservation easements, tax credits and penalties can increase the amount of land where biodiversity conservation is prioritized. What is arresting in this report is the scale at which livestock and biodiversity conservation are on a collision course. What is also clear is that the FAO has identified the magnitude of this international problem, as well as putting forward some options to mitigate the adverse impact of livestock production on biodiversity.

A report of this status is basically an endorsement of what many researchers and conservation-oriented bodies have been saying, and starkly. The LEAD-FAO report has a section (p215), entitled 'Mitigation options for conservation of biodiversity'. The opening sentence states that classical approaches to conservation, such as preserve habitats within national parks and other protected areas, and developing corridors between them, will always be necessary. The next statement is even sharper: "But in

view of the severity and variety of current threats to biodiversity, efforts are also needed to reduce the many other pressures on wildlife. The livestock sector is a very significant source of many of these pressures, with a wide variety of impacts, many if not most of which occur in already disturbed environments." The report gives examples that it says stand out as important: the impact of land use intensification and habitat pollution induced by the intensive production environments; desertification in extensive grazing areas; and forest fragmentation related to both the extensive and intensive sectors. That statement is followed by the report's view (p 216) that, "In essence, mitigating the impact will consist partly in reducing the pressures, partly in better management of the interaction with natural resources, be it fisheries, wildlife, vegetation, land or water. The improvement of that management is more an issue of policy and regulation than of technical capacity building and research", the report believes, and that "Consolidating a network of well protected areas is an obvious start." This section of the report (p 217) concludes with a test of clashing ideas: "It is important also to consider a more general principle. Land use intensification has been presented ... as a threat to biodiversity because it is often synonymous with an uncontrolled profit-driven process with insufficient consideration for externalities (leading to loss of agro-ecosystem diversity). However, given the growth of the global livestock sector, intensification is also an important technological pathway, because it allows a reduction of the pressure on natural land and habitat, also reducing the risk of plant invasions." What this statement underscores is both the magnitude of the problem and the complexity of mitigating solutions. This part of the report (p 218) concludes with a box presenting an unusual option: "Livestock production to safeguard wildlife." It states that bushmeat was, and remains, an important inexpensive source of protein in African society and that hunting pressure on wild fauna has considerably increased over recent decades. The final paragraph states that non-traditional livestock production systems of selected wildlife species offer alternatives to reduce hunting pressure on wildlife. The example presented is the farm production of the Greater Cane Rat *Thryonomys swinderianus*, which can supply urban centres with bushmeat. The final sentence considers that, in rural areas, game ranching can provide regular bushmeat supply to the communities, regulating the market price of bushmeat and *de facto* reducing the poaching pressure on wildlife.

What emerges from a consideration of this LEAD-FAO report is that a wide range of options is available, with bushmeat and protected areas among them. If we do not meet the challenge of the loss of biodiversity from livestock's long shadow because of a faint heart when it comes to implementing new policies, researching options and arguing the case for change, then our planet, including Australia, will be spoilt, will never recover, and will suffer and slowly die.

³ <ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e.pdf>

Some Australian thinkers had already put forward similar views, including the case that raising or utilising wildlife species confers many conservation benefits (Grigg *et al.* 1994; Grigg 2002, 2017; Archer and Beale 2004; Cooney 2017; Lunney and Dickman 2002; Lunney *et al.* 2017). These individual voices are not missing in the debate, it is just that there are too few with the zoological insights and the skills to put the case, to speak up, and deal with the science, the sustainability and politics of the food we eat.

McAlpine *et al.* (2009) specifically addressed the issue of increasing world consumption of beef as a driver of regional and global change. Their study found that while the global community is seeking to reduce fossil fuel consumption, a parallel but equally important issue is the environmental impacts of increased world consumption of beef. They provided a comparative analysis and synthesis of the expansion of beef cattle production and its regional and global environmental impacts for Queensland (Australia), Colombia and Brazil. The evidence they assembled indicates that rising beef consumption is a major driver of regional and global environmental change, and warrants greater policy attention. They proposed four policy imperatives to help mitigate escalating environmental impacts of beef: stop subsidising beef production and promoting beef consumption; control future expansion of soybeans for fodder and extensive grazing; protect and restore regrowth forests in grazing lands, and allocate resources to less environmentally damaging alternative land uses. One point that emerges is that while McAlpine *et al.* are scientists (geographers and zoologists) the matter of beef production and export has other dimensions. The different perspectives on this matter come from a range of disciplines, and zoology is in the mix because land use, climate change and forest restoration are all matters central to conserving biodiversity.

From the relatively easy life of hunter-gatherers 10,000 years ago

Zooarchaeologist Juliet Clutton-Brock (2012, 41-2), in her treatise, 'Animals as domesticates: a world view through history', adds a new dimension to the debate by looking at the arrival of domesticates in Europe. She asks, what were the motives for the radical change from the relatively easy life of hunter-gatherers 10,000 years ago to about 5000 years ago when the inhabitants of the most densely populated area had become farmers and engaged in the drudgery of managing livestock and sowing, protecting and harvesting crops? In Europe, she says, the driving force may have been the increasing human population and, adds Clutton-Brock in italics, it looks increasingly like the answer was *milk*. She expands on this idea by pointing out that the Neolithic revolution used to be considered as a gradual progression for the provision of meat from killing animals through hunting to those kept in captivity, that is, she explains, they were the walking larder. The next stage was the secondary products revolution, presumed to have begun about the

4th millennium BCE in the near East, and involved the secondary products of milk, wool, traction and riding. The archaeological evidence, Clutton-Brock states, appears to indicate that, 1000 years later, this cultural change had spread to Europe and the rest of Asia. Serpell (2012), in his foreword to Clutton-Brock's book, considers that domesticated animals have fundamentally altered the evolutionary trajectory of our species, that it ranks in its influence on human culture and ecology with stone tools, religion, writing, and the recent information revolution. Pointedly, he adds, it receives far less attention from scholars than might be expected.

In the Royal Zoological Society of NSW forum Zoology on the Table, Pyke (2017) paid attention to this matter, and looked through the lens of optimal foraging theory. Human foraging is caught, says Pyke in "evolutionary traps". As generalist omnivores, Pyke reasons that we evolved a 'balanced diet', commonly represented by 'food pyramids', reflecting how often we encountered and consumed various food types during our evolutionary past. We therefore evolved preferences, says Pyke, to collect and consume foods high in fats, oils, sugar and salt, valuable when rare, but adversely affecting our health with increasing availability. This outlook of Pyke is good zoology by using both theory, and an evolutionary outlook, to consider modern diets. On this point, Pyke adds that, being omnivores, animal meat will likely remain 'on the table' indefinitely.

What emerges from such historical and pre-history accounts is how deeply embedded both the walking larder and the secondary products are in our society, and societies across the globe. The calls to abandon eating meat and consuming milk strike at the heart of our evolutionary history, to take up Serpell's point. In that context, we can reflect on Peter Singer's (2008) comment that those who know his views from 'Animal Liberation' may be surprised that he is writing a foreword to a book entitled 'The future of animal farming' (Stamp and Bonney 2008). He adds that he does not resile from the position that he took in 'Animal Liberation', but in the face of the vast universe of animal suffering, which he notes is also an ecological catastrophe, Singer asks whether the animal movement should confine itself to promoting veganism? The chances, he considers, of persuading the majority of meat-eaters to abandon all animal products are remote. He concludes that it seems better to pursue a different strategy, we should do our utmost to reduce the suffering of the billions of animals in the vast factory farms. Singer closes his foreword with the thought that the book, *The future of animal farming*, continues to bridge the gap between science, farming and the ethically-concerned consumer.

The end of plenty

In the *Sydney Morning Herald* 10-11 October 2015 (a few weeks before the forum on Zoology on the Table), under

the cryptic heading, 'The El Nino crisis you've never heard of', Matt Wade reported that, 'The number estimated to be in need of emergency food assistance in drought-stricken Ethiopia has surged from 4.5 million to about 7.5 million since August. More than 300,000 children are already severely malnourished and the UN warns that 15 million people could need assistance by early next year. Food shortages are set to worsen over the next six months as the El Nino event keeps large parts of the country dry well into 2016.' He concludes his piece with, 'But a repeat of the 2011 Horn of Africa famine must not be allowed. It will test the generosity of wealthy nations like Australia.'

One can add to Wade's conclusion by noting that this issue will also test our ecological understanding of climate change, population sizes and sustainable development. Generosity is not the only issue here, the grim story from Ethiopia will repeat across the globe as the human population rises, and food crises will become the ethical flashpoint of a larger problem of too many people for the earth to sustain. Zoologically, Lunney *et al.* (2007) compared the overpopulation of koalas on Kangaroo Island in South Australia and the human population on Earth and found many parallels - that the burgeoning human population of the world and the koalas on Kangaroo Island as part and parcel of the same understandable process, with overabundance as an ecological speciality, throwing up similar biological and ethical dilemmas with the same potential for inaction and timidity. We need to face the converse of the food shortage more squarely, and that is the issue of the overabundance of people, and zoologically, the overabundance of any species that eats itself into starvation, with the flow-on effect to other species dependent on the same food sources or the same landscapes. The invasion of sheep then rabbits into Australia is a local example, with their vast numbers being a primary cause of the extinction of 24 native species in western NSW within 60 years of European settlement (Lunney 2001).

In a well-written journalistic style, Bourne (2015, 302), trained as an agronomist, considers the 'end of plenty'. He touches on what a zoologist considers to be central when he cites what Harvard biologist E. O. Wilson calls the 'sixth great spasm of extinction'. Bourne summarises the problem simply by saying that in just 200 years of the hydrocarbon-based industrial revolution we have changed the basic chemistry of the atmosphere and the oceans and that our bottomless demand for food, water, energy and space shoves thousands of fellow species off Earth every year. Bourne says that it is no coincidence that in the four decades since agronomist Norman Borlaug won the Nobel Peace Prize, for what has been called the green revolution (p145), the populations of other vertebrate species (birds, mammals, reptiles, frogs, fish) have plummeted by more than half. It is at that point where a zoologist pays particular attention; the facts of which species, where and why is part of a zoologist's work. It is such subjects that make the zoologist's voice – often sequestered in the academy and

ignored by politicians and pundits – absolutely essential to the broader debates in the community.

Bourne (2015, p304) cites Jon Foley (2011), former head of the Institute of the Environment at Bourlaug's alma mater, the University of Minnesota, as stating that 'Providing food and nutrition for 9 billion people without compromising the global environment will be one of the greatest challenges that our civilisation has ever faced'. The population of Earth is now 7.3 billion, but on current trends we can expect 9 billion by the middle of the century. Foley's 5-point plan to deal with the issue is: stop the farmland expansion, especially in tropical rainforests; use existing agronomy to close yield gaps; reallocate critical inputs such as water and fertiliser to places where they are scarce; shift our diets away from meat and wean our cars off biofuels; and reduce the amount of food that is discarded, spoiled, or eaten by pests, which amounts to about one third of global agricultural production. Foley (2014) expands on his earlier work in a lead paper in *National Geographic*. In his opening paragraph, he identifies that agriculture accelerates the loss of biodiversity and that agriculture is a major driver of wildlife extinction. The environmental challenges, he says, will become even more pressing as we try to meet the need for food worldwide.

Such overviews show how critical food is to a raft of globally important issues and, as Bourne and Foley emphasise, the matter also hinges on the growth of the human population. Zoologists enter the arena from a number of points, including ecological considerations. Ecology is a scientific discipline that looks at populations, including human populations, and the causes of changes in population sizes, including extinction. As Krebs (2016, p 13) points out in his crisp treatise, 'Why ecology matters', the ecologist's job is to stop pest species from increasing and threatened species from declining, and that the human population growth will stop either by careful planning or undesirable catastrophes.

Ecologists are one of many specialist groups looking at land use changes, forest logging, conversion of native vegetation to farmland, the allocation of water, and pest management. These all warrant careful and sustained attention, and it is apparent that no one discipline can encompass all the problems. Zoologists have a role from local wildlife conservation programs to global initiatives, as well as the behind the scenes research on subjects as diverse as taxonomy, palaeontology, and running forums that place zoology on the table for closer scrutiny. Conversely, placing zoology as a partner is both defining the issues and finding and testing solutions. If I now turn to examining just part of the rich field of academic writing on the subject of food, particularly where that writing intersects with zoology, we can see that zoology, in all of its many parts, is vital to this wider debate on the food we eat.

The pervasive theme of famine

Under the subheading, 'The last half century of food discourse in development ethics', Thompson (2015) makes the observation that: 'It may be difficult for scholars under the age of 55 to appreciate how pervasive themes of famine were in philosophical work on development ethics before 1990. Peter Singer made his initial contribution to applied ethics with the seminal paper 'Famine, Affluence and Morality', in 1972. Singer discussed the Bengal Famine and claimed that comparatively well-off individuals had a moral obligation to offer assistance. The philosophical basis for this obligation rested on a principle that Singer said would be supported by any moral theory: if someone can prevent serious harm at little cost to themselves, they are obligated to do so. He argued for this principle using his famous drowning child argument. A few years later, Singer would deploy the same principle in his argument for animal liberation and vegetarian diets (Singer 1975).'

There is a number of intersections here with zoology. The first is the application of Singer's views to the use of animals for food, including kangaroos (Lunney 2010), and an evident gap in the application of Singer's concern for individual animals to the vexed field of wildlife management (Lunney 2012a,b). Another connection is the relationship of famines to population sizes and rates of growth. Thompson (2015) makes this association, as follows: By the 1960s the 'food for peace' program (PL 4804) had a number of critics, and some were coming from the field of population ecology. The challenges of global population growth were brought to popular attention in *The Population Bomb*, a book that has sold over 2 million copies since its original publication (Ehrlich 1968). Ehrlich predicted, says Thompson, that the decade of the 1970s would be characterized by food shortage and punctuated by a series of devastating famines in India, Africa and Latin America. The message that many took from it was one of imminent and uncontrolled growth of global population accompanied by extensive and massive starvation. Population ecology, says Thompson (2015), was joined to ethical argument by Garrett Hardin, who wrote against food aid on the ground that it would only encourage unsustainable population growth in the developing world (Hardin 1968, 1974, 1976a). Although seemingly forgotten today, says Thompson, *The Population Bomb* was widely known at the time that Hardin was initially making his argument.

Hardin tied Ehrlich's ecological analysis, says Thompson, to a critique of altruism, arguing that it is unethical to provide food to poor nations in the absence of a 'birthrate solution', because doing so would only defer the onset of famine, leading to an even greater amount of suffering in the future (Hardin 1976b). For several decades, says Thompson, philosophy professors teaching college courses

4 PL 480, the 'Food for Peace' program, was authorized by the Congress of the USA in 1954. For many decades and perhaps even still, this program of finance for programming at the US Agency for International Development (USAID) has shaped the public debate over foreign aid, especially in the USA (Thompson 2015).

in applied ethics used anthologies, with Singer arguing for food assistance paired against Hardin making the ecological case for allowing the death rate to take its toll. Even today, Thompson adds, when undergraduates lack the background supplied by *The Population Bomb*, the pairing of Hardin and Singer continues to appear in applied ethics anthologies, and especially those with a focus on ethics and development. I draw a number of points from this discussion by Thompson (2015). Firstly, the science of ecology is drawn into the argument on food ethics in a robust, even deadly, debate; secondly, there is a link between populations, food ethics and the ethical treatment of animals via the connection with Peter Singer; and thirdly, the debate is long-standing, and policy decisions arising from one viewpoint or another do have major consequences. What I also note is that the subject is 'food', rather than what sort of food, whether animal or not, whether grain, and if grain, whether wheat or rice. Each food type has differing ethical implications, and even if totally grain, the ecosystem, whether rangelands or wetlands, matters because the area available is finite and the wildlife in each system suffers as these ecosystems are converted to agriculture.

'Biodiversity is the enemy of human food resources'

In an alarming book, entitled, 'What's so good about biodiversity?' Maier (2013), published in a series under the heading 'The International Library of Environmental, Agricultural and Food Ethics', introduces himself by saying that he is an environmentalist, trained as a scientist, and a moral philosopher by current profession (p 1). The current overwhelmingly popular environmentalist view, says Maier (p 2), is that we must save biodiversity because biodiversity is too valuable to lose. He concludes that, 'Disturbingly, these prevailing views have barely been examined or questioned', then adds that he 'could not find a single argument that does not have serious logical flaws, crippling qualifications, or indefensible assumptions.' (p2). My intent here is to look at what such a critical view has to say about food and biodiversity because it seems that the many voices advocating increasing agricultural production are insistent and demanding of, and expecting, additional resources from river water, to cleared land and from the sea – without mentioning the consequences for biodiversity and thus not considering mitigating options.

Under the heading 'Biodiversity as Resource' (pp 163-166), Maier comes to a startling conclusion. He comments that there is much talk about ecologically less destructive agricultural practices and systems, but he notes that 'less destructive means still very destructive' (p 166). They might somewhat ameliorate the effect on biodiversity, says Maier, but they cannot undercut the general and overwhelmingly dominant principle. Food for people decreases biodiversity. Or conversely, as Maier so bluntly puts it, 'biodiversity is the enemy of human food resources'. On the evidence, says Maier, great diversity – of species, at least – is not of any great benefit, considered as either

actual or potential resource. Quite to the contrary, Maier concludes, 'attempts to maintain biodiversity are fundamentally at odds with efforts to produce food – the most valuable of all resources'.

This argument by Maier helps explain why so many zoologists, and all those keen to conserve biodiversity, feel that they are on the losing side when it comes to landuse decisions, developments, or where to put their effort to conserve biodiversity. The logic is clear. If we acknowledge the rate of growth in the human population, both in Australia and across the world, then much more food will be needed. If conserving biodiversity is the enemy of food resources, then biodiversity is sentenced to execution. Is this the only realistic scenario for our future? Absolutely not, and one alternative solution was on display in a science museum in Leiden, Netherlands, in October 2015, just before the RZS NSW forum.

Foodtopia

If we leave the grim clash of food vs biodiversity and consider a new approach to food – manufactured food, rather than food grown in a paddock – then we can see one scientific response to this pressing problem of future food. This potential was visually engaging in a fascinating display when I visited the Boerhaave Museum in Leiden, Netherlands in October 2015. It is a science museum, and the display was entitled Foodtopia⁵. The brochure and the accompanying book were written in Dutch, which alas I cannot read beyond the skills of a tourist, but the display itself had English subtitles, and one website had some explanations.

The exhibition provided, as stated in the website, an overview of over one century's worth of food innovations in the Netherlands. Guest curator, Louise O. Fresco, food expert, showed her personal top 10 of exciting innovations for the future, ranging from algae appetizers to personal foods. Foodtopia, the exhibition states, focuses on the challenge of providing 6 billion people with sustainable, high-quality food by the year 2050. Innovations such as cultured meat, 3D-printed food, a camera that determines the freshness of fish, space food and good old margarine are on show in the food lab. They illustrate how scientists are always looking for new and inventive solutions to the food question. Surrounded by jars with colourful, edible seaweed and scent extracts, visitors will realise, says the website, that this ambition is of all times. At the end of the exhibition, immersed in foodtopic images, you get to sit down at the interactive table of the future. Trays with potato seed, miniature robots, insect lollipops, and other delicacies roll by. You get to discover the story behind these innovative food concepts by taking them off the conveyor. What the website did not mention was the view by Fresco in the museum display that the issue of cruelty to animals in industrial agriculture needs to be addressed.

⁵ <http://www.tinker.nl/en/news/foodtopia-opened-in-museum-boerhaave>. Last accessed 1 November 2015.

The exhibition, with an Australian accent, would be a success in Australian museums. In our heated debates of conservation vs food production, a third option of food generation is rarely canvassed except by the interested few. People find it hard to imagine generated food, let alone imagine it as healthy.

The target of providing 6 billion people by the year 2050 with sustainable, high quality food may be unattainable. In the UN's (2015) Snapshot of global population in 2015, the results of the 2015 *Revision*, the world population reached 7.3 billion in mid-2015, and has added approximately one billion people in the last twelve years. The projections by Revision 2015 are for the world population to increase by more than one billion people within the next 15 years, reaching 8.5 billion in 2030, and to increase further to 9.7 billion in 2050 and 11.2 billion by 2100. Thus, at the end of this century, the population will be almost twice the 6 billion in the Foodtopia target. Arguably, the growth in the human population will outstrip any improvements in food production, food quality and the ability of this planet to supply sustainable, good quality food for everyone. The consequences for biodiversity are alarming, the boundary of biodiversity will be inversely related to human population size. This makes food, food ethics, sustainability and the politics of the food we eat inextricably linked to all the biological sciences, including zoology.

Wildlife conservation and food security

By asking the question at the RZS NSW, 'What's food and nutrition security got to do with wildlife conservation?', Alders and Kock (2017) are at the heart of zoologists' keen awareness of the relevance of their discipline, even if others do not see the need to think zoologically. They review the linkages between food security, nutrition and wildlife conservation in the early 21st century and argue that adopting a nutrition-sensitive landscape approach would improve consumer understanding of food systems, nutrient cycles and ecosystem services, and potentially link dietary diversity with recovering biodiversity. They provide striking examples from Africa, and the photo of a rodent, ntika *Mastomys natalensis*, lying dead on a sheet of newspaper is explained in the text. The authors state that given the current concerns over loss of food diversity, mobilization of neglected or underutilized crops and sustainable harvest of wild food have the potential to improve food security. Grigg (2017) examined this issue with an Australian perspective in 'Eating kangaroo (good) and goat (bad) for rangelands'. Grigg here links food with wildlife management and invasive species on the rangelands, as discussed previously. This too is the territory of the zoologist, but as is evident in the plenary session that followed, it is not just zoologists whose voices lead in this arena. Presenter Robyn Alders (see Alders and Kock 2017) asked a question of the audience: How many people in this room actually produced some or all of the food that they ate today? Please put up your hand

if you've produced some of your food? Fewer than 10 hands went up in the audience. By reaching out to the audience, Alders had put her finger on an issue - we are primarily consumers with strong views, but we are not producers, and thus less likely to see the consequences for the landscape of what we eat, or chose not to eat.

The discussion of animal rights and being vegan or vegetarian appears to be well away from considering goats, kangaroos and bushmeat as food (Cooney 2017), yet the question is central, as Ian Wallis (2017) acknowledges with his paper on semi-vegetarianism. The politics across this subject is as wide as our survival itself. For the zoologist, the central issues are the survival of biodiversity, in other words our wildlife and the ecosystems upon which they depend. Grigg's categorisation of kangaroos good, goats bad, is as much a statement ecosystem management as it is about alternative foods. This discussion highlights how the topic can change across the world, from one ecosystem to another and from one researcher to another. In the first plenary, David Booth stated that by far our most valuable fishery in Australia is the cage-introduced salmon fishery in Tasmania:

Booth: I love salmon, but I think it's disgusting. I mean, we're introducing fish into a waterway. It could escape.

Pat Hutchings: What about the communities underneath the salmon ponds?

Booth: Yes, they're an ecological disaster... they are delicious.

That exchange has parallels to the kangaroo-goat dilemma in the rangelands, the general principle being the issue of the impact of our food supply derived from alien species (goats, salmon), rather than native species (kangaroos, native fish). More importantly, the decisions that continue to give priority to a human food supply do so often at the expense of conserving biodiversity, even though the native biodiversity is a largely overlooked fine food source that is also integrated into the local ecosystems. When you look

at the overarching direction of the debate on the science, sustainability and politics of the food we eat, it becomes vividly clear that biodiversity in Australia, and worldwide, is losing ground, set on a trajectory of relentless loss as our food supply inexorably expands.

Conclusion

A zoological perspective on the human need for food has much to contribute to the science, sustainability and politics of eating animals. To a zoologist, food is a key defining attribute of a species: its anatomy, physiology and ecology are intimately linked to what it eats. If climate change, over-exploitation, loss of habitat, pollution or invasive species diminish the food supply for the native animals in a particular area, individuals cease breeding, the death rate increases, and the population declines, in extreme circumstances, to extinction. An underlying concern for me as a zoologist is that the subject areas of zoology, such as species survival, ecosystem management and conserving biodiversity, are poorly covered, or not even mentioned, in so many writings on food, food ethics, agriculture and economic growth, yet zoology needs to be on the table at every discussion. For some discussions, it is vital, yet food, its abundance, its cost and the sort of food produced more often than not trumps conserving biodiversity. Zoology needs to be at the table when every subject from animal rights, to agricultural expansion, to population growth is debated and decisions are made. What has become clear is that the zoologist has been a missing voice in the debates and discussions on the consequences of feeding the world. Zoologists need to speak up, and anyone at all interested in, or has responsibility for, conserving biodiversity needs to seek the missing voice of the zoologist from the sea to the arid lands.

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APPENDIX I

Foodtopia – a display in the Boerhaave Museum, Leiden, Netherlands. (All photos by Dan Lunney October 2015)

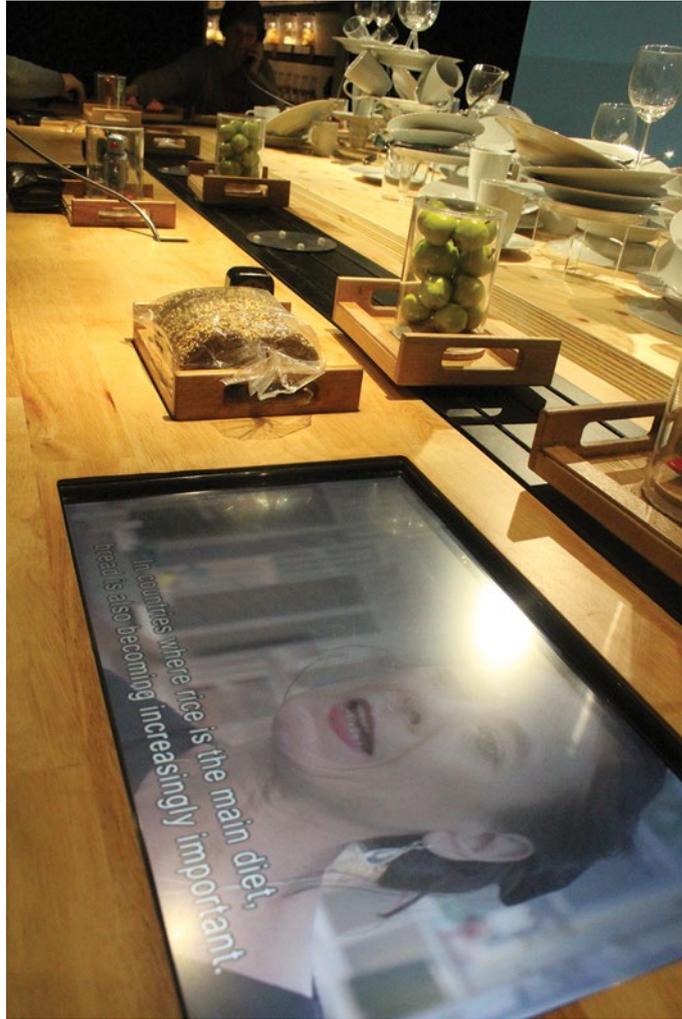


The street location displaying the advertisement for the foodtopia exhibition.



Visitors to the exhibition, and the style of lighting and display of the material.

APPENDIX I



The display here has movies in the foreground, with fixed items, and a moving conveyor belt with items that can be removed and examined.



A series of photos capturing images from a short movie on the moral position on how we treat animals, the value of meat and the humane treatment of animals.