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Recommendations for Intertidal Biodiversity Surveillance

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Contents

Executive Summary

Surveillance monitoring is essential to meet both UK and international targets of halting the loss of biodiversity. To achieve this goal effective surveillance strategies need to be implemented. The aims of this project, therefore, were to provide recommendations for surveillance of intertidal marine biodiversity to enable progress to meet UK and EU targets of reversing declines in biodiversity by 2010. In particular, this project identified intertidal species that are likely to respond to environmental change and therefore could act as potential indicator species for change to the community as a whole; provided bioclimatic models to predict species range shifts in response to global climate change; recommended scales at which intertidal surveillance programmes need to be undertaken to meet best and worst case scenarios for survey design; and identified locations, at a variety of scales, in which surveillance monitoring of the rocky intertidal could be undertaken.

Findings

1. Fifty-seven rocky intertidal species have been identified as potential indicator species. The species were identified because they have previously been identified as Environment Agency 'exposure pressure' species (Hiscock *et al.* 2005), climate indicator species (Simkanin *et al.* 2005), characteristic species of key intertidal biotopes (Grosholz *et al.* 2000) and/or non-native species.

2. Neighbourhood occupancy predictive models were created for 28 of the 57 indicator species to forecast the likely species range changes under different UKCIP02 climate models. We were unable to create models for all species due to a lack of information on the distribution and abundance of some and the rarity of others.

3. The use of biotopes as indicators of environmental change was shown to be poor at the EUNIS level 3 classification. However, modelling changes in the distribution of characteristic species of key biotopes, at EUNIS level 5, to global climate change showed that many of these species are likely to retreat or expand their ranges, which is likely to alter the balance of intertidal biotopes. Bioclimate envelope predictions of future species ranges have been created for ten characteristic species of intertidal biotopes.

4. Power analysis of the broadscale data collected during the MarClim project has given an indication of the best and worst case scenarios for undertaking surveillance programmes. To just meet UK obligations under the Habitats Directive i.e. changes in species abundance of an order of magnitude, 50 sites would need to be surveyed to detect a decrease and 20 sites to detect an increase in species abundance. To meet targets over and above UK and international targets 85 sites and 40 sites would need to be surveyed to detect a decrease and increase in species abundance of one SACFOR category. However, to detect the predicted change in abundance of the most temperature sensitive species for the High 2020s scenario over 200 sites would need to be surveyed.

5. ESRI Shape files have been created for 20, 30, 50, 100, 200 and 400km spaced survey schemes for intertidal areas.

Recommendations

Annual surveys of approximately 100 sites would meet targets over and above UK and international obligations to undertake surveillance as well providing enough information to separate noise from signal. Larger surveys, such as those to detect changes in the abundance of, for example, the most climate sensitive species, need only be undertaken every ten years. Both these survey strategies would meet UK and EU aims of reducing the loss of biodiversity and be deemed cost effective by both managers and the general public.

Further work

The findings of this pilot project are limited to the rocky intertidal. Further work needs to be done to extend this project to other intertidal habitats and the subtidal. In addition the predictive models are based on observed data collected during the MarClim project. Unfortunately there are some areas of the UK that were not surveyed during the MarClim project e.g. north-east England and it is imperative, to validate these models, that data on species distributions and abundances are collected from where there are gaps in our knowledge. Our findings show that up to 200 sites will need to be surveyed to observe changes in species abundance under some environmental change scenarios. Therefore, work started during the MarClim project, to establish a low cost UK wide monitoring network, needs to be addressed.

1. Introduction

Information on the condition and changes in the condition of the marine environment are of major concern to government and non-government organisations, as well as the general public. The World Summit on Sustainable Development stated that '*halting the loss of marine biodiversity*' was imperative. At an EU and pan-European level the objective is to protect and restore the structure and functioning of natural systems and halt the loss of biodiversity both in the European Union and on a global scale by 2010 (European Commission 2001). There is therefore a growing need for better information on the state of marine biodiversity to guide management and regulatory decisions, verify the efficiency of existing programmes and help shape policy on marine environmental protection.

Surveillance (or trend monitoring) needs to be designed to identify and quantify long-term environmental changes as a result of anthropogenic change from naturally occurring fluctuations. In particular, to ensure an ecosystem approach to marine stewardship, the influence of global environmental change (i.e. anthropogenically forced warming and introduction of non-native species) needs to be separated from regional (e.g. fishing, eutrophication and modification of coastal processes) and local impacts (e.g. point sources, acute pollution incidents, specific sea defence schemes, habitat loss due to coastal development and recreational activities). This can only be done via broadscale and long-term research networked over appropriate spatial and temporal scales. Surveillance programmes carried out over such spatial and temporal scales will be able to detect changes in habitats and species, signalling areas where declines in diversity are occurring and enable hypotheses to be developed to understand the causes of these declines. In addition surveillance undertaken both within and outside protected (designated) areas will provide information on the condition of protected areas and the contribution they make to maintain the wealth of the UK's biodiversity. Such surveillance programmes also ensure that national and international obligations for undertaking of surveillance and monitoring are met, as well as contributing to European and global audits of the state of biodiversity and its contribution to ecosystem processes.

Effective trend monitoring should provide a rationale for setting standards and priorities that not only provides effective management of marine ecosystems, but also resonates with the general public. Therefore an effectively designed surveillance programme should provide:

- a potential early warning of future problems, especially if the surveys can be carried out in a way that is not solely reliant on an identified 'need' by decision makers;

- an enhanced knowledge of marine ecosystems, their variability, and societal impacts on them – thus allowing the targeting of resources;

- a rationale for setting standards and priorities. When surveillance shows a clear change or trend, for example, a reduction in fish abundance, public confidence in the decision maker's limits on catches is enhanced;

- a better understanding of the health of the marine environment;

- information for generating hypotheses to inform process orientated research on the underlying mechanisms behind the alteration in species distributions to provide a better understanding of the processes structuring marine communities and ecosystems; and

- information to construct, adjust and verify quantitative predictive models to predict rates and scales of future changes in species ranges and population structure and to provide a basic tool in evaluating and selecting management strategies.

Any surveillance programme should aim to detect changes in the status of biodiversity, the impacts of different factors upon biodiversity and the effects of policy and management responses taken to counteract the causes of changes in biodiversity. It is, however, impossible to undertake surveillance of all biodiversity directly due to constraints of time, biological knowledge and perhaps more importantly cost. Therefore attempts should be made, wherever possible, to use species that can act as indicators of change for the community as a whole. In particular surveillance programmes need to ensure that enough sampling is undertaken to detect more than just catastrophic change, but not sample far in excess of what is necessary.

The aim of this pilot project was to provide recommendations for surveillance in the intertidal zone. The intertidal was specifically chosen for this project as considerable amounts of quantitative and semi-quantitative time-series data, collected over a fifty-year period and covering much of the UK, has been collated enabling re-survey as part of the recently completed Marine Biodiversity and Climate Change (MarClim) project. The rocky intertidal is also an ideal system in which to undertake this pilot project as it is the most studied of marine habitats due to ease of access, most of the organisms being either sedentary or sessile, resulting in a good understanding of the biology and ecology of the species. More recently a suite of intertidal species have been shown to be good indicators of changes in species abundance and range in response to climatic warming, mirroring changes that are occurring offshore (Simkanin *et al.* 2005). Intertidal species have therefore been suggested as cheap indicators of more general responses to climate change of marine biodiversity (Laffoley *et al.* 2005, Simkanin *et al.* 2005).

1.1. Policy drivers and commitments

A key driver for surveillance is the need to set priorities for nature conservation action. Many of these priorities have been set through our need to comply with national and international obligations for surveillance. Obligations to detect changes in the status of biodiversity, and the causes of change, arise primarily from the EC Habitats and Birds Directives, Convention on Biological Diversity, Ramsar Convention, OSPAR and the requirement by Government to monitor and report on the condition of designated sites. There are a number of other Directives currently being considered that may also affect the need and scope of a marine biodiversity surveillance programme.

The UK Governments' vision of "*clean, safe, healthy, productive* and *biologically diverse oceans and seas*" (as set out in the first Marine Stewardship Report *Safeguarding our Seas*, published in May 2002), is central to the development of a surveillance programme that is likely to be implemented through the new UK Marine Monitoring and Assessment Strategy, currently undergoing consultation.

1.2 Project aims and objectives

The aims of this pilot project (26 funded days of scientist time) were to provide recommendations for surveillance of intertidal biodiversity, to enable progress to EU and UK targets of reversing the decline of biodiversity by 2010. In particular, we aimed to provide information on how to measure biodiversity in the marine environment using intertidal indicator species and the spatial and temporal scale at which monitoring studies need to be undertaken to meet different national and international agreements.

The specific objectives of this report were to:

- identify indicators key for measuring changes in biodiversity in intertidal biotopes;
- provide projected changes in species ranges using a bioclimate envelope model, incorporating species which are diagnostic of particular biotopes;
- recommend comprehensive and minimalist intertidal sampling designs suitable for detecting changes in biodiversity;
- identify appropriate sampling locations and methodologies, as appropriate; and
- provision of pilot GIS polygon shape files that can be used as a template for locating sampling stations.

This report stems from the work of the JNCC-part-funded MarClim project (MarClim 2001), the main aims of which were to understand and predict likely change in intertidal fauna and flora in a changing climate, by reference to earlier survey work done in the 1950s and intervening period. In this context therefore, much of the analysis presented here derives from methods developed for detection of climate-related change. These methods are, however, largely portable to other environmental drivers of change, and should be interpreted with this in mind.

2. Intertidal indicators to measure biodiversity

It is unrealistic in terms of time and hence cost to undertake monitoring of all marine biodiversity directly. A more realistic alternative is to identify indicator species or sensitive biotopes that are known to respond to changes in environmental conditions and are likely to act as indicators of changes in biodiversity. Using the rocky intertidal as an example we have created a list of candidate indicator species for monitoring the effects of changes in marine biodiversity (Appendix 1).

The species chosen have been selected because they are easily identifiable and represent species that are likely to respond to environmental change because they have been identified as Environment Agency 'exposure pressure' species (Hiscock *et al.* 2005), climate indicator species (Simkanin *et al.* 2005), and/or key non-native species (see Appendix 1). Characteristic species of key intertidal biotopes (Grosholz *et al.* 2000) have also been proposed as indicator species as changes in the presence or abundance of these species are likely to track wider changes in marine biodiversity and have knock-on effects if they are habitat forming species (ecosystem engineers) or important consumers (keystone species).

3. Predicted range extensions of indicator species

3.1 Models developed in the MarClim project

A major goal of the MarClim project was the resurvey of the intertidal rocky coastlines of the UK and Ireland 50 years after the last major surveys by Alan Southward and Dennis Crisp in the 1950s, using methods comparable with the earlier work and compatible with those in use today. 617 sites were surveyed up to October 2005, forming the 'observed' set of categorical abundance data for the development of statistical models used in forecasting the changes presented in this report. The spatial extent of the MarClim surveys had some gaps in coverage, and to extend model predictions to the entire UK coastline we have added 126 further sites in areas not yet surveyed. 'Predicted' data in maps shown in this Report thus covers 743 sites around the UK.

Abundance categories used by Crisp and Southward (1958) spanned six categories from Abundant (corresponding to ecologically dominant), Common, Frequent, Occasional, Rare and Absent, a sequence that has become known as the ACFOR scale. While these categories represent the loss of some numerical information in terms of counts of organisms, particularly at the higher ranges of abundance, they are well suited to capture the lower range of abundance when individuals may occur in scattered patches or as isolated individuals. At the upper end of the abundance scale, a better ability to capture numbers of organisms by direct counts in quadrats has led to the addition of extra categories: Extremely Abundant and Super Abundant. The latter is included in the now-standard SACFOR scale. Most of the data collected in the MarClim project was collected as SACFOR data. To detect change since the 1950s, however, for the modelling the Super Abundant and Abundant categories were collapsed into a single Abundant class. This has no effect on the changes in distributions projected by the models, since forecast changes are based on changes in the likelihood of Abundant or Common categories. Likewise, use of the ACFOR scale in this modelling exercise does not undermine the adoption of the SACFOR scale as the presently accepted standard.

Models of species distributions were developed during the MarClim project based on ordinal logistic regression of ACFOR categorical abundance scores. Two predictor variables were found to give good prediction of species abundance for a wide range of species recorded during surveys. The best predictions of the distributions of warm-water species, generally restricted to western and south-western coasts, was achieved using February sea surface temperature, averaged between 1961 and 1990. An index of wave exposure developed during the project, the summed fetch up to a maximum of 200km in 16 angular sectors, successfully distinguished distributions of exposed-shore species (e.g. *Laminaria hyperborea*, *Alaria esculenta*, *Chthamalus stellatus*) from those of species generally restricted to shelter (*Elminius modestus*, *Ascophyllum nodosum*, *Fucus spiralis*, *Pelvetia canaliculata*). Models were produced for 55 species using data from 617 sites surveyed by MarClim teams in the UK and Ireland mostly between 2002 and 2004.

These 'bioclimate envelope' models (hereafter BE models) are a useful first step in establishing the nature of the association between species distributions and the major environmental variables in a region. Making forecasts of changes in distributions as a result of environmental changes using this class of models is not without difficulty (Davis *et al.* 1998), since such models take no account of the underlying processes determining population spread, including any potential barriers to dispersal, connectivity and availability of suitable habitat.

We attempted to account for the effects of limits to population spread by modifying our original models to include the effect of occupancy of nearby sites. If the species were absent from an area yet environmental conditions were apparently favourable, such as for *Patella depressa* in southern Ireland, the modified model predicts much-reduced abundance in such areas. The incorporation of the neighbourhood occupancy rate into models was achieved by fitting ordinal logistic regressions to the ACFOR data using February SST, wave fetch and a single index of the proportion of sites occupied in a 100km neighbourhood around each site (henceforth PO models).

The models themselves predict the likelihood that the ACFOR category at each site will be <u>at least a particular category</u>. To use these models to determine changes in species ranges, it is necessary to set a criterion for whether the predicted 'likelihood of a category' defines the site as being inside or outside the species range. For most species, mere presence defines the range so the appropriate category to consider is **<u>at least RARE</u>**. The critical likelihood of being rare that may define the species range is less easy to set but experimentation suggests a value of P(at least Rare)>0.3 is sufficient to delineate the range of the species (Figure 1).

UKCIP recommend (Hulme *et al.* 2002) that models that make forecasts from climate projections should present the results from several forecasts for comparison. To this end we have predicted range changes for three scenarios: High CO_2 emissions for the 2020s (High 2020s), Medium-Low CO_2 emissions for the 2080s (Medium-Low 2080s), and High CO_2 emissions for the 2080s (High 2080s). Table 1 gives the expected range of February SST increases for each scenario.

Table 1. Projected changes in average sea surface temperature for February under UKCIP02 scenarios. Values shown are the minimum and maximum for all sites around the UK and Ireland. * shows scenarios used in predictions of range changes (Section 4 below and Appendix Fig. A3)

	Min	Max
Low 2020s	0.34	0.67
Medium-Low 2020s	0.38	0.74
Medium-High 2020s	0.38	0.74
High 2020s*	0.41	0.8
Low 2080s	0.86	1.69
Medium-Low 2080s*	1.01	1.98
Medium-High 2080s	1.42	2.78
High 2080s*	1.67	3.28

Examples of forecast changes in species distribution are shown in Figures 2 and 3. The topshell *Osilinius lineatus* is currently restricted to southwest England, south and west Wales and southern and western Ireland. With a 0.4 to 0.8°C change in February SST (Figure 2), the species is predicted to extend eastwards in the Channel to mid Kent, northwards along the Irish coast and across into southern and western Scotland. With a further 0.6 to 1.2°C increase in the long-term average of February SST, the species is expected to continue its expansion eastwards into the southern North Sea and northwards along the west coast of Scotland (Figure 3).

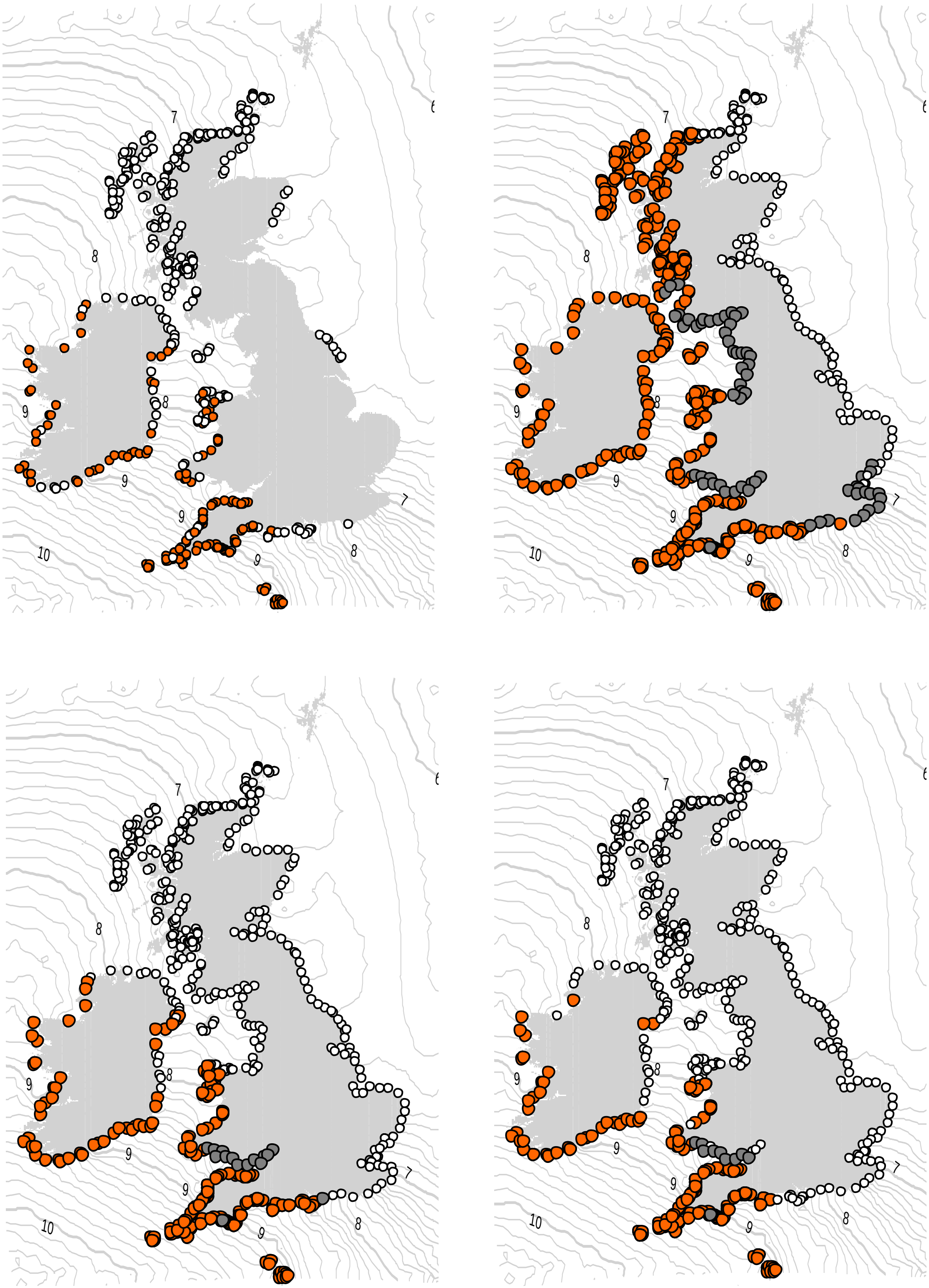

Figure 1. Observed (top left) and predicted (top right, bottom left and right) species range for the topshell, *Osilinus lineatus*, using the criterion P(R)>*x* where *x*=0.1 (top right), 0.3 (bottom left), 0.5 (bottom left). For observed distributions (top left), orange and grey filled circles indicate sites where the species is at least rare and white open circles show where the species is absent. For species ranges predicted using present day conditions of temperature and wave exposure, filled circles show sites where the likelihood of the species being rare is greater than the threshold value, *x*. Grey lines indicate February sea surface temperature isotherms, here and in successive Figures.

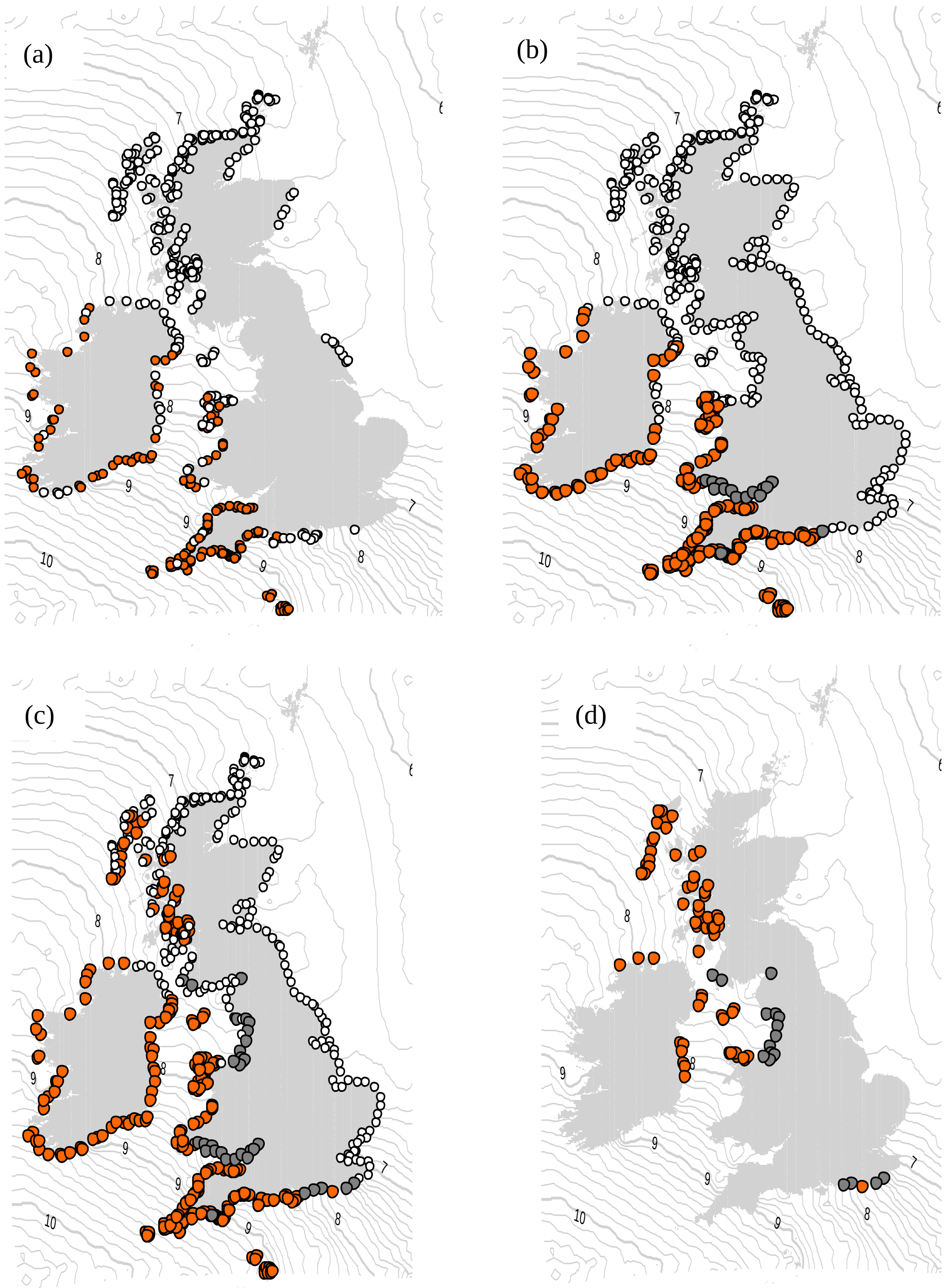

Figure 2. Predicted change in species range for the topshell, *Osilinus lineatus*, under the UKCIP02 High 2020s scenario (Feb SST increase 0.4°C to 0.8°C, PO model). From top left to bottom right, plots show (a) recorded range 2002-04, (b) range as predicted by PO model using present day Feb. SST and wave fetch and P(R)>0.3 as the criterion, (c) range predicted for the UKCIP02 High 2020s scenario, and (d) range extensions. For plots (a) to (c) filled symbols denote presence (orange for sites visited during the MarClim project), open symbols absence. For plot (d) filled symbols show sites where the species is likely to appear.

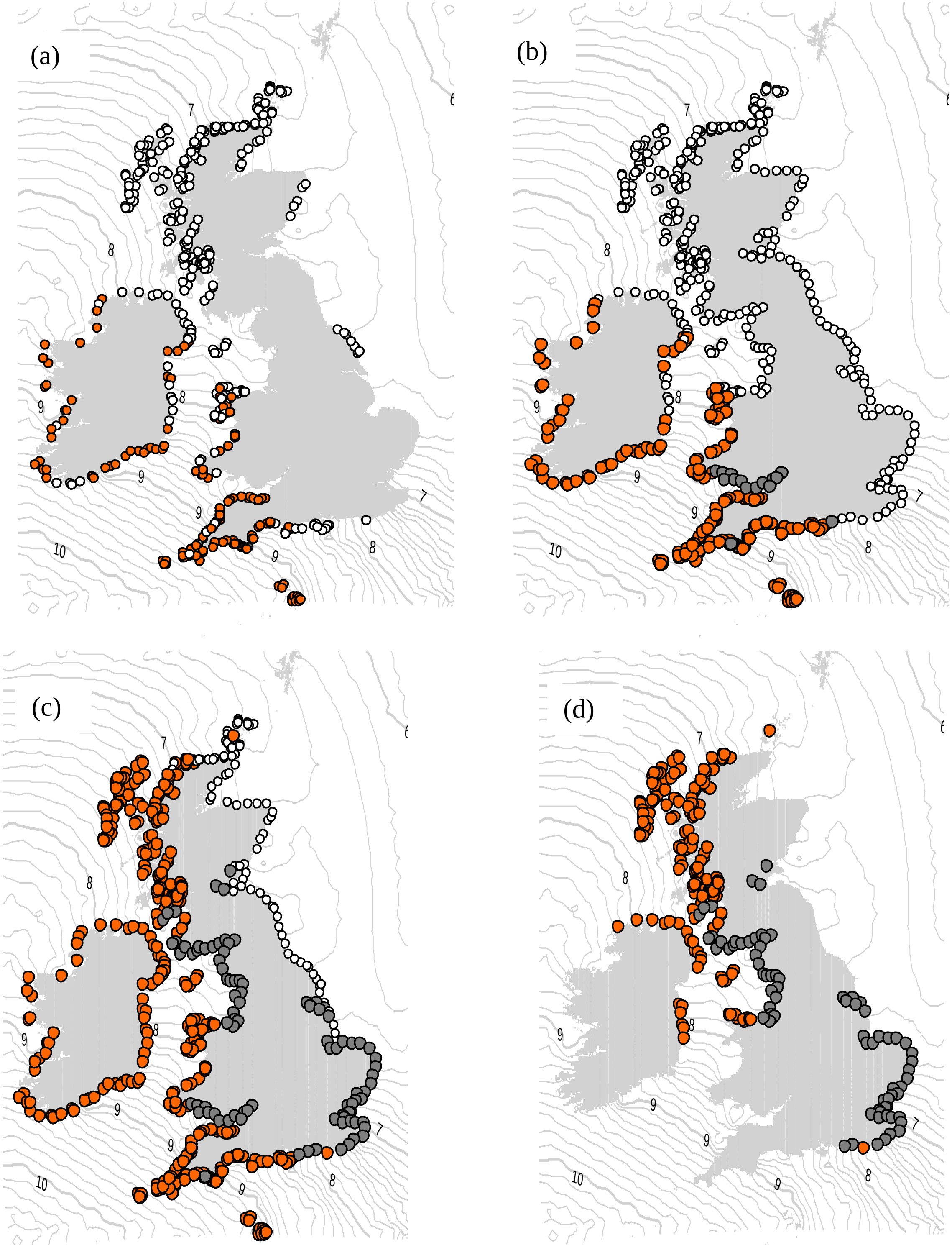

Figure 3. Predicted change in species range for the topshell, *Osilinus lineatus*, under the UKCIP02 Medium-Low 2080s scenario (Feb SST increase 1.0°C to 2.0°C, PO model). From left to right, plots show (a) recorded range 2002-04, (b) range as predicted by PO model using present day Feb. SST and wave fetch and P(R)>0.3 as the criterion, (c) range predicted for the UKCIP02 Medium-Low 2080s scenario, and (d) range extensions. Symbols as Fig. 2.

Maps of forecast ranges and range changes are given in Appendix A2 for all the climate indicator species predicted to show a change in range in the UK. Table 2 summarises these forecasts and gives the numbers to the Figures in the Appendix. Species are shown as indicators of two EUNIS Level 3 Biotope Complexes: Moderately-Exposed Littoral Rock, and Exposed Littoral Rock, and in addition, two further distinct biotopes: Rockpools as Features of Littoral Rock and Moderately- exposed littoral rock with *Sabellaria* reefs (both EUNIS Level 4). While rockpools are found on moderately exposed and exposed littoral rock, this biotope does have a different flora and fauna with potentially different sensitivities to environmental pressures. *Sabellaria* reefs form very untypical assemblages.

Table 2. Rocky intertidal indicator species as characterising species of key intertidal biotopes. Completely ubiquitous species (e.g. *Corallina officinalis*) were omitted from the analysis of dependence of species distributions on temperature, as were those found at only a handful of sites during the MarClim surveys (e.g. *Calliostoma zizyphinum*, *Crassostrea gigas*). Temperature dependence is shown by the value of the logistic regression parameter, *b*, where logit(P)= *a* + *b*.February SST in degrees.

Biotope indicator species (1 Moderately-exposed littoral rock (LR); 2 Exposed LR; 3 LR (rockpools); 4 Moderately-exposed LR with *Sabellaria* reefs)		Dependence on Feb SST	P Incidence	Figure A2	Forecast Change in range
Algae					
Alaria esculenta	*2	0.498	0.243	1	-
Ascophyllum nodosum	*1	0.752	0.559	2	-
Bifurcaria bifurcata	*3	6.880	0.265	3	+
Chondrus crispus	*1, 2, 3	2.227	0.530	4	+
Codium spp.	*3	1.660	0.312	5	+
Corallina officinalis	*1, 2, 3				
Cystoseira spp.	*3	3.093	0.156	6	+
Fucus distichus	*2	0.744	0.004		R
Fucus serratus	*1, 2, 3, 4	1.052	0.846		nc
Fucus spiralis	*1, 2	0.996	0.696		nc
Fucus vesiculosus	*1, 2	0.848	0.647		nc
Halidrys siliquosa	*3	0.714	0.355	7	-
Himanthalia elongata	*1, 2, 3	1.741	0.364	8	+
Laminaria digitata	*1, 2, 3	0.972	0.718		nc
Laminaria hyperborea		1.299	0.133	9	+
Laminaria ochroleuca		3.712	0.008		R
Laminaria saccharina	*3	1.429	0.248	10	+
Lichina pygmaea	*1, 2	1.833	0.545	11	+
Lithophyllum & Lithamnion crusts	*				
Mastocarpus stellatus	*1, 2, 3	1.801	0.701		nc
Palmaria palmata	*2, 3				
Pelvetia canaliculata	*1	0.715	0.727		nc
Porphyra spp.	*2				nc
Sargassum muticum	*3	4.607	0.330	12	+
Porifera and Cnideria					
Actinia equina	*1, 2, 3	1.617	0.873		nc
Actinia fragacea		1.684	0.169	13	+
Anemonia viridis	*3	3.362	0.309	14	+
Aulactinia verrucosa		1.894	0.125	15	+
Halichondria panicea	*1, 3	1.387	0.449		nc

Biotope indicator species (1 Moderately-exposed littoral rock (LR); 2 Exposed LR; 3 LR (rockpools); 4 Moderately-exposed LR with *Sabellaria* reefs)		Dependence on Feb SST	P Incidence	Figure A2	Forecast Change in range
Annelids					
Sabellaria alveolata	*4	1.401	0.121	16	+
Sabellaria spinulosa	*4	0.727	0.012		
Crustaceans					
Balanus crenatus	*4	0.599	0.096	17	-
Balanus perforatus		4.366	0.312	18	+
Chthamalus montagui	*1, 2	3.372	0.840	19	+
Chthamalus stellatus	*1, 2	3.586	0.586	20	+
Elminius modestus		1.504	0.459	21	+
Semibalanus balanoides	*1, 2, 3	0.426	0.965		nc
Molluscs					
Calliostoma zizyphinum					
Crassostrea gigas					
Crepidula fornicata					
Gibbula cineraria	*1, 3	1.164	0.451		nc
Gibbula umbilicalis	*3	3.250	0.776	22	+
Littorina littorea	*1, 3, 4	0.707	0.829		nc
Littorina neglecta	*1, 2	1.602	0.122	23	+
Littorina saxatilis agg.	*2	0.718	0.857		nc
Melarhaphe neritoides	*1	1.513	0.633	24	+
Mytilus spp.	*1, 2, 3	0.993	0.695		nc
Nucella lapillus	*1, 2, 3, 4	0.743	0.928		nc
Onchidella celtica		2.004	0.024		R
Osilinus lineatus		5.484	0.624	25	+
Patella depressa	*1	3.739	0.473	26	+
Patella ulyssiponensis	*3	2.102	0.658	27	+
Patella vulgata	*1, 2, 3, 4	1.532	0.982		nc
Tectura testudinalis		0.417	0.031		R
Echinoderms					
Asterias rubens		1.154	0.162		NFR
Leptasterias muelleri		43.535	0.004		+
Paracentrotus lividus	*3	2.251	0.051	28	(+)

Expected changes in species ranges are: - (minus), contraction; +, expansion; nc, no change in the UK; R, species too rare to build a reliable model; NFR, species not fully recorded around the UK in the MarClim project.

4. Predicted distributions of dominant intertidal biotopes

Intertidal biotopes under the EUNIS classification are recognised by the association of habitats and species they comprise. Here we examine the species predicted to change in range as characteristic of particular biotopes.

From Table 3 it can be seen that biotope indicator species tend to be less likely to be affected by a changing marine climate around the UK than those not characteristic of a particular biotope. Out of the 18 species identified as characteristic of Moderately Exposed Littoral Rock, only 4 are expected to show any change in range (22%). In contrast, of the 26 other species modelled, 24 out of 26 (92%) are expected to show large changes in range. A similar pattern exists for Exposed Littoral Rock species – only 3 out of 15 are likely to show changes in distribution (20%). Rockpool species are much more likely to show significant changes in range than exposed rock surface species (52% of characteristic species forecast to change). This difference in climate sensitivity between biotope indicator species and non-indicator species is not surprising. Biotope indicator species have generally been chosen for their ubiquity in the UK to add to their usefulness in diagnosing particular biotopes. Climatically sensitive species on the other hand are inferred as such by their absence from critical parts of the UK coastline, usually the east and north in the case of southern or warm-water species and, rarely, from the south and west for northern or cold-water species.

Table 3. Forecast changes in species ranges by status of species as indicators of intertidal biotopes. The Table shows the numbers of species ranges likely to expand (+), contract (-) and to show no change (nc).

Moderately Exposed Littoral Rock	Forecast Change			
	-	nc	+	Total
Indicator species	0	14	4	18
Other species	4	2	20	26
Total	4	16	24	44

Indicator species set to increase:
Chondrus crispus
Himanthalia elongata
Melarhaphe neritoides
Patella depressa

Indicator species set to decrease:
None

Exposed Littoral Rock	Forecast Change			
ELR	-	nc	+	Total
Indicator species	1	12	2	15
Other species	3	4	22	29
Total	4	16	24	44

Indicator species set to increase:
Chondrus crispus
Himanthalia elongata

Indicator species set to decrease:
Alaria esculenta

Littoral Rock (Rockpools)	Forecast Change			
LR(R)	-	nc	+	Total
Indicator species	1	11	11	23
Other species	3	5	14	22
Total	4	16	25	45

Indicator species set to increase:	Indicator species set to decrease:
Bifurcaria bifurcata	*Halidrys siliquosa*
Chondrus crispus	
Codium spp.	
Cystoseira spp.	
Himanthalia elongata	
Laminaria saccharina	
Sargassum muticum	
Anemonia viridis	
Gibbula umbilicalis	
Patella ulyssiponensis	
Paracentrotus lividus	

Moderately exposed Littoral Rock with *Sabellaria* Reefs	Forecast Change			
MLR(S)	-	nc	+	Total
Indicator species	1	4	1	6
Other species	3	12	24	39
Total	4	16	25	45

Indicator species set to increase:	Indicator species set to decrease:
Sabellaria alveolata	*Balanus crenatus*

All the species listed in Table 3 are characteristic of the EUNIS Level 3 classification of intertidal biotopes, the coarsest level of biotope classification. The Level 5 classification, does incorporate species identity as the defining criterion for classification. Species-specific changes, such as a change from a *Chthamalus*-dominated mussel-barnacle biotope to a *Semibalanus balanoides*-dominated mussel-barnacle biotope (LR.HLR.MusB.Sem.Sem to LR.HLR.MusB.Cht.Cht), will be expected to reflect changes at species level (see Table 3).

Despite this lack of sensitivity to climate of the species range of the major biotope-characterising species, the models do predict changes in abundance of some of these species in response to changing temperatures. Biotopes are more likely to be defined not by the presence and absence of particular species but rather by these species achieving near dominance of the biological communities at these localities. Here we have defined the level of abundance at which we might expect species to define a biotope as being at least Abundant. For the MarClim survey data, this simply allows the definition of those sites likely to have biotopes associated with particular species. If we set the likelihood that a species is at least Abundant at 30% (P(>=A)>0.3) as the criterion for a site likely to have enough of the species to form a biotope, then we can identify those sites where particular biotopes may occur from model forecasts of species abundance.

Appendix A3 gives the present day distributions of sites where biotope characterising species are abundant and forecasts under the same three UKCIP02 scenarios as used for species range changes (Table 1). Bioclimate envelope models have been used instead of proportional occupancy models for forecasts because of the ubiquity of the species involved: there are no biogeographical barriers to spread in these particular species.

For *Ascophyllum* biotopes (LR.HLR.FT.AscT, LR.LLR.F.Asc, LR.LLR.FVS.AscVS, LR.LLR.FVS.Ascmac, IR.LIR.Lag.AscSpAs, Grosholz *et al.* 2000) survey results and model predictions show these are likely to occur only in sites with Low energy littoral rock (Figure A3.1). With increased temperatures in the higher emissions scenarios, the models forecast that *Ascophyllum* biotopes will retreat further into wave sheltered areas and be lost from the more wave-exposed areas. The biotopes may eventually be restricted to Scottish sea lochs.

Pelvetia canaliculata biotopes (LR.MLR.BF.PelB, LR.LLR.F.Pel, LR.LLR.FVS.PelVS) are currently likely to occur almost anywhere around the UK (Figure A3.2). Warmer temperatures may result in the loss of these biotopes around southern Britain. For the High 2020s scenario, models predict losses of this biotope from wave exposed sites along the Channel, in north Cornwall and Devon and in Wales. For the High 2080s scenario, the model predicts the loss of *Pelvetia* biotopes from all around English and Irish coasts, as well as Scottish coasts, with the effect most pronounced in wave exposure.

Changes in fucoid dominated biotopes are less simple to predict, since at least five species are involved. *Fucus distichus* (LR.HLR.FR.Fdis) was never recorded on MarClim surveys and only found in Caithness on other surveys in the last five years. Warming is likely to see the disappearance of this boreal species from the UK mainland. *Fucus vesiculosus* was more likely to be abundant in shelter and at lower average February SST. Models thus predict a decline of *Fucus vesiculosus* in moderately wave exposed sites in the west and south with increasing temperatures (Fig. A3.3). The most likely affected biotope would therefore be '*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock' (LR.MLR.BF.FvesB). This mirrors changes that occur with latitude and are largely mediated by limpet grazing (Coleman *et al.* 2006, Hawkins & Southward 1992, Jenkins 2005). *F. vesiculosus*-related biotopes in more wave sheltered areas would be less affected (LR.LLR.F.Fves, LR.LLR.FVS.FvesVS, LR.LLR.FVS.AscVS).

Fucus serratus was found throughout the UK and Ireland from the far south to the far north, as likely as in wave shelter as wave exposure (Fig. A3.4). No changes are expected in biotopes associated with this species (LR.HLR.FT.FserT, LR.HLR.FT.FserTX, LR.MLR.MusF.MytFR, LR.MLR.BF.Fser, LR.LLR.F.Fserr, LR.LLR.FVS.FserVS). *Fucus spiralis* is similarly ubiquitous (Fig. A3.5), with no changes forecast for these biotopes (LR.MLR.BF.FspiB, LR.LLR.F.Fspi, LR.LLR.FVS.FspiVS). This is the hardiest *Fucus* spp. and is found as far south as North Africa, the Azores and Canaries. *Fucus ceranoides* was never recorded in MarClim surveys since sites were deliberately chosen to be fully marine wherever possible.

Of the biotopes associated with limpets, *Patella vulgata* (LR.HLR.MusB.Sem.Sem) and *Patella ulyssiponensis* (LR.HLR.FR.Coff.Puly), only the latter may be expected to show any change with climate warming (Fig. A3.7) since the former shows little by way of spatial trends in the UK (Fig. A3.6). *P. ulyssiponensis* is forecast to become more abundant in the north and east.

Finally, there may be considerable changes in biotopes dominated by the barnacles *Semibalanus balanoides* (LR.HLR.MusB.Sem) and *Chthamalus montagui* and *Chthamalus* *stellatus* (LR.HLR.MusB.Cht). *S. balanoides* is a northern species, absent only locally from some parts of the coasts of Devon and Cornwall but otherwise found all around the UK. Models and past trends predict that this species will become less abundant on south-western coasts (Fig. A3.8) with increasing warming (Hawkins & Southward 1992, Jenkins 2005, Southward & Crisp 1954, Southward 1967, Southward 1991, Southward *et al.* 1995). Similarly *Chthamalus montagui* and *C. stellatus* (Figs. A3.9 & A3.10) are predicted to become abundant in the north and east. Here, the forecasts from the bioclimate envelope models must be interpreted with caution since they take no account of potential interactions among species. The distributions of *C. montagui* and *C. stellatus* are limited by the presence of *S. balanoides*, the superior competitor for space in barnacle-dominated intertidal rock communities. *S. balanoides* is faster growing and tends to undercut, overgrow and crush the slower growing *Chthamalus* species (Connell 1961). Changes in *Chthamalus* species are unlikely to be fully realised without a concomitant decline in *S. balanoides*.

5. Suitable temporal and spatial scales for surveillance of key assemblages

One important way in which the extent and spatial and temporal frequency of surveys can be objectively established is through the consideration of the number of sites needed to detect a statistically significant change. Methods for doing this, generally known as 'power analysis', are well established in the statistical literature and examples of their application are readily available (Keough & Mapstone 1997, Osenberg *et al.* 1996).

Change in this context can be expressed as a 'null hypothesis', often referred to by the abbreviation H_0, that states 'there is no change in the response variable' between, for example, comparison periods or survey sites. In statistical terms, it is concluded that change has occurred or a difference exists if the Null Hypothesis is rejected. Power analysis seeks to establish the likelihood of making mistakes in accepting or rejecting null hypotheses, and through this, establish either the minimum change that can be detected for a survey of a given design or the size that a survey must be to detect a change of a set magnitude.

Table 4. The two types of error in hypothesis testing (after Zar 1984)

	If H_0 is true	If H_0 is false
If H_0 is rejected	Type I error (α)	No error ($1-\beta$)
If H_0 is accepted	No error ($1-\alpha$)	Type II error (β)

Statistical power analysis deals with the likelihood of making the two types of errors, Type I – mistakenly rejecting a true null hypothesis (α) and Type II – failing to reject a false null hypothesis (β). Power itself is measured by the quantity ($1-\beta$), the likelihood that a real change is correctly detected. Values of the likelihood of Types I and II error are generally set at $\alpha = 0.05$ and $\beta = 0.20$, the latter equivalent to a statistical power of a test of 80%. Thus, a well-designed survey should detect a predetermined change by correctly rejecting the null hypothesis of 'no change' 80% of the time.

For numerical estimates of population abundance, such as numbers per m^2 or percentage cover, establishment of the within-population variance in the abundance estimate allows determination of the number of samples needed to detect a significant change. Many statistical texts give this methodology in full, and we will not repeat this here.

We use this criterion here to investigate the consequences of different sampling frequencies for the ability of a MarClim-type broadscale survey to detect change in rocky intertidal communities, when the surveys use the SACFOR scales to record abundance. Further funding would enable this approach to be extended to quantitative time series on barnacles, limpets and trochids.

5.1 Best and worse case scenarios

The first step is to define the magnitude of the change that the survey is designed to detect. The change may be considered as either relatively small or relatively large according to 'best' and 'worse' case scenarios for survey designs – defined thus:

i.. Best case: over and above U.K. and international obligations: ecosystem approach and statistically rigorous.

ii. Worst case: only to meet U.K. obligations to undertake surveillance under the Habitats directive; resource restricted.

Translation of these two scenarios into an expected magnitude of change is a non-trivial matter. The Gothenburg Summit in June 2001 (Commission 2001), relating to 2010 target states: Biodiversity decline should be halted with the aim of reaching this objective by 2010 as set out in the 6th Environmental Action Programme (page 9, 3rd bullet from top). However, a decrease in abundance for a single species may well be within expected natural bounds for that species and not in any way cause for concern. Marine intertidal species, especially those relying on settlement of larvae from the plankton, often show large variation in abundance from year to year.

In this context, therefore, and in order to make some projections about the level of survey effort required to detect a change (a decline in the strict terms of the 6th EAP), we have considered changes in abundance of two levels, corresponding to changes in average abundance of one or two categories as measured on the SACFOR scale.

This scale measures abundance on a semilogarithmic scale, with two categories separating values of abundance approximately an order of magnitude apart. For example, in algae the upper limit of the Occasional category is equivalent to 1% cover, Frequent 5%, and Common 30%. For argument's sake, here we consider:

i. **that 'best case' monitoring strategy should be able to detect at least a UK-wide increase or decrease of one abundance category** in a biotope-characterising species, corresponding to either a five-fold increase (500%) or a decline to 20% of the former value;

ii. **for a 'worst case' survey scenario, this requirement could be relaxed to the detection of a decrease or increase of two categories on the SACFOR scale** . This approximates to a 2500% increase or a decline to 4% of the original value.

To illustrate the relative size of these 'best case' and 'worst case' changes, consider the macroalga *Ascophyllum nodosum* – the egg wrack. A decline of two abundance categories from Abundant to Frequent would involve the percentage cover of the weed changing from over 30% of the rock surface to less than 5% cover, a dramatic change that would be equivalent to the loss of the biotope characterised by that species. A change of one abundance category ('best case') would be less striking but could have profound ecological consequences.

5.2 Simulations of surveys of different spatial frequencies using the MarClim data set

As stated earlier, data collected during the MarClim project mostly followed the JNCC-accepted SACFOR scale (MarClim 2002). However, to enable comparisons with surveys made in the 1950s for detection of broadscale change, this data was downgraded to the truncated ACFOR scale by reclassifying Super Abundant records to Abundant. For Bioclimate Envelope modelling, this change will have no effect on the predicted outcomes for either species ranges (Section 3) or the predicted extent of dominant intertidal biotopes (Section 4). Inclusion of the Super Abundant point on the abundance scale simply adds another intercept term to the ordinal logistic regression models linking species abundance to wave fetch and sea temperature.

In this section also, the addition of an extra abundance category would have only an insignificant effect on the outcome of the following analyses. Here we consider changes across a number of sites either within regions or spanning a broad geographical area. Such changes need not be caused only by a climatic change, but could result from a change in any one of the potential environmental factors involved in selecting ‘exposure pressure’ species (Hiscock *et al.* 2005) (substratum loss, smothering, suspended sediment, increased turbidity, physical disturbance, priority substances, nitrate/phosphate, salinity, oxygen concentration, thermal range/heat, industrial effluents). The MarClim dataset contains much information on the natural variability in species assemblages among sites. It is this variability that allows an assessment of the power of a survey to detect change whatever the cause. Adoption of ACFOR or SACFOR scales makes no difference to the ability of a survey to detect a change, except at the upper range of abundance values.

The effect of changing the size of the survey on the ability to detect change can be determined by using the UK-wide frequency distribution of abundance categories to establish a null hypothesis. Abundance data from the 617 sites in the MarClim dataset allows the present-day ‘likelihood of each category’ for each species to be determined. The effect of an increase or decrease of an average of one or two categories on the frequency of sites in each category can be predicted with the ordinal logistic regression models used to forecast changes in species ranges (section 3). Using this approach, a new frequency distribution that produces the change in average category can be produced (Figure 4 left).

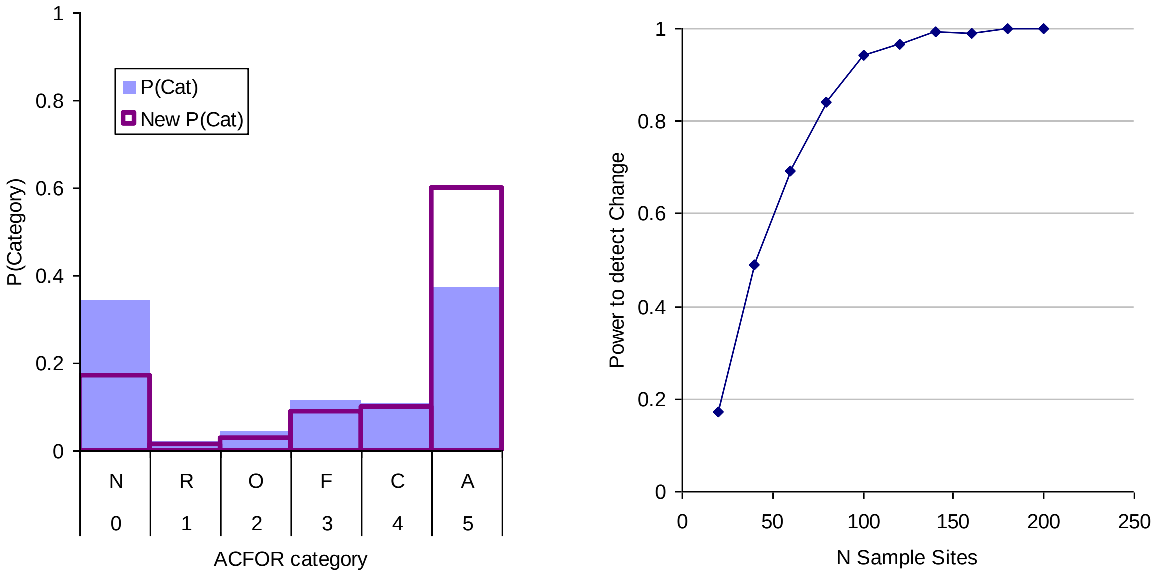

Figure 4. (left) Change in proportional incidence of abundance categories of *Patella ulyssiponensis* equivalent to an average increase of 1 abundance category. (right) Power (1- β) of increasing numbers of sample sites to detect this change as statistically significant (α = 0.05).

In our simulations we generated samples of abundance category data for a set number of sites from the projected new distribution of categories. A chi-squared test was used to determine whether the frequency of each category differed from the present-day distribution of frequencies. If the chi-squared statistic was significant (α = 0.05) then the null hypothesis of no change was rejected, if not, the null hypothesis was accepted. By generating many samples (1000 replicates were used) of the same set number of sites, the probability of correctly rejecting the false null hypothesis, the power, of the sample size could be determined. Thus, 75 sample sites would be needed for a survey designed to detect an average increase of one category for *Patella ulyssiponensis* (Figure 4 right) with a statistical power of 80%.

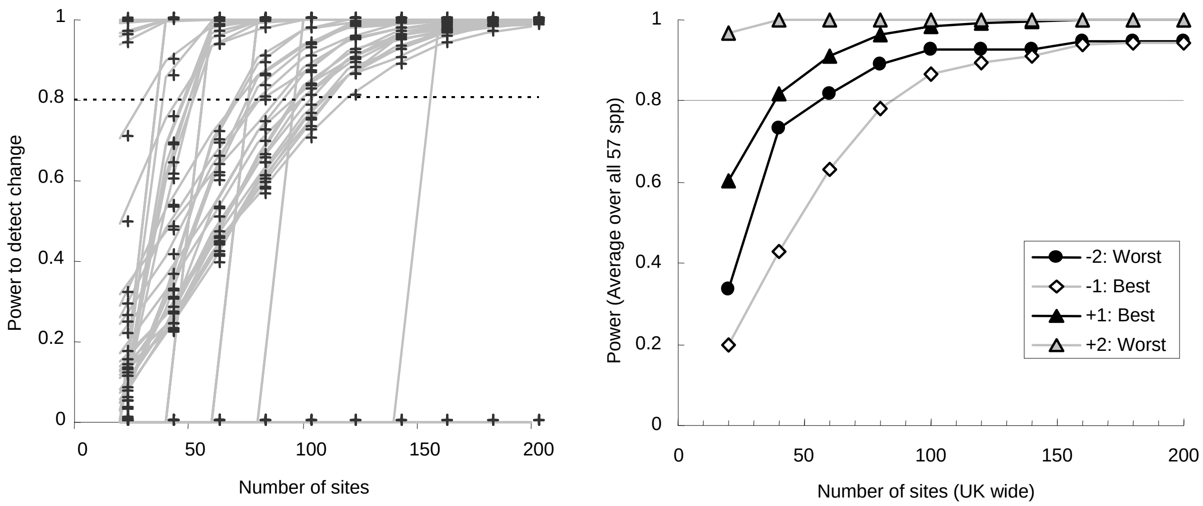

Figure 5. Determination of number of sites needed to detect change. (left) Power to detect a decrease of one category for all MarClim species. (right) Average power over all species for changes of -2, -1, +1 and +2 abundance categories.

This process has been applied for changes in all (57) MarClim species (Figure 5). On average, a survey of 50 sites around the UK would be needed to detect a decrease of 2 categories with a power of 80%. 85 sites on average would be needed to detect a decrease of one category, while 39 and less than 20 sites would be needed to detect increases of 1 and 2 categories respectively.

Variability between species in the number of sample sites needed to detect changes with 80% power is largely associated with the prevalence of the species (Figure 6). Rare or ubiquitous species need surveys of fewer sampling sites to detect change.

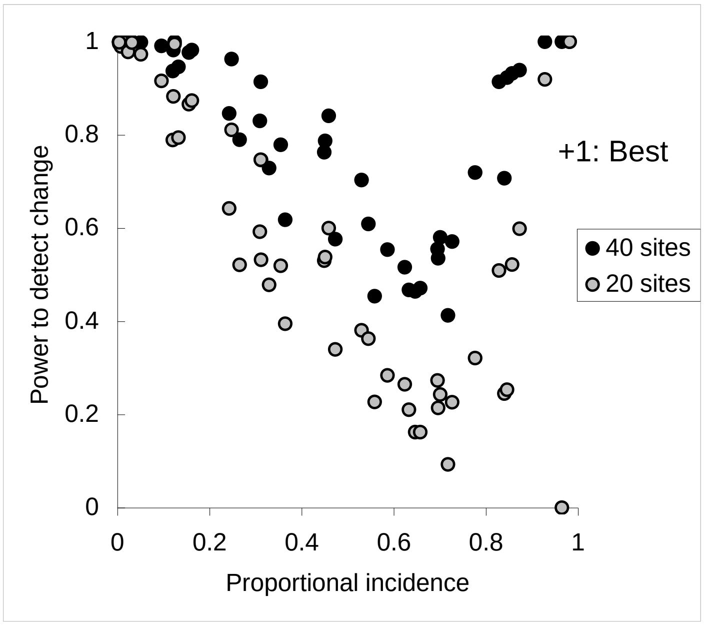

Figure 6. Power to detect an increase of 1 abundance category for two sample sizes (n=20, n=40) for each of 57 MarClim species as a function of the proportional incidence of each species (Table 2).

5.3 Surveys designed to detect changes forecast under UKCIP02 scenarios

Power analysis can be used to determine the number of sites in a survey that would be necessary to detect changes as forecast by bioclimate envelope models. Here we demonstrate the number of sites needed for 80% power in detecting change as forecast for the High 2020s emissions scenario.

A similar approach was adopted. For a sample size of 20 sites for example, 20 MarClim sites were selected at random from the total dataset. Predicted likelihoods of each abundance category at each of these sites using a present-day bioclimate envelope model were summed to give the expected frequencies of each category under a null hypothesis of no change. Projected ‘observed’ data was then simulated for each site using the likelihoods of abundance categories from the scenario model. The significance of the difference in expected and projected ‘observed’ frequencies of abundance categories was determined using a chi-squared test. Many simulations were repeated for each sample size to give power / sample size curves similar to those in Figure 6.

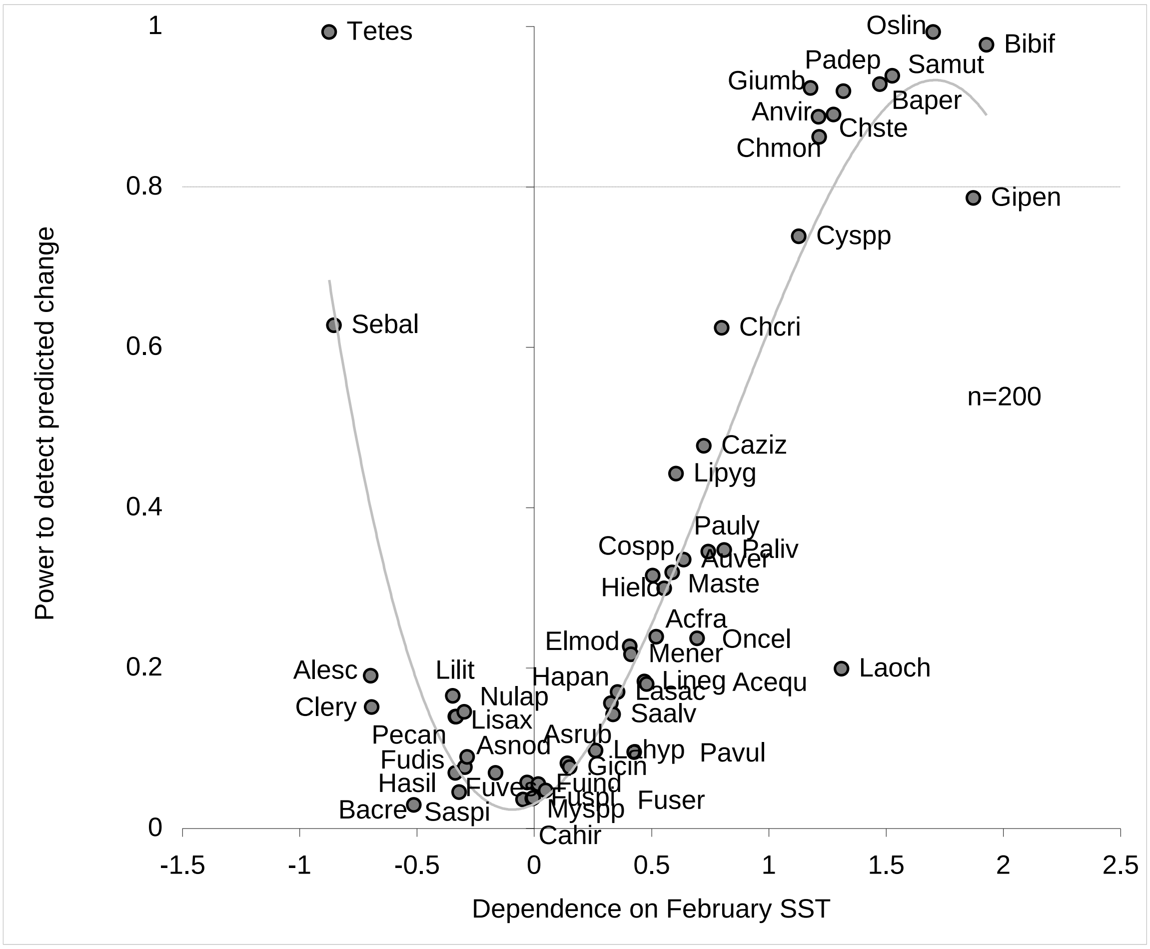

Figure 7. Power of a sample size of 200 sites to detect the changes forecast for each of the MarClim species under the High 2020s emissions scenario, as a function of the sensitivity of each species to February sea surface temperatures.

For changes in distribution in relation to climate as predicted for the High 2020s emissions scenario (0.4 to 0.8°C), it can be seen that far more sites will be needed to detect the relatively smaller changes than even the ‘best case’ scenario. A relatively large sample size of 200 sites will only successfully discriminate the projected changes (with a power of 80%) for those species for which large changes are predicted (
Figure 7). This means that, while the climate sensitive species are expected to show appreciable changes in geographical ranges (Section 3) and overall abundance (this Section), for the size of change forecast under the High 2020s scenario a relatively large survey (200 sites) will be needed to detect the expected changes as statistically significant with an acceptable level of confidence in the findings.

Intertidal systems remain our most accessible marine habitat, both to scientists and the general public, and changes in the species on rocky shores are likely to be indicative of changes happening in coastal seas. The public perception of the state of the seas often hinges on events on the shoreline. Strandings and spread of unusual species, native and non-natives, oil washed ashore and affected seabirds all shape public opinion and prompt a thirst for answers. The approach presented here offers one objective way to address the issue as to whether change has occurred or is occurring on coastal scales, whatever the cause, over and above obvious local impacts. Thus, the importance of establishing large-scale responses of intertidal biota to environmental change, climate-related or otherwise, would more than justify the cost of such a large survey, only necessary every 10 years or more. In addition, targeted surveys annually at range edges (e.g. Scotland, Wales, Northern Ireland, north-east England and south-west England) could provide the 100 or so sites needed to track changes and separate noise from signal. Two people can work two shores per tide. Therefore between April and October inclusive there are 7 months × 2 spring tide periods per month × 5 suitable tides in each spring tide period in which fieldwork can be undertaken; which with working two tides per day in some locations (e.g. Irish Sea, Eastern English Channel, Scotland) gives over 100 locations.

6. Location of surveillance sites under different scenarios

ESRI Shape files provided for 20, 30, 50, 100, 200 and 400km spaced survey schemes for intertidal areas. These files show idealised locations, without regard to access or substratum constraints (the availability of intertidal hard substrata), with the nearest MarClim sampling location for reference and survey use. We recommend that MarClim sites be used wherever possible to enhance the power of the survey to detect change.

The location of the MarClim sites and their recommendations for inclusion or otherwise in surveys of different spatial frequencies are given in Appendix 5.

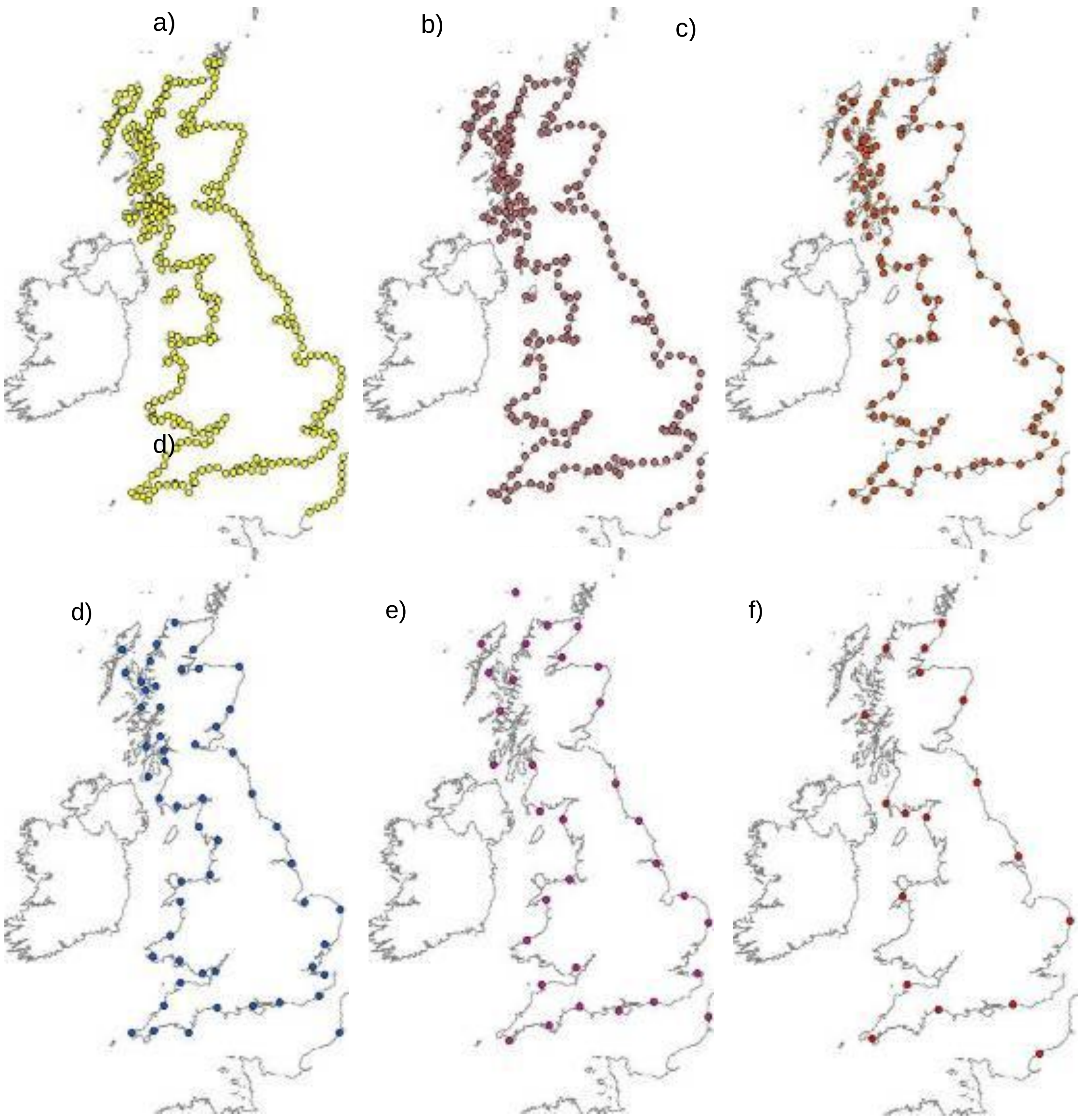

Figure 8. GIS shape files showing the location of surveillance sites at different spatial scales a) 20km (n=359) b) 30km (n=238) c) 50km (n=135) d) 100km (n=54) e) 200km (n=32) f) 400km (n=18) around the UK. Distances along complex coastlines are not equivalent to straight-line distances between sites.

The final choice of sites for surveys with different spatial frequencies should always be guided by issues such as ease of access and availability of rocky shores. Large stretches of coastline may lack suitable bedrock outcrops in the intertidal zone, for example, and the selection of sites in these areas may well be limited to groynes, breakwaters, pier pilings and other artificial hard structures. Such artificial structures may have quite different species compositions from nearby hard natural substrata so may not always be very representative of the regional species pool.

7. Conclusions

The main conclusions to be drawn from the analyses using data from the broadscale MarClim surveys are:

1. Rapid semi-quantitative assessments of rocky shores using multiple species at multiple sites, provides suitable data to report on the diversity and health of marine systems (Section 2). Choice of species is guided by their ease of identification, status as 'exposure pressure' species, climate sensitivity and being key non-natives. A full list is given in Appendix 1.

2. Changes in species abundances and ranges are better indicators of species responses to anthropogenic impacts than whole biotope responses. Statistical models fitted to present day abundance distributions allow us to forecast changes likely under new climatic temperature regimes, taken from UKCIP models run under different emissions scenarios (Section 3).

3. Representative species within biotopes, which are sensitive to a number of anthropogenic impacts, are proposed as the best focus for surveillance programmes designed to detect changes in biotopes (Section 4).

4. Examination of the statistical power of surveillance schemes to detect change allows the evaluation of the worth of different levels of survey efforts (Section 5):

   i. **For a worst case scenario**, where surveillance programmes perhaps only just meet U.K. obligations under the Habitats Directive, **50 sites and 20 sites would need to be surveyed to detect an order of magnitude increase and decrease, respectively, in species abundance.**

   ii. **For a best case scenario**, meeting targets over and above U.K and international obligations, **85 and 40 sites would need to be surveyed to detect a change of a single category species abundance.**

5. However, to detect the change predicted for most temperature sensitive intertidal indicator species for the High 2020s emission scenarios (0.4 to 0.8ºC) over 200 sites would need to be surveyed.

7.1 Further work

Five areas are highlighted by this pilot project for further work:

1. Follow up this specific project by extending the power analysis to MarClim quantitative datasets (barnacles, limpet and trochids) and other available intertidal time-series data as well as extending the analysis to subtidal regions.

2. This project indicates that relatively large sample sizes (n = 200 sites) will be needed to detect the relatively small changes in species abundances expected under High 2020s emissions scenarios. Therefore the more general issue of work started as part of the

MarClim project, to provide a monitoring network need to be addressed (see Appendix 3 for the MarClim proposed monitoring strategy).

3. To update species distribution maps using data collected during the MarClim project and MNCR data already in existence.

4. Undertake surveys where gaps in species distribution data still exist for areas such as east, north-east and north-west England where surveys were not undertaken during the MarClim project. Undertaking surveys at locations along theses sections of U.K. coastline are important for validating and creating predictive models.

5. Develop better models of distributions of intertidal species, including other environmental pressures (as listed in Appendix Table 1, and including potential anthropogenic impacts other than climate and better descriptors of the physical environment) emerge as strong predictors from further analysis of the MarClim intertidal dataset. Future models should be extended to whole coastlines and linked to predictive habitat mapping projects such as the MESH programme.

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Appendix 1: Potential rocky intertidal indicator species as identified due to being ‘exposure pressure’ species, climate indicator species, non-native species of characterising species of key intertidal biotopes. Environmental factors involved in selecting ‘exposure pressure species are: [1] substrate loss, [2] smothering, [3] suspended sediment, [4] increased turbidity, [5] physical disturbance, [6] priority substances, [7] Nitrate/Phosphate, [8] salinity, [9] oxygen concentration, [10] thermal range/heat, [11] industrial effluents (Hiscock et al. 2005) and references within). Key intertidal biotopes are: [1] Moderately-exposed littoral rock; [2] Exposed littoral rock; [3] Littoral rock (rockpools); [4] Moderately- exposed littoral rock with *Sabellaria* reefs

Species	**‘Exposure pressure’ species**	**Climate Indicator**	**Introduced species**	**Biotope indicator species**	**Notes**
Algae					
Alaria esculenta	* [8, 10]	*		* [2]	Northern retreater
Ascophyllum nodosum	* [1, 2, 5, 6]	*		* [1]	
Bifurcaria bifurcata		*		* [3]	Range extensions along English Channel
Chondrus crispus	* [6]	*		* [1, 2, 3]	
Codium spp.		*		* [3]	
Corallina officinalis	* [11]			* [1, 2, 3]	
Cystoseira spp.		*		* [3]	
Fucus distichus	* [2, 10]	*		* [2]	
Fucus serratus	* [2, 6, 11]	*		* [1, 2, 3, 4]	
Fucus spiralis	* [2, 6]	*		* [1, 2]	
Fucus vesiculosus	* [2]	*		* [1, 2]	
Halidrys siliquosa		*		* [3]	
Himanthalia elongata	* [2, 8]	*		* [1, 2, 3]	
Laminaria digitata	* [11]	*		* [1, 2, 3]	
Laminaria hyperborea	* [6, 10, 11]	*			
Laminaria ochroleuca		*			
Laminaria saccharina	* [2, 8, 11]	*		* [3]	
Lichina pygmaea		*		* [1, 2]	
Lithophyllum & *Lithamnion crusts*	* [1, 2, 3, 5, 7, 8]	*		*	Habitat for *Tectura testudinalis*; a northern retreater
Mastocarpus stellatus	* [11]	*		* [1, 2, 3]	
Palmaria palmata	* [6]			* [2, 3]	
Pelvetia canaliculata	* [2, 6, 11]	*		* [1]	
Porphyra spp.	* [6, 11]			* [2]	
Sargassum muticum		*	*	* [3]	

Porifera and Cnideria					
Actinia equina	* [11]	*		*[1, 2, 3]	
Actinia fragacea		*			Range extensions along eastern English Channel
Anemonia viridis		*		*[3]	Range extensions along eastern English Channel
Aulactinia verrucosa		*			
Halichondria panicea	* [2, 5, 6, 11]	*		*[1, 3]	
Annelids					
Sabellaria alveolata	* [4]	*		*[4]	Biodiversity Action Plan species. Reaches northern limit in the British Isles. Northern range extensions
Sabellaria spinulosa	* [1, 4, 8, 11]	*		*[4]	
Crustaceans					
Balanus crenatus	* [1, 2, 6, 9, 10, 11]	*		*[4]	
Balanus perforatus		*			Reaches northern limit in the British Isles. Range extensions along eastern English Channel.
Chthamalus montagui	* [8, 9, 10]	*		*[1, 2]	Reaches northern limit in the British Isles. Extended ranges along North Sea coasts
Chthamalus stellatus	* [8, 9 ,10]	*		*[1, 2]	Reaches northern limit in the British Isles. Extended ranges along North Sea coasts
Elminius modestus	* [6, 11]	*	*		Reaches northern limit in the British Isles
Semibalanus balanoides	* [6]	*		*[1, 2, 3]	
Molluscs					
Calliostoma zizyphinum	* [5]	*			
Crassostrea gigas			*		Escaped from farms in 1980s and increasing in abundance
Crepidula fornicata	* [6]		*		
Gibbula cineraria		*		*[1, 3]	
Gibbula umbilicalis		*		*[3]	Reaches northern limit in the British Isles. Range extensions in northern Scotland and along eastern English Channel.
Littorina littorea	* [2, 6, 7]	*		*[1, 3, 4]	
Littorina neglecta		*		*[1, 2]	
Littorina saxatilis agg.	* [11]	*		*[2]	
Melarhaphe neritoides	* [6]	*		*[1]	Range extensions along eastern English Channel.
Mytilus spp.	* [2, 6, 7, 9, 11]	*		*[1, 2, 3]	

Nucella lapillus	* [1, 6, 8, 11]	*		* [1, 2, 3, 4]	
Onchidella celtica		*			
Osilinus lineatus	* [2, 9, 10]	*			Reaches northern limit in the British Isles. Range extensions along eastern English Channel.
Patella depressa		*		* [1]	Reaches northern limit in the British Isles. Range extensions along eastern English Channel.
Patella ulyssiponensis	* [2, 6]	*		* [3]	Range extensions along eastern English Channel.
Patella vulgata	* [2, 6, 11]	*		* [1, 2, 3, 4]	
Tectura testudinalis		*			Northern retreater
Echinoderms		*			
Asterias rubens	* [1, 5, 6, 8, 9, 10, 11]	*			
Leptasterias mulleri		*			
Paracentrotus lividus		*		* [3]	

Species that may be important intertidal indicator species in certain regions of Britain include *Clibanarius erythropus* (northern limit Channel Islands, formerly found on southwest coasts of Devon and Cornwall), *Gibbula pennanti* (northern limit Channel Islands), *Haliotis tuberculata* (northern limit Channel Islands), *Stronglyocentrotus droebachiensis* (southern limit Shetland Islands), *Fucus distichus* (southern limit northern coasts of Scotland.

Appendix 2. Predicted Changes in Species Ranges

Changes in species ranges as predicted by MarClim models based on February sea surface temperatures, wave fetch index and the present-day proportional occupancy of sites within 100km by that species. See full report for further details of model specifications. February temperatures are those from 1961-1990 UKCIP baseline average data, and those predicted by Hadley Centre models for three emissions scenarios (High 2020s, Medium-Low 2080s, High 2080s).

Figures are presented only for those species predicted to show change under the three scenarios.

Sites are classified as being within the species range when the species is recorded as at least Rare, or having a predicted probability of being at least rare of more than 30%. (P(>=R)>0.3).

List of Figures

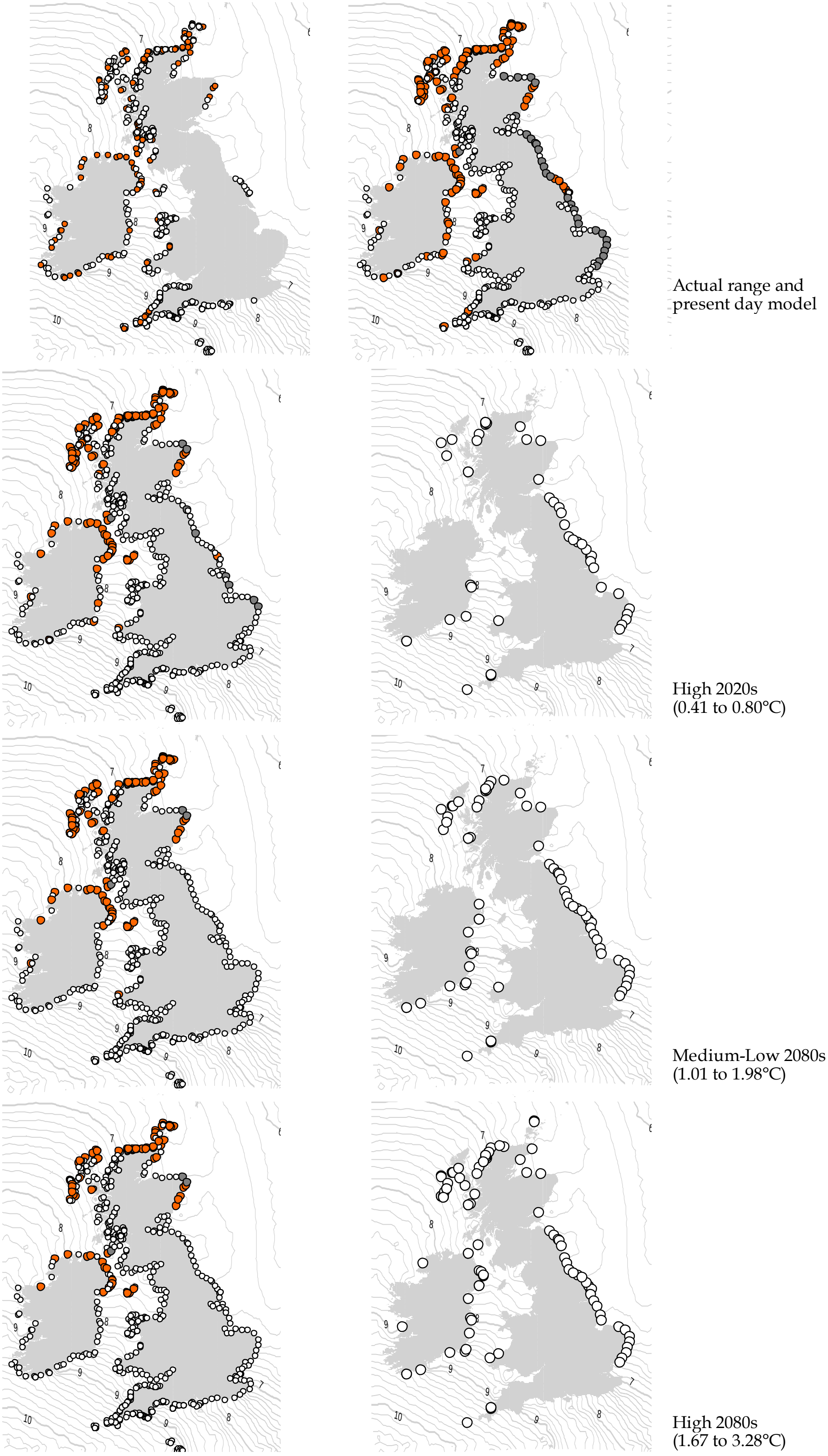


Figure A2. 1 *Alaria esculenta*: Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 UKCIP climate scenarios. Orange filled symbols denote observed and predicted presence at MarClim survey sites (top left), grey symbols denote predicted presence at model locations, open symbols show observed and predicted absence. Grey lines indicate February sea surface temperature isotherms as baseline 1961-90 averages from UKCIP02.

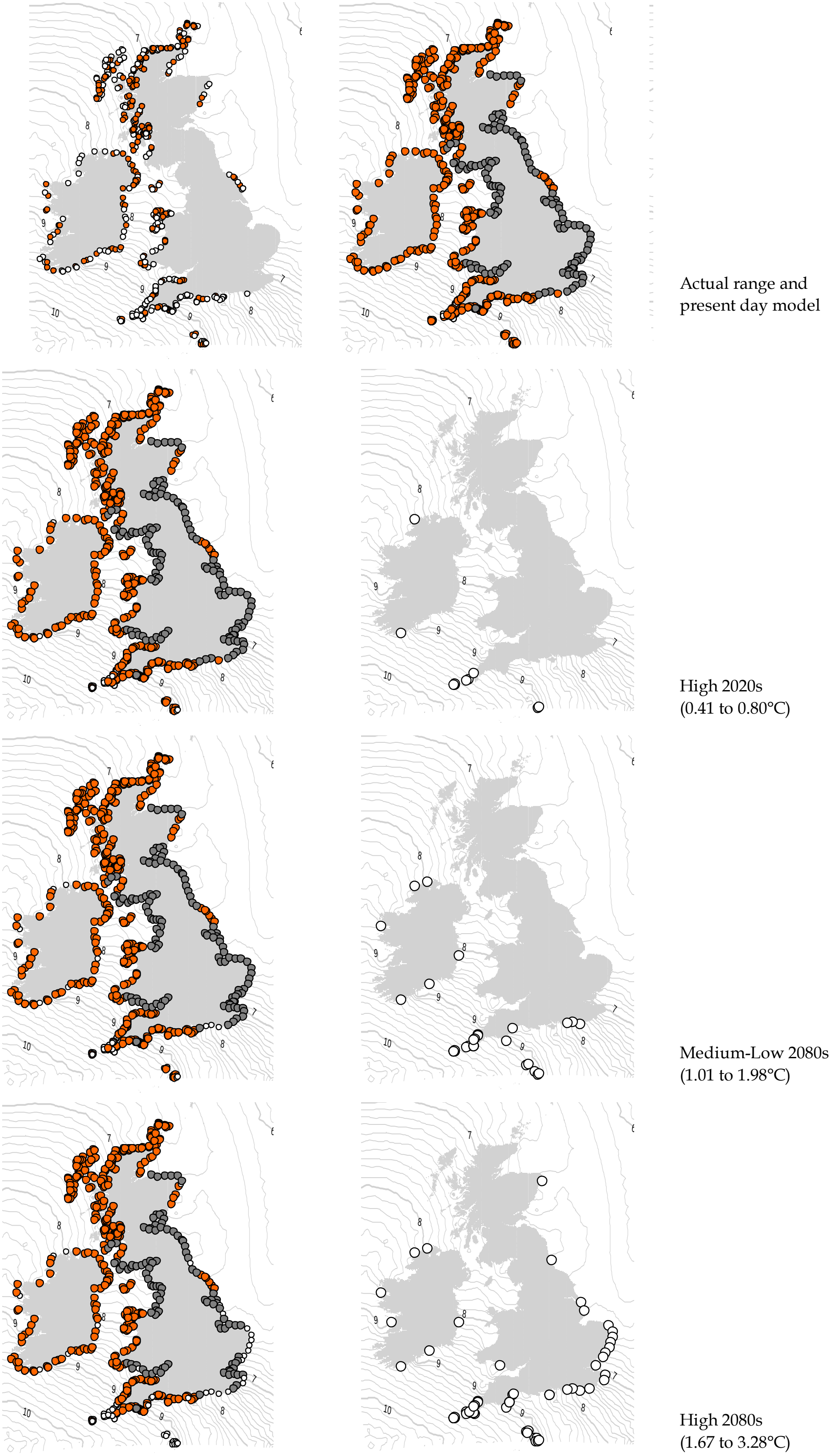


Figure A2. 2. *Ascophyllum nodosum*: Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

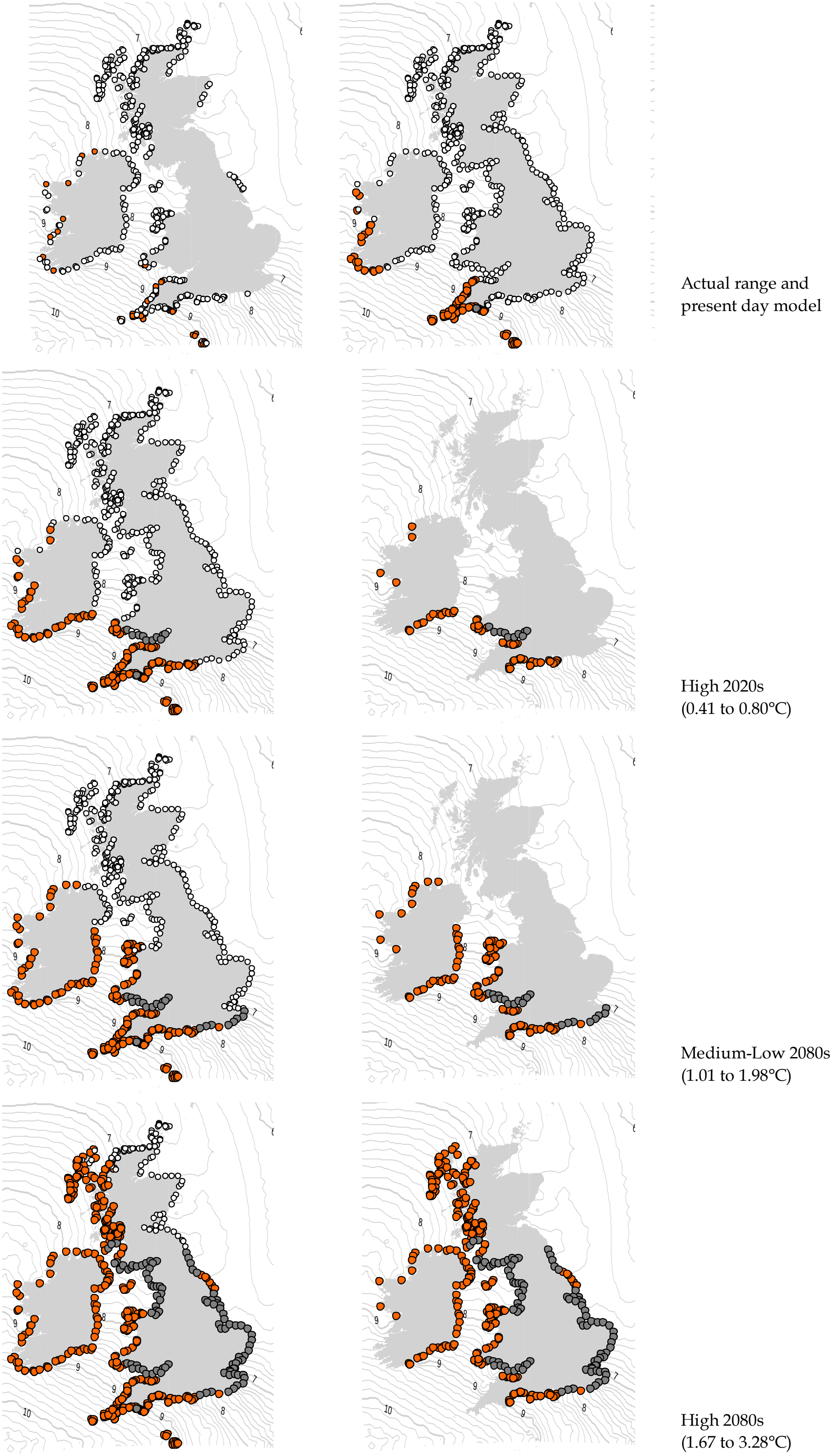


Figure A2. 3. *Bifurcaria bifurcata*: Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

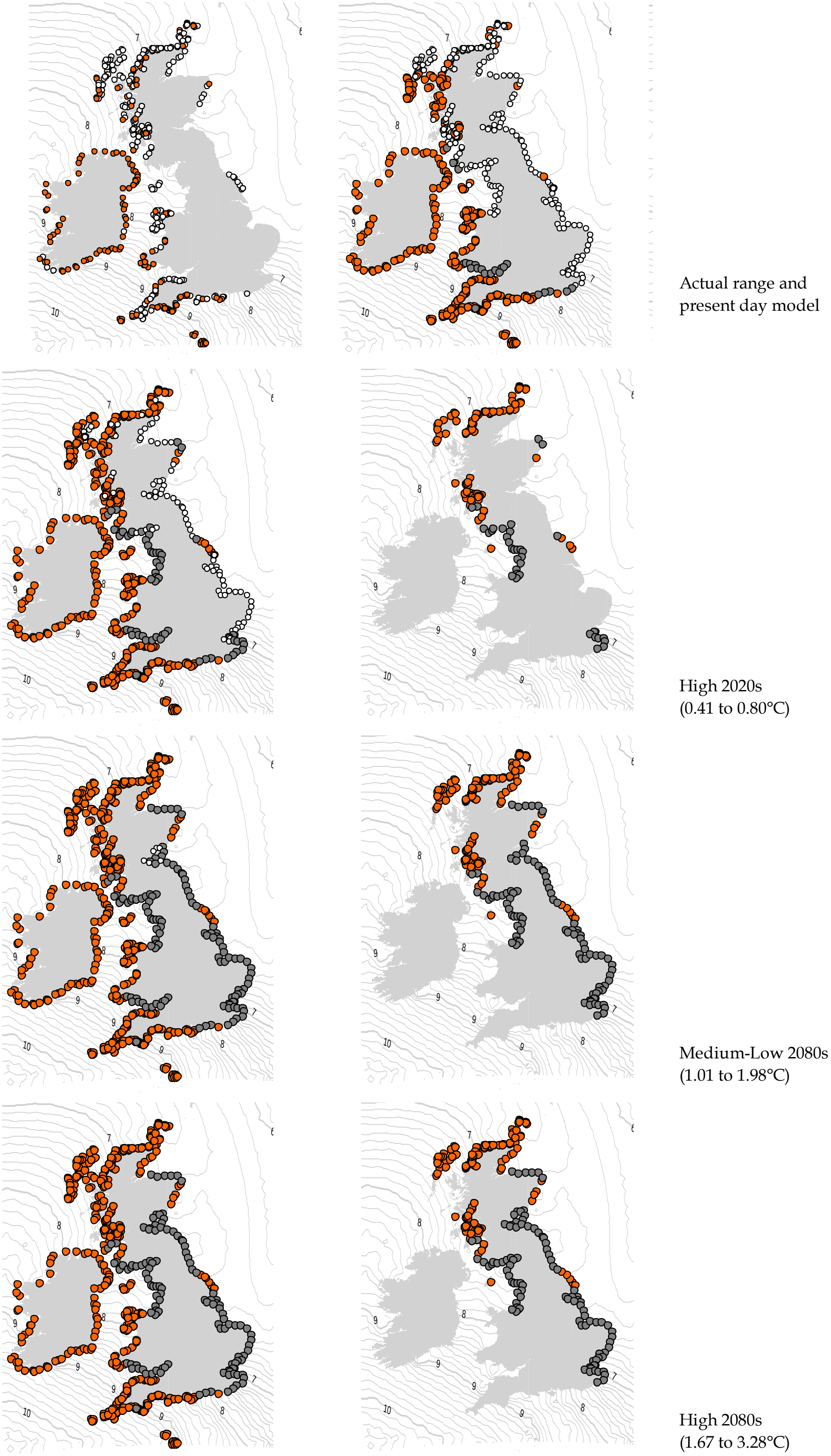


Figure A2. 4. *Chondrus crispus.* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

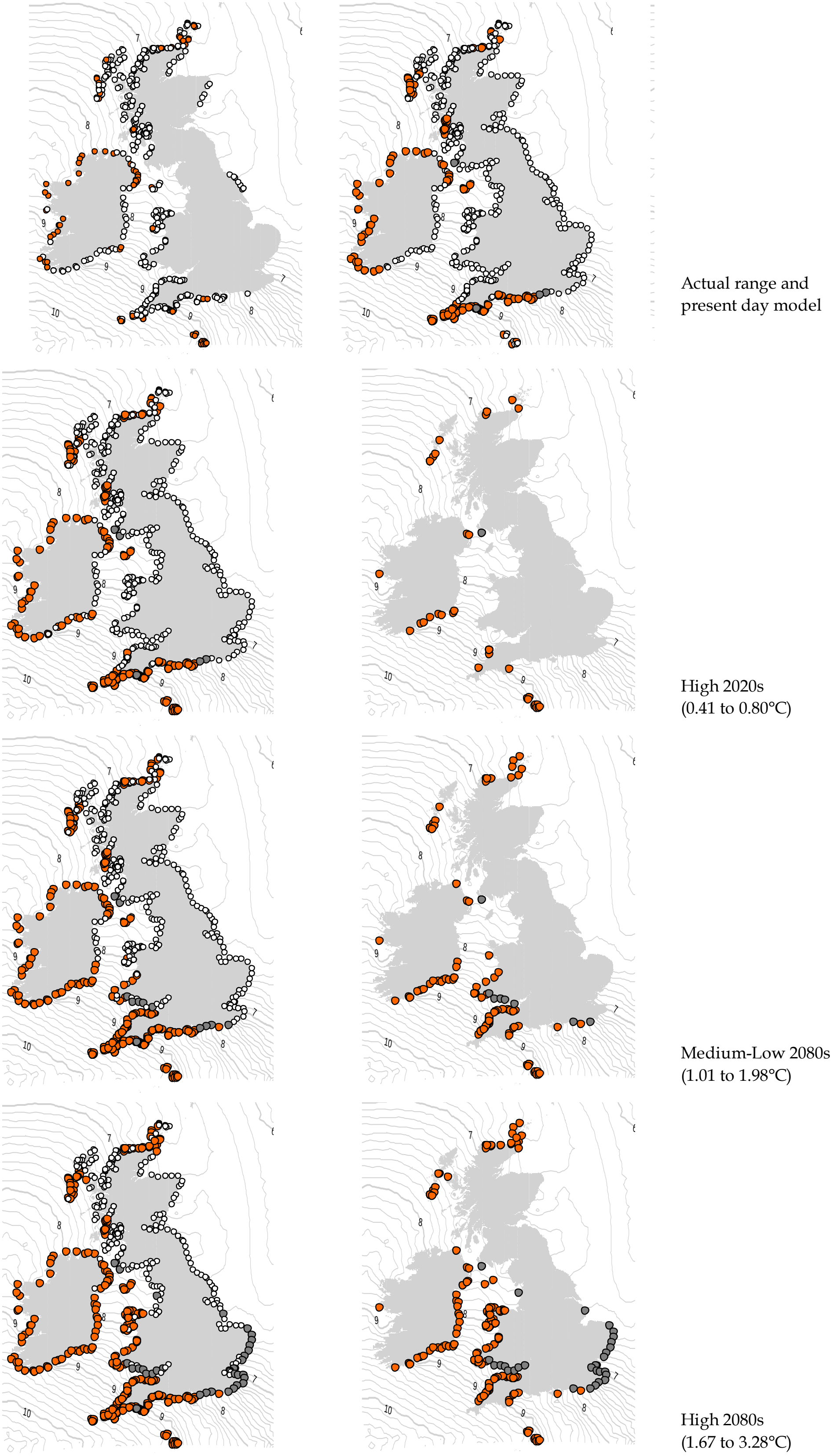


Figure A2. 5. *Codium* spp. Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

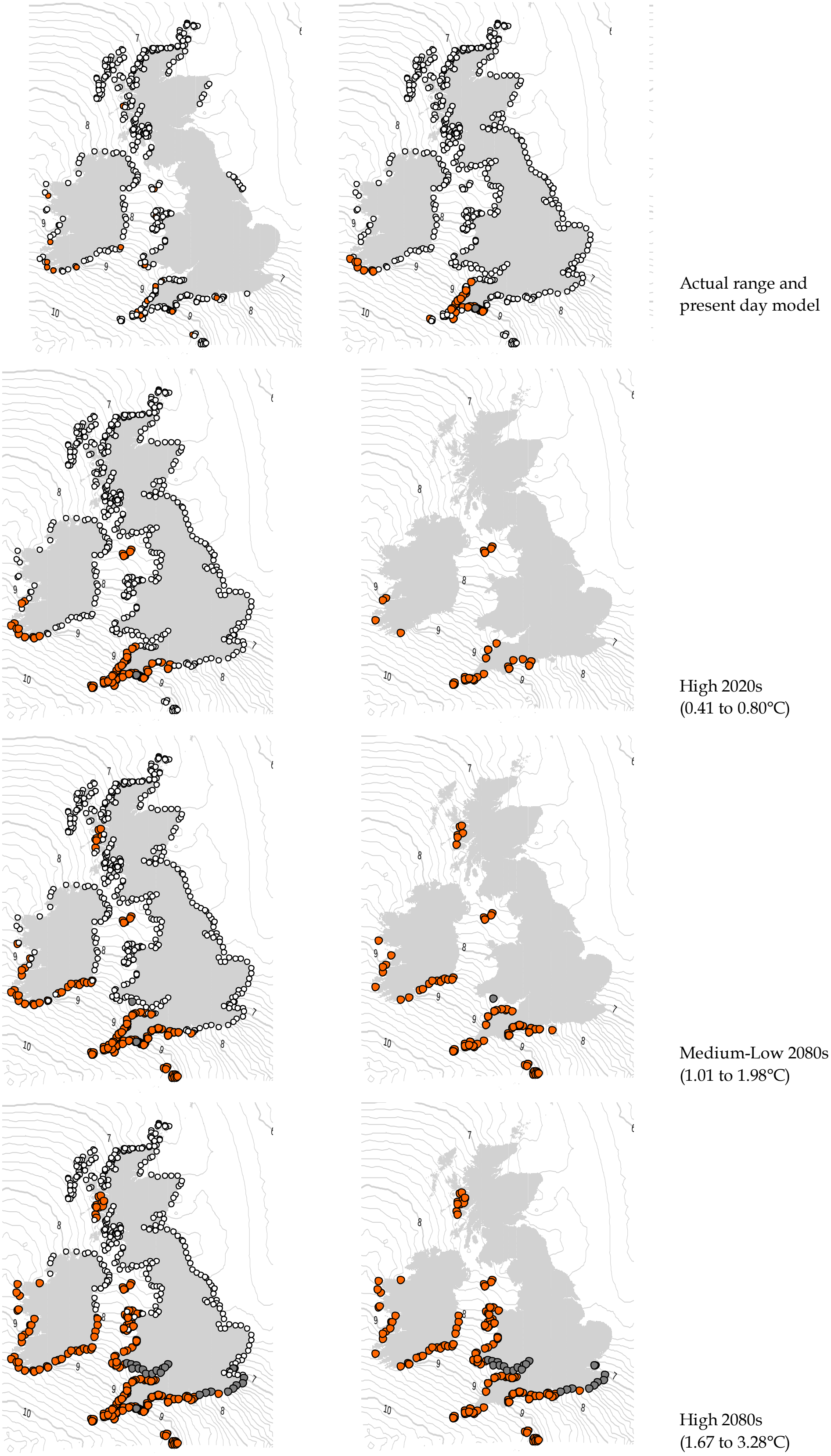


Figure A2. 6. *Cystoseira* spp. Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

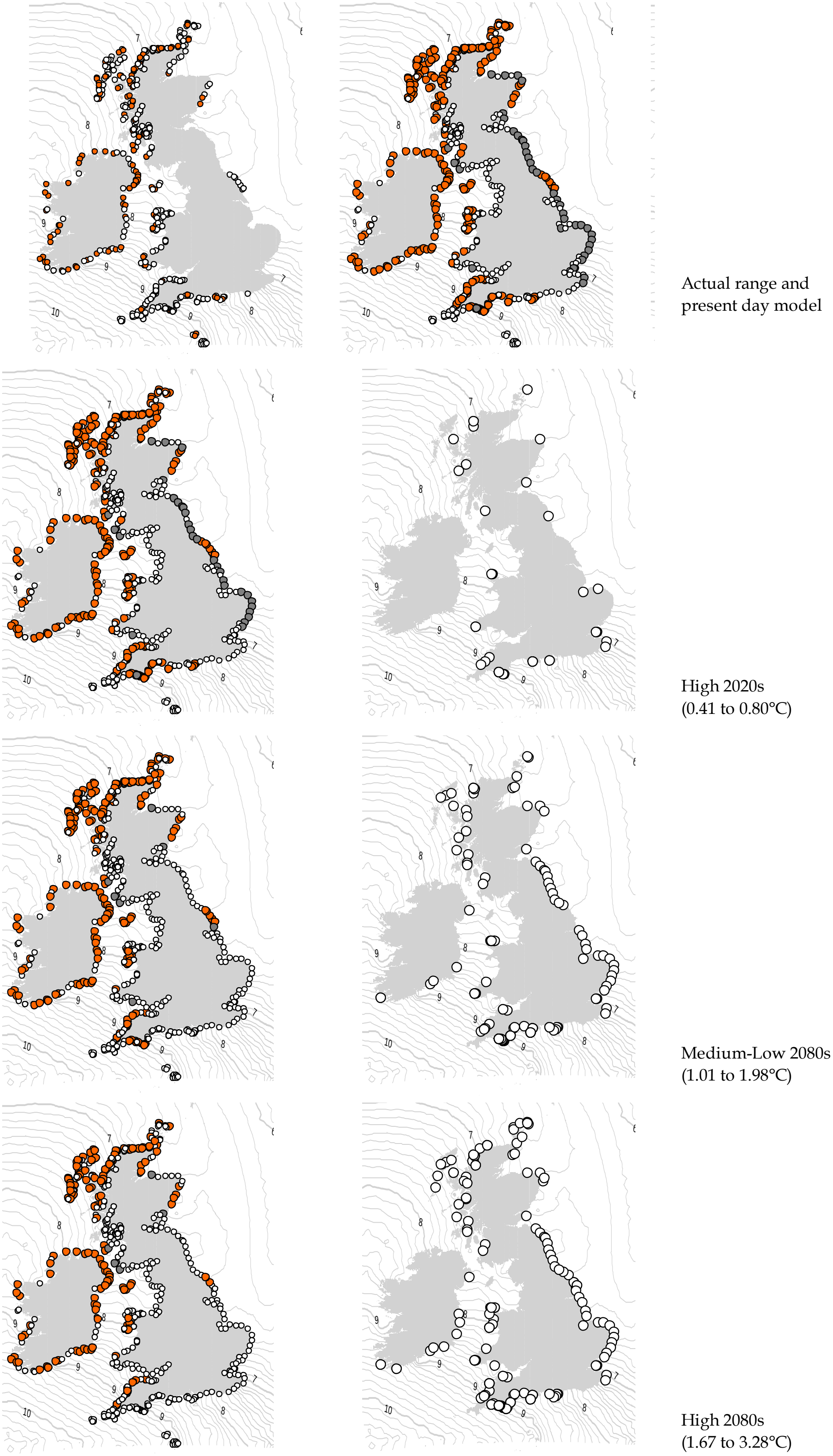


Figure A2. 7. *Halidrys siliquosa.* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

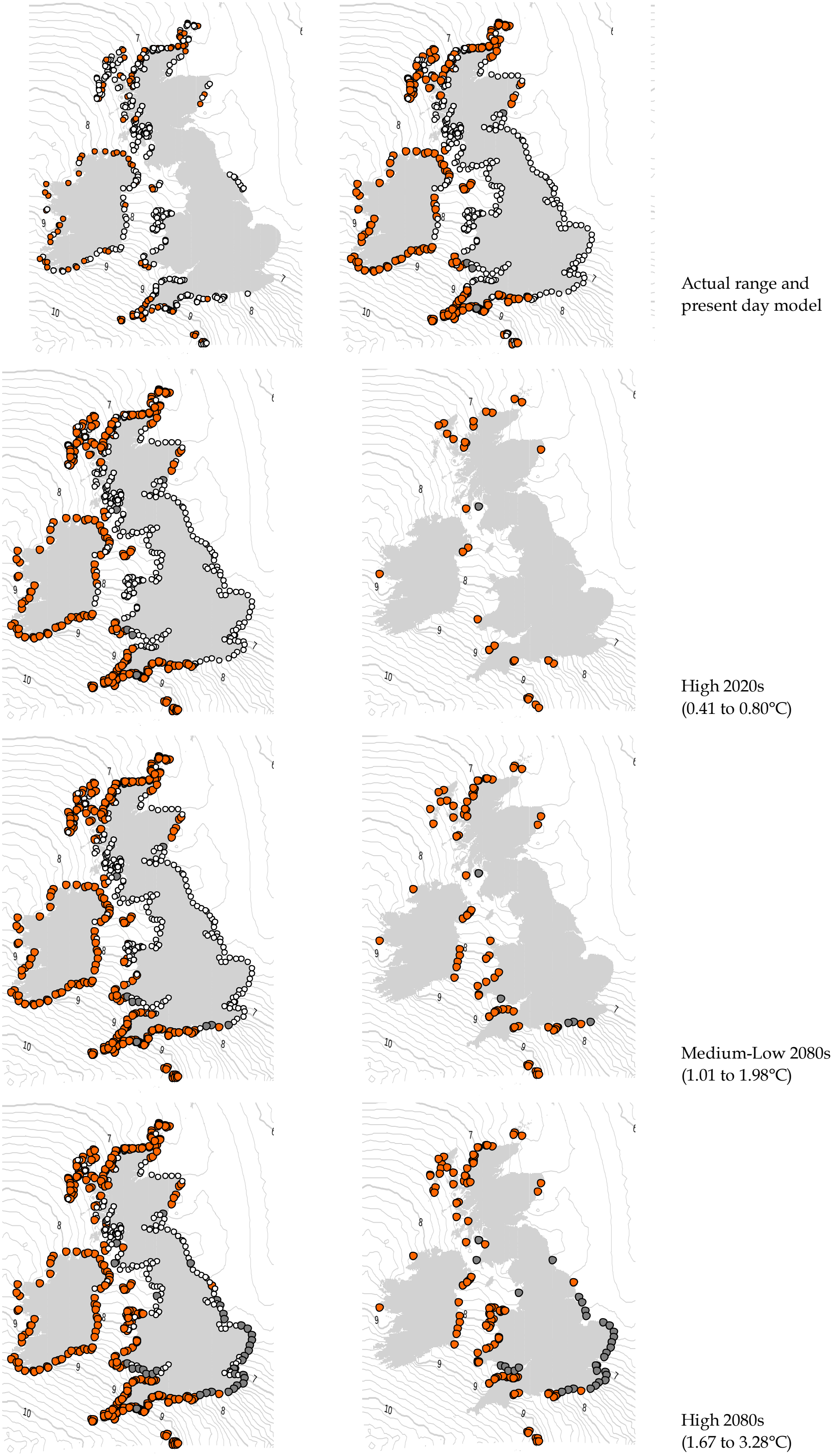


Figure A2. 8. *Himanthalia elongata.* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

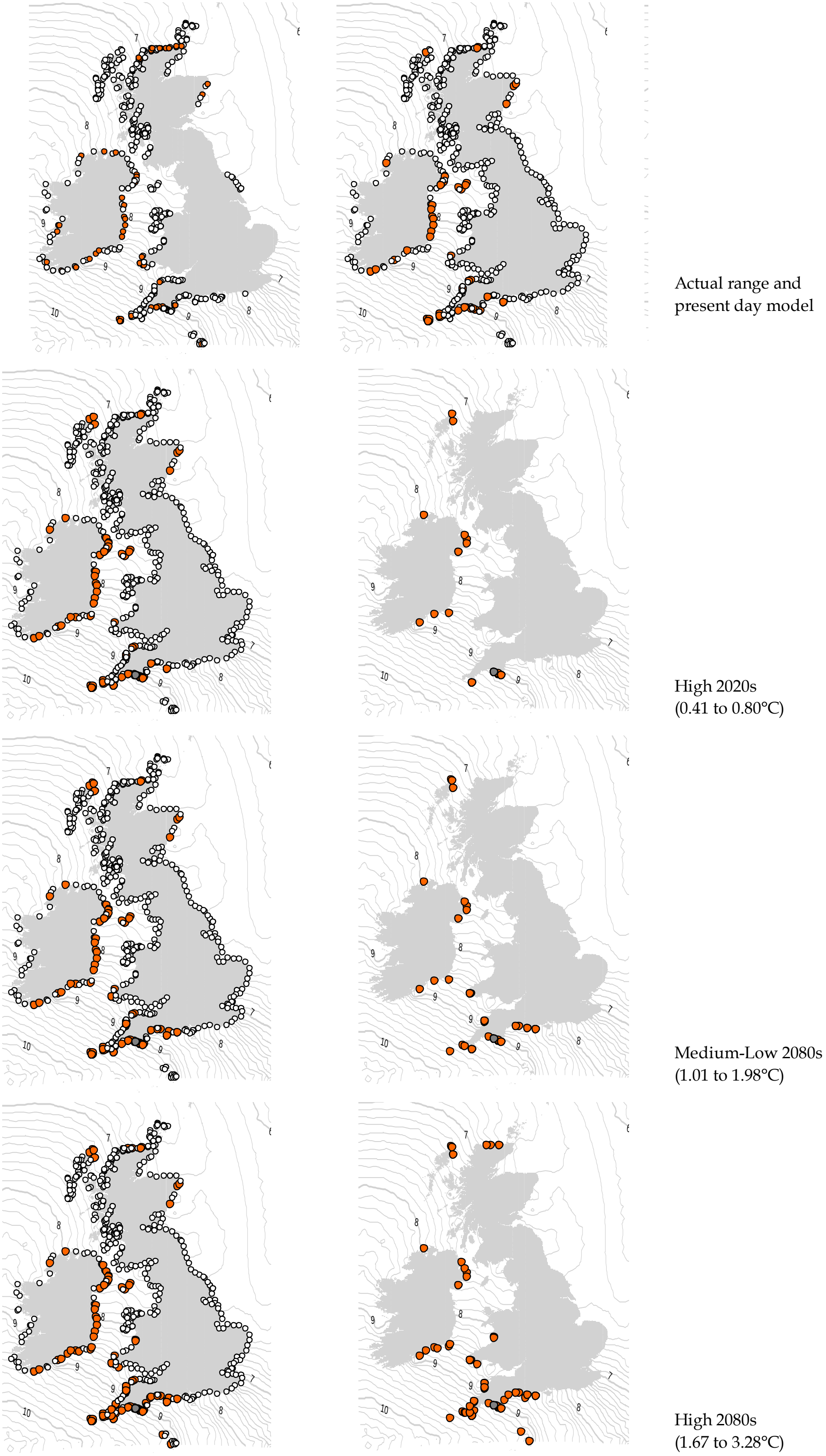
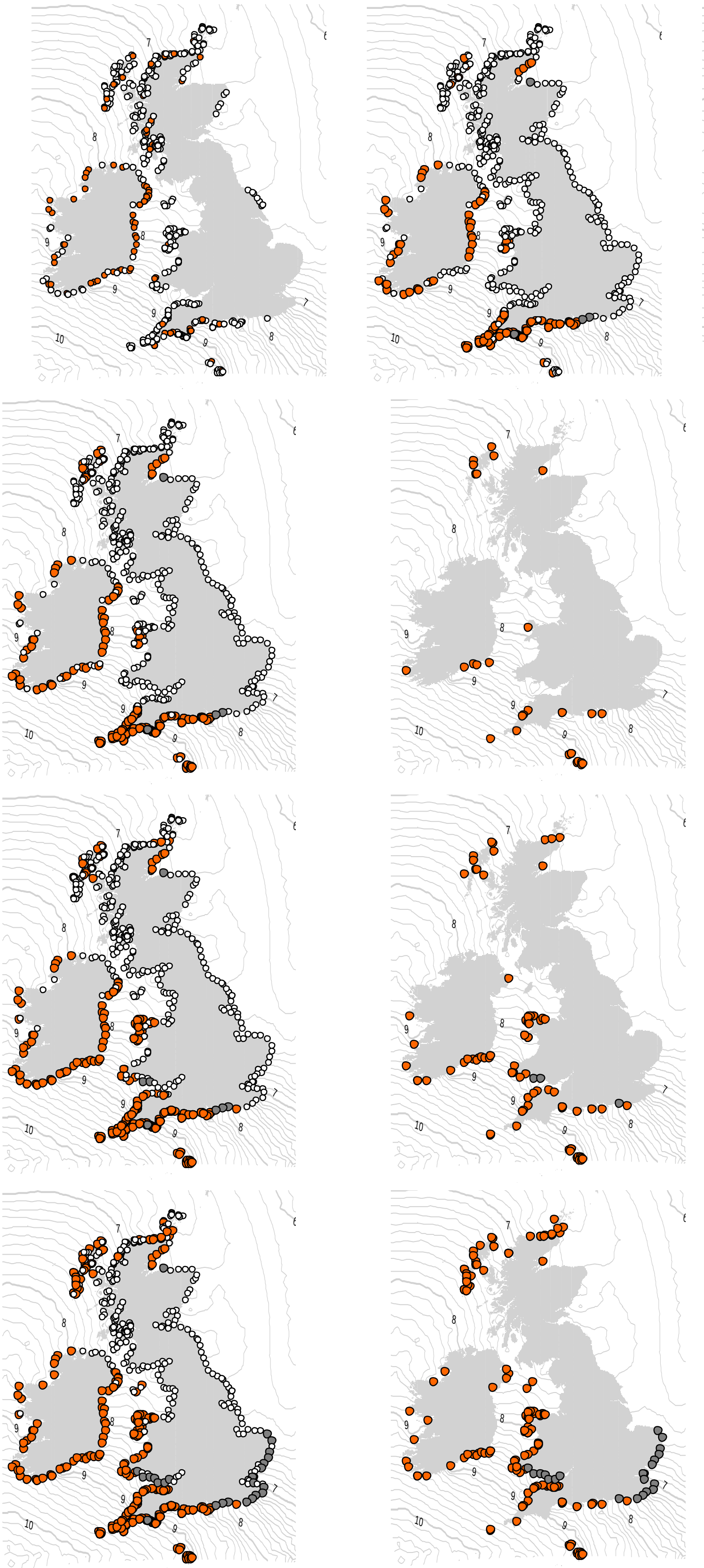


Figure A2. 9. *Laminaria hyperborea*. Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



Actual range and
present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A2. 10. *Laminaria saccharina* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

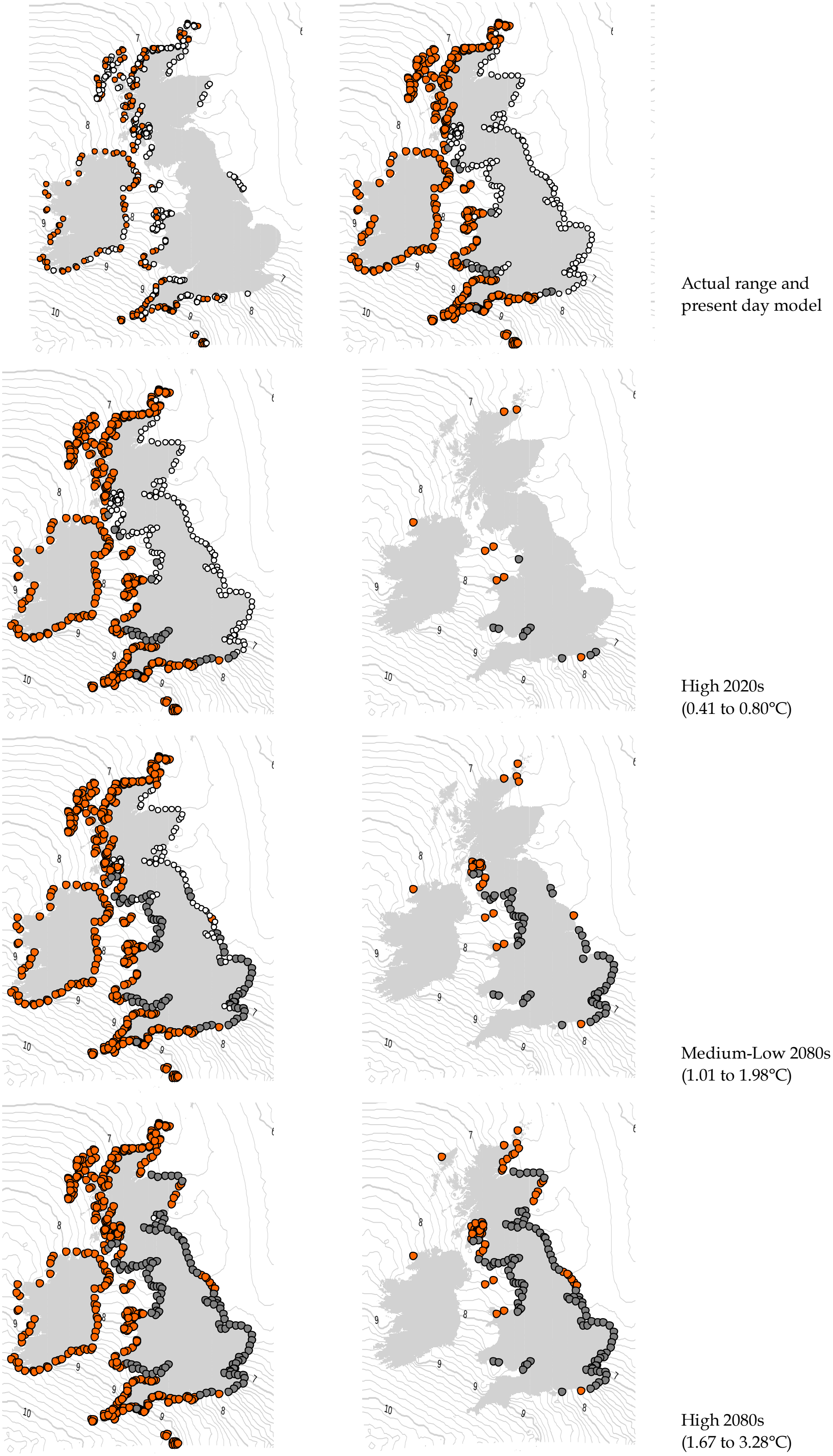


Figure A2. 11. *Lichina pygmaea* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

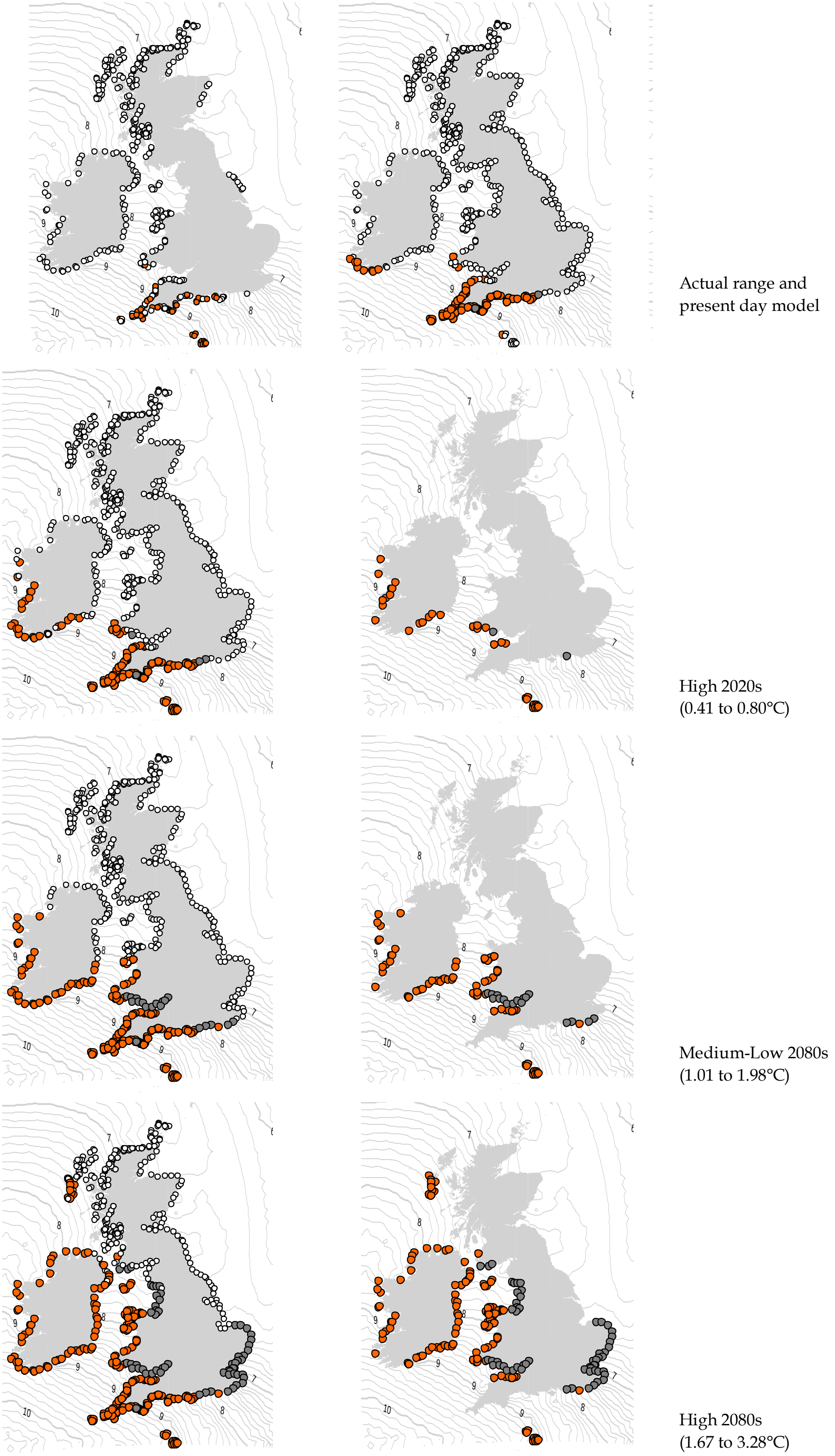


Figure A2. 12. *Sargassum muticum* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

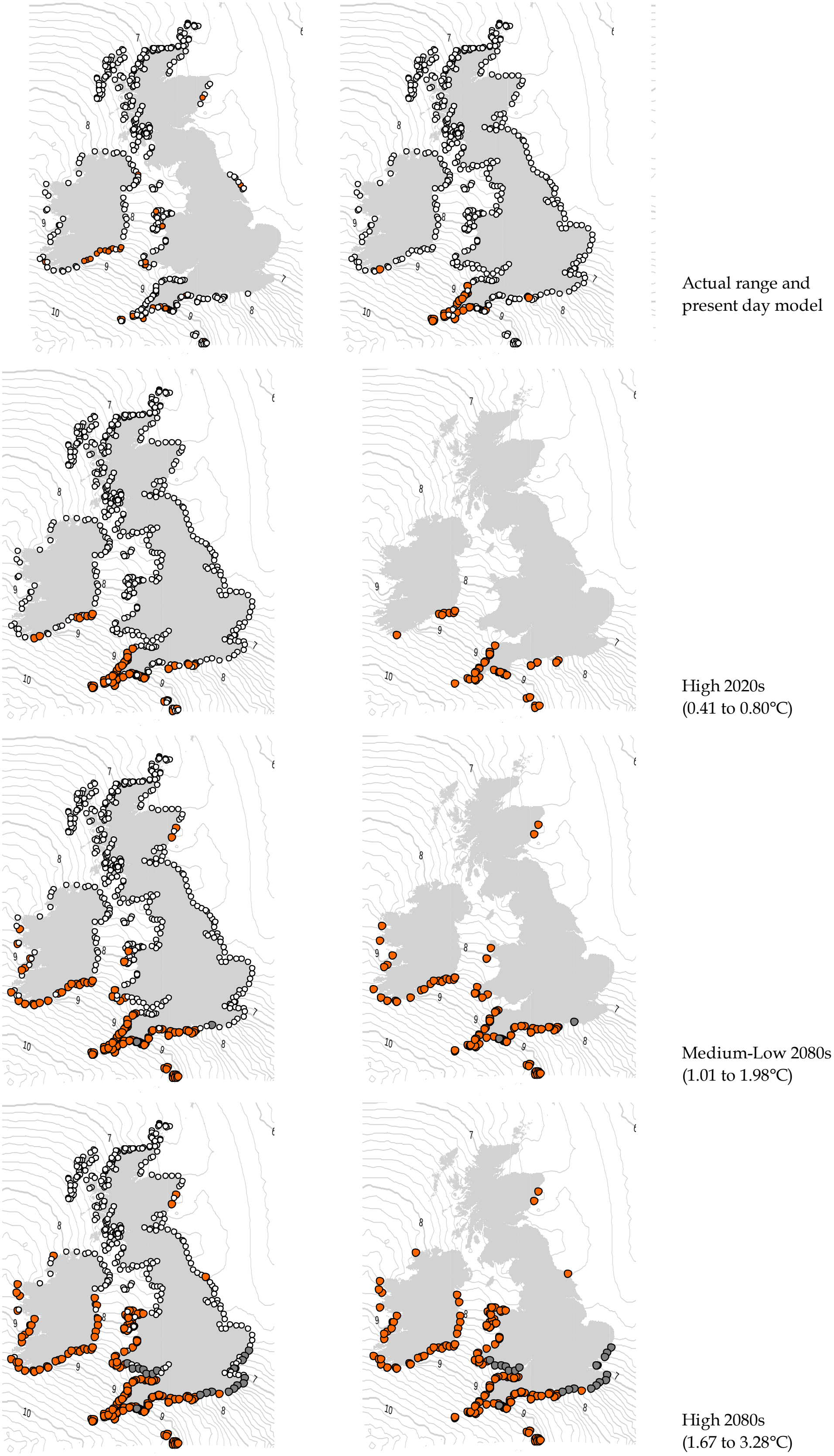


Figure A2. 13. *Actinia fragacea* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

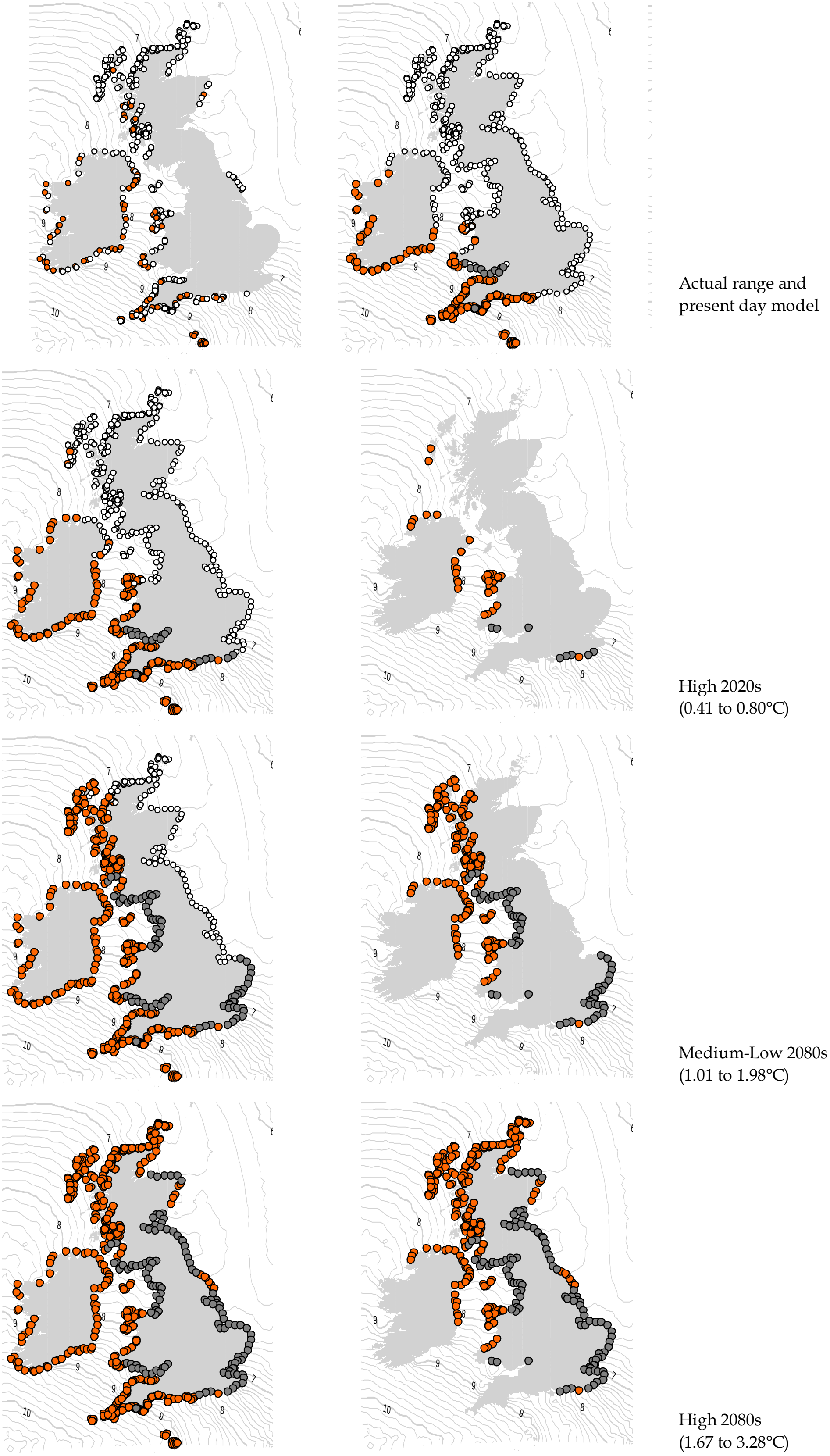


Figure A2. 14. *Anemonia viridis* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

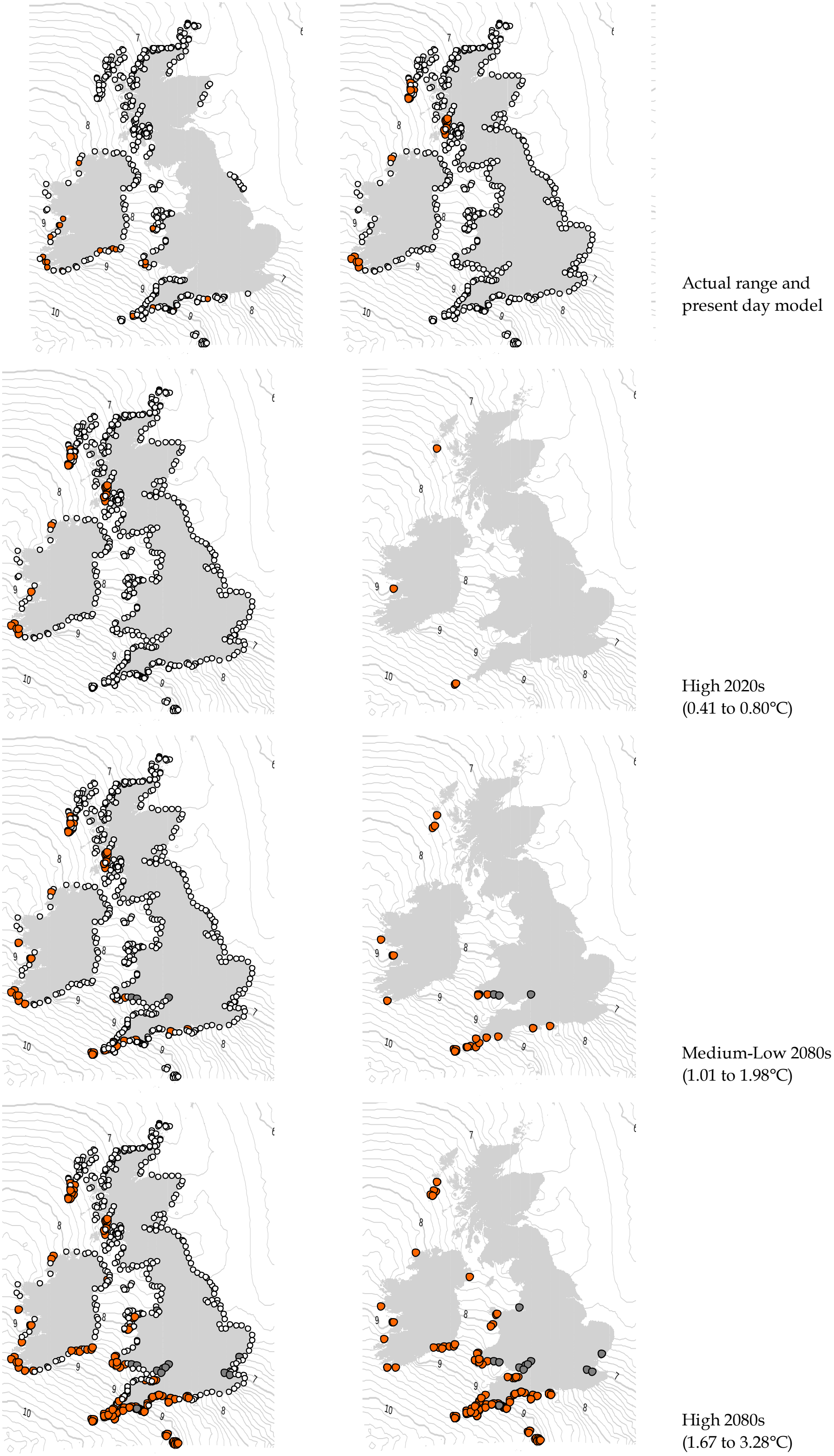
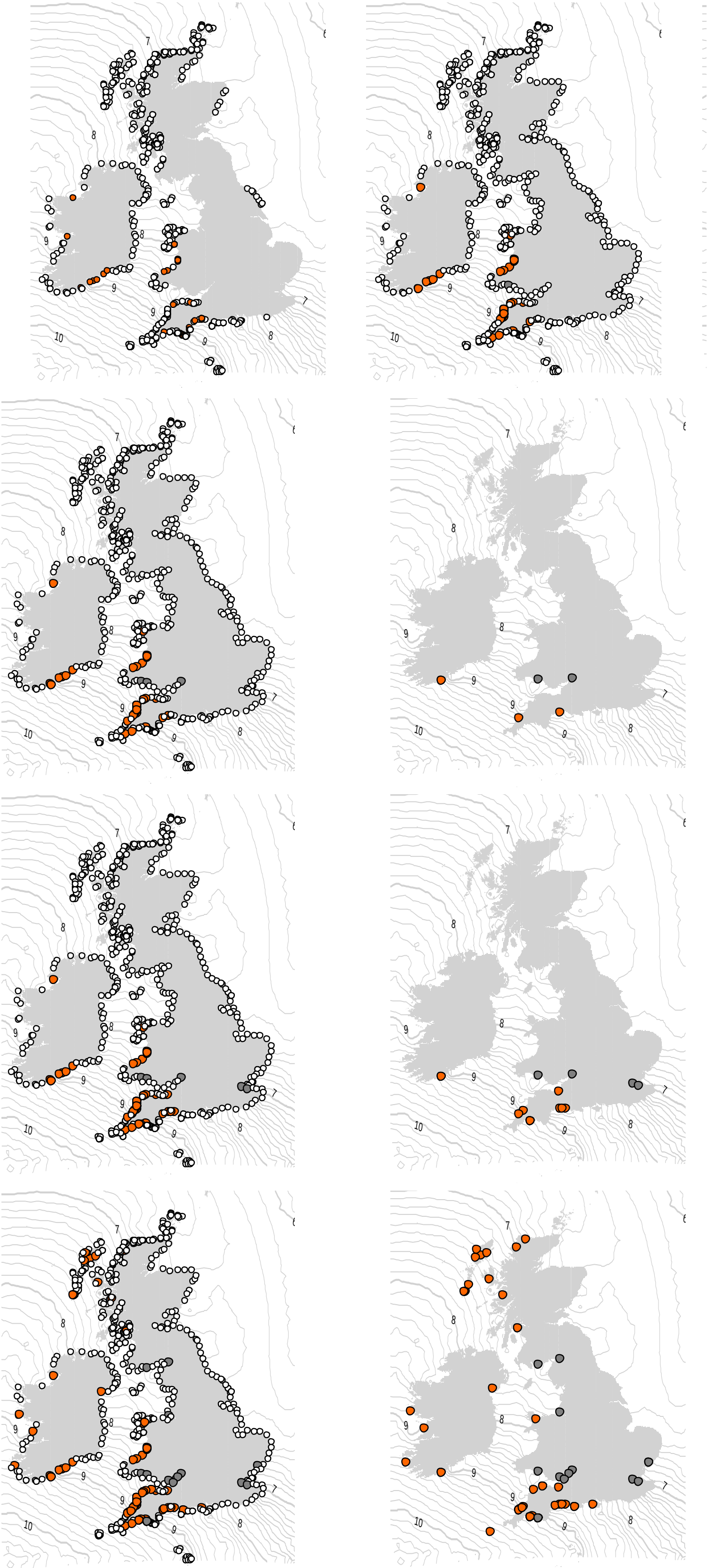


Figure A2. 15. *Aulactinia verrucosa* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



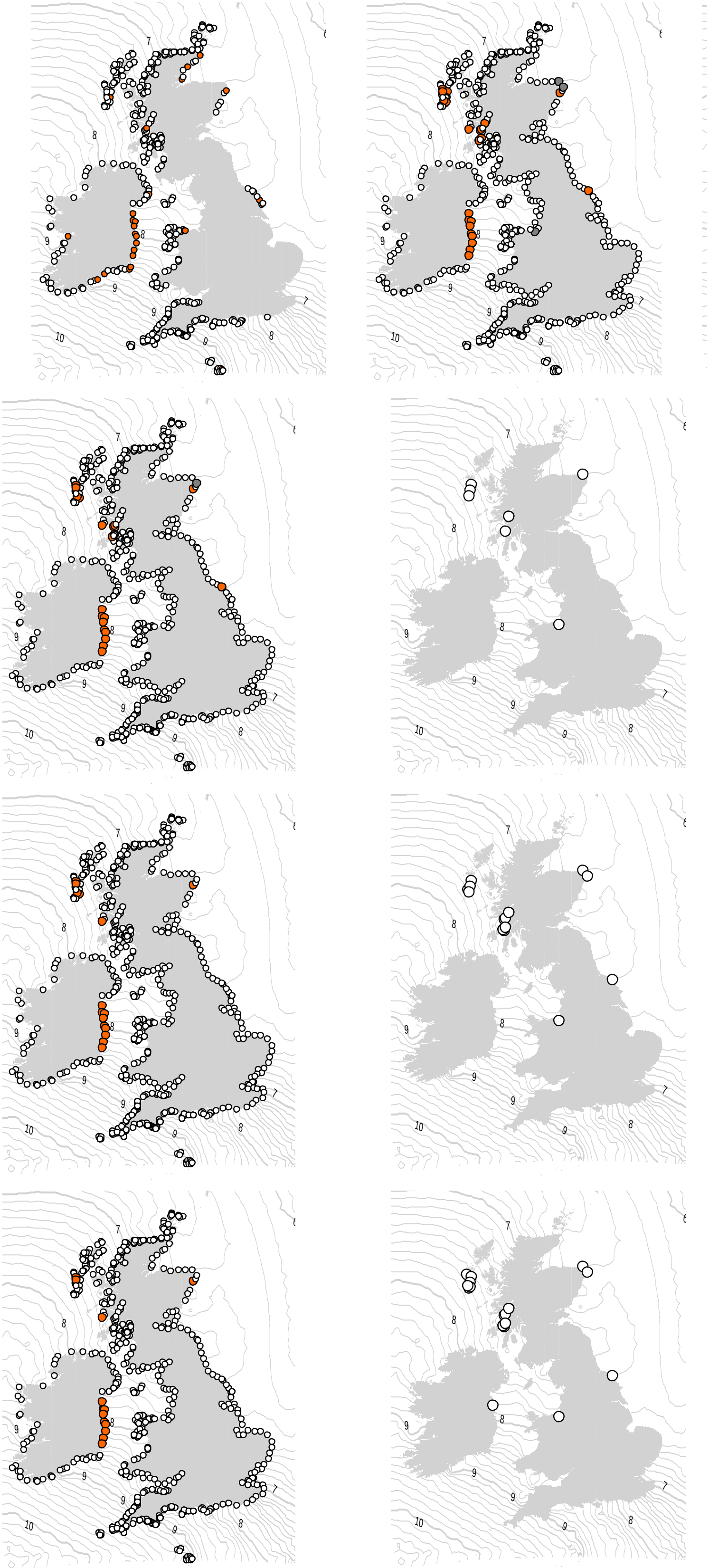
Actual range and
present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A2. 16. *Sabellaria alveolata* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



Actual range and
present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A2. 17. *Balanus crenatus Sabellaria alveolata* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

Actual range and
present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A2. 18. *Balanus perforatus* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

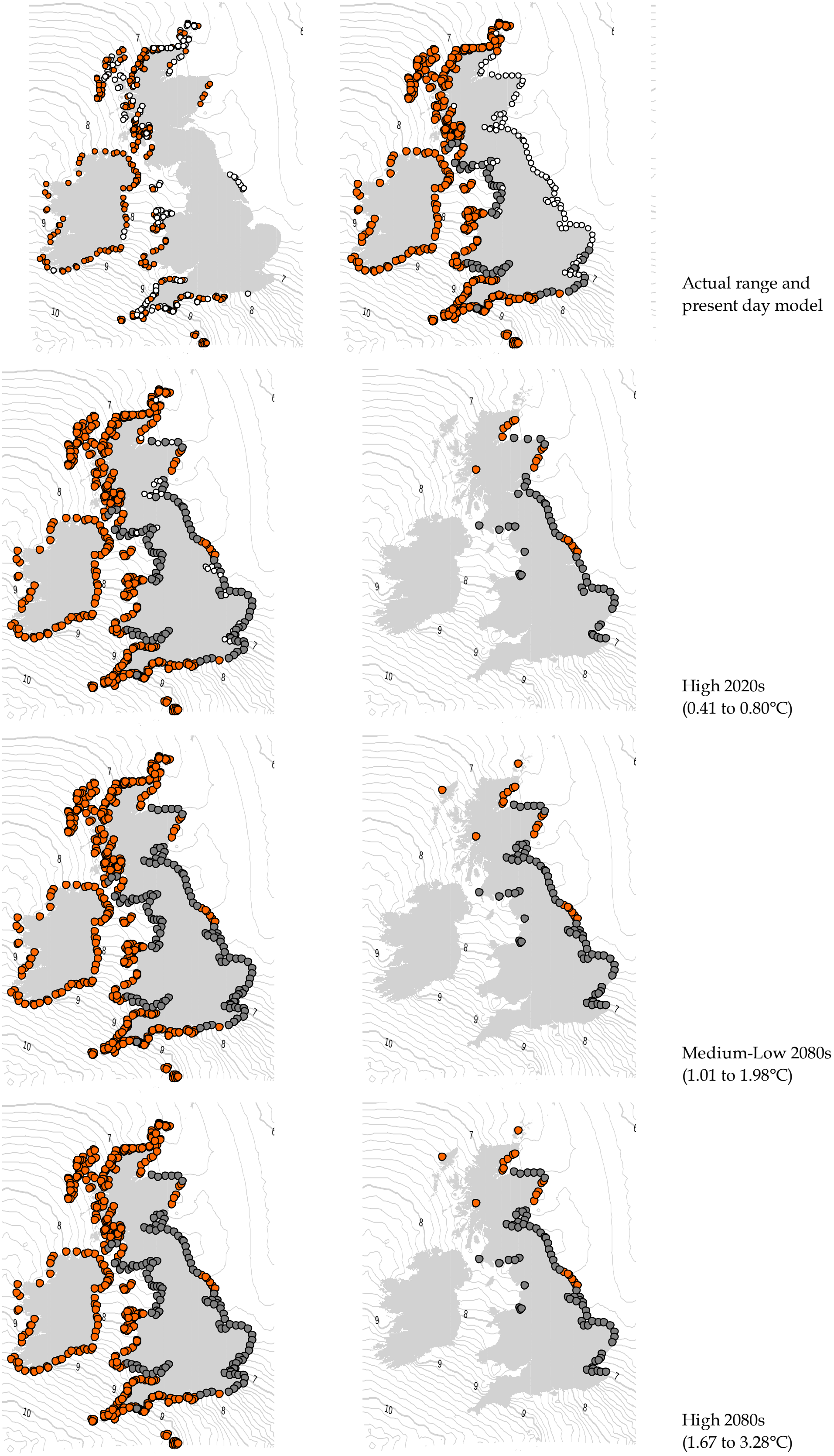
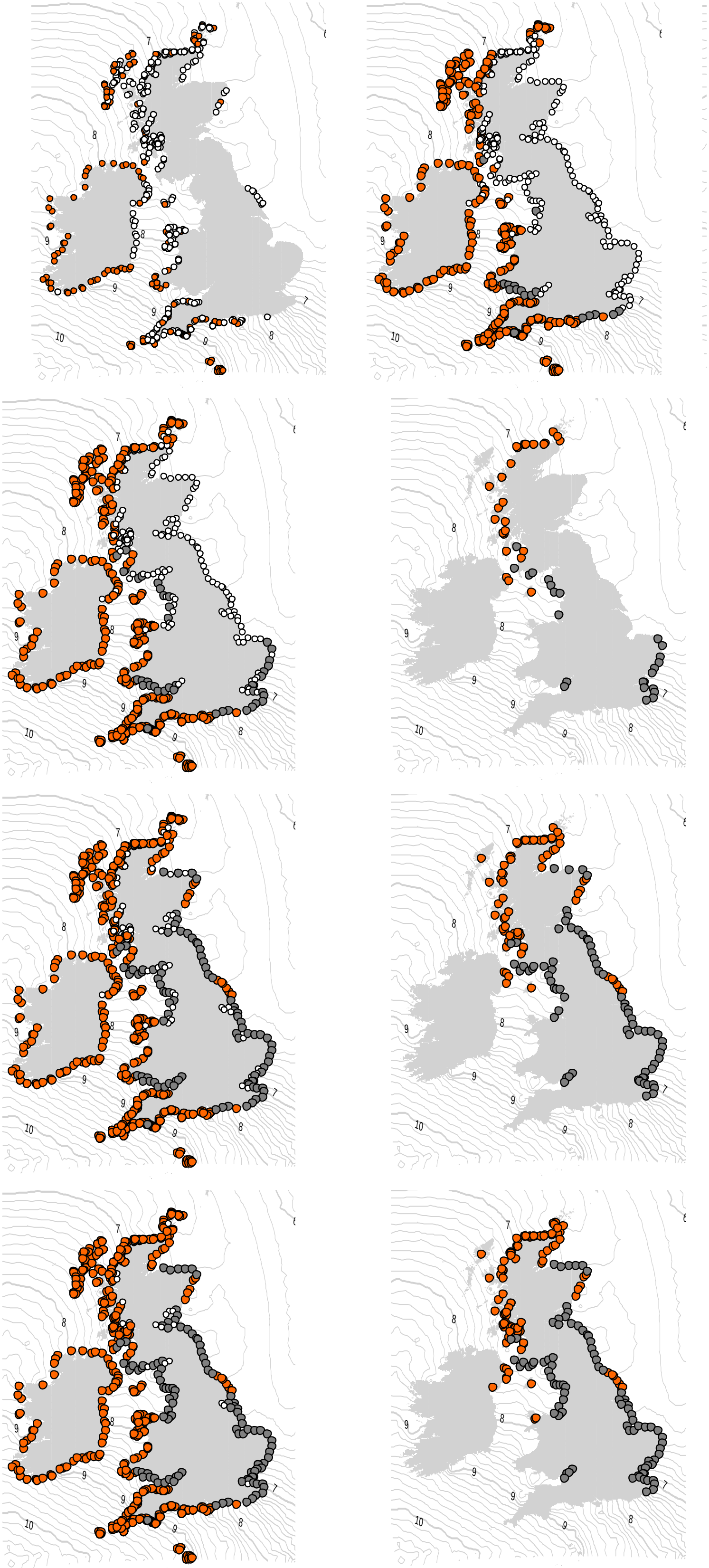


Figure A2. 19. *Chthamalus montagui* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



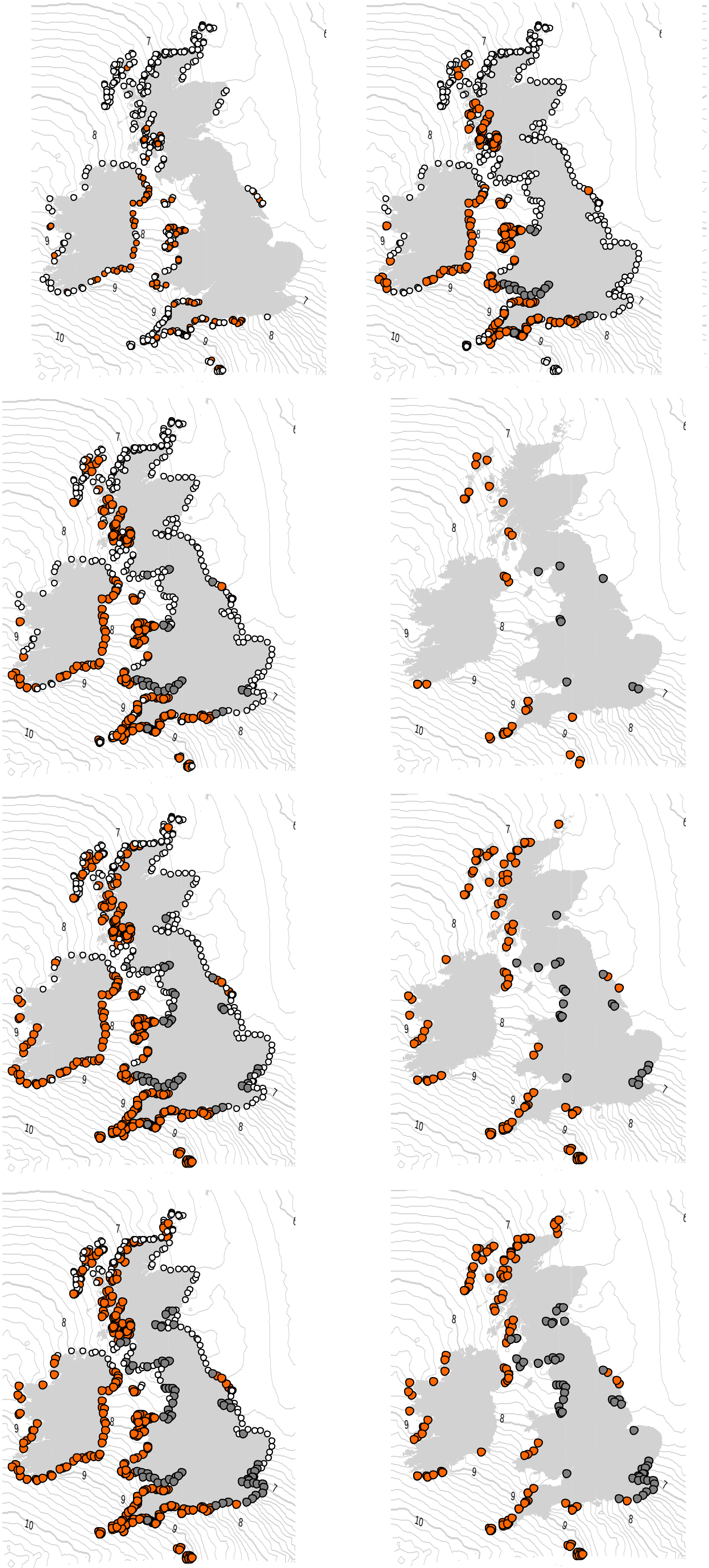
Actual range and
present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A2. 20. *Chthamalus stellatus* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



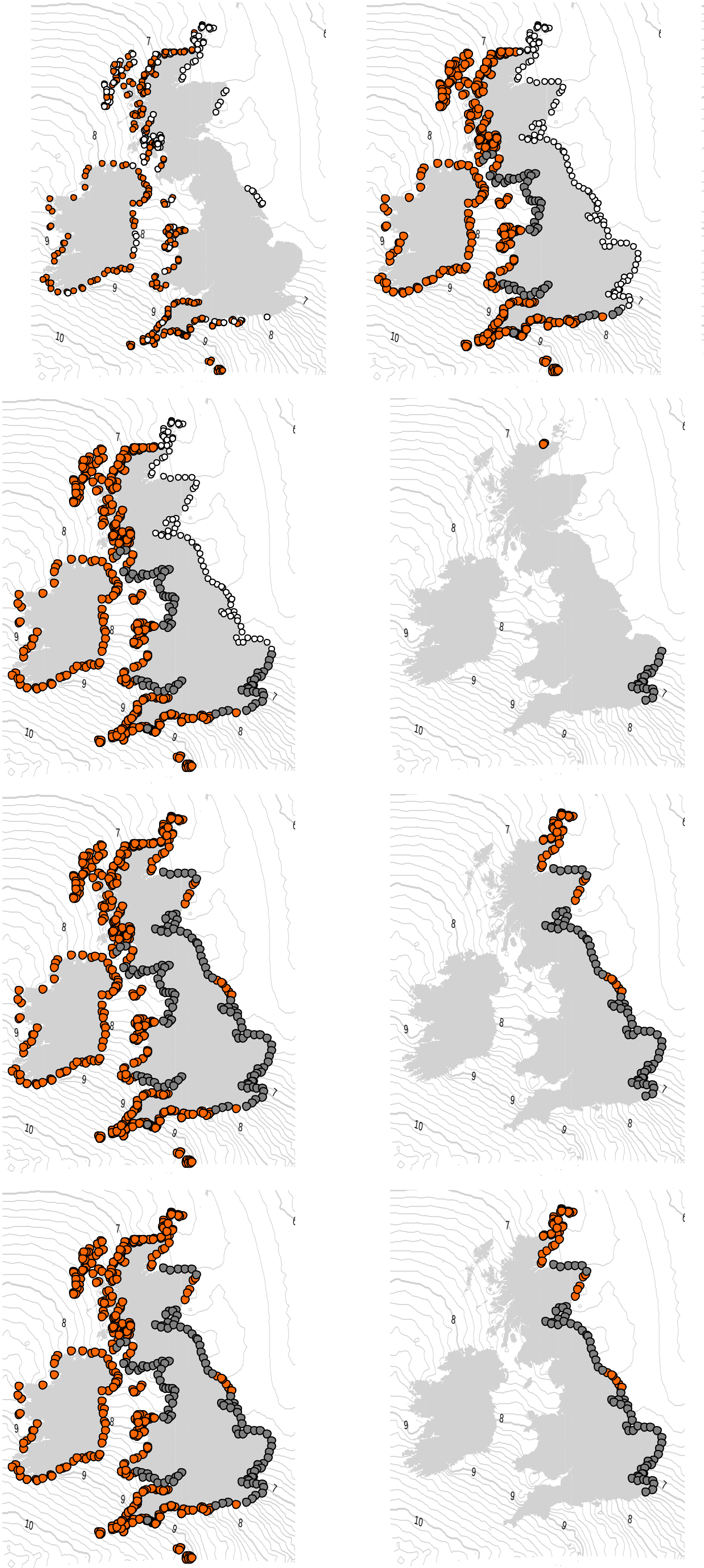
Actual range and
present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A2. 21. *Elminius modestus* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



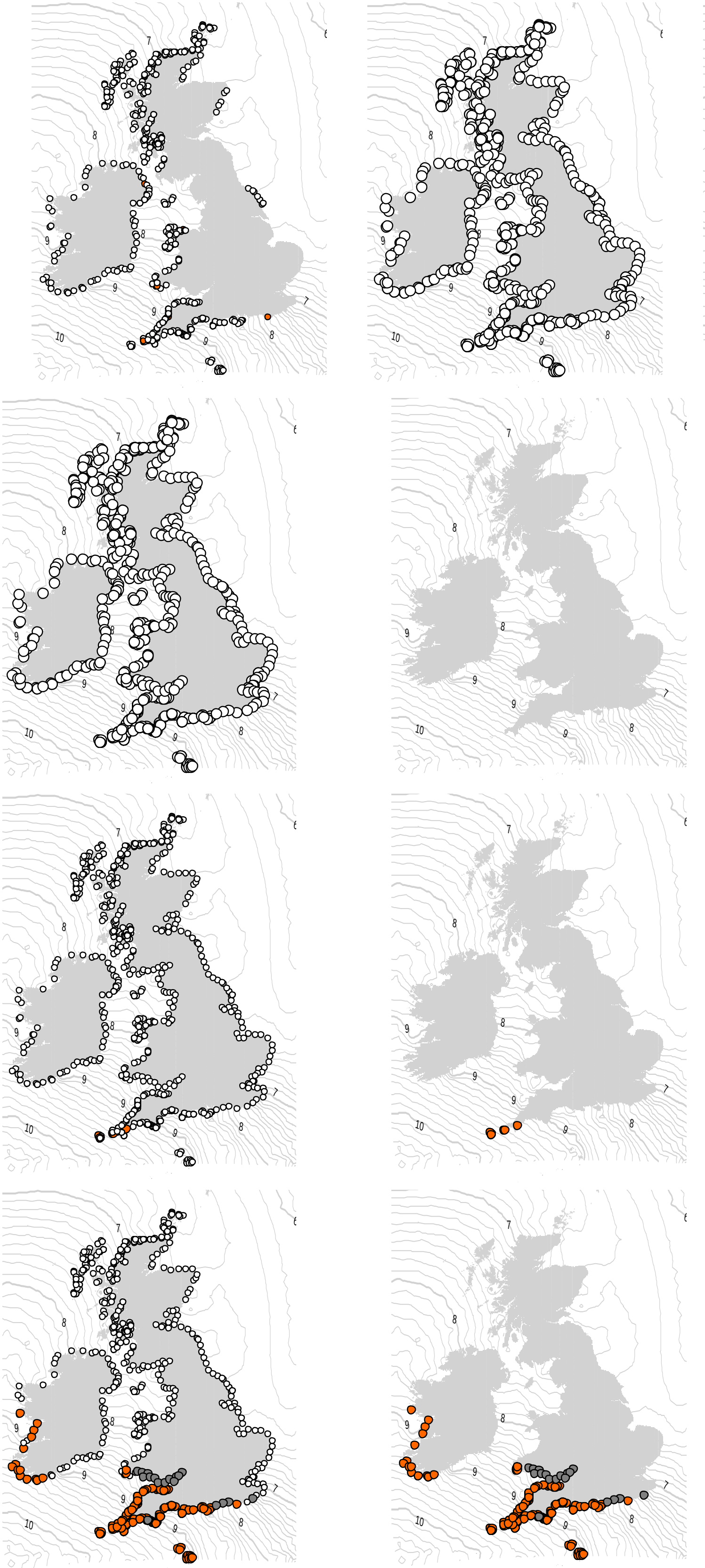
Actual range and present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A2. 22. *Gibbula umbilicalis*. Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



Actual range and
present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A2. 23. *Littorina neglecta* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

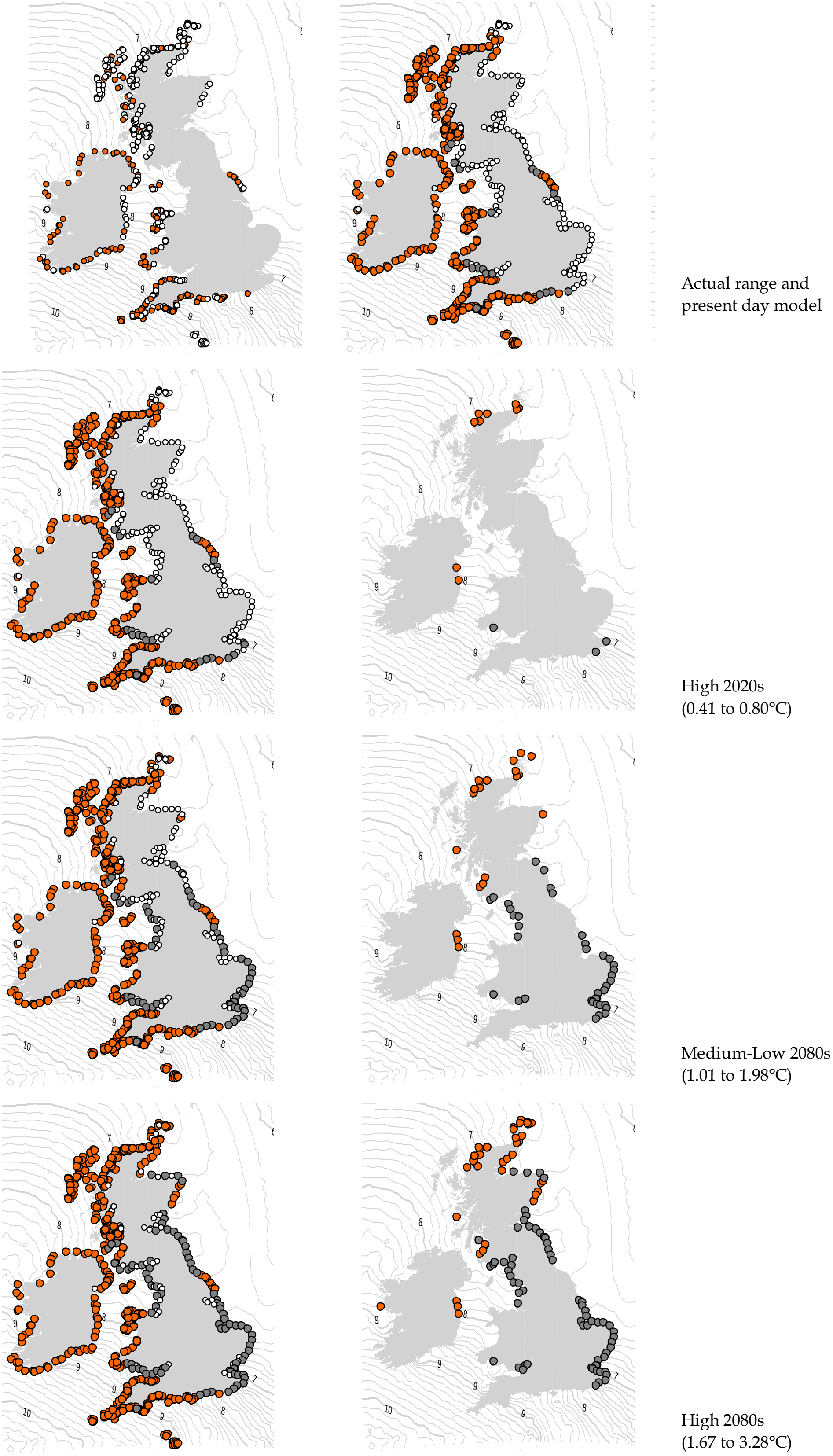


Figure A2. 24. *Melarhaphe neritoides* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

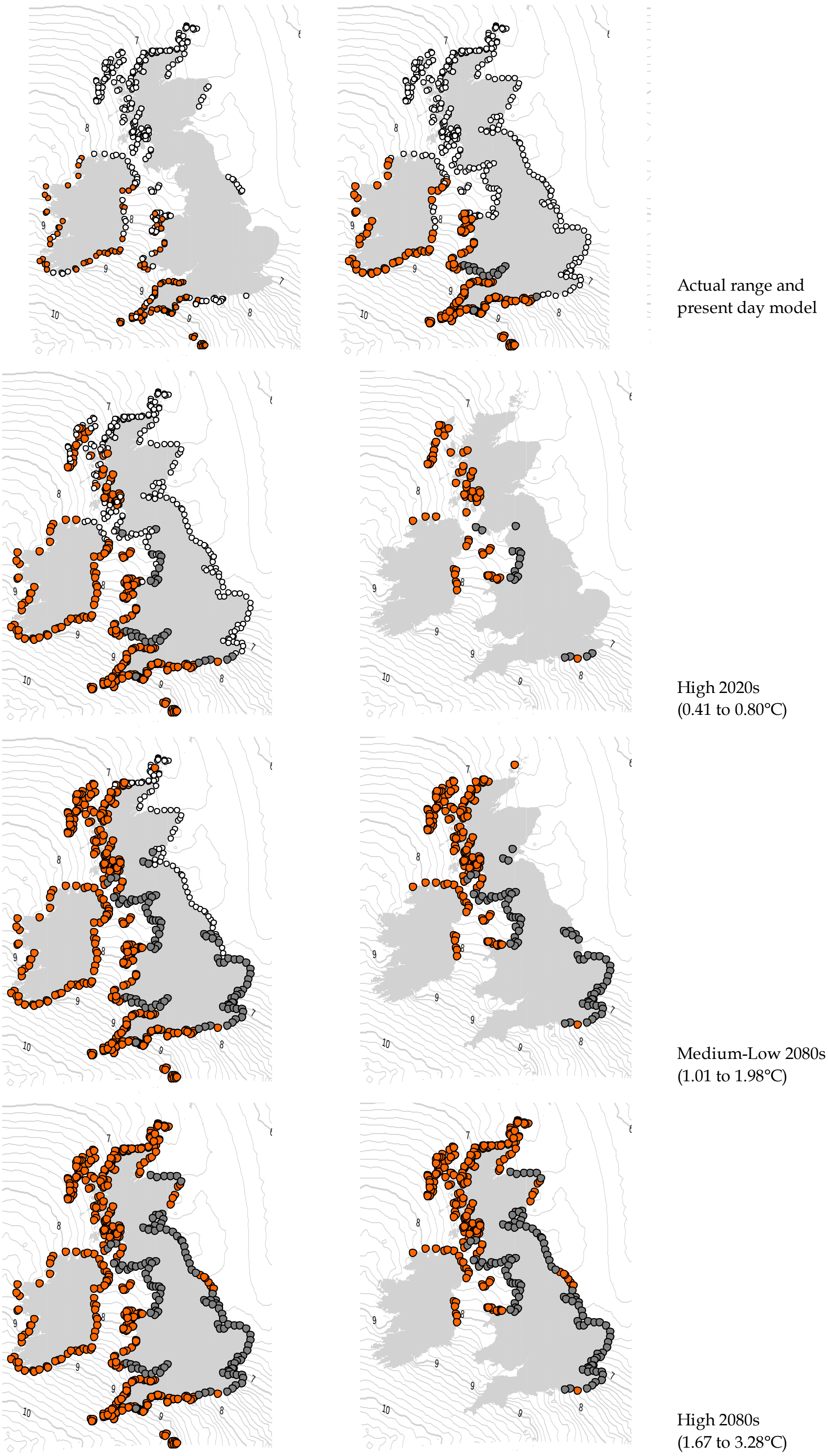


Figure A2. 25. *Osilinus lineatus* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

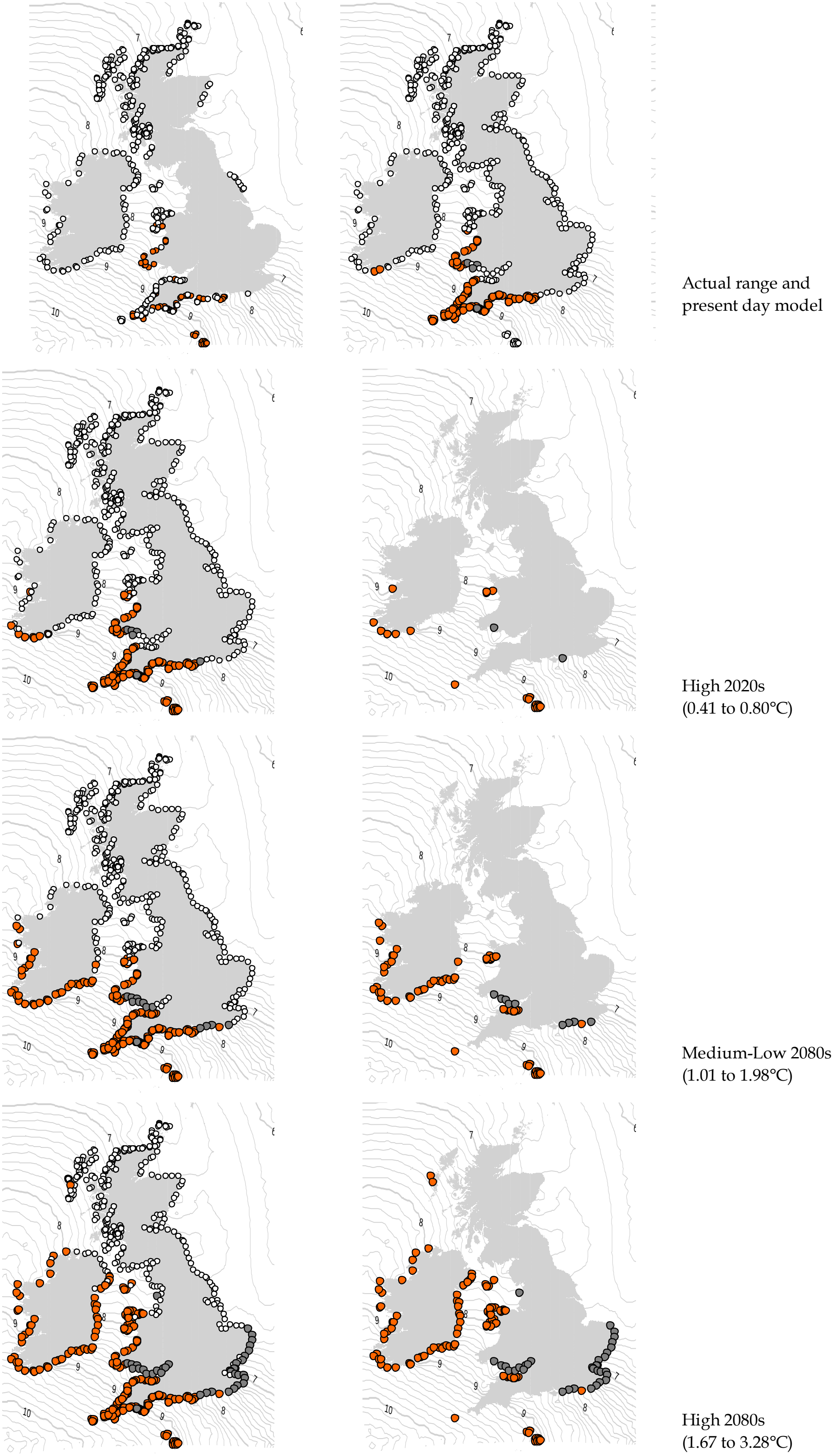


Figure A2. 26. *Patella depressa* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

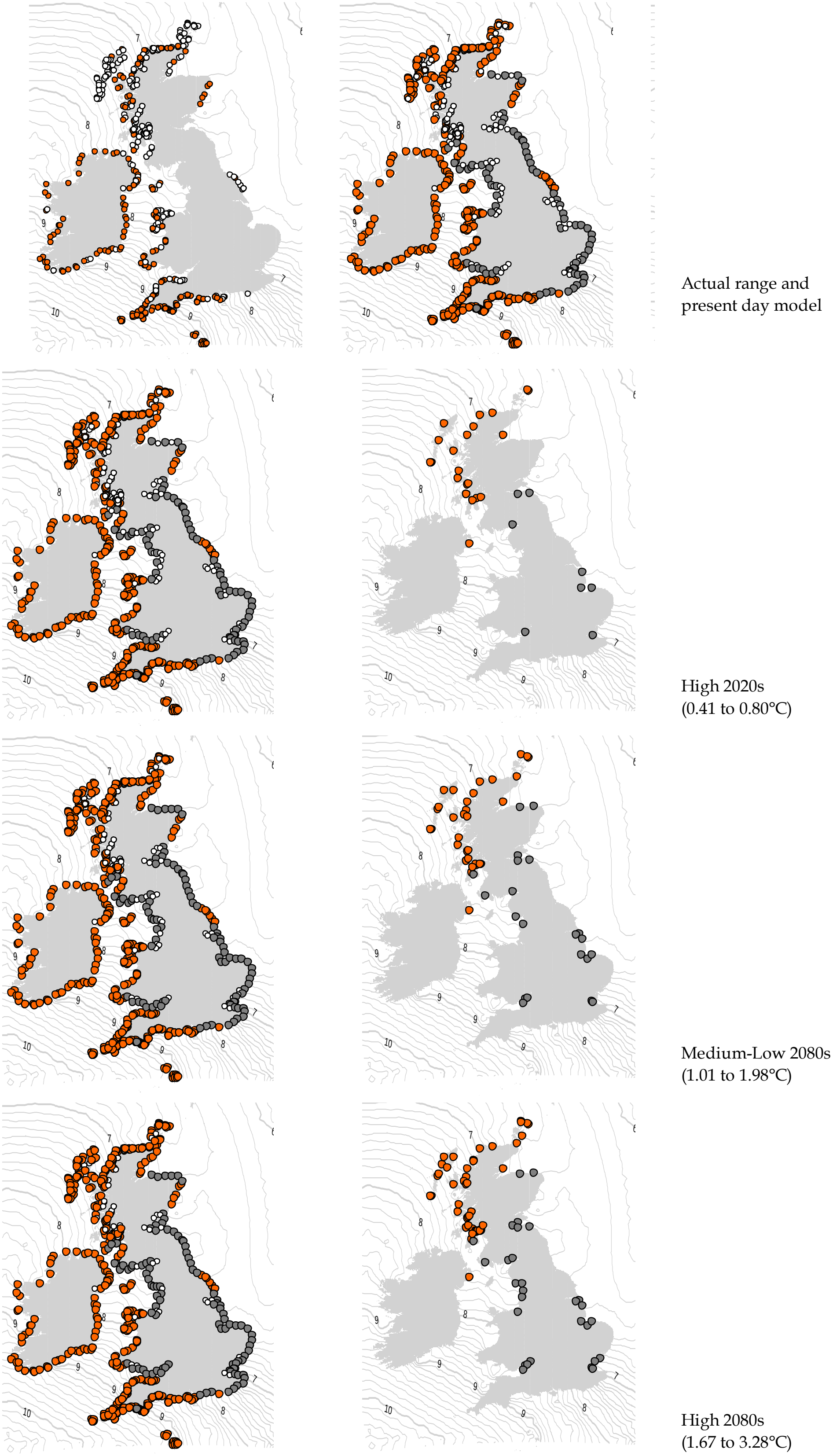


Figure A2. 27. *Patella ulyssiponensis* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

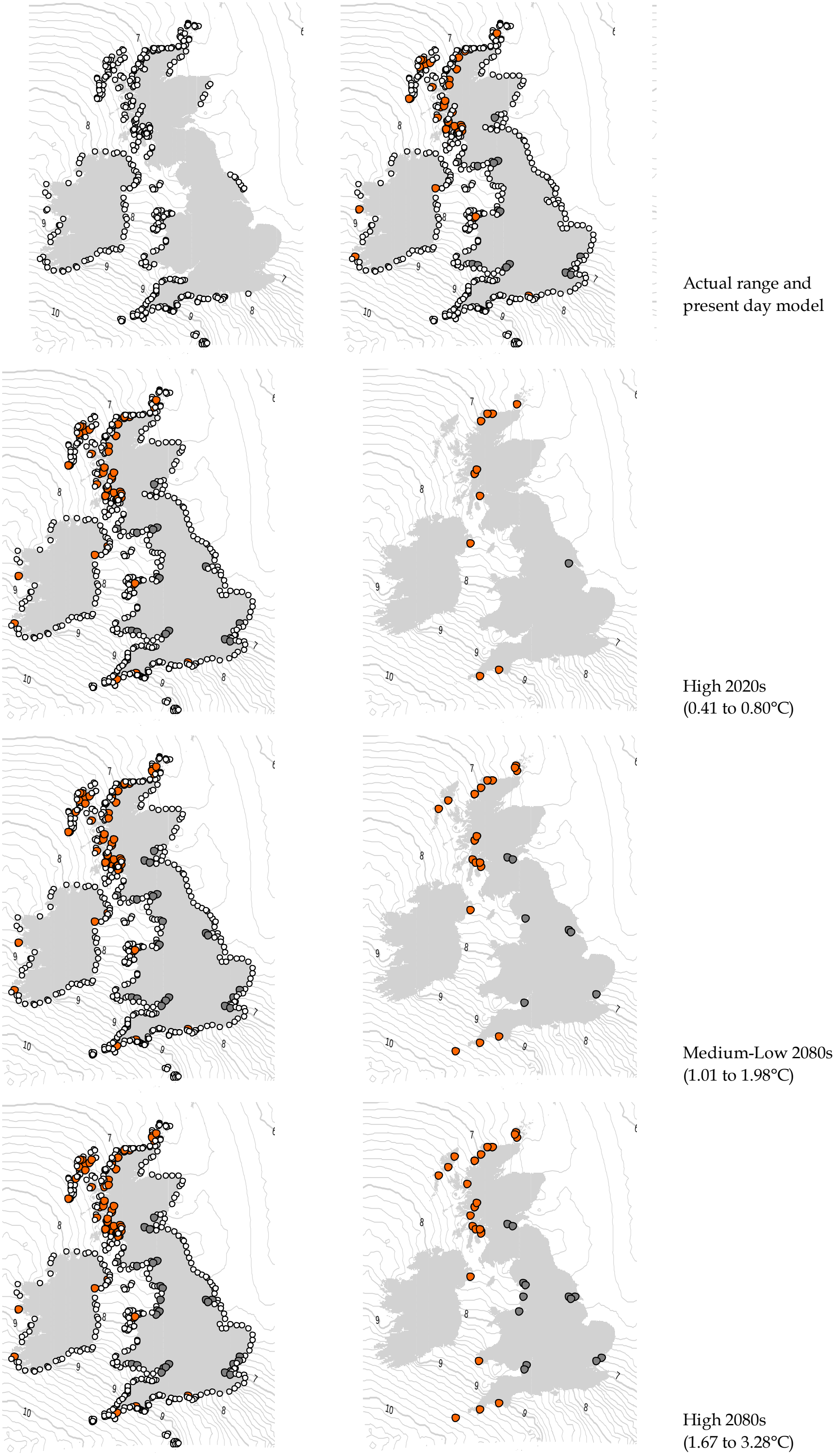


Figure A2. 28. *Paracentrotus lividus* Observed (top left) and present-day predicted species range (top right). Plots show predicted ranges (left) and range changes (right) for 3 climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

Appendix 3. Predicted Changes in abundance of Biotope-characterising Species

Changes in species distributions as predicted by MarClim models based on February sea surface temperatures and wave fetch index (Bioclimate Envelope models). See full report for further details of model.

February temperatures are those from 1961-1990 UKCIP baseline average data, and those predicted by Hadley Centre models for three emissions scenarios (High 2020s, Medium-Low 2080s, High 2080s).

Sites are classified as having the biotope-characterising species Abundant or not, or having the predicted probability of being Abundant at least 30% (P(>=A)>0.3).

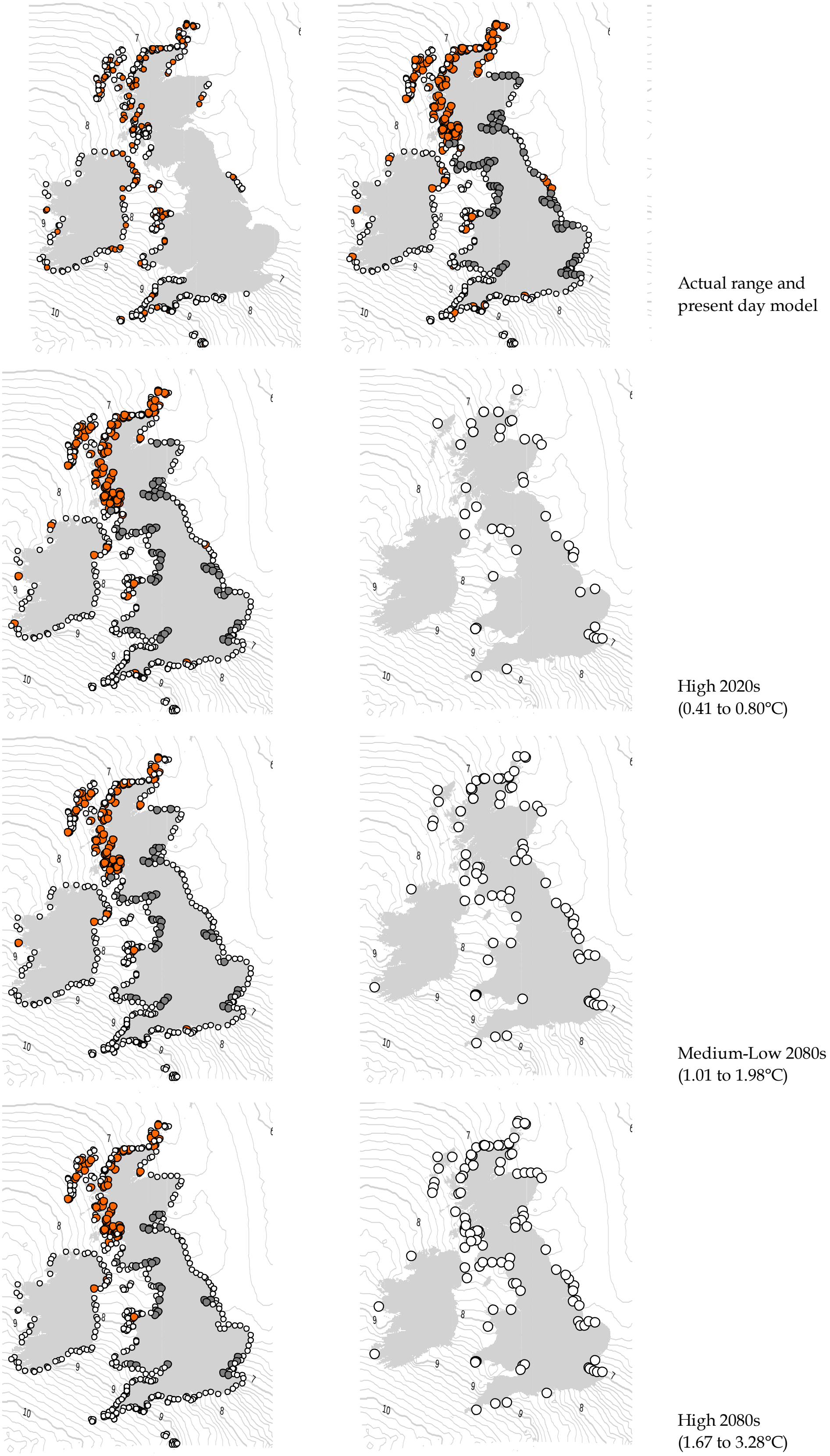


Figure A3. 1. *Ascophyllum nodosum.* Observed (top left) and present-day predicted sites where Abundant (top right). Plots show predicted sites where Abundant (left) and changes (right) for 3 UKCIP climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence. Grey lines indicate February sea surface temperature isotherms in all maps.

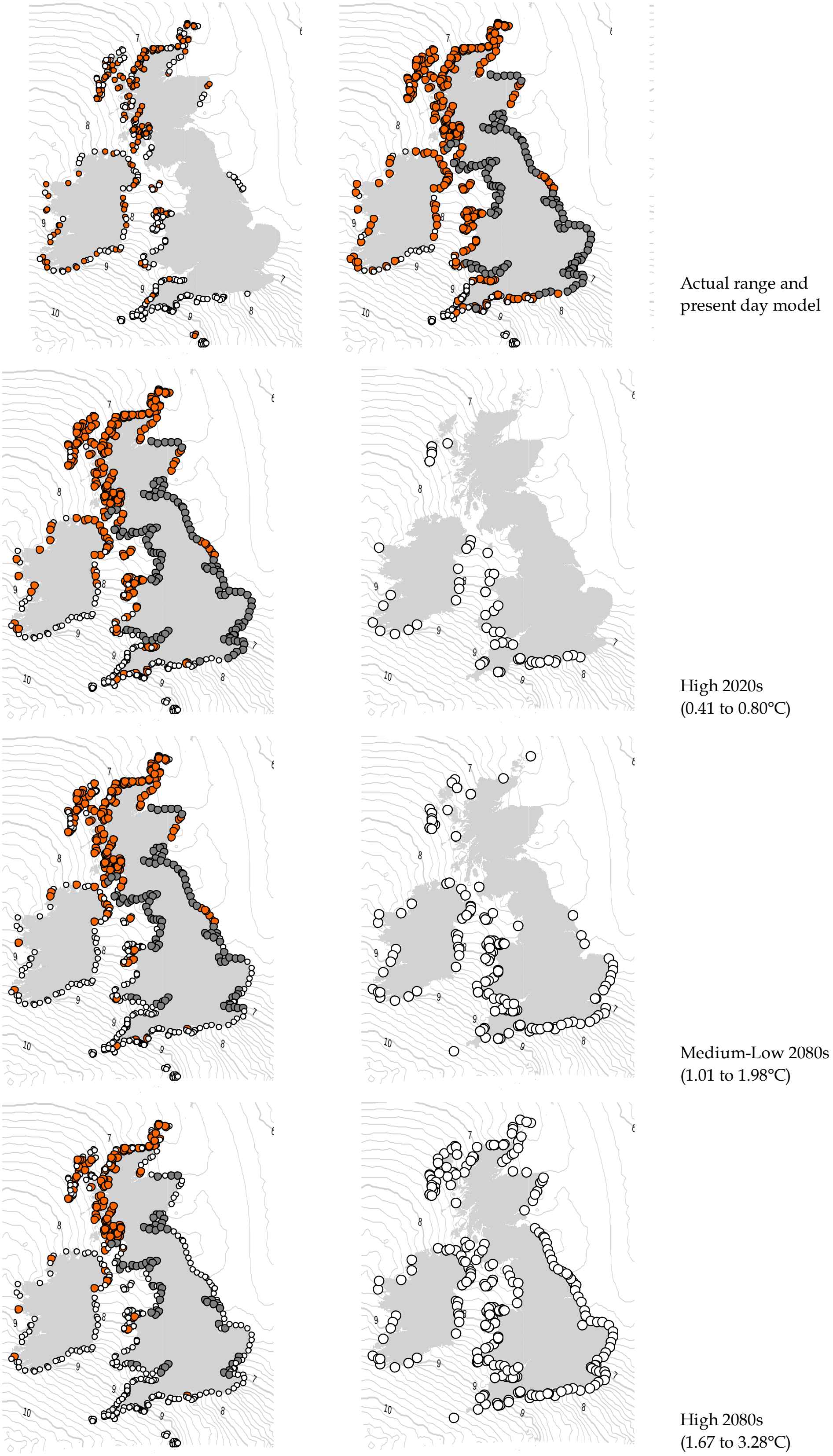


Figure A3. 2. *Pelvetia canaliculata.* Observed (top left) and present-day predicted sites where Abundant (top right). Plots show predicted sites where Abundant (left) and changes (right) for 3 UKCIP climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

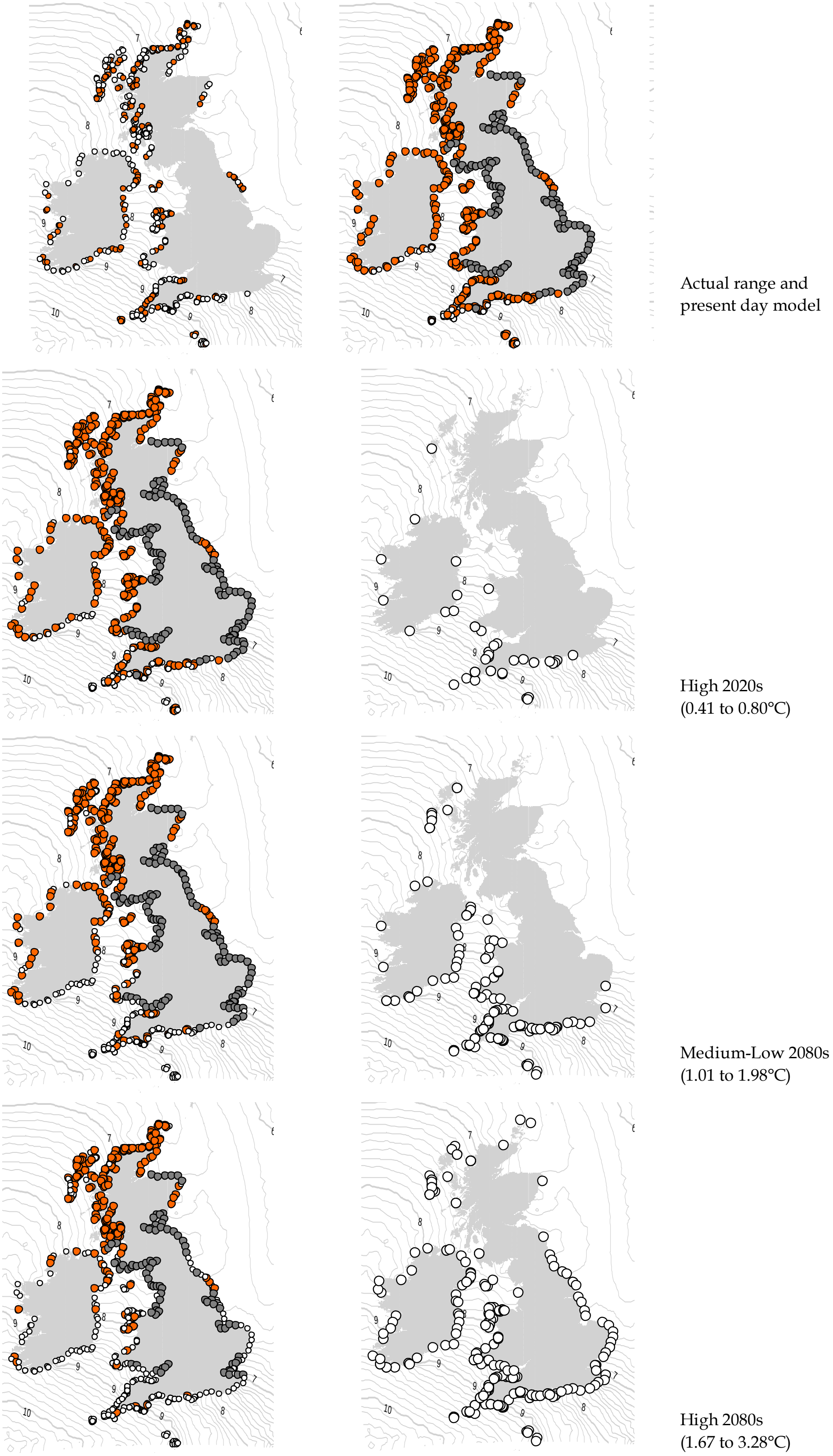


Figure A3. 3. *Fucus vesiculosus*. Observed (top left) and present-day predicted sites where Abundant (top right). Plots show predicted sites where Abundant (left) and changes (right) for 3 UKCIP climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

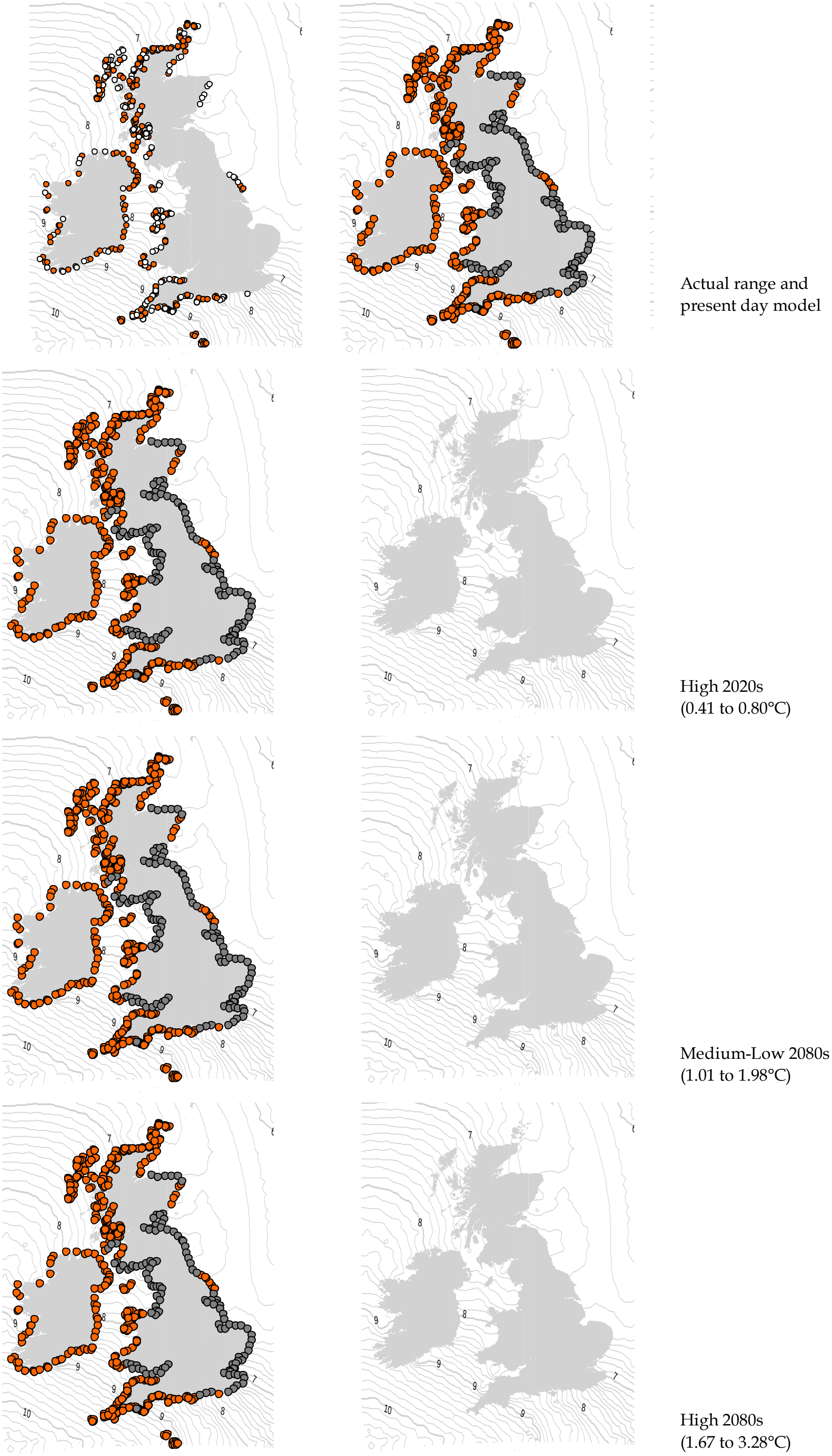
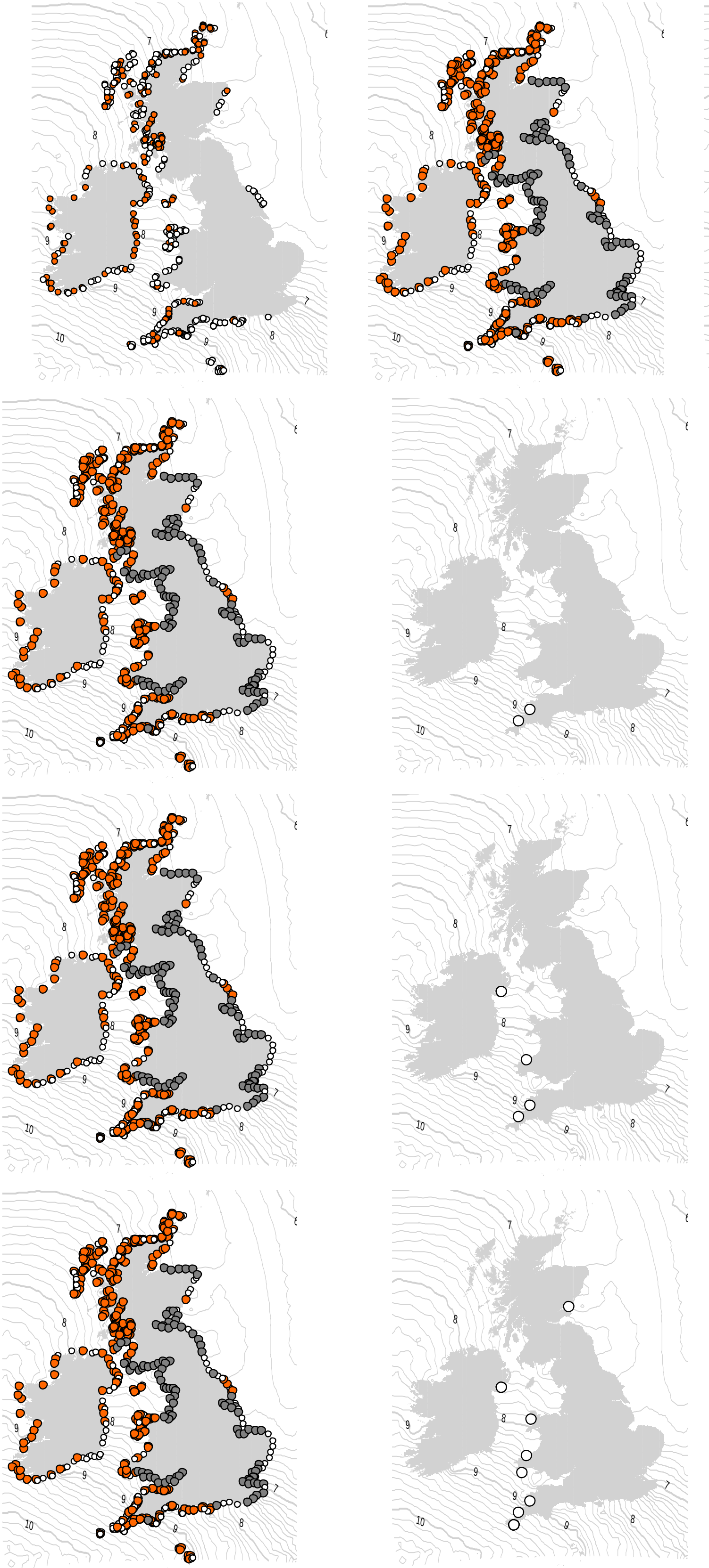


Figure A3. 4. *Fucus serratus.* Observed (top left) and present-day predicted sites where Abundant (top right). Plots show predicted sites where Abundant (left) and changes (right) for 3 UKCIP climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



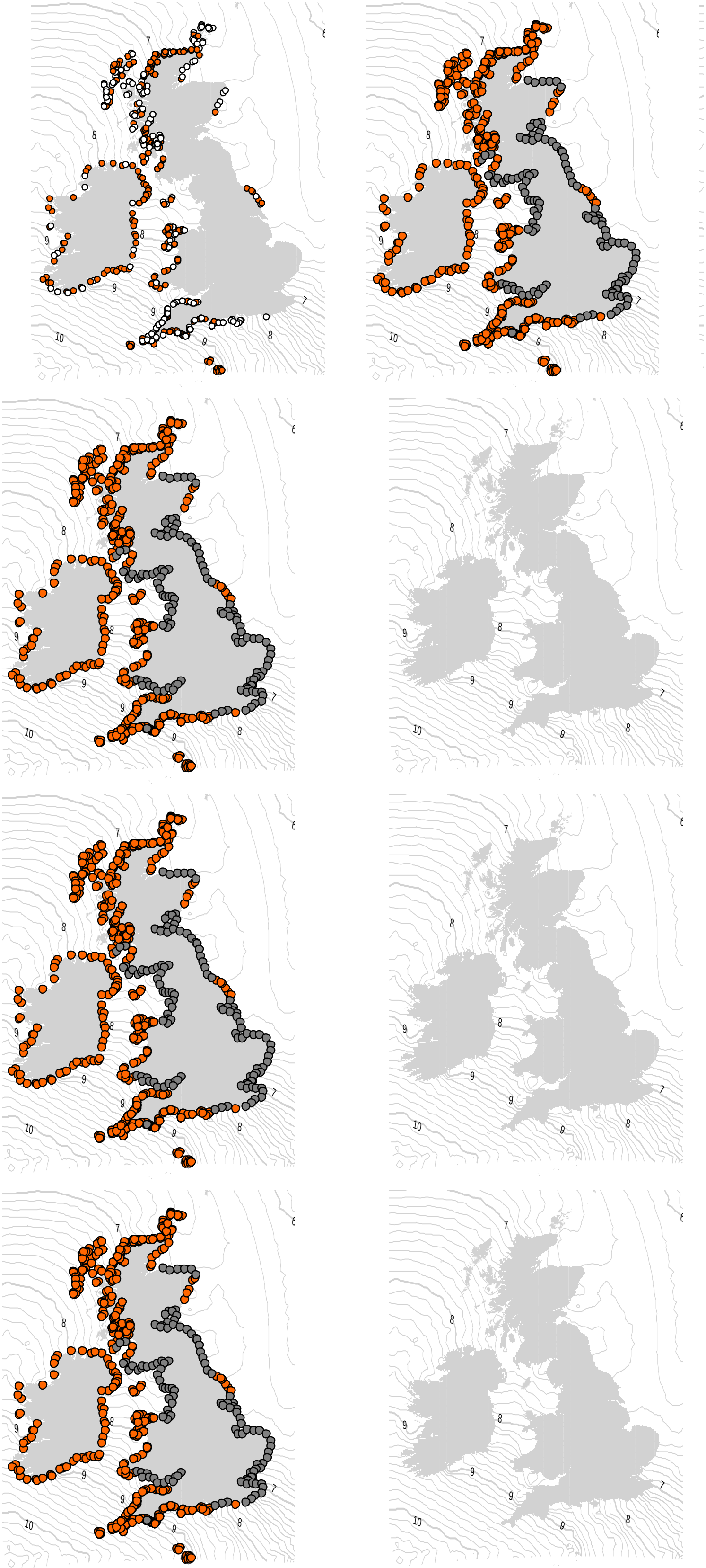
Actual range and
present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A3. 5. *Fucus spiralis*. Observed (top left) and present-day predicted sites where Abundant (top right). Plots show predicted sites where Abundant (left) and changes (right) for 3 UKCIP climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



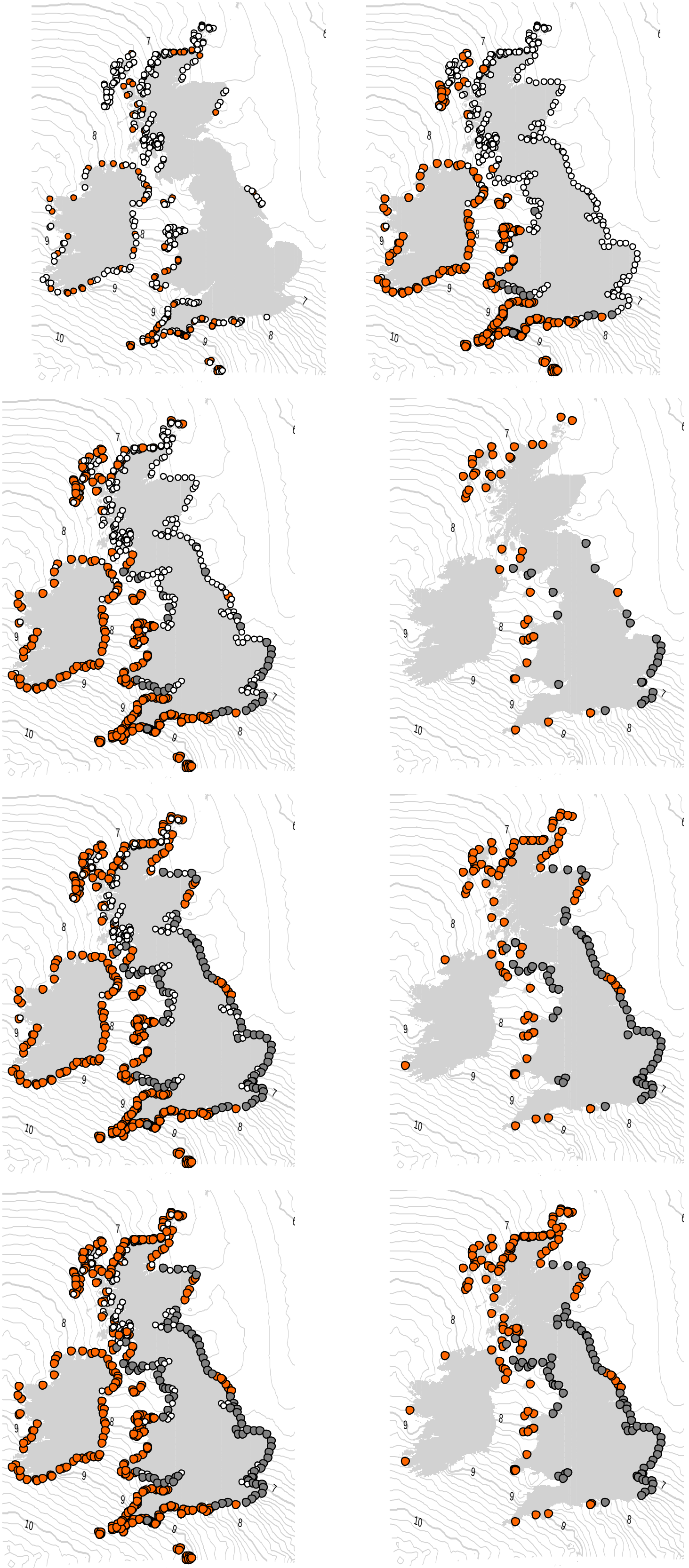
Actual range and present day model

High 2020s (0.41 to 0.80°C)

Medium-Low 2080s (1.01 to 1.98°C)

High 2080s (1.67 to 3.28°C)

Figure A3. 6. *Patella vulgata*. Observed (top left) and present-day predicted sites where Abundant (top right). Plots show predicted sites where Abundant (left) and changes (right) for 3 UKCIP climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



Actual range and
present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A3. 7. *Patella ulyssiponensis* Observed (top left) and present-day predicted sites where Abundant (top right). Plots show predicted sites where Abundant (left) and changes (right) for 3 UKCIP climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

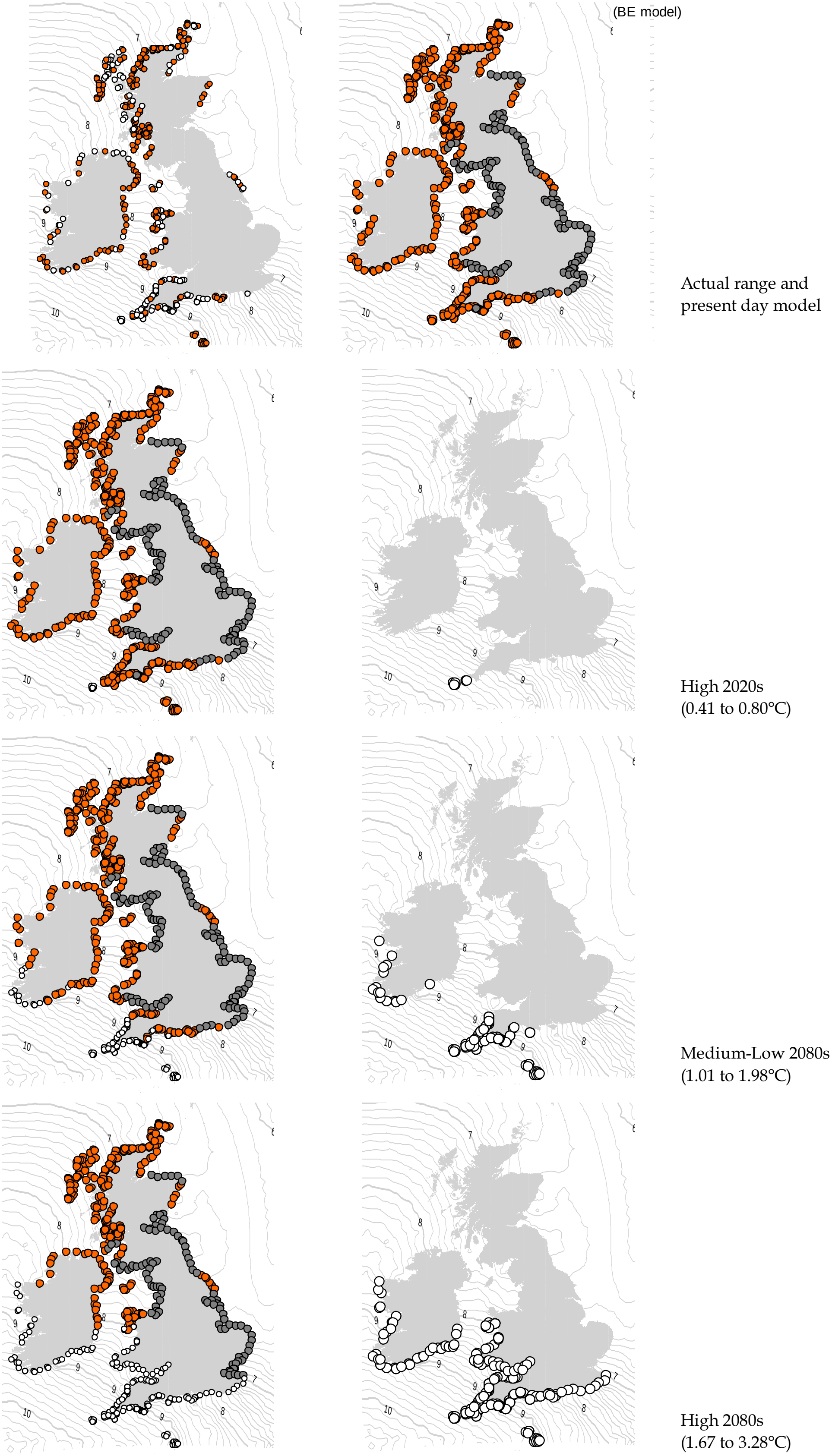
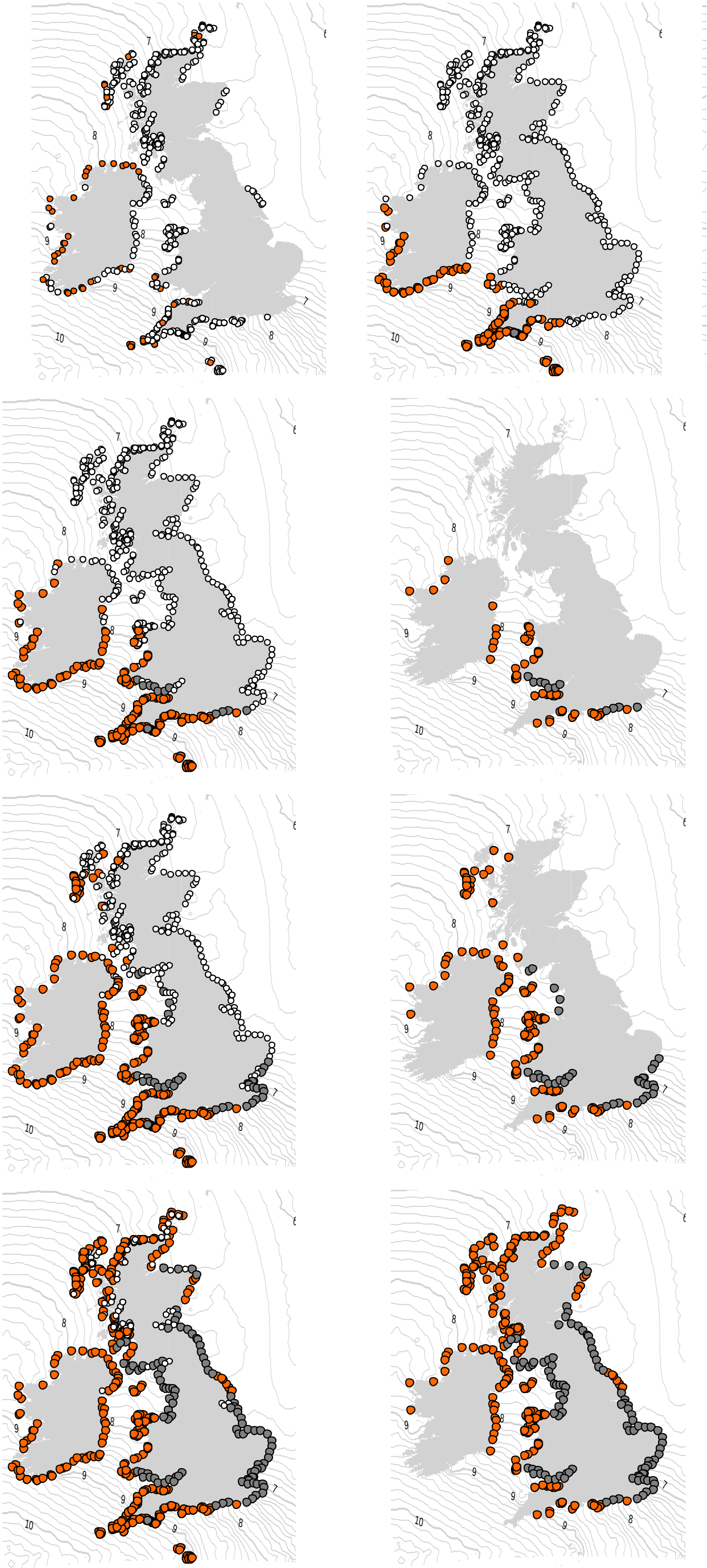


Figure A3. 8. *Semibalanus balanoides*. Observed (top left) and present-day predicted sites where Abundant (top right). Plots show predicted sites where Abundant (left) and changes (right) for 3 UKCIP climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



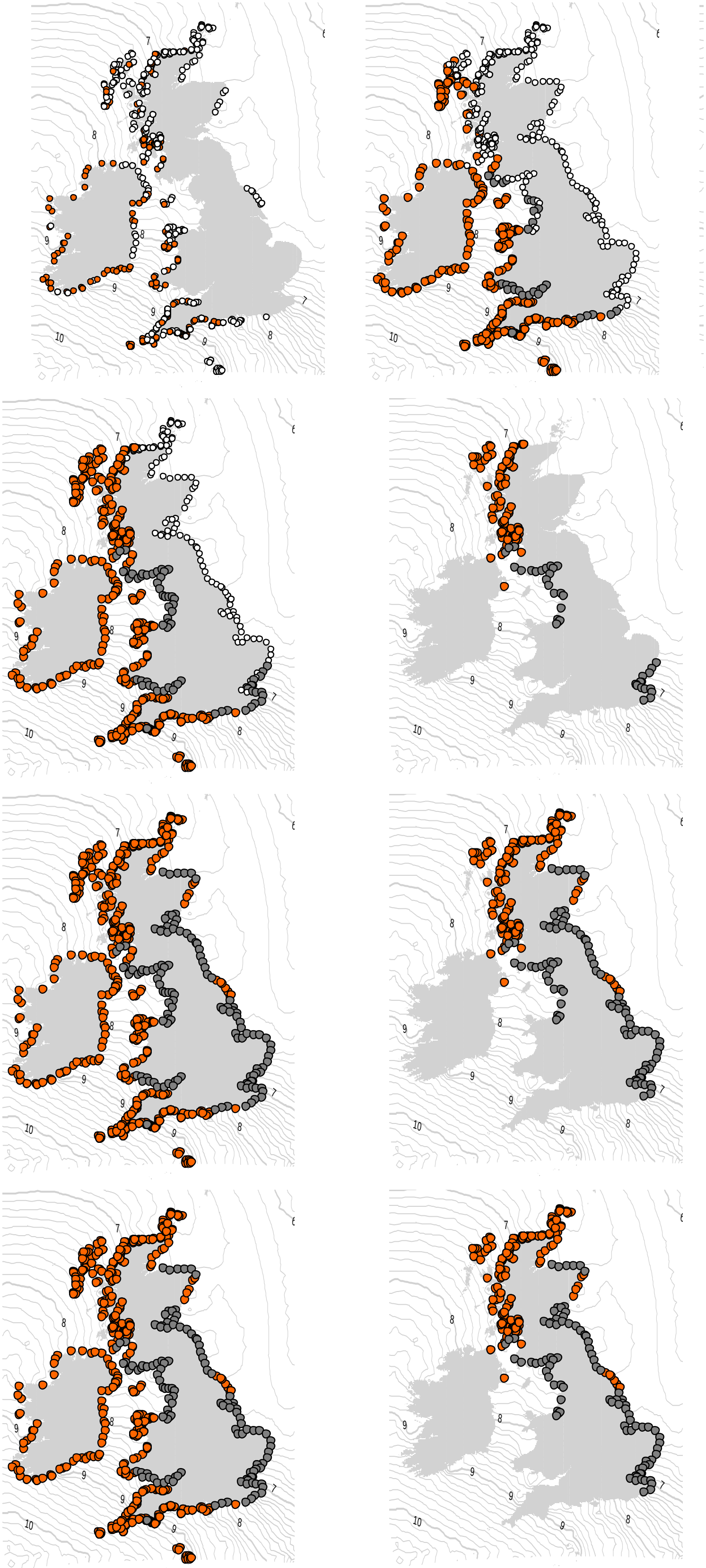
Actual range and
present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A3. 9. *Chthamalus stellatus*. Observed (top left) and present-day predicted sites where Abundant (top right). Plots show predicted sites where Abundant (left) and changes (right) for 3 UKCIP climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.



Actual range and
present day model

High 2020s
(0.41 to 0.80°C)

Medium-Low 2080s
(1.01 to 1.98°C)

High 2080s
(1.67 to 3.28°C)

Figure A3. 10. *Chthamalus montagui* Observed (top left) and present-day predicted sites where Abundant (top right). Plots show predicted sites where Abundant (left) and changes (right) for 3 UKCIP climate scenarios. Orange circles: observed and predicted presence, grey circles: predicted presence at model sites, open symbols: observed and predicted absence.

Appendix 4. MarClim proposed surveillance network structure

The surveillance network proposed by the MarClim project divided the U.K into 8 coastal sectors: Channel Islands; East; Isle of Man & Northern Ireland; Scilly Isles; Scotland; South; south-west; and Wales. Within these sectors, 115 monitoring were selected based on the availability of existing data and their location within the geographic range of target species. The coverage of the network included locations within SACs, SPAs and candidate SAC/SPA sites. The existing data underpin the network as the temporal and spatial resolution selected has been already been demonstrated by MarClim *to be sufficient to* detect and quantify species responses to climatic fluctuations.

It was proposed that rapid semi-quantitative surveys of a suite of up to 40 temperature-sensitive and ecologically important species would be conducted annually at all 115 locations in order to continue the long-term data collection on the abundance and distribution of these species in the UK. Quantitative surveys of a subset of 9 species (including barnacles, limpets and trochids) for which quality-controlled data has been collected between the 1950s and the present were proposed to be carried out at 80 of these 100 sites. Both quantitative and semi-quantitative surveys are required on an annual basis to provide suitable temporal resolution for the detection of further climate-induced changes in distribution, abundance, population and community dynamics. Surveys of barnacles would use digital photography to ensure both high levels of replication and expert quality control of identification.

It was proposed that a set of 20 additional locations, close to and beyond current range edges of sentinel species, would also be monitored to determine the extent of future climate-driven expansions and contractions in a range of species which have already shown biogeographic responses to rapid climate change. It was proposed that these surveys would undertaken at five yearly sampling intervals, an appropriate level to detect range changes.

Collection of data would be co-ordinated by an academic institution (e.g. the Marine Biological Association, with the Scottish Association for Marine Science) in conjunction with the Countryside Agencies. Specific sites would be designated in conjunction with the Environment Agency/Scottish Environmental Protection Agency as reference sites under the Water Framework Directive.

Appendix 5. MarClim sites.

The table shows dates and locations of sites visited during the MarClim project. The rightmost six columns show whether these should be included in future surveys of decreasing spatial frequencies, from an average site separation of 20km up to 400km. Three letter abbreviations after the site name indicate sampling personnel from the MarClim team.

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
1	2002	Lyme Regis (MAK)	SY329909	50.71377563	-2.951807976	0	0	0	0	0	1
2	2002	Hartland Quay	SS221248	50.99497604	-4.536562443	0	0	0	0	0	0
2	2002	Welcombe	SS210179	50.93264771	-4.548816204	0	0	0	0	0	0
2	2002	Prawle	SX776351	50.20315933	-3.716539621	0	0	0	0	0	0
3	2002	Wembury	SX518481	50.31409454	-4.082922459	0	0	0	0	0	0
3	2002	Polkerris	SX091522	50.33864212	-4.684126377	1	1	0	0	0	0
3	2002	West Looe	SX252519	50.34095001	-4.457967281	1	0	0	0	0	0
3	2002	Prawle	SX776351	50.20315933	-3.716539621	0	0	0	0	0	0
4	2002	Brixham	SX937568	50.40136719	-3.497128725	1	0	0	0	0	0
4	2002	Torbay	SX909632	50.45838928	-3.538376331	1	1	0	0	0	0
4	2002	Newquay	SW802628	50.42376328	-5.095873356	0	0	1	0	0	0
4	2002	Trevone	SW886760	50.54539871	-4.985251427	0	0	0	0	0	0
4	2002	Salcombe	SX734380	50.22834015	-3.776329279	0	0	0	0	0	0
4	2002	Brixham	SX937568	50.40136719	-3.497128725	1	0	0	0	0	0
4	2002	Lyme Regis	SY345920	50.72385025	-2.929334641	0	0	0	0	0	0
4	2002	Seaton	SY256896	50.70119858	-3.054920673	1	0	0	0	0	0
4	2002	West Bay	SY459904	50.71064377	-2.767609835	1	1	1	1	0	0
4	2002	Lulworth Cove	SY824798	50.61757278	-2.250159979	0	0	0	0	0	0
4	2002	Osmington	SY735816	50.63342285	-2.376098633	0	1	0	0	0	0
4	2002	Swanage	SZ040786	50.60703659	-1.944850922	1	1	1	0	0	0
4	2002	Alum Bay	SZ305858	50.67100906	-1.569777608	1	0	0	0	0	0
4	2002	Hanover Point	SZ378837	50.65169525	-1.466687918	0	0	0	0	0	0
4	2002	Kimmeridge	SY904791	50.61146927	-2.137061596	1	0	0	0	0	0
4	2002	Totland	SZ324879	50.68978882	-1.542702079	0	1	0	0	0	0
4	2002	Bembridge	SZ659879	50.68696213	-1.068488598	1	1	1	1	0	0
4	2002	Bonchurch	SZ576777	50.59613037	-1.187555671	0	0	0	0	0	0
4	2002	Freshwater Bay	SZ345855	50.66808319	-1.513198376	0	0	0	0	1	0
4	2002	Sandown	SZ612849	50.66049576	-1.135519743	1	0	0	0	0	0
4	2002	Ventnor	SZ558772	50.59180069	-1.213071108	0	1	0	0	0	0
4	2002	St. Catherine's Point	SZ504754	50.57610321	-1.289587021	0	1	0	0	0	0
5	2002	Portland (Pulpit Rock)	SY675682	50.51261902	-2.459761143	0	0	0	0	0	0
5	2002	Start Point	SX831372	50.22315216	-3.640147209	0	1	0	0	0	0
5	2002	Looe	SX257525	50.34649277	-4.451217175	0	0	0	0	0	0
5	2002	West Looe	SX252519	50.34095001	-4.457967281	1	0	0	0	0	0
5	2002	Bude	SS199072	50.83618164	-4.559185028	0	0	0	0	0	0
5	2002	Hartland Quay	SS221248	50.99497604	-4.536562443	0	0	0	0	0	0
5	2002	Woolacombe	SS452446	51.17956543	-4.216143131	0	0	0	0	1	0
5	2002	Renny Rocks	SX491486	50.31790924	-4.121023655	1	0	0	0	0	0
5	2002	Hope Cove	SX673399	50.2440834	-3.862469196	0	0	0	0	0	0
5	2002	Lizard	SW700115	49.95920944	-5.208200932	1	1	1	0	0	0
5	2002	Porthleven	SW625254	50.08107758	-5.321190834	1	0	0	0	0	1
5	2002	Cape Cornwall	SW351320	50.12873459	-5.707966328	1	1	1	1	0	0
5	2002	St. Ives	SW522411	50.21781158	-5.47510004	1	0	0	0	0	0
5	2002	Duckpool (MAK)	SS198116	50.8756752	-4.562773228	0	0	0	0	0	0
5	2002	Thurlestone	SX668420	50.26285172	-3.8702178	0	0	0	0	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
5	2002	Borve Point (North)	NF650021	56.98823166	-7.517895699	0	0	0	0	0	0
5	2002	Balintore	NH868758	57.7576561	-3.904043436	1	1	1	1	0	1
5	2002	Borve (Cemetary)	NF646015	56.98257065	-7.523638248	0	0	0	0	0	0
5	2002	Borve Point (Outer)	NF645023	56.98965073	-7.526351452	0	0	0	0	0	0
5	2002	Brora	NC912033	58.00562286	-3.842719555	1	0	1	1	0	1
5	2002	Castlebay	NL661980	56.95236206	-7.494448662	0	0	0	0	0	0
5	2002	Helmsdale	ND032151	58.11434555	-3.644626856	1	1	0	0	0	0
5	2002	Loch Obe Gorge Mouth	NF718012	56.98505402	-7.405322075	0	0	0	0	0	0
5	2002	Orosary	NL704995	56.968853	-7.426036358	0	0	0	0	0	0
5	2002	Portmahomack	NH898383	57.834413	-3.836609602	1	1	1	0	1	0
5	2002	Bay of Sannick	ND395738	58.64793015	-3.04412818	1	0	0	0	0	1
5	2002	Gills Bay	ND326730	58.63972092	-3.162746906	0	0	0	0	0	0
5	2002	Latherton	ND191320	58.26928711	-3.380734444	0	0	0	0	0	0
5	2002	Loch Boisdale (South)	NF792179	57.13962555	-7.305402279	0	1	0	0	0	0
5	2002	Lybster	ND246348	58.29540634	-3.28792119	1	1	0	0	0	0
5	2002	Pollachar	NF745145	57.10591888	-7.378293037	0	0	0	0	0	0
5	2002	Aird an Runair	NF686701	57.59884644	-7.54998827	0	0	0	0	0	0
5	2002	Dounreay	NC978669	58.57815933	-3.759207487	0	1	0	0	0	0
5	2002	Fresgoe	NC959657	58.56692505	-3.791309357	0	0	0	0	0	0
5	2002	Fresgoe West	NC959663	58.57231522	-3.791586161	0	0	0	0	0	0
5	2002	Gerraidh Siar Jetty	NF756526	57.44742966	-7.410117149	0	0	0	0	0	0
5	2002	Murkle Bay	ND174695	58.60567093	-3.423230648	0	0	0	0	0	0
5	2002	Wick (North Head)	ND384508	58.4412384	-3.056842804	1	1	1	0	1	0
5	2002	Caolas an Scarp	NA988124	57.99846268	-7.099998474	0	0	0	0	0	0
5	2002	Cliasmol	NB075064	57.95057297	-6.94595623	1	0	1	1	0	0
5	2002	Farr	NC714637	58.54242706	-4.211044788	1	1	0	0	0	0
5	2002	Kempie by Brock	NC445582	58.48430252	-4.668926716	0	0	0	0	0	0
5	2002	Lochmaddy (Near Pier)	NF922680	57.59675598	-7.154106617	1	1	0	0	0	0
5	2002	Portskerra	NC870660	58.56739807	-3.944375753	1	0	1	0	0	0
5	2002	Scarasta	NG018939	57.83495331	-7.026212215	1	1	0	0	0	0
5	2002	Skerray	NC660641	58.544384	-4.303966045	0	0	0	0	0	0
5	2002	Borve Melbost	NB408578	58.43148422	-6.44226408	0	0	0	0	0	0
5	2002	Clashnessie	NC062315	58.22956467	-5.30227375	0	0	0	0	0	0
5	2002	Culkein	NC042335	58.24661255	-5.337953091	0	0	0	0	0	0
5	2002	Geodha Ruadh	NB190444	58.2980957	-6.797953606	0	1	0	0	0	0
5	2002	Loch Seaforth	NB198119	58.00771332	-6.745387554	0	1	0	0	0	0
5	2002	Port Nis	NB540638	58.49285507	-6.22329855	0	0	0	0	0	0
5	2002	Port Stoth	NB525659	58.51081085	-6.251235485	0	0	0	0	1	0
5	2002	Stoer	NC036281	58.19792938	-5.343595505	0	0	0	0	0	0
5	2002	Achmelvich	NC053250	58.17089081	-5.312145233	1	1	0	0	0	0
5	2002	Berneray Bridge	NB164340	58.20335007	-6.829455376	1	0	1	0	0	0
5	2002	Causeway Eye Peninsula	NB483319	58.2039032	-6.285992622	1	1	0	0	0	0
5	2002	Clachtoll	NC038268	58.18636322	-5.339106083	0	0	0	0	0	0
5	2002	Loch Erisort	NB360215	58.1035881	-6.48290062	1	1	1	0	0	0
5	2002	Scourie	NC148449	58.35343552	-5.166788101	0	1	1	0	0	0
5	2002	Tiumpan Head	NB575376	58.26010895	-6.135812759	1	0	0	0	0	0
5	2002	Achnahaird	NC016142	58.07240677	-5.365768433	0	0	0	0	1	0
5	2002	Alltain Duibh	NB982115	58.04666138	-5.420995712	0	0	0	0	0	1
5	2002	Reiff	NB963143	58.07089996	-5.455533981	0	0	0	0	0	0
5	2002	Renish Point	NG038823	57.7324791	-6.978312016	1	1	0	0	0	0
5	2002	Roghadal	NG048826	57.73581696	-6.961960793	0	0	0	0	0	0
6	2002	Criccieth	SH494376	52.91463852	-4.241235733	1	0	0	0	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
6	2002	Porth Dinllaen	SH274415	52.94304276	-4.570168495	1	1	0	0	0	0
6	2002	Porth Oer	SH165298	52.83436584	-4.725593567	0	0	0	0	0	0
6	2002	Aberdesach	SH425515	53.03750992	-4.350539207	1	0	0	0	0	0
6	2002	Caernarfon	SH521671	53.18037796	-4.214660168	0	0	0	0	0	0
6	2002	Penaenmawr	SH699763	53.26767731	-3.952234268	1	0	0	0	0	0
6	2002	Porth Neigwl	SH288245	52.79081726	-4.540422916	0	0	0	0	0	0
6	2002	Trefor	SH376474	52.99921799	-4.421482086	0	0	0	0	0	1
6	2002	Bull Bay	SH427945	53.42376709	-4.368785858	0	1	0	0	0	0
6	2002	Moelfre	SH513859	53.34901428	-4.235424995	1	0	0	0	0	0
6	2002	Penmon (North)	SH641813	53.31114578	-4.04129076	0	0	0	0	0	0
6	2002	Point Lynas	SH484929	53.41106796	-4.282313824	0	0	0	0	0	0
6	2002	Cemlyn	SH332938	53.41455841	-4.511244774	0	0	0	0	0	0
6	2002	Port Dafarch	SH233798	53.28562927	-4.652218819	0	0	0	0	0	0
6	2002	Rhosneigr	SH313728	53.22537231	-4.528625011	0	1	0	0	0	0
6	2002	Marazion	SW512304	50.12134171	-5.482097626	0	1	0	0	0	0
6	2002	Nanjizal	SW354237	50.05437469	-5.698021412	0	0	0	0	0	0
6	2002	Sennen Cove	SW347264	50.07829666	-5.709660053	0	0	0	0	0	0
6	2002	Whitsand Bay	SW362278	50.09153748	-5.68970871	0	0	0	0	0	0
6	2002	Crag Aoil	NM808112	56.24267578	-5.539232731	0	0	0	0	0	0
6	2002	Craignish	NM762003	56.14279175	-5.604117393	1	0	0	0	0	0
6	2002	Cullipool	NM737128	56.25369263	-5.654938698	0	0	0	0	0	0
6	2002	Lamorna Cove	SW451237	50.05861282	-5.562787056	0	0	0	0	0	0
6	2002	Mousehole	SW472265	50.0846405	-5.535360336	1	0	0	0	0	0
6	2002	North Craobh	NM801092	56.22441864	-5.548846245	0	0	0	0	0	0
6	2002	Porthgwarra	SW372213	50.03363419	-5.671282291	0	0	0	0	0	0
6	2002	Tinside	SX479537	50.36343002	-4.13992548	1	0	0	0	0	0
6	2002	Bantham	SX659433	50.27433395	-3.883295774	0	0	0	0	0	0
6	2002	Penzance	SW476298	50.1144371	-5.531968117	0	0	0	0	0	0
6	2002	Poldhu Cove	SW664199	50.03324127	-5.263409138	0	0	0	0	1	0
6	2002	Polkerris	SX091522	50.33864212	-4.684126377	1	1	0	0	0	0
7	2002	Appin	NM928491	56.58797455	-5.375947475	1	0	0	0	0	0
7	2002	Corran	NN021635	56.72115326	-5.235835552	1	1	1	1	0	0
7	2002	Ganavan	NM860326	56.43695831	-5.472894669	1	1	1	0	0	0
7	2002	Achnahaird (MTB)	NC016139	58.06971359	-5.365521908	0	0	0	0	0	0
7	2002	Reiff (MTB)	NB964143	58.07094193	-5.453851223	1	0	1	1	0	0
7	2002	Rhue	NH094973	57.92427826	-5.220103741	1	0	0	0	0	0
7	2002	Ullapool	NH137935	57.89201355	-5.144653797	0	0	0	0	0	0
7	2002	Ard Neackie	NC447598	58.49872208	-4.666582584	0	0	0	0	0	0
7	2002	Causeway	NC574593	58.49857712	-4.44858551	0	0	0	0	1	0
7	2002	Lerinmore	NC426666	58.55897903	-4.707276344	1	1	0	0	0	0
7	2002	Port Vasgo	NC585650	58.55008316	-4.433272362	1	0	0	0	0	0
7	2002	Rispond (MTB)	NC452653	58.54824829	-4.66174984	1	0	1	1	0	0
7	2002	Skerray (MTB)	NC659638	58.54165649	-4.305519104	0	0	0	0	0	0
7	2002	Talmine	NC588631	58.53313446	-4.426928043	0	0	0	0	0	0
7	2002	Clashnessie (MTB)	NC060312	58.22678375	-5.305428028	0	0	0	0	0	0
7	2002	Culkein	NC040332	58.24383163	-5.341107845	0	0	0	0	0	0
7	2002	Fish Farm Slip	NC203328	58.24720383	-5.063553333	1	0	0	0	0	0
7	2002	Kylesku	NC230338	58.25726318	-5.018386841	1	0	0	0	0	0
7	2002	Camas Allt Eoin Thomais	NG810896	57.84221268	-5.691520691	0	0	0	0	0	0
7	2002	Firemore	NG821883	57.83109665	-5.67184639	1	1	0	0	0	0
7	2002	Opinan	NG880972	57.91371155	-5.580620289	1	1	1	0	0	0
7	2002	Rubha Nan Sasan	NG814921	57.86482239	-5.687081814	1	0	0	0	0	0
7	2002	Slaggan	NG839942	57.88485718	-5.646944523	0	0	0	0	0	0
7	2002	Fearnbeg	NG737599	57.57238388	-5.786282063	0	1	0	0	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
7	2002	Inverbain	NG786551	57.53179169	-5.700169563	0	1	0	0	0	0
7	2002	Lonbain	NG685530	57.50792313	-5.866455078	1	1	0	0	0	0
7	2002	Sron Na Carra	NG742734	57.69363403	-5.790550232	1	1	1	1	0	0
7	2002	Ardnamurchan	NM417670	56.72301483	-6.223771095	0	0	0	0	0	0
7	2002	Camas Fearna	NM574617	56.68394089	-5.962864876	1	1	1	0	0	0
7	2002	Fascadale	NM499708	56.76153564	-6.093837261	0	1	0	0	0	0
7	2002	Glenuig	NM661778	56.83269882	-5.835878372	1	1	1	1	0	0
7	2002	Roshven	NM724786	56.84299088	-5.7335639	0	0	0	0	0	0
7	2002	Salen	NM685634	56.7048111	-5.783607483	1	1	1	0	0	0
7	2002	Claonaig	NR876560	55.7506752	-5.386105537	1	1	0	0	0	0
7	2002	Columba's Cave	NR751765	55.92887115	-5.601834297	0	0	0	0	0	0
7	2002	Kilmory	NR700744	55.90762711	-5.681497574	0	1	0	0	0	0
7	2002	Ormsary	NR720699	55.86822128	-5.645780087	1	1	0	0	0	0
7	2002	Port Ban	NR706655	55.82810974	-5.664399147	1	1	1	0	0	0
7	2002	Tarbert	NR863737	55.90886307	-5.420691967	1	0	0	0	0	0
7	2002	Ardlamont Point	NR990639	55.8264122	-5.210599899	0	0	0	0	0	0
7	2002	Glenstriven	NS085771	55.94870758	-5.068521976	1	0	0	0	0	0
7	2002	Port Lamont	NS095704	55.88899231	-5.047804832	0	1	0	0	0	0
7	2002	Strathlachlan	NS000944	56.10043716	-5.217308998	1	1	1	1	0	0
7	2002	Toward Point	NS136671	55.8609848	-4.980070591	0	0	0	0	0	0
7	2002	Langerstone Point	SX783353	50.20510101	-3.706796169	1	0	1	1	0	0
7	2002	Maenporth	SW794295	50.12440872	-5.08769846	1	0	0	0	0	0
7	2002	Newquay (Fistral Beach)	SW798626	50.42181778	-5.101381779	0	0	0	0	0	0
7	2002	Portland (Pulpit Rock)	SY675682	50.51261902	-2.459761143	0	0	0	0	0	0
7	2002	Downderry (Bass Rock)	SX322538	50.36006165	-4.360527992	0	1	1	0	0	0
7	2002	Flushing	SW810335	50.16092682	-5.067642212	1	1	1	1	0	0
8	2002	Port St. Mary	SC211669	54.06689835	-4.735411644	0	0	0	0	0	0
8	2002	Langness	SC284667	54.06758118	-4.623868465	1	0	0	0	0	0
8	2002	Niarbyl	SC208775	54.16195297	-4.746282101	0	1	0	0	0	0
8	2002	Port Mooar	SC492907	54.28962326	-4.31834507	1	1	1	1	1	1
8	2002	Gorran Haven	SX015415	50.24001312	-4.785181046	0	0	0	0	0	0
8	2002	Aberaeron	SN457633	52.24616241	-4.261589527	1	1	0	0	0	0
8	2002	Aberystwth	SN582828	52.42472076	-4.086867332	0	0	0	0	0	0
8	2002	Borth	SN605888	52.47922134	-4.055578232	1	1	1	0	0	0
8	2002	Clarach	SN585841	52.43648148	-4.083013058	0	0	0	0	0	0
8	2002	Le Grand Etaquerel	WV546552	49.24615803	-2.249840838	0	0	0	0	0	0
8	2002	La Corbiere (Inner)	WV552480	49.18134614	-2.242588166	0	0	0	0	0	0
8	2002	La Corbiere (Lighthouse)	WV548481	49.18228143	-2.248062532	0	0	0	0	0	0
8	2002	Plemont Point	WV564570	49.26218414	-2.224859185	0	0	0	0	0	0
8	2002	Torridon	NG894565	57.5494957	-5.521358013	0	1	0	0	0	0
8	2002	Fremont	WV641564	49.25602944	-2.119141616	0	0	0	0	0	0
8	2002	White Rock Rozel	WV692552	49.24468148	-2.049274759	0	0	0	0	0	0
8	2002	Elisabeth Castle	WV634476	49.17695588	-2.130149865	0	0	0	0	0	0
8	2002	La Rocque	WV713455	49.15720186	-2.022149275	0	0	0	0	0	0
8	2002	Mont Oregueil	WV718504	49.20121266	-2.014418291	0	0	0	0	0	0
8	2002	Aberporth	SN260518	52.13698959	-4.543954372	1	1	1	1	0	0
8	2002	Gwbert	SN158504	52.12111282	-4.692076683	1	0	0	0	1	0
8	2002	Abercastle	SM851338	51.96100616	-5.129399776	1	1	1	0	0	0
8	2002	Abereiddy	SM792315	51.93805313	-5.213659286	1	1	0	0	0	0
8	2002	Broadhaven	SM859144	51.78714752	-5.105734348	1	0	0	0	0	0
8	2002	West Angle Bay	SM848038	51.69155884	-5.115104675	0	0	0	0	0	0
8	2002	Saundersfoot	SN150033	51.69783783	-4.678433418	1	1	1	1	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
		(Monkstone Point)									
8	2002	St. Govan's Chapel	SR967929	51.59811783	-4.936846256	1	1	0	0	0	0
8	2002	Littlewick Bay	SM864066	51.71731186	-5.093716621	1	1	1	1	0	0
9	2002	Budleigh Salterton	SY079818	50.62853241	-3.303560495	1	0	1	0	0	0
9	2002	Sidmouth	SY122869	50.67505646	-3.243990183	0	1	0	0	0	0
9	2002	Lynmouth	SS718501	51.23559189	-3.8377738	1	1	1	0	0	0
9	2002	Cellar	SX531477	50.31082916	-4.064520359	0	0	0	0	0	0
9	2002	Port Eilian	SH477929	53.41086578	-4.292837143	0	0	0	0	0	0
9	2002	Cemlyn Bay (East)	SH337934	53.41112518	-4.503517628	1	0	0	0	0	0
9	2002	Llanbadrig (Cemaes Bay)	SH375945	53.42219162	-4.446966171	0	0	0	0	0	0
9	2002	Duckpool	SS198111	50.87118149	-4.562522888	0	0	0	0	0	0
10	2002	Dale	SM824052	51.70320129	-5.150655746	0	0	0	0	0	0
10	2002	Blue Anchor	ST034438	51.18518066	-3.383593559	0	0	0	0	0	0
10	2002	Stolford	ST231461	51.20885468	-3.102269411	1	1	1	1	1	0
10	2002	Swill Point	ST099436	51.18445587	-3.290561199	0	0	0	0	0	0
10	2002	Gore Point	SS859485	51.2242012	-3.635375023	0	0	0	0	0	0
10	2002	Hurlstone Point	SS898493	51.23216248	-3.579802513	1	1	0	0	0	0
10	2002	Minehead	SS972471	51.21376419	-3.473220825	1	1	0	0	0	0
10	2002	Mothercome	SX608472	50.30820847	-3.956264973	1	1	0	0	1	0
11	2002	Swanage	SZ040786	50.60703659	-1.944850922	1	1	1	0	0	0
11	2002	Clay Ope Cove	SY681723	50.54951859	-2.451649189	1	0	0	0	0	0
11	2002	Portland (Pulpit Rock)	SY675682	50.51261902	-2.459761143	0	0	0	0	0	0
11	2002	Portland Bill (RJH)	SY679714	50.54141617	-2.454386234	0	0	0	0	0	0
11	2002	Lulworth Cove	SY824798	50.61757278	-2.250159979	0	0	0	0	0	0
11	2002	Osmington	SY735816	50.63342285	-2.376098633	0	0	0	0	0	0
11	2002	Kimmeridge (RJH)	SY905793	50.61326218	-2.135655642	1	1	0	0	0	0
2	2003	Wembury	SX518481	50.31409454	-4.082922459	0	0	0	0	0	0
2	2003	Garretstown	W595436	51.64425276	-8.585141172	0	0	0	0	0	0
2	2003	Garretstown	W595436	51.64425276	-8.585141172	0	0	0	0	0	0
3	2003	Reiff	NB963143	58.07089996	-5.455533981	0	0	0	0	0	0
3	2003	Scourie	NC148449	58.35343552	-5.166788101	0	1	1	0	0	0
3	2003	Rispond	NC454653	58.54832077	-4.658321857	0	0	0	0	0	0
3	2003	Fresgoe	NC959657	58.56692505	-3.791309357	0	0	0	0	0	0
3	2003	Portskerra	NC870660	58.56739807	-3.944375753	1	0	1	0	0	0
3	2003	Ballycotton	W999638	51.82718649	-8.001450633	0	0	0	0	0	0
3	2003	Gyleen	W865601	51.79378301	-8.19569076	0	0	0	0	0	0
3	2003	Knockadoon Head	X092703	51.88550637	-7.866369135	0	0	0	0	0	0
3	2003	Helvick Head	X315892	52.05448426	-7.540734312	0	0	0	0	0	0
4	2003	Tranabo Pier	W107280	51.49850973	-9.286100073	0	0	0	0	0	0
4	2003	Toe Head	W142263	51.48378233	-9.235293085	0	0	0	0	0	0
4	2003	Toe Head Bay	W137264	51.48460448	-9.242514361	0	0	0	0	0	0
4	2003	Seaford	TV491978	50.76057816	0.112674013	1	1	1	1	1	1
4	2003	Brixham	SX937568	50.40136719	-3.497128725	1	0	0	0	0	0
4	2003	Brownstown Head	X613978	52.12924317	-7.104752771	0	0	0	0	0	0
4	2003	Bunmahon	X430987	52.13905417	-7.371877759	0	0	0	0	0	0
4	2003	Wembury	SX518481	50.31409454	-4.082922459	0	0	0	0	0	0
4	2003	Baginbun Head	S795031	52.17453144	-6.837766657	0	0	0	0	0	0
4	2003	Hook Head	X731974	52.12421625	-6.932536968	0	0	0	0	0	0
4	2003	West Looe	SX252519	50.34095001	-4.457967281	1	0	0	0	0	0
4	2003	Cullenstown Reef to W	S867077	52.21476386	-6.731358719	0	0	0	0	0	0
4	2003	Trevone	SW886760	50.54539871	-4.985251427	0	0	0	0	0	0
4	2003	Bude	SS199072	50.83618164	-4.559185028	0	0	0	0	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
4	2003	Hartland Quay	SS221248	50.99497604	-4.536562443	0	0	0	0	0	0
4	2003	Welcombe Mouth	SS210179	50.93264771	-4.548816204	0	0	0	0	0	0
4	2003	Crackington Haven	SX138969	50.74171829	-4.640498638	0	0	0	0	0	0
4	2003	Newquay (SJH)	SW800628	50.42368698	-5.09868145	0	0	0	0	0	0
4	2003	Prawle	SX776351	50.20315933	-3.716539621	0	0	0	0	0	0
4	2003	Looe	SX257525	50.34649277	-4.451217175	0	0	0	0	0	0
4	2003	Forlorn Point/Crossfarnoge	S961032	52.17278977	-6.595130385	0	0	0	0	0	0
4	2003	Rosslare Harbour Waddingsland Point	T144117	52.24563282	-6.324850373	0	0	0	0	0	0
4	2003	Aird of Sleat	NG592002	57.02992249	-5.969977379	0	0	0	0	0	0
4	2003	Armdale	NG639036	57.06282425	-5.895925522	1	1	1	1	0	0
4	2003	Carnsore Point	T118036	52.17342625	-6.365577114	0	0	0	0	0	0
4	2003	Greenore Point	T151112	52.24099692	-6.314775276	0	0	0	0	0	0
4	2003	Hartland	SS221248	50.99497604	-4.536562443	0	0	0	0	0	0
4	2003	Welcombe Mouth (MAK)	SS211178	50.93177414	-4.547346115	1	1	0	0	0	0
5	2003	Balmaquiem	NG441750	57.69186401	-6.29578495	0	1	1	0	0	0
5	2003	Crackington Haven (North Headland)	SS221248	50.99497604	-4.536562443	1	0	1	1	0	0
5	2003	Duntulm	NG412746	57.68662643	-6.343873024	1	0	0	0	0	0
5	2003	Duntulm (North)	NG409754	57.69361115	-6.349741459	0	0	0	0	0	0
5	2003	Staffin Slipway	NG495682	57.63398743	-6.198408127	1	0	0	0	0	0
5	2003	Widemouth	SS191010	50.78022766	-4.567476273	0	0	0	0	0	0
5	2003	Carbosht Pier	NG374324	57.30645752	-6.362007618	1	0	0	0	0	0
5	2003	Talisker Bay	NG310299	57.2803421	-6.465197086	1	1	1	0	0	0
5	2003	Trumpan North	NG218611	57.55419159	-6.652667522	1	1	1	1	1	0
5	2003	Ardnamurchan Point	NM417670	56.72301483	-6.223771095	0	0	0	0	1	0
5	2003	Kilchoan Pier	NM493626	56.68773651	-6.095619202	1	0	0	0	0	1
5	2003	Mallaig Harbour	NR687806	55.96258545	-5.707567215	0	0	0	0	0	0
5	2003	Prince's Cairn	NM718844	56.89469147	-5.748593807	1	0	0	0	0	0
5	2003	Rubha Baile	NM447350	56.4379425	-6.143357754	1	1	1	0	0	0
5	2003	Brenfield	NR850824	55.98630524	-5.448382854	1	1	0	0	0	0
5	2003	Gortein Onseach	NM471245	56.34514618	-6.094398022	1	1	0	0	0	0
5	2003	Keills Jetty (Exposed)	NR687806	55.96258545	-5.707567215	0	0	0	0	0	0
5	2003	Keills Jetty (Less Exposed)	NR687806	55.96258545	-5.707567215	1	1	0	0	0	0
5	2003	Port Uisken	NM390185	56.2869873	-6.219147682	1	0	0	0	0	0
5	2003	Old Head of Kinsale	W630393	51.60586446	-8.534122111	0	0	0	0	0	0
5	2003	Ringalurisky Point	W611413	51.62370354	-8.561770388	0	0	0	0	0	0
5	2003	Fort Hommet	WV281806	49.47640941	-2.612123537	0	0	0	0	0	0
5	2003	Lihou Island	WV244793	49.46487666	-2.663275399	0	0	0	0	0	0
5	2003	Fort Doyle	WV359841	49.50747795	-2.504142646	0	0	0	0	0	0
5	2003	Grand Camp Chouet	WV332844	49.51033003	-2.54140901	0	0	0	0	0	0
5	2003	Bordeax Harbour	WV358820	49.48859608	-2.505714077	0	0	0	0	0	0
5	2003	Le Petit Bot	WV307749	49.42501573	-2.576677303	0	0	0	0	0	0
5	2003	Whiteball Head Bay	V583409	51.6036311	-10.04553517	0	0	0	0	0	0
5	2003	Goleen	V816280	51.4931671	-9.705023682	0	0	0	0	0	0
5	2003	Goleen	V816280	51.4931671	-9.705023682	0	0	0	0	0	0
5	2003	Goleen (Sheltered)	V815280	51.49314616	-9.706463049	0	0	0	0	0	0
5	2003	White Ball Head	V583409	51.6036311	-10.04553517	0	0	0	0	0	0
5	2003	Lizard	SW700115	49.95920944	-5.208200932	1	1	1	0	0	0
5	2003	Porthleven	SW625254	50.08107758	-5.321190834	1	0	0	0	0	1
5	2003	Portland (Pulpit Rock)	SY675682	50.51261902	-2.459761143	0	0	0	0	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
5	2003	Portland Bill	SY677681	50.51172638	-2.45691824	0	0	0	0	0	0
5	2003	St. Ives	SW522411	50.21781158	-5.47510004	1	0	0	0	0	0
5	2003	Ballantrae (Exposed)	NX079830	55.10412598	-5.012822151	1	1	1	1	0	1
5	2003	Ballantrae (Sheltered)	NX082831	55.10513687	-5.008199215	1	1	1	1	0	0
5	2003	Croy	NS242127	55.3767395	-4.776178837	0	0	0	0	0	0
5	2003	Dunure Castle	NS251159	55.40578079	-4.763998985	1	1	0	0	0	0
5	2003	Girvan South	NX180962	55.2264061	-4.8632164	1	0	1	0	0	0
6	2003	Cape Cornwall	SW351320	50.12873459	-5.707966328	0	0	0	0	0	0
6	2003	Lyme Regis	SY345920	50.72385025	-2.929334641	0	0	0	0	1	0
6	2003	Sennen Cove	SW347264	50.07829666	-5.709660053	0	0	0	0	0	0
6	2003	Port Oriel Clougherhead	O172845	53.79681158	-6.22114454	0	0	0	0	0	0
6	2003	Balbriggan	O202644	53.61560906	-6.183429915	0	0	0	0	0	0
6	2003	Skerries	O255612	53.58562835	-6.104666105	0	0	0	0	0	0
6	2003	Malahide Coast	O234462	53.45141717	-6.142266449	0	0	0	0	0	0
6	2003	Porthleven	SW625254	50.08107758	-5.321190834	1	0	0	0	0	1
6	2003	Bray	O277179	53.196289	-6.088962298	0	0	0	0	0	0
6	2003	Greystones	O296126	53.14824187	-6.062691914	0	0	0	0	0	0
6	2003	Lizard	SW700115	49.95920944	-5.208200932	1	1	1	0	0	0
6	2003	St. Ives	SW522411	50.21781158	-5.47510004	1	0	0	0	0	0
6	2003	Ardmore Point	T329883	52.92924927	-6.02340173	0	0	0	0	0	0
6	2003	Kilmichael Point	T253667	52.73712347	-6.144653587	0	0	0	0	0	0
6	2003	Cahore Point	T220478	52.56816449	-6.200474375	0	0	0	0	0	0
6	2003	Kerry Head Southside	Q699289	52.39658668	-9.911559467	0	0	0	0	0	0
7	2003	Appin	NM928491	56.58797455	-5.375947475	1	0	0	0	0	0
7	2003	Loch Creran	NM943414	56.51958084	-5.345477581	1	1	0	0	0	0
7	2003	Lough Kay Doulus Bay	V434793	51.9444024	-10.27775072	0	0	0	0	0	0
7	2003	Portmagee Channel Opposite Bray Head	V352728	51.88369068	-10.39380378	0	0	0	0	0	0
7	2003	Abbey Island Derrynane	V521586	51.76094378	-10.14246071	0	0	0	0	0	0
7	2003	Daniels Island Near Whitestrand	V605595	51.77117849	-10.02122446	0	0	0	0	0	0
7	2003	Millport	NS170540	55.74474335	-4.917014122	1	1	1	1	1	0
7	2003	Ardlamont Bay	NR981649	55.83500671	-5.22569561	0	0	0	0	0	0
7	2003	Boathouse	NS009774	55.94831467	-5.190244675	1	0	0	0	0	0
7	2003	Fearnoch	NS013763	55.93860626	-5.183039188	0	0	0	0	0	0
7	2003	Portavadie	NR925693	55.87210464	-5.318318844	1	0	1	0	0	0
7	2003	Strone Point	NS072714	55.89705276	-5.08523798	0	0	0	0	0	0
7	2003	Clate Point	NS004683	55.86646271	-5.191524506	1	1	0	0	0	0
7	2003	Dunagoil Bay	NS084533	55.73513031	-5.053320885	1	0	0	0	0	0
7	2003	Kerrycroy	NS107619	55.8132019	-5.022711754	1	0	0	0	0	0
7	2003	Kilchattan Bay	NS108545	55.74684143	-5.015987396	0	0	0	0	0	0
7	2003	Kildanavan Point	NS024660	55.8466568	-5.157946587	0	0	0	0	0	0
7	2003	Undraynian Point	NS077688	55.87392426	-5.075409412	0	0	0	0	0	0
7	2003	Cloch	NS201748	55.93255234	-4.881484985	1	0	0	0	0	0
7	2003	Innellan	NS155710	55.89671326	-4.952422619	1	1	1	1	0	0
7	2003	Inverchaolain	NS089755	55.93451309	-5.060997486	0	0	0	0	0	0
7	2003	Port Lamont	NS095704	55.88899231	-5.047804832	0	1	0	0	0	0
7	2003	Strathlachlan	NS000944	56.10043716	-5.217308998	1	1	1	1	0	0
7	2003	Toward Castle	NS119675	55.86391449	-5.007471561	0	0	0	0	0	0
7	2003	Rhue	NH094973	57.92427826	-5.220103741	1	0	0	0	0	0
7	2003	Ullapool	NH137935	57.89201355	-5.144653797	0	0	0	0	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
7	2003	An-t-sron	NC446579	58.48164368	-4.666993141	0	1	0	0	0	0
7	2003	Causeway	NC574593	58.49857712	-4.44858551	0	0	0	0	1	0
7	2003	Port Vasgo	NC585650	58.55008316	-4.433272362	1	0	0	0	0	0
7	2003	Rispond (MTB)	NC452653	58.54824829	-4.66174984	1	0	1	1	0	0
7	2003	Skullomie	NC616615	58.51967621	-4.37791872	0	0	0	0	0	0
7	2003	Achlyness	NC016139	58.06971359	-5.365521908	0	0	0	0	0	0
7	2003	Galley Head	W337311	51.52952022	-8.955494254	0	0	0	0	0	0
7	2003	Kinlochbervie	NC221557	58.45331573	-5.050598621	1	0	0	0	0	0
7	2003	Oldshoremore	NC200583	58.4757843	-5.088585377	0	0	0	0	0	0
7	2003	Osmington	SY735816	50.63342285	-2.376098633	0	1	0	0	0	0
7	2003	Rispond Outer	NC449656	58.55083084	-4.667098045	0	0	0	0	0	0
7	2003	Sangobeg	NC428664	58.55725479	-4.703691006	0	0	0	0	0	0
7	2003	Sheigra	NC181595	58.48574829	-5.122059822	0	0	0	0	0	0
7	2003	Achnahaird (MTB)	NC016139	58.06971359	-5.365521908	0	0	0	0	0	0
7	2003	Badenscallie	NC035060	57.99972153	-5.326773643	0	1	0	0	0	0
7	2003	Clachtoll (MTB)	NC038270	58.1881485	-5.339276314	0	0	0	0	0	0
7	2003	Kylesku Bridge	NC218338	58.25677872	-5.038805962	0	0	0	0	0	0
7	2003	Lyme Regis (MAK)	SY329909	50.71377563	-2.951807976	0	0	0	0	0	1
7	2003	Scourie (MTB)	NC147448	58.35249329	-5.168412209	0	0	0	0	0	0
7	2003	Unapool	NC238326	58.24682617	-5.00385046	0	0	0	0	0	0
7	2003	Ardheslaig	NG780568	57.54673386	-5.711710453	1	0	0	0	0	0
7	2003	Camusteel	NG704420	57.41028976	-5.824505806	1	1	1	1	0	0
7	2003	Fearnbeg	NG737599	57.57238388	-5.786282063	0	1	0	0	0	0
7	2003	Lonbain	NG685530	57.50792313	-5.866455078	1	1	0	0	0	0
7	2003	Drumbuie	NG770314	57.31856155	-5.70527792	1	1	1	0	1	0
7	2003	Plockton	NG807337	57.34096909	-5.646005154	1	1	0	0	0	0
7	2003	Slumbay	NG895384	57.38726425	-5.504112244	1	0	1	1	0	0
7	2003	Appin	NM928491	56.58797455	-5.375947475	1	0	0	0	0	0
7	2003	Colliston	NK044287	57.34886169	-1.928508401	1	1	1	0	0	0
7	2003	Corran	NN021635	56.72115326	-5.235835552	1	1	1	1	0	0
7	2003	Cruden Bay	NK098355	57.40985489	-1.838512897	1	1	1	1	1	0
7	2003	Easdale	NM752168	56.29027176	-5.634167194	0	0	1	0	0	0
7	2003	Ganavan	NM860326	56.43695831	-5.472894669	1	1	1	0	0	0
7	2003	Campbeltown	NR734203	55.42409897	-5.582564831	1	1	1	1	0	0
7	2003	Carradale	NR817386	55.59199524	-5.466079235	1	1	1	0	0	0
7	2003	Claonaig	NR876560	55.7506752	-5.386105537	1	1	0	0	0	0
7	2003	Machrihanish North	NR654265	55.47592545	-5.713933468	1	1	1	0	1	0
7	2003	Southend	NR673076	55.30735016	-5.668190479	1	1	0	0	0	0
7	2003	Cove Bay	NJ957005	57.09553909	-2.072583437	1	0	0	0	0	0
7	2003	Johnshaven	NO798669	56.79326248	-2.332285881	1	1	1	1	0	0
7	2003	Stonehaven	NO893866	56.97055817	-2.177607059	1	1	0	0	1	1
7	2003	Carrick Castle	NS193945	56.10902786	-4.907526016	1	1	0	0	0	0
7	2003	Coulport	NS212868	56.04064941	-4.871872425	0	0	0	0	0	0
7	2003	Cove	NS219828	56.00501633	-4.857992649	1	1	1	1	0	0
7	2003	Ballywalter (South)	J642677	54.53093847	-5.463123676	0	0	1	0	0	0
7	2003	Portaferry	J576523	54.39479752	-5.573186653	0	0	0	0	0	0
8	2003	Black Head	M154122	53.15369101	-9.264753076	0	0	0	0	0	0
8	2003	Great Orme	SH749834	53.33267212	-3.880113125	0	0	0	0	0	0
8	2003	Cangregga	R009877	52.93115822	-9.473926292	0	0	0	0	0	0
8	2003	Furreera	R039880	52.93439753	-9.429411107	0	0	0	0	0	0
8	2003	Penmon North	SH641813	53.31114578	-4.04129076	1	1	1	1	0	0
8	2003	Porth Swtan	SH298891	53.37127304	-4.559817791	0	0	0	0	0	0
8	2003	Aberdaron	SH166260	52.80027771	-4.721978188	0	0	1	0	0	0
8	2003	Abersoch	SH323266	52.81078339	-4.489646435	0	0	0	0	0	0
8	2003	Castle Point	Q834575	52.65645315	-9.72333193	0	0	0	0	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
8	2003	Doonbeg	Q965670	52.74442725	-9.532782338	0	0	0	0	0	0
8	2003	Menai Straits	SH548717	53.22244644	-4.176388741	1	1	1	0	0	0
8	2003	Porth Oer	SH165298	52.83436584	-4.725593567	0	0	0	0	0	0
8	2003	Llanbedrog	SH335311	52.85156631	-4.474157333	0	0	0	0	0	0
8	2003	Moneen Loop Head	Q730498	52.58497937	-9.874000454	0	0	0	0	0	0
8	2003	Porth Neigwl	SH288245	52.79081726	-4.540422916	0	0	0	0	0	0
8	2003	Criccieth	SH494376	52.91463852	-4.241235733	1	0	0	0	0	0
8	2003	Laxey	SC444835	54.22353363	-4.388279438	1	1	0	0	0	0
8	2003	Port St. Mary	SC211669	54.06689835	-4.735411644	0	0	0	0	0	0
8	2003	Broadhaven	SM859144	51.78714752	-5.105734348	1	0	0	0	0	0
8	2003	Culdaff nr Dunmore Hd	C553500	55.29380363	-7.129388641	0	0	0	0	0	0
8	2003	West Angle Bay	SM848038	51.69155884	-5.115104675	0	0	0	0	0	0
8	2003	Fanad Head	C230479	55.27750532	-7.638053609	0	0	0	0	0	0
8	2003	Martin's Haven	SM759091	51.73565674	-5.247072697	0	0	0	0	0	0
8	2003	Swanage	SZ040786	50.60703659	-1.944850922	1	1	1	0	0	0
8	2003	Bloody Foreland N+S	B809338	55.15100875	-8.299620938	0	0	0	0	0	0
8	2003	North Haven	SM735093	51.73648071	-5.281891823	0	0	0	0	0	0
8	2003	Rinnalea Pt	B754210	55.03578001	-8.384791409	0	0	0	0	0	0
8	2003	Maghery-Termon	B713095	54.93225148	-8.447769965	0	0	0	0	0	0
8	2003	St. Johns Point	G700689	54.56743647	-8.463863657	0	0	0	0	0	0
9	2003	Cellar	SX531477	50.31082916	-4.064520359	0	0	0	0	0	0
9	2003	Duckpool	SS198111	50.87118149	-4.562522888	0	0	0	0	0	0
9	2003	Lynmouth	SS718501	51.23559189	-3.8377738	1	1	1	0	0	0
9	2003	Woolacombe	SS452446	51.17956543	-4.216143131	0	0	0	0	1	0
9	2003	Bangor	J497825	54.66828551	-5.679387966	0	0	0	0	0	0
9	2003	Donaghadee	J587807	54.64937784	-5.540987387	1	0	0	0	0	0
9	2003	Marconi's Cottage	D149419	55.21078615	-6.194767212	0	0	0	0	0	0
9	2003	Marconi's Cottage	D149419	55.21078615	-6.194767212	0	0	0	0	0	0
9	2003	Portrush	C854414	55.21227249	-6.658236319	0	0	0	0	0	0
9	2003	Portrush	C854414	55.21227249	-6.658236319	0	0	0	0	0	0
9	2003	Garron Point	D303238	55.04447049	-5.961273362	0	0	0	0	0	0
9	2003	Giant's Causeway	C947448	55.24111134	-6.511031427	0	0	0	0	0	0
9	2003	Larne	D403045	54.8684921	-5.814360072	0	0	0	0	0	0
9	2003	Portmuck	D459024	54.84804046	-5.728256607	0	0	0	0	0	0
9	2003	Ballywalter	J632688	54.54113454	-5.477947903	0	0	0	0	0	0
9	2003	Townhead	J661632	54.48993046	-5.436333056	0	0	0	0	0	0
9	2003	Ardglass	J562364	54.25249837	-5.603040799	0	0	0	0	0	0
9	2003	Ballyquintin Point	J624453	54.33045802	-5.503166202	0	0	0	0	0	0
9	2003	Kearney Point	J650517	54.38706957	-5.459691479	0	0	0	0	0	0
9	2003	Kilclief	J599458	54.33573503	-5.541295309	0	0	0	0	0	0
9	2003	Annalong	J378197	54.10783484	-5.892811197	0	0	0	0	0	0
9	2003	Annalong (AMP)	J375193	54.10432348	-5.897577047	0	0	0	0	0	0
9	2003	Rosstrevor	J170180	54.09771519	-6.211348228	0	0	0	0	0	0
9	2003	St. John's Point	J530336	54.22832808	-5.653527593	0	0	0	0	0	0
9	2003	St. John's Point	J530336	54.22832808	-5.653527593	0	0	0	0	0	0
10	2003	Cellar	SX531477	50.31082916	-4.064520359	0	0	0	0	0	0
11	2003	Bunowen Point	L592413	53.40306712	-10.11731061	0	0	0	0	0	0
11	2003	Mannin Bay Clifden	L643473	53.45827156	-10.0432556	0	0	0	0	0	0
11	2003	Cloghmore Achill Sound	L706936	53.87564171	-9.967740601	0	0	0	0	0	0
11	2003	Dooagh Achill Island	F601047	53.97258624	-10.13236914	0	0	0	0	0	0
11	2003	Termoncarragh	F644362	54.25657152	-10.08100066	0	0	0	0	0	0
11	2003	Easky east of quay	G380385	54.29143837	-8.952241079	0	0	0	0	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
2	2004	Churston	SX898573	50.40513611	-3.552138329	1	0	0	0	0	0
2	2004	Crackington Haven (North Headland)	SX138969	50.74171829	-4.640498638	1	0	1	1	0	0
2	2004	Bridlington Promenade	TA187666	54.08164978	-0.187025607	1	1	1	1	1	1
2	2004	Filey Brig (Exposed)	TA135814	54.21577072	-0.260901958	0	0	0	0	0	0
2	2004	Filey Brig (Sheltered)	TA133814	54.2158165	-0.263975054	1	1	0	0	0	0
2	2004	Flamborough North Landing	TA239721	54.12982941	-0.105326958	0	0	0	0	0	0
2	2004	Flamborough South Landing	TA232692	54.10394287	-0.117214933	1	1	1	1	1	1
2	2004	Scalby Mills	TA037907	54.30139923	-0.40790987	0	0	0	0	0	0
2	2004	Robin Hood's Bay	NZ954051	54.43239212	-0.530798793	1	0	1	1	0	0
2	2004	Saithes Cowbar	NZ784192	54.56198502	-0.789057314	1	1	1	1	1	1
2	2004	Whitby Pier (west outer wall)	NZ899117	54.49269485	-0.613558292	0	1	0	0	0	0
3	2004	Kimmeridge	SY904791	50.61146927	-2.137061596	1	0	0	0	0	0
3	2004	Portland Bill	SY677681	50.51172638	-2.45691824	0	0	0	0	0	0
3	2004	Ilfracombe	SS518479	51.21097183	-4.123141289	1	0	1	1	0	1
4	2004	Clashnessie	NC062315	58.22956467	-5.30227375	0	0	0	0	0	0
4	2004	Culkein	NC042335	58.24661255	-5.337953091	0	0	0	0	0	0
4	2004	East Quantoxhead	ST135445	51.19309616	-3.239279032	1	0	1	1	0	0
4	2004	Reiff	NB963143	58.07089996	-5.455533981	0	0	0	0	0	0
4	2004	Watchet	ST067437	51.18484116	-3.336359739	0	0	1	0	0	0
4	2004	Loch Eriboll	NC410553	58.45702362	-4.726861	0	0	0	0	0	0
4	2004	Portnancon	NC427602	58.50159836	-4.701123714	0	0	0	0	0	0
4	2004	Rispond	NC454653	58.54832077	-4.658321857	0	0	0	0	0	0
4	2004	Wembury	SX518481	50.31409454	-4.082922459	0	0	0	0	0	0
4	2004	Brixham	SX937568	50.40136719	-3.497128725	1	0	0	0	0	0
4	2004	Portskerra	NC870660	58.56739807	-3.944375753	1	0	1	0	0	0
4	2004	Skerray	NC660641	58.544384	-4.303966045	0	0	0	0	0	0
4	2004	Fresgoe (Sandside)	NC958660	58.56959534	-3.793178797	0	0	0	0	0	0
4	2004	Hartland Quay	SS221248	50.99497604	-4.536562443	0	0	0	0	0	0
4	2004	Lizard	SW700115	49.95920944	-5.208200932	1	1	1	0	0	0
4	2004	Murkle (West)	ND169698	58.60826492	-3.431937933	1	0	0	0	0	0
4	2004	Cape Cornwall	SW351320	50.12873459	-5.707966328	1	1	1	1	0	0
4	2004	Trevone	SW886760	50.54539871	-4.985251427	0	0	0	0	0	0
4	2004	Sennen Cove	SW347264	50.07829666	-5.709660053	0	0	0	0	0	0
4	2004	St. Ives	SW522411	50.21781158	-5.47510004	1	0	0	0	0	0
4	2004	Bude	SS199072	50.83618164	-4.559185028	0	0	0	0	0	0
4	2004	Lizard	SW700115	49.95920944	-5.208200932	1	1	1	0	0	0
4	2004	Porthleven	SW625254	50.08107758	-5.321190834	1	0	0	0	0	1
4	2004	Lyme Regis	SY345920	50.72385025	-2.929334641	0	0	0	0	1	0
4	2004	Prawle	SX776351	50.20315933	-3.716539621	0	0	0	0	0	0
4	2004	Polzeath	SW931798	50.58113098	-4.923931599	0	0	0	0	0	0
5	2004	Newford Island	SV904113	49.92146683	-6.314981461	0	0	0	0	0	0
5	2004	The Garrison	SV897098	49.90765381	-6.323498249	0	0	0	0	0	0
5	2004	Porth Hellick Point	SV928104	49.9146347	-6.280916214	0	0	0	0	0	0
5	2004	Porth Loggos	SV928102	49.91283798	-6.280765533	0	0	0	0	0	0
5	2004	Porth Minick	SV916099	49.90953064	-6.297195435	0	0	0	0	0	0
5	2004	Carsaig Bay	NR735881	56.03212738	-5.637143612	0	1	0	0	0	0
5	2004	Carsaig Bay	NR735880	56.03123474	-5.637065411	0	0	0	0	0	0
5	2004	Darrity's Hole	SV931114	49.92375183	-6.277544975	0	0	0	0	0	0
5	2004	Dunaverty Bay	NR681078	55.30951691	-5.655781269	0	0	0	0	0	0
5	2004	Dunaverty Bay	NR680077	55.30857086	-5.657269478	0	0	0	0	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
		(MTB)									
5	2004	Innisgden	SV922129	49.93674088	-6.291241646	0	0	0	0	0	0
5	2004	Linnhe Mhuirich	NR724835	55.99036026	-5.650865555	0	0	0	0	0	0
5	2004	Linnhe Mhuirich	NR724835	55.99036026	-5.650865555	1	0	1	1	0	0
5	2004	Carn Near	SV890133	49.93867493	-6.33603096	0	0	0	0	0	0
5	2004	Horse Rock	SV875163	49.96479416	-6.359304905	0	0	0	0	0	0
5	2004	Shipman-Great Mussel	SV874162	49.9638443	-6.360613346	0	0	0	0	0	0
5	2004	Clachan Sound	NM784196	56.31689072	-5.584939003	1	1	0	0	0	0
5	2004	Newquay (SJH)	SW800628	50.42368698	-5.09868145	0	0	0	0	0	0
5	2004	St. Martin's Head	SV942162	49.96736526	-6.266079426	0	0	0	0	0	0
5	2004	Carn Thomas	SV905108	49.91703033	-6.31319046	0	0	0	0	0	0
5	2004	Penninis Head	SV913094	49.90489197	-6.300952911	0	0	0	0	0	0
5	2004	Wembury	SX518481	50.31409454	-4.082922459	0	0	0	0	0	0
5	2004	St. Ives	SW522411	50.21781158	-5.47510004	1	0	0	0	0	0
5	2004	Portland (CafΘ)	SY677682	50.51262665	-2.456936121	0	0	0	0	0	0
5	2004	Portland (Pulpit)	SY675682	50.51261902	-2.459761143	0	0	0	0	0	0
5	2004	West Looe	SX252519	50.34095001	-4.457967281	1	0	0	0	0	0
5	2004	Looe	SX257525	50.34649277	-4.451217175	0	0	0	0	0	0
5	2004	Criccieth	SH494376	52.91463852	-4.241235733	1	0	0	0	0	0
5	2004	Criccieth (East)	SH506380	52.91856766	-4.223588467	1	1	1	1	1	0
5	2004	Pwllheli	SH381349	52.88710403	-4.407803059	0	0	0	0	0	0
6	2004	Porth Neigwl	SH288245	52.79081726	-4.540422916	0	0	0	0	0	0
6	2004	Stoke Point	SX559458	50.29444122	-4.024499893	0	0	0	0	0	0
6	2004	Porthleven	SW625254	50.08107758	-5.321190834	1	0	0	0	0	1
6	2004	Swanage	SZ040786	50.60703659	-1.944850922	1	1	1	0	0	0
6	2004	Mealabost Bhuirgh	NB407575	58.42873383	-6.44363308	1	0	0	0	0	0
6	2004	Port nan Giuran	NB556372	58.25548553	-6.167695999	0	0	0	0	0	0
6	2004	Port Nis (MTB)	NB538634	58.48915863	-6.226290226	0	0	0	0	0	0
6	2004	Tiumpan Head (MTB)	NB574373	58.25737381	-6.137199402	0	0	0	0	0	0
7	2004	Mealasta	NA990248	58.10952759	-7.11249876	1	0	0	0	0	0
7	2004	Miavaig Pier	NB091343	58.20128632	-6.953567982	1	1	0	0	0	0
7	2004	Mol Shanndabhaig	NB438315	58.19772339	-6.361906052	1	0	0	0	0	0
7	2004	Triasmol Bay	NB035335	58.19039917	-7.047450066	0	0	0	0	0	0
7	2004	Abhainn Suidhe	NB044082	57.96463394	-7.000367165	0	1	0	0	0	0
7	2004	Aird Adhanais	NG223945	57.85351563	-6.68285656	0	0	0	0	0	0
7	2004	Caolas an Scarp	NA988124	57.99846268	-7.099998474	0	1	0	0	1	0
7	2004	Freshwater Bay	SZ345855	50.66808319	-1.513198376	0	0	0	0	1	0
7	2004	Scalpay Village	NG217960	57.86656952	-6.694680691	1	1	1	0	0	0
7	2004	Yarmouth	SZ354898	50.70670319	-1.500044942	1	1	1	1	0	0
7	2004	Hogha Gearraigh	NF705713	57.61096191	-7.519972324	0	0	0	0	0	0
7	2004	Leac na Thobha North	NF975730	57.64507294	-7.072026253	1	0	0	0	0	0
7	2004	Loch Amhlasaraigh	NF955736	57.64909744	-7.10615778	0	0	0	0	0	0
7	2004	Rubha Port Scolpaig	NF699687	57.58728027	-7.52643919	1	1	0	0	0	0
7	2004	Totland	SZ324879	50.68978882	-1.542702079	0	1	0	0	0	0
7	2004	Ceann Traghad	NF757542	57.46180725	-7.410566807	1	1	0	0	0	0
7	2004	Cuinabunag	NF757523	57.4448204	-7.408049583	0	0	0	0	0	0
7	2004	Hanover Point	SZ378837	50.65169525	-1.466687918	0	0	0	0	0	0
7	2004	Port Pheadair	NF855456	57.39178085	-7.236886978	1	0	1	0	0	0
7	2004	Reagam	NF869445	57.38290405	-7.212281704	0	0	0	0	0	0
7	2004	Eilean Bholuim	NF831281	57.23357773	-7.254200935	0	0	0	0	0	0
7	2004	Rubha Aird Mhicheil	NF730334	57.27387619	-7.427762032	0	0	0	0	0	0
7	2004	Rubha Aird na Machrach	NF737457	57.38436508	-7.432451725	0	0	0	0	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
7	2004	Sruthan Beag outer	NF805273	57.22461319	-7.296066284	1	0	0	0	0	0
7	2004	Acarsaid	NF789098	57.0669632	-7.299961567	0	0	0	0	0	0
7	2004	Sloc Caol	NF808119	57.08707428	-7.271421909	0	0	0	0	0	0
7	2004	Smeircleit	NF737152	57.11161423	-7.392360687	0	1	0	0	0	0
7	2004	Trolaisgeir	NF721274	57.21957397	-7.434681416	1	0	0	0	0	0
7	2004	Castlebay	NL663982	56.9542923	-7.491443157	0	0	0	0	0	0
7	2004	Gob Bhuirgh	NF643018	56.98503494	-7.528961658	0	0	0	0	0	0
7	2004	Leinis	NL704987	56.96169662	-7.42498064	0	0	0	0	0	0
7	2004	Vatersay Causeway West	NL636975	56.94607925	-7.534691334	0	0	0	0	0	0
7	2004	Trebarwith Strand	SX046864	50.64438248	-4.765173912	0	1	1	0	0	0
7	2004	Woolacombe	SS452446	51.17956543	-4.216143131	0	0	0	0	1	0
8	2004	Port Gaverne	SX001811	50.59524918	-4.825892448	1	0	0	0	0	0
8	2004	Banks	HY252287	59.13860703	-3.308958769	0	0	0	0	0	0
8	2004	Bight of Lotheran	HY773432	59.27479935	-2.400008678	0	0	0	0	0	0
8	2004	Bow Head	HY452526	59.35625458	-2.965536594	0	0	0	0	0	0
8	2004	Chapel Porth	SW696497	50.30207062	-5.236848831	0	0	0	0	0	0
8	2004	Chapel Porth	SW696497	50.30207062	-5.236848831	0	0	0	0	0	0
8	2004	Chapel Porth (North)	SW696505	50.30925369	-5.237329006	1	0	0	0	0	0
8	2004	Bay of Skaill	HY229197	59.05739212	-3.345966816	0	0	0	0	0	0
8	2004	Bu of Cairston	HY274092	58.96390915	-3.264075518	1	1	0	0	0	0
8	2004	Churchill Barrier No. 3	ND472986	58.87163544	-2.917317867	1	0	1	0	0	0
8	2004	Gill Pier	HY447490	59.32387543	-2.973403692	0	0	0	0	0	0
8	2004	Harlyn Bay	SW879758	50.54334641	-4.995007515	1	1	0	0	0	0
8	2004	Kettletoft	HY658382	59.22912979	-2.600968838	0	0	0	0	0	0
8	2004	Perranporth	SW476298	50.1144371	-5.531968117	0	0	0	0	0	0
8	2004	Kirbist	HY423435	59.27416229	-3.014104128	0	0	0	0	0	0
8	2004	Kirk Geo	ND488934	58.82513428	-2.88838315	1	1	0	0	0	0
8	2004	Longhope	ND300908	58.79913712	-3.213086843	0	0	0	0	0	0
8	2004	Muckle Head	HY212052	58.92689896	-3.37041831	0	0	0	0	0	0
8	2004	Muckle Kiln	HY650450	59.29012299	-2.616099119	0	0	0	0	0	0
8	2004	Noust of Ayre	HY652412	59.25601959	-2.611968517	0	0	0	0	0	0
8	2004	Portreath	SW654456	50.2635994	-5.293179989	0	1	0	0	0	0
8	2004	Quoyness	HY252027	58.90517807	-3.300119162	0	0	0	0	0	0
8	2004	Scarva Taing	HY363141	59.00933075	-3.11077857	1	1	0	0	0	0
8	2004	Snelsetter	ND322885	58.77883148	-3.174316406	1	0	0	0	0	0
8	2004	Tuquoy	HY454440	59.27906418	-2.959847212	0	0	0	0	0	0
8	2004	Boscastle	SX092916	50.69262314	-4.70288229	0	0	0	0	0	0
8	2004	North Haven	SM735093	51.73648071	-5.281891823	0	0	0	0	0	0
8	2004	Martin's Haven	SM759091	51.73565674	-5.247072697	0	0	0	0	0	0
8	2004	South Haven	SM733088	51.73191833	-5.284466267	0	0	0	0	0	0
8	2004	Baggy Point	SX531477	50.31082916	-4.064520359	0	0	0	0	0	0
9	2004	Port Issac	SX531477	50.31082916	-4.064520359	0	0	0	0	0	0
9	2004	Port Issac (Harbour)	SW996812	50.59597778	-4.832993984	0	0	0	0	0	0
9	2004	Duckpool	SS198111	50.87118149	-4.562522888	0	0	0	0	0	0
9	2004	Millock Haven	SS419405	51.14182663	-4.261508942	1	1	0	0	0	0
9	2004	Criccieth	SH494376	52.91463852	-4.241235733	1	0	0	0	0	0
9	2004	Criccieth (East)	SH506380	52.91856766	-4.223588467	1	1	1	1	1	0
9	2004	Little Ormes Head	SH812825	53.32603455	-3.785220385	0	0	0	0	0	0
9	2004	Rhos-on-Sea	SH843808	53.31144714	-3.73808217	1	1	1	1	1	0
9	2004	Aberffraw (Briach-Lwyd)	SH337674	53.17763519	-4.489887714	1	0	0	0	0	0
9	2004	Porth Neigwl	SH288245	52.79081726	-4.540422916	0	0	0	0	0	0
9	2004	Abersoch (North)	SH317280	52.82316208	-4.499254227	1	1	0	0	0	0

M	Year	Site	OS ref	LAT	LONG	20	30	50	100	200	400km
9	2004	Porth Oer	SH165298	52.83436584	-4.725593567	0	0	0	0	0	0
9	2004	Cellar	SX531477	50.31082916	-4.064520359	0	0	0	0	0	0
10	2004	Port. St. Mary	SC211669	54.06689835	-4.735411644	1	0	0	0	0	0
10	2004	West Angle Bay (CCW)	SM852031	51.68542862	-5.108893871	1	0	0	0	0	0
10	2004	Broadhaven (North)	SM858141	51.7844162	-5.107003689	0	0	0	0	0	0
10	2004	Cellar	SX531477	50.31082916	-4.064520359	0	0	0	0	0	0

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