Are protected areas good for the human species?

Effects of protected areas on rural depopulation in Spain

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Abstract

Protected areas (PAs) seek to conserve valuable genes, species and ecosystems by applying a legal regime that restricts many socioeconomic activities and also offers opportunities for new ones. As a result, PAs have been claimed by some authors to boost socioeconomic conditions in rural areas mainly through tourism activities. However, others have claimed that PAs contribute to rural depopulation through the worsening of living conditions of local residents because of restrictions resulting from protection regulations. Here, we applied a multiple-paired Before-After-Control-Impact (BACI) research design on a census on protected rural municipalities (cases; N=52) versus unprotected rural municipalities (controls; N=55) in Spain to ascertain whether PAs had positive or negative effects on rural populations using three indicators on depopulation with official municipal data from 1996 until 2019: Compound annual growth rate (CAGR); Proportion of reproductive individuals (REP); and Proportion of reproductive females (WREP). We controlled for some confounders such as biophysical characteristics and regional regulations by carefully selecting our sample of municipalities spatially. Our results show that depopulation figures were worse in cases than in controls, with some exceptions whose characteristics should be further explored. Municipalities in Sites of Community Importance (SCIs) performed best against rural depopulation and generally better than their controls, whereas municipalities in Biosphere Reserves and Special Protection Areas (SPAs) showed mostly worse figures. Our findings suggest that, while necessary and important for biodiversity, multiple-use PAs generally entailed negative consequences for Spanish rural populations that need to be offset by State's intervention.

Keywords: Natura 2000; Biosphere Reserve; rural demography; reproductive cohort; municipality; BACI design

1. Introduction

Protected areas (PAs) are legally recognised and geographically defined spaces aimed at the long-term conservation of biodiversity, ecosystem services and associated cultural values (Dudley, 2008). Currently, PAs cover more than 20 million km^2, or 15% of the terrestrial and freshwater ecosystems globally (Protected Planet, 2020). Actually, biodiversity conservation is the second largest land use globally after agriculture which covers around 30% of the World's terrestrial area (UNEP, 2014). Current international biodiversity targets for 2020 (CBD, 2010) are political in nature and far lower than what scientific studies recommend in light of disappointing conservation outcomes (Butchart et al., 2010; Noss et al., 2012; IPBES; 2019), especially for the most important areas for biodiversity (Butchart et al., 2015; Cunningham & Beazley, 2018; UNEP-WCMC et al., 2018). Therefore, countries and international conservation organisations are having active discussions to set up more ambitious and scientifically-driven post-2020 biodiversity targets (CBD, 2020), which will most likely entail a substantial increase both in PA coverage and greater legal and managerial stringency in order to curve down biodiversity loss (IUCN, 2020).

PAs include the remaining populations of many endangered species, as well as other species of conservation interest (Deguise & Kerr, 2006; Barnes et al., 2016). Nevertheless, PAs do not only harbour important biodiversity. Some PAs, especially in highly humanised contexts like Europe, also include human populations within their boundaries. A broad distinction of PAs according to their legal stringency can be made between: 'reserves' (*i.e*. legally stringent PAs that restrict or forbid most human activities within their boundaries) and 'multiple-use PAs' (*i.e*. legally lenient PAs that allow a diversity of human uses that are compatible with the conservation of biodiversity; Nelson & Chomitz, 2011). Reserves generally align with IUCN management categories I, II and III, whereas multiple-use PAs usually encompass categories IV to VI (Dudley, 2008; Nagendra, 2008). Human populations are not usually allowed to live inside 'reserves' whereas in some areas like South America, India, Central Africa, Mongolia or the European Union, large PAs such as nature parks, Biosphere Reserves, Natura 2000 sites or even national parks may include human dwellings and a range of socioeconomic activities (Coad et al., 2008; Rodríguez-Rodríguez, 2012; Järv et al., 2016; UNESCO, 2019; European Commission, 2020a). Together with expected positive biodiversity outcomes, forecast increases in international biodiversity protection targets will most likely involve greater social and economic impacts on human populations around the World, chiefly for those living in rural areas and in developing nations (Ferraro, 2002; Naughton-Treves et al., 2005; De Santo, 2013).

A diversity of studies have assessed the environmental effects of PAs in different settings (Geldmann et al., 2013; Davis et al., 2014; Edgar et al., 2014; Spracklen et al., 2015; Barnes et al., 2016). However, not so many have yet assessed the social and economic effects of PAs on local communities (Joppa, 2012), especially in Europe (Jones et al., 2020). On the one hand, many PAs are located in remote, socioeconomically depressed areas where conservation regulations do not affect human interests much; on the other, PAs harbour a range of well-conserved natural and cultural heritage that may act as endogenous socioeconomic drivers for rural areas (Chape et al., 2008). Therefore, two main strains of thought interpret PAs' social and economic impacts. The first one considers PAs as socioeconomic drivers that promote sustainable development of rural populations as a result of direct employment in PAs or new business opportunities linked to eco-friendly products and services such as tourism (Kettunen & Ten Brink, 2013; Sala et al., 2013; Stolton et al., 2015). The second one deems PAs bureaucratic hindrances to local development that result in the impoverishment, loss of quality of life and marginalisation of affected rural areas (West et al., 2006; De Santo, 2013; Paniagua, 2017). Either way, the regulations in force to conserve biodiversity impose some restrictions to the customary use of natural resources that are likely to affect local residents and businesses positively or negatively on a sectoral, case-by-case basis (Naughton-Treves et al., 2005; Oglethorpe et al., 2007; Coad et al., 2008; Joppa et al., 2009; Joppa, 2012; Jones et al., 2020).

The European Union created the largest multi-nationally coordinated PA network in 1992: The Natura 2000 Network (EEC, 1992). It is made of three multiple-use PA categories aimed at the sustainable development of sites: Sites of Community Importance (SCIs); Special Areas of Conservation (SACs); and Special Protection Areas for Birds (SPAs; European Commission, 2020a). Together, they cover 17.9% of the Union's land territory (EEA, 2020a) and the largest part of its countries' designated protected area, mostly in rural areas. However, Natura 2000 planning and management processes have not always had sufficient stakeholder input across the European Union (Ferranti et al. 2014; Blicharska et al. 2016). As a result, designation of PAs has sometimes been contested by local populations on governance and socioeconomic grounds that may influence depopulation of rural areas (Grodzinska-Jurczak & Cent, 2011; Vidal-González & Calero, 2014). In other cases, local populations have actively advocated for the protection of some natural areas (Pérez, 2013).

Depopulation of rural areas in the European Union is a selective process that is chiefly driven by two main factors: 1) Negative birth-death dynamics and; 2) Emigration of young people and middle aged people, especially of trained young women, to middle cities as a result of insufficient job opportunities, transport and communication infrastructures, social care and health facilities, education and banking services, and cultural activities (Perpiña et al., 2018). Young and middle age classes are however essential to the maintenance of rural populations as they deal with basic socioeconomic activities including productive work, reproduction and care of the elderly (Delgado y Martínez, 2017; CES, 2018).

Spain is a biodiversity-rich, Mediterranean country of the European Union (Araújo et al., 2007; Múgica et al., 2010). Twenty-eight point twelve per cent of its land and freshwater territory has been designated under different, sometimes overlapping, categories of PAs (UNEP-WCMC & IUCN, 2020). This makes the largest absolute PA coverage figures of the European Union and one of the largest World's relative figures (OECD, 2017; EEA, 2020a). Spain also outstands as the second world's tourism destination (UNWTO, 2019). It has a rich natural and cultural heritage (UNESCO, 2017; 2020), a vast territorial capital that may help to revitalise depressed rural areas

(Labianca & Navarro, 2019; Molinero y Alario, 2019). At the same time, loss of population in rural areas is a long-lasting phenomenon in Spain and other European areas as a result of poorer living conditions linked to fewer job opportunities and less access to essential services than in urban areas (CES, 2018; Perpiña et al., 2018; Molinero y Alario, 2019). In particular, scarcity of young women due to scant job opportunities, limited services and greater gender discrimination than in urban areas is one of the major limitations to rural demography in Spain (Bustos, 2005; CES, 2018). Rural depopulation has resulted in environmental and socioeconomic impacts in rural areas including: Agricultural abandonment; natural succession and forest recovery leading to increased fire risk; massive land development around main cities and coastal areas; ageing; predominantly male resident populations; decline of traditional economic activities and cultural practices; and marginalisation of remote rural populations (Saco, 2010; Van der Zanden et al., 2017; CES, 2018; Labianca & Navarro, 2019).

Depopulation of rural areas in the European Union has been addressed through specific policies, such as cohesion policy instruments or the second pillar of the Common Agricultural Policy, devoted to rural development (European Parliament, 2017; 2020). Such policies have been translated to the Spanish rural context through regional development programmes using EAFRD funds, although with marked regional differences in implementation and efficiency across the country’s autonomous regions (CES, 2018). Only recently was rural depopulation paid attention to by the passing of the Law on Sustainable Rural Development (Spanish Government, 2007a) and its implementing Sustainable Rural Development Programme (Spanish Government, 2010). More recently, the Spanish Government has paid more institutional attention to the issue by producing the National Strategy before the Demographic Challenge (Spanish Government, 2019) and creating the Ministry for Ecological Transition and

Demographic Challenge (Spanish Government, 2020a). Nevertheless, the implementation of the measures included in such policies is low, slow and very different across measures so far (CES, 2018).

To our knowledge, no study has yet scientifically assessed the effects of PAs on human demography in a country with acute rural depopulation figures and more than one fourth of its territory under biodiversity conservation regulations such as Spain. Are PAs an opportunity for sustainable development in impoverished rural Spain or the final blow for human populations in Spanish rural areas? This is the research question we tried to answer here through a two-tailed hypothesis that was tested: PAs have had an impact on human demography in rural Spain. We assessed the effects of PA designation on human populations in rural Spain with an emphasis in the reproductively-active cohort, and explored possible contextual factors for those effects.

2. Methods

2.1. Study area

Spain is an administratively decentralised country where the central government holds competency for basic environmental (Spanish Government, 2007b) and rural development (Spanish Government, 2007a) law-making that the 17 regional governments and 2 autonomous cities must abide by and can expand in their territories. PA designation and management is a regional competency in Spain, as it is the development and implementation of rural development policies, which may entail substantial regional differences in the socioeconomic effects of PA designation in rural areas (CES, 2018; Maroto y Pinos, 2019).

We used an official, operative definition of rural area based on demography that is applied by Spanish institutions such as the Ministry of Environment or the National Statistics Institute. It considers rural municipalities those having less than 10,000 inhabitants (Perales y Martínez, 2017; CES, 2018). Thus, human settlements equal to or greater than 10,000 inhabitants were selected as cities from an official GIS layer (N= 633; IGN, 2020a). Defining purely "rural" areas was challenging, as urbanisation and population density gradients between urban and rural areas normally occur producing fuzzy peri-urban areas from cities' boundaries (Karg et al., 2019). Thus, an operational definition of 'peri-urban areas' was used by applying 20 km buffers around city polygons across the Spanish land territory. Twenty kilometres was considered an adequate average distance for which the largest effects from cities and the greatest concentration of infrastructures can be found and it was similarly used in previous studies (Karg et al., 2019). All the remaining land territory was considered 'rural area': Approximately 263,450 km^2 or 52% of the Spanish land territory.

2.2. Study design

A BACI research design was applied whereby rural municipality population data for the 1996-2019 available time series was retrieved yearly (INE, 2020) for a maximum of six years *Before* the designation date of each selected PA (*Impact*), and a minimum of four years *After* their designation date, for a sample of Case and *Control* municipalities. BACI designs are adequate research designs to assess causality (Smith, 2002).

Cases were rural municipalities whose territories were completely covered by PAs (>99%), thus affected by PA regulations. In case of spatial overlaps between different PA categories (e.g. Nature Park and Biosphere Reserve), the cases were assigned the PA category covering the largest proportions of their territories (>50%) and the designation date of that category was considered the *Impact* date of that case. Controls were rural municipalities adjacent to cases (*i.e*. sharing boundaries) whose territories were completely unprotected (<1% was protected) and that were located in the same administrative region as their cases in order to spatially control for both bio-physical and administrative confounders.

Some authors have claimed the reduced validity of some ‘uncontrolled’ comparisons between cases and controls when using BACI designs and the need to ‘match’ them according to a set of covariates that may influence the dependent variable/s (Andam et al., 2010; Nelson & Chomitz, 2011). Thus, an initial bio-physical similarity check was further performed for seven covariates that might influence depopulation in Spanish rural areas in order to ascertain the internal validity of comparisons between cases and controls. The seven considered covariates were: Size of municipality; Initial population at year 1; Distance to cities; Distance to main transport infrastructures (motorways); Percentage of urban land cover; Percentage of agricultural land cover; and Percentage of forest land cover. Corine-Land Cover’s land use-land cover data for the year 2012 (IGN, 2020b) was used to check for municipalities’ land covers. The normalised Manhattan Similarity Coefficient (S) was used to assess similarity between cases and controls (Cha, 2007). It ranges between 0 (complete dissimilarity between groups) and 1 (complete similarity):

$$D(X, X') = 1 - \frac{\sum_{i=1}^{k} |X_i - X'_i| \,/Range\ (Xi)}{K}$$

Where, X_i is the median value of group X for variable *i*; Range is the amplitude of measurement X_i in the study area; and K is the number of variables used to assess groups X and X’. Figure 1 shows a methodological outline of the study.

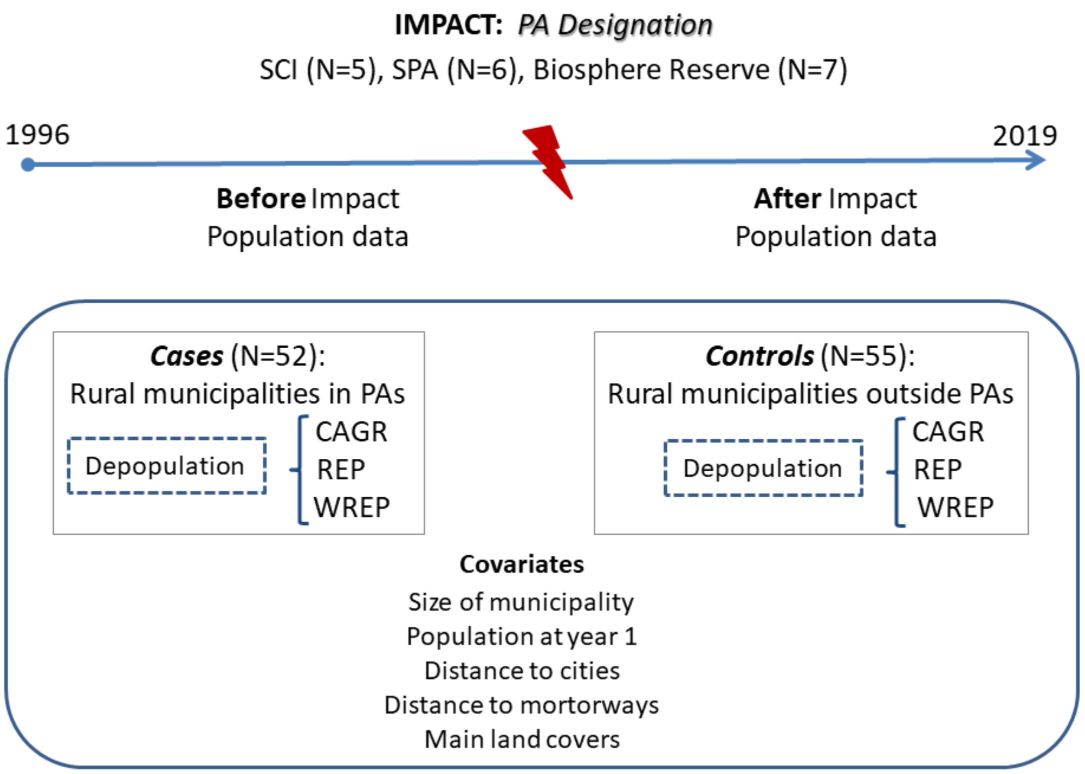

Figure 1. Outline of the research design

2.3. Data sources

PA GIS layers, administrative boundary layers (municipalities' and regions') and potential covariate GIS layers were downloaded from official data sources in April 2020 (Appendix A). Yearly registered municipal population data from 1996 till 2019 was obtained from the National Statistics Institute (INE, 2020). Three relevant metrics to rural depopulation were retrieved for each case and control municipality: total population, total reproductive population (ages 15-49), and women reproductive population (15-49 years old). That reproductive age range was selected because the proportion of reproductive age classes outside it is anecdotal (UN, 2019).

2.4. Data analysis

Designation dates of individual PAs were originally included in the official Biosphere Reserve layer and the national PA categories' layer. For those dates that only included the designation year, the median date 30/06/year were selected as 'designation date'. For SCIs and SPAs, we added their 'proposal' and 'designation' dates, respectively, from the latest version of the Natura 2000 Database (end of 2018 version; EEA, 2020b). Designation dates of Ramsar sites were retrieved from the official Ramsar Convention's website (Ramsar, 2020) and added to the GIS layer. Then, the five PA layers were unioned in a single complete PA layer including all designation dates. The complete PA layer was clipped against the Spanish land territory to produce a terrestrial protected polygon (PP) layer. Resulting PPs less than 10 ha were deleted to prevent layer alignment errors as a result of previous operations.

The rural municipalities' layer and the terrestrial PA layer were intersected to identify potential cases. Rural municipalities that were completely protected (>99%) were identified as potential cases. Conversely, rural municipalities with less than 1% of their area protected were identified as potential controls. Then, the pre-selection was refined by identifying case and control municipalities in the same administrative region that shared boundary segments, as covariate values likely affecting population figures such as territorial policies and some biophysical characteristics will most likely be more similar than among distant municipalities. Pre-selected cases were assigned the PA category that covered the largest area of the municipality (>50%) and its designation date was selected for that case, even though some smaller areas of its territory might have an oldest designation category. In this process, only three 'multiple use' PA categories (IUCN Management Categories IV-VI; Dudley, 2008) remained, as they were either the biggest ones or the oldest ones: SCIs, SPAs and Biosphere Reserves.

Finally, pre-selected cases whose largest PAs had been designated before the initial date of the first available municipal population data (1996) or after 2015 (four years before the final available municipal population data, 2019) were excluded. Four years was selected as a reasonable period for designated PAs to have a measurable effect on local populations. The final census of municipalities following those selection criteria included 52 cases and 55 controls in 18 PAs and six regions (Figure 2). The 18 PAs included five SCIs, six SPAs and seven Biosphere Reserves (Appendix B).

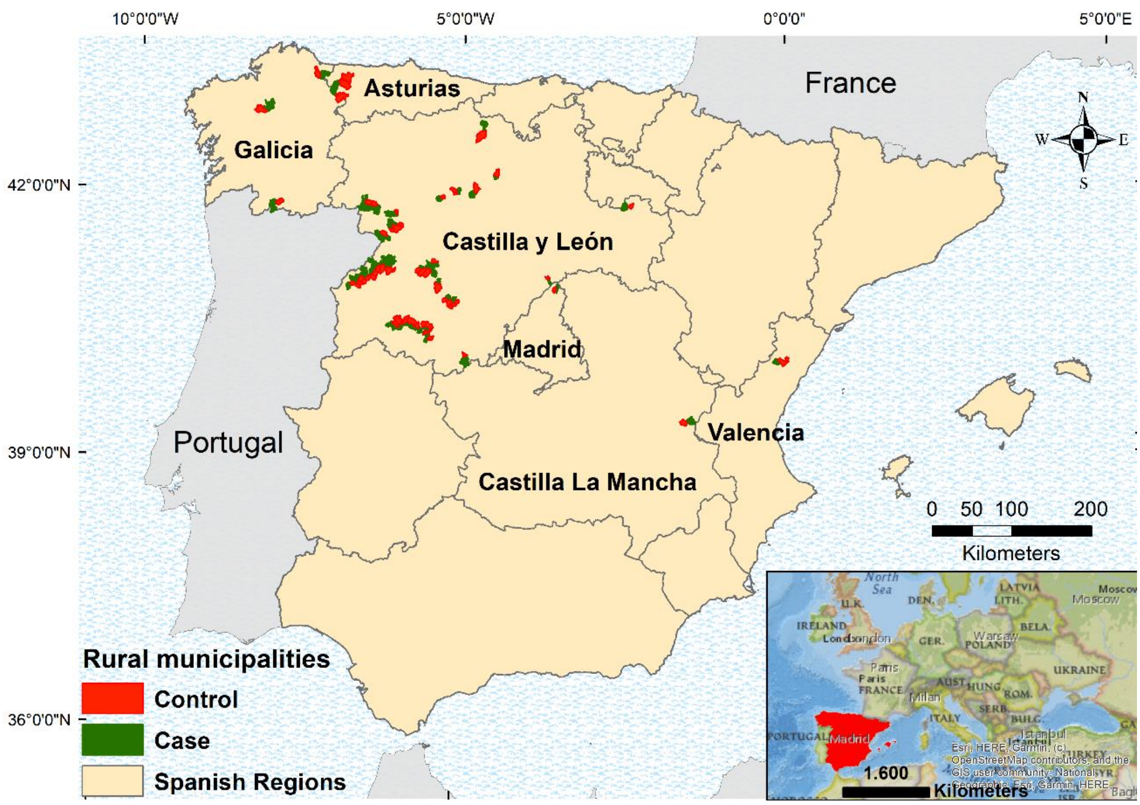

Figure 2. Case and control municipalities in the administrative map of Spain (note that the Canary Islands Region is not showing)

Three indicators were used to compare *Before* PA designation data and *After* PA designation data: 1) Absolute change of the compound annual growth rate (CAGR; for total population); 2) Relative change in proportion means of total reproductive population (REP); and 3) Relative change in proportion means of women reproductive population (WREP). For large PAs that encompassed different municipalities, median case and control values for those indicators were compared in order to minimise bias by individual municipalities acting as outliers. Our census sample of case and control municipalities was segmented and analysed according to potentially influential variables: 1) All cases and controls; 2) By administrative region; 3) By PA; 4) By PA category; 5) By the degree of protection of PAs, that accounts for the number of overlapping legal categories on a PP (Rodríguez-Rodríguez et al., 2016); and 6) By PA age (*i.e.* designation date).

In order to explore potentially explanatory factors for depopulation figures, Spearman correlation tests among the three population indicators and a number of context variables: Area of municipalities; number of overlapping legal categories; PA age & PA category were performed for an $\alpha = 0.05$ after checking the non-normality of the data, using SPSS software v. 24.

3. Results

3.1. Similarity between cases and controls

Regional cases and controls were bio-physically similar for all covariates but two complementary ones: Percentage of agricultural cover and percentage of forest cover. The cases were notably more forested and less agricultural than controls (Table 1). Similarity between groups was nevertheless very high overall: S = 0.91.

Covariate	Cases	Controls
Size (ha)	3,839	3,487
Initial population at year 1 (inhs.)	311	235
Distance to cities (km)	42.39	42.11
Distance to motorways (km)	14.51	10.55
Artificial land cover (%)	0.88	0.69
Agricultural land cover (%)	32.45	52.05
Forest land cover (%)	66.67	47.26

Table 1. Biophysical similarity between cases and controls (median values)

All the 107 municipalities but three (maximum population of 2,569 inhabitants) are classified as small rural municipalities with less than 2,000 inhabitants. Population density at t_1 ranged between 1.61 inh/km^2 and 44.37 inh/km^2 in cases and controls, with 59% of them being classified as areas of very low population density (<8 inh/km^2) or population deserts (Appendix C).

3.2. Effects of PAs on rural populations

3.2.1. In Spain

Both cases (N=52) and controls (N=55) increased their losses of population after the designation of PAs. However, median absolute population decrease in the cases more than doubled that in controls ($CAGR_{cases}$ = -0.77; $CAGR_{controls}$ = -0.37). Nevertheless, REP was slightly better in cases (REP_{cases} = -8.11) than in controls ($REP_{controls}$ = -8.28) although WREP was worse for cases ($WREP_{cases}$ = -9.75) than for controls ($WREP_{controls}$ = -8.66) after PA designations.

3.2.2. By administrative region

The best performing regions were Asturias and Galicia, with lower depopulation figures in cases than in controls for some indicators, yet with negative values. In all the other regions, cases behaved worse than controls for all the indicators (except for CAGR in Madrid), especially so regarding REP and WREP in Madrid and Valencia (Appendix D).

3.2.3. By PA

Cases in nine PAs (50% of PAs) showed worse depopulation figures than their controls for most or all the indicators. However, REP decreased less in most cases (50%) and PAs (58.82%) than in their controls. In turn, WREP depopulation figures were better just for 34.62% of the cases and 52.94% of the PAs (Appendix E).

3.2.4. By PA category

The cases in SCIs were the only ones that produced better depopulation figures for the three indicators than their controls on average. They lost population 5.28 times more slowly than their controls. Also, the relative decrease in WREP was 2.30 times lower than in the SCIs' controls. The cases in the other two PA categories showed average worse depopulation figures than their controls (Table 2). When the three depopulation indicators are considered, 20% of the studied SCIs, 57% of Biosphere Reserves and 67% of SPAs provided worse depopulation results for their municipalities than their controls.

Protected area category	Cases				Controls			
	N	CAGR (%)	REP (%)	WREP (%)	N	CAGR (%)	REP (%)	WREP (%)
SCI	6	-0.37	-7.68	-4.37	5	-1.93	-9.89	-10.05
SPA	15	-0.69	-11.70	-16.38	16	-0.22	-7.01	-10.17
Biosphere Reserve	31	-1.08	-7.90	-9.68	34	-0.09	-7.42	-7.09

Table 2. Average depopulation figures by protected area category

3.2.5. By degree of protection

Cases in PAs with 2 overlapping legal categories performed best against rural depopulation, and substantially better than their controls for all the indicators. Cases in PAs with greater or smaller legal overlaps usually performed worse than their controls (Appendix F).

3.2.6. By PA's age

The cases in the oldest PAs tended to show better $CAGR_{abs}$ figures than their controls. There seemed to be no clear pattern linking PA age and case performance for REP and WREP, although 'middle aged' PAs (6-13 years old) tended to perform better than their controls (Appendix G).

3.3. Correlations.

None of the three population indicators used was significantly correlated to any of the contextual variables for the case municipalities. Nevertheless, some significant correlations appeared between the contextual variables, the most important of which related the number of legal designations with PP's age (positively) and PA category (SIC > SPA > Biosphere Reserve; Appendix H).

4. Discussion

4.1. Effects of PAs on human populations

With some exceptions, multiple-use PAs did not prevent rural depopulation in Spain. Actually, municipalities affected by biodiversity conservation regulations generally showed poorer depopulation figures than their controls. Although young people tended to resist slightly better in protected rural municipalities, young women were more negatively affected in protected rural communities. REP figures may have been a little better in PAs as a result of: Fewer old people; less youth emigration; and/or greater youth immigration, the two later causes might be due to more PA-related job opportunities for youngsters, but this hypothesis remains to be studied. Population change can come from birth-death dynamics or from migration processes (Oglethorpe et al., 2007; Joppa, 2012). Given that the relationships between birth and death rates and the different environmental and socioeconomic conditions created by PA regulations can be complex and difficult to ascertain, we will chiefly interpret of our depopulation results in terms of changing migration patterns, especially of young and middle aged people (REP and WREP), as suggested elsewhere (Camarero, 2009; Joppa, 2012; Delgado y Martínez, 2017; Labianca & Navarro, 2019). Moreover, the effects of migration are much more likely to be present in the short and medium terms shown in this study than those of fertility-mortality (Oglethorpe et al., 2007).

Most of our census of rural municipalities is in northern-western remote inland areas of Asturias, Galicia and Castilla y Leon, where patchy dwelling patterns and depopulation processes have been known for a long time (Delgado y Martínez, 2017; Molinero y Alario, 2019) and where PA designations have not been enough to curve down such processes. On the contrary, our results would underpin previous studies and common claims that PAs might be ‘good for nature, but bad for people’ (West et al., 2006; De Santo, 2013). Biodiversity protection regulations are likely to hamper much needed service and infrastructural development in remote rural settings in order to overcome historic and biophysical restrictions to wellbeing (Paniagua, 2017). However, rural depopulation in Spain and other places is a multi-factorial process linked to a diversity of physical, historic and socioeconomic related factors (CES, 2018; Perpiña et al., 2018) on which PA regulations are likely to have some, though limited, impact (Rodríguez-Rodríguez & López, 2018). Thus, though lenient multiple-use PA regulations may contribute to increasing or decreasing depopulation figures through new opportunities and restrictions, depopulation effects should most likely not be attributed to them exclusively. Similarly to our results, Rodríguez-Rodríguez & López (2019) found a very light perceived effect (of less than 3% change) in the number of residents living in the municipalities where multiple-use PAs were designated or in residents’ age by a large sample of multi-sectoral organisations in Spain.

In order to address local claims and compensate for the restrictions imposed by PA regulations, some socioeconomic funding programmes have been put in place nationally (Spanish Government, 2005) and regionally (e.g. Government of Castilla y Leon, 2017; Government of Galicia, 2018; Government of Cantabria, 2019). Such programmes can finance initiatives by public entities, businesses, individuals or NGOs that are aimed at promoting rural development and sustainable tourism, enhancing local services and facilities, improving the natural environment, and rehabilitating cultural heritage. Some of these programmes, such as the Socioeconomic Subsidies Programme in the

Socioeconomic Influence Zones (SIZs) of the Spanish Network of National Parks (Spanish Government, 2005) have rendered good sustainability outcomes in participating municipalities (Martínez-Vega et al., 2020). Two broad socioeconomic studies on the 168 municipalities in Spanish National Parks' SIZs showed that a number of demographic factors including total population, resident's age, youth emigration and immigration were better on average in SIZs than in the whole country between 1991 and 2016 and that only unemployment was slightly worse in them between 2007 and 2016 (Perales y Martínez, 2016; 2017). Regarding their economic structure, around 70% of local businesses in the SIZs belonged to the tertiary sector, whereas just around 15% belonged to the primary sector around 2015 (Perales y Martínez, 2017). Such generally positive socioeconomic figures contrast with ours for a sample of less known, visited and subsidised municipalities in Natura 2000 sites or Biosphere Reserves.

National Park is a widely known, highly protected and respected PA category around the World (Dudley, 2008). In the United States in 2019, visitation to national parks reached 328 million people who spent some 21 billion USD in nearby businesses, chiefly in accommodation and restaurants, with a steady expenditure increase since 2012 (NPS, 2019). In Germany, a cost-benefit analysis of the Bavarian Forest National Park also found positive economic results for surrounding communities, with tourism generating 60% of the benefits and compensating for over two thirds of the costs (Mayer, 2014). Similarly, Robalino & Villalobos (2015) reported positive effects of visitors to national parks on the income of local private sector workers in Costa Rica. In Spain, more than 15 million people visited its 15 national parks in 2016, with some of them outstanding as massive tourist destinations (Spanish Government, 2016), which most likely benefitted surrounding communities. Communities in national parks have also benefitted from the Spanish Government's Socioeconomic Subsidies Programme since 1999 and, since 2005 from Regional Governments' Programmes. Between 1999 and 2016, the Central Government alone spent 145 million Euros in such programme (Spanish Government, 2016). New forms of rural tourism linked to natural and cultural heritage have evolved and increased in Spain for the past 30 years. They have been the only economic activity in remote rural areas to do so (Jurado y Pazos-García, 2016). However, serious doubts remain that most remote rural municipalities outside the well-known and particularly visited Network of National Parks, or even within it, could have such positive socioeconomic figures without relying on public subsidies (Jurado y Pazos-García, 2016). These suggestions align with depopulation figures in national parks in other European countries like Estonia that have shown mixed results (Järv et al., 2016).

Adequate means of living including employment and basic infrastructures are essential to a decent life and rural development (Delgado y Martínez, 2017; CES, 2018). Though both factors were not studied here, our depopulation results align with previous results that PAs may, with some exceptions, not be able to act as socioeconomic drivers in rural areas of developed countries and offer sustainable development alternatives in socially depressed areas (Jurado y Pazos-García, 2016; Rodríguez-Rodríguez & López, 2018; 2019). National or supra-national State support in the form of subsidies, tax exemptions, quality labels (EUROPARC Federation, 2010; IUCN, 2017; European Commission, 2020a; Spanish Government, 2020b), publicity or other is likely needed to help generate enough economic activity for rural municipalities in PAs to thrive. State help in the form of business creation, favourable tax policies or better infrastructures was deemed necessary by small rural populations in inland Spain to address the depopulation issue (Gómez-Limón et al., 2007). The European Structural Fund for Rural Development, that allocated 11-20% of its expenditure to enhance economic development in rural areas in its 2014-2020 period, can be a useful tool to improve the quality of life in depressed European rural areas through bottom-up, participatory approaches such as LEADER (European Communities, 2006). Nevertheless, some such areas where human capital has been severely eroded may not have the capacity to implement such endogenous initiatives and are therefore facing a gloomy future (Labianca & Navarro, 2019).

In a recent study, a large multi-sectoral sample of organisations perceived mixed effects on local municipalities affected by PA designations in Spain. Among the largest positive effects, they rated residents' environmental awareness, research activities, local quality of life, and local tourist activity (Rodríguez-Rodríguez & López, 2019). Though these variables are likely to increase local economic activity and thus help retain existing population and attract new residents, they seem not to offset the population impacts of the perceived negative socioeconomic effects of PA designation, including: Restriction to property rights; regulation breaches and sanctions; local bureaucracy; and limitation to residential construction. Most of these limitations to social sustainability in PAs have been identified in European PAs (Järv et al., 2016; Blicharska et al., 2016). In developing nations, scholars have found mixed results, with some showing positive PA effects on the economic conditions of local communities (Andam et al., 2010), and others showing worsening figures (Ferraro, 2002).

Reconciling the three conventional dimensions of sustainability is often challenging (Spangenberg, 2011; Cunningham & Beazley, 2018). The negative impacts of growing human populations (social dimension) on biodiversity (environmental dimension) are well established (McKee et al., 2003; Cunningham & Beazley, 2018). However, in places that have been inhabited by humans for millennia, biodiversity and human activities have co-evolved producing ecologically valuable semi-natural (cultural) landscapes that dominate, for instance, the European territory (Jongman, 2002).

Actually, very few pristine areas, if any, remain in such places. Therefore, in these places the territorial processes linked to human depopulation of rural PAs may entail mixed effects for other species. Some species are likely to benefit from reduced human intervention, land abandonment and forest recovery, whereas some others, chiefly those linked to agrarian ecosystems, will probably decrease as a result of ceasing traditional land management practices (Araújo et al., 2007; Van der Zanden et al., 2017).

Whereas rural, multiple-use PAs in Spain did not stop depopulation, and similar to other settings (Radeloff et al., 2010; Labianca & Navarro, 2019), peri-urban PAs in Spain seem to attract population from urban centres and are threatened with new residential and infrastructural developments (Rodríguez-Rodríguez, 2012; Jurado y Pazos-García, 2016). Thus, a sustainable territorial planning strategy in Spain should be dual. On the one hand, it should promote socioeconomic activities and basic infrastructures (such as internet connection and health, education and transport facilities) in remote rural areas (CES, 2018; Molinero y Alario, 2019). On the other, it should reinforce protection and restrict further development in natural peri-urban areas and heavily pressured coastal areas (OS, 2018; Rodríguez-Rodríguez et al., 2019). Actually, our definition of 'rural area' excluded most Spanish Mediterranean coastal area and a large proportion of its Atlantic coastal area with few exceptions chiefly related to coastal PAs where land development is severely restricted.

The PA category that performed best against rural depopulation in Spain was SCI. Actually two of them: Sierra de Urbion y Cebollera SCI and Sabinares de Somosierra SCI were the only PAs showing better population values for the three indicators than their controls. Moreover, they showed increasing figures for all of them in the study period: total population, proportion of reproductive individuals and proportion of reproductive women. SCIs tended to be the oldest PA category and overlap more with other legal categories. The two best-performing SCIs shared some characteristics: they were located in Castilla y Leon region; they were around 20 years old; they overlapped with other PA category; and they were designated as SACs in 2015. Here, over three-quarters of the nine successful PAs in terms of overall depopulation figures were managed for all or some time since their designation, but so were most unsuccessful ones. Both Biosphere Reserves and SPAs are aimed at reconciling biodiversity conservation and local development (UNESCO, 2019; European Commission, 2020a). However, such PA categories did not generally render positive results on depopulation as an indicator of social sustainability in Spanish rural areas, even though Biosphere Reserves are actively managed in Spain (Spanish Government, 2020c). As previously suggested in studies on PA effectiveness in Spain (Rodríguez-Rodríguez & Martínez-Vega, 2018), PA management does not seem to influence rural depopulation. Uncertainty remains on whether 'reserve' categories such as Nature Reserves or National Parks (Spanish Government, 2007b; Nagendra, 2008) may render better depopulation results in Spanish rural areas. Some semi-experimental studies pointed to greater social sustainability (including population density values) in municipalities affected by National Park regulations than in control municipalities (Perales y Martínez, 2016; 2017; Martínez-Vega et al., 2020). However, those authors did not differentiate between rural and urban areas or accounted for other PA legal categories that likely affected their control areas, thus reducing internal validity.

4.2. Methodological considerations

Limited effects affecting the internal validity of results from cases with overlapping legal categories having different designation dates are likely to exist. Nevertheless, those effects affect just some of the studied sample of cases in which older, smaller PAs had been designated before the considered PAs, and just for a minor part of their territories. In contrast, similarity between cases and controls was very high and greater than in previous studies using the same metric (Rodríguez-Rodríguez et al., 2019), which reinforces the internal validity of the study. Only the proportions of agricultural land versus forest land were notably different between cases and controls, as found for the rest of protected versus unprotected areas in the Iberian Peninsula (Araújo et al., 2007).

5. Conclusions

Small remote rural municipalities in Spain showed, similar to the rest of the country, worrisome depopulation trends that jeopardise their future. Whereas PAs provide essential biodiversity conservation and a range of valuable ecosystem services to local populations, they are not always good at maintaining human populations in rural areas. The majority of Spanish municipalities in multiple-use PAs showed worse depopulation figures than their controls, suggesting that the socioeconomic opportunities provided by those PAs cannot compensate for the limitations linked to their regulations. SCIs performed best against rural depopulation, whereas other allegedly sustainable PAs such as SPAs and Biosphere Reserves showed disappointing demographic figures. However, even though PA regulations probably affect rural depopulation, they are most likely not the sole factor to do so, as emigration and birth-death dynamics are complex and multi-factorial.

Our results also suggest that, on their own, multiple-use PAs are not usually able to generate enough economic activity to act as territorial economic drivers and fix population in remote Spanish rural areas and that, to do so, some State support in the form of subsidies, investment, promotion or other may be needed. Even though some backing is likely necessary for Spanish PAs to act as socioeconomic territorial assets, territorial planners and decision-makers should be careful not to put socioeconomic development before nature conservation by making PAs mass residential or tourism attractions that will jeopardise their primary goal that is, and should always be, biodiversity conservation.

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