



Utilising cetacean species distribution data to identify hotspots in European Seas

Peter G.H. Evans and James J. Waggitt

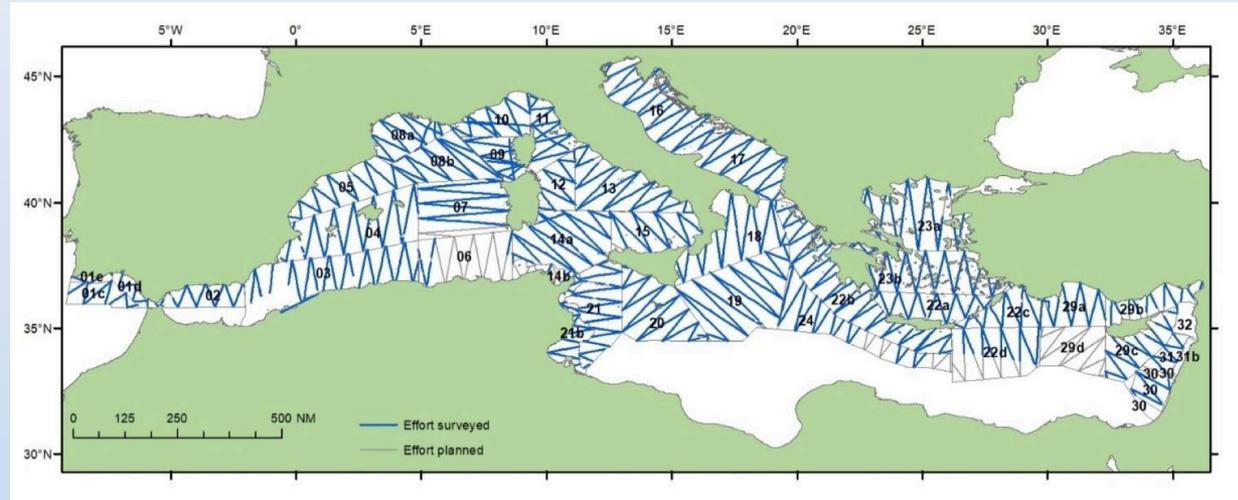
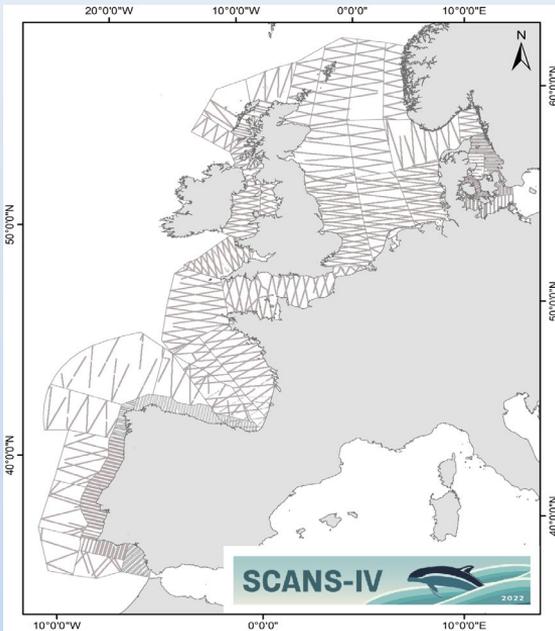
University of Bangor & Sea Watch Foundation



Marine Ecosystems Research Programme
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Project and Knowledge Exchange Office hosted by Plymouth Marine Laboratory
Funded by the Natural Environment Research Council and the Department for Environment, Food and Rural Affairs



Cetacean Large-scale Surveys

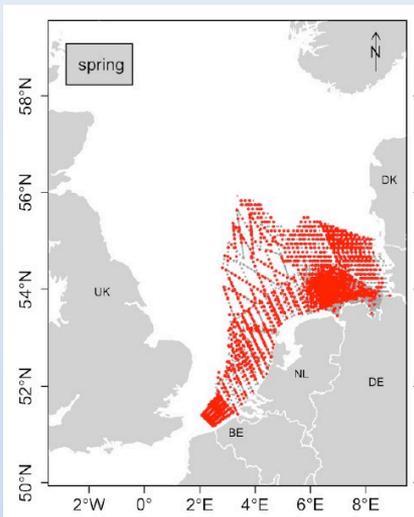


SCANS-IV, 2022

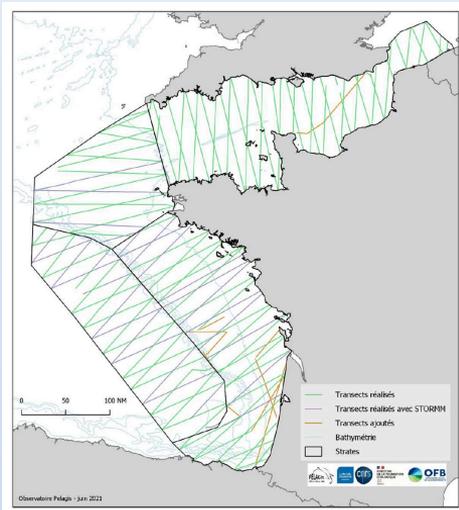
ACCOBAMS Survey Initiative, 2018-19



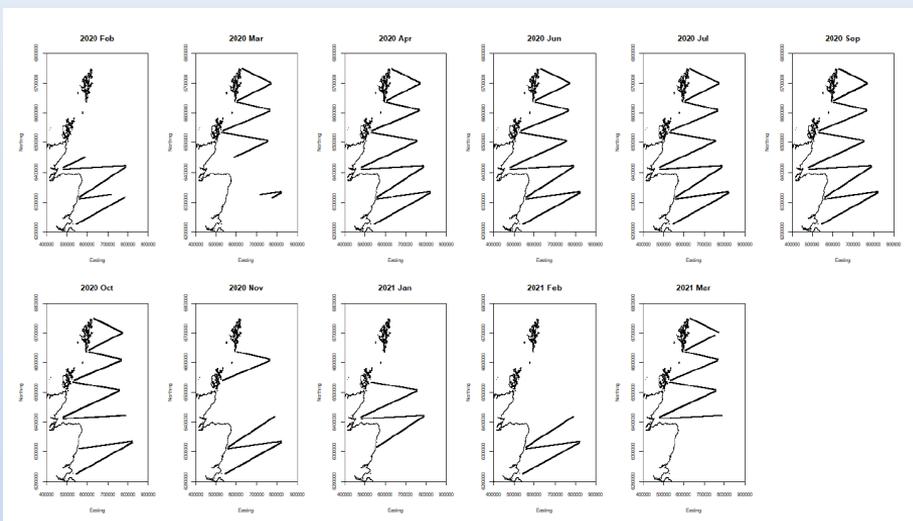
Cetacean Regional Surveys



Gilles *et al.* (2016)

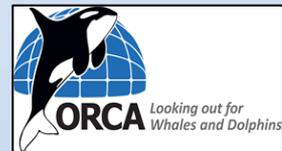
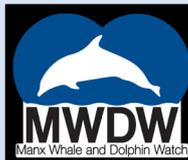


SAMM-2 (2022)



Paxton *et al.* (2022)

Thanks to the very many organisations contributing data



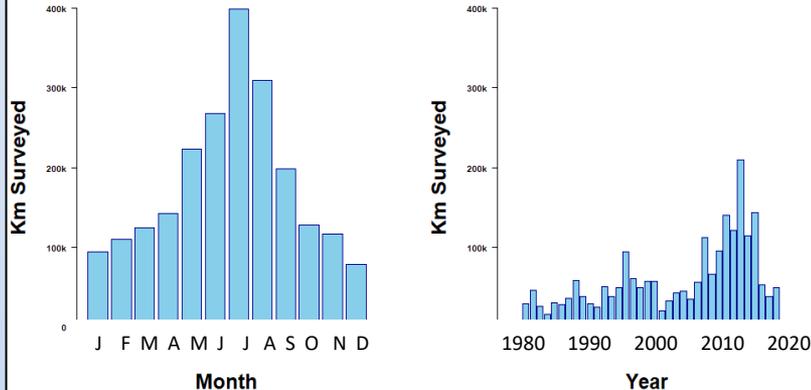
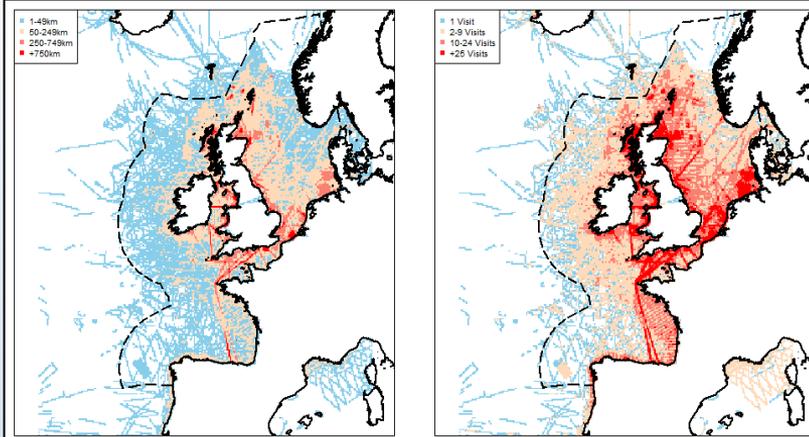


Marine Ecosystems
Research Programme

Summary of Work

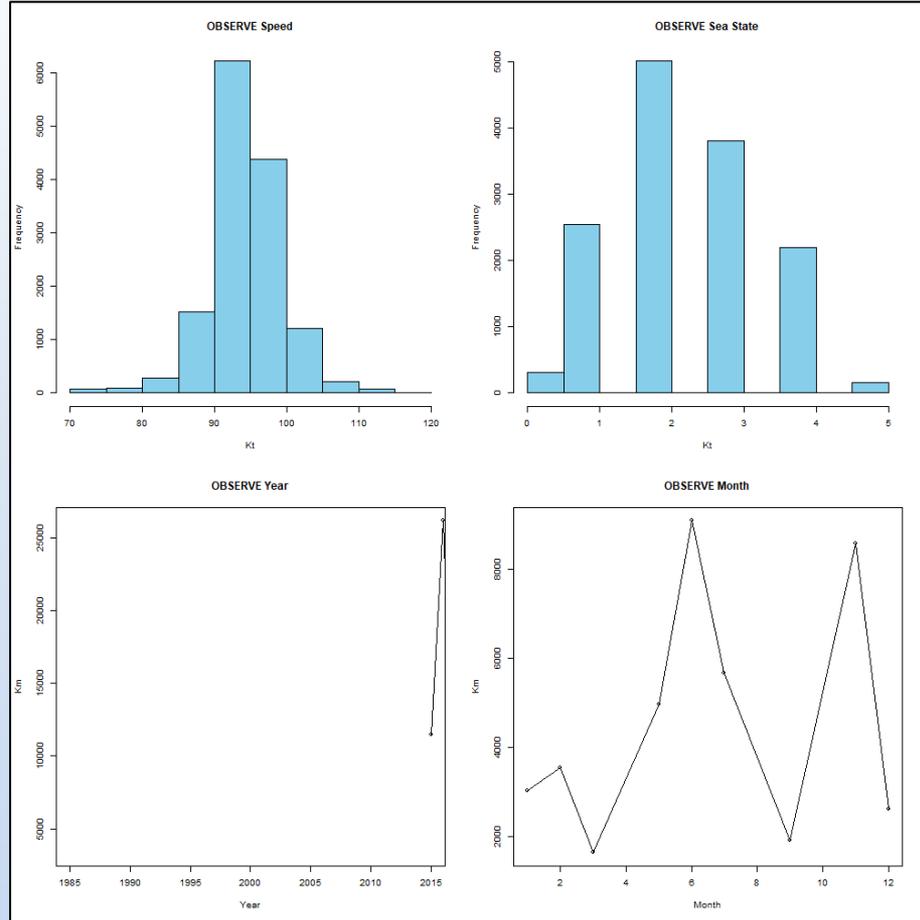
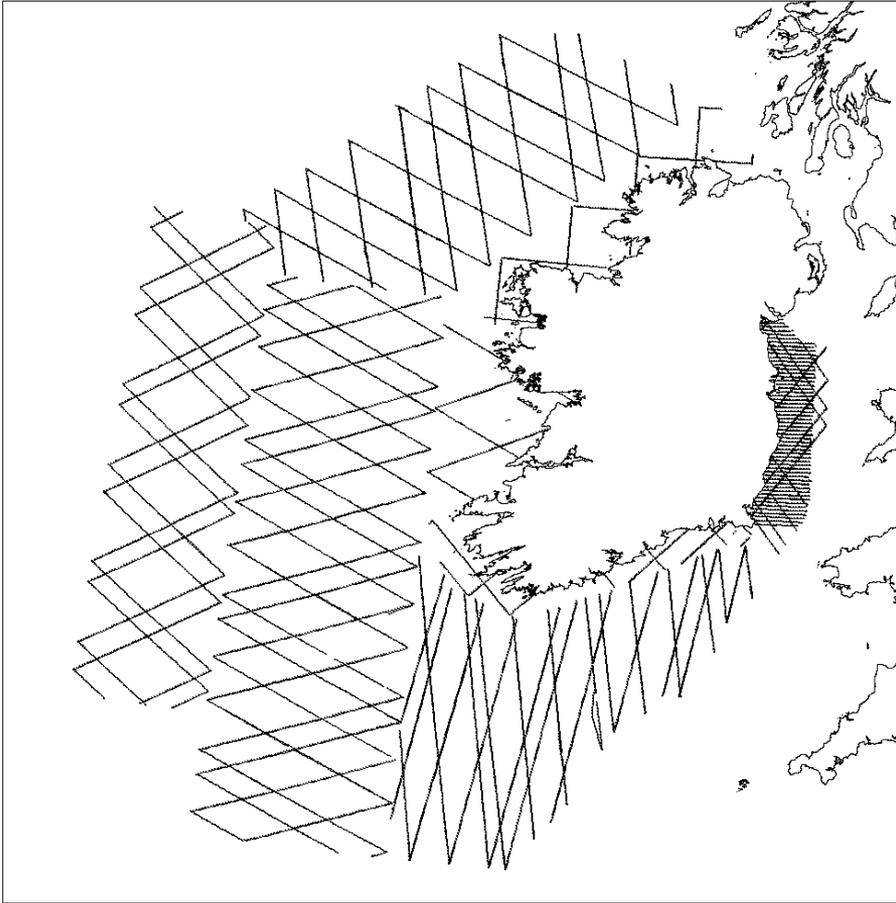
- Collation of dedicated seabird & cetacean surveys across NW European seas
- Standardisation across surveys by estimating effective strip width and $g(0)$
- Ecologically informed habitat modelling using environmental variables believed to influence distributions
- Density surface maps with abundance estimates at 2.5 & 10 km & monthly resolution for various time periods between 1980 and the present

Data Collation



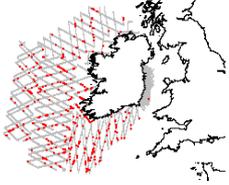
- 55 main data sources from 11 countries
- 3 million km of surveys
- Aerial, digital & vessel effort-based data from 1980 to the present
- Data used only where sufficient information exists on the survey protocols plus variables affecting detection rates
- Cleaned & processed into single spreadsheet

Data Processing

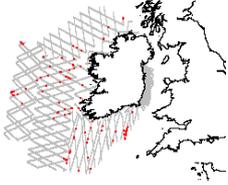


Data Processing

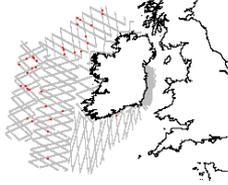
Bottlenose Dolphin



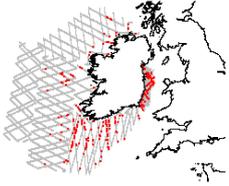
Common Dolphin



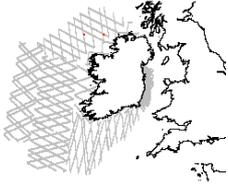
Fin Whale



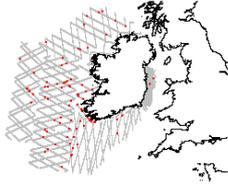
Harbour Porpoise



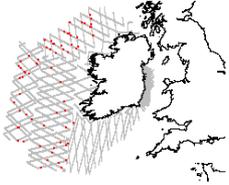
Killer Whale



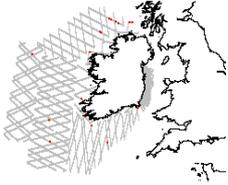
Minke Whale



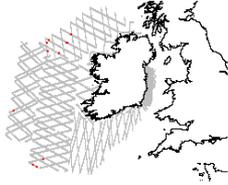
Long Finned Pilot Whale



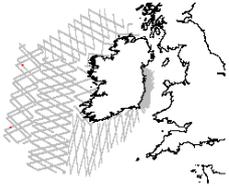
Risso's Dolphin



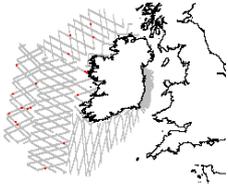
Sperm Whale



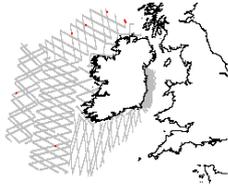
Striped Dolphin



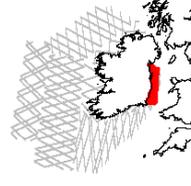
White Beaked Dolphin



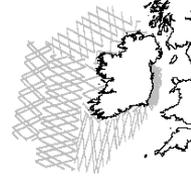
Atlantic White Sided Dolphin



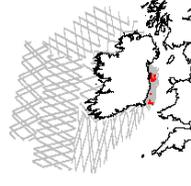
Large Auk Species



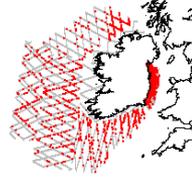
Large Gull Species



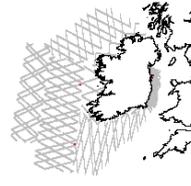
Atlantic Puffin



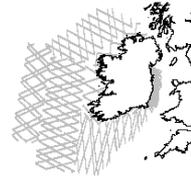
Black Legged Kittiwake



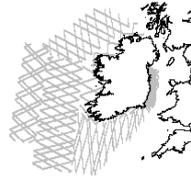
Common Guillemot



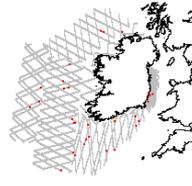
European Shag



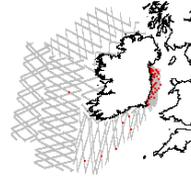
European Storm Petrel



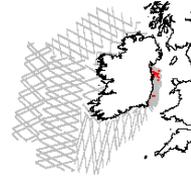
Great Skua



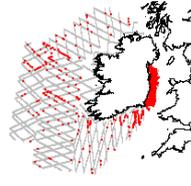
Herring Gull



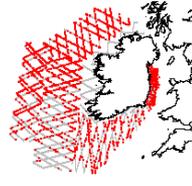
Lesser Black Backed Gull



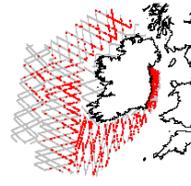
Manx Shearwater



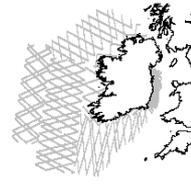
Northern Fulmar



Northern Gannet



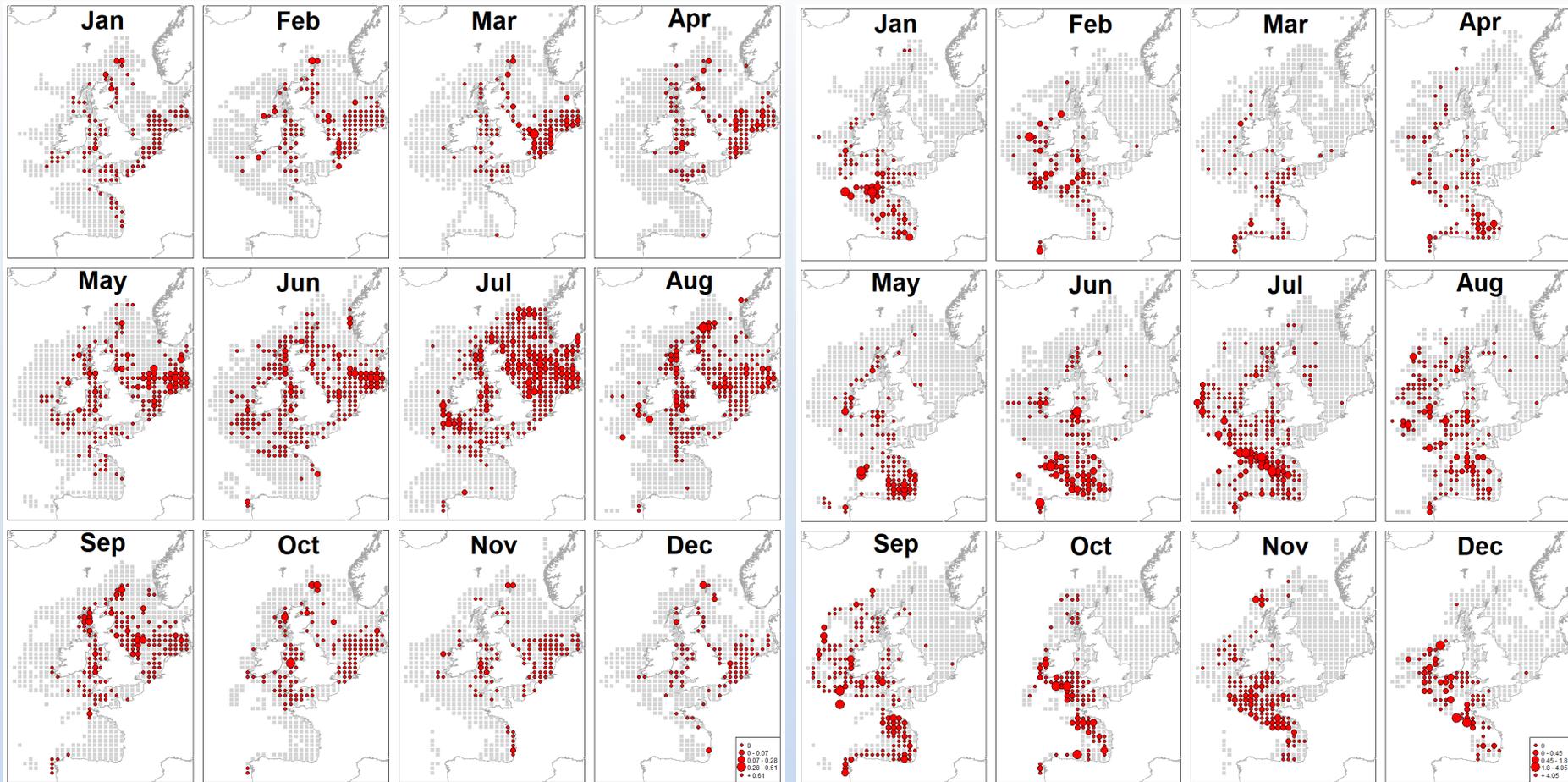
Razorbill



Harbour Porpoise

SAMPLE CETACEAN SPECIES

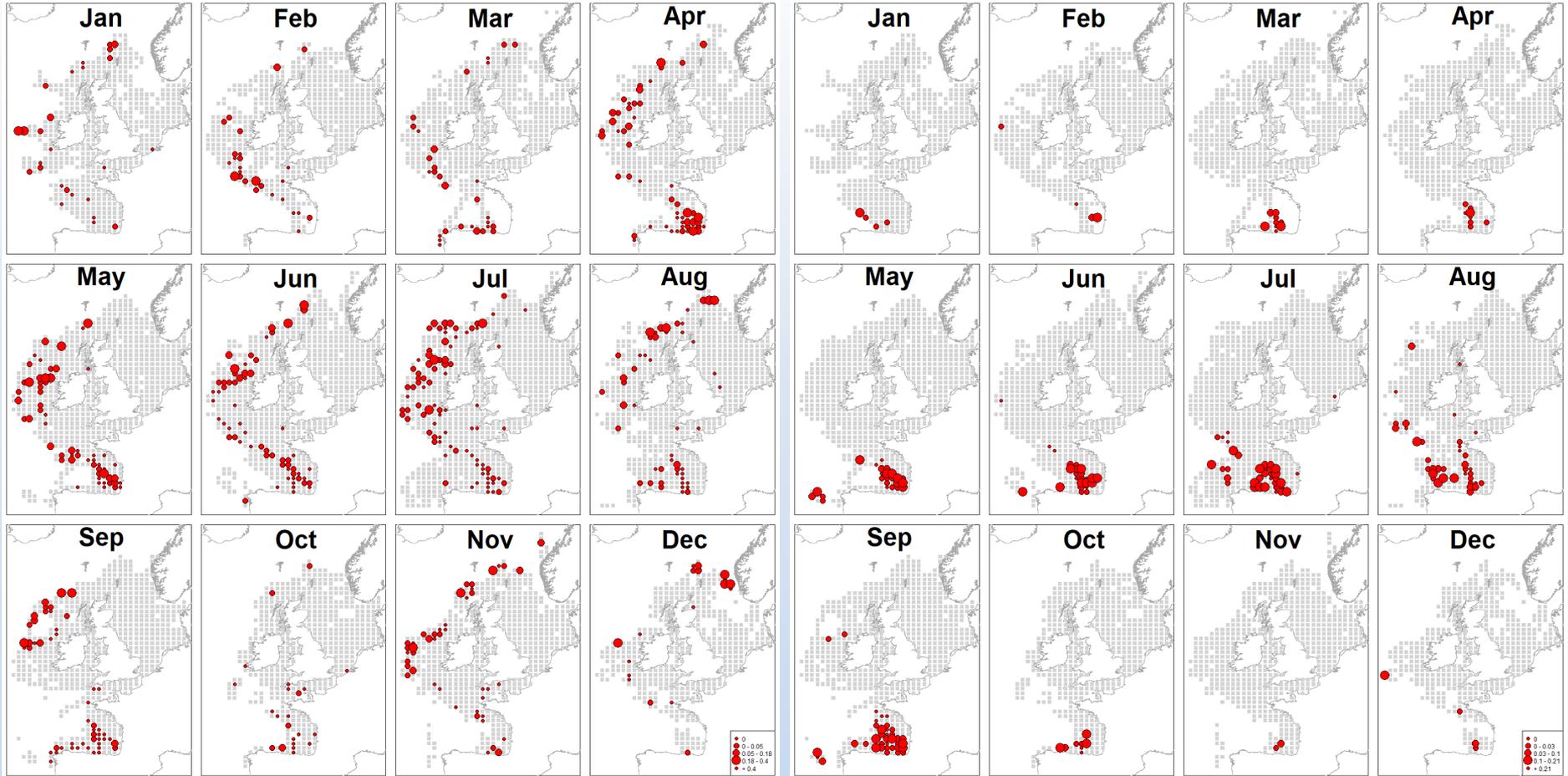
Common Dolphin



SAMPLE CETACEAN SPECIES

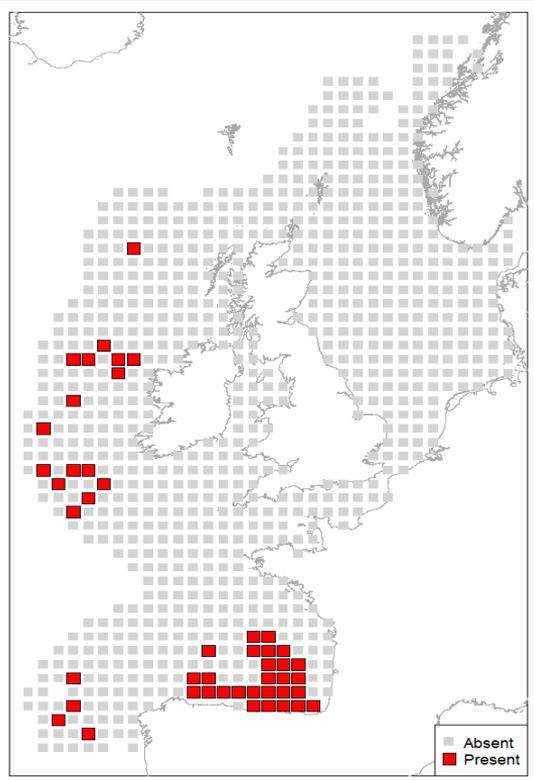
Long-finned Pilot Whale

Striped Dolphin

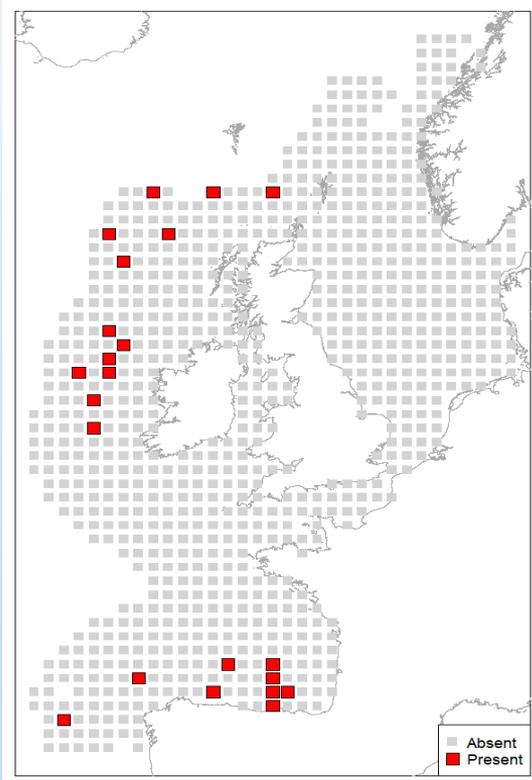


• maps produced for 25 cetacean species

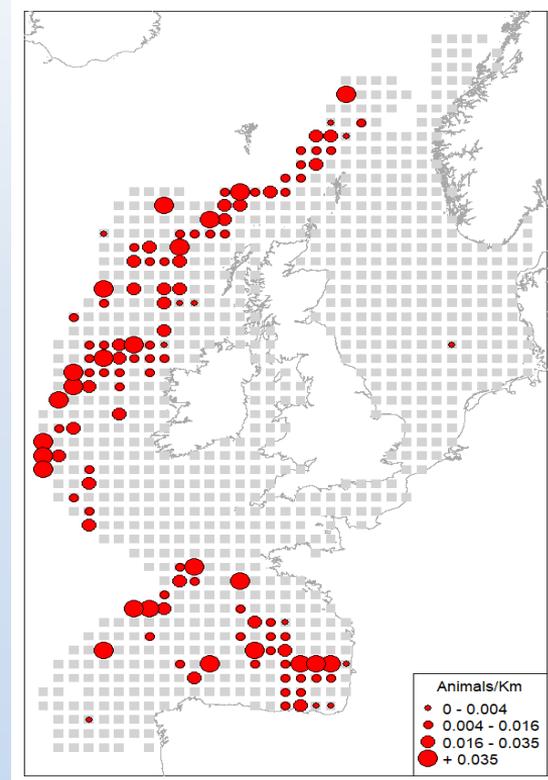
Cuvier's Beaked Whale



Sowerby's Beaked Whale



Sperm Whale



Standardisation

Summary of esw and g(0) calculations across explanatory variables.

DOL= Bottlenose Dolphin, Common Dolphin, Striped Dolphin, White-Beaked Dolphin, Atlantic White-Sided Dolphin

GOB = Killer Whale, Long-finned Pilot Whale, Risso's Dolphin, **MIN**= Minke Whale, **POR** = Harbour Porpoise, **FIN** = Fin Whale

Group	Measure	LINE	STRIP	2.5m	5m	10m	20m	30m	Aircraft	SS0	SS1	SS2	SS3	SS4
DOL	esw	0.38	0.17	0.23	0.26	0.29	0.32	0.34	0.21	0.32	0.3	0.27	0.25	0.23
GOB	esw	0.54	0.21	0.4	0.4	0.4	0.4	0.4	0.24	0.44	0.41	0.37	0.34	0.31
MIN	esw	0.47	0.18	0.29	0.32	0.34	0.37	0.39	0.24	0.38	0.35	0.33	0.3	0.28
POR	esw	0.31	0.17	0.19	0.22	0.26	0.3	0.32	0.16	0.29	0.26	0.24	0.22	0.2
FIN	esw	0.73	0.21	0.51	0.51	0.51	0.51	0.51	0.28	0.47	0.47	0.47	0.47	0.47
DOL	g(0)	0.49	0.49	0.6	0.57	0.51	0.4	0.29	0.57	0.58	0.56	0.46	0.44	0.41
GOB	g(0)	0.4	0.4	0.27	0.29	0.33	0.43	0.53	0.57	0.5	0.47	0.38	0.35	0.33
MIN	g(0)	0.5	0.5	0.27	0.33	0.46	0.73	0.9	0.3	0.47	0.49	0.5	0.51	0.52
POR	g(0)	0.25	0.25	0.31	0.29	0.26	0.2	0.15	0.31	0.39	0.31	0.24	0.18	0.14
FIN	g(0)	0.28	0.28	0.17	0.19	0.23	0.32	0.44	0.3	0.28	0.28	0.28	0.27	0.27

Habitat Modelling: GLM-GEE in a hurdle-model framework

GLM

Linear or quadratic terms

Identify functional relationships

Avoid overfitting relationships

GEE

Survey source/month as the correlation structure

Spatial and temporal autocorrelation

Accounting further for differences among surveys

Hurdle-Model

Presence-absence and count model

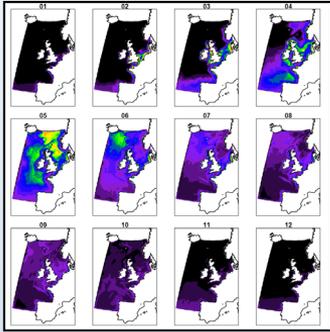
Reduces problems with zero inflation and overdispersion

Use knowledge of scale- dependent associations

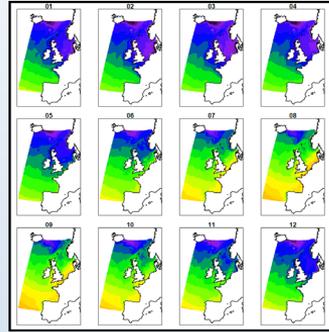
Incorporating Environmental Data

Coarse-scale processes likely to influence prey communities and abundances

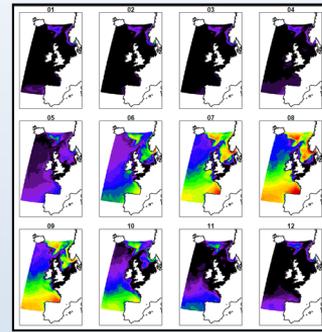
Primary Productivity



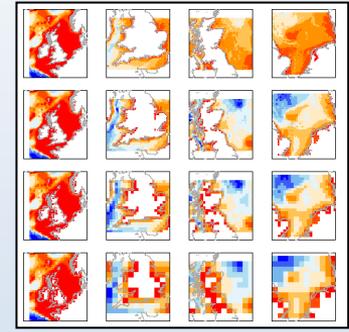
Sea Surface Temperature



Stratification

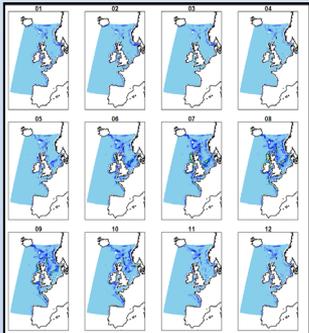


Depth

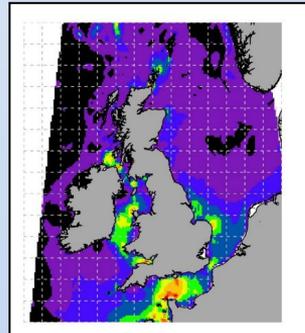


Finer-scale processes likely to influence prey availability

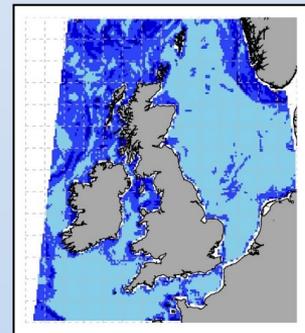
Tidal Fronts



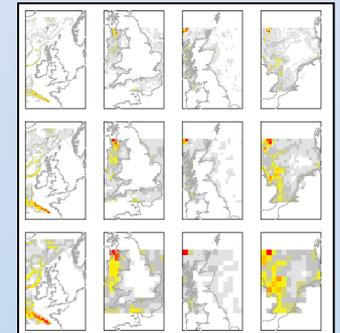
Current Speed



Eddy Potential



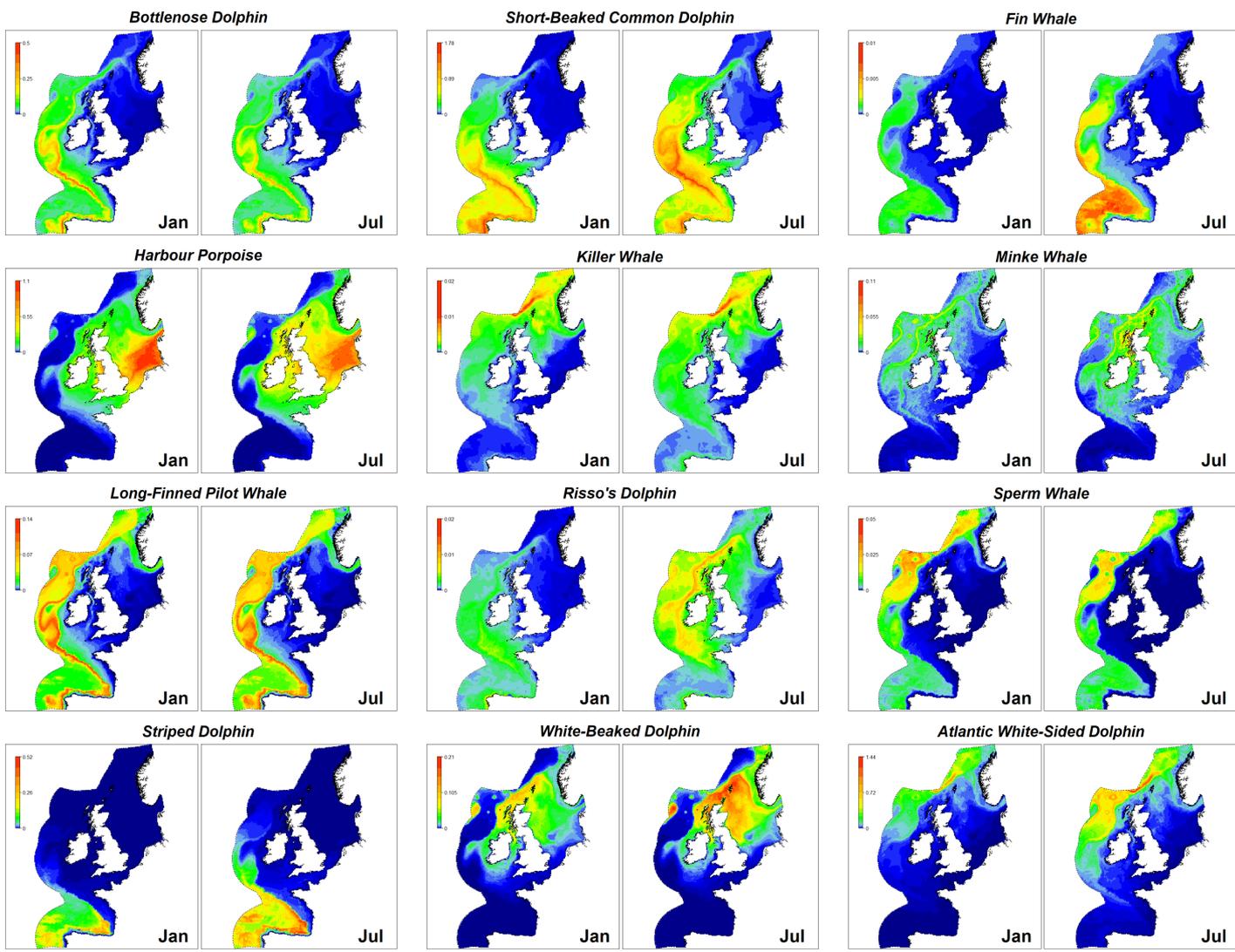
Seabed Roughness



Spatial Patterns – Cetaceans



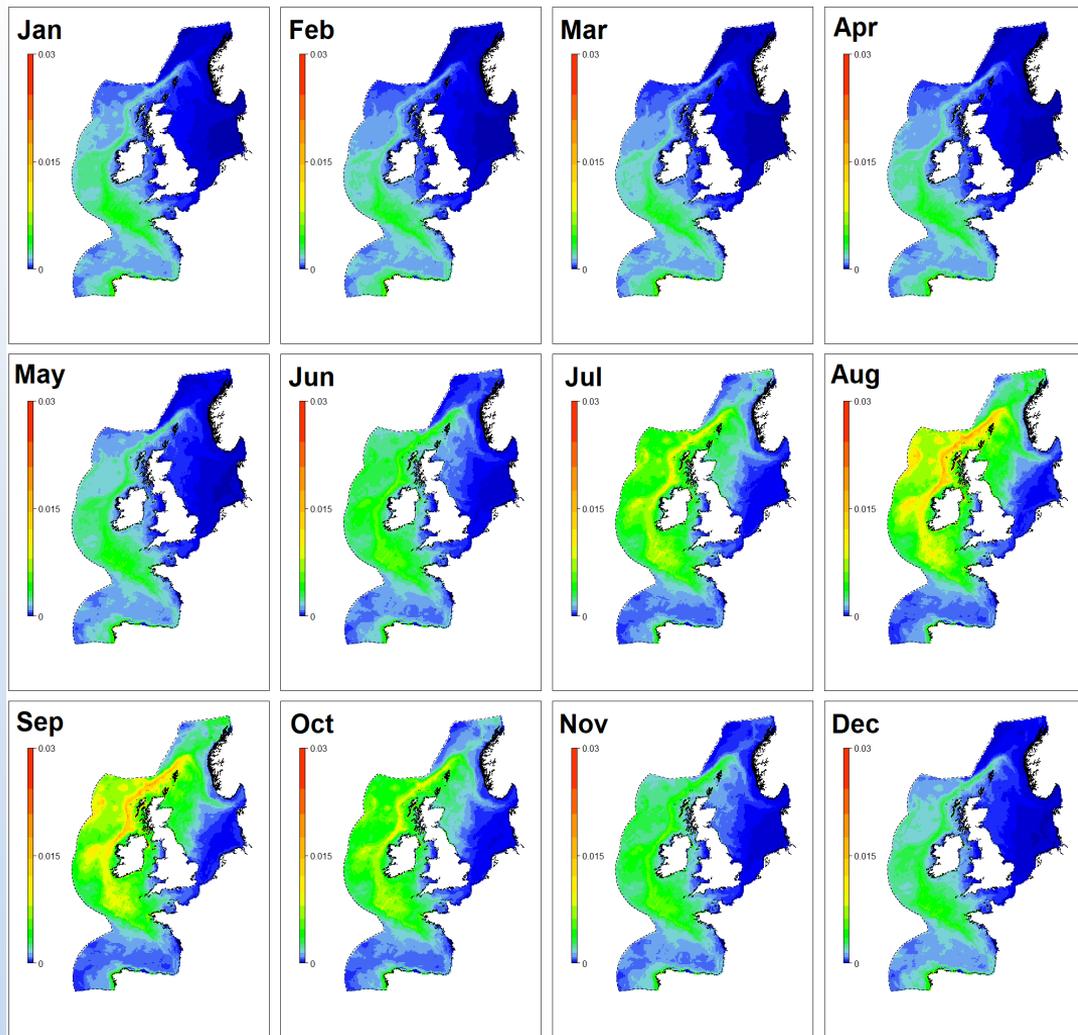
1.2 million individuals



Monthly Trends: Risso's Dolphin



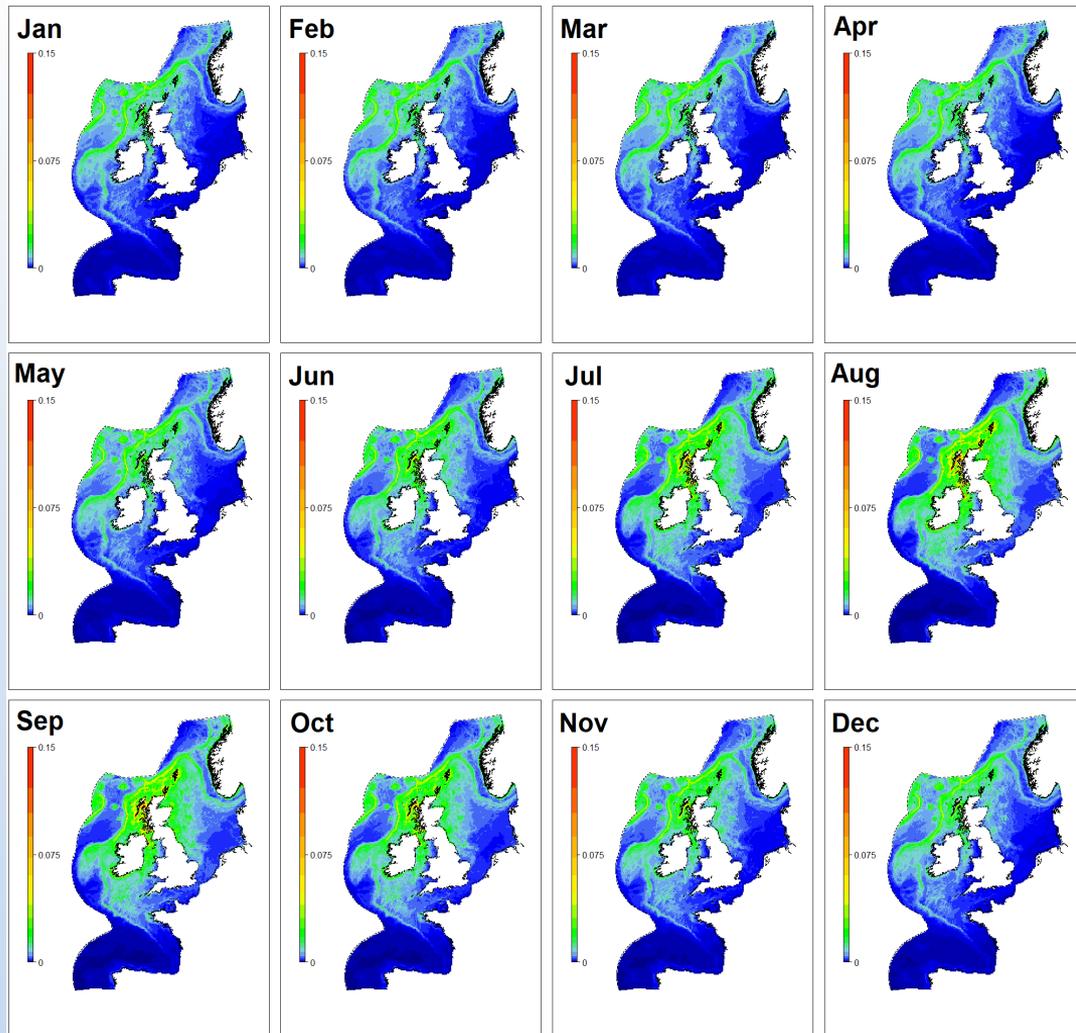
Risso's Dolphin



Monthly Trends: Minke Whale



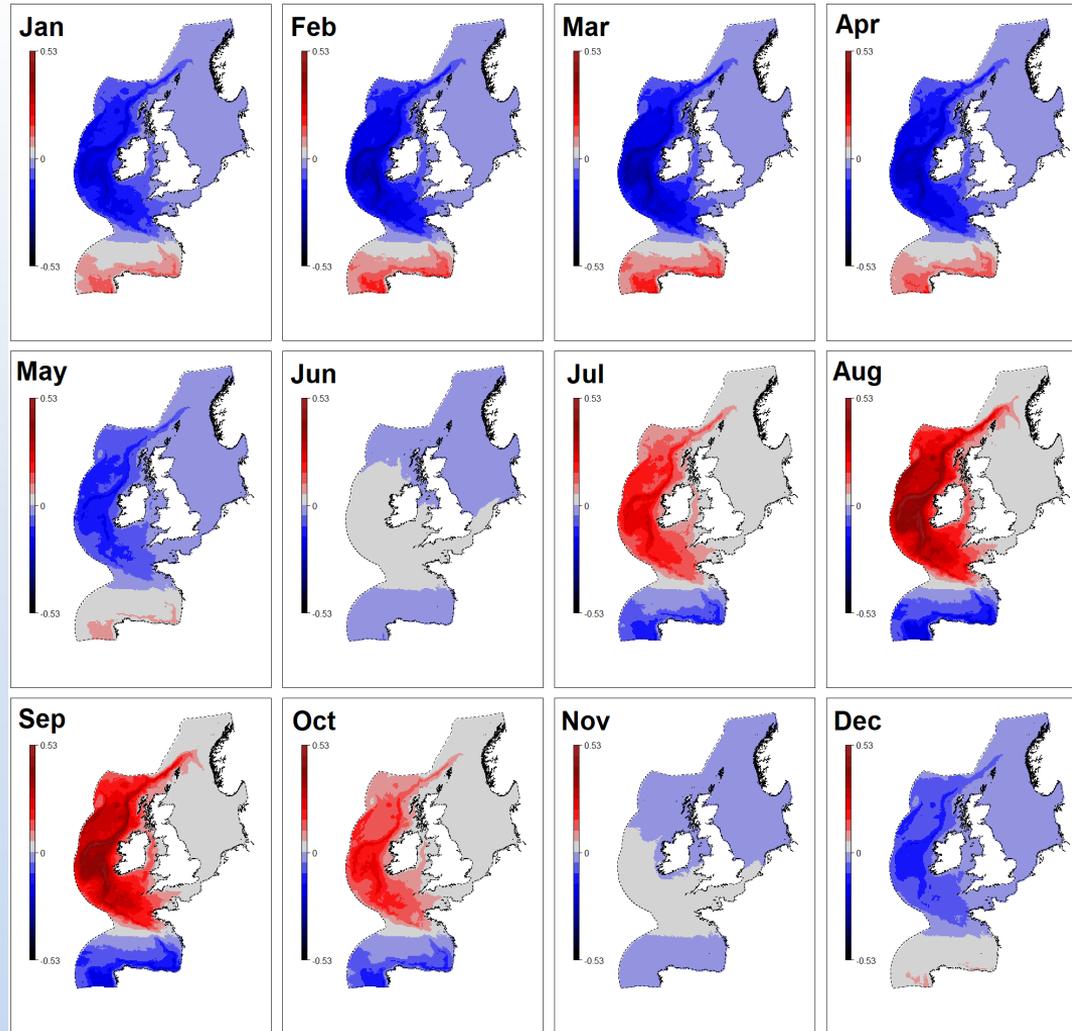
Minke Whale



Inshore-Offshore Movements: Common Dolphin

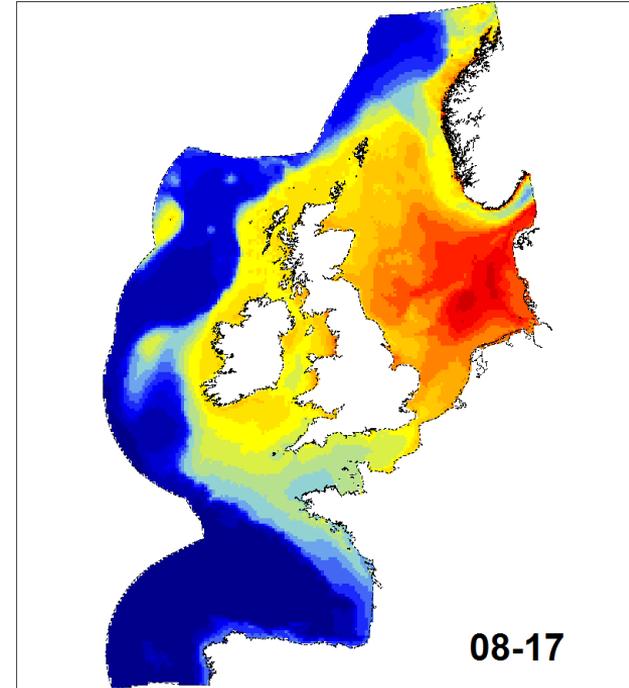
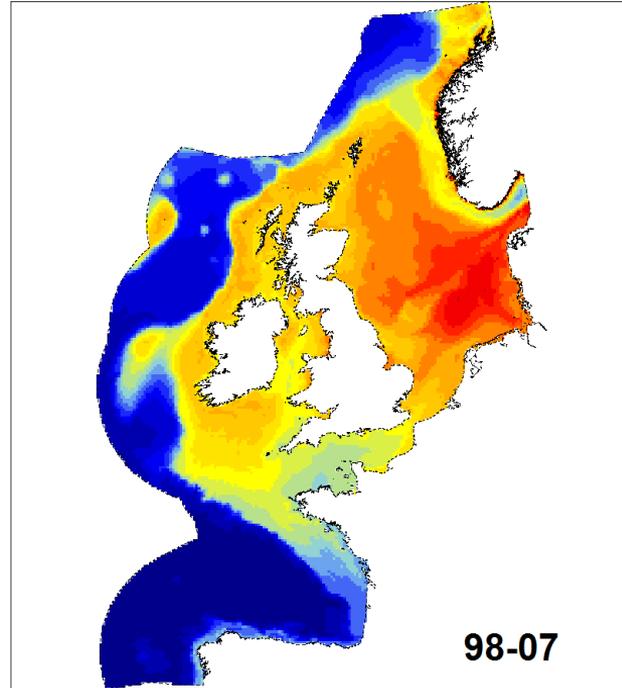
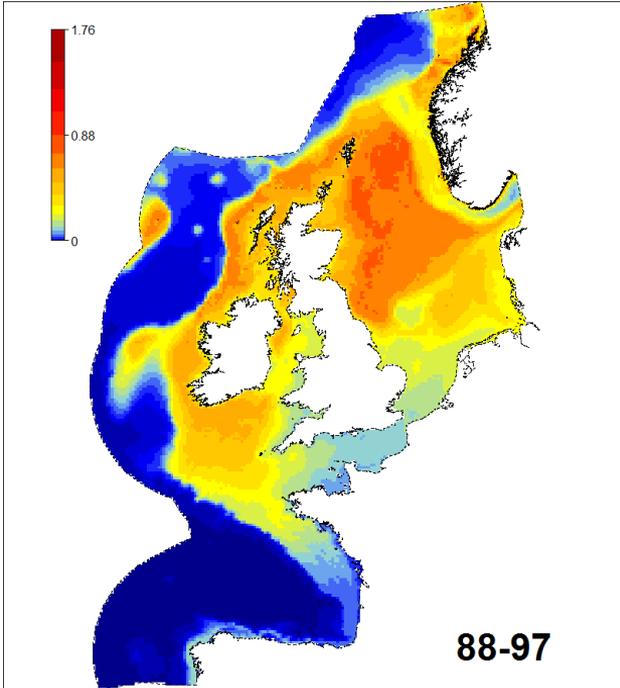
- % deviation from the annual mean for each month of the year
- Red denotes positive and blue negative deviations
- Results show a movement northwards in summer and into the Bay of Biscay between Jan & Apr

Delphinus delphis

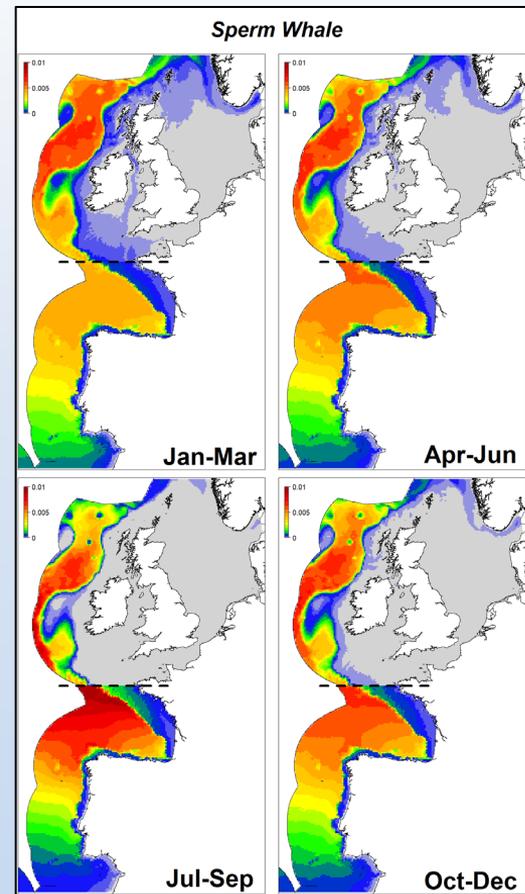
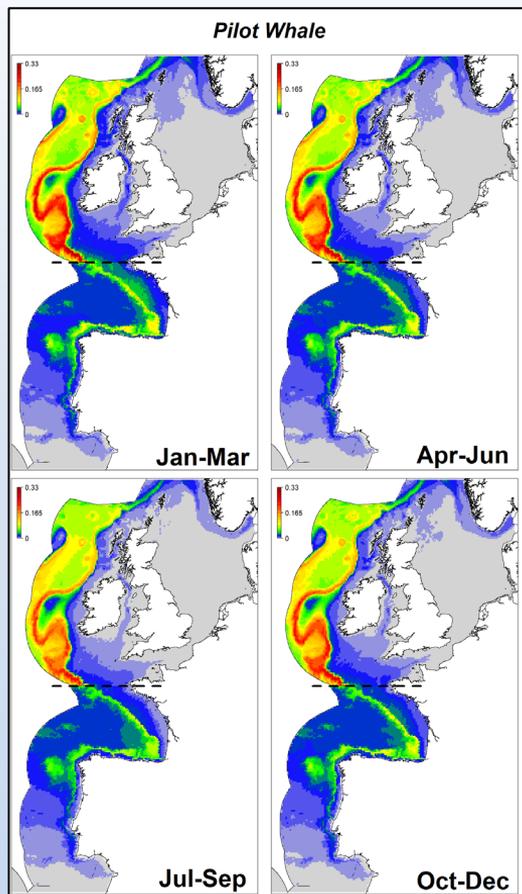
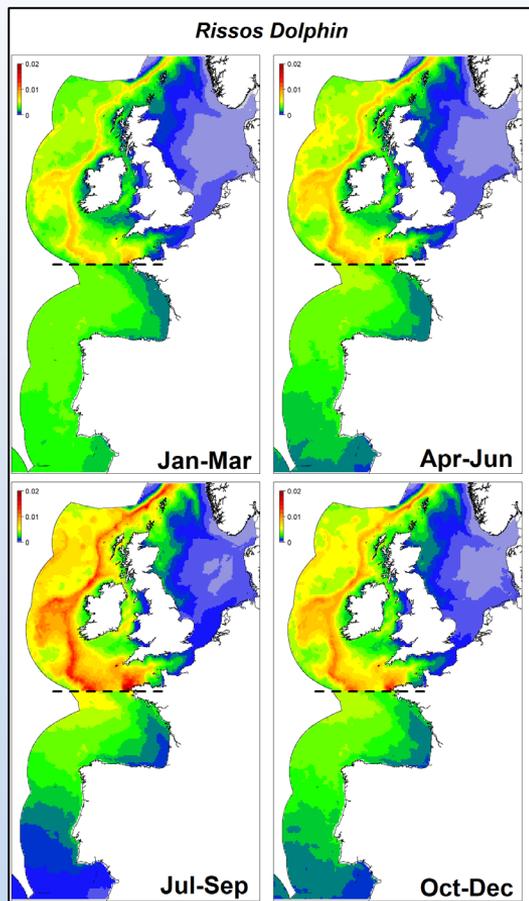


Long-term Trends in Harbour Porpoise Distribution

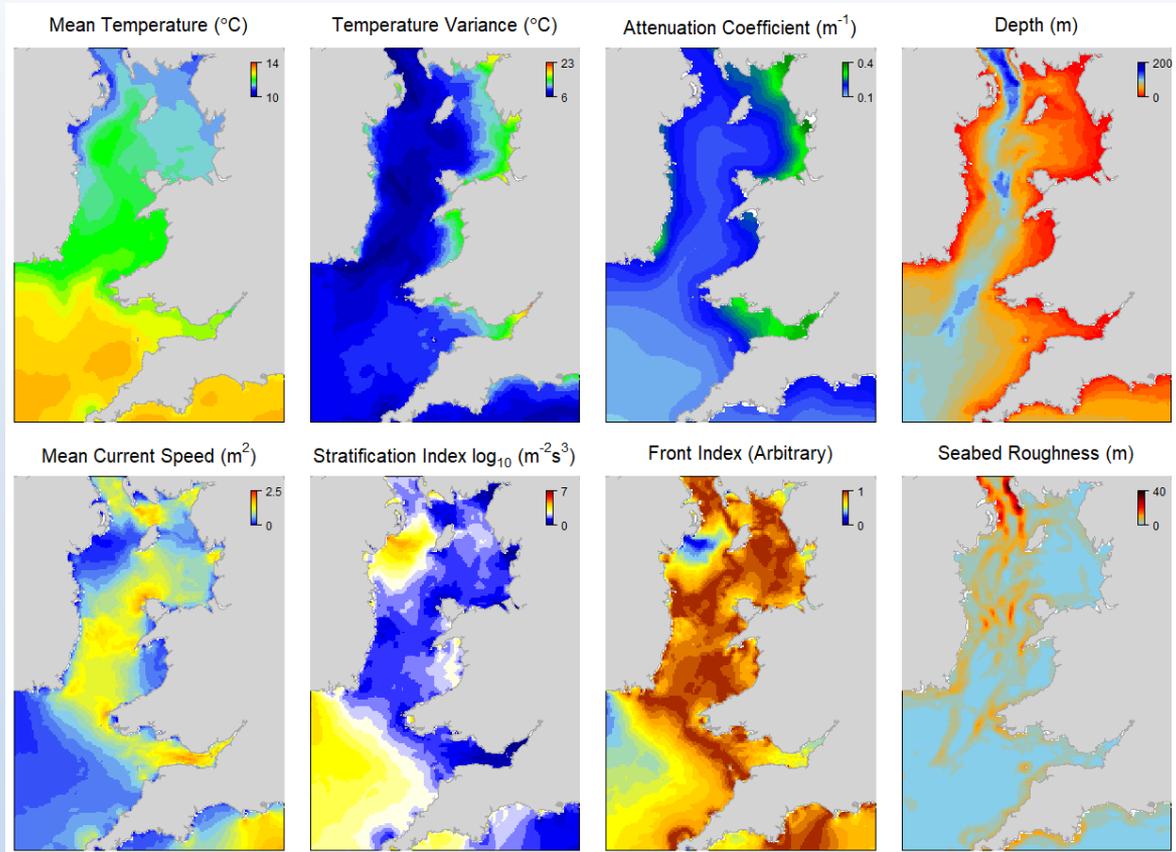
Phocoena phocoena



New Distribution Maps – large-scale

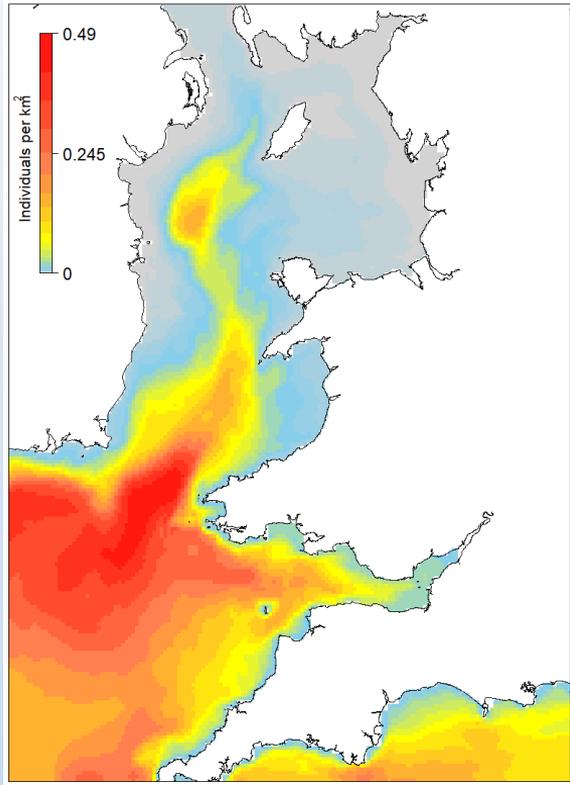


Incorporating Regional Environmental Variables

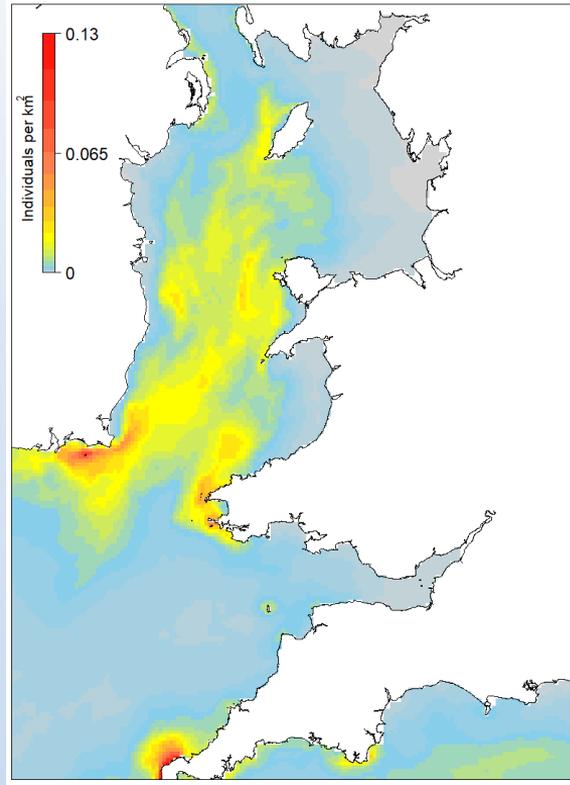


New Distribution Maps – regional

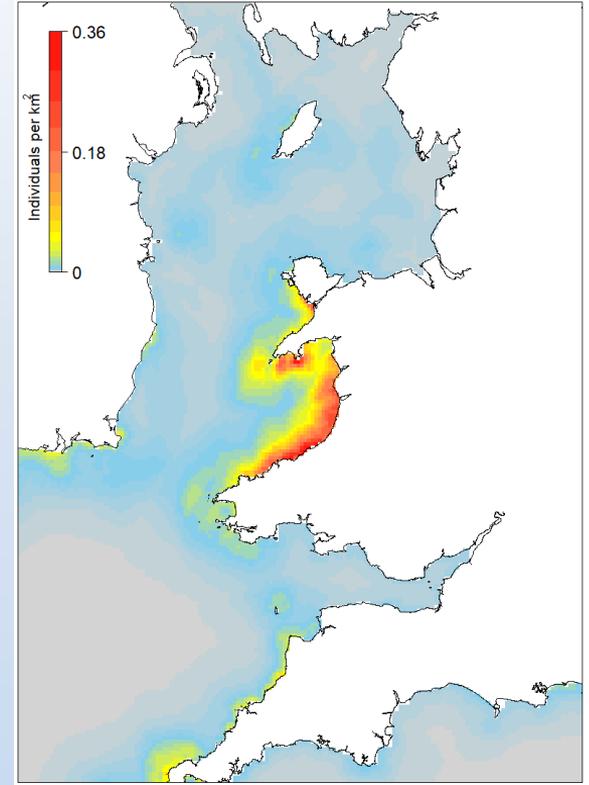
Common Dolphin



Risso's Dolphin

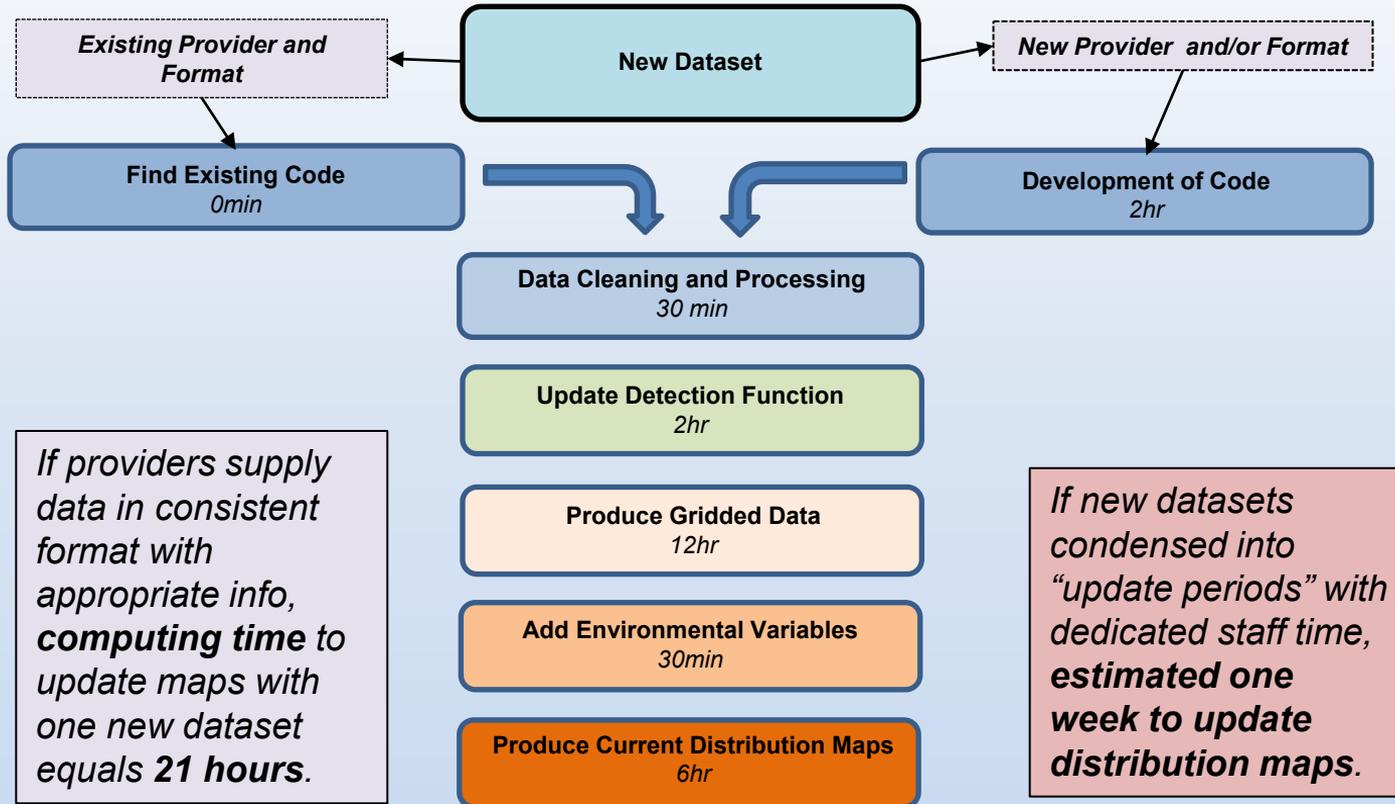


Bottlenose Dolphin

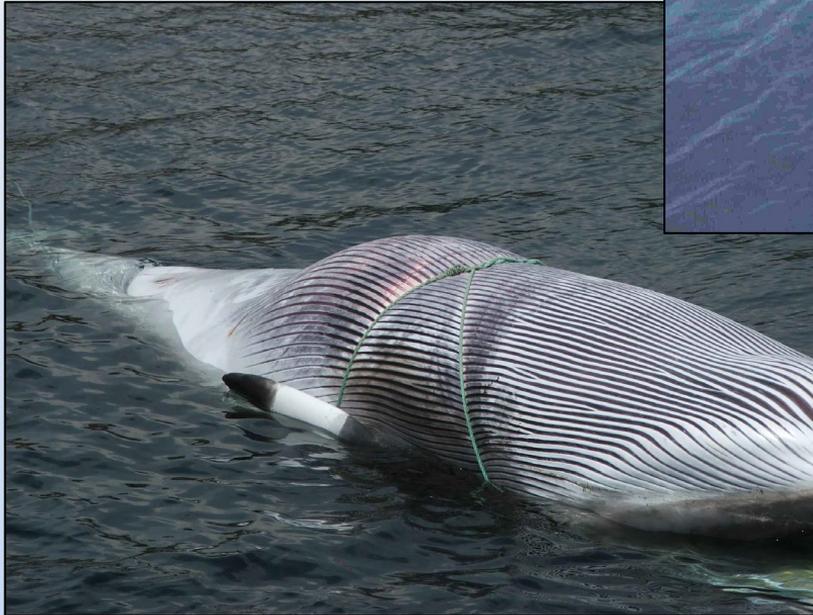


Evans & Waggitt (2023)

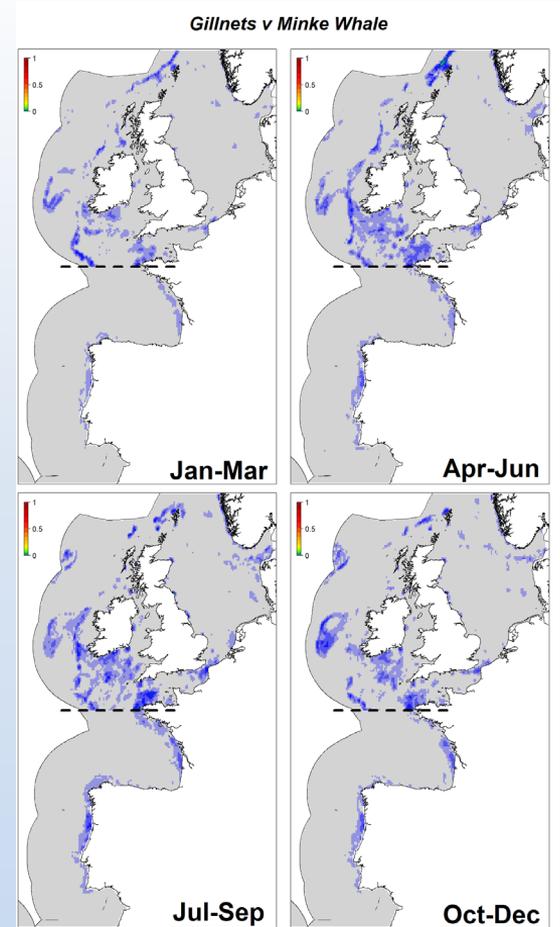
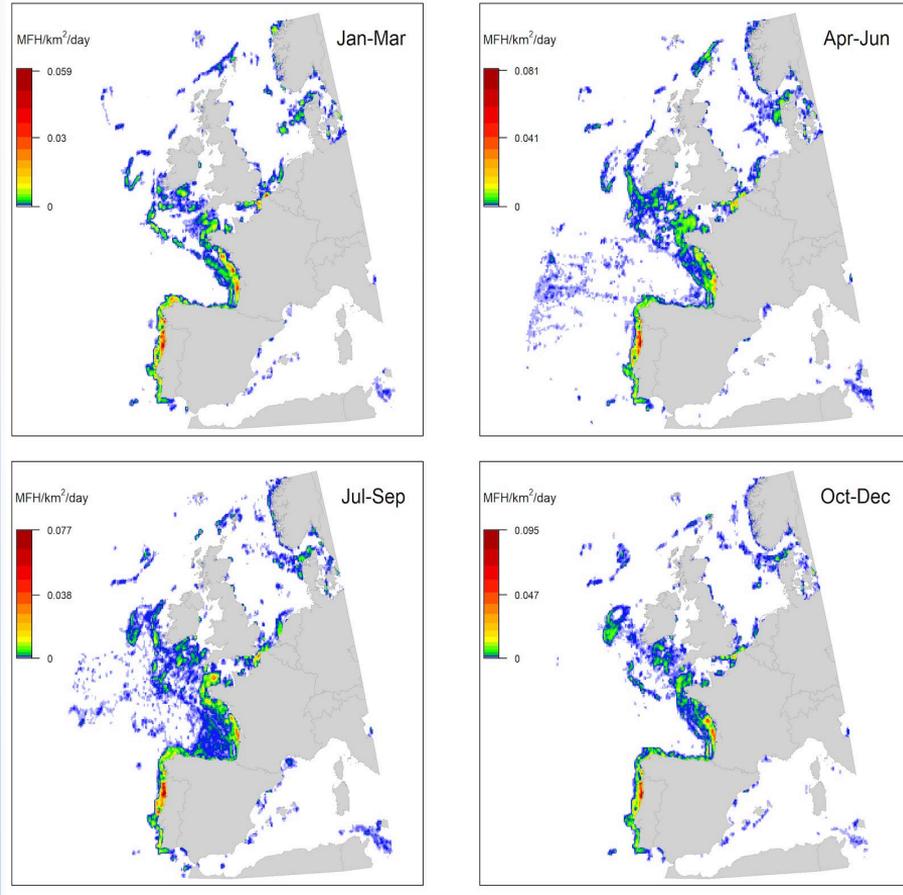
Distribution Map Updates



FISHING GEAR ENTANGLEMENT AFFECTING MINKE WHALES



MAPPING STATIC NET FISHING EFFORT & RISK OF ENTANGLEMENT TO MINKE WHALE



Source: Evans *et al.* (2021)

