European Shag *Phalacrocorax aristotelis*

Summary

European Shag is projected to increase considerably in population size in the INTERREG VA area from 1998-2002 to 2050 under climate change. Overall, European Shag is projected (with poor confidence) to have moderate vulnerability under climate change in the INTERREG VA area.

Table 1. Current (observed) and future (projected) European Shag population size (breeding pairs) in GB & Ireland, INTERREG VA area and MarPAMM management areas.

Area	1998-2002	Projection for 2050	
GB & Ireland	32202	44600	↑+39%
INTERREG VA area	9511	14422	↑+52%
Argyll	2800	3570	↑+27%
Co. Down – Co. Louth	20	21	↑+5%
N Coast Ireland – N Channel	906	1425	↑+57%
Outer Hebrides	2661	3734	↑+40%

Under climate change, European Shag **population size** is projected to **increase** considerably in the INTERREG VA area between 1998-2002 and 2050, at a higher rate than across Britain and Ireland as a whole (Table 1, Fig. 2a).

European Shag abundance trend is projected to vary considerably across the INTERREG VA area, with no clear spatial pattern (Fig. 2a). It is unlikely that new sites will become more suitable for shag under climate change (Fig. 2b); therefore this projected increase in abundance at existing sites is unlikely to be supplemented by additional colonisation of new sites.

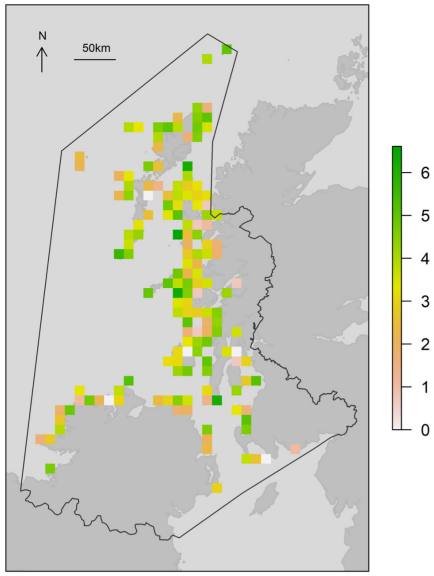

Figure 1. Observed European Shag abundance (log breeding pairs), 1998-2002. Black polygon = INTERREG VA area.

This work was produced as part of the Marine Protected Area Management and Monitoring (MarPAMM) project. MarPAMM has been supported by the European Union's INTERREG VA Programme, managed by the Special EU Programmes Body.

Projected change in breeding pairs

Projected change in presence probability

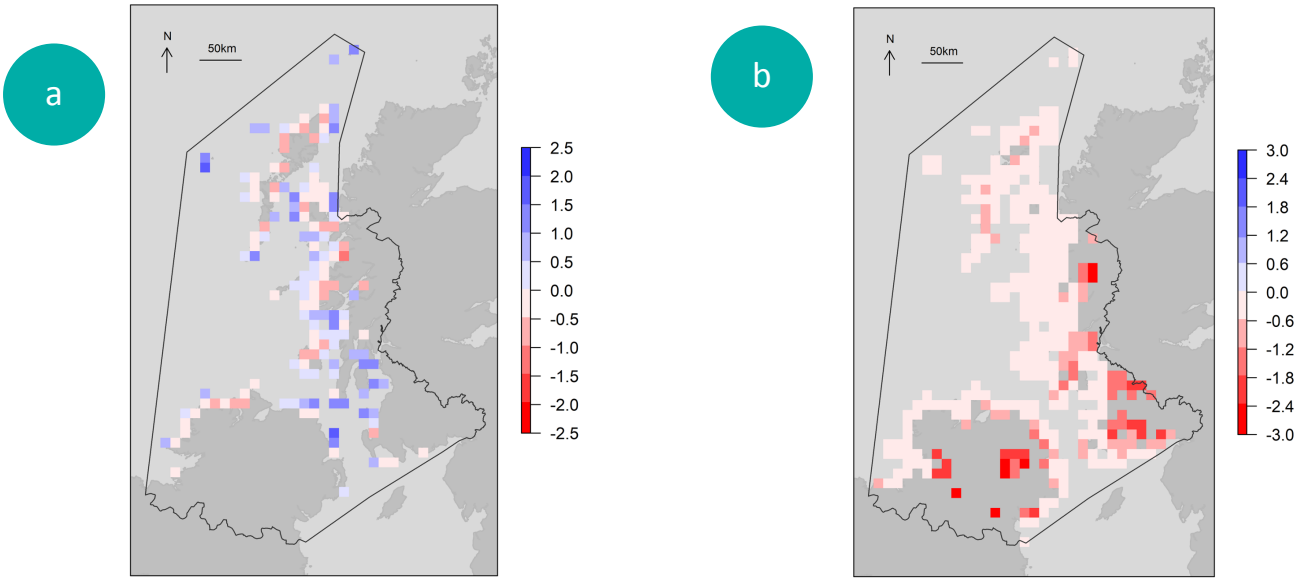

Figure 2. Projected change (1998-2002 to 2050; log proportional change) in: a) European Shag breeding pairs, for all cells where European Shag was present in 1998-2002; (b) European Shag presence probability for all squares where any seabird was censused in 1985-1988 or 1998-2002. White/blue = increase, red = decrease. Black polygon = INTERREG VA area.

Model predictive power was good for the presence/absence component of the model, but poor for the abundance component*. European Shag presence/absence and abundance had significant relationships with terrestrial climate, oceanographic and nuisance variables (Table 2).

Table 2. Effect on presence and abundance for significant variables in model*. Variables included in table if significant in at least one model component; field left blank if variable not significant in that model component. Variables shown in parentheses represent quadratic terms. Projections made using full model (i.e. not just significant variables).

Variable	Presence	Abundance
Breeding season maximum temperature	-	-
Winter minimum temperature	+	
Breeding season precipitation	-	
Winter precipitation	+	
(Winter precipitation)^2	+	
Breeding season potential energy anomaly		-
Winter potential energy anomaly		+
Breeding season sea surface temperature	+	
(Winter sea surface temperature)^2	-	+
Bathymetry	-	
Coast length	+	+
Distance inside coast	-	
Small islands area		+

Table 3. Projected change for European Shag at the ten sites with the most breeding pairs in 1998-2002. Sites are as defined in Seabird 2000 census. Superscript denotes MarPAMM management region, where applicable: [A], Argyll; [B], Co. Down - Co. Louth; [C], North Coast Ireland - North Channel; [D], Outer Hebrides.

Site	Breeding pairs, 1998-2002 (count)	Projected breeding pairs, 2050 (median & 95% CI*)	Projected % change in breeding pairs (median & 95% CI*)
Isle of Canna	740	1237 (127, 8113)	+67.2 (-82.8, +996.3)
Treshnish Isles[A]	601	851 (132, 3485)	+41.5 (-78.1, +479.9)
Shiant Islands[D]	506	560 (153, 1589)	+10.6 (-69.7, +214.1)
Sanda Island, Sheep Island and Glunimore Island	500	1651 (193, 8041)	+230.1 (-61.4, +1508.2)
Butt of Lewis to Gress – Lewis[D]	475	711 (126, 2807)	+49.6 (-73.5, +491)
Skye	392	468 (64, 2464)	+19.3 (-83.7, +528.6)
Mull[A]	328	284 (52, 1428)	-13.5 (-84.2, +335.4)
Coll[A]	273	328 (52, 1435)	+20.2 (-80.9, +425.5)
Gigha[A]	260	439 (57, 1993)	+68.9 (-78.2, +666.7)
Starling Knowe to Downan Point	251	198 (54, 612)	-21.2 (-78.3, +143.9)

* See main report for details of modelling, variables, categories of model predictive power and derivation of confidence intervals for projections.

Climate Change Mechanisms

The review of climate change mechanisms affecting seabirds (Johnston et al. 2021) identified a wide range of indirect and direct effects of climatic variation on European Shag demography, operating through food supply and adverse weather. European Shag's diet composition varies with SST, perhaps underlying negative relationships between European shag abundance or productivity and SST. Chick mortality, juvenile and adult survival and productivity are also negatively related to precipitation and wind. Breeding phenology is also related to the strength and direction of spring winds, and variably to SST and NAO.

Overall, climate change is projected (with **poor confidence**) to present European Shag with **high risk** and **medium opportunity** in the INTERREG VA area.

Citation: European Shag factsheet. From Davies, J.G., Humphreys, E.M. & Pearce-Higgins, J.W. 2021. Projected future vulnerability of seabirds within the INTERREG VA area to climate change. Report to Agri-Food and Biosciences Institute and Marine Scotland Science as part of the MarPAMM Project. BTO, Thetford

BTO
Looking out for birds

For more information on the MarPAMM project please visit the project website:

www.mpa-management.eu