The Violent Narrowing of Animal Life

Tony Weis
University of Western Ontario

Abstract: Mainstream environmentalism has long prioritized wild animals and their habitats while paying little attention to the explosive growth of global livestock production and consumption. However, this blind spot to livestock is changing quickly, in large part because of the rising general awareness of the resource and emissions intensity of animal-based foods and how it relates the interwoven crises of climate change and biodiversity loss. This paper considers both the fertile ground for animal advocacy to be found in the mounting scientific evidence about environmental inefficiencies of animal-based foods, and the need to be attentive to the risks it bears. The principal danger of efficiency-centred narratives is that if they are largely focused on climate change and biodiversity loss, the goal of reducing relative associated impacts can appear in a way that helps to further stoke the growth of industrially produced birds, which should be understood in relation to the already well-established poultrification of global livestock supply and demand. This paper highlights the importance of challenging this partial lens and response, and stresses the need to connect macro-scale environmental concerns to critical reflection about the ways that animal lives are organized in industrial livestock production. The concern for declining wild animal populations among environmentalists is a key lever for this, as industrial livestock can be shown to bear on the loss and fragmentation of habitats while at the same condemning a large and growing share of all birds and mammals to a short and agonizing existence. What emerges is an indelible image of a pathological mode of production that is violently narrowing how other animals get to inhabit the earth.

Keywords: environmentalism; defaunation; commodifaunation; industrial livestock production; poultrification

Introduction

Environmental thought, advocacy, and policy are heavily influenced by the ways that rapidly changing animal populations and distributions are understood, and what aspects of these changes register as morally significant (WWF). Influential strands of environmentalism have long focused on the declines of charismatic wild animals and efforts to arrest them (Adams), while paying little or no attention to the explosive population growth occurring among a small range of domesticated species and its implications. Fortunately, these blinders have started to break down, owing in large part to the overwhelming scientific evidence that plant-based foods tend to be vastly superior to animal-based foods in environmental terms, requiring far less land, water, fossil energy, and other inputs to produce a comparable level of nutrition, and generating far fewer greenhouse gas (GHG) emissions and pollution loads (see for example Cederberg et al.; Crist et al.; Foley et al.; Gerber et al.; Godfray et al.; Grossi et al.; Hayek and Miller; Hedenus et al.; Herrero et al.; IPCC; Machovina et al.; Poore and Nemecek; Mekonnen and Hoekstra; Ramankutty et al.; Springmann, Clark et al.; Vermeulen et al.; Willett et al.; Xu et al.). In short, the inefficiency of livestock production has become impossible to ignore for anyone who is mindful of the biodiversity crisis and the climate emergency and feels compelled to take action.

Biophysical assessments of the comparative efficiency of plant- and animal-based foods can clearly provide strong footing for animal advocacy, and help to reduce the exploitation and suffering of animals by convincing environmentally-minded people to reduce or cut out their consumption of meat, eggs, and dairy products. But this paper warns there is also a potentially slippery slope associated with analyses and outreach that are largely or entirely focused at the level of biophysical efficiency, as is frequently the case in influential environmental impact analyses of agriculture and food with respect to mitigating climate change and biodiversity loss. The essential risk associated with this focus is that the ensuing guidance can end up encouraging some forms of livestock production over others in ways that can be manipulated by advocates of industrial livestock production, and in turn can serve to amplify the already well-entrenched boom in poultry supply and demand (and to a lesser degree, encouraging pigs over ruminants). From this central problematic – that efficiency-centred analyses of animal-based foods

simultaneously contain great promise and serious risks – this paper considers how the growing consciousness about the negative environmental impacts of livestock production and consumption could be marshalled to help foster more humane and sustainable sensibilities. It finds a key lever for this in the abiding focus on threatened and endangered species within environmentalism, and the emotional and intellectual resonance of large animals in particular. Concerns about declining wild animal populations and the loss and fragmentation of their habitat (and, conversely, hopes of ecological restoration and rewilding) provide a good way into critical conversations about rising livestock production and consumption, given its role in magnifying the amount of land, water, energy, and other resources used in agriculture. To appreciate this magnifying effect compels attention to the problems posed by the pursuit of scale and the ways they are overridden, which must be understood in relation to how individual animal lives are organized and accelerated in industrial systems, and how these systems now contain a large and growing share of all mammals and birds on earth. In other words, efforts to convey the *extensive environmental burden* associated with livestock production and consumption can flow directly into an appreciation of industrial systems as *intensive lived environments*. Through this lens, the deteriorating conditions and possibilities of animal life – in both falling and soaring populations – appear not as separate material and ontological problems, but rather as differentiated outcomes of the same powerful political economic imperatives that must be acted on together.

Animals in environmentalism: inspiration and blinders

The decline of large animals, especially charismatic mammals, has always been an animating concern of the modern conservation movement, as well as having a prominent place within mainstream environmentalism more broadly. The modern conservation movement arose in the 19th century amid desperate efforts to protect large charismatic animal species from extinction, as their populations crashed amid rapid habitat destruction and voracious hunting (Adams; Brockington et al.). Some early conservationists and organizations viewed this as a purely ethical imperative, while other influential currents were motivated by blatant self-interest; big game hunters seeking to ensure their biggest trophies would be there into the future. In either case, as

the race against the extinction of large animals emerged as the crucial 'bottom line' for conservation it became bound up with a race to defend key pieces of their remaining habitat (Adams).

The US west was a key crucible in conservation thought and practice. The establishment of Yellowstone National Park in 1872 was motivated in part by growing concerns about the decimation of the bison and other large mammals, and this new designation – which gave legal and moral force to a conception of wild land without permanent human settlement – quickly grew into the most important pillar of conservation strategies. It also involved an iniquitous and oft-repeated precedent: expulsions of Indigenous people who were living there (Brockington, et al.; Dowie; Jacoby). For champions of the Yellowstone or US park model, the moral significance of human expulsions and exclusions of customary use has tended to be either downplayed or justified by a greater good that is defined and symbolized, to a significant degree, by the plight of charismatic mammals.

In short, conservation advocacy has fixed a great deal of attention on a particular conception of wild land as the primary basis for responding to the declines of wild animals, and it has succeeded in driving a dramatic expansion in the global extent of land designated as protected areas since the middle of the 20th century. Less than 10% of the earth's land was designated as protected areas in the 1980s, but by 2021 this had surpassed 17%, and in 2022 the 15th Conference of the Parties of the Convention on Biological Diversity pushed the target far higher and faster, calling for 30% of all land to be protected by 2030.[1] Attention to the declines of particular charismatic mammals has played a major part in the expansion of protected areas, in terms of both targeting specific land acquisitions and broad ethical narratives, as can be seen in a wide range of settings, such as with tigers in India, panda bears in China, mountain gorillas in the DR Congo, and the so-called 'big 5' of African wildlife (lions, leopards, elephants, rhinos, cape buffalo) in various savannah regions of Africa. Animals also feature heavily in the tourism promotion surrounding parks, which is increasingly important to conservation financing, especially in the tropics (Brockington, et al.; UNEP-WCMC and IUCN).

Roughly 60% of the world's top predators and large herbivores are now threatened with extinction, following drastic declines in their populations and former range, and most have become increasingly reliant on protected areas for their survival (Ripple; Ripple et al.; WWF). This reliance becomes more precarious the more protected areas are separated from other functional habitat by the increasing extent of farming, ranching, logging, mining, hunting, roads, and urban development on their margins. A good illustration of this precarity can be seen in the US and Canada, given that they possess two of the most well-resourced park systems in the world. The problem of isolation for large animals was evident by the 1980s, as a survey of 24 sizable national parks in the western US and Canada revealed that many mammals got extirpated from the national parks *after* their establishment (Newmark), and the barriers to movement beyond parks must also now be understood in light of the fact that climate change is forcing many animals to seek new habitat (Shafer). Recent assessments of national parks in Canada found that many are in a state of deteriorating ecological health owing in part to the extent of development on their peripheries (CPAWS; Parks Canada).

Researchers have also clearly documented the dangers from inbreeding and the genetic bottlenecks facing increasingly isolated animal populations. Even the largest parks cannot resolve the problems of habitat fragmentation for large animals (Ripple; Ripple et al.; Shafer; Stolzenburg; Watson et al.; Wolf and Ripple), and in parks with extensive tourist infrastructure and visitations, the scale of resorts, roads, and car traffic can also contribute to the fragmentation of animal habitat *within* parks. One emergency response that is being deployed with a few endangered species is to sedate, move, and breed individuals between parks in order to enhance genetic variability, and there is good reason to expect that this practice will soon involve many more species. A more durable response to improve the genetic health of animal populations is to protect or rebuild viable corridors that enable them to better move between ample patches of habitat, especially for large herbivores and top predators that tend to have extensive ranges together with relatively low reproductive rates and population densities (Ripple et al.; Stolzenburg; Wolf and Ripple; WWF). As well as needing improved landscape connectivity, large mammals are crucial to the ambitious imaginaries needed to pursue it. One celebrated example of how top predators can help convey the need to greatly expand the scale of

conservation thought and practice is the Yellowstone-to-Yukon (Y2Y) Conservation Initiative, which highlights the circuit of a radio-collared wolf named Pluie as part of its founding narrative. There are many other instances where large mammals have a central place in representations of corridor planning, such as Jaguars in Central and South America, elephants in the Kavango Zambezi Transfrontier Conservation Area, and brown bears in the Carpathian Mountains.[2]

Along with increasing the isolation of parks from other areas of suitable habitat, another big problem for large animals is that park designations have often proven incapable of stopping various sorts of incursions, especially across large areas of the tropics. There are profound disparities in conservation budgets between high and low income countries, and many parks in the tropics are mired in a perpetual state of insecurity, with too few rangers and too little monitoring and enforcement capacity relative to the pressures at hand (Brockington et al.; UNEP-WCMC/IUCN). Rising international demand for both live animals and body parts has driven intensified poaching within and on the margins of parks, to an extent that it now represents a proximate threat to the survival of some especially endangered charismatic megafauna, including tigers, lions, elephants, and rhinos. This has led some of the world's leading conservation organizations to devote increasing resources to monitoring and exposing black markets and transhipment networks and fighting poaching in and around parks (ICCWC; Parry-Jones and Allan).

In the 1980s and 1990s, the notion of 'fences and fines' was often used to characterize the nature of 'fortress conservation', and without dismissing the inequalities and tensions this entailed, today the idea that simple physical barriers and economic penalties could suffice as deterrents can seem almost quaint given the intensity of pressure in a range of settings, especially sub-Saharan Africa. Today, fortress conservation increasingly entails real militarization, including armed rangers informed by high-tech surveillance, with GIS, satellite data, drones, and hidden cameras used to track movements of animals and poachers alike, which is vital to making tactical deployments efficient and effectively stretching limited budgets (Duffy; Sandbrook).[3] One of the world's most influential conservation organizations, the WWF, now markets a 'Back a Ranger' program to donors, with images of conservation officers carrying semi-automatic weapons. The *Thin Green Line*

Foundation is also illustrative of the increasing militarization of conservation, as it is expressly financed to train park rangers in the Global South in the use of arms and surveillance tactics and supply them with weapons, ammunition, and apparel.[4]

It is clear that large endangered animals, especially mammals, have crucial strategic and symbolic roles in defining conservation agendas and mobilizing popular and political attention. It is equally evident that the survival of some species now hinges on the forceful defence of parks and on efforts to stop wildlife trade. Yet while the focus on charismatic endangered animals and parks is undeniable on one level, and the urgency impossible to overstate, there is also a danger that it can be a profoundly limiting way to understand problems and necessary responses. One aspect of this danger is that while charismatic endangered animals can have a sort of ambassadorial role for other species, to some this might also obscure the scope of the biodiversity crisis and downplay the significance of the losses unfolding below the radar of endangerment. For instance, if the population of an animal species has declined by roughly 90% and it has lost 90% of its former range in the past century, but is now deemed to be relatively stable by conservation biologists and does not appear on the IUCN Red List, to what extent does this decline matter for conservation agendas? Does this greatly diminished population still register as a moral concern and its protection as a practical ambition? Is there a need to reflect on the diminished lives of the surviving individuals that have so much less range and so many fewer conspecifics than members of their species had in the recent past?

Distinguished conservation biologists have developed the concept of *defaunation* to express how global declines of wild animals run much deeper than threatened and endangered species, and how we must also take into account both the reduced array of non-threatened species within a given area (which, from an animal perspective, entails a loss of range) and the declines in abundance among those species that persist (Ceballos et al.; Dirzo et al.; Ripple et al.). While the past and present populations of some animals may be difficult to estimate, there are rigorous scientific surveys of the population trajectories of thousands of species that stretch over many decades, and overwhelming empirical evidence that broad-based population declines are occurring among all classes of vertebrates from the tropics to the poles (Rees et al.; WWF; IPBES; Ceballos et al.; Ripple et al.; Dirzo et al.). The *Living Planet Report* has helped draw

attention to the extent of defaunation, drawing headlines in the mainstream media upon its biannual release, and the 2020 report estimated that among roughly 4400 representative species of mammals, birds, reptiles, amphibians, and fish (with relatively good data over time), there has been an average decline of 68% in the past half century alone (WWF).

The fact that this extraordinary narrowing of animal life has occurred over the same period that parks have greatly expanded reflects the limits of what protected area designations can do if the forces that are transforming environments everywhere else are not confronted (IPBES; Watson). Whether the target is 17% of all land, or the revised CBD framework of 30% by 2030, as Dan Brockington, Rosaleen Duffy, and Jim Igoe stress, the primacy of parks can serve to greatly restrict how 'conservation's theatre of operations' is understood (46) in a way that reinforces the dualistic view of 'nature' as something that is and, to survive, must be kept separate from 'society'. Viewed in this way, both problems and responses appear as matters that are mostly detached from the dynamics of everyday life, which only distant organizations can affect; they might inspire a donation but could also diminish the sense of what the sort of change is seen to be achievable and necessary and what is not.

Rising attention to the environmental impacts of livestock production and consumption: opportunities and dangers for animal advocacy

The failure to seriously consider the multidimensional impacts of livestock production and consumption has been one of the longstanding blind spots within the conservation movement and environmentalism more broadly, though there is much to indicate that this is changing. One way that the environmental impacts of livestock have been put into focus is through assessments that set the precipitous declines in the biomass of wild mammals and birds over the past century against the staggering increase in the biomass of just a handful of species of farmed animals (Bar-On et al.; Smil). Today, cattle, pigs, goats, and sheep together constitute the large majority of all terrestrial mammalian biomass, and well over 90% of the biomass of non-human terrestrial mammals (the biomass of almost 8 billion humans is itself an order of magnitude higher than that of all of the wild animals on earth combined). Poultry birds, overwhelmingly chickens, now

make up more than 70 percent of the total biomass of all living birds, or more than twice that of all of the wild birds on earth combined (Bar-On et al.). The trajectories of mammalian and bird biomass also help to convey why farmed animals exert so much pressure on land, the atmosphere, and freshwater, connections that have received increasing attention in scientific assessments and among a range of environmental organizations. The FAO's landmark 2006 report, *Livestock's Long Shadow*, played an important part in this, especially for marking rising animal production as a major factor in climate change, including an estimate that livestock was responsible for 18% of annual GHG emissions on a world scale (Steinfeld et al.) that has been subject to considerable debate and attempts to revise upwards and downwards.

Assessments of livestock's role in climate change generally start with the fact that livestock occupies far more land than any other human activity, with extensive ranching and herding covering 22-25% of all land and feed crops commanding nearly one-third of all arable land, which amounts to another 3-4% of all land (Foley et al.; IPCC; Ramankutty et al.; Steinfeld et al.). Key factors used to add up the annual GHG emissions directly attributable to livestock production include: the carbon dioxide (CO_2) emissions from livestock-related deforestation, principally cattle ranching in Amazonia; the CO_2 emissions from livestock-induced land degradation, which is most acute in arid and semi-arid regions (where desertification both affects and is affected by climate change); the methane (CH_4) emissions from the enteric fermentation of ruminants; the CO_2 and CH_4 emissions from the resource intensity of industrial livestock operations and the great aggregations of biowastes they entail; and the CO_2 and nitrous oxide emissions associated with feed crop production (for example, machinery, fertilizers), which involve large shares of the useable nutrition being wasted in animals' metabolic processes before becoming flesh, eggs, and milk (Cederberg et al.; Gerber et al.; Godfray et al.; Grossi et al.; Hayek and Miller; Hedenus et al.; Herrero et al.; IPCC; Poore and Nemecek; Springmann, Clark et al.; Vermeulen et al.; Xu et al.).

Along with the amplification of land and GHG emissions, animal foods have also been shown to have far greater water footprints than plant-based foods on average, as there are much more embedded water and pollutants per unit of nutrition due to the water given to animals to drink, the irrigation of feed crops, the water and feed lost in 'non-productive' metabolic

processes, the immensity of faeces and urine, and the water intensity of industrial livestock operations and slaughter and packing plants (Hoekstra; Mekonnen and Hoekstra). Resource- and emissions-based arguments are further braced by a growing chorus of health scientists conveying the basic message that the need to reduce diet-related environmental harms is entwined with public health objectives, based on both mounting climate change related health problems and the clear evidence linking animal-heavy diets to increased risks of a range of non-communicable diseases and reduced animal consumption to improved health outcomes (Anand et al.; Popkin; Springmann, Godfray et al.; Willett et al.). The emergence of a new field of environmental nutrition is also noteworthy here (Sabaté et al.).

The inefficiencies of livestock relative to plant-based nutrition featured prominently in the IPCC's special report on *Climate Change and Land*, with a central conclusion encapsulated by contributing author Peter Smith: 'All meats have a higher climate, land and water footprint than the same quantity of plant-based foods. In the worst case (meat from ruminants, like beef and lamb), this can be 10–100 times greater than plant-based foods… The best foods by far, from an environmental perspective, are plant-based' (quoted in BBC). Yet as important as it is to rigorously account annual emissions, stopping at this underrepresents how livestock production is contributing to further climate change and impeding the prospects for mitigation. Because the inefficiency of cycling feed through animals and using high quality arable land for pasture rather than crops greatly expands the total amount of land used in food production, relative to what could be attained if nutritional needs were met directly through plants, this represents a substantial barrier to large-scale ecological restoration which could play a crucial role enhancing carbon sequestration (Crist, Mora, and Engelman; Weis). In other words, livestock production as it exists today not only generates the lion's share of annual GHG emissions from agriculture and food, but also contains an immense opportunity cost with respect to mitigating both climate change and biodiversity loss. Some influential conservation biologists have begun to stress how reductions in livestock production and consumption are inextricable from the prospects of making more space for other species (Crist et al.; Machovina et al.), and one indication that this

is gaining traction among conservation organizations can be found in the *2020 Living Planet Report*, which identified the scale of livestock production as a significant factor in the loss of biodiversity and highlighted reduced consumption is a necessary response (WWF).

Assessments of the environmental impacts of food and diets clearly provide strong footing for animal advocacy, in consistently marking the superior efficiency of plant-based foods in comparison to animal flesh, milk, and eggs. However, animal advocates should nevertheless take heed of a serious danger laden in these assessments: they also consistently highlight the land, emissions, water, and public health advantages of intensive poultry production relative to mammals, including extensive forms of husbandry where the welfare of individual animals is much better (see, for example, Anand et al.; Cederberg et al; Gerber et al.; Godfray et al.; Grossi et al.; Hedenus, et al.; Herrero et al.; Machovina et al.; Steinfeld et al.; Willett et al.). Biomass assessments, though valuable, nevertheless underrepresent the scale of animal production because they are a measure of living organisms, and for poultry birds and pigs especially, life cycles have been so accelerated that there are many more individuals killed every year than are alive at any given point in time, with the result that the annual tonnage of flesh is far greater than the living biomass at any one point. The best illustration of this can be seen in the fact that while cattle constitute far more biomass than any terrestrial mammal, pigs and poultry birds accounted for 72% of global meat consumption in 2021, and these species have been the driving force in the near doubling of per capita meat consumption in just a few human generations, from 23 to 45 kg/year from 1961 to 2021, over a period the human population grew from roughly 3 to almost 8 billion (FAOSTATS).

A central danger of efficiency-oriented narratives with respect to livestock production relates to those who might be motivated to reduce but not eliminate their consumption of animals with the climate or biodiversity crises in mind, for instance campaigns like Meatless Mondays or groups like flexitarians, conscientious omnivores, pescatarians, and pollotarians. To the extent that bird meat and eggs appear much better than mammalian flesh and milk with respect to land, water, energy, and emissions (complimented by reduced epidemiological risks relative to red meat), it can help to sanction shifts towards things like chickens, turkeys, ducks, and geese (or even pigs relative to ruminants) on environmental and public health grounds.

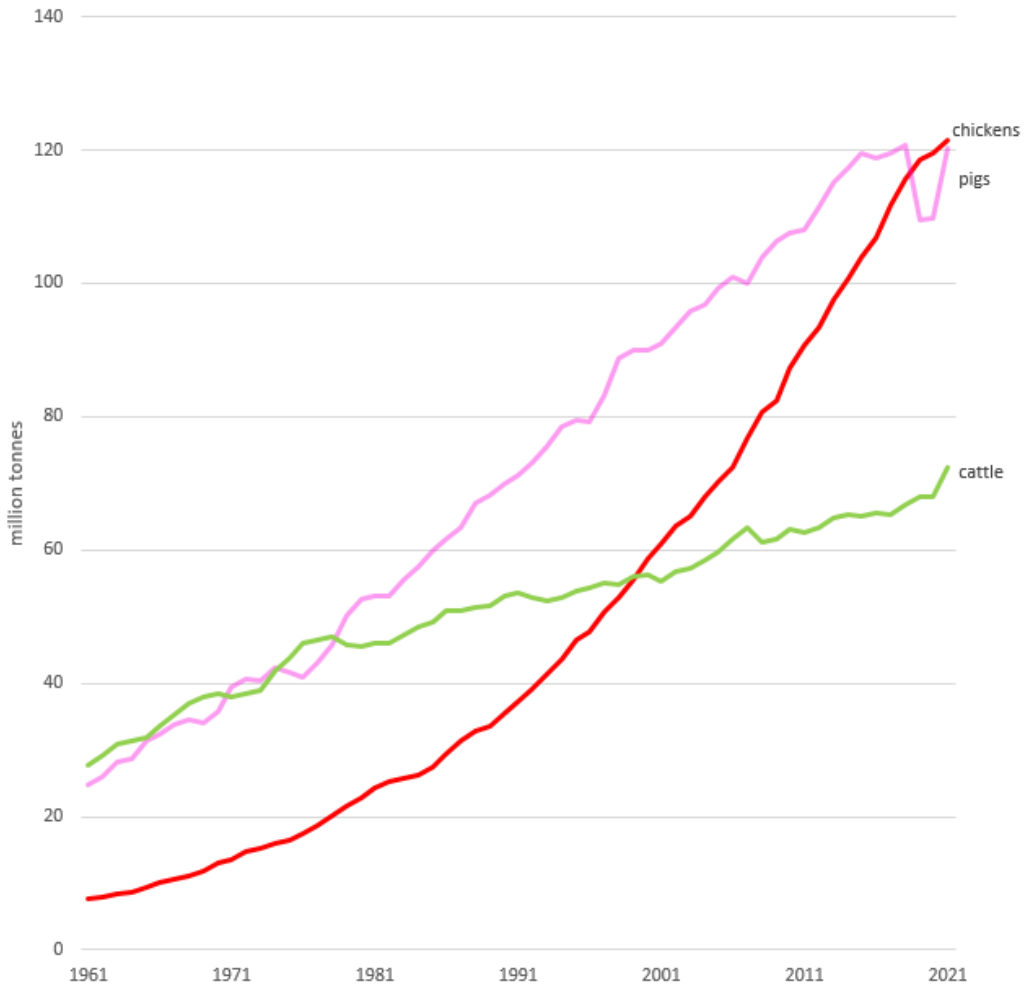


Figure 1. The 'Big 3' of Global Meat Production, 1961-2021.
Source for data: FAOSTATS

It is important to consider this possibility in light of the 'poultrification' of global livestock supply and demand, or the faster rates of growth in farmed birds than with mammals, which has been deeply entrenched on a global scale well before serious environmental concerns about the environmental impacts of livestock production were identified. In 1961, the 3 biggest ruminant species (cattle, sheep, and goats) accounted for 47% of global meat production, while poultry birds accounted for less than 13%. In 2021, these same 3 ruminant species accounted for

25% of global meat production, while poultry birds had risen to 39%. It is also very illustrative to consider differential rates of growth on a global scale. From 1961 to 2021, the annual volume of meat produced from birds rose by a stunning factor of 15, driven by chickens, in comparison to a 5-fold growth in pig meat production and 2.6-fold growth in cattle meat production (see Figure 1). Global egg production also rose more than 6-fold over this period. While chickens account for roughly 90% of the total volume of meat produced from birds, the production of meat from turkey, ducks, and geese has surged at comparable rates (see Figure 2) and rose from 1.9 to 4.6% of annual volume meat production from 1961 to 2021 (FAOSTATS).

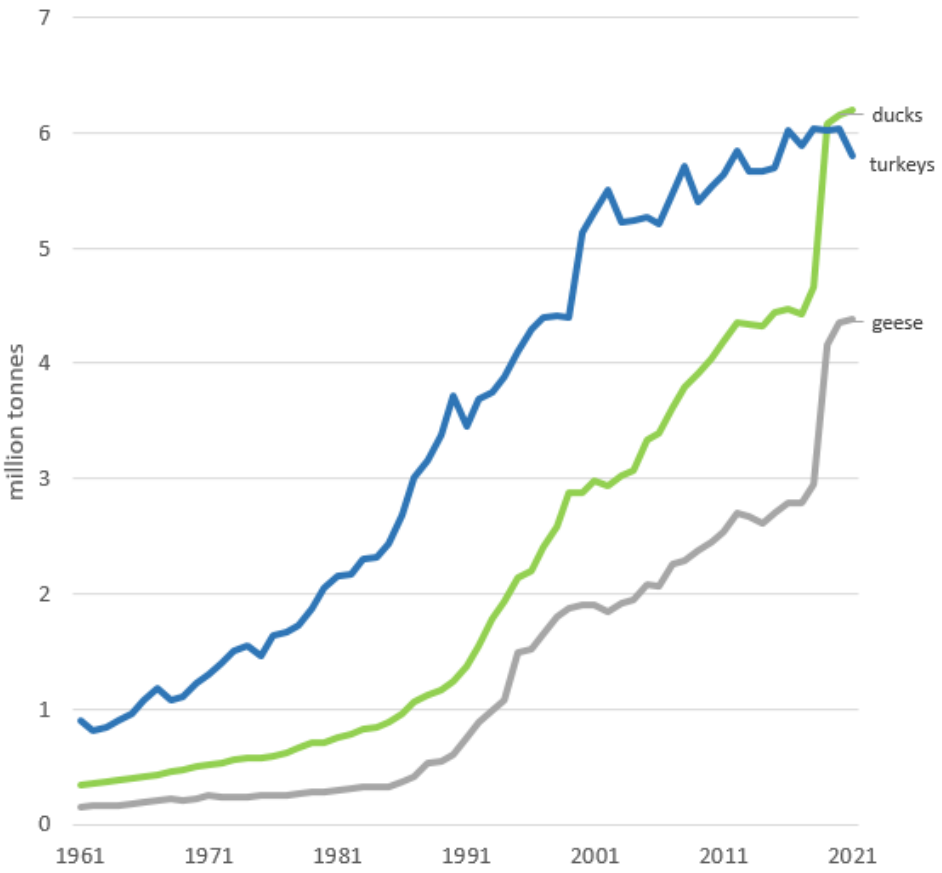


Figure 2. Global Duck, Turkey, and Goose Production, 1961-2021.

Source: FAOSTATS

The economic dimensions of feed conversion disparities are a key factor in the much faster rates of growth in meat production from birds, augmented by health guidance favouring the leaner flesh of birds over the fattier flesh of mammals, and feed conversion disparities are also part of why the production of pigs has significantly outpaced that of cattle. Birds make up the large majority of all animals raised and killed for food on a global scale, and the pace of growth in both bird 'stocks' and annually slaughtered populations has been astounding: because the great majority of farmed birds are produced in industrial systems, where they are brought from hatch to slaughter very quickly, there are roughly three times as many individuals killed every year than there are living 'stock' at any one time. The number of farmed birds killed on an annual basis rose from around 7 billion in 1961 to around 83 billion in 2021, including almost 74 billion chickens (see Figure 3) (FAOSTATS).

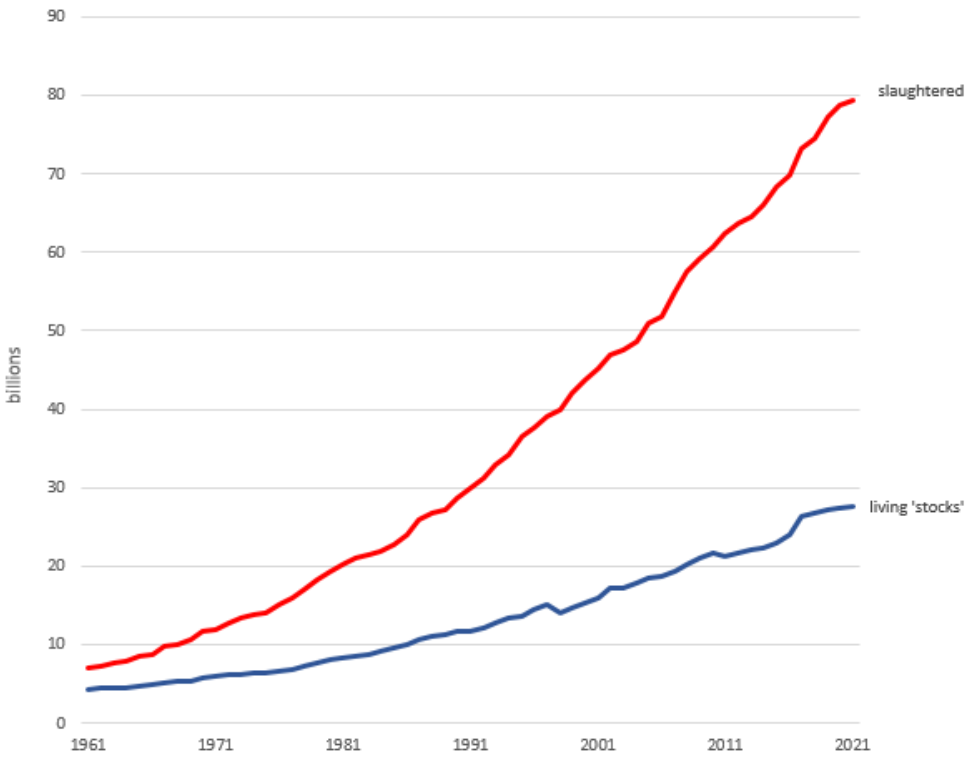


Figure 3. Global Populations of Farmed Birds, 1961-2021.

Source: FAOSTATS

In short, focusing on inefficiency, as often occurs in environment-centred (and environmental plus health) assessments of livestock, could inadvertently hasten a disastrous outcome from the perspective of animal exploitation and suffering, and might also obscure the fact that cycling corn, soybeans, and other feed crops through birds still entails far more land, emissions, and water than is necessary to meet the nutritional needs of human societies, with all of the attendant impacts. Shifting towards farmed birds is not more efficient, but rather is merely somewhat less *in*efficient relative to mammals, and should have no moral sanction on the grounds of climate change mitigation or biodiversity conversation. It is also serving to amplify the risks of that dangerous variants of avian influenza and other infectious diseases could emerge and fuel a future pandemic (Davis; Wallace).

Animals in environmentalism: widening the lens

Given the sorts of fixations and blinders that have long prevailed within the conservation movement and mainstream environmentalism more generally, animal advocates must be attentive to the way the impacts of livestock production and consumption are conveyed in the context of climate change and how it bears on extinction risks. Part of the challenge here is to destabilize the speciesism that inheres in much environmentalism (Davis, 'Thinking Like a Chicken'), and to draw connections between the spatially expansive environmental burden of livestock production, which bears on the worsening conditions of life facing wild animals, and the large and growing share of all mammals and birds forced to endure short and wretched lives in dense enclosures; in short, between macro-scale impacts and micro-scale conditions of life. Together, this can be understood as the violent narrowing of animal life, with violence denoting how harm gets inflicted through a combination of amoral systemic compulsions (the relentless pursuit of growth, capital accumulation, and expanded commodity relations), economic calculations, and industrial design, from the direction of technological innovation to routinized practices. While the notion of narrowing should not diminish the diversity of conditions and challenges that various species face (or the agency of individuals within human-dominated landscapes and moving between fragmented patches of viable habitat), it does reflect the need to express global-scale tendencies and patterns in an age of cascading global crises.

To appreciate how animal lives are organized in industrial systems, it helps to start by briefly considering the pursuit of economies scale at a general level. The pursuit of scale is an intractable part of capitalist competition because the ability to substitute technology for labour can reduce costs and bring decisive advantages for firms, and once significant labour-saving innovations take root in a given sector, they become difficult or impossible for others in the sector to avoid. A central way that the continual pressure to grow and compete manifests is in the need for firms to perpetually reinvest in cost (centrally labour) saving innovation, which connects to the tendency to break the labour process into smaller tasks. The factory floor is the most common way to think about economies of scale and the segmentation and displacement of labour, from the cotton mill dislocating handloom weavers, to Fordist assembly lines dislocating countless skilled artisans and tradespeople, to robotics displacing workers on Fordist assembly lines and in large warehouses.[5] Some of the greatest gains in labour productivity from mechanization have occurred in spatially extensive productive environments like industrial monocultures and forestry plantations, where the growing scale and sophistication of tractors, harvester combines, feller-bunchers, and other machinery has displaced a growing amount of human (and animal) labour over time – a process that pivots on the biological simplification and standardization of landscapes over wide expanses. Monocultures of things like corn, wheat, soybeans, sugar, cotton, palm oil, eucalyptus, rubber, and pine amount to largely interchangeable spaces governed by capital (Moore), and veritable wastelands for most animals.

While biological simplification and standardization is a fundamental aspect of labour productivity gains, it also poses intractable biophysical problems for production, most of all with deteriorating soil quality and amplified pest threats. These problems, or biophysical barriers to scale, are never resolved but rather get repeatedly overridden with external inputs (Weis), most crucially the manufacturing and long-distance movement of fertilizers (for agriculture) and the proliferation of pesticides (for both agriculture and forestry) – what Rachel Carson famously described as constituting a 'permanent war' on nature. Further, as productive environments get specialized on ever larger scales, they must be articulated to sites of refining and manufacturing through longer transhipment networks, entailing bigger arteries of asphalt, gravel, concrete, and steel, and more fossil energy expended in moving inputs and outputs around. In addition to

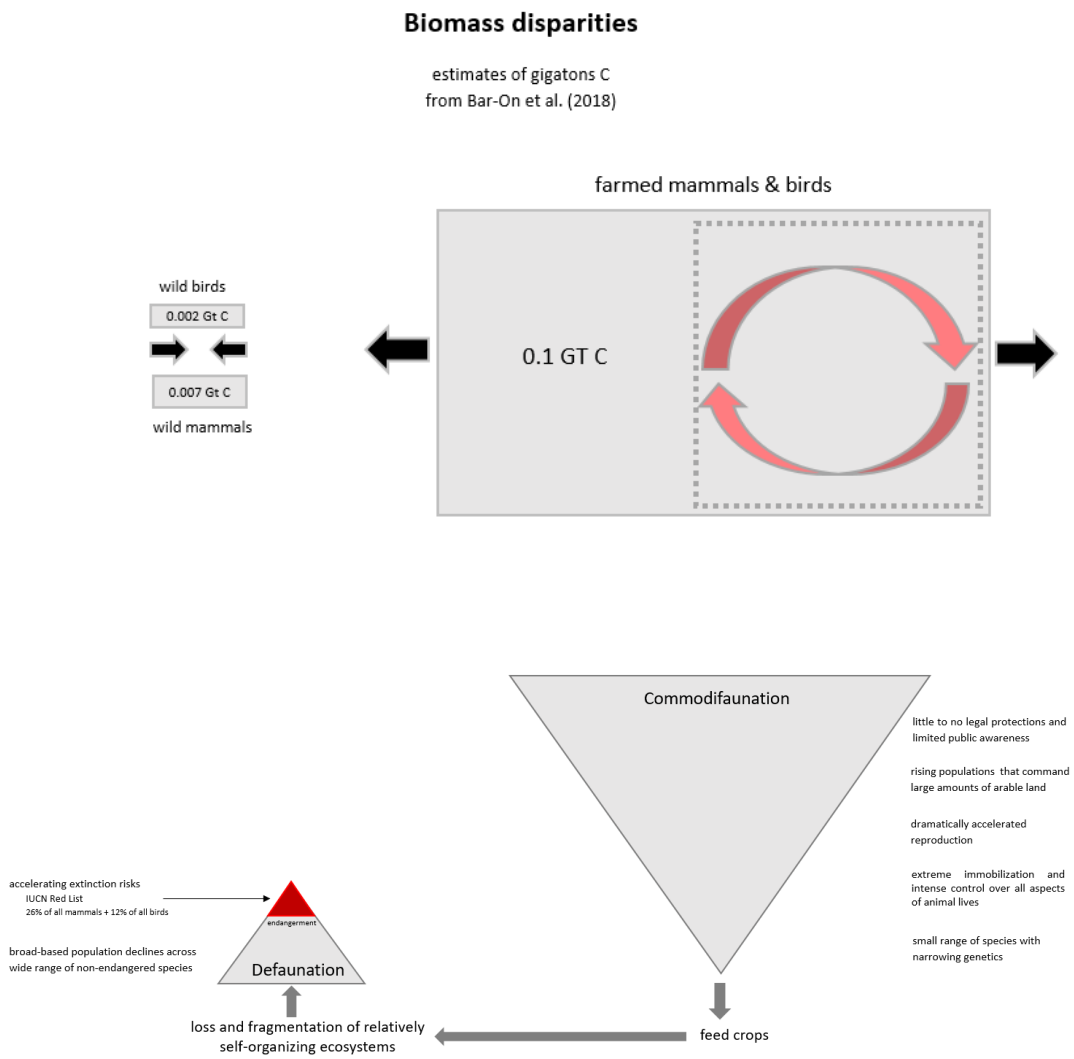
reducing and dividing habitats for other species, these transformations are implicated in climate change, through both past and present carbon dioxide emissions and by reducing the long-term capacity for carbon sequestration in the vegetation and soils of a given landscape. The pursuit of scale further contributes to the narrowing of life through the pollution of terrestrial and aquatic environments, which at its worst can create almost uninhabitable spaces for animal life, as in so-called 'exclusion' or 'sacrifice' zones.[6]

The pursuit of scale in producing animal flesh, milk, and eggs is simultaneously spatially intensive and extensive, with growing animal populations increasingly disarticulated from fields and packed into 'islands' of concrete, steel, and dust, which depend upon vast 'oceans' of monocultures (Weis). The basic combination of the density and immobility of animals and the automation of various tasks (such as feeding, watering, monitoring, extracting eggs, advancing robotics in milking parlours) lies at the heart of how industrial operations can greatly reduce the amount of labour needed per animal relative to small-scale husbandry, and density and immobility also serve to reduce fixed capital costs and variable operational expenses like feed and electricity per unit (Blanchette; Gillespie; Imhoff; Lymbery; Reichert et al.; Weis). Productivity gains have been further augmented by the genetic alteration of animal bodies to grow, lay, and lactate more, together with the physical acceleration of reproduction through artificial insemination – or the routinization of sexual assault (Davis, 'Interspecies Sexual Assault') – which are together entwined with the development of patentable traits, the narrowing corporate control over animal genetics, and the increasing specialization of sub-populations of breeding animals.

As with monoculture landscapes, industrial animal production must respond to a number of intractable biophysical problems, most centrally the amplified risks of infectious disease associated with dense populations of unfit animals living amidst great accumulations of biowastes and the associated noxious gases and particulate matter. Antibiotics and vaccines are the principal way that heightened risks of infectious disease are managed (Davis, *The Monster Enters*; Wallace), while biowaste problems are met with a combination of inputs (for example, water, disinfectants, pesticides) and engineering (for example, sewers, cesspools, ventilation, heating). Beyond the biophysical problems lies another inexorable barrier to scale: injurious

behaviours, including frequent acts of self-harm and attacks on neighbours, which are induced by the stifling confinement, monotony, stench, and noise of these spaces.[7] The central way this damage gets mitigated is through unanaesthetised bodily mutilations, which includes removing body parts that can inflict harm (beaks, needle teeth, horns), are prone to damage (tails), and affect aggressive tendencies in males (testicles), and the proliferation of pharmaceuticals has the complimentary benefit of inducing some degree of lethargy in animals. The growing consolidation of slaughter and packing translates to a range of design and operational challenges as well. The same drive for mechanization holds in these spaces holds, there are much greater barriers to substituting technology for labour at the point of killing than in large-scale enclosures for growing, laying, and milking, which entails a range of miserable jobs. Animals tend to squirm, kick, or otherwise resist domination when they are fearful or in pain, and human dexterity, adaptability, and reflexivity is needed to respond to this unpredictability,[8] especially since there is a need to prevent damage to the end product. Human labour is needed for a wide range of grim tasks such as: offloading animals from transport trucks, shackling them to slaughter lines, firing stun-guns, and slicing throats. There are also limits to how much packing lines can be mechanized, with workers needed for tasks like de-skinning, de-boning, eviscerating, and sectioning carcasses (Blanchette; Eisnitz; Pachirat).

In sum, the lives and deaths of ever more mammals and birds are being determined by the pursuit of economies of scale, and the competitive discipline that drives it, a process that can be thought of as *commodifaunation* to help place it in relation to defaunation (see Figure 4). The essence of commodifaunation is that the nature of industrial design and the arc of innovation – from the design of enclosures and slaughterhouses, to genetic research, to routine techniques like insemination and physical mutilations – hinges on a conception of individual animals as little more than fungible objects, which gets solidified by the indifference that prevails in patterns of mass consumption.



Notes: not to scale but intended to suggest the great differences. The black arrows suggest the long-term direction of change. The rounded red arrows denote how a growing share of farmed animals and birds is 'turned over' quickly.

Figure 4. Defaunation and Commodifaunation

Conclusions

Rachel Carson famously recognized the power of animals to move people to think about broad-based environmental harms, using the demise of songbirds to warn about the threats associated with the onslaught of pesticides. Carson's stirring warning of a future spring fallen silent in the absence of songbirds is often celebrated for having an important part in helping inspire broad popular consciousness about the scope of biophysical problems associated with industrial development in the 1960s and 1970s, along with a movement capable of pushing for new institutions and regulations. Yet while concrete achievements propelled by environmentalists played a crucial part in the rebound of some large raptor species like bald eagles from the edge of extinction, bird populations continue to experience catastrophic declines on a global scale (Lees et al.; Rosenberg et al.; Stutchbury), with implications for ecosystems that are hard to fathom. As Bridget Stutchbury puts it, 'birds are not just bio-indicators of environmental change; they are nature's blue-collar workers, helping to sustain the environment that we share with them' through activities like pollination and control of insect populations (219). A major survey published in 2019 estimated that there were roughly 3 billion fewer wild birds in North America than there were in 1970 (Rosenberg et al.), a jarring number that received considerable play in the media. It is notable, but not surprising, that neither the study nor the associated media coverage set this against the explosive growth in other bird populations that was occurring over the same period: between 1970 and 2020, the annual population of slaughtered birds in North America more than *quadrupled*, increasing from 3.8 to 12.3 billion (FAOSTATS).

Among the many attempts to dislodge the problematic terminology of the Anthropocene, celebrated environmental scientist and philosopher E.O. Wilson offered the Eremocene as a way to mark the decimation of biodiversity in human terms: a looming *Age of Loneliness*. The Eremocene has had a good deal of traction and loneliness clearly resonates with recurring imagery in environmentalism, from Rachel Carson's stirring warning about the loss of songbirds to Kent Redford's haunting characterization of increasingly 'empty forests' in the neotropics. This sort of imagery can help to convey the narrowing of animal life and some of its moral, spiritual, or aesthetic weight, in ways that might inspire people to act. Unfortunately,

some of the messaging about how to act with respect to agriculture and food is partial and misleading, and could serve to further solidify the poultrification of global livestock supply and demand. To counter this, animal advocates must make vivid connections between macro-scale environmental impacts and micro-scale living environments for animals. Metaphors of loneliness, silence, and emptiness might help to convey part of the impoverishment of animal life, but it must not be understood apart from another momentous trajectory among a small array of species, one that is seething, cacophonous, and full of anguish.

Notes

[1] The initial target set out in both the 1987 World Commission on Environment and Development and the 1992 Convention on Biological Diversity (CBD) called on nations to set aside 12% of land in protected areas, which was long criticized as too small by conservation biologists. In 2010, the CBD target was increased to 17%, and this was reached through new designations over the following decade (Greenfield). The 'High Ambition Coalition for Nature and People' (which included 50 signatory countries) lobbied for the ambitious '30x30' target in the buildup to the 2022 Conference of the Parties of the CBD, and was successful in having it adopted in the framework text – though merely as an aspirational goal without any disciplinary mechanisms.

[2] The website of the Yellowstone-to-Yukon Conservation Initiative notes that 'Pluie's story intertwines with Y2K beginnings, and to this day, inspires the work we do for all wide-ranging wildlife' (see: https://y2y.net/blog/mammals-on-the-move-show-why-protected-and-connected-habitats-matter/). The Connectivity Conservation Specialist Group of the IUCN and World Commission on Protected Areas provides a good summary of large-scale corridor

planning around the world, and notably has a large bear as the icon for its 'Conservation Corridor' logo (see: https://conservationcorridor.org/ccsg/).

[3] For now, this just entails drones wielding cameras, but given the increasingly militarized character of some conservation, it is not beyond the imagination to expect this might some day involve mounting drones with weapons. The growing presence of drones and surveillance threatens to further complicate relations with surrounding communities that are already often filled with tensions (Sandbrook; Duffy).

[4] The Thin Green Line claims to work with park ranger groups and associations in more than 60 countries (see: https://thingreenline.org.au/)

[5] Regular plant closures and shifts in manufacturing zones also reflect the incessant pressure to reduce the relative cost of labour, and how the search for cheaper pools of human labour accompany the process of technological displacement.

[6] The burden of toxicity also tends to have a deeply uneven social character, disproportionately born by poorer and racialized populations, that amounts to a 'slow violence' both in the siting exclusion zones and other extreme hazards, and in the chronic exposure to polluted land and water (Nixon).

[7] While the industry tends to euphemistically refer to these behaviours as responses to 'stress' they are more reasonably understood as an outcome of suffering (Weis).

[8] Despite the standardization of genetics, breeding, feed regimes, and growth cycles, geared to deliver very similar animals to the slaughter and packing lines, a degree of bodily irregularity nevertheless persists (Pachirat).

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