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IFMA Module 1f - Economic and social welfare impacts of changes in seabird distribution in the UK due to climate change

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Executive Summary

It is widely recognised that climate change will have an effect on the different processes and components of coastal and marine ecosystems and that these effects will ultimately impact human welfare. Several studies on the impacts of climate change on human welfare have largely focused on the effects of a changing climate on food security, human health and property damage (e.g. due to an increased risk of flooding), but the availability of studies that examine the welfare impacts of changes in biodiversity or shifts in species distribution due to climate change is limited.

The work done for this report aims to fill part of the evidence gap by providing an initial indication of the welfare impacts of a change in species distribution in the UK due to climate change; specifically the impacts of a change in the distribution and range of seabirds, in terms of the economic value of these impacts and the stakeholders that will be affected. This study makes use of three different pieces of work to assess the potential impacts of a change in seabird distribution in the UK on social welfare. First is the study by Huntley et al., (2007) which outlines the potential changes in the breeding distributions of bird species brought about by future climate change. The second is a report by the RSPB (Royal Society for the Protection of Birds) on the local economic value of seabirds (RSPB, 2010), which estimates visitor spending in four coastal reserves in the UK and the associated impacts on the local economy that are attributable to the presence of seabirds. The last piece of work that has been used to inform this study is an investigation of the 'willingness to pay' among the UK population to prevent a decline in seabirds due to their contribution to the recreational experience in coastal areas and their role in the functioning of the coastal and marine food-webs (Paltriguera, 2013). This study also refers to other sources to show how changes in biodiversity (not specific to seabirds or climate change) affect human welfare and discuss how other issues such as substitution and individual/social perceptions influence overall welfare changes.

In order to systematically assess the welfare impacts in the UK from a change in seabird distribution under a climate change scenario, the study makes use of the Balance Sheets approach, as proposed by Turner (2011). This allows different socio-economic impacts to be examined, and makes use of different but complementary and interlinked components; namely an economic impact/cost-benefit analysis, and a regional and local financial impacts analysis.

The economic impact analysis focuses on the impacts of the change in seabird distribution on those who hold 'use' and 'non-use' values for seabirds and how overall welfare changes translate to a

change in national welfare. Those who hold use values are members of society who directly benefit from the presence of seabirds around the UK coasts; these are those who participate in recreational activities that are enhanced by the presence of seabirds (e.g. bird watchers, visitors to coastal nature reserves). On the other hand, those who hold non-use values are those who prefer to maintain the existence of seabirds currently found in the UK even though they have never participated in activities enhanced by the presence of seabirds nor have any plans in participating in these activities.

The use values placed on seabirds can be partly measured by the amount of money spent by individuals to participate in coastal recreational activities that 'feature' seabirds. A loss of these birds around the UK due to climate change means that specific aspects of coastal recreation are no longer the same. The economic impact of this change can be quantified by measuring the anticipated change in visitor spending and how this change affects the overall productivity of the national economy, as measured by changes in Gross Domestic Product (GDP). The RSPB study (2010) shows that the money spent by visitors to RSPB reserves that can be attributed to the presence of seabirds range from £3.50 to £18.13 (2012 prices) per person. These amounts give an indication of how much these visitors value participation in activities that are 'enhanced' by the presence of the birds, presented in monetary terms. There are visitors to reserves who consider themselves as keen bird watchers and bird enthusiasts, and a loss in the seabird species currently found in the UK could result in these individuals no longer participating in this specific activity. Even though new seabird species can be found along the UK coasts, these people may not consider these particular species as strong substitutes to 'traditional' species which means that the satisfaction derived from participating in other recreational activities is not the same. This means there will be losses of use values attached to native seabirds by these individuals, as expressed by the cost they are willing to incur to view these birds. However, when measured relative to the overall UK economy, it is unlikely that these losses will be large. This is because other individuals will switch to other recreational activities and continue to spend money to participate in these activities.

Non-use values can be measured using stated preference techniques. These techniques elicit how much an individual is willing to pay in order to increase or avoid a loss in the consumption of a non-market good. The Paltriguera (2013) study found that a sample of the UK population is willing to pay £4.11 to £15.43 to prevent a decline in the seabird population in the Flamborough Head and Bempton Cliffs Special Protection Area. These values are taken as an indication of the benefits attached to the prevention of a loss of seabirds found in that particular area. There are also other studies which show that UK society places a value on knowing that marine biodiversity and specific

species are in good condition, even though there are no direct benefits derived. These show that 'local endowment' or having unique species present in the UK is highly valued, and it can be inferred that adverse changes in the state of species currently found in the UK will result in a loss in non-use values at the individual and national level.

The regional and local financial impact analysis focuses on the impacts on businesses and local economies that benefit from the activities of users and from the presence of seabirds in a particular area. The RSPB (2010) study shows that the total visitor spending in the four RSPB coastal reserves attributable to seabirds amount to almost £1 million (2012 prices) per year, and this spending benefits local economies and the people living in the areas that have these reserves. If there is a loss of seabird species in a particular area, people are likely to reduce their visits to nature reserves or participation in activities that allow them to watch and learn about seabirds. This will result in a decrease in the demand of visitors for the goods and services provided by businesses in the area. This will affect the revenues of these businesses and their ability to retain or employ more staff, thus affecting local economies. This will also have consequent effects on other businesses that provide other goods and services to businesses in the tourism and recreation industries. However, the overall impacts on these local businesses and economies will depend on the availability of other recreational activities within the area. If visitors continue to participate in other recreational activities in areas where seabird populations were once found, then they will continue to spend part of their income on goods and services in the area and the businesses there will benefit from this continued spending. However, support for businesses from individuals who visit the area specifically to view the seabirds will be lost as it is more likely that these people will no longer visit and there could be specific businesses that will be affected by this. If there is a complete loss in visitor spending due to loss of seabirds, the magnitude of impact will be greater than the £1 million estimated in the RSPB study.

Overall, it is likely that the most significant impacts brought about by a loss of native seabird species due to climate change will be on local economies that currently benefit from the presence of seabirds in specific areas and on the non-use values attached to seabirds. This is because there are few options for substitutes that could compensate for these losses. There may be few options for other recreational activities in a particular area which means that a reduction in visitor numbers to the area will affect local businesses and employment. Additionally, several seabird species currently found in the UK are considered unique and a loss of these species may not be compensated by the arrival of new species.

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1 Introduction

It is widely recognised that climate change will have an effect on the different processes and components of coastal and marine ecosystems and that these effects will ultimately impact human welfare (Nicholls et al., 2007, Harley et al., 2006). These impacts on human welfare are varied and include changes in: the productivity of fisheries (Hollowed et al., 2013); flood and coastal erosion risks (Horsburgh et al., 2010); and biodiversity (Harley et al., 2006).

Several studies on the impacts of climate change on human welfare have largely focused on the effects of a changing climate on food security, human health and property damage (e.g. due to an increased risk of flooding) (e.g. Parry et al., 2007, Ebi et al., 2008). Existing studies that examine the welfare impacts of changes in biodiversity or shifts in species distribution due to climate change are limited (e.g. Lundhede et al., 2013). Findings from the UK National Ecosystem Assessment confirm that the UK society interact with nature and wildlife in different ways (e.g. through recreation, artistic expression, education, religious/spiritual experience) (Church et al., 2011); therefore it can be inferred that a change in the status of wildlife in the UK under a future climate change scenario could result in changes to how society interacts with nature and potentially the quality of this interaction.

The work done for this report aims to fill part of the evidence gap by providing an initial indication of the welfare impacts of a change in species distribution in the UK due to climate change; specifically the impacts of a change in the distribution and range of seabirds found in the UK in terms of the economic value of these impacts and the stakeholders that will be affected. Important issues related to changes in seabird distribution that could affect welfare will be discussed including how these impacts are realised and measured and the extent of these impacts. The gaps in evidence and limitations of the analysis will also be discussed.

This study makes use of three different pieces of work to assess the potential impacts of a change in seabird distribution in the UK on social welfare. First is the work by Huntley et al., (2007) which investigates the potential changes in the breeding distributions of bird species during the last 30 years of the 21st century brought about by changes in climate relative to current distributions. The second is the report by the Royal Society for the Protection of Birds (RSPB) on the local economic value of seabirds (RSPB, 2010), which estimates visitor spending in four coastal reserves in the UK

and the associated impacts on the local economy that are attributable to the presence of seabirds. The last piece of work that has been used to inform this study is an investigation on the willingness to pay of the UK population to prevent a decline in seabirds due to their contribution to the recreational experience in coastal areas and their role in the proper function of the coastal and marine ecosystems (Paltriguera, 2013).

This work fits with the National Adaptation Programme (NAP) action on biodiversity indicators (listed on NAP report page 168) and on species/habitat vulnerability (listed on NAP report page 162). The National Adaptation Programme sets out actions for government, business, councils and civil society to address the most significant climate risks we face as a country.

2 Seabirds in the UK

The UK is home to many different seabird species; there are 25 species that come to the UK specifically to breed, and an additional 13 species can be found in the UK but breed elsewhere (JNCC, 2013). Species that can be found in the UK include puffins (*Fratercula arctica*), northern gannets (*Morus bassanus*), fulmars (*Fulmarus glacialis*) and guillemots (*Uria aalge*), and there are specific areas in the UK where large colonies can be found. For example, Bempton Cliffs in East Yorkshire is the location of the largest mainland breeding colony of gannets in England.

The number of breeding seabirds in the UK increased from around 4.5 million in the late 1960s to around 7 million by the end of the 1990s (UKMMAS, 2010). However, population trends for individual species are different. For example, the population trend for the arctic skua and black-legged kittiwake has been decreasing between 2000 and 2012 while populations of the roseate tern and the black-headed gull have increased (JNCC, 2012). These changes in breeding population size have been attributed to habitat loss, the introduction of non-native species which prey on the birds and their eggs and changes in the availability of food (UKMMAS, 2010).

2.1 Seabirds and climate change

Seabirds are important indicators of the condition of the marine environment due to their role as predators at the top of the food chain, and changes in the food chain due to climate change will inevitably have an impact on the birds (MCCIP, 2009). Most seabirds in the UK feed exclusively on sandeels, small clupeid fish (e.g. herring) or zooplankton, and seabird prey are dependent on plankton. Warming sea temperatures result in changes in primary production at the base of the food

chain (i.e. phytoplankton and zooplankton communities), which in turn leads to a change in the food supply of fish that are part of a seabird's diet. Reduced availability of food for seabirds then affect their breeding success, breeding frequency and adult survival.

Apart from changes in food supply (due to climate change), other pressures also affect seabird populations. These include invasive species such as the American mink that prey on seabirds and their eggs (Craik, 1997), habitat loss due to offshore developments (Busch et al., 2012), mortality due to by-catch in certain types of fishing gears (Brothers et al., 2010) and pollution (Furness and Camphuysen, 1997). Increases in the frequency and intensity of storms in the UK which may have a link to climate change also have an on impact seabird populations (e.g. BBC News, 2014).

2.2 Seabirds and Societal Welfare in the UK

It could be argued that seabirds have a part in the marine and coastal heritage of the UK. As an island nation with a rich marine environment, the UK has several seabird "hotspot" areas where large populations of seabirds gather to feed, breed and raise their young. Some species such as the herring gull (*Larus argentatus*) are found throughout the UK for the whole year, while some species such as puffins are found in the UK coast only at specific times of the year as they spend most of their lives out at sea.

In the past, seabirds and their eggs were considered a food source (Baldwin, 2009), and they were also hunted due to competition with fishermen. (Mitchell and Parsons, 2007). Nowadays, they are seen as important components for tourism and recreation in coastal areas, as shown by the popularity of nature reserves around the UK that allow visitors to watch and get close to these animals. There is also an increase in participation and interest in 'amateur' bird watching activities, fuelled by initiatives such as Big Garden Birdwatch organised by the British Trust for Ornithology (BTO) and the RSPB and popular nature television programmes shows such as the BBC's Springwatch (BBC, 2013) which sometimes feature seabirds. The contribution of (the presence of) seabirds to the recreational experience of humans can be considered as the 'use value' of seabirds, and this can be measured either through the costs incurred to travel to or spend time in areas that feature seabirds or through willingness to pay values gathered from stated preference surveys[1] (Holland et al., 2010).

[1] Stated preference survey is a technique to elicit people's preferences on goods that are not traded in markets. Respondents to these surveys, which are representative of a population, are asked how much money they are willing to pay in order to gain or retain a particular (amount of) good. The Contingent Valuation method and the Choice Experiment method are two types of stated preference surveys commonly used to elicit willingness to pay values.

Seabirds are also seen as important in their own right regardless of any benefits humans derive from their presence[2] (Carson et al., 2003), and this is considered to be part of the 'non-use value' of seabirds and can also be measured using results stated preference surveys.

3 Sources and method of analysis

3.1 Huntley *et al* (2007) future seabirds distribution assuming climate change

The Huntley et al., (2007) study examined how the distribution of breeding birds in Europe will change at the end of the current century under a climate change scenario. The study adopted a variant of a widely used 'climate-envelope'[3] approach to model the relationship between the distribution of different bird species in Europe and a limited number of bioclimatic variables which represent the current climate in Europe. Fitted models for each bird species were used to simulate the species' potential breeding range and distribution for a future climate scenario[4,5], but these maps are not meant to be used as predictions of the future range of areas where the seabirds can be found.

The results of the modelling show that areas in the UK currently favourable for several seabird species will no longer be favourable under a climate change scenario at the end of the century. This suggests that these species will leave these areas and move northwards, and it is likely that (northern) parts of Scotland will become the southern range of certain species. Since this modelling is not meant as a prediction of the areas where seabirds will be found under a climate change scenario, it is probable that smaller populations of some species could still be found around the UK coast but it is difficult to comment on the potential size of these populations and where these areas might be. A summary of this shift in seabird distribution has been provided in the most recent

[2] However, it is also important to note that some seabird species such as the herring gull are considered as pests because of their increasing numbers in towns and cities and their aggressive behaviour especially during breeding season. Declines in these species may have positive welfare effects (e.g. less "nuisance") but in the context of this study, this needs to be assessed relative to the overall impacts of a change in seabird distribution.

[3] Climate envelope models map the distribution of species under current climate conditions, i.e. the current climate 'envelope' for that species, and predict how this envelope shifts under climate change.

[4] The fitted model for each bird species was used to simulate that species' potential breeding distribution for a future climate scenario, which represent the mean conditions for the last 30 years of the 21st century as simulated by the Hadley centre HadCM3 atmosphere-ocean general circulation model.

[5] The authors of the Huntley et al., (2007) work advise that results of the simulation should only be used to assess which species are most at risk from climate change and not be used to develop specific conservation strategies for these species.

Climate Change Risk Assessment for the Marine and Fisheries Sector report (Pinnegar et al., 2012), and is reproduced below in Table 1.

Species	Latin name	Anticipated distribution change
Fulmar	*Fulmarus glacialis*	Loss of breeding sites in southern and eastern England
Manx shearwater	*Puffinus puffinus*	Loss of breeding sites in southwest England, expansion in western Scotland and Iceland
Leach's storm petrel	*Oceanodroma leucorhoa*	Loss of all breeding sites in the British Isles, expansion in Iceland
Gannet	*Morus bassanus*	Loss of breeding sites in southwest England, expansion Iceland
Cormorant	*Phalacrocorax carbo*	Loss of breeding sites throughout southern England, expansion in Scotland
Shag	*Phalacrocorax aristotelis*	Loss of breeding sites in southwest England, Bay of Biscay and Normandy, expansion in Iceland and northern Norway.
Arctic skua	*Stercorarius parasiticus*	Loss of all breeding sites in the British Isles and southern Norway.
Great skua	*Stercorarius skua*	Loss of all breeding sites in the British Isles, expansion in Iceland
Black headed gull	*Larus ribibundus*	Loss of breeding sites in central England, Wales and Northern Ireland
Common gull	*Larus canus*	Loss of breeding sites in southern Scotland and Northern Ireland, expansion in Iceland
Lesser black-backed gull	*Larus fuscus*	Loss of breeding sites in southern England and East Anglia
Herring gull	*Larus argentatus*	Loss of breeding sites in southern England and East Anglia
Yellow-legged gull	*Larus cachinnans*	New breeding colonies in southern England
Kittiwake	*Rissa tridactyla*	Loss of breeding sites in southwest England, Bay of Biscay and Normandy.
Sandwich tern	*Sterna sandvicensis*	Loss of breeding sites in eastern England
Roseate tern	*Sterna dougallii*	Loss of breeding sites in southern England, expansion in Scotland
Common tern	*Sterna hirundo*	Fragmented distribution in the British Isles, loss of breeding sites in southeast England and Northern Ireland
Arctic tern	*Sterna paradisaea*	Loss of breeding sites in most of mainland Britain, limited to northern fringe of Scotland and Shetland
Guillemot	*Uria aalge*	Loss of breeding sites in southwest England and Normandy
Razorbill	*Alca torda*	Loss of breeding sites in southwest England, Wales, eastern Scotland and Normandy
Black Guillemot	*Cepphus grylle*	Loss of breeding sites in mainland Scotland and Northern Ireland, restricted to outer Hebrides and Shetland
Puffin	*Fratercula arctica*	Loss of breeding sites in southwest and eastern England, also in eastern Scotland including Shetland.

Table 1. Projected changes in seabird distribution pattern at the end of the 21st century under a climate change scenario (source: Pinnegar et al, 2012)

The study only focuses on European breeding birds, therefore it does not further explore the suitability of the climate in Europe (and the UK in particular) to bird species that are currently not found in the region/continent. However, it is probable that other species could 'move in' as conditions become more suitable for them.

3.2 RSPB study on the local economic value of seabirds

The RSPB study (RSPB, 2010) estimated visitor spending in four coastal reserves in the UK and the associated impacts on the local economy that are attributable to the presence of seabirds. The nature reserves considered in the study are: the Bempton Cliffs Reserve (East Yorkshire, England), the South Stack Cliffs Reserve (Anglesey, Wales), the Mull of Galloway Reserve (Dumfries and Galloway, West Scotland), and the Rathlin Island Reserve (County Antrim, Northern Ireland). Figure 1 shows their locations. Seabird species that can be found in these reserves include gannets, fulmars, kittiwakes, puffins, razorbills. More details on the species found in each reserve can be found in Annex 1.

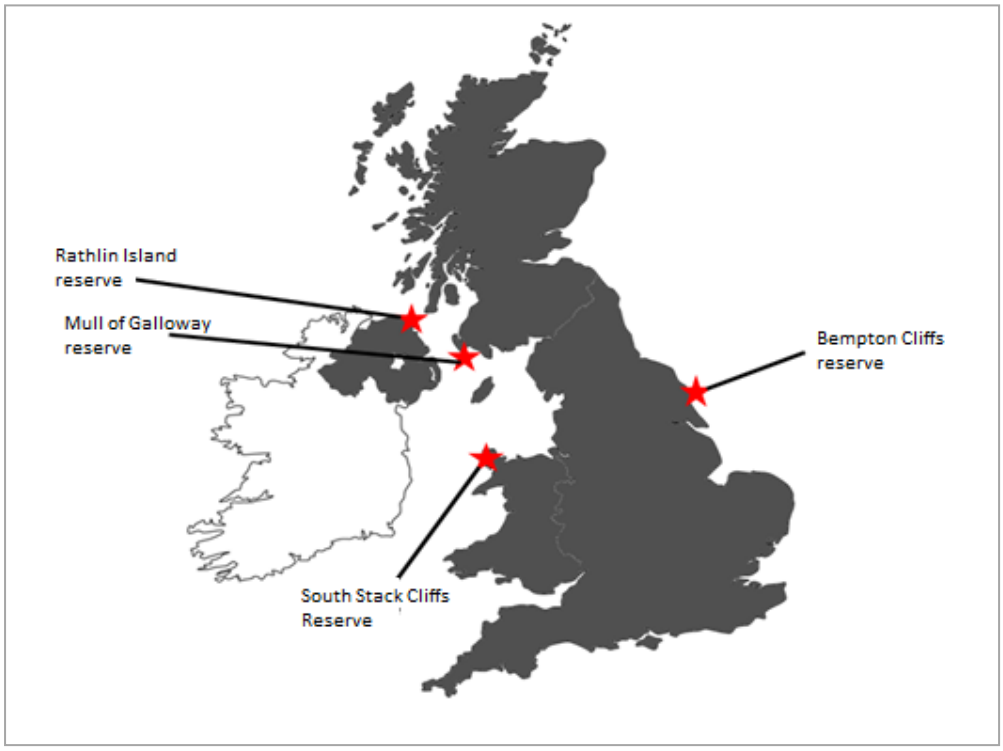


Figure 1. Locations of coastal RSPB reserves around the UK

In the RSPB study, data on the spending of visitors (local and non-local day-trippers and holiday makers) on accommodation, travel, food and drink, souvenirs and entertainment was gathered using engagement surveys. This data was used to estimate the proportion of amount spent that was directly attributable to the presence of seabirds in the reserves and was also used to estimate the number of additional Full Time Equivalent (FTE) jobs that the amount of visitor spending could support. The study also explored the impacts of tourism due to the presence of the reserves on RSPB staff and local businesses using qualitative data from semi-structured interviews.

There are several businesses such as guest accommodation, food and drink establishments (e.g. food trucks, cafes) and wildlife watching tour providers that benefit from the presence of seabirds and the reserves. These businesses, even though small in size, make important contributions to the local economies in terms of Gross Value Added and employment.

It has to be noted that there are other wildlife and nature reserves in the UK featuring seabirds that are owned and managed by other organisations such as the Wildlife Trusts and the National Trust. It is recognised that visitor spending in these sites also have an important and potentially significant impact on local economies in terms of business revenues and employment but are not reflected in the figures reported in the RSPB study. Additionally, it is recognised that visits to wildlife and nature reserves are not the only ways wherein people can participate in seabird related recreational activities[6].

3.3 Paltriguera study on willingness to pay to prevent a seabird decline

This study is an investigation into willingness to pay (WTP) to prevent a decline of seabird populations in the UK. The contingent valuation method, a recognised method of measuring the value of non-market goods (Mitchell and Carson, 1989), was employed to elicit the willingness to pay of users and non-users to reduce the risk of a decline in the current population of seabirds in the Flamborough Head and Bempton Cliffs Special Protection Area (SPA)[7]. Respondents to the survey were given a hypothetical scenario wherein the proposed extension to the existing SPA will not be put in place due to government spending controls[8] , but there is an option to locally manage the area (that would have been covered under the proposed extension) in order to minimise the risk of a decline in the seabird population. They were then asked if they were willing to support this local management and if they were willing to (voluntarily) contribute a monetary donation to support this local management scheme.

[6] The term 'seabird related recreational activities' is used several times in this report. This term includes recreational activities that are enhanced by the presence of seabirds; for example, seabird/wildlife watching, participation in watersports in areas near seabird colonies, sea angling, etc.
[7] There is an on-going consultation on the extension of the boundaries of this SPA, and once the extension is put in place, the SPA will be known as the "Flamborough and Filey Coast Special Protection Area".
[8] Note that in reality, socio-economic interests cannot be used as a reason to override the decision to designate a Special Protection Area (source: European Commission, 2006, p.15)

Results of the study showed that there is a positive willingness to pay value to prevent the risk of a decline in the current seabird population at the Flamborough Head and Bempton Cliffs SPA. Mean stated WTP amount of the sample population is £8.81 per household per year; users were willing to pay £15.43 per household per year while non-users were willing to pay £4.11 per household per year (all in 2013 prices). Respondents who were willing to pay towards the local management of the area declared use (e.g. for tourism and leisure) and non-use (e.g. existence and bequest) values as motivations for their willingness to give up part of their income to help protect seabirds. On the other hand, most of those who were not willing to pay declared their income constraint as the main driver of their decision.

The results from the study give an indication that UK society receives positive welfare benefits from the presence of seabird populations around the UK and prefers to maintain the current condition of existing seabird populations. From these, it can be inferred that changes to the current state of seabirds as a result of climate change or some other pressure will result in changes to social welfare; either because of a change in the settings which allow recreation (i.e. a loss of the seabirds in nature reserves that are home to specific species can affect the quality of recreation in these areas) or because of a loss of non-use values.

Other studies also shed light on the welfare impacts of changes in marine biodiversity. McVittie and Moran (2010) examined the non-use values/benefits derived by UK residents from the conservation of ecosystem goods and services from the designation of Marine Conservation Zones in England. Their study showed that there are benefits derived from both the halt in the loss of and an increase of marine biodiversity in UK waters, with the halt in the decline of marine biodiversity given a higher value than an increase in the current levels of marine biodiversity. This study does not focus on the halt of a loss or an increase in the population of specific species, but findings from this study support the idea that a decline in seabird populations currently found around the UK will result in losses in welfare.

4 Balance Sheets Approach and assumptions in the analysis

Changes in UK seabird distribution will encompass a wide diversity of impacts and affect different stakeholders, which means that an analysis of these impacts needs to take this diversity into account. In this study, the 'Balance Sheets' approach (Turner, 2011) will be employed to assess and evaluate the social and economic impacts of a change in seabird distribution in the UK.

The Balance Sheets approach is a framework which allows different trade-offs of a particular decision to be examined. The framework makes use of three different but complementary and interlinked components (i.e. the 'sheets'); namely an economic impact/cost-benefit analysis, a regional and local financial impacts analysis and a multi-criteria analysis. The economic cost-benefit analysis makes use of a conventional economic efficiency criterion (efficiency at the national level), but augmented with a distributional analysis of economic impacts and possible equity weighting. The regional and local financial impacts and policy analysis, covering impacts such as local unemployment, loss of community identity and related financial multiplier effects which often raise issues of compensation. Lastly, the multi-criteria analysis (non-monetary) deals with collective or shared values across wider society such as intrinsic value in biodiversity, cultural assets value, etc.

The Balance Sheets approach, applied to this study makes use of the cost benefit analysis sheet and the regional and local financial impacts analysis sheets. The cost-benefit analysis 'sheet', is used to examine the immediate economic impacts of a change in seabird distribution to those who hold 'use' and 'non-use' values for seabirds. Those who hold 'use values' for seabirds are ones who participate in recreational activities enhanced by the presence of seabirds (e.g. bird watchers, visitors to nature coastal reserves). On the other hand, those who hold 'non-use values for seabirds are those who are willing to give up part of their income to maintain the existence of the seabirds even though they have never used it nor has any planned use for it (Bateman et al., 2002). This sheet also examines the national impacts of a change in seabird distribution. On the other hand, the regional and local financial impacts analysis will focus on the impacts on local economies (e.g. revenues of businesses, employment), using the 4 areas around the UK that have coastal RSPB reserves to illustrate the extent of these financial and local impacts. These local communities will be impacted as a result of changes in the behaviours of users (examined in the cost-benefit analysis sheet).

Before proceeding to discuss the potential welfare impacts on a change in seabird distribution under a future climate change scenario, it is important to first set out some assumptions in the analysis.

- It is assumed that the preferences of a future UK society on seabirds and seabird related recreational activities are at least the same as current preferences. In other words, UK society at the end of the 21st century will hold at least the same use and non-use values for seabirds as current UK society. This means that the future UK society will at least:
    - enjoy participating in coastal and seabird related recreational activities as current society does;
    - consider the protection of seabirds for the benefit of others and future generations as important as current society does;
    - still consider seabirds as important in their own right regardless of any benefits humans derive from them.

  This assumption means that the inferences on the impacts of a change in seabird distribution in the UK are based on observations on existing/current social preferences and there is no second guessing on what preferences the future UK society might hold;
- The purchasing power of household income in the future is comparable to current levels. This means that the tourist spending in RSPB reserves and other businesses that benefit from the presence of these reserves are similar to current spending. This assumption is made so that the most recent data on spending on seabird related recreational activities can be taken as the representation of the magnitude of spending that could potentially be lost under a climate change scenario;
- The UK, at the end of the current century, is still comprised of the four countries of England, Wales, Scotland and Northern Ireland. Currently, there is a Scottish referendum for independence (The Scottish Government, 2014) and if Scottish voters choose for Scotland to be an independent country separate from the UK, Scotland can no longer be considered as part of the UK. If Scotland is no longer part of the UK, then it could be said that the future UK (i.e. England, Wales and Northern Ireland) will no longer have a 'local endowment' of seabirds within its borders since projections for changes in seabird distribution show that Scotland will be the southernmost range of several species currently found around the UK.

Overall, these assumptions are equivalent to the continuation of the baseline or current scenario into the future, except that there is a change in the distribution of seabirds.

5 Economic and social impacts under a future climate change scenario

As shown by the work of Huntley *et al* (2010), it is likely that existing seabird habitats in the UK will no longer be suitable under a future climate change scenario. Seabird populations currently found around the UK coasts will shift northwards where conditions are more suitable for them, which means that these populations will be lost or will be significantly reduced. Any 'native' seabird populations in the UK are likely to be found in the northernmost parts of Scotland. There is also the potential that other seabird species will make areas around the UK their new home due to these areas being more suitable for them. These changes will have different impacts and are discussed further below.

5.1 Economic (monetary) impacts

As described in the previous section, the economic impacts of a change in seabird distribution under a climate change scenario focus on the effects on those considered as 'users' and 'non-users' and what this implies on a national level, i.e. the whole UK economy.

Use and non-use values make up the total economic value of a good (Bateman et al., 2002). Use values refer to the monetary measure of welfare, well-being or benefit derived from the direct consumption of the good, but it could also refer to the benefit derived from knowing that there is the option to consume the good in the future. These values can be measured using the market price of the good or through willingness to pay (to increase or maintain consumption of the good) elicited through stated preference techniques[9]. On the other hand, non-use or passive use values refer to an individual's willingness to pay to maintain the existence of the good even though he/she has never used it nor has any planned use for it (Bateman et al., 2002), and can be measured through stated preference techniques. Non-use values are usually divided into three separate categories: existence value, which refers to the value placed on the existence of a good regardless of any human benefit; bequest value, which refers to the value placed on the good for the benefit of future generations; and altruistic value, which refers to the value placed on the good for the benefit of others in the present generation.

[9] These techniques involve public participation surveys or forums to ask individuals or groups of individuals how much they are willing to pay, usually expressed in monetary terms, to consume or increase consumption of a particular good or to avoid a decline in consumption of this good. The 'Choice Experiment' technique captures the specific values attached to the use and non-use aspect of a good, while the 'Contingent Valuation Method' captures the total economic value (i.e. combination of both use and non-use values) of a good.

Impacts on use values

Members of society considered as 'users' are those who directly benefit from the presence of seabirds which enhance their experience when participating in specific recreational activities. These members of society include bird watchers and coastal bird reserve visitors and potentially other participants in coastal recreational activities (e.g. kayakers). The economic value these users place on the presence of seabirds can be inferred through the costs they incur to travel to or recreate in areas that feature seabirds, while the economic value to the UK economy can be measured by looking at the aggregate of these costs, i.e. how much spending towards coastal recreational activities that benefit from the presence of seabirds contribute to the national economy (the UK Gross Domestic Product or GDP). A change in economic value due to a change in seabird distribution under a climate change scenario can then be measured by looking at the marginal changes in visitor spending and how the aggregate of these changes affect the overall economy.

The RSPB study on the local economic value of seabirds (RSPB, 2010) reveals how much visitors to RSPB coastal reserves spend during their visits. These visitors, either (local or non-local) day-trippers or holiday makers spend money on accommodation, travel, food and drink, souvenirs and entertainment. This spending gives an idea on how much these visitors are willing to pay to recreate in areas that feature seabirds as one of the main attractions. From responses to the people engagement surveys, the authors of this RSPB study estimated the amount spent that is directly attributable to the presence of seabirds, and this is summarised in Table 2 below. Results show that holiday makers spend more than day trippers, but on average, a larger proportion of the spending of day-trippers is attributable to the presence of seabirds. This is understandable since it is more likely that day-trippers to the reserve make the visit specifically to view the seabirds while holiday makers visit the reserve because it is in the vicinity of the area where they are spending their holiday[10].

[10] Apart from the Rathlin Island Reserve, these RSPB seabird reserves are in close proximity to seaside towns and other places of interests such as local museums and lighthouses.

RSPB Reserve	Day tripper		Holiday-maker	
	Mean Spend per person (£; 2012 prices)	**Mean spend per person attributable to seabirds (£; 2012 prices)**	**Mean Spend per person (£; 2012 prices)**	**Mean spend per person attributable to seabirds (£; 2012 prices)**
Bempton Cliffs (East Riding of Yorkshire, England)	18.05	10.33	50.78	16.56
South Stack Cliffs (Anglesey, Wales)	18.54	5.72	20.03	5.72
Mull of Galloway (Dumfries and Galloway, West Scotland)	15.63	3.48	37.36	8.21
Rathlin Island (Country Antrim, Northern Ireland)	22.42	6.09	64.74	18.13
Note: 2008 values have been inflated to 2012 prices using the HM Treasury's latest GDP deflators: https://www.gov.uk/government/publications/gdp-deflators-at-market-prices-and-money-gdp-march-2013 (accessed 13 February 2014)				

Table 2. Summary of visitor spending at the 4 coastal RSPB reserves

The mean spend per person attributable to seabirds, which range from about £3.50 to £18.13 (2012 prices), can be taken as a proxy of the cost these visitors are willing to incur specifically to see the seabirds. This gives an indication of how much these visitors value participation in activities that are 'enhanced' by the presence of the birds and the magnitude of the welfare impact of participating in these activities, presented in monetary terms.

Impacts on non-use values

As described at the beginning of this section (Section 5.1), non-use values are measured using stated preference techniques. These techniques elicit how much an individual is willing to pay in order to increase or avoid a loss in the consumption of a good.

The study on the UK public's willingness to pay to prevent a decline in seabird populations (Paltriguera, 2013) asked survey respondents how they would feel if there was a decline in the seabird population in the Flamborough Head and Bempton Cliffs SPA. 90% of respondents, who

were considered as 'users' in the survey (i.e. visitors to the RSPB Bempton Cliffs reserve), said that they would be concerned if this scenario were to occur. On the other hand, 60% of respondents considered as 'non-users' in the survey expressed concern if this scenario were to occur. These mean that a complete loss or large decline in the population of existing seabird species currently found around the UK will result in negative welfare impacts. The study found that individuals were willing to pay £4.11 to £15.43 (2013 prices) to prevent a decline in the seabird population in the area. These values are taken as an indication of the values attached to the prevention of a loss of seabirds found in the Special Protection Area, but note that it is likely that those who were considered as 'users' were expressing both use and non-use values in their responses[11]. Due to the small sample size used in the study, it is difficult to extrapolate this willingness to pay value at a national level, i.e. multiply the value by the number of households in the UK, in order to show the overall magnitude of the value. Conclusions derived from doing so could be misleading. However, results indicate a potential loss in use and non-use values due to a loss of native seabird populations in the UK.

In the climate change scenario, a loss of seabird species due to a shift in their distribution cannot be prevented (unless drastic actions to cut carbon emissions are implemented straight away) and this scenario is different from one where a decline in seabird populations or marine biodiversity can be prevented through the designation and appropriate management of protected areas. The first is a cost (of climate change) while the other is a benefit (of protected area designation and management). In welfare economics, a loss in welfare is appropriately measured by willingness to accept the loss while an increase in welfare is appropriately measured by willingness to pay to gain the increase[12] (Bateman et al., 2002). In the economics literature, there is overwhelming evidence that willingness to accept value is almost always larger than willingness to pay value (Horowitz and McConnell, 1999, Haneman, 1991), potentially due to the endowment effect[13]. This means that willingness to pay (to prevent a loss) values can be taken as the minimum value of willingness to accept a loss. From this, it can surmised that the loss in social welfare due to a change in seabird distribution is at the very least the same as the amount society is willing to pay to avoid this loss.

[11] Depending on the nature of the good in question, the Contingent Valuation Method does not always make a distinction between use and non-use values.

[12] In order to make this concept clearer, one needs to think of the presence of seabirds around the UK as an economic good that an individual benefits from. If this good is taken away from the individual, there exists a "price" at which the individual will be willing to be compensated with in order to accept this loss. This is related to the concept of "willingness to accept". On the other hand, if an individual wants to maintain (or increase) the benefits from the availability of this good, then there exists a price which the individual is willing to pay in order to maintain (or increase) these benefits. For further discussion, refer to Bateman et al., 2002, p. 24-28.

[13] Or the perception that whatever one currently benefits from is 'rightfully theirs'.

National impacts

If seabird species currently found in the UK are lost due to climate change, it is likely that use and non-use values will be negatively affected. On use values, enjoyment levels derived from the presence of these species will decrease implying a negative impact on well-being. This could also result in a decrease in participation in seabird related recreational activities. On the other hand, non-use values will be negatively affected because the good where non-use values are attached to is no longer available. It is easy to conclude that this could result in an overall loss (i.e. cost) of use and non-use values at a national level, but it is important to consider the substitution effects of this change.

The decision to visit a particular area is affected by several variables. This includes the time taken and cost to travel to the site, the features of the site, the activities that can be done at the site, the perceived consequences of recreation at the site and the available substitute sites (i.e. other recreational areas and activities). Welfare economic theory predicts that the welfare of an individual who participates in a recreational activity can be maintained given different combinations of levels of these variables (i.e. substitution between these variables) (Bateman et al., 2002). For example, an individual may choose to visit a far away site that features seabirds and incur high travel costs if this is compensated by the (perceived) enjoyment level of going to this site. On the other hand, an individual may choose to visit one site over another because the features are better. In these examples, the individual is as "well-off", in the sense of well-being and not monetary resources, in either one of the options as they are in the other options.

Seabirds can be considered as features of an area visited for recreation, therefore a change in this feature due to climate change could result in individuals either: travelling further to visit remaining seabird reserves (i.e. travel to parts of Scotland which is predicted to be the southernmost range of seabirds under a climate change scenario); making decisions to visit other areas, i.e. participate in a different kind of recreational activity; or continuing to participate in the same activity and consider new species as direct substitutes. The net economic impact of this substitution will be highly influenced by the degree of substitution between the different variables that affect the decision to participate in a particular recreational activity or to visit a specific area; in this case, visiting coastal reserves that feature seabirds. If overall there is strong substitution between the different variables, then it is unlikely that there will be a complete loss at a national level, i.e. spending on recreational activities will stay relatively unchanged. If a large proportion of those who participate in seabird related recreational activities are happy to switch to other activities once'traditional' seabird species

in the UK are lost due to climate change, then overall participation in recreational activities will not decrease significantly. These individuals will spend their money in other areas or will spend it doing other activities thus, other things being equal, not making significant changes to the UK's GDP. In other words, the money will still be used within the national economy and will only be redistributed in terms of how and where this is spent. On the other hand, if there is no or very little substitution between the different variables, then there will be a high level of loss.

It is also not clear how the availability of substitutes can affect non-use values. It could be argued that there is an 'intrinsic' value to each species that cannot be replaced by another, thus there are no substitute effects when it comes to non-use values. For example, the intrinsic value of a puffin which could be lost in the UK under a climate change scenario cannot be compared to the intrinsic value of another seabird species (such as a yellow legged gull) which may find its way into the UK under different future climatic conditions. This is because the puffin is perceived by UK society as a unique and charismatic species (Fischer and van der Wal, 2007) that is completely different to other bird species. In other words, members of the public do not see the puffin in the same way as they do another species and there is a value attached to having puffins in the UK (i.e. a local endowment effect).

There is still a debate on whether willingness to pay is greater or lower in situations where the problem is driven by human actions (e.g. climate change) compared to where the problem is a result of natural causes (e.g. disease). Some authors have found that willingness to pay values to mitigate problems caused by human actions are lower compared to willingness to pay values to mitigate natural problems (Walker et al., 1999), while others have found the opposite (Bulte et al., 2005). An examination on whether willingness to pay to prevent a loss of existing seabird populations in the UK due to climate change is lower or higher compared to willingness to pay to prevent a loss in seabirds to natural causes (e.g. a disease) will help shed light on people's perceptions about changes in species distribution due to climate change and the level of loss that will be experienced. If the willingness to pay to mitigate climate change impacts induced by human activities is higher than willingness to pay to mitigate problems caused by natural forces, then it shows that welfare losses are higher under the first scenario.

In reality, it is likely that there will be some costs in the form of losses in use and non-use values. There are visitors to reserves who consider themselves as keen bird watchers and bird enthusiasts, and a loss in the seabird species currently found in the UK could result in these individuals no longer

participating in this specific activity. Even though new seabird species can be found along the UK coasts, these people may not consider these as strong substitutes to traditional species which means that the satisfaction derived from participating in other recreational activities are not the same. The change in seabirds found in the UK could result in losses to the use values attached to native seabirds by these individuals, as expressed by the cost they are willing to incur to view these birds. However, at a national level, it is unlikely that participation in recreational activities in the UK will significantly reduce since not everyone in the UK prefers seabird related recreational activities over other available options for recreation. Assuming that these people who don't have a strict preference on seabird related recreation will shift to other local types of recreational activities (i.e. recreation within the UK and not abroad), the money they could have spent participating in seabird related activities will stay within the UK economy through their spending on these other activities. On the other hand, there will be losses in non-use values because of the perception of uniqueness of the native seabird species in the UK and the local endowment effect. Additionally, there is evidence that willingness to pay to conserve 'local' or 'native' species is higher than willingness to pay to preserve 'new' species that move in due to a change in natural conditions (Lundhede et al., 2013). These mean that the overall impact on non-use values due to a change in seabird distribution under a climate change scenario is likely to be a very large loss or a complete loss of these non-use values[14].

5.2 Regional and local financial impacts

The recreation and tourism 'industry' is not a single industry in itself, but is instead composed of different industries, which include transport, accommodation, leisure and entertainment and food and drink (White, 2010). Tourism is highly dependent on consumer demand, and an analysis on the national and local impacts needs to focus on the spending of visitors and how this could change given changes in the characteristics of an activity, in this case, a loss of species in a particular area.

If seabirds that are currently found along the UK coasts disappear due to climate change, there is the potential that those who participate in seabird related activities will decrease their participation or stop altogether. This change in behaviour or participation is because of a change in a feature of the activity; i.e. a loss in the seabird species that these visitors have come to see. The results of surveys conducted for the RSPB study (2010) shows that the majority of visitors to coastal reserves consider the chance to see birds/wildlife as influential in their decision to visit the reserve. However, the survey also shows that the chance to watch seabirds in the reserves is not necessarily the main

[14] However, we cannot make conclusions on how much these values are at the moment due to a lack of studies which examine these values at the UK level.

reason why people visit the reserve. These indicate that if the seabird populations in these reserves contract or the populations disappear altogether because of a change in conditions, then it is likely that potential or frequent visitors to the site will no longer have the incentive to visit the area.

The impacts on local communities and businesses that benefit from the presence of seabirds result from this change in the behaviour of visitors to reserves. If visitor numbers decrease, then the overall visitor spending on services such as accommodation, transport, leisure and entertainment and food and drink could potentially decrease as well. This will result in a loss of earnings or income to local businesses that provide these services and to other 'support' businesses (e.g. suppliers to the food and drink industry). This loss of earnings will also affect these businesses' ability to retain or employ additional staff, which will have further impacts on local communities.

Results of the RSPB study on the annual visitor spend in 2008 at each of the four coastal reserves attributable to seabirds and the equivalent number of additional FTE jobs supported by this spending are summarised below in Table 3.

RSPB reserve name	**Total spend[a] attributed to seabirds in 2008 inflated to 2012 prices[b]**	**Full time equivalent (FTE) jobs that visitor spending could support (additional to existing employment at the nature reserves)[c]**
Bempton Cliffs (East Riding of Yorkshire, England)	£597,879.40	15.58
South Stack Cliffs (Anglesey, Wales)	£134,165.10	3.50
Mull of Galloway (Dumfries and Galloway, West Scotland)	£139,076.80	3.62
Rathlin Island (Country Antrim, Northern Ireland)	£102,538.80	2.67

Total	**£973,660.10**	**25.37**

[a] Total spend figures are an aggregation of the mean spend per person attributed to seabirds, as reported in the RSPB (2010) study.

[b] Prices were inflated using the HM Treasury's latest GDP deflators: https://www.gov.uk/government/publications/gdp-deflators-at-market-prices-and-money-gdp-march-2013 (accessed 13 February 2014)

[c] These figures are not adjusted to take into account the number of jobs supported by the visitor spending inflated to 2012 prices.

Table 3. Summary of total visitor spending attributable to seabirds and FTE jobs supported from the RSPB (2010) study

Magnitude of the impact on local economies

There is existing data on regional tourism expenditure in the UK that is prepared by the Office of National Statistics. The 2008 data (Office of National Statistics, 2011), which fits the timeline of the RSPB (2010) study, provides information on estimated tourism expenditure (£ million) in different NUTS[15] regions in the UK and by visit type. This data is summarised in Table 4 below.

NUTS3 Area	**Expenditure of Visitors[a] at the regional NUTS3 level (inflated to 2012 prices)[b]**	**Percentage of total spend attributed to seabirds relative to total expenditure of visitors[c]**
East Riding of Yorkshire	£250 million	0.239
Isle of Anglesey	£167 million	0.08
Dumfries and Galloway	£270 million	0.052
Northern Ireland (total)	£1,636 million	0.006

Notes:

[a] This is an aggregation of ONS data on: expenditure of inbound, domestic overnight and domestic day visitors. Please refer to http://www.ons.gov.uk/ons/rel/tourism/sub-national-tourism/sub-regional-value-of-tourism/rft-nuts3-demand.xls for the data.

[b] Prices were inflated using the HM Treasury's latest GDP deflators: https://www.gov.uk/government/publications/gdp-deflators-at-market-prices-and-money-gdp-march-2013 (accessed 21 March 2014)

[c] These figures are calculated by dividing the total spend attributed to seabirds (shown in Table 3) by expenditure of visitors at the regional NUTS3 level (shown in this table).

Table 4. Tourist expenditure in NUTS3 Regions in the UK and proportion of seabird related spending

[15] Nomenclature of Units for Territorial Statistics

The figures above show that visitor spend in RSPB reserves when compared to the total value of recreation and tourism activities in the regions where these reserves are located are not very large. However, this does not necessarily mean that visitor spend in these reserves are not important at the micro level. Most of the businesses that cater to visitors to the reserves state that these visitors constitute a large proportion of their customers, which means that the money spent by these visitors make a significant proportion to these businesses' annual income (RSPB, 2010). Additionally, these businesses provide employment, income and training to local people. A few owners of these businesses have also stated that their business will be adversely affected if the populations of seabirds in the area decline (RSPB, 2010).

Estimates on the multiplier effect[16] of tourism in the UK (Oxford Economics, 2013) shows that a change in consumer demand/spending in the tourism economy results in larger spill-over effects throughout the rest of the UK economy. It is estimated that for every £1 increase in demand by consumers in tourist industries, this results in an additional change in output in the supply chain worth £1.2 in England (excluding London), Wales and Northern Ireland and £1.1 in Scotland ((Oxford Economics, 2013). These figures show the extent of the 'Type I' spill-over effects on the supply chain of tourist/visitor spending on the local (and national) economy[17]. The figures on visitor spending, at the regional and local level also do not reflect the tax revenues that are derived from the purchase of goods and services (e.g. Value Added Tax) and the incomes of the businesses (e.g. business tax, sole trader and partnerships tax) that benefit from visitor spending[18]. Additionally, the employment supported by this visitor spending and business income means that those who are employed spend their own earnings in the local economies which then support other businesses not directly related to tourism industries (e.g. the local butcher or hairdresser). Estimates on this 'Type II' multiplier effect show that for every £1 earned by an employee in the tourism industries, employees in Wales and Northern Ireland spend an additional £1.8 while employees in England (excluding London) spend an additional £1.7 (Oxford Economics, 2013)[19]. These effects show that changes to the demand of those who participate in tourist and recreation activities could have significant effects on local economies (and the national economy).

[16] Multiplier effect refers to how direct spending affects indirect (supply chain) and induced (knock-on consumer spending) spending.

[17] It has to be noted that these estimates include all tourist activities and not just visits to nature reserves, therefore may not reflect the overall multiplier effects of spending in bird reserves.

[18] Note that if visitors go to other areas instead, they will purchase goods and services from other businesses and these businesses will also pay taxes. Thus at the macro or national economy level, a loss of tax receipts from one region could be compensated by an increase in tax receipts in another region.

[19] This Type II multiplier effects includes all tourism industries and may not be a correct reflection of the multiplier effect of spending in bird reserves. Additionally, this covers effects on the national economy and not just on the local economies.

As mentioned in Section 5.1 on the economic impacts of a change in seabird distribution, a change in the behaviour of those who participate in seabird related recreational activities will be largely determined by their perception on the substitutability between the different aspects of recreation. Additionally, this will be influenced by the availability of other recreational activities within the area. For example, three of the four RSPB reserves discussed in this study are in the vicinity of other attractions; the Bempton Cliffs reserve is near the seaside towns of Bridlington and Scarborough, while the South Stack Cliffs and Mull of Galloway reserves are near other local attractions, and these mean that there are other options for recreation in the areas. This means that if visitors continue to participate in other recreational activities in coastal areas where seabird populations were once found, then they will continue to spend part of their income on goods and services in the area and continue to benefit the businesses there. However, support for businesses from individuals who visit the area specifically to view the seabirds will be lost as it is more likely that these people will no longer visit. Additionally, demand for some specific services (e.g. boat tours to view the seabirds) will decrease or be completely lost and businesses that offer these services and individuals who own and work for these businesses are those that will be adversely affected. On the other hand, if the majority of visitors choose to go to other locations around the UK which offer other types of recreational activities, then more local businesses will see a reduction in income and this will have further local effects on employment. If this is the case, then the magnitude of impact will be greater than the amount of the total visitor spend in the four RSPB reserves (see Table 3). This is because of a loss in income of businesses in the area which will result in a decrease in demand for other goods and services along the supply chain. This will also result in negative impacts on employment and on the demand for goods and services by these employees. Additionally, this amount does not take into consideration losses in other areas in the UK that have seabird reserves not managed by the RSPB therefore it is likely that the loss of around £1 million showed in Table 3 is an underestimate.

It has to be noted that projections of changes in seabird distribution in the UK under a climate change scenario show that there may still be parts in the north of Scotland where these seabirds can be found. Under this scenario, it is possible that visits to bird reserves located in the north of Scotland could increase due to the perception of rarity of these species. This increase in visitors could bring about benefits to the local economies in these reserves. However, it is difficult to describe the likelihood of this happening and the magnitude of impacts because of uncertainties on where these birds can be found (i.e. whether the particular sites they are found are accessible) and whether visitors from other parts of the UK are willing to travel all the way to the north of Scotland to view the birds.

6 Conclusions

It is projected that climate change will result in a change in seabird distribution in the UK and around Europe. Work by Huntley et al (2007) shows that under a climate change scenario at the end of the 21st century, the populations of seabirds currently found around the UK coast will shift northwards with the northern parts of Scotland as the southernmost range within the UK. This change will result in a range of socio-economic impacts.

The Balance Sheets approach, as proposed by Turner (2011) was used in order to undertake a systematic assessment of these socio-economic impacts. This approach covers an economic impact analysis, a regional and local financial impact analysis and a multi-criteria analysis; but only the first two analyses were employed for the study. The economic impact analysis focuses on the impacts of the change on those who hold 'use' and 'non-use' values' for seabirds. Those who hold use values are members of society who directly benefit from the presence of seabirds around the UK coasts; these are those who participate in recreational activities that are enhanced by the presence of seabirds (e.g. bird watchers, visitors to nature coastal reserves), while those who hold non-use values are ones who prefer to maintain the existence of the seabirds even though he/she has never used it nor has any planned use. This analysis also examines changes at the level of the national economy, i.e. how changes in the behaviour and preferences of users and non-users translate to a change in national welfare. The regional and local financial impact analysis focuses on the impacts on businesses and local economies that benefit from the activities of users and from the presence of seabirds in a particular area.

The amount of money spent by those who participate in coastal recreational activities give light to how much these individuals value the presence of seabirds in particular areas. A loss of the traditional seabird populations around the UK means that specific aspects of coastal recreation will change and the economic impact of these changes can be measured by looking at the marginal changes in visitor spending and how the aggregate of these changes affect the national economy. The RSPB (2010) study shows that visitors to coastal bird reserves spend around £3.50 to £18.13 (2012 prices) per person to visit the reserves and the immediate area. The loss of seabirds in these reserves mean that enjoyment levels derived by individuals from participating in these recreational activities could potentially decrease, implying a negative impact on well-being. A decrease in enjoyment levels could result in these individuals reducing or stopping participation in these coastal recreational activities, but others will switch to other types of recreational activities in order to

compensate for the loss. At a national level, it is unlikely that participation in recreational activities in the UK will significantly reduce since not everyone in the UK has a strong preference towards seabird related recreational activities over other available options for recreation. Assuming that these people who don't have a strict preference on seabird related recreation will shift to other local types of recreational activities (i.e. recreation within the UK and not abroad), the money they could have spent participating in seabird related activities will be spent participating in other activities and stay within the UK economy.

The non-market welfare impacts of a loss of native seabird species around the UK is related to non-use values; specifically the values attached to the existence of birds regardless of any human benefit and the values placed on the opportunity for others in the current and future generations to benefit from the presence of these birds. There is evidence showing that UK society places a value on knowing that marine biodiversity and specific species are in good condition, even though there are no direct benefits derived. This means that 'local endowment' or the perception of having unique species present in the UK is highly valued. From these, it is clear that adverse changes in the state of biodiversity or species will result in a negative impact on welfare, or a loss in non-use values. Due to the perception of uniqueness of several native seabird species in the UK, it is likely that the loss of these species will result in large losses of non-use values.

The regional and local financial impacts of a change in seabird distribution will result from a change in the behaviour of visitors to seabird reserves and those who participate in other recreational activities that benefit from the presence of seabirds. Due to a loss of seabird species in a particular area, people are likely to reduce their visits to nature reserves or participation in activities that allow them to watch or learn about seabirds. This will result in a decrease in the demand for the goods and services provided by the accommodation, food and drink, travel and leisure and entertainment industries. This will affect the revenues of several businesses in these industries and their ability to retain or employ more staff, thus affecting local economies. This will also have consequent effects on other businesses that provide other goods and services to businesses in the tourism and recreation industries (i.e. the supply chain). However, the overall impacts on these local businesses and economies will depend on the availability of other recreational activities within the area. If visitors continue to participate in other recreational activities in coastal areas where seabird populations were once found, then they will continue to spend part of their income on goods and services in the area and continue to benefit the businesses there. However, support for businesses from individuals who visit the area specifically to view the seabirds will be lost as it is more likely that

these people will no longer visit and there could be specific businesses that will be affected by this. If there is a complete loss in visitor spending due to loss of seabirds, then the magnitude of impact will be greater than the amount of the total visitor spend in the four RSPB coastal reserves of almost £1 million (2012 prices) per year. This is because of a loss in income of businesses in the area which will result in a decrease in demand for other goods and services along the supply chain. This will also result in negative impacts on employment and on the demand for goods and services by these employees. Additionally, this amount does not take into consideration losses in other areas in the UK that have seabird reserves not managed by the RSPB. This means that the loss of £1 million per year is likely to be an underestimate.

Overall, it is likely that the most significant impacts brought about by a loss of native seabird species due to climate change will be incurred as costs to local economies that currently benefit from the presence of seabirds in specific areas and as losses of non-use values attached to seabirds. This is because there are few options for substitutes that could compensate for these costs/losses. There may be few options for other recreational activities in a particular area which means that a reduction in visitor numbers to the area will affect local businesses and employment. Additionally, several seabird species currently found in the UK are considered unique and a loss of these species may not be compensated for by the arrival of new species.

It has to be noted that this analysis, is limited to the socio-economic effects of a change in seabird distribution in the UK. This is an anthropocentric approach to analysing the effects of a loss in native seabird species in the UK as a result of climate change. This does not take into consideration the fact that seabirds play a larger role in the overall health of the ecosystem, regardless of any views humans may have on them and any changes in their status will have knock-on effects on the ecosystem which provide other benefits to society. Also, this analysis only touches on a specific impact of climate change, which is largely linked to tourism and recreation. Any conclusions derived from this work only present a narrow picture of the socio-economic impacts of climate change. As a last point, it has to be noted that the analysis of the socio-economic implications of a change in seabird distribution in the UK is done by comparing a snapshot of the present to a snapshot of the future, in other words looking at what will happen tomorrow based on the current situation. A change in seabird distribution due to climate change will not happen overnight, which means that any welfare losses will be incurred gradually and the magnitude of impact may be different from what is presented here.

7 References

BALDWIN, J. R. 2009. Harvesting Seabirds and their Eggs on the Irish Sea Islands (Part 1: The Welsh Islands, Lundy and Scilly). *Journal of Ethnological Studies,* 47**,** 76-91.

BATEMAN, I. J., CARSON, R. T., DAY, B., HANEMANN, M., HANLEY, N., HETT, T., JONES-LEE, M., LOOMES, G., MOURATO, S., OZDEMIROGLU, E., PEARCE, D., SUGDEN, R. & SWANSON, J. 2002. *Economic Valuation with Stated Preference Techniques: A Manual,* Cheltenham, Edward Elgar Publishing Limited.

BBC. 2013. *Springwatch: Guide to Seabirds* [Online]. Available: http://www.bbc.co.uk/programmes/b01m6n6c [Accessed 07 November 2013].

BBC NEWS. 2014. *'Record number' of dead seabirds washed up from storms* [Online]. Available: http://www.bbc.co.uk/news/uk-england-26440087 [Accessed 06 March 2014].

BROTHERS, N., DUCKWORTH, A. R., SAFINA, C. & GILMAN, E. L. 2010. Seabird Bycatch in Pelagic Longline Fisheries Is Grossly Underestimated when Using Only Haul Data. *PLoS ONE,* 5(8): e12491. doi:10.1371/journal.pone.0012491.

BULTE, E., GERKING, S., LIST, J. A. & DE ZEEUW, A. 2005. The effect of varying the causes of environmental problems on stated WTP values: evidence from a field study. *Journal of Environmental Economics and Management,* 49**,** 330-342.

BUSCH, M., KANNEN, A., GARTHE, S. & JESSOPP, M. 2012. Consequences of a cumulative perspective on marine environmental impacts: Offshore wind farming and seabirds at North Sea scale in context of the EU Marine Strategy Framework Directive. *Ocean and Coastal Management,* 71**,** 213-224.

CARSON, R. T., MITCHELL, R. C., HANEMANN, M., KOPP, R. J., PRESSER, S. & RUUD, P. A. 2003. Contingent Valuation and Lost Passive Use: Damages from the Exxon Valdez Oil Spill. *Environmental and Resource Economics,* 25**,** 257-286.

CHURCH, A., BURGESS, J., RAVENSCROFT, N., BIRD, W., BLACKSTOCK, K., BRADY, E., CRANG, M., FISH, R., GRUFFUDD, P., MOURATO, S., PRETTY, J., TOLIA-KELLY, D., TURNER, K. & WINTER, M. 2011. Cultural Services. *The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment.* Cambridge: UNEP-WCMC.

CRAIK, C. 1997. Long-term effects of North American Mink *Mustela vison* on seabirds in western Scotland. *Bird Study,* 34**,** 303-309.

EBI, K. L., SUSSMAN, F. G. & WILBANKS, T. J. 2008. *Analyses of the effects of global change on human health and welfare and human systems. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research,* Washington, DC, USA., U.S. Environmental Protection Agency.

EUROPEAN COMMISSION 2006. Nature and Biodiversity Cases: Ruling of the European Court of Justice. Luxembourg.

FISCHER, A. & VAN DER WAL, R. 2007. Invasive plant suppresses charismatic seabird – the construction of attitudes towards biodiversity management options. *Biological Conservation,* 135**,** 256-267.

FURNESS, R. W. & CAMPHUYSEN, C. J. 1997. Seabirds as monitors of the marine environment. *ICES Journal of Marine Science,* 54**,** 726-737.

HANEMAN, W. M. 1991. Willingness to Pay and Willingness to Accept: How Much Can They Differ? *The American Economic Review,* 81**,** 635-647.

HARLEY, C. D. G., RANDALL HUGHES, A., HULTGREN, K. M., MINER, B. G., SORTE, C. J. B., THORNBER, C. S., RODRIGUEZ, L. F., TOMANEK, L. & WILLIAMS, S. L. 2006. The impacts of climate change in coastal marine systems. *Ecology Letters,* 9**,** 228-241.

HOLLAND, D. S., SANCHIRICO, J. N., JOHNSTON, R. J. & JOGLEKAR, D. 2010. *Economic Analysis for Ecosystem-Based Management: Applications to Marine and Coastal Environments,* Washington, RFF Press.

HOLLOWED, A. B., BARANGE, M., BEAMISH, R. J., BRANDER, K., COCHRANE, K., DRINKWATER, K., FOREMAN, M. G. G., HARE, J. A., HOLT, J., ITO, S.-I., KIM, S., KING, J. R., LOENG, H., MACKENZIE, B. R., MUETER, F. J., OKEY, T. A., PECK, M. A., RADCHENKO, V. I., RICE, J. C., SCHIRRIPA, M. J., YATSU, A. & YAMANAKA, Y. 2013. Projected impacts of climate change on marine fish and fisheries *ICES Journal of Marine Science,* doi:10.1093/icesjms/fst081

HOROWITZ, J. & MCCONNELL, K. E. 1999. A Review of WTA/WTP Studies. *Working Paper.* Department of Agricultural and Resource Economics, University of California.

HORSBURGH, K., BALL, T., DONOVAN, B. & WESTBROOK, G. 2010. Coastal Flooding in MCCIP Annual Report Card 2010-11. MCCIP Science Review, 10pp. www.mccip.org.uk/arc.

HUNTLEY, B., GREEN, R. E., COLLINGHAM, Y. C. & WILLIS, S. G. 2007. *A Climatic Atlas of European Breeding Birds,* Barcelona, Durham University, The RSPB and Lynx Edicions.

JNCC. 2012. *Seabird Population Trends and Causes of Change: 1986-2012 Report.* [Online]. Joint Nature Conservation Committee. Updated July 2013. Available: http://www.jncc.defra.gov.uk/page-3201 [Accessed 22 January 2014].

JNCC. 2013. *Seabirds and Seaduck* [Online]. Available: http://jncc.defra.gov.uk/page-1530 [Accessed 07 November 2013].

LUNDHEDE, T. H., JACOBSEN, J. B., FJELDSÅ, J., RAHBEK, C., STRANGE, N., THORSEN, B. J. & HANLEY, N. 2013. Public support for conserving bird species runs counter to climate change impacts on their distributions. *Paper submitted to Bioecon 2013.*

MCCIP 2009. Marine Climate Change Ecosystem Linkages Report Card 2009. *In:* BAXTER, J., BUCKLEY, P. & FROST, M. (eds.) *Summary Report.* Lowestoft: MCCIP.

MCVITTIE, A. & MORAN, D. 2010. Valuing the non-use benefits of marine conservation zones: An application to the UK Marine Bill. *Ecological Economics,* 70**,** 413-424.

MITCHELL, P. I. & PARSONS, M. 2007. Appendix 2- Impacts of Pressures on Seairds. *Strategic Review of the UK Seabird Monitoring Programme. JNCC Unpublished report.*

MITCHELL, R. C. & CARSON, R. T. 1989. Using Surveys to Value Public Goods: The Contingent Valuation Method. Washington, DC: Resources for the Future.

NICHOLLS, R. J., WONG, P. P., BURKETT, V. R., CODIGNOTTO, J. O., HAY, J. E., MCLEAN, R. F., RAGOONADEN, S. & WOODROFFE, C. D. 2007. Coastal systems and low-lying areas *In:* PARRY, M. L., CANZIANI, O. F., PALUTIKOF, J. P., LINDEN, P. J. V. D. & HANSON, C. E. (eds.) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, UK: Cambridge University Press.

OFFICE OF NATIONAL STATISTICS 2011. The Regional Value of Tourism 2008.

OXFORD ECONOMICS 2013. Tourism: Jobs and Growth. The economic contribution of the tourism economy in the UK. November 2013.

PALTRIGUERA, L. 2013. Public preferences and values on seabird protection in the UK: A contingent valuation study in the Flamborough Head and Bempton Cliffs Special Protection Area. Report prepared under ODEMM Work Package 6 'Cost-benefit analysis'. EC FP7 project (244273) 'Options for Delivering Ecosystem-based Marine Management'. ISBN Number 978-0-906370-82-7. 24pp.

PARRY, M. L., CANZIANI, O. F., PALUTIKOF, J. P., LINDEN, P. J. V. D. & HANSON, C. E. (eds.) 2007. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* Cambridge, United Kingdom and New York, NY, USA.: Cambridge University Press.

PINNEGAR, J., WATT, T. & KENNEDY, K. 2012. Climate Change Risk Assessment for the Marine and Fisheries Sector. UK Climate Change Risk Assessment. Defra Project Code GA0204.

RSPB 2010. The Local Value of Seabirds: Estimating spending by visitors to RSPB coastal reserves and associated local economic impact attributable to seabirds. Sandy, UK: The RSPB.

THE SCOTTISH GOVERNMENT. 2014. *Scotland's Referendum* [Online]. Available: http://www.scotreferendum.com/ [Accessed 06 March 2014].

TURNER, K. 2011. *A Pluralistic Approach to Ecosystem Valuation* [Online]. Defra's Natural Capital Committee Available: http://www.defra.gov.uk/naturalcapitalcommittee/files/ncc-assetcheck-03.pdf [Accessed 22 March 2012].

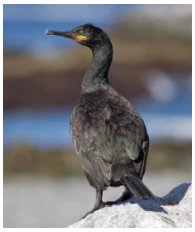
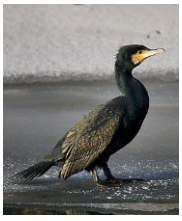
UKMMAS 2010. Charting Progress 2: The state of UK seas. London: Department for Environment, Food and Rural Affairs.

WALKER, M. E., MORERA, O. F., VINING, J. & ORLAND, B. 1999. Disparate WTA-WTP disparities: the influence of human versus natural causes. *Journal of Behavioural Decision Making,* 12**,** 219-232.

WHITE, S. (ed.) 2010. *Measuring Tourism Locally- Guidance Note Two: Local Economic Impact Modelling Approaches*: Office of National Statistics.

Annex 1. Seabird species that can be found in the different RSPB Coastal Reserves

Species	**Bempton Cliffs**	**South Stack Cliffs**	**Mull of Galloway**	**Rathlin island**
Gannet  Photo credit: Andreas Trepte www.photonatur.de	X	X	X	
Fulmar  Photo credit: Dick Daniels http://carolinabirds.org/	X	X		X
Kittiwake  Photo credit: Dick Daniels http://carolinabirds.org/	X		X	X

Species	**Bempton Cliffs**	**South Stack Cliffs**	**Mull of Galloway**	**Rathlin island**
Razorbill  Photo credit: neekoh.fi (Flickr)	X	X	X	X
Guillemot  Photo credit: Dick Daniels http://carolinabirds.org/	X	X	X	X
Puffin  Photo credit: Eysteinn Guðni Guðnason	X	X	X	X
Shag  Photo credit: Andreas Trepte www.photonatu.de	X			X
Herring gull  Photo credit: Andreas Trepte www.photonatu.de	X			
Cormorant  Photo credit: Andreas Trepte www.photonatu.de	X			

Species	**Bempton Cliffs**	**South Stack Cliffs**	**Mull of Galloway**	**Rathlin island**
Black guillemot  Photo credit: Christian Bickel			X	
Manx shearwater  Photo credit: Matt Witt		X		
Notes: Information on the different seabird species found in the 4 RSPB reserves was taken from the RSPB website (https://www.rspb.org.uk/reserves/). The list is not comprehensive as it is possible that other seabird species can (occasionally) be found in the reserves but are not included in the list. Additionally, other species (i.e. terrestrial and waterbird species) can be found in these reserves. All images have been taken from Wikimedia Commons (http://commons.wikimedia.org/wiki/Main_Page) and reproduced according to each image's license requirement, as specified by the owner of each image.				

Annex 2. Projections of change in the distribution of specific seabird species as outlined in the Huntley et al. (2007) study

Species	Description of results of modelling and changes in distribution
Gannet	Model has "poor fit", but shows that simulated potential future breeding range is shifted north-westwards, with suitable areas being in Iceland while southern areas (in current range) are simulated to be no longer suitable. The maps show that it is possible that Bempton Cliffs will be the only RSPB site that will 'lose' this species; other reserves may still have these species, but potentially in smaller numbers.
Fulmar	Model has "very good fit". The simulation shows that there is a contraction in the current southern distribution, with France, southern Britain and southern Norway shown as no longer suitable sites for the species. The map of future distribution show that the species can still be found in the Western parts of the UK, and potentially a small population in East Yorkshire (i.e. Bempton Cliffs)
Kittiwake	Model has "very good fit". The simulation shows that distribution shifts northwards and contracts in extent. The map of future distribution show that the species can still be found in the Western parts of the UK, and potentially a small population in East Yorkshire (i.e. Bempton Cliffs)
Razorbill	Model has "good fit". The future potential distribution is shifted northwards. The coasts of southern Ireland, southern Britain, Britanny and much of the Baltic sea are simulated as areas that are no longer suitable. The map of future distribution shows that the species may still have a small population in north Wales and Northern Ireland, but most of the UK population will be in Scotland.
Guillemot	The model has "good fit", but there are minor discrepancies due to failure to simulate colonies south of Brittany and in the Baltic Sea. The future potential distribution is shifted northwards, where currently occupied areas in southern Britain is simulated to become unsuitable. The map of future distribution show that in the UK, the bulk of the population will be

Species	Description of results of modelling and changes in distribution
	in Scotland but there are areas in Wales and Northern Ireland that this species can still be found.
Puffin	The model has a "good fit", but minor discrepancies include failure to simulate precisely the smaller scattered breeding localities. Southern Britain and southern Norway are simulated as no longer suitable. The map of future distribution shows that areas in Scotland, Wales and Northern Ireland may still have populations of these species, but it is likely that these populations will be small.
Shag	Model has "very good fit". The simulated future potential distribution extends northwards to Svalbard and Novaya Zemlya. Maps of future distribution shows that the bulk of the UK population will be in Scotland and the west of Northern Ireland. There may be populations in Wales and England, but may be small.
Herring gull	Model has "good fit". The simulated future potential distribution is reduced in extent and shifted somewhat northwards. The map of future distribution shows that there will be populations in the UK, but populations in the eastern part of England may be smaller (including around Flamborough and Bempton Cliffs)
Cormorant	Model only has a "fair fit". The simulated future potential distribution is shifted north-eastwards. The map of future distribution shows that there will be populations in the UK, and the Flamborough Head and Bempton Cliffs area may be the southernmost area in the east of England where these species can be found.
Black guillemot	Model has "very good fit". The simulated future potential distribution is markedly reduced in extent and contracted northwards. The coasts of Ireland, south-western and much of north-east Scotland are simulated as no longer suitable. The map of future distribution shows that these species can be found only in the northern parts of Scotland.
Manx shearwater	The model has "fair fit". Simulated potential future distribution extends northwards and most of the present range is simulated as no longer suitable. The map of future distribution shows that in the UK, this species will be found mostly in Eastern Scotland, although there may be small populations in Northern Ireland and

Species	Description of results of modelling and changes in distribution
	Wales.
Note: This table is only meant as a summary of the results of the modelling work done by Huntley et al (2007). Maps showing the potential range of specific species should only be taken as an indication of where the birds are likely to be found given a change in climatic conditions. It is advised that the reader refer to the Huntley et al (2007) report for more information rather than relying on the summary presented in this table.	

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