Appendix 2: Projected changes to SPA classifications

Introduction

Protected areas are a key tenet of biodiversity conservation. In excess of 100,000 protected areas now cover some 12 % of the terrestrial surface area (Chape *et al.* 2005) and provide significant conservation benefit in buffering protected populations and habitats from loss (e.g. Bruner *et al.* 2001, Gaston *et al.* 2008). Increases in the coverage of protected areas through time have significantly reduced global rates of biodiversity loss, although there remain significant gaps in protected area coverage and indicators of biodiversity continue to worsen (Rodrigues *et al.* 2004, Butchart *et al.* 2010). Although most of the current threats to species and habitats are largely associated with habitat loss, over-exploitation of populations and the introduction of non-native species (Hoffman *et al.* 2010), climate change is projected to become an increasingly important driver of loss over the course of this century, which by 2050 may commit some 15-37 % of species to extinction under a mid-range climate warming scenario (Thomas *et al.* 2004).

Impacts of Climate change

In addition to direct effects on species, climate change is likely to reduce the effectiveness of current conservation effort. Most current protected areas are based upon static assessments of species and habitat distributions (Pressey *et al.* 2007). However, because of the close link between climate and species' distributions, as exemplified by latitudinal shifts in species and habitats derived from the Palaeological record, climate change is projected to result in significant shifts in the distribution of species and habitats (e.g. Huntley *et al.* 2008). Indeed, there is increasing evidence for species' distributions having responded to recent warming (Parmesan & Yohe 2003, Parmesan 2007, Hickling *et al.* 2006). Such range shifts may result in species abandoning existing protected areas as they become increasingly unsuitable climatically or colonising new protected areas at the expanding range-margin of a species (Green & Pearce-Higgins 2010, Pearce-Higgins *et al.* 2011). A number of modelling studies of species range shifts have examined this (e.g. Hannah *et al.* 2007, Coetzee *et al.* 2009, Hole *et al.* 2009). Although there is considerable variation between them, they generally suggest that existing networks of protected areas are likely to continue to overlap with the future projected ranges of most species, thus providing support to the continued utility of protected areas in the future. However, given the likely magnitude of future range shifts, many protected areas are projected to experience high rates of species turnover (Hannah *et al.* 2007, Coetzee *et al.* 2009, Hole *et al.* 2009). Such information may be used to revise the existing location of protected areas in order to improve the likely coverage of future species' distributions (Araujo *et al.* 2004, Olsen & Lindsay 2009, Caroll *et al.* 2010 GCB), although achieving this within existing policy and legal frameworks remains a significant challenge (Cliquet *et al.* 2009, Dodd *et al.* 2010).

The future conservation status of species will not just be determined by their range, however, but by population size, with, for example, the magnitude of population declines in farmland birds exceeds observed range change (Fuller *et al.* 1995). This means that being able to model likely future changes in population abundance, as opposed to just range change, is likely to be of critical importance for understanding true climate change impacts on species' conservation. At a site-level, such information is even more important. Currently, protected areas should support sufficient individuals to ensure a low probability of extinction risk (McCarthy *et al.* 2005). Climate change introduces greater uncertainty over assessments of likely future population size at particular sites, and hence means that in order to provide adequate protection for particular populations, protected areas should generally be larger than they would be based upon current assessments, in order to account for this uncertainty. It is therefore important not just to assess how climate change may impact upon the distributional overlap of species within protected areas, which has been the focus of the studies outlined above, but also the abundance of species within those protected areas. We address this gap with reference to an internationally classified protected area network for birds within the UK.

The SPA Network

The focus of this study is the Special Protection Area (SPA) network, established in Europe to protect key sites for species listed under Annex I of the Council Directive 79/409/EEC on the Conservation of Wild Birds, species regarded as particularly vulnerable or rare, or migratory species . Sites were initially classified on the basis of supporting a particular population threshold for a given species (generally > 1% of the national population for Annex I species or > 1 % of the biogeographical population for migratory species), although in some cases, alternative criteria have been used; see the main report for more details. This network currently delivers significant conservation benefit, with the extent of SPAs within a country having a positive impact upon country-specific bird population trends (Donald *et al.* 2007). However, climate change is projected to have a significant impact upon the distribution of species' ranges within Europe (Huntley *et al.* 2007, 2008) with potential implications for the likely overlap between species ranges and the SPAs for which they are classified (Cliquet *et al.* 2009, Dodd *et al.* 2010). Indeed, there is already evidence that the distribution of one particular suite of European birds protected by SPAs, wintering waders, have shifted their distributions in response to climate change (Austin & Rehfisch 2005; Maclean *et al.* 2008). The network has been successful in reducing continent-wide biodiversity loss, but given the increasing evidence for significant impacts of climate change, the effects of which are only likely to increase into the future, it is important to understand the likely implications of climate change on this network in the future. This is particularly important given the legal framework underpinning the protection of these sites (Cliquet *et al.* 2009, Dodd *et al.* 2010).

We therefore use existing data on the density of Annex I and II European birds to model likely future changes in the abundance of those species upon existing SPAs within the UK in order to answer the following questions.

1) The extent to which existing SPAs will continue to support qualifying populations of particular species.
2) The extent to which any losses in qualifying species will be replaced by additional colonising species.

In doing so we therefore test the resilience of the existing SPA network within the UK to likely future climate change.

Methods

Details of the individual species models are described in Appendix 1.

Future projections

Models projected densities of birds as a function of climate at each site and were used to project future changes in the densities of birds at each site using future climate projections from UKCP09. These give probabilistic changes in temperature and precipitation variables for a range of time-slices and scenarios of climate change (UKCP09 2010). We used projections for low, medium and high emissions scenarios, which roughly equate to 2º, 2.5 º and 3 º increases in mean summer temperature by 2050 (UKCP09 2010). We also used projections for each of three timeframes: 2020, 2050 and 2080 and we present projections for the 50th quantile of the climate probability distribution (i.e. the median projection of change) using two complementary approaches (see the main report and Appendix 1 for more details). Projections for the 33rd and 67th quantiles of the future climate probability distributions were also calculated. In order to prevent inappropriately high future projections of abundance, we capped the maximum projected densities to be equal to the top 1 % of observed densities within the original data. Given the fact that UKCP09 data does not cover a number of remote seabird colonies, we were unable to make projections for 22 seabird SPA's.

Firstly (the absolute method), model outputs were used directly in order to estimate densities within each SPA, which were then multiplied by site area in order to calculate the likely population size at that site. In order to prevent densities being projected inappropriately, each SPA was classed as being either for seabirds, coastal, freshwater, and terrestrial species and projections were only made for that SPA if a particular species was likely to occupy that habitat. These projected densities are therefore equivalent to likely mean densities for a given climate, irrespective of site quality.

Secondly (the proportional method), in order to account for potential variation in site quality, which the relatively low fit of many of the models suggests is a critical determinant of abundance (Appendix 1), the proportional change in climate suitability at each site was indexed from the ratio of the projected future abundance of birds from the projected current abundance. This ratio was then used as a multiplier of existing observed densities.

Differences between the projection methods

The two projected outputs provide different information. The first estimates mean projected densities for a given site, all other things being equal, and therefore indicates the likely range of birds projected to be supported at that site if it is of average quality relative to the monitored sites. Sites which are currently unoccupied for non-climatic reasons will therefore appear occupied. Using this approach it is possible to project future densities of potential colonising species to sites on the basis of climate, on the assumption that potential colonisers are able to reach those sites, and will not be limited by other processes, such as dispersal rate. The second approach estimates likely projected densities given the current quality of that site relative to other sites. However, given the lack of information about site quality for currently unoccupied sites, this approach cannot project future colonisations and therefore assumes no range expansion. This twin approach of producing projections assuming either no restrictions to colonisation or no possible colonisation is common in bioclimatic modelling of species ranges (e.g. Huntley *et al.* 2007) and therefore encapsulates an optimistic (the absolute method) and pessimistic (the proportional method) range of possible futures. In general, methods produce similar findings (main report Section 3).

Effects on the SPA network

For each site and scenario combination, we assess the coverage of species by the existing SPA network, in relation to the population thresholds used for classification. In order to relate these changes to the present situation, we base them on the existing 1% national or biogeographical thresholds applied to Annex I and migratory species respectively, taking the population estimates in Stroud *et al.* (2001) and for waterbirds some more recent estimates from Calbrade *et al.* (2010). Although the assumption that these thresholds will not change is unrealistic, because they are direct proportions of national populations, we maintain the current thresholds because they provide a fixed measure against which we can assess the rate, direction and magnitude of projected future change. We also recognise that these thresholds are likely to change as a result of the current SPA review process. Note that this approach means that estimates of current SPA coverage may differ from the number of sites for which a particular species is classified / listed as a qualifying feature, because we exclude examples where a species is listed but does not achieve the qualifying threshold. For the two groups of species where sites may be classified for significant assemblages (> 20,000 individuals), namely wintering waterbirds and breeding seabirds, we also model likely changes in the number of sites which achieve this threshold by summing the totals for the relevant species groups. This is possible for these two groups because we model the abundance of all of the major potential contributing species. We therefore test the following null hypotheses:

1 – Climate change will not result in significant changes to the importance of the SPA network for individual species, based on the number of individuals projected to occur at a particular site, relative to the current threshold. Related to this, we also note differences in the response of different species groups (seabirds, wintering waterbirds, terrestrial species etc) to climate change.
2 - Climate change will not result in changes to the importance of individual SPAs, as assessed by the number of species attaining current thresholds at a particular site. Related to this, we model the number of qualifying species (features) as a function of area, longitude, latitude, and habitat, with interactions between area and habitat, and quadratic relationships and interactions between longitude and latitude, testing for significant interactions between species groups
3 – Climate change will not result in changes to the number of sites supporting significant species assemblages of > 20,000 individuals. Current and projected abundances are summed for different assemblages (seabirds and breeding assemblages) in order to estimate the total number of individuals of particular assemblages of birds projected to occur at each site. The proportional change in this total number of individuals relative to the current number indicates the extent to which the overall importance of the assemblage at a site is projected to change, and again related to the 20,000 threshold values.

Combined, we therefore model the likely implications of climate change across the SPA network in terms of patterns of change in both overall importance and the species assemblage.

Results

Changes to the importance of the SPA network for individual species.

The absolute method projects a total of 514 species x site combinations will reach the current qualifying threshold in 2020 under the low emissions scenario, with 63 of 105 features (species or assemblages) achieving qualifying status in at least 1 site, and 138 of 249 UK SPAs supporting important numbers of at least one species. In 2080 under the high scenario there are projected to be 516 classifications over 129 sites and 59 features . The equivalent figures for the proportional method, based upon the most recent observational data, are that 586 species x site combinations will achieve threshold status in 2020 under the low scenario across 70 species and 145 sites. In 2080 under the high scenario there are projected to be 533 species x site classifications, across 61 features and 133 sites.

Models suggest that on average, more species are likely to achieve current qualifying status at more sites as a result of climate change (winners) than are likely to lose qualifying status (termed losers). Overall, of the 103 species modelled, 25 are projected to increase in the number of sites where they are features using the proportional method under a medium 2050 scenario, whilst 15 are projected to be listed as features on a smaller number of sites than at present. There are projected to be a greater number of climate change winners than losers in 2020, but with the difference between the two groups gradually decreasing, and by 2080, the losers are projected to be equivalent to the winners (Figure 1). In other words, by 2080, the same number of species will achieve the current threshold status on fewer SPAs than at present, than will achieve the current threshold status on more SPAs. Under the medium 2050 scenario, we project 40 species (50 %) remain unchanged, although 18 of these are species with very poor models and therefore remain stable by default.

However, of the 25 Annex 1 species that comprise this list and had reasonable models, 5 were projected to achieve threshold status on more sites by 2050 under a medium emissions scenario, whilst 5 were projected to achieve threshold status on fewer, indicating that climate change impacts are projected to be worse for that group than for migratory species. This contrast becomes greater under a high climate change scenario (Figure 2). The overall number of ‘losers’ is projected to increase through time and with severity of climate change, whilst the number of ‘winners’ is likely to decline with increasing severity of change (Figure 1). These changes are projected to be broadly similar when using either proportional or absolute methods. Thus by 2080 under a high scenario, 25 species are projected to be SPA features at a greater number of sites than at present, but 26 are projected to be features on fewer sites. This equates to 6 Annex 1 species achieving threshold status on more sites, but 10 reaching threshold status on fewer. Comparing the trends projected between the Annex I and migratory species (Figure 2), Annex I ‘losers’ are projected to overtake ‘winners’ by 2050, whilst in the migratory group this only happens in 2080 under the high scenario.

Looking at how the trends compare across species groups (Figure 3) provides more information. In breeding birds the number of losers is likely to be greater than the number of winners by the end of the projected time frame, but fewer at the beginning.

In wintering species, the number of losers is lower than the number of winners and passage species show a changing response over time, and by 2080 the number of losers is equal to the number of winners. Splitting these species groups further into only Annex I species (Figure 4), a similar pattern is seen for most of the species groups. For breeding species, a higher proportion of Annex I species are projected to be losers, than the proportion seen across all species. A similar difference is seen in the wintering and passage species.

Comparing the results from the proportional method to the results obtained by using the absolute method, highlights some key differences (Figure 5). When using the absolute method, there are no projected changes in the number of sites classified for breeding bird species, but the absolute method projects a higher proportion of losers in the passage and wintering groups. This may be because the quality of sites is not taken into account in this method, meaning that good sites are reduced to average sites (whereas they stay ‘good’ in the future using the proportional method), resulting in a higher number of losers.

Examining only the projected changes in Annex I species with the absolute method (Figure 6) reveals some unrealistic results. This may be due to the small number of Annex 1 species, the high number of Annex 1 colonisers projected, and the coarseness with which the absolute method treats individual site quality. However, one key pattern is still apparent in all species groups. Through time, the number of climate change winners is expected to decrease, and the number of climate change losers is expected to increase.

Changes in the importance of individual sites

The pattern of changes in the number of qualifying species modelled at each site is similar to that of the analysis of species. Based upon the proportional method, which better assesses change relative to current abundance, 48 of the 249 SPAs tested are projected to gain additional species achieving qualifying status (features) whilst 30 are projected to lose featuresby 2050 with the medium scenario. The remainder either remain stable, or increases in classifications of some species are compensated for by declines in others.

As with the species-based analysis, the number of sites projected to gain additional species achieving qualifying status is likely to be greater than the number of sites projected to lose species. However, through time and with increasing severity of climate change, the number of site 'losers' is projected to approach the number of winners (Figure 7). Focussing on Annex I species, under a 2050 medium emissions scenario, 24 sites are projected to gain additional Annex I features, whilst 19 are projected to lose Annex I features, again indicating more negative effect on this group of species. (Figure 8). By 2080 the number of sites losing Annex I features is projected to be similar to the number of sites gaining Annex I features. For migratory species, many more sites are projected to gain than lose features under all emissions scenarios and timeframes.

When comparing the different species groups, the same patterns are evident. In passage and wintering waterbirds, there are projected to be fewer sites with fewer features (‘losers’) than sites gaining features (‘winners’). This is most marked in the wintering waterbirds (Figure 9). In all species groups, the number of losing sites is expected to increase through time and with increasing severity of climate change. The breeding birds and seabirds show low proportions of sites with changes in the number of features. Amongst seabirds, many species had poor models, whilst in the breeding (non-seabird) group fewer species had poor models, however many sites are classified for single species. Both groups indicate more sites will be losers than winners. For Annex I species only, the patterns are slightly more positive for breeding seabirds and more negative for wintering waterbirds (Figure 10). In 2080 under the high scenario there are projected to be more sites losing Annex I features, than those gaining them.

Results from the absolute method, in which both the projected current and therefore projected future distribution of species is not limited by the existing range and site-specific habitat factors, project greater rates of colonisation. However, both methods project that the number of sites projected to gain features will level or decline with increasing severity of climate change, whilst the number of sites potentially losing features is projected to increase through time. As with the proportional method, the absolute method projects more sites to grain seabird features (Figure 11). However for wintering species, the effect is the opposite: more sites are projected to be losers and with fewer winners, when comparing to the proportional method. More sites are projected to gain features of breeding species, wintering species and passage species under the absolute methods, than are projected to lose classifications of the same groups.

When looking at Annex I features only, the overall picture is less-positive than for all species (Figure 12). With the exception of passage species. the proportions of sites losing Annex I features is greater than the proportions of sites losing all classifications. This suggests that the resilience of the SPA network is lower for Annex I species than for migratory species. However for passage species and breeding seabirds, there are also a higher proportion of sites gaining Annex I species classifications than for all species.

Models of variables effecting changes in site importance
The change in the number of SPA features per site was calculated between current modelled classifications, and average projected classifications over all scenarios and timeframes. This response variable was modelled within each species group using the following variables as projector variables: site size, species status (Annex I or migratory), habitat (coastal or non-coastal, for wintering and passage species), easting, easting squared, northing, northing squared, and interactions between species status and habitat, and easting and northing (Table 1). Figure 13 shows the average projections for each species group, split by species status. All other variables in the final model are held at their mean value observed for the SPAs for the relevant group. Sites with Annex I breeding species and Annex I breeding seabird features were all projected to have a statistically significant average decline in the mean number of classifications, whilst there was a projected increase in the number of breeding, passage and wintering migratory species. There were no significant differences predicted overall for the other groups. For all groups, projected losses tended to be greater for Annex I features than migratory features.

Site size was not a significant predictor of anticipated change in passage or wintering features, suggesting that larger sites are not likely to gain or lose a different proportion of their classifications, compared to smaller sites (Table 1). Easting was not a significant correlate for any group and northing was only a significant correlate for sites holding individuals from seabird groups (Figure 14). Sites in the south are anticipated to have significantly more gains in features than sites in the north.

Spatial location of sites gaining and losing classifications

The overall patterns of change may be also represented by maps of projected changes to the number of qualifying species at individual SPAs by 2050 under a medium emissions scenario. These projections indicate likely losses and gains of qualifying features at SPAs as a result of climate change (Figure 15). As these projections are based on proportional changes, the potential for such colonisation by southerly-distributed terrestrial breeding species is not described. Seabirds show a number of losses, particularly at northerly sites, but some gains in the south. Breeding birds show few changes with the proportional model. Projected increases in wintering and passage waterbirds are reflected in a greater number of SPAs projected to gain in qualifying features, although there are some losses projected in the south and west.

Changes in species assemblages

Summing the numbers of projected individuals within each of the two assemblages at each SPA identifies those sites for which the wintering water bird or breeding seabird assemblage is likely to exceed the 20,000 individual threshold. The models project little change in the number of sites for which the wintering waterbird assemblage will be a qualifying feature, with many sites projected to increase the number of wintering waterbird classifications they have, and resulting in increases in total numbers. For seabirds, however, the number of sites projected to support a significant seabird assemblage is projected to decline with increasing severity of climate change, by up to a third under a 2080 High scenario (Figure 16).

Discussion

Changes in the importance of the SPA network for individual species

There are a wide range of projected species responses to climate change. However here we examine the changes in importance of the SPA network across species groups. Over all species, in 2020 the SPA network is projected to have gained classifications for more species than it loses classifications, (although this modelled short term change may be sensitive to the climate from the most recent five years used to model 'current' numbers, relative to the magnitude of future projected climate change). However by 2050 the difference between these two groups of winners and losers will be reduced with increasing severity of climate change and disappear by 2080.. Therefore, over time, particularly under high emissions scenarios, the resilience of the SPA network to support species to the same extent as it does at the moment is likely to decrease. Although the two groups of species follow broadly the same patterns, Annex I species are projected to fare worse than migratory species. By 2050 the number of Annex I species projected to be features at fewer sites is likely to exceed the number projected to be features at more sites

Splitting the results by species groups; passage and wintering groups are likely to experience the greatest proportion of species with an increase in the number of qualifying features across the SPA network, whilst breeding birds (seabirds and other breeding birds) are modelled to be more likely to experience losses, as assessed using the proportional method. There are some limitations which must be taken into account when examining projections from the absolute method. Firstly, many of the species modelled have specific habitat requirements. The absolute method may be projecting high numbers at sites which are climatically suitable, but not of suitable habitat in terms of habitat. In addition many of the colonising species from abroad are projected to have climatically suitable breeding habitat in the UK in the future. However, these breeding numbers may not be realised, due to restrictions on dispersal (and hence colonisation), a long time-lag before colonisation, competitors in the UK, or habitats which aren't suitable. Therefore the absolute method models an average projected capacity for these sites based on climate, but other factors may substantially reduce this number in reality.

Changes in the importance sites within the SPA network.

The summaries of sites projected to gain or lose features show a different pattern to those of the species. At all time frames, and under all emissions scenarios, the number of sites gaining species classifications is greater than the number of sites losing species classifications, and this is without accounting for the fact that new sites will probably enter the SPA network if they gain species at qualifying levels. This largely appears driven by likely significant increases in abundance for a number of species, such as little egret, brent goose and teal. As time progresses, the number of sites projected to lose features increases at a greater rate than the number of sites projected to gain features. Therefore the impact of climate change on sites within the SPA network is still projected to increase with time. As in the analysis of species, losses of Annex I features at sites are expected to be greater than migratory features. Sites are projected to gain many more passage and wintering waterbirds features than they lose, but lose more breeding bird (seabirds and terrestrial) features than they gain. These patterns again indicate that Annex I features are much more susceptible to negative effects of climate change than migratory features.

Overall more sites are projected to gain features than are projected to lose them, but marginally more species are projected to be less represented in SPAs based on current classification thresholds than better represented, at least under a high 2080 emissions scenario. This contrast suggests that some species will become more widespread and become features on more sites, whereas a greater number will contract and decline in abundance. The number of site gains outweighs the number of site losses, but the number of species gains is closer to or less than the number of species losses.

Spatial variation and other correlates of site importance

The status of species (Annex I or migratory) was an important factor in determining the average change in the number of features at a site across all four of the species Groups, with a more negative coefficient for Annex I species. This may be because Annex I species are those which are already scarce or rarer than the migratory species, and may therefore be more vulnerable to a changing climate. The coefficient of the coastal habitat variable for the model of wintering waterbird sites was not significant, suggesting that coastal sites are no more likely to gain SPA species classifications than freshwater sites. The area of a site was also not an important variable for waterbirds, suggesting as a proportion of existing features, large sites are no more likely to gain or lose classifications than small sites. There was a significant latitudinal trend in projected changes for seabirds, with SPAs in the south projected to have the highest resilience and greatest increase in numbers in features, whilst those in the north were projected to lose features. Losses may be particularly marked on the north coast of Scotland, and the Northern Isles. The birds which contribute to these changes and the communities with comprise them are discussed in Appendix 3 in more detail.

Changes in assemblage classifications

Climate change is projected to have little impact on the number of SPAs classified on the basis of holding an important wintering waterbird assemblage. These changes are consistent with the projections for the number of sites with wintering waterbirds which are 'winners' and 'losers'. In the future there are projected to be roughly the same number of large important sites for wintering waterbirds, although the sites which are important may change, and the composition of that assemblage almost certainly will. Examining changes in the number of sites reaching the threshold for the breeding seabird assemblage provides a new dimension to the seabird changes. There is a strong trend for a decrease in the number of sites qualifying for a breeding seabird assemblage feature. This pattern may be occurring because those sites projected to gain individual species classifications are already classified for an assemblage, or because those projected to lose individual species classifications lose their assemblage status in the process. In general, there are projected to be fewer large very important seabird colonies in the future than there are at the moment.

General Conclusions

The impacts of climate change on species' abundances and distributions will be species-specific, and perhaps unpredictable. However projections of general patterns of change should provide a good indication of the direction of travel of species movements. Thus, projections of large-scale impacts on the SPA network are likely to be robust to less certain projections of individual species. However, there are many sources of uncertainty associated with these projections and it is important to bear these in mind. In this Appendix, we have only presented results from the median percentile of the projected climate distribution, so our projections are dependent on the magnitude of future climate change, which is uncertain. Also, all modelled projections of numbers have an error associated with them, and these errors are also not presented here. Furthermore, thresholds for feature classification are assumed to stay constant in these results, which will only be the case for the assemblage thresholds.

The graphs and results in this Appendix illustrate that climate change is projected to have marked impacts on the sites and species of the SPA network in the UK. In the future, more sites are projected to gain SPA classification levels than lose them, but by 2050, more species are projected to have lost site classification levels than will gain them. Therefore in the future, an SPA network based on current classification thresholds will be likely to represent fewer species but overall have a greater number of features across all sites.

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Table 1. Summary of analyses examining spatial variation in the projected change in the number of qualifying species as a result of climate change. Model selection was by backwards and forwards stepwise selection using AIC as the diagnostic criterion.

	Estimate	**Std Error**	***P*-value**
Breeding birds (exc seabirds)			
Intercept	0.5000	0.1620	
Annex I	-0.5435	0.1654	0.0020
Breeding seabirds			
Intercept	0.4908	0.1301	
Annex 1	-0.2558	0.1020	0.1408
Northing	-7.9×10^{-7}	0.16×10^{-7}	<0.0001
Wintering waterbirds			
Intercept	0.4247	0.0841	
Annex I	-0.3870	0.1272	0.0030
Passage waterbirds			
Intercept	0.4861	0.1052	
Annex I	-0.4755	0.1237	0.0003

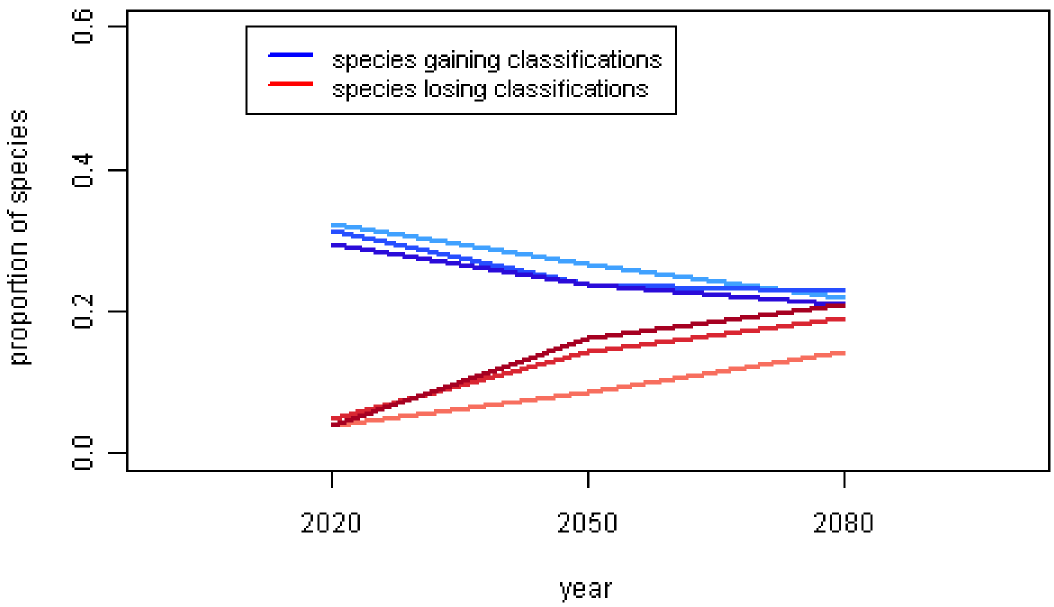

Figure 1. The number of species projected to exceed the current qualifying status in more (blue) or fewer (red) SPAs than at present, in relation to different climate change scenarios (low, palest hue; medium, medium hue; high, darkest hue). Projections are made using the proportional method.

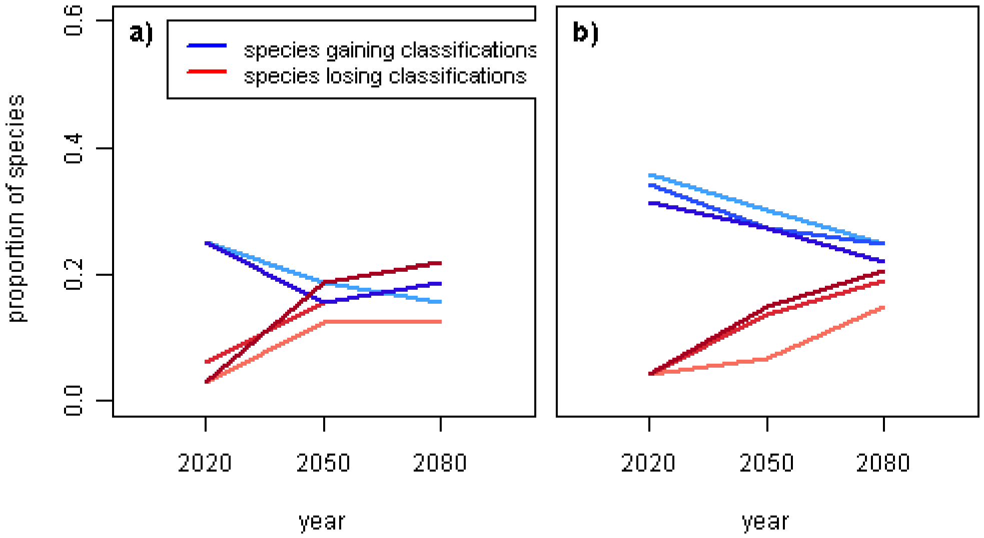

Figure 2. The number of Annex 1 (left) and migratory (right) species projected to exceed the current qualifying status in more (blue) or fewer (orange) SPAs than at present, in relation to different climate change scenarios (low, palest hue; medium, medium hue; high, deepest hue). Projections are made using the proportional method.

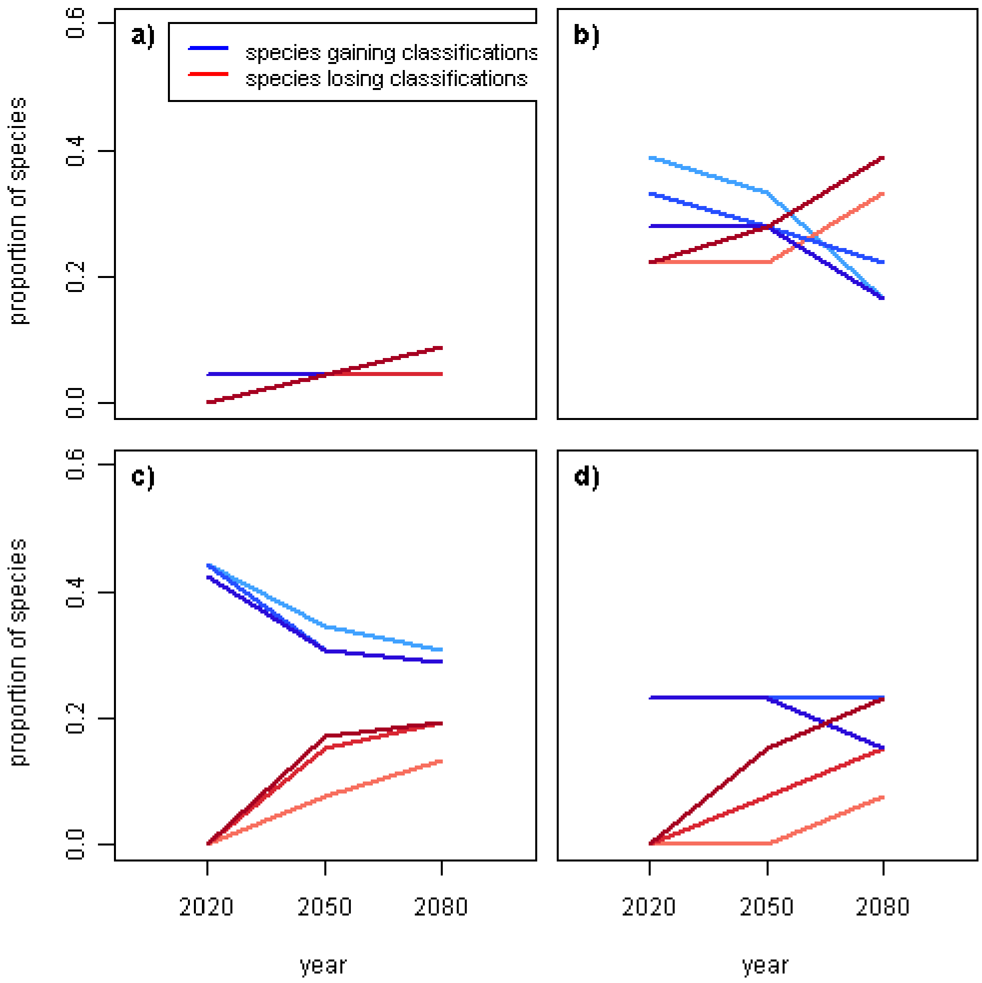

Figure 3. Th e proportion of species projected to achieve qualifying status at more (blue) or fewer (red) sites under different climate change scenarios (low, palest hue; medium, medium hue; high, deepest hue) and assessed using the proportional method for the following groups of species: a) Breeding birds (excluding seabirds); b) Breeding seabirds; c) Wintering waterbirds; d) Passage waterbirds.

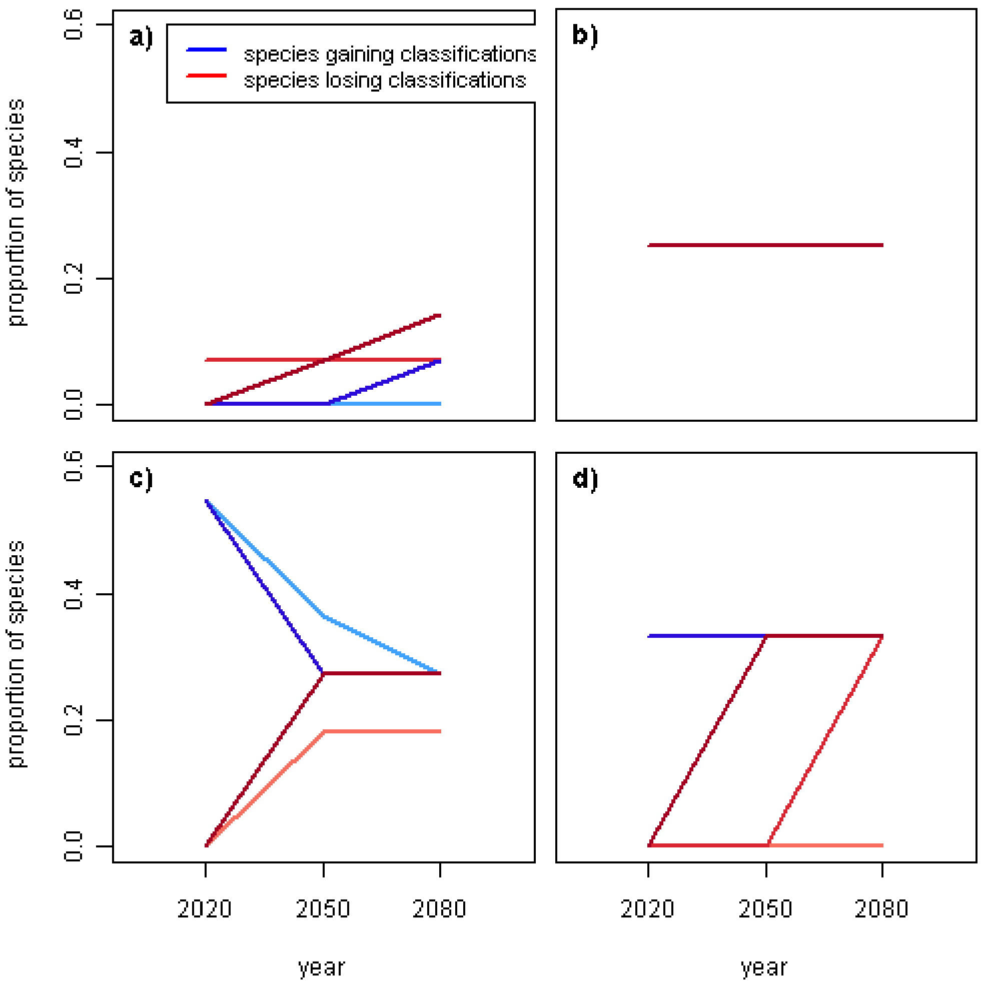

Figure 4. The proportion of Annex I species projected to achieve qualifying status as more (blue) or fewer (red) sites under different climate change scenarios (low, palest hue; medium, medium hue; high, deepest hue) and assessed using the proportional method for the following groups of species: a) Breeding birds (excluding seabirds); b) Breeding seabirds; c) Wintering waterbirds; d) Passage waterbirds.

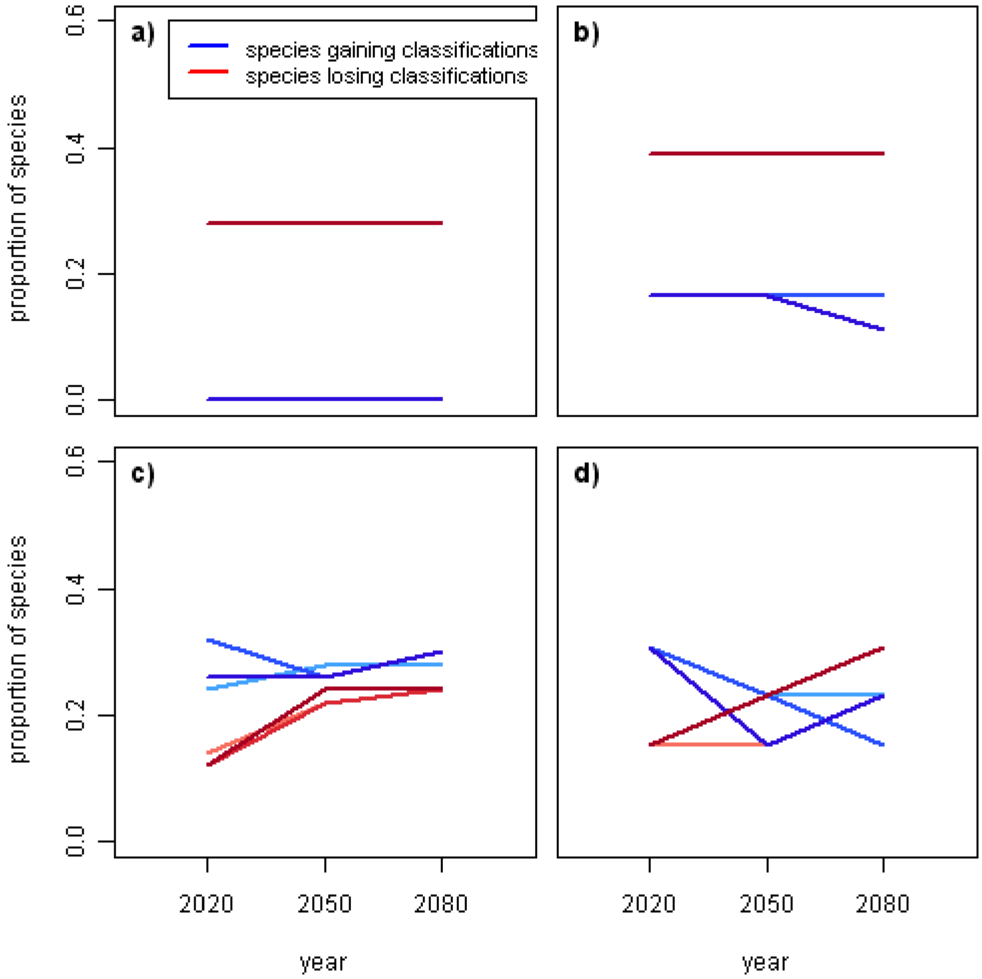

Figure 5. The proportion of species projected to achieve qualifying status as more (blue) or fewer (red) sites under different climate change scenarios (low, palest hue; medium, medium hue; high, deepest hue) and assessed using the absolute method for the following groups of species: a) Breeding birds (excluding seabirds); b) Breeding seabirds; c) Wintering waterbirds; d) Passage waterbirds.

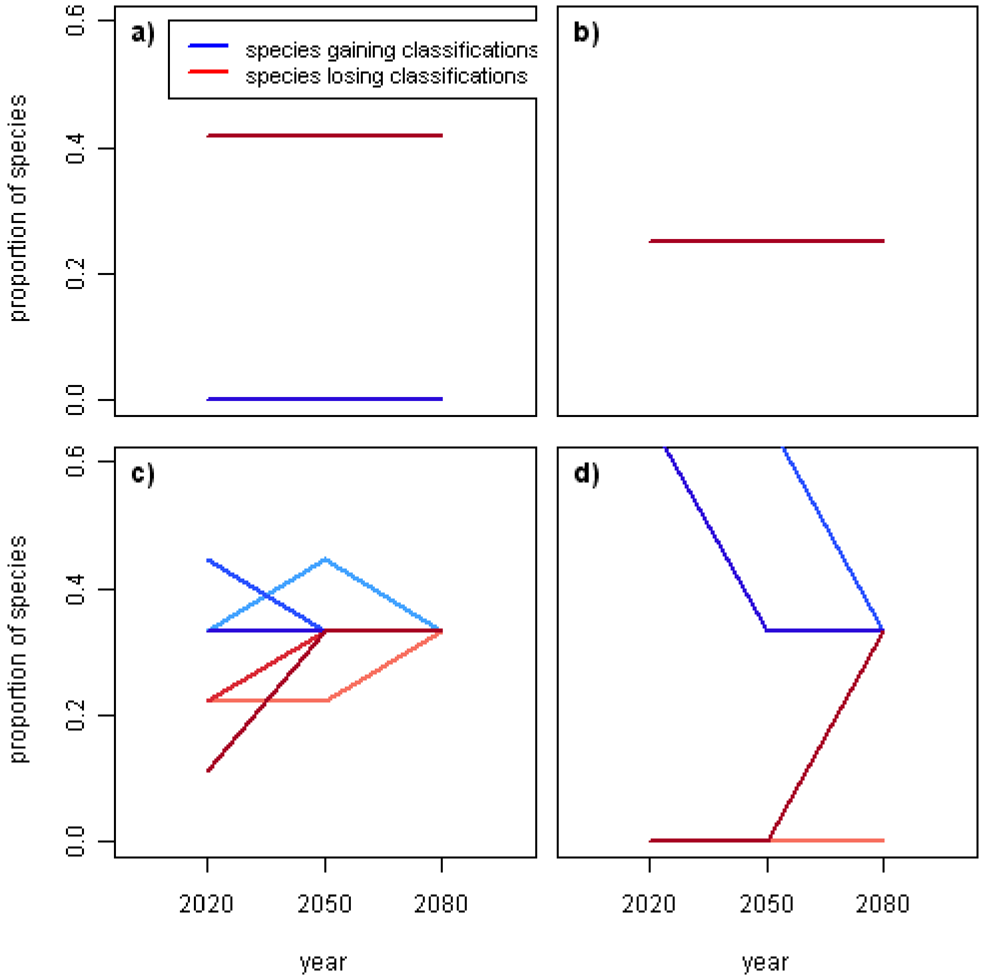

Figure 6. The proportion of Annex 1 species projected to achieve qualifying status as more (blue) or fewer (red) sites under different climate change scenarios (low, palest hue; medium, medium hue; high, deepest hue) and assessed using the absolute method for the following groups of species: a) Breeding birds (excluding seabirds); b) Breeding seabirds; c) Wintering waterbirds; d) Passage waterbirds.

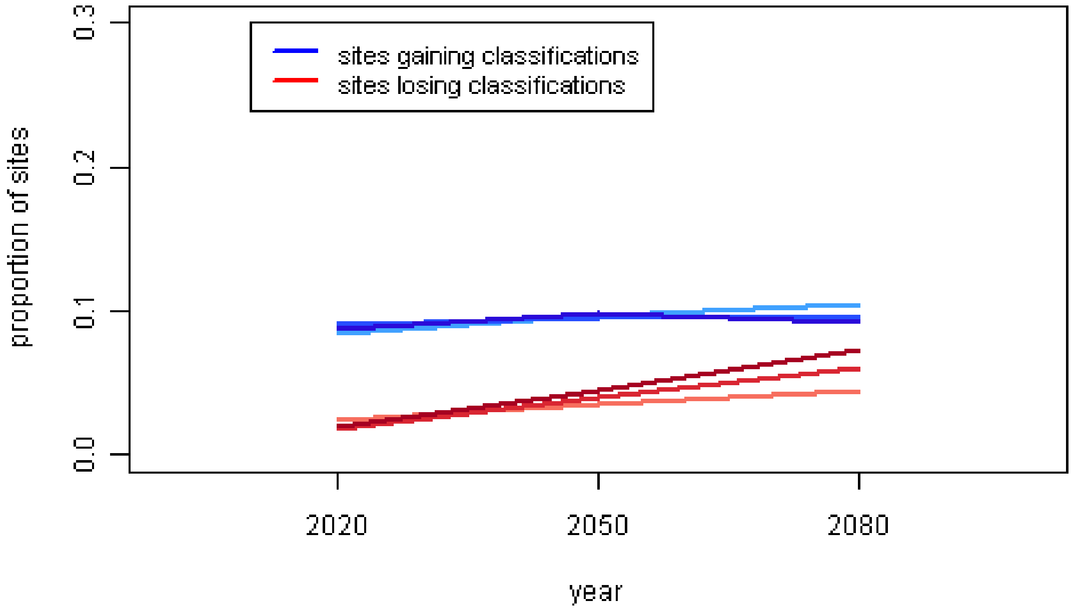

Figure 7. The number of SPAs projected to gain more (blue) or fewer (red) species exceeding the current qualifying threshold than at present, in relation to different climate change scenarios (low, palest hue; medium, medium hue; high, deepest hue). Projections are made using the proportional method.

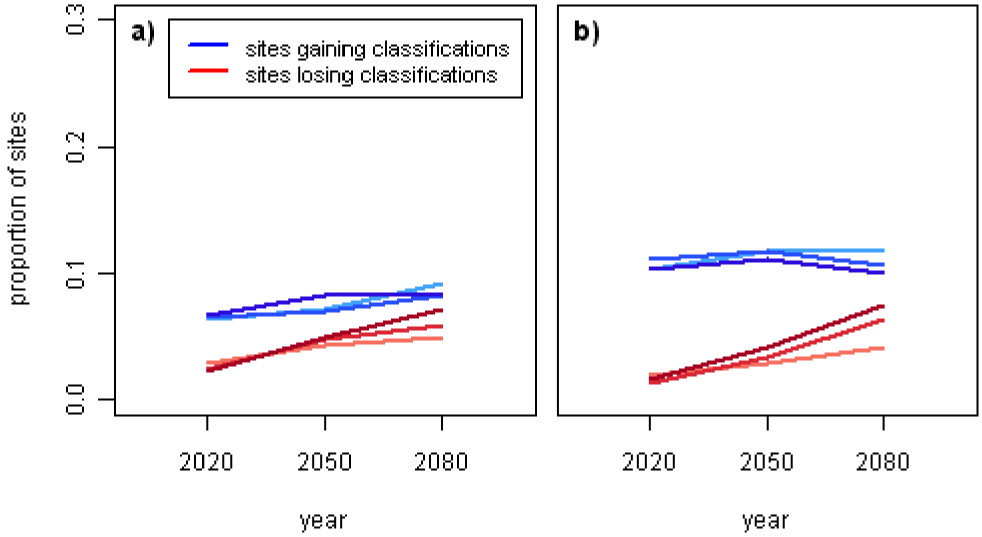

Figure 8. The number of SPAs projected to gain more (blue) or fewer (orange) Annex 1 (left) and migratory (right) species exceeding the current qualifying threshold than at present, in relation to different climate change scenarios (low, palest hue; medium, medium hue; high, darkest hue). Projections are made using the proportional method.

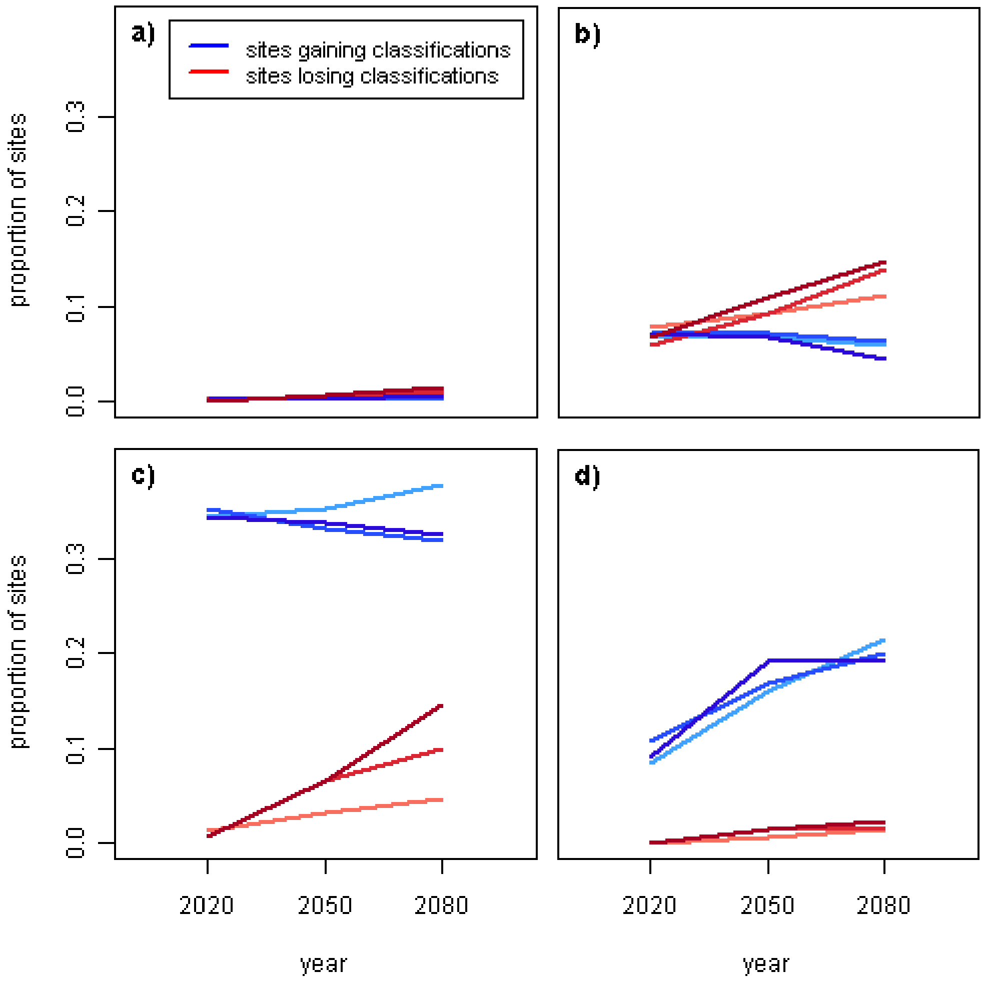

Figure 9. The proportion of sites projected to achieve qualifying status for more (blue) or fewer (red) species under different climate change scenarios (low, palest hue; medium, medium hue; high, darkest hue) and assessed using the proportional method. Shown for 4 different species groups: a) Breeding birds (excluding seabirds); b) Breeding seabirds; c) Wintering waterbirds; d) Passage waterbirds.

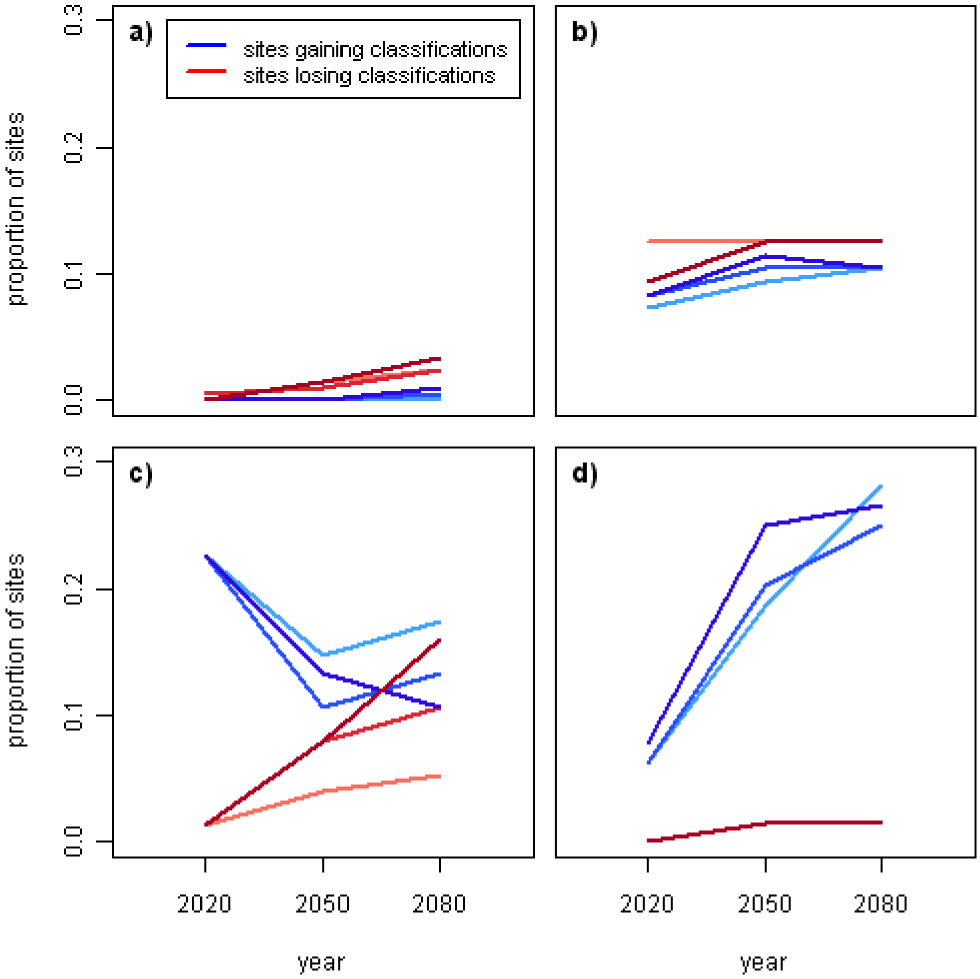

Figure 10. The proportion of sites projected to achieve qualifying status for more (blue) or fewer (red) Annex I species under different climate change scenarios (low, palest hue; medium, medium hue; high, darkest hue) and assessed using the proportional method. Shown for 4 different species groups: a) Breeding birds (excluding seabirds); b) Breeding seabirds; c) Wintering waterbirds; d) Passage waterbirds.

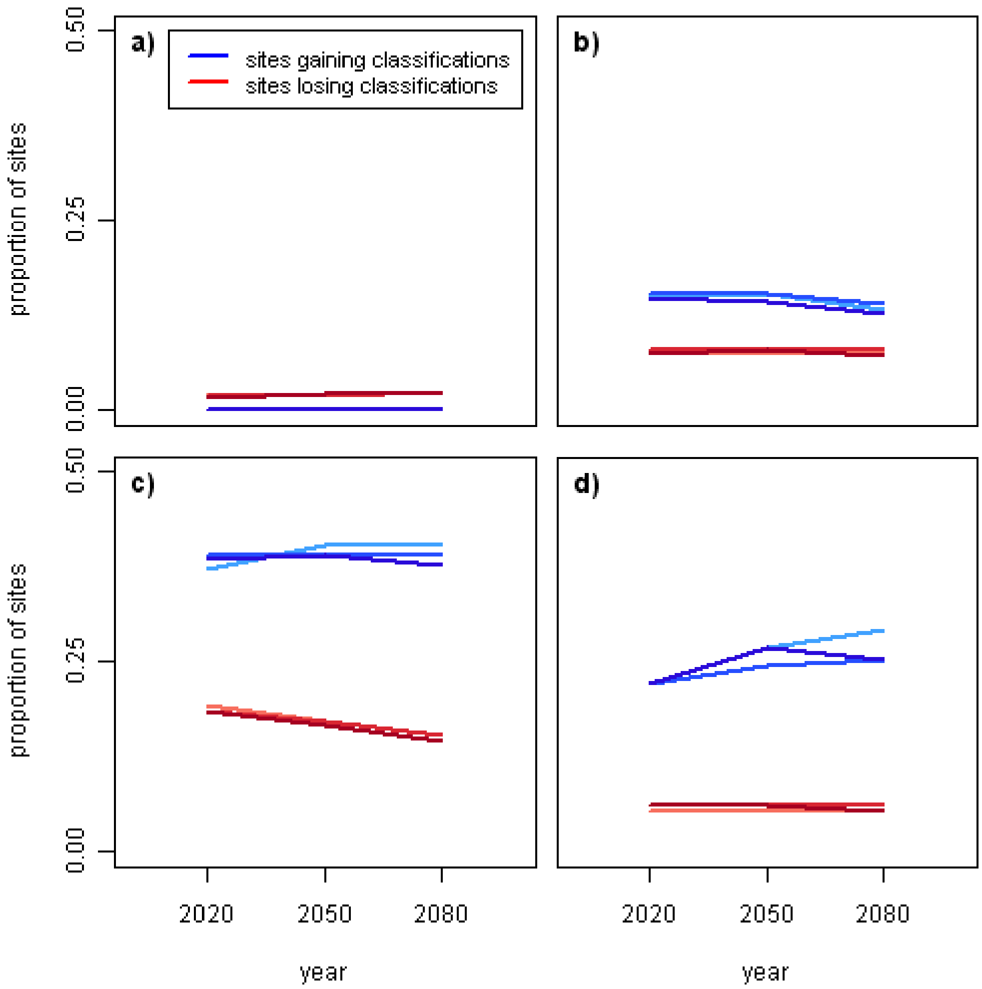

Figure 11. The proportion of sites projected to achieve qualifying status for more (blue) or fewer (red) species under different climate change scenarios (low, palest hue; medium, medium hue; high, darkest hue) and assessed using the absolute method. Shown for 4 different species groups: a) Breeding birds (excluding seabirds); b) Breeding seabirds; c) Wintering waterbirds; d) Passage waterbirds.

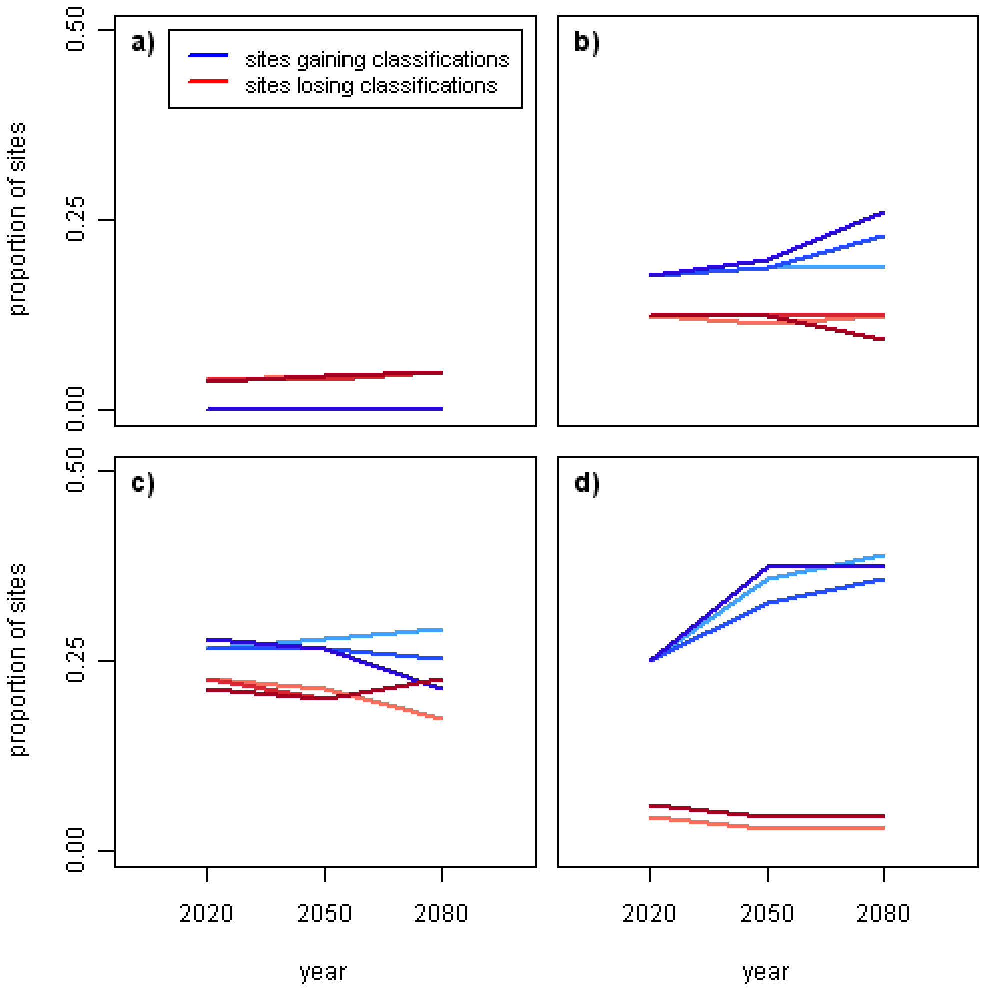

Figure 12. The proportion of sites projected to achieve qualifying status for more (blue) or fewer (red) Annex I species under different climate change scenarios (low, palest hue; medium, medium hue; high, darkest hue) and assessed using the absolute method. Shown for 4 different species groups: a) Breeding birds (excluding seabirds); b) Breeding seabirds; c) Wintering waterbirds; d) Passage waterbirds.

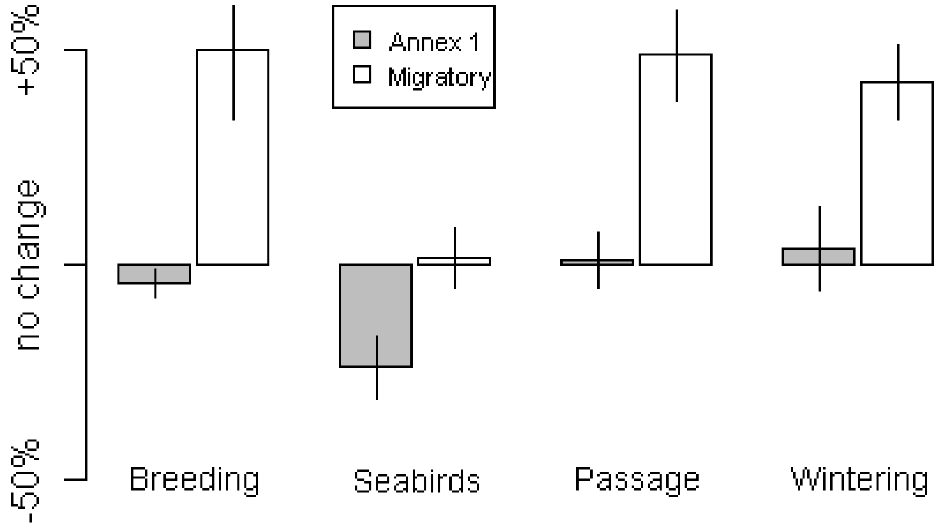

Figure 13. Projected changes in the mean proportion of classifications per site separated by species group and species status (Annex 1 or migratory) averaged over all future scenarios. Lines represent 95% confidence intervals of means.

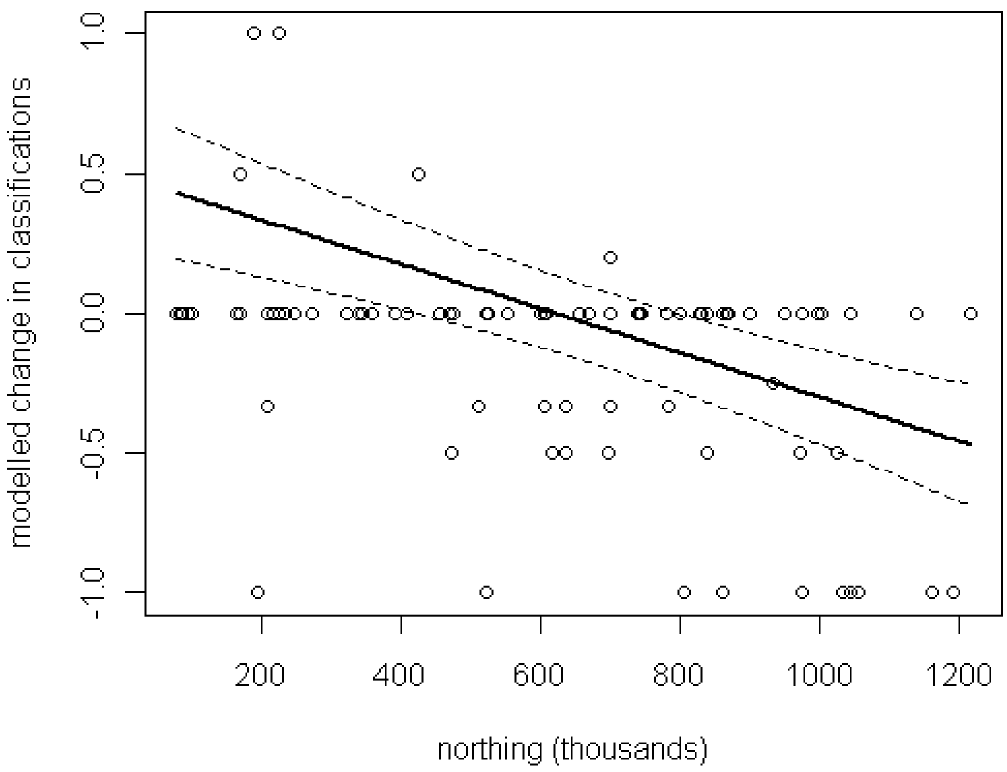

Figure 14. Projected changes in the mean proportion of classifications per site for sites holding breeding seabirds. Points represent the data, and lines the fitted relationships, with dotted lines representing the 95% confidence intervals of the fitted model. The response is the change in number of classifications averaged over all future scenarios and timeframes.

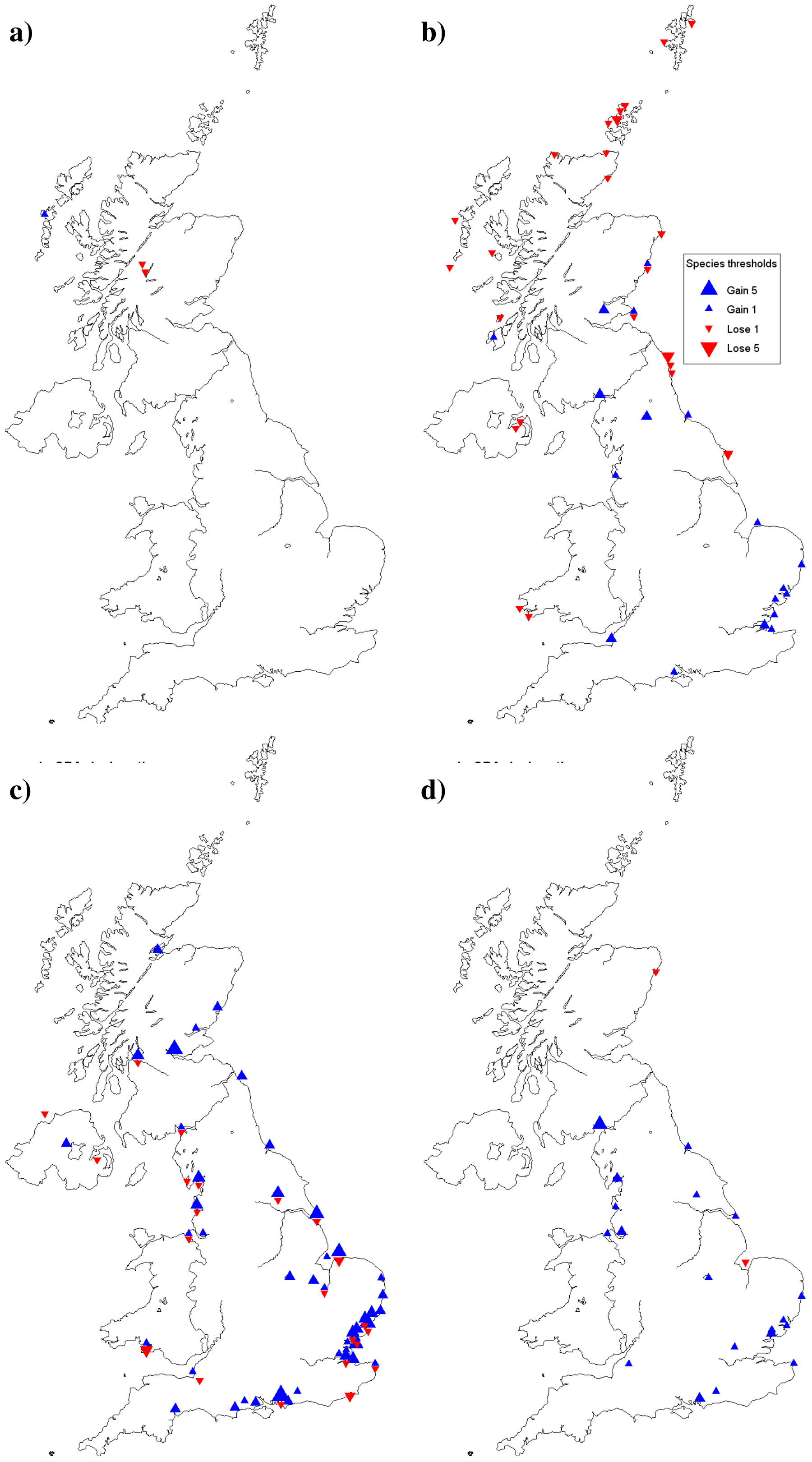

Figure 15. Change in SPA classifications between observed 2006 classifications (based on threshold classifications only) and projected number of classifications in 2050 under the medium emissions scenario and at the median climate projection percentile. For groups a) Breeding birds (excluding seabirds); b) Breeding seabirds; c) Wintering waterbirds; d) Passage waterbirds.

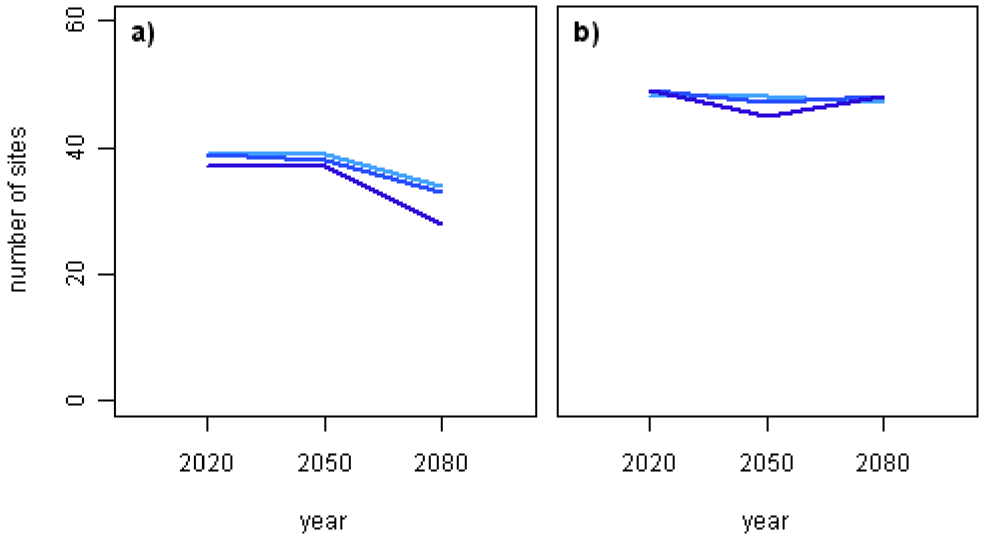

Figure 16. The number of sites projected to have sufficient numbers for assemblage qualification for a) Breeding seabirds and b) Wintering waterbirds. The colours represent different climate change scenarios (low, palest hue; medium, medium hue; high, darkest hue).