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Author(s): Philip Cafaro and Frank Götmark

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PEER REVIEWED ARTICLE

The potential environmental impacts of EU immigration policy: future population numbers, greenhouse gas emissions and biodiversity preservation

Philip Cafaro and Frank Götmark

Philip Cafaro is Professor of Philosophy at Colorado State University. His work centers on population and consumption issues and on the preservation of wild nature. Cafaro is co-editor of *Life on the Brink: Environmentalists Confront Overpopulation* and author of *How Many Is Too Many? The Progressive Argument for Reducing Immigration into the United States*.

philip.cafaro@colostate.edu

Frank Götmark is Professor of Animal Ecology and Conservation Biology at the University of Gothenburg. His research interests include population and human ecology, and the ecology of oak forests. He is the author of numerous articles on the ecological functioning, scientific management and conservation of temperate forest ecosystems. Along with Cafaro he is co-Principal Investigator of The Overpopulation Project.

frank.gotmark@bioenv.gu.se

Abstract

This article clarifies the potential environmental impacts of more or less expansive EU immigration policies. First, we project the demographic impacts of different immigration policy scenarios on future population numbers, finding that relatively small annual differences in immigration

levels lead to large differences in future population numbers, both nationally and region-wide. Second, we analyze the potential impacts of future population numbers on two key environmental goals: reducing the EU's greenhouse gas emissions and preserving its biodiversity. We find that in both cases, smaller populations make success in these endeavors more likely – though only in conjunction with comprehensive policy changes which lock in the environmental benefits of smaller populations. Reducing immigration in order to stabilize or reduce populations thus can help EU nations create ecologically sustainable societies, while increasing immigration will tend to move them further away from this goal.

Keywords: Immigration; Population; European Union; Carbon emissions; Biodiversity protection.

1. Introduction: an implicit assumption

According to recent demographic projections (Lutz et al., 2019; United Nations, 2019), immigration levels will make a substantial difference in the size of future EU populations. Since population size is one of the fundamental parameters determining the human impact on the environment (Millennium Ecosystem Assessment, 2005; IPCC, 2014), this would appear to raise the question of how EU immigration policy choices could impact future environmental protection efforts. Yet surprisingly, this question rarely gets asked by environmentalists, or influences EU policy-makers. The following evidence illustrates the typical failure to consider this issue.

In the run up to elections to the European Parliament in May, 2019, the coalition of European Green parties put forth a statement of principles and political goals, "Priorities for 2019" (European Greens, 2019a). It was organized around twelve key goals, starting with fighting climate change – "the defining challenge of our times" – by phasing out all coal use by 2030, promoting energy efficiency, and moving quickly to 100% renewable energy sources. It continues with commitments to boost trains at the expense of (more polluting) air travel, reducing air and water pollution within the EU, and eliminating non-recyclable plastics. "To preserve our valuable nature," Greens advocate that nations "expand protected natural areas

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significantly so that they cover key ecosystems.” They also seek to reorient EU agricultural policy, by “producing good local, GMO and pesticide-free food” and “farming without cruelty to animals.”

Curbing population growth, however, was not one of these twelve key environmental goals, or even a subsidiary goal. Neither in “Priorities for 2019,” nor in the related “Manifesto 2019,” nor in a more elaborate list of policy positions on its website, did the EU Green coalition affirm the need to limit, end, or reverse population growth – either as a stand-alone policy goal, or as necessary to any of the environmental goals it did endorse (European Greens, 2019a, 2019b). In discussing the means to decrease carbon emissions, increase protected areas, or achieve any other environmental goals, limiting population was not mentioned.

Immigration policy was discussed in these documents, not for any potential role in impacting future population numbers, but as part of affirming immigrants’ rights and combatting xenophobia and racism. A core Green goal in “Priorities for 2019” was to “defend the right to asylum and establish legal and safe channels for migration,” expressed in language implying that attempts to limit immigration are immoral (European Greens, 2019a). A related statement on “Human Rights and Migration” advocated “a more ambitious resettlement and relocation scheme,” with the clear goal of increasing immigrant numbers and no indication that this potential increase demands demographic or environmental analysis (European Greens, 2019c).

Based on a review of recent policy manifestos from several national Green parties, these coalition statements appear to accurately represent the national parties’ own positions on population matters (see, for example, statements from the UK’s Green Party (2003, 2017) on population and migration). Based on these documents, the EU’s Green parties appear to make the following implicit assumption: *Population size and immigration rates have no important roles to play in the efforts of EU nations to meet their environmental challenges and create ecologically sustainable societies.*

To be clear, neither EU Green parties nor the coalition affirm such a position explicitly. However, they act as if this assumption is true by proposing immigration policies that could greatly increase future EU population sizes, while

simultaneously endorsing a number of very ambitious environmental goals. We could find no evidence that any of these parties praise Europe's sustained low fertility trends, which suggests that they see no environmental value in the smaller populations to which they could lead. Some, such as Austria's Green party, argue for more immigration for conventional economic reasons (Die Grünen, 2017), which implies that they see little environmental disvalue in higher populations or increased economic activity. All this indicates that European Greens assume that the implicit assumption is correct.

In a similar manner, the chief European Commission documents setting out current EU policy goals for greenhouse gas emission reductions (European Commission, 2018), biodiversity preservation (European Commission, 2011a, 2015), and general environmental sustainability (European Commission, 2011b; European Parliament, 2013) are all equally silent regarding any connection between future population numbers and achieving ambitious environmental goals. Like the EU's Green parties, the EU itself has not formulated a population policy. It does have an immigration policy, or rather a complex suite of policies, which are contentious and in flux (European Commission, 2011c, 2019). But these policies make little reference to immigration's potential impact on population numbers, beyond recurring statements that immigration will help support workers' pensions in the future (European Commission, 2011c, 2014). This suggests that belief in "the implicit assumption" extends more widely to agencies and policy-makers across the political spectrum.

In response, this paper makes the implicit assumption explicit and attempts to test it against reality. Section two explores the potential demographic impacts of immigration on future EU population numbers. Sections three and four consider the potential impacts of human numbers on EU greenhouse gas emissions and on possibilities for biodiversity conservation in Europe. Section five concludes that the implicit assumption is false and that immigration policy should be made in recognition of its environmental effects.

2. Impacts of immigration on future population numbers

Europe is the first continent to end the population explosion that has characterized humanity's recent demographic trajectory. This is largely a function of sustained below-replacement fertility levels over the past two generations, with strong indications that they are likely to continue (Balbo et al., 2013). Recent projections out to 2100 predict relatively slow population growth across much of western

and northern Europe and more or less sharply decreasing populations among eastern and southern European nations (Lutz et al., 2019; United Nations, 2019). However, such baseline projections mask wide uncertainty and future numbers will vary depending on actual fertility, mortality, immigration, and emigration rates. Demographers tend to agree that immigration trends have the greatest potential to influence future EU population numbers (Azose et al., 2016). This is because increases in longevity will remain popular and uncontroversial goals for future political leaders; because immigration numbers can be raised or lowered much more quickly than fertility rates through direct policy choices; and because there is growing pressure for increased immigration coming from rapidly growing countries in Africa and the Middle East (United Nations, 2019).

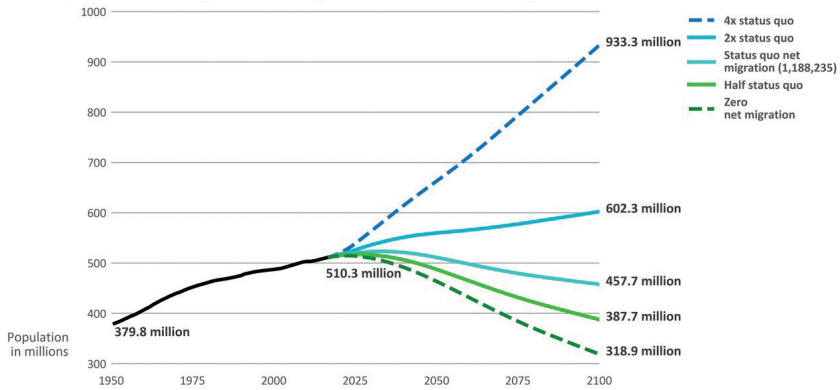
In an effort to understand the potential impact of immigration, family support and economic safety net policies on future population numbers, the authors and colleagues recently developed new policy-based EU population projections out to 2100 (Cafaro and Dérer, 2019). The sheer range of immigration policies advocated by European political parties is impressive and we sought to capture this range in our projections. For western European nations and the EU as a whole, five different immigration scenarios were considered, built around multiples of the average annual net immigration for the past twenty years, which we labelled “status quo.” These scenarios were zero net migration, ½ status quo annual net migration, status quo net migration, 2X status quo net migration, and 4X status quo net migration. This last scenario represents a rough proxy for an “open borders” policy, which is difficult to model. These broad migration scenarios capture the range of policy choices advocated across the EU today, from drastically curtailing immigration to greatly expanding it, with the three middle alternatives (½ to 2X the status quo) covering the most likely range of alternatives (see Cafaro and Dérer, 2019, for methodological details). For a full range of population projections for all EU nations and the EU as a whole, please see the website of The Overpopulation Project.

Consider first our projections for the European Union as a whole. The current 28 countries in the EU had a combined population in 1950 of 379.8 million and their combined population in 2016 was 510.3 million.¹ The region’s current total fertility

¹ Note that past, present and future numbers for “the EU” include all the EU’s current members, including the UK.

rate (TFR) is 1.60 and its average annual net migration level over the past 20 years (1998-2017) was about 1.2 million. Figure 1 graphs population projections for the EU under our five migration policy scenarios.

Figure 1: European Union Projections Under Five Migration Scenarios



Status quo migration is the continuation of the past 20 years average annual net migration level (1,188,235). Migration scenarios use total fertility rates varying between 1.65 and 1.90, with higher immigration levels projected to drive higher TFRs.

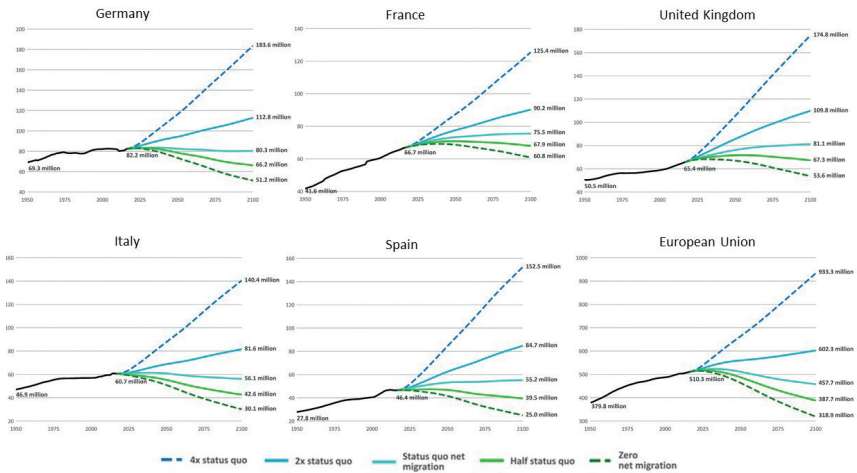
Source: Cafaro and Dérer, 2019.

How might immigration influence future EU population numbers? Continuing the status quo of about 1.2 million annual net positive migration (along with status quo family support policies and economic safety net policies, which influence fertility rates) would lead to a 10% population decrease, or 52.6 million fewer people in 2100. Cutting net average migration in half would reduce the EU population by an additional 70 million people, or an extra 14% compared to the population loss under the status quo scenario, for a total drop of 122.6 million people by 2100 (24%) compared to the current (2016) population. Doubling net migration, conversely, would switch the EU’s population from declining by 52.6 million (-10%) under the status quo to growing by 92.0 million (+18%). That’s a difference of 214.6 million people across the most likely range of immigration policy changes (cutting in half or doubling current migration rates). The spread across all five policy choices is much greater: over 600 million people, from

swelling to 933.3 million in 2100 (an 83% increase) in the case of quadrupling status quo net migration numbers, to contracting to only 318.9 million in 2100 (a 38% decline) by reducing net migration to zero.

Clearly, immigration policy changes have the potential to increase or decrease the EU population by hundreds of millions of people by 2100 (Lutz et al., 2019; Cafaro and Dérer, 2019). A key take-away is that relatively small *annual* changes have the potential to cumulate into large *overall* changes in the not-too-distant future. And what is true for the EU as a whole, holds true for its individual nations. Figure 2 graphs population changes for the five most populous EU nations under our five immigration scenarios. It shows that by 2100, just three generations from now, different immigration policies could generate widely different national population numbers.

Figure 2



Population projections for the five most populous EU countries and the EU as a whole under five migration scenarios: zero net migration, ½ status quo migration, status quo migration, 2X status quo migration, and 4X status quo migration. Total fertility rates vary, with higher immigration levels projected to drive higher TFRs.

Source: Cafaro and Dérer, 2019.

For example, annual net migration levels into Germany have averaged a little less than 260,000 over the past twenty years. Continuing at this level for the rest of the century would lead to a stable German population, according to our calculations, while increasing or decreasing annual immigration levels would lead to populations that were tens of millions higher or lower. Such variations are possible. Net immigration into Germany has varied widely in recent years, from – 56,000 in 2008 to 1.2 million in 2015 (Eurostat, 2019), and there is widespread support both for greatly increasing immigration (Social Democrats and especially *Die Grünen*) and greatly decreasing it (Christian Democratic Union and especially *Alternative für Deutschland*). The three most likely immigration policy scenarios generate a population range in 2100 of 46.6 million people, while considering the full range of migration scenarios increases the 2100 population variability to 132.4 million: between 62% and 123% of the current population.

France, with higher native fertility rates and lower net migration levels, exhibits a less dramatic demographic range than Germany, while Spain, Italy and the UK exhibit greater potential demographic volatility. But in every case, immigration's potential impacts on future populations are substantial (see table 1).

Table 1

	Annual status quo net migration	Zero net migration	½ status quo	Status quo migration	2X status quo	4X status quo
European Union	1,188,235	-38%	-14%	-10%	+10%	+83%
Germany	259,316	-38%	-19%	-2%	+37%	+123%
France	100,525	-9%	+2%	+13%	+35%	+88%
United Kingdom	230,107	-18%	+3%	+24%	+68%	+167%
Italy	229,093	-50%	-30%	-8%	+34%	+131%
Spain	270,112	-46%	-15%	+19%	+82%	+228%

Status quo annual net migration numbers (average from 1998-2017) and percentage change from current population by 2100 under different migration scenarios.

Source: Eurostat, 2019; Cafaro and Dérer, 2019.

The key point is that population decrease is not a given for the EU during the coming century, despite much attention in the media and among economists to “aging and shrinking populations.” EU fertility rates may remain low compared to other regions of the world. But immigration policies clearly have the power to cancel the population decreases to which low fertility rates otherwise would lead: indirectly, by increasing European fertility rates (Sobotka, 2008; Kulu et al., 2017; Pailhé, 2017), and more directly, by adding tens of millions more people and their descendants (Pew Research Center, 2017). However, in most cases, EU nations appear well placed to stabilize or slowly reduce their populations, should they choose to do so. But should they? That depends, at least in part, on whether the implicit assumption is correct, that population sizes are irrelevant to achieving environmental goals. We turn now to this question.

3. Impacts of human numbers on EU greenhouse gas emissions

To their credit, the EU and its member states have set some of the most ambitious climate goals in the world. The EU enacted legislation to reduce greenhouse gas emissions 20% by 2020 compared to 1990 levels, a goal it achieved several years early. It set a 40% reduction target for 2030 as the union’s “nationally determined contribution” under the Paris Agreement (European Council, 2014), subsequently developing a “low-carbon economy roadmap” aiming for 80% to 95% reductions by 2050. The European Commission recently strengthened these goals, committing to 55% reductions by 2030 and “zero net emissions” by 2050 (European Commission, 2018).

In the past, population growth has been identified along with increased economic activity as one of two main drivers of increased global CO₂ emissions (IPCC, 2007, 2014) and reducing population growth has been identified as an important potential mitigation response (O’Neill et al., 2012; Casey and Galor, 2017; Bongaarts and O’Neill, 2018). A recent study found that regional population growth has contributed considerably to recent CO₂ emissions in Western Europe (Weber and Sciubba, 2018). In contrast, looking forward, the implicit assumption implies that population size has no important role to play in the efforts of EU nations or the EU as a whole to meet their carbon emissions reduction goals. Is this assumption plausible?

We do not know how successful the nations of the EU will be in decreasing their per capita carbon emissions by 2050. We analyze the potential impact of population on this effort by considering three possible per capita emission paths to determine how different population sizes could impact reduction targets. The first, pessimistic scenario is a continuation of current (2016) emissions levels of 8.7 tonnes CO₂e (CO₂ equivalent). The second is the “reference scenario” where existing national commitments reduce annual GHG emissions 48% by 2050 relative to 1990 levels, with per capita emissions declining to an average of 5.7 tonnes CO₂e (Capros et al., 2016). In the most optimistic scenario, we imagine increased national commitments reducing the average EU citizen’s per capita emissions to 2.2 tonnes CO₂e; 18% of 1990 levels, equivalent to the GHG emissions of the average UK citizen in 1800.

As the annual GHG emissions of a nation or region equal its total population multiplied by their per capita emissions, a simple equation can show how our five immigration scenarios could intersect with these three per capita emissions scenarios to determine future emissions. Table 2 shows the different annual emissions outcomes in 2050. In every case, increased immigration leads to larger populations, which in turn lead to smaller decreases in total greenhouse gas emissions, in individual countries and in the EU as a whole. For example, under the reference scenario, Germany achieves a decrease to 56% of current emissions levels at zero net migration, but only a decrease to 88% of current levels when net immigration increases to 4X recent levels. The greater the decrease in per capita emissions, the smaller the increase in 2050 emissions caused by increased immigration. However, for all per capita emissions rates, total emissions in 2050 are significantly higher at higher immigration levels. Thus, at least for this medium-range time frame, the implicit assumption appears provisionally falsified.

Table 2

	Zero net migration	½ status quo	Status quo	2X status quo	4Xstatus quo
Per capita emissions remain at current levels (2016)					
European Union	90.8%	95.5%	100.1%	109.7%	129.9%
Germany	89.5%	95.7%	100.5%	114.8%	141.7%
France	102.5%	105.8%	109.4%	115.8%	130.4%
United Kingdom	102.4%	109.4%	116.3%	130.8%	161.0%
Italy	83.5%	90.8%	99.8%	112.9%	144.0%
Per capita emissions decrease as in the reference scenario					
Germany	55.6%	59.5%	62.4%	71.3%	88.0%
France	73.6%	76.0%	78.6%	83.2%	93.7%
United Kingdom	59.6%	63.7%	67.7%	76.2%	93.8%
Italy	56.8%	61.8%	67.9%	76.8%	98.0%
Spain	66.2%	74.4%	84.6%	99.4%	134.4%
Per capita emissions decrease to 2.2 tonnes CO₂e					
European Union	23.0%	24.1%	25.3%	27.7%	32.8%
Germany	17.3%	18.5%	19.4%	22.2%	27.4%
France	31.7%	32.8%	33.9%	35.9%	40.4%
United Kingdom	28.5%	30.5%	32.4%	36.4%	44.8%
Italy	25.5%	27.7%	30.5%	34.5%	44.0%
Spain	26.9%	30.2%	34.3%	40.3%	54.5%

Percentage of annual greenhouse gas emissions in 2050 expressed as a percentage of GHG emissions in 2016, for five EU countries and the EU as a whole. The boldfaced scenarios achieve the minimum decreases needed to stay on track for the “low carbon economy” target (80% reductions from 1990 levels).

Source: own calculations.

Notably, the scenarios that achieve the emissions decreases needed to stay on track for the “low carbon economy roadmap” (boldfaced areas in table 2) combine low average per capita emissions with relatively low immigration levels. This suggests that human numbers, average consumption levels, and the technologies used to accommodate them, all make a substantial difference to total emissions. By itself, curbing population is not enough to achieve ambitious EU emissions reduction goals, but clearly it would help. Table 3 illustrates the same point, calculating what percentage of per capita emissions reductions would be necessary for the EU’s most populous countries to achieve the minimum target for the low carbon economy roadmap under different immigration scenarios. As immigration and thus total population increases, so does the need to decrease average per capita emissions, leading to the common phenomenon of having to “run faster just to stand still” and safeguard environmental achievements (Palmer, 2012).

Table 3

	Zero net migration	½ status quo	Status quo	2X status quo	4Xstatus quo
European Union	71.6%	73.0%	74.3%	76.5%	80.2%
Germany	69.8%	71.8%	73.1%	76.5%	80.9%
France	77.2%	77.9%	78.7%	79.8%	82.1%
United Kingdom	66.3%	68.5%	70.4%	73.6%	78.6%
Italy	69.8%	72.2%	74.7%	77.7%	82.5%
Spain	80.7%	82.9%	84.9%	87.2%	90.5%

Per capita emissions reductions required to meet the 2050 minimum goal for the low carbon economy roadmap, expressed as a percentage reduction compared to per capita emissions in 2016.

Source: own calculations.

Readers may wonder why we do not analyze a 100% emissions reduction alternative, which, after all, is now an official EU policy goal for 2050 (although not an official policy goal for most EU nations). We do not do so because the goal of “zero net emissions” is not really the same as reducing average per capita or personal emissions to zero, which is impossible, at least by 2050. Zero net emissions, if it is achieved, will instead combine low per capita emissions (generated by continued

food consumption, transport, etc.) with so-called “negative emissions,” in which as yet untested and unscaled technologies would remove carbon from the air, water, or soil (European Commission, 2018).² Achieving these negative emissions at the necessary scale is likely to be very expensive, if it is possible at all, and some of the technologies being considered may be more dangerous than climate disruption itself (Lenzi et al., 2018). For these reasons, climate experts agree that it would be best to decrease actual “positive emissions” quickly and to the greatest extent possible (Van Vuuren et al., 2018). EU citizens deserve a realistic picture about the contributions reducing their consumption or population numbers could make in helping them do their part to limit global climate change.

To get a fuller picture, let us look further out in time and consider not just potential GHG emissions at some discrete point in the future, but the *cumulative* impacts of immigration policies on *total* emissions during the rest of the century. After all, many GHG emissions will remain in the atmosphere for a long time, warming the Earth for the entire time and contributing to ocean acidification when they eventually cycle back down (IPCC, 2013). The challenge is to transform our societies as quickly as possible so as to minimize their GHG emissions over the course of this century.

Consider how our five immigration scenarios would influence the total reductions achieved under three plausible emissions reduction scenarios: 50%, 70% and 90% per capita GHG reductions, each phased in linearly between now and 2100. Taking 80 years to reduce per capita emissions 50% would represent a waning EU commitment to deal with climate change, with slow renewable electrification and lifestyle changes, etc.; it is a pessimistic yet possible scenario. 70% per capita reductions represent a stable to modest increase in current national commitments, especially taking into account that per capita emissions have not improved since 2014 for the EU-28 population. 90% per capita reductions can stand in for an optimistic “total decarbonization” scenario, since as we have seen, “zero net emissions” is shorthand for low per capita emissions combined with high-tech efforts to suck carbon out of the environment and safely sequester it.

2 While allowing former farmlands to regrow forests can provide significant carbon removal from the atmosphere, scaling up such negative emissions will demand more energy- and technology-intensive methods as well.

Table 4

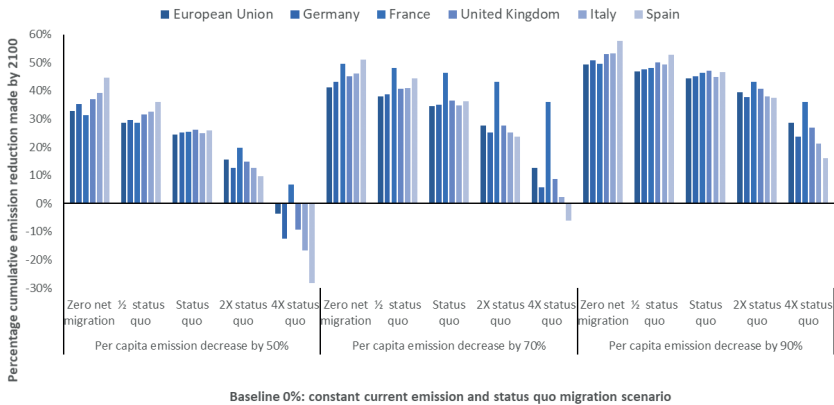
	Zero net migration	½ status quo	Status quo	2X status quo	4Xstatus quo
Per capita emissions decrease 50% by 2100					
European Union	243.2	258.7	274.2	306.1	376.0
Germany	50.7	55.1	58.7	68.5	88.1
France	29.9	31.1	32.5	34.9	40.6
United Kingdom	31.9	34.6	37.4	43.0	55.3
Italy	21.8	24.1	26.9	31.4	41.8
Spain	17.8	20.6	23.9	29.1	41.4
Per capita emissions decrease 70% by 2100					
European Union	213.0	225.2	237.3	262.3	316.8
Germany	44.6	48.1	50.8	58.6	73.9
France	21.9	22.6	23.4	24.7	27.9
United Kingdom	27.8	29.9	32.1	36.5	46.1
Italy	19.3	21.1	23.4	26.8	35.0
Spain	15.7	17.9	20.5	24.6	34.2
Per capita emissions decrease 90% by 2100					
European Union	183.9	192.7	201.5	219.7	259.0
Germany	38.5	41.0	43.0	48.7	59.7
France	21.9	22.6	23.4	24.7	27.9
United Kingdom	23.7	25.3	26.8	30.0	36.9
Italy	16.8	18.1	19.8	22.3	28.2
Spain	13.7	15.3	17.2	20.1	27.1

Cumulative GHG emissions in gigatons, 2016–2100, for the five most populous EU countries and the EU as a whole, under three per capita emissions reduction scenarios and five net migration scenarios. Immigration changes are phased in over 10 years, per capita emissions reductions are phased in linearly over the course of the century.

Source: own calculations.

Table 4 shows that for every country, higher immigration leads to higher population numbers, which in turn lead to substantially greater cumulative GHG emissions. Under the 70% per capita emissions reduction scenario, for example, cumulative emissions would be 18% less for Germany if they halved net migration compared to doubling it, and 14% less for the EU as a whole. The impact of immigration numbers on cumulative emissions decreases with faster per capita emissions reductions. But even under the optimistic 90% per capita emissions reduction scenario, the impact of changing immigration levels remains substantial. Figure 3 compares cumulative GHG emissions under various scenario combinations to the cumulative emissions that would be generated if per capita emissions and net migration levels remained at current (2016) levels.

Figure 3



Percentage emission reductions by 2100, compared with emissions that would be generated if per capita emissions and net migration levels remained at current levels. Calculated for the five most populous EU countries and the EU as a whole, under three per capita emissions reduction scenarios and five net migration scenarios. Negative percentages indicate cumulative emissions would be worse than a continuation of current per capita emission and net migration levels.

Source: own calculations

One important result is that changes in immigration levels appear to have about as powerful an impact on cumulative GHG emissions as changes in per capita emissions. For example, decreasing Germany's per capita emissions 90% rather than 50% while keeping immigration at current levels leads to 15.7 gigatons fewer emissions by 2100, while the difference between reducing German net migration to ½ current levels and increasing it to 2X current levels spans 13.5 gigatons at 50% per capita reductions. For the EU as a whole, cumulative emissions under a 4X status quo migration/90% per capita emissions reduction scenario would be more than cumulative emissions under a zero net migration/50% per capita emissions reduction scenario: 259 vs. 243 gigatonnes CO₂e.

These results show that the implicit assumption is mistaken, at least regarding climate change. Population size will play an important role in the efforts of individual EU nations and the EU as a whole to meet their GHG emissions reduction goals, and immigration policy could play an important role in facilitating or undermining such efforts.³

4 Impacts of human numbers on EU biodiversity conservation

Biodiversity loss is as serious a global environmental problem as climate disruption and the EU and its member states have set ambitious goals for preserving and, where possible, restoring Europe's biodiversity. Legal mandates include the Directive on the Conservation of Wild Birds (European Commission, 2009) and the more encompassing Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (European Commission, 1992): the former decreed "the conservation of all species of naturally occurring birds in the wild state" within Europe, by "preserving, maintaining and re-establishing" sufficient habitat for them; the latter set in motion the creation of a pan-European network of conservation areas, Natura 2000, to preserve sufficient habitat for all native plant and animal species (Campagnaro et al., 2019). A review in 2010 showed that despite some progress, "up to 25% of European animal species were facing extinction, and 65% of habitats of EU importance were in an unfavourable

3 One might object that any increase in EU countries' GHG emissions from immigration would be offset by emissions reductions in the EU's sender countries. But this is unlikely; since immigration into the EU tends to move people from countries with lower per capita emissions to ones with higher per capita emissions, overall emissions are likely to increase, as has been the case with immigration into the US (Kolankiewicz and Camarota, 2008).

conservation status, mainly due to human activities” (European Commission, 2015). In response, the EU strengthened its biodiversity protection strategy, aiming to “halt the loss of biodiversity and ecosystem services by 2020” and “to restore ecosystems in so far as is feasible” (European Commission, 2011a).

As with climate change, population growth has been identified as a key factor driving biodiversity losses around the world (Millennium Ecosystem Assessment, 2005; Driscoll et al., 2018). McKee et al. (2003) found that two factors, population density and species richness, accounted for 88% of the variation in countries’ numbers of threatened and endangered species in 2000. Conservation biologists agree that habitat loss and degradation are by far the leading causes of biodiversity loss (Maxwell et al., 2016) and a recent study found that population increases contributed significantly to urbanization and habitat loss in western Europe between 1990 and 2006 (Weber and Sciubba, 2018). Increased human numbers have also been shown to multiply other important factors driving biodiversity loss, including habitat fragmentation (Krishnadas et al., 2018) and agricultural expansion (Crist et al., 2017). In the UK, increased human population density has been linked to the extirpation of rare local plant species (Thompson and Jones, 1999).

Unfortunately, quantifying biodiversity loss and species extinction in relation to human population density cannot be done as easily as for GHG emissions and population size, in part because conservation biologists have failed to give the relationship between human and wildlife numbers the attention it deserves (Rust and Kehoe, 2017; Driscoll et al., 2018). Thus, we cannot calculate figures for likely habitat availability or species extinctions under our five different immigration scenarios, as we could for future greenhouse gas emissions. Still, these scenarios lead to great variation in future population densities in Europe (table 5) and the evidence suggests that future EU population numbers could greatly influence the success of efforts to preserve biodiversity in the EU.

Table 5

	Current inhabitants per km ²	Density				
		Zero net migration	½ status quo	Status quo	2X status quo	4X status quo
European Union	117.7	73.0 (-38%)	101.2 (-14%)	105.9 (-10%)	129.5 (+10%)	215.4 (+83)
Germany	233.1	144.5 (-38%)	188.8 (-19%)	228.4 (-2%)	319.3 (+37%)	519.8 (+123%)
France	105.3	95.8 (-9%)	107.4 (+2%)	119.0 (+13%)	142.2 (+35%)	198.0 (+88%)
United Kingdom	270.6	221.9 (-18%)	278.7 (+3%)	335.5 (+24%)	454.6 (+68%)	722.5 (+167%)
Italy	205.4	102.7 (-50%)	143.8 (-30%)	189.0 (-8%)	275.2 (+34%)	474.5 (+131%)
Spain	92.5	50.0 (-46%)	78.6 (-15%)	110.1 (+19%)	168.4 (+82%)	303.4 (+228%)

Population density (inhabitants per km²) and percentage change in density: current (2016) and in 2100 under five migration scenarios.

Source: Eurostat 2017 and own calculations.

Consider the main targets pursued under the EU's current biodiversity strategy (European Commission, 2011a). Target 1 focuses on protecting habitats needed by nonhuman species, in part by completing the Natura 2000 system of protected areas and improving their management. Target 2 involves creating "green infrastructure" that is less environmentally harmful to other species and restoring 15% of currently degraded ecosystems, improving them as wildlife habitat. Target 3 focuses on making agriculture and forestry less destructive of biodiversity, either by making production less harmful to other species, or by shifting agricultural or forestry lands out of production altogether (e.g., by increasing designated wilderness acreage on public forest lands). Target 4 makes similar efforts to improve fisheries management and increase the number of marine protected areas. We can sum up these efforts by saying that the EU biodiversity strategy seeks to increase the amount of habitat available to other species and improve its quality and effectiveness, both within protected areas and outside them.

All these efforts to preserve effective wildlife habitat will be facilitated by having fewer people and undermined by having more, since they all depend on reducing human impacts on the habitat that we are trying to protect. We summarize some of the scientific evidence for this in table 6 below.

Table 6

Driver of biodiversity decrease (in one case, increase)	Scientific study affirming increased population density as a key driver of factor in question
Habitat availability	
Protected areas “downgraded, downsized, or degazetted” due to development/settlement pressure	Radeloff et al., 2010; Watson et al., 2014; Symes et al., 2016; Qiu et al., 2018; Krishnadas et al., 2018
Natural areas lost to agriculture or industrial forestry	Scharlemann et al., 2005; Estrada et al., 2017; Marques et al., 2019
Natural areas lost to urbanization, sprawl	Scharlemann et al., 2005; Seto et al., 2011; Colsaet et al., 2018; Driscoll et al., 2018; Qiu et al., 2018; Weber and Sciubba, 2018
Increased protected area acreage facilitated by rural depopulation	Navarro and Pereira, 2015a; Corlett, 2016; DeSilvey and Bartolini, 2018
Habitat quality or effectiveness	
Increased habitat fragmentation by human settlements, transportation corridors, other factors	Radeloff et al., 2010; Estrada et al., 2017; Driscoll et al., 2018; Krishnadas et al., 2018; Qiu et al., 2018; Tucker et al., 2018
Increased pollution, both ecotoxicity and eutrophication	Turvey, 2008; Driscoll et al., 2018
Increased hunting pressure	Stanford, 2012; Boitani and Linnell, 2015
Increased spread of invasive species	Driscoll et al., 2018
Increased climate disruption	IPCC, 2007; IPCC, 2014; Marques et al., 2019

Summary of recent scientific evidence that increased human population density drives biodiversity loss. Also included are studies showing that rural population decrease facilitates increased protected area acreage. Note: a similar table would be possible, collecting evidence for how economic sectors that are most harmful to biodiversity are made more damaging by increased human numbers.

While the complexity of the phenomenon prevents us from affirming a strict 1:1 inverse relationship, the overall trend is clear: greater human numbers reduce biodiversity. Knowing that changes in human population density correlate well with changes in habitat availability and quality, both generally (Seto et al., 2011; Symes et al., 2016; Khrishnadas et al., 2018) and specifically in Europe (Thompson and Jones, 1999; Navarro and Pereira, 2015a; Lehsten et al., 2015; Weber and Sciubba, 2018), we sketch broadly the impacts of changing population densities on biodiversity preservation in the EU in table 7.

Table 7

	Habitat trends under five migration scenarios				
	Zero net migration scenario	½ status quo migration scenario	Status quo migration scenario	2X status quo migration scenario	4X status quo migration scenario
European Union	▲▲▲	▲▲	▲	▼	▼▼
Germany	▲▲▲	▲▲	▲	▼	▼▼
France	▲	▼	▼	▼	▼▼
United Kingdom	▲▲	▼	▼	▼▼	▼▼▼
Italy	▲▲▲	▲▲	▲	▼▼	▼▼
Spain	▲▲▲	▲▲	▼	▼	▼▼▼

Expected population-driven changes in habitat availability and quality by 2100 in the EU under five migration scenarios. Small, medium and large habitat improvements correspond with the following changes in human population density: ▲ = 1-10% decreased density, ▲▲ = 11-30% decreased density, ▲▲▲ = 31-50% decreased density. Small, medium and large habitat declines correspond with the following changes in population density: ▼ = 1-50% increased density, ▼▼ = 51-150% increased density, ▼▼▼ = 151-250% increased density.

Source: own calculations.

Just as every extra individual, now and in the future, will generate some GHGs and thus help heat Earth's climate, with more individuals generating greater climate change, so every extra individual, now and in the future, will take some habitat and resources away from other species, with more individuals generating greater biodiversity losses. Habitat losses or degradation caused by population increases could be mitigated by other factors, such as more efficient use of resources and

better management of protected areas. But habitat increases or improvements caused by population decreases could be boosted by those same factors. Under all possible environmental futures, lower human population densities clearly will be better for other species.

As further evidence, consider the impact of recent EU population decreases in furthering ecological restoration, a cornerstone of the EU's biodiversity preservation strategy. Since 1960, Europe's rural population has declined by 20% (United Nations, 2014), contributing to extensive farmland "abandonment." Within the past two decades, up to 7.6 million hectares of agricultural land have gone out of production in Eastern Europe, southern Scandinavia and Europe's mountainous regions, as have 10-20% of the agricultural lands in the Baltic states (Leal Filho et al., 2017). Overall, these trends have been valuable for wildlife, particularly for larger herbivores and carnivores (Deinet et al., 2013; Boitani and Linnell, 2015). One promising European organization working for restoration of large natural areas, Rewilding Europe, acknowledges the positive role of rural population decreases, and most of their projects include ecological restoration of abandoned agricultural lands (Rewilding Europe, 2019). In turn, nature-based tourism can create jobs that benefit younger residents (Navarro and Pereira, 2015b).

Continued population reductions and release of land from agriculture could contribute even more to such successes in the future, helping European nations to meet and hopefully exceed their targets for restoring degraded ecosystems and increasing protected area acreage. The population of predominantly rural regions is projected to fall by another 7.9 million people by 2050 (ESPON, 2017). According to the Institute for European Environmental Policy, an additional 3–4% of total EU land will go out of production by 2030, with 126,000–168,000 km² potentially available for nature restoration (Keenleyside and Tucker, 2010). Other estimates range from 5 to 15% of agricultural areas (arable land and pasture), or 10 to 29 million hectares of land released between 2000 and 2030 (Verburg and Overmars, 2009). Many factors influence land abandonment, such as urbanisation and the profitability of various farming practices. But if population declines accelerate, more agricultural land within the EU could be released from intensive human use over the course of this century, while if population declines are reversed, less land is likely to be available for ecological restoration

or biodiversity-sensitive agriculture or forestry. Since resource demands cross national boundaries, lower populations would also help EU nations reduce their negative impacts on biodiversity elsewhere, another key target of the EU biodiversity strategy (European Commission, 2011a).

Of course, realizing the benefits of population decreases for wildlife depends on putting in place the right policies and management (Cerqueira et al., 2015; Navarro and Pereira, 2015b) – just as in the case of greenhouse gas emissions. Unfortunately, the potential benefits of smaller populations have largely been ignored by European policy makers, who tend to view decreased agricultural activity as a problem, rather than an opportunity (Queiroz et al., 2014). Under the European Common Agriculture Policy (CAP) “less favored areas” (i.e., areas where agricultural use is less profitable) have been designated mainly to maintain agricultural production, regardless of its appropriateness. The largest amounts of funding for biodiversity conservation are available through EU and national agro-environmental schemes aimed at preserving traditional farming systems and reversing abandonment trends (Navarro and Pereira, 2015b). These support biodiversity preservation efforts in many rural areas (Zingg et al. 2019), but simultaneously CAP encourages large-scale intensive agriculture which displaces biodiversity on many other lands (Pe’er et al., 2014). Conservation policies should include keeping extensive acreages of traditional farmlands, while also recognizing that some former agricultural lands can be given back to nature through rewilding (Corlett 2016). Both kinds of efforts are needed and both would be furthered by smaller populations.

Once again, then, the evidence seems clear that “the implicit assumption” is mistaken. Population size will play an important role in EU efforts to preserve biodiversity, and immigration policy could play an important role in facilitating or undermining such efforts.

5 Conclusion

In the absence of convincing evidence to the contrary, what holds true for climate change and biodiversity loss can be presumed to hold true more generally. The implicit assumption under which most EU environmental advocates and policymakers have labored in recent decades appears mistaken. Population size will play an important role in the efforts of EU nations to meet their future

environmental challenges. Reducing immigration can help create ecologically sustainable societies that share the landscape generously with other species, while increasing immigration will tend to move EU nations further away from these goals.⁴

One straightforward policy implication, based on the EU's strong environmental commitments, might be that European nations with high immigration levels, like Germany, Spain and the United Kingdom, should reduce them. Countries with stable or declining populations, like Italy, Poland, Hungary and the Netherlands, could embrace rather than fight these demographic trends (Götmark et al., 2018). Alternately, EU nations could reduce their current environmental commitments, increase immigration and embrace even denser human populations. Sustainability is not the only proper goal of policy-making. Arguably however, it is a fundamental goal, necessary to long-term societal flourishing (Millennium Ecosystem Assessment, 2005; European Commission, 2011b; Foreman and Carroll, 2014).

At a minimum, EU citizens deserve an honest discussion of how immigration policies will impact their environmental goals going forward, since demographic trends are not set in stone but strongly depend on public policies (Lutz et al., 2019; Cafaro and Dérer, 2019). Whatever immigration policies are decided on should respect the claims of justice, including the rights of refugees and would-be immigrants to fair treatment (Miller, 2016), the rights of EU citizens to democratically choose policies that will affect their societies in fundamental ways (Phillips, 2018) and the rights of other species not to be extinguished by human beings (Staples and Cafaro, 2012). But they also must respect the reality of ecological limits to safe human resource use, which humanity is already seriously transgressing (Ripple et al., 2017; O'Neill et al., 2018). Partha Dasgupta (2019) recently wrote, "to me it remains a puzzle that population [ethicists] haven't subjected their reasoning to a world facing socio-ecological constraints of the kind we have now come to know." As we have shown, policy-makers also tend to avoid subjecting their reasoning to such constraints. We believe the time for such avoidance is over.

4 Similar arguments hold for Australia (Smith, 2011) and the United States (Cafaro, 2015).

References

- Azose, J.J. et al., 2016. Probabilistic population projections with migration uncertainty. *Proceedings of the National Academy of Sciences*, 113 (23), pp.6460–65.
- Balbo, N. et al., 2013. Fertility in advanced societies: a review of research. *European Journal of Population*, 29 (1), pp.1–38.
- Boitani, L. and Linnell, J.D.C., 2015. Bringing large mammals back: large carnivores in Europe. In Pereira H. and Navarro L. eds. 2015. *Rewilding European Landscapes*. Cham: Springer International Publishing. pp.67–84.
- Bongaarts, J. and O'Neill, B., 2018. Global warming policy: is population left out in the cold? *Science* 361 (6403) pp.650–52.
- Cafaro, P., 2015. *How many is too many? The progressive argument for reducing immigration into the United States*. Chicago: University of Chicago Press.
- Cafaro, P. and Dérer, P., 2019. Policy-based population projections for the European Union: a complementary approach. *Comparative Population Studies*, 44, pp.171-200.
- Campagnaro, T. et al., 2019. Half earth or whole earth: what can Natura 2000 teach us? *BioScience*, 69, pp.117-124.
- Capros, P. et al., 2016. *EU reference scenario 2016: energy, transport and GHG emissions trends to 2050*. [pdf] European Commission. Available at: <https://ec.europa.eu/energy/sites/ener/files/documents/20160713%20draft_publication_REF2016_v13.pdf> [Accessed 8 November 2019].
- Casey, G. and Galor, O., 2017. Is faster economic growth compatible with reductions in carbon emissions? The role of diminished population growth. *Environ Res Lett*. 12.
- Cerqueira, Y. et al, 2015. Ecosystem services: the opportunities of rewilding in Europe. In: Pereira H. and Navarro L. eds. 2015. *Rewilding European landscapes*. Cham: Springer International Publishing. pp.47–64.
- Colsaet, A. et al., 2018. What drives land take and urban land expansion? A systematic review. *Land Use Policy*, 79, pp.339–349.
- Corlett, R.T., 2016. The role of rewilding in landscape design for conservation. *Current Landscape Ecology Reports*, 1, pp.127–33.

Crist, E. et al., 2017. The interaction of human population, food production, and biodiversity protection. *Science*, 356, pp.260–264.

Dasgupta, P., 2019. *Time and the generations: population ethics for a diminishing planet*. New York: Columbia University Press.

Deinet, S. et al., 2013. *Wildlife comeback in Europe: the recovery of selected mammal and bird species. Final report to Rewilding Europe*. London: ZSL.

DeSilvey, C. and Bartolini, N., 2018. Where horses run free? Autonomy, temporality and rewilding in the Côa valley, Portugal. *Transactions of the Institute of British Geographers*, Volume 44, Issue 1, pp.94-109.

DieGrünen, 2017. Inklusions-Bericht. 2017. [pdf] Available at: <<https://www.gruene.at/partei/programm/gruene-teilprogramme/der-gruene-inklusionsbericht.pdf>> [Accessed 8 November 2019].

Driscoll, D. et al., 2018. A biodiversity-crisis hierarchy to evaluate and refine conservation indicators. *Nature: Ecology & Evolution*, 2: 775–781.

Estrada, A., 2017. Impending extinction crisis of the world's primates: why primates matter. *Science Advances*. [e-journal] Vol. 3, no. 1, e1600946. DOI: 10.1126/sciadv.1600946

European Spatial Planning Observation Network (ESPON), 2017. *Policy brief: shrinking rural regions in Europe*. Available at: <<https://www.espon.eu/rural-shrinking>> [Accessed 9 November 2019]

European Commission, 1992. *Council directive 92 / 43 / EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora*. [online] Available at: <<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:31992L0043&from=EN>> [Accessed 9 November 2019].

European Commission, 2005. *Green paper. Confronting demographic change: a new solidarity between the generations*. [pdf] Available at: <<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52005DC0094&from=EN>> [Accessed 9 November 2019].

European Commission, 2009. *Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds*. [online] Available at: <<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0147&from=EN>> [Accessed 9 November 2019].

European Commission, 2011a. *Our life insurance, our natural capital: EU biodiversity strategy to 2020*. [pdf] Available at: <https://www.eea.europa.eu/publications/eu-2010-biodiversity-baseline/at_download/file> [Accessed 9 November 2019].

European Commission, 2011b. *Roadmap to a resource efficient Europe*. COM (2011) 571 final. [online] Available at: <<https://www.eea.europa.eu/policy-documents/com-2011-571-roadmap-to>> [Accessed 9 November 2019].

European Commission, 2011c. *The global approach to migration and mobility*. COM (2011) 743 final. [online] Available at: <https://ec.europa.eu/home-affairs/what-we-do/policies/international-affairs/global-approach-to-migration_en> [Accessed 9 November 2019].

European Commission, 2014. *Population ageing in Europe: facts, implications, and policies*. [pdf] Available at: <https://ec.europa.eu/research/social-sciences/pdf/policy_reviews/kina26426enc.pdf> [Accessed 9 November 2019].

European Commission, 2015. *The mid-term review of the EU biodiversity strategy to 2020*. COM (2015) 478 final. [pdf] Available at: <https://eur-lex.europa.eu/resource.html?uri=cellar:5254559f-68eb-11e5-9317-01aa75ed71a1.0001.02/DOC_2&format=PDF> [Accessed 9 November 2019].

European Commission, 2018. *A clean planet for all: a European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy*. COM (2018) 773. [pdf] Available at: <<https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2018:0773:FIN:EN:PDF>> [Accessed 9 November 2019].

European Commission, 2019. *Progress report on the implementation of the European*. COM (2019) 126 final. [online] Available at: <<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0126&from=EN>> [Accessed 9 November 2019].

European Council. 2014. *2030 climate and energy framework*. EUCO 169/14. [online] Available at: <https://ec.europa.eu/clima/policies/strategies/2030_el> [Accessed 9 November 2019].

European Greens, 2019a. *Priorities for 2019: what European greens fight for*. [online] Available at: <<https://europeangreens.eu/priorities-2019-what-european-greens-fight>> [Accessed 10 November 2019].

European Greens, 2019b. *Positions*. [online] Available at: <<https://europeangreens.eu/positions>> [Accessed 10 November 2019].

European Greens, 2019c. *Human rights & migration*. [online] Available at: <<https://europeangreens.eu/positions/human-rights-migration>> [Accessed 10 November 2019].

European Parliament, 2013. *Decision No 1386/2013/Eu of the European parliament and of the Council of 20 November 2013, on a general Union environment action programme to 2020: Living well, within the limits of our planet*. [online] Available at: <<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32013D1386&from=EN>> [Accessed 10 November 2019].

Eurostat, 2017. *Statistics explained*. [online] Available at: <https://ec.europa.eu/eurostat/statistics-explained/index.php/Main_Page> [Accessed 10 November 2019].

Eurostat, 2019. *Main tables, immigration and emigration*. [online] Available at: <<https://ec.europa.eu/eurostat/web/population-demography-migration-projections/data/main-tables>> [Accessed 10 November 2019].

Foreman, D. and Carroll, L., 2014. *Man swarm: how overpopulation is killing the wild world*. LiveTrue Books.

Götmark, F. et al., 2018. Aging human populations: good for us, good for the Earth. *Trends in Ecology & Evolution*, 33: pp.851–62.

Intergovernment Panel on Climate Change (IPCC), 2007. *AR4 climate change 2007: mitigation of climate change*. [online] Available at: <<https://www.ipcc.ch/report/ar4/wg3/>> [Accessed 10 November 2019].

Intergovernment Panel on Climate Change (IPCC), 2013. *Climate change 2013: The physical science basis*. [online] Available at: <<https://www.ipcc.ch/report/ar5/wg1/>> [Accessed 10 November 2019].

Intergovernment Panel on Climate Change (IPCC), 2014. *AR5 climate change 2014: mitigation of climate change*. [online] Available at: <<https://www.ipcc.ch/report/ar5/wg3/>> [Accessed 10 November 2019].

Kallis, G., 2018. *Degrowth*. New York: Columbia University Press.

Keenleyside, C. and Tucker, G., 2010. *Farmland abandonment in the EU: an assessment of trends and prospects*. London: World Wildlife Fund and Institute for European Environmental Policy.

Kolankiewicz, L. and Camarota, S.A., 2008. *Immigration to the United States and world-wide greenhouse gas emissions*. Washington, D.C.: Center for Immigration Studies.

Krishnadas, M. et al., 2018. Parks protect forest cover in a tropical biodiversity hotspot, but high human population densities can limit success. *Biological Conservation*, 223, pp.147–155.

Kulu, H. et al., 2017. Fertility by birth order among the descendants of immigrants in selected European countries. *Population and Development Review*. 43, pp.31–60.

Leal Filho, W. et al., 2017. An assessment of the causes and consequences of agricultural land abandonment in Europe. *International Journal of Sustainable Development and World Ecology*, 24, pp.554–60.

Lehsten, V. et al., 2015. Disentangling the effects of land-use change, climate and CO₂ on projected future European habitat types. *Global Ecology and Biogeography*, 24, pp.653–63.

Lenzi D. et al., 2018. Don't deploy negative emissions technologies without ethical analysis. *Nature*, 561, pp.303–5.

Lutz W. et al., 2019. *Demographic scenarios for the EU: migration, population and education*. Luxembourg: Publications Office of the European Union.

Marques, A. et al. 2019. Increasing impacts of land use on biodiversity and carbon sequestration driven by population and economic growth. *Nature: Ecology & Evolution*, 3, pp.628–637.

Millennium Ecosystem Assessment, 2005. *Ecosystems and human well-being: biodiversity synthesis*. Washington, D.C.: World Resources Institute.

Miller, D., 2016. *Strangers in our midst: the political philosophy of immigration*. Cambridge: Harvard University Press.

Navarro, L.M. and Pereira, H.M., 2015a. Rewilding abandoned landscapes in Europe. In: Pereira H. and Navarro L. eds. 2015. *Rewilding European landscapes*. Cham: Springer International Publishing. pp.3–23.

- Navarro, L.M. and Pereira, H.M., 2015b. Towards a European policy for rewilding. In: Pereira H. and Navarro L. eds. 2015. *Rewilding European landscapes*. Cham: Springer International Publishing. pp.205–223.
- O'Neill, B.C. et al., 2012. Demographic change and carbon dioxide emissions. *The Lancet*, 380, pp.157–64.
- O'Neill, D.W. et al., 2018. A good life for all within planetary boundaries. *Nature Sustainability*, 1, pp.88–95.
- Palmer, T., 2012. Beyond futurity. In: Cafaro, P. and Crist, E. eds. 2012. *Life on the brink: environmentalists confront overpopulation*. Athens: University of Georgia Press. pp.98-107.
- Pe'er, G. et al., 2014. EU agricultural reform fails on biodiversity. *Science*, 344, pp.1090–92.
- Pew Research Center, 2017. *Europe's growing Muslim population*. [online] Available at: <<http://www.pewforum.org/2017/11/29/europes-growing-muslim-population/>> [Accessed 10 November 2019].
- Phillips, A., 2018. *Immigration ethics: creating flourishing, just, and sustainable societies in a world of limits*. Master's thesis, Colorado State University.
- Queiroz, C., et al., 2014. Farmland abandonment: threat or opportunity for biodiversity conservation? A global review. *Frontiers in Ecology and the Environment*, 12, pp.288–96.
- Qiu, C. et al., 2018. Human pressures on natural reserves in Yunnan province and management implications. *Scientific Reports*, [e-journal] 8, 3260. DOI:10.1038/s41598-018-21654-w.
- Radeloff, V. et al., 2015. Housing growth in and near United States protected areas limits their conservation value. *PNAS*, 107, pp.940–945.
- Rees, P. et al., 2012. European regional populations: current trends, future pathways, and policy options. *European Journal of Population / Revue Européenne de Démographie*, 28, pp.385–416.
- Ripple, W.J. et al., 2017. World scientists' warning to humanity: a second notice. *BioScience*, 67, pp.1026–28.

Rust, N. and Kehoe, L., 2017. A call for conservation scientists to empirically study the effects of human population policies on biodiversity loss. *Journal of Population and Sustainability*, 1 (2), pp.53-66.

Seto K.C., 2011. A meta-analysis of global urban land expansion. *PLoS ONE*, [e-journal] 6, e23777. doi:10.1371/journal.pone.0023777.

Scharlemann, J., 2005. The level of threat to restricted-range bird species can be predicted from mapped data on land use and human population. *Biological Conservation*, 123, pp.317–326.

Smith, D., 2011. *Dick Smith's population crisis: the dangers of unsustainable growth for Australia*. Sydney: Allen & Unwin.

Sobotka, T., 2008. Overview chapter 7: the rising importance of migrants for childbearing in Europe. *Demographic Research*, 19. pp.225–48.

Staples, W. and Cafaro, P., 2012. For a species right to exist. In: Cafaro, P. and Crist, E. eds. 2012. *Life on the brink: environmentalists confront overpopulation*. Athens: University of Georgia Press. pp.283-300.

Stanford, C., 2012. *Planet without apes*. Cambridge: Harvard University Press.

Symes, W. et al., 2016. Why do we lose protected areas? Factors influencing protected area downgrading, downsizing and degazettement in the tropics and subtropics. *Global Change Biology*, [e-journal] 22, pp.656–665. doi: 10.1111/gcb.13089.

Thompson, K. and Jones, A., 1999. Human population density and prediction of local plant extinction in Britain. *Conservation Biology*, 13, pp.185-189.

Tucker, M. et al., 2018. Moving in the Anthropocene: global reductions in terrestrial mammalian movements. *Science*, 359, pp.466–469.

Turvey, S., 2008. *Witness to extinction: how we failed to save the Yangtze River Dolphin*. Oxford: Oxford University Press.

United Nations, 2014. *2014 revision of the world urbanization prospects*. [online] Available at: <<https://www.un.org/en/development/desa/publications/2014-revision-world-urbanization-prospects.html>> Accessed 10 November 2019].

United Nations, 2019. *World population prospects*. [online] Available at: <<https://population.un.org/wpp/>> [Accessed 10 November 2019].

UK Green Party, 2003. *Population*. [online] Available at: <<https://policy.greenparty.org.uk/pp.html>> [Accessed 10 November 2019].

UK Green Party, 2017. *Migration*. [online] Available at: <<https://policy.greenparty.org.uk/mg.html>> [Accessed 10 November 2019].

Van Vuuren D.P. et al., 2018. Alternative pathways to the 1.5 °C target reduce the need for negative emission technologies. *Nature Climate Change*, 8, pp.391–7.

Verburg, P.H. and Overmars, K.P., 2009. Combining top-down and bottom-up dynamics in land use modeling: exploring the future of abandoned farmlands in Europe with the Dyna-CLUE model. *Landscape Ecology*, 24, pp.1167–81.

Watson, J.E. et al., 2014. The performance and potential of protected areas. *Nature* 515, pp.67–73.

Weber, H. and Sciubba, J.D., 2018. The effect of population growth on the environment: evidence from European regions. *European Journal of Population*, [e-journal] April 9, 2018. <https://doi.org/10.1007/s10680-018-9486-0>

Wynes, S. and Nicholas, K.A., 2017. The climate mitigation gap: education and government recommendations miss the most effective individual actions. *Environmental Research Letters*, [e-journal] 12. <https://doi.org/10.1088/1748-9326/aa7541>

Zingg, S. et al., 2019. Increasing the proportion and quality of land under agri-environment schemes promotes birds and butterflies at the landscape scale. *Biological Conservation*, 231, pp.39-48.