Projected climate change and limited dispersal potential threaten the seahorse species *Hippocampus hippocampus* and *Hippocampus guttulatus*

Friederike Peiffer[1,2], Jorge Assis[3,4], André R. A. Lima[1], Sofia Henriques[2,5], Miguel A. Pardal[6], Filipe Martinho[6], Jorge M.S. Gonçalves[3], Emanuel J. Gonçalves[1], Miguel Correia[1,7,8], Gonçalo J. F. Silva[9,10]

[1] MARE – Marine and Environmental Sciences Centre / ARNET – Aquatic Research Network, ISPA – Instituto Universitário, Rua jardim do Tabaco 34, 1149-041 Lisbon, Portugal

[2] MARE – Marine and Environmental Sciences Centre / ARNET – Aquatic Research Network, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

[3] CCMAR—Centre of Marine Sciences, University of Algarve, Campus de Gambelas, 8005-139 Faro, Portugal

[4] Faculty of Bioscience and Aquaculture, Nord Universitet, Bodø, Norway

[5] IPMA – Instituto Português do Mar e da Atmosfera, Av. Dr. Alfredo Magalhães Ramalho 6, 1495-165 Algés, Portugal

[6] Centre for Functional Ecology – Science for People & the Planet (CFE), Associate Laboratory TERRA, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal

[7] Seahorse, Pipefish, and Seadragon Specialist Group, IUCN Species Survival Commission, Gland, Switzerland

[8] Project Seahorse, Institute for the Oceans and Fisheries, The University of British Columbia, Vancouver, British Columbia, Canada

[9] MARE - Marine and Environmental Sciences Centre, ARNET - Aquatic Research Network Associate Laboratory, NOVA School of Science and Technology, NOVA University Lisbon, Caparica, Portugal

[10] MARDIVE - Associação Ciência e Educação para a Conservação da Biodiversidade Marinha, MARE– Marine and Environmental Sciences Centre, Cascais, Portugal

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Email address of corresponding author: f.peiffer@alunos.fc.ul.pt

Supplementary Material:

Table 1: Databases for the collection of occurrence points

Name	Source
Ocean Biodiversity Information System (OBIS)	www.obis.org
Global Biodiversity Information Facility (GBIF)	www.gbif.org
Biodiversity4all, iNaturalist, iSeahorse *[1]	www.inaturalist.org; www.biodiversity4all.org
International Council for the Exploration of the Sea (ICES)	www.ices.dk/data/data-portals/Pages/DATRAS.aspx
Coastal Monitoring Network (COASTNET)	https://coastnet.pt/
Project: Inforbiomares	https://arrabidaparquemarinho.ualg.pt/en/
Project: CavALMar	Silva et al. 2023*[2]

*[1] Biodiversity4all, iNaturalist and iSeahorse have obscured coordinates by default; sightings could only be used in the model when the owner allowed access to the original coordinates.
*[2] Gonçalo Silva, Mariana Coxey & Miguel Correia, 2023. "CavALMar - Avaliação populacional das espécies de cavalos-marinhos na frente ribeirinha do concelho de Almada", Relatório técnico final, 82 pp., Almada, Portugal.

Table 2: Selected variables that were tested in different combinations in the Ensemble Species Distribution Model for both species.

Variables	Units	Original Resolution	Source
Distance to the nearest coast	km	0.01°	NASA*[1]
Bathymetry (min, mean, max)	m	0.05°	BIO ORACLE*[2]
Terrain ruggedness index	-	0.05°	BIO ORACLE*
Topographic slope	-	0.05°	BIO ORACLE*
Topographic aspect	-	0.05°	BIO ORACLE*
Topographic position index	-	0.05°	BIO ORACLE*
Temperature at minimum depth (min, mean, max)	°C	0.05°	BIO ORACLE*
Salinity at minimum depth (min, mean, max)	-	0.05°	BIO ORACLE*
Dissolved oxygen at minimum depth (min, mean, max)	mmol. m-3	0.05°	BIO ORACLE*
Chlorophyll at minimum depth (min, mean, max)	mmol. m-3	0.05°	BIO ORACLE*
Primary productivity at minimum depth (min, mean, max)	mmol. m-3	0.05°	BIO ORACLE*
Sea water velocity at minimum depth (min, mean, max)	m.s-1	0.05°	BIO ORACLE*
Nitrate	mmol. m-3	0.05°	BIO ORACLE*
Phosphate	mmol. m-3	0.05°	BIO ORACLE*
Silicate	mmol. m-3	0.05°	BIO ORACLE*
Iron	mmol. m-3	0.05°	BIO ORACLE*
pH	-	0.05°	BIO ORACLE*

*[1]https://oceancolor.gsfc.nasa.gov/docs/distfromcoast
*[2](Assis et al., 2024)

Table 3: Environmental predictors used in the final model set-up.

Variables	Units
Distance to the nearest coast	Km
Bathymetry (at minimum depth)	M
Temperature at minimum depth (mean)	°C
Salinity at minimum depth (mean)	-
Primary productivity at minimum depth (mean)	mol.m-3

Sea water velocity at the minimum depth (mean)	m/s
pH at minimum depth (mean)	-
Dissolved oxygen at minimum depth (mean)	mol.m-3

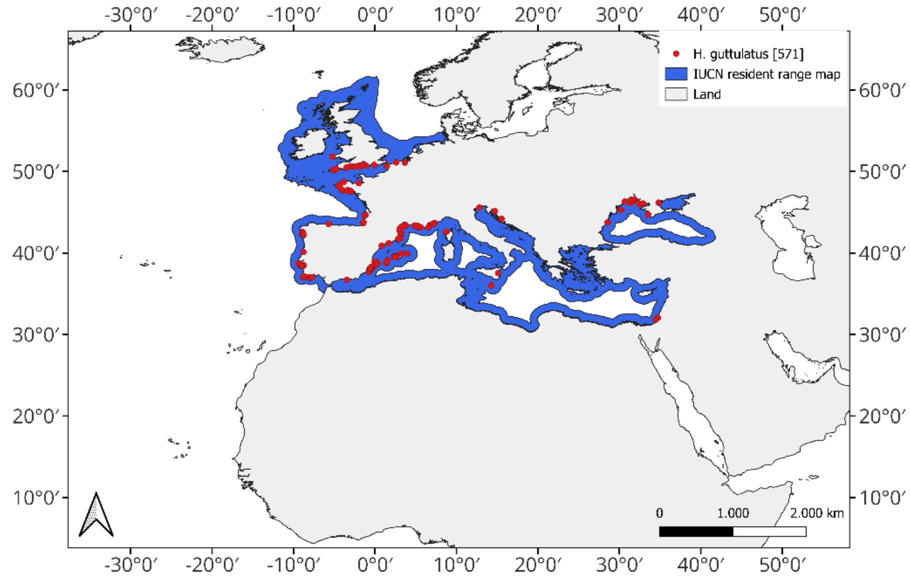

Fig. 1. Occurrence points of *H. guttulatus* from the years 2000-2022 used in the Ensemble Model as presence data and the IUCN resident range map as a polygon vector layer (Pollom, 2017)

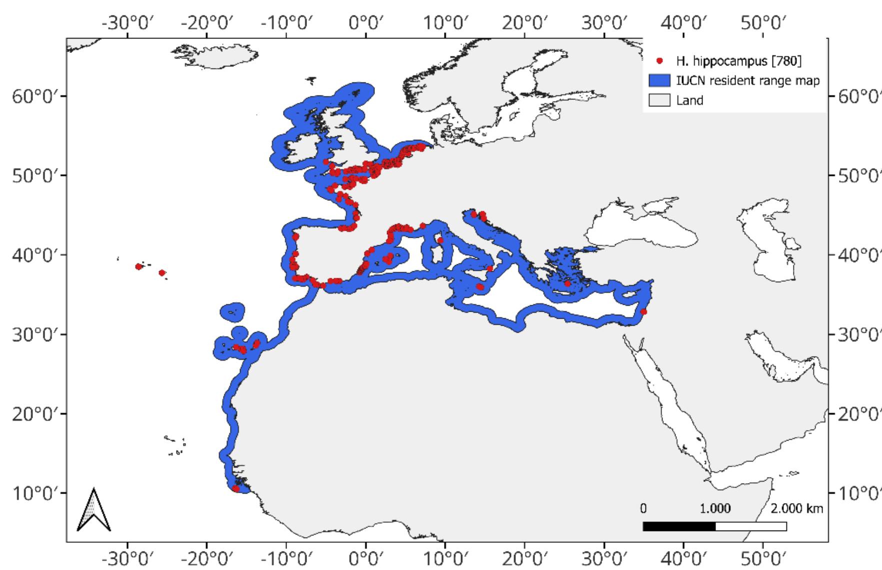

Fig. 2. Occurrence points of *H. hippocampus* from the years 2000-2022 used in the Ensemble Model as presence data and the IUCN resident range map as a polygon vector layer (Woodall, 2017)

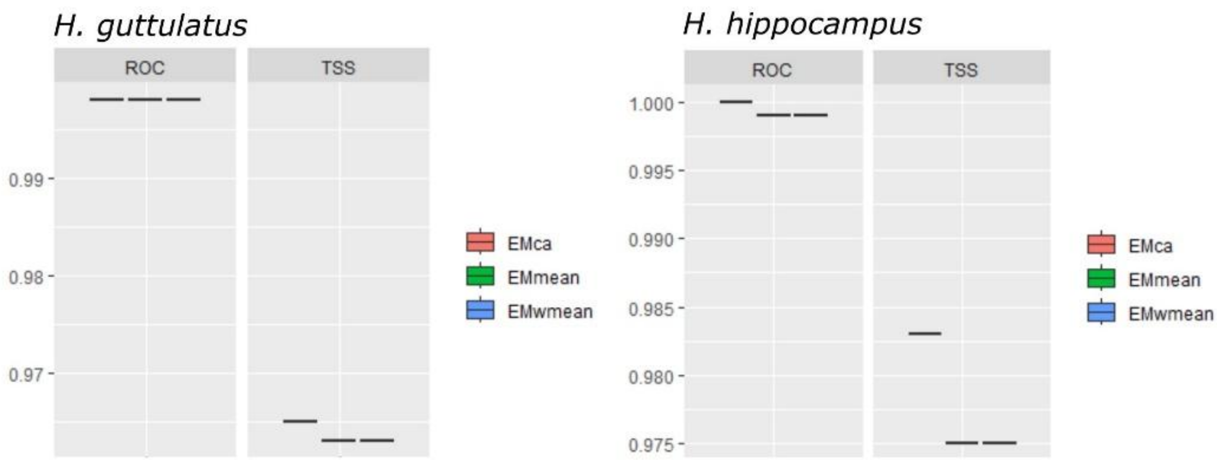

Fig. 3: Evaluation metrics of the Ensemble models for *Hippocampus guttulatus* and *H. hippocampus*. EMca = Ensemble model community average; EMmean= Ensemble model mean; Emwmean = Ensemble model weighted mean

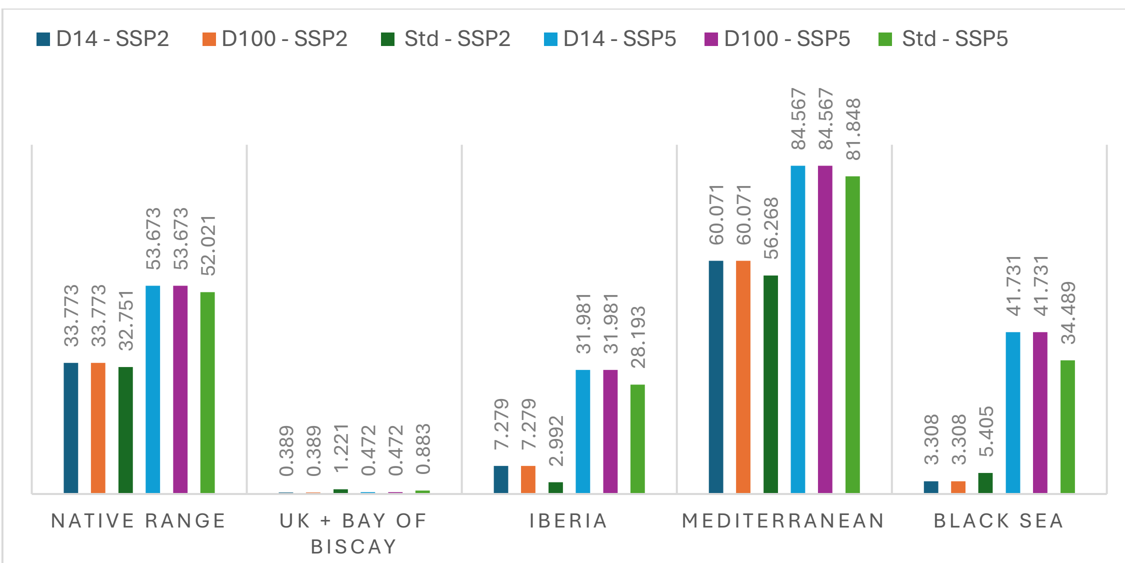

Fig. 4: Percentage of loss in suitable habitat for *H. guttulatus* calculated as the proportion of grid cells predicted as present in the present-day but absent in future projections, based on binary maps. The areas are divided by population units ("Native range", "UK + Bay of Biscay", "Iberia", "Mediterranean", "Black Sea") under two future climate scenarios (SSP2 and SSP5) for unlimited dispersal according to the standard model ("Std") and for restricted dispersal due to connectivity for 14 Days and 100 Days ("D14", "D100").

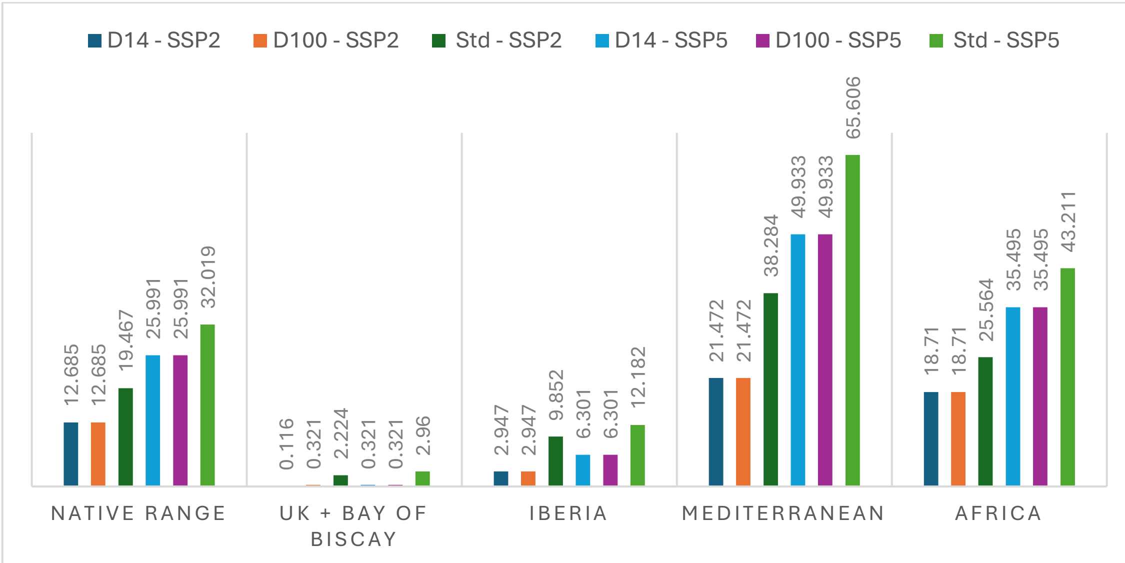

Fig. 5: Percentage of loss in suitable habitat for *H. hippocampus* calculated as the proportion of grid cells predicted as present in the present-day but absent in future projections, based on binary maps. The areas are divided by population units ("Native range", "UK + Bay of Biscay", "Iberia", "Mediterranean", "Black Sea") under two future climate scenarios (SSP2 and SSP5) for unlimited dispersal according to the standard model ("Std") and for restricted dispersal due to connectivity for 14 Days and 100 Days ("D14", "D100").

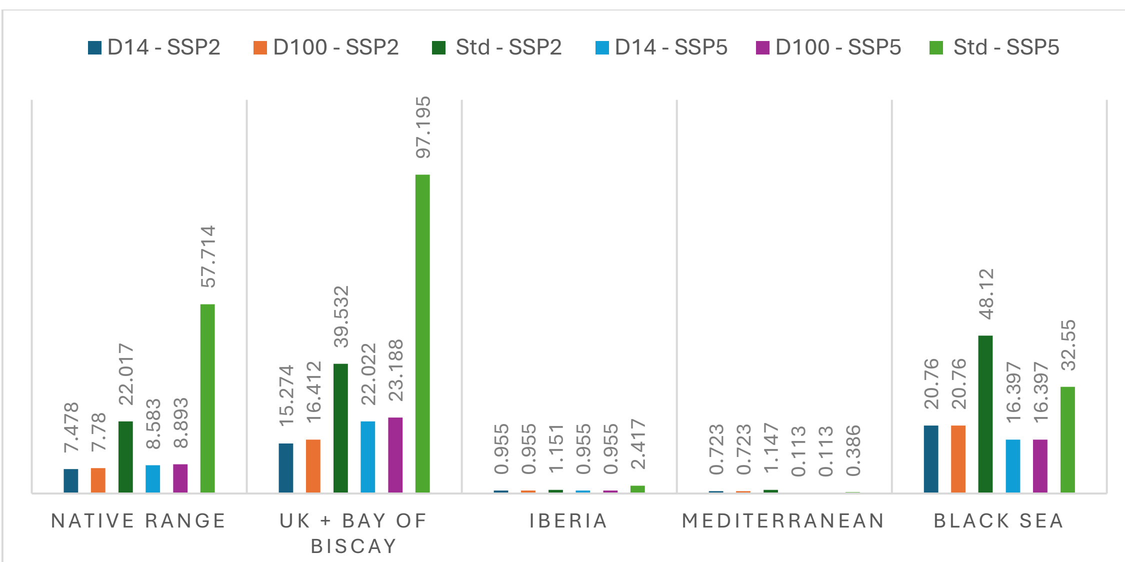

Fig. 6: Percentage of gain in suitable habitat for *H. guttulatus* calculated as the proportion of grid cells absent in the present but predicted as suitable in future projections, based on TSS-selected binary maps. The areas are divided by population units ("Native range", "UK + Bay of Biscay", "Iberia", "Mediterranean", "Black Sea") under two future climate scenarios (SSP2 and SSP5) for unlimited dispersal according to the standard model ("Std") and for restricted dispersal due to connectivity for 14 Days and 100 Days ("D14", "D100").

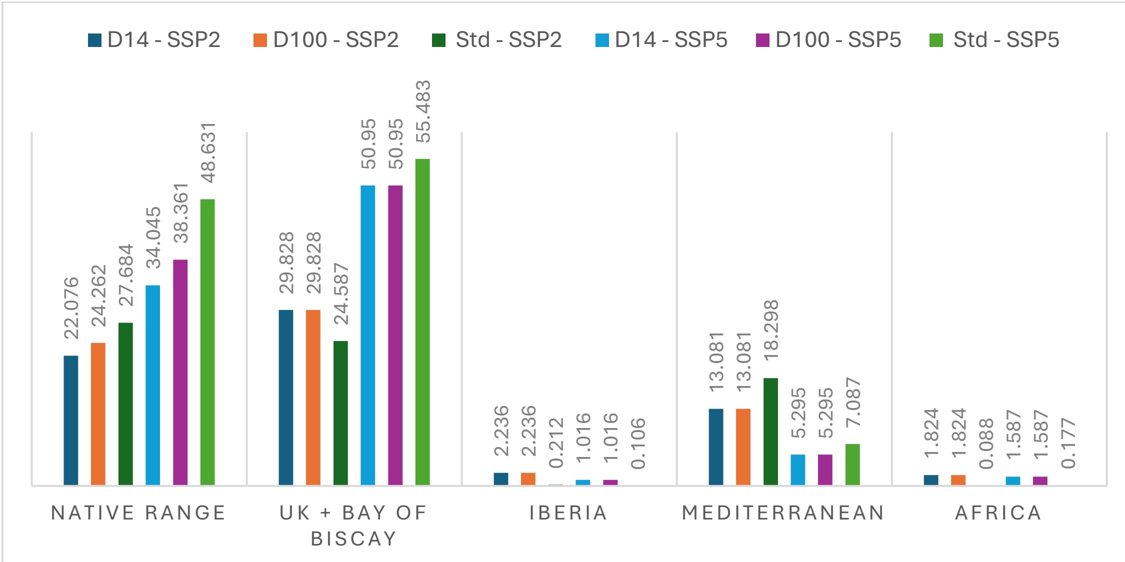

Fig. 7: Percentage of gain in suitable habitat for *H. hippocampus* calculated as the proportion of grid cells absent in the present but predicted as suitable in future projections, based on binary maps. The areas are divided by population units ("Native range", "UK + Bay of Biscay", "Iberia", "Mediterranean", "Black Sea") under two future climate scenarios (SSP2 and SSP5) for unlimited dispersal according to the standard model ("Std") and for restricted dispersal due to connectivity for 14 Days and 100 Days ("D14", "D100").

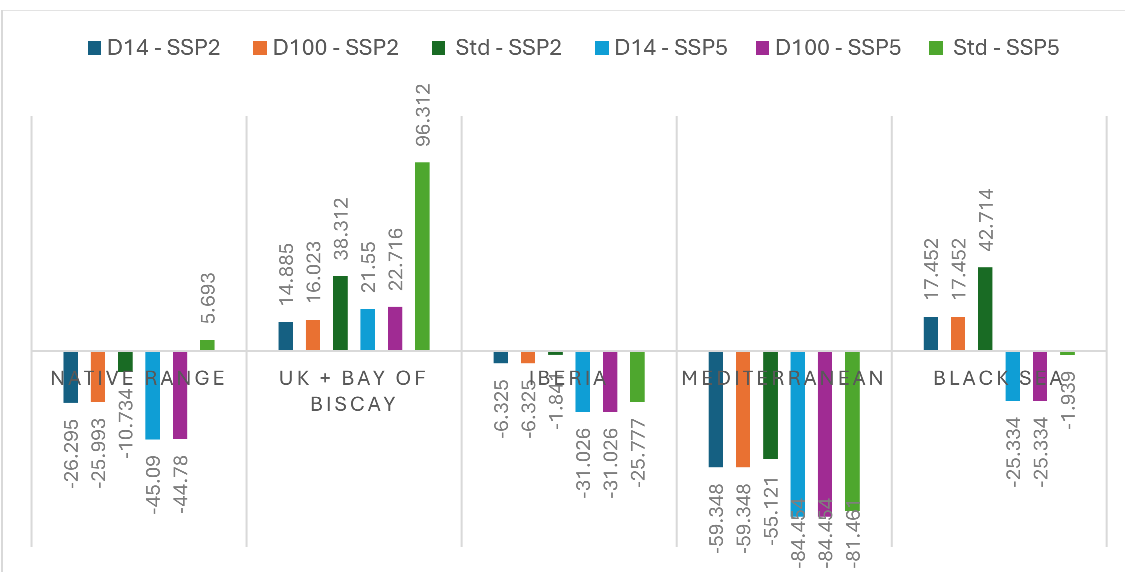

Fig. 8: Expansions (+%) and contractions (-%) in the distribution range of *H. guttulatus* expressed as overall change in suitable habitat area. The areas are divided by population units ("Native range", "UK + Bay of Biscay", "Iberia", "Mediterranean", "Black Sea") under two future climate scenarios (SSP2 and SSP5) for unlimited dispersal according to the standard model ("Std") and for restricted dispersal due to connectivity for 14 Days and 100 Days ("D14", "D100").

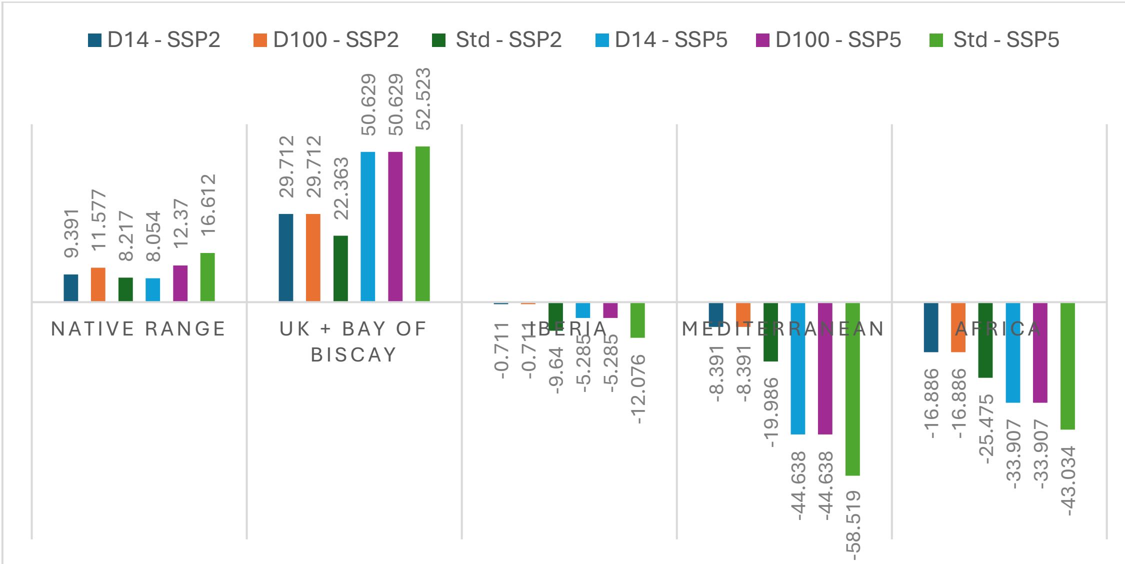

Fig. 9: Expansions (+%) and contractions (-%) in the distribution range of *H. hippocampus* expressed as overall change in suitable habitat area. The areas are divided by population units ("Native range", "UK + Bay of Biscay", "Iberia", "Mediterranean", "Black Sea") under two future climate scenarios (SSP2 and SSP5) for unlimited dispersal according to the standard model ("Std") and for restricted dispersal due to connectivity for 14 Days and 100 Days ("D14", "D100").