Similarity assessment of OWFs within UK marine habitats

University of Exeter

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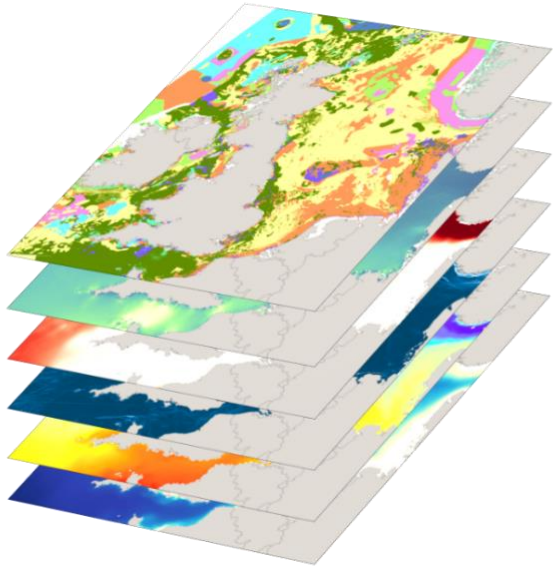
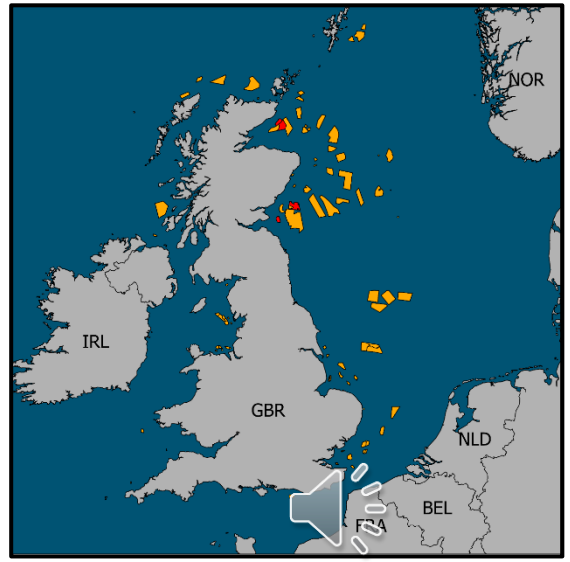
PrePARED

Predators + Prey Around Renewable Energy Developments



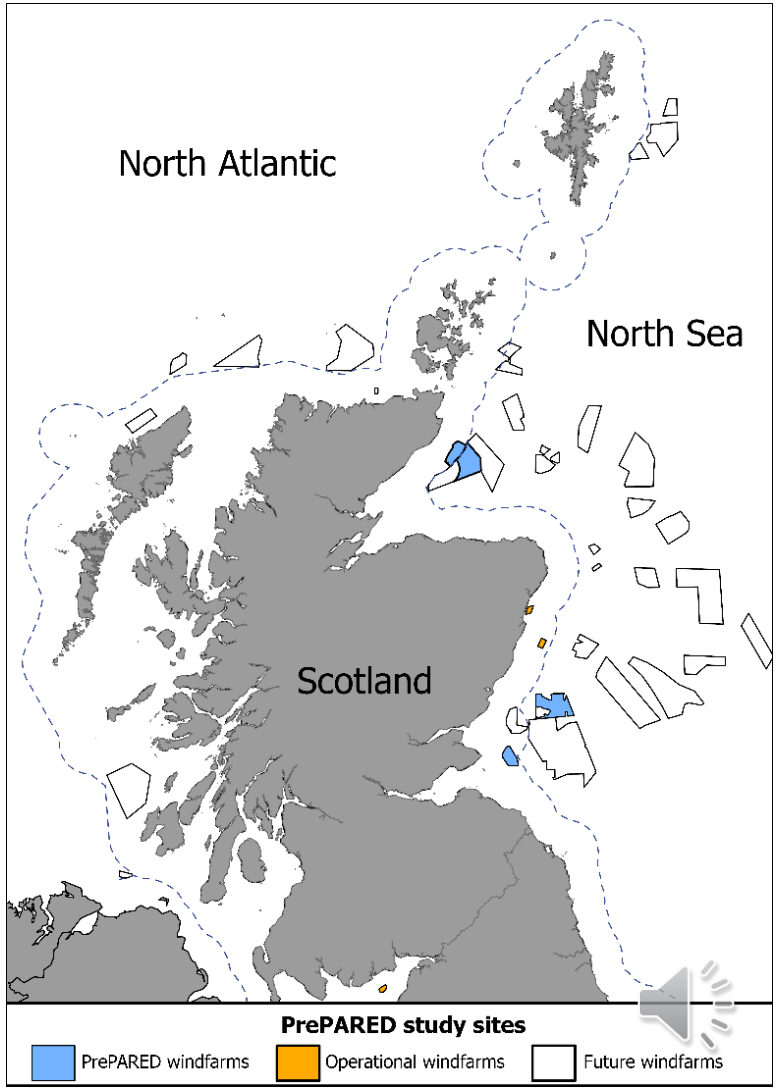


Scottish Government Riaghaltas na h-Alba · SMRU Consulting understand • assess • mitigate · Sea Mammal Research Unit · University of Aberdeen · University of Exeter · Aarhus University · UK Centre for Ecology & Hydrology · BioSS · Natural England · NatureScot · Crown Estate Scotland · Offshore Wind Evidence + Change Programme

Objective

- Identify environmental similarities between PrePARED sites and other offshore wind farms, to:
  - **Seek sites where findings might be potentially transferable**
  - **Identify potential reference or comparison sites for future studies**

- Use a broad bio-geographical approach that considers key aspects of the environment to investigate similarity and site comparison
- This analysis has been conducted using both PrePARED sites (i.e. Moray Firth & Firth of Forth)



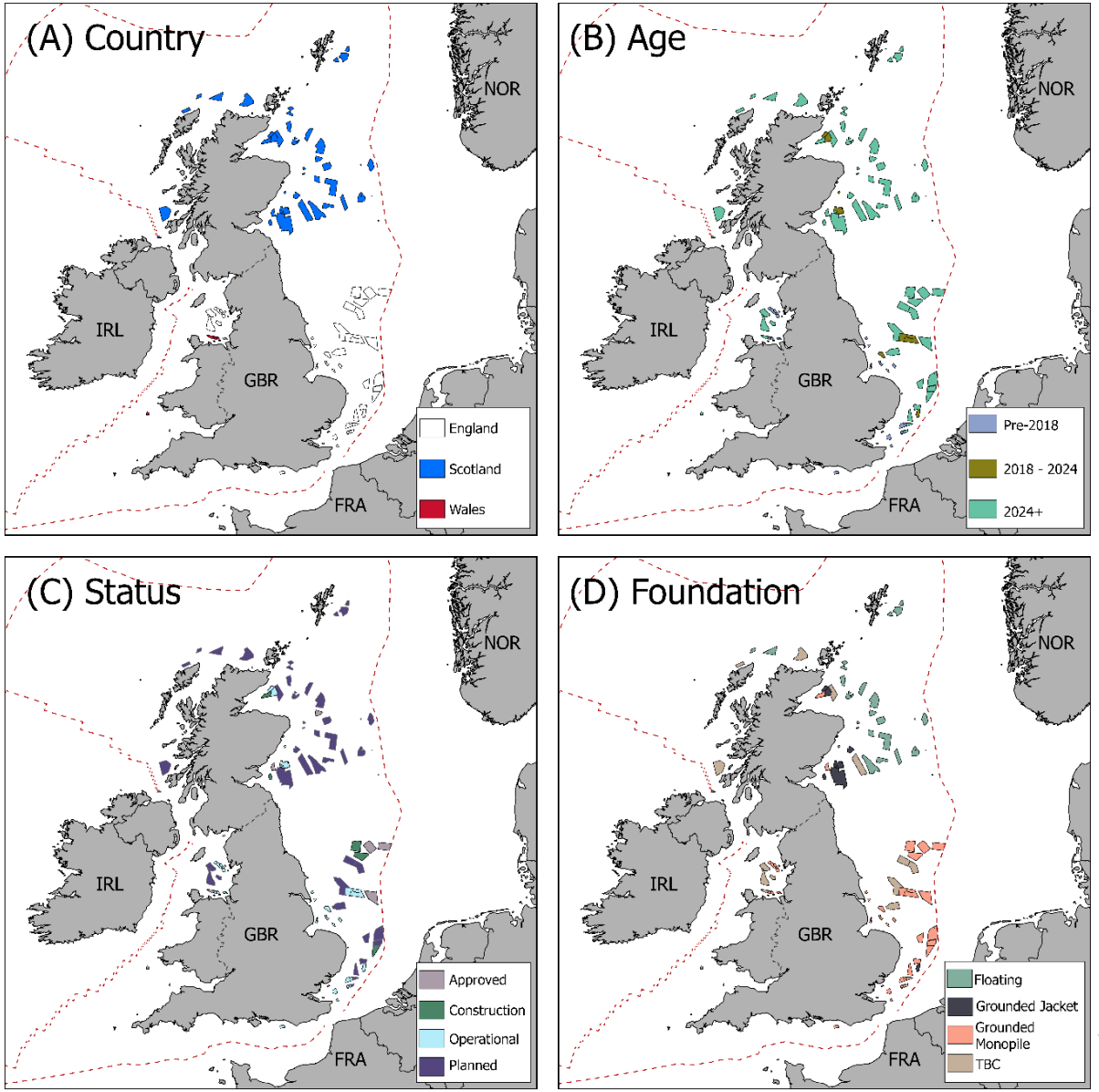
Wind farm database

Includes:

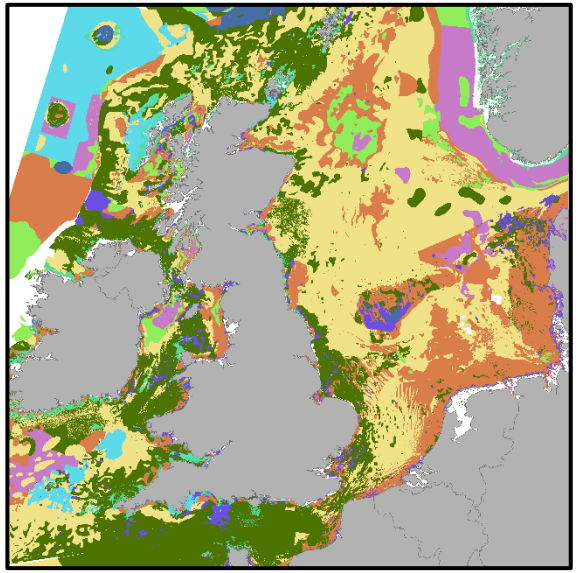
- UK offshore wind farms (n=96)
  - Currently operational (n=36)
  - Under construction, approved or planned (n=60)
- Range of foundation types:
  - floating (n=30)
  - grounded jacket (n=10)
  - grounded monopile (n=47)
  - To be confirmed (n=14)
- ScotWind and INTOG leasing sites

Excludes:

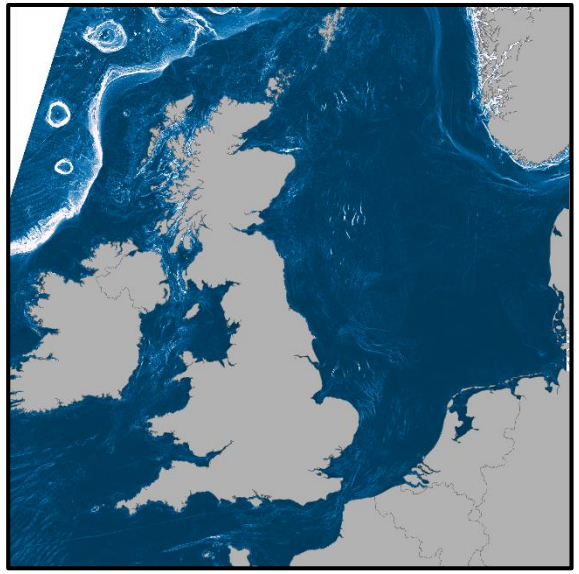
- Leasing round 5
- Non-UK windfarms



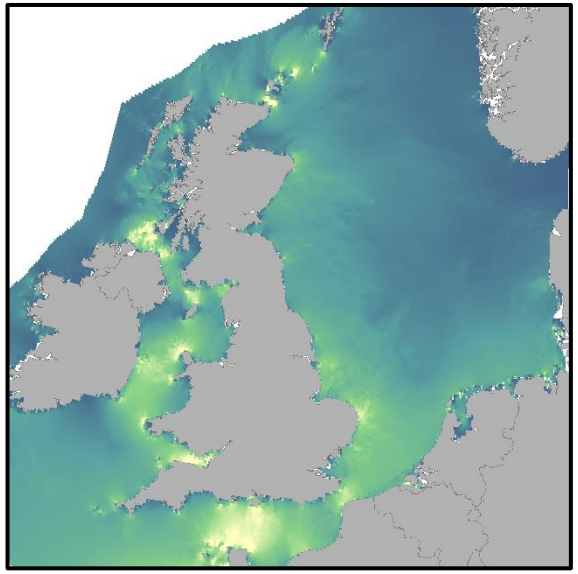
Seabed substrate



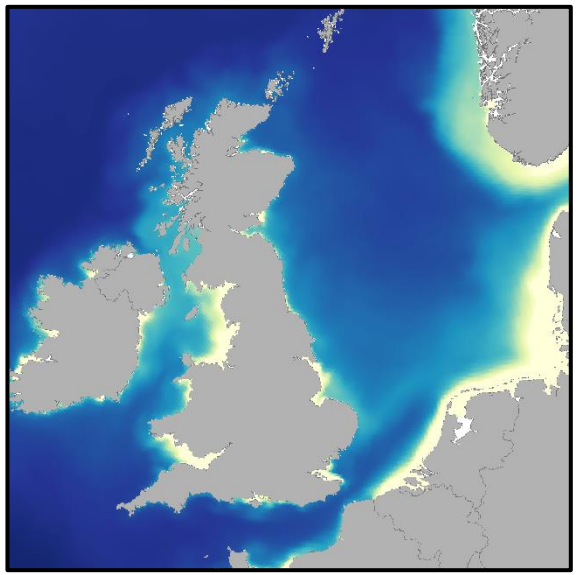
Seabed slope (arc °)



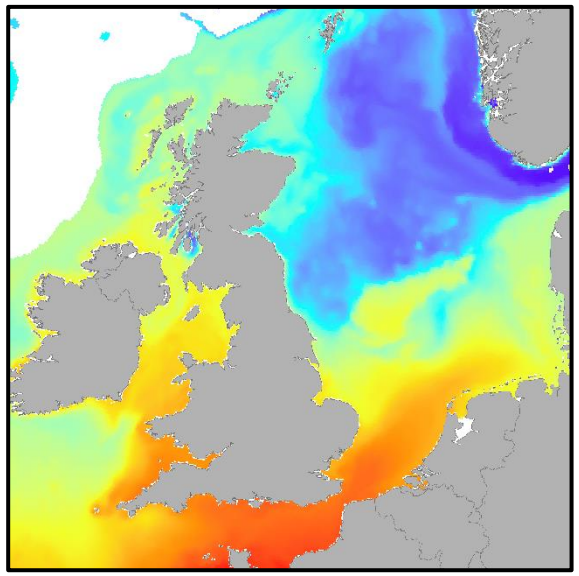
Spring tide current (m/s)



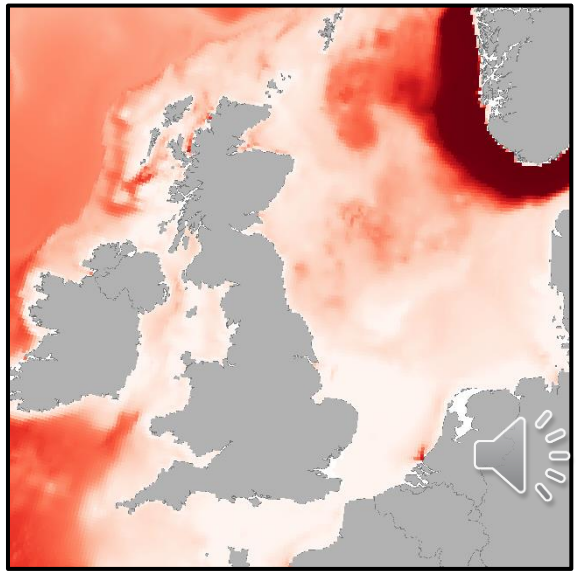
Salinity (PSU)



Sea bottom temperature (°C)



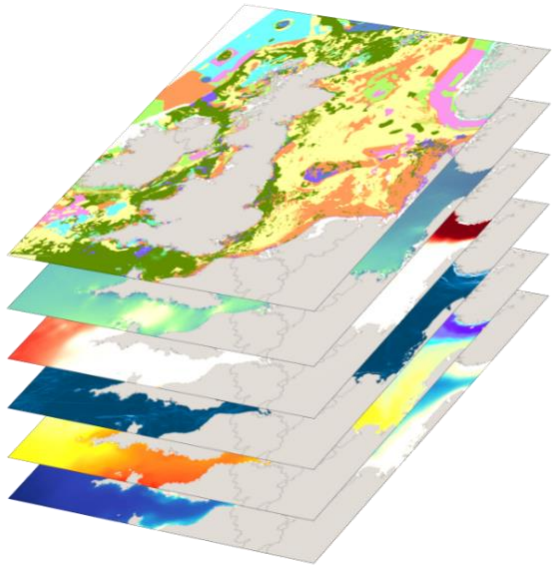
Vertical stratification (J m^{-3})



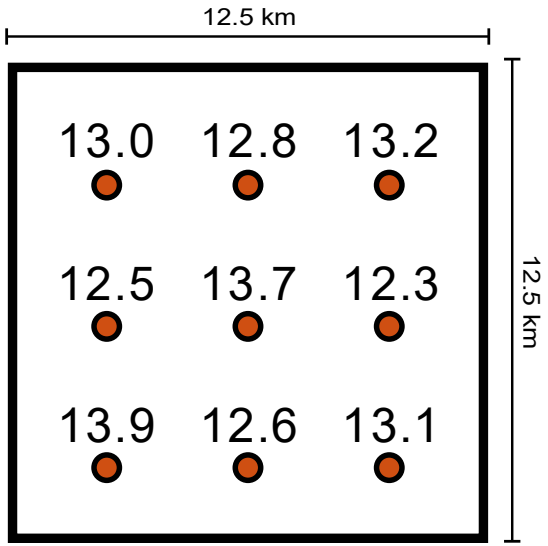
Environmental data processing

1. Environmental variable extraction to uniform cells

2. Averaging of cells

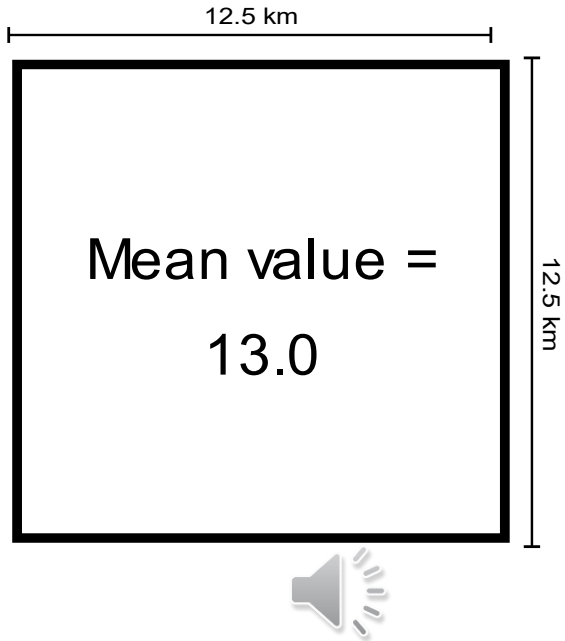


Extract values from each environmental layer



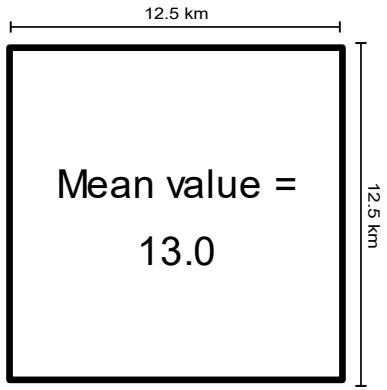
Example: Sea bottom temperature (°C)

Calculate mean across all points for each environmental layer

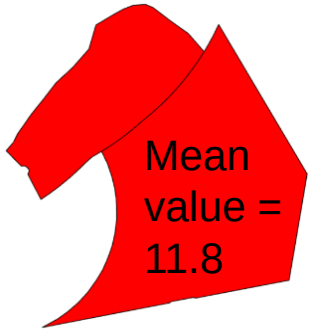


Similarity Search Methods

3. Similarity Search



Comparison to a study site



Example: Moray Firth

For each environmental variable, the mean value is compared to the study site's mean value

Similarity Score =

0.54

The similarity scores range from 1 (perfect similarity), to -1 (perfect dissimilarity)

Similarity values	Descriptor
> 0.6	Highly similar
> 0.4 to 0.6	Considerably similar
> 0.2 to 0.4	Moderately similar
> 0 to 0.2	Slightly similar
0	*Neutral
0 to > -0.1	Slightly dissimilar
-0.1 to > -0.4	Moderately dissimilar
-0.4 to > -0.6	Considerably dissimilar
-0.6 to -1	Highly dissimilar

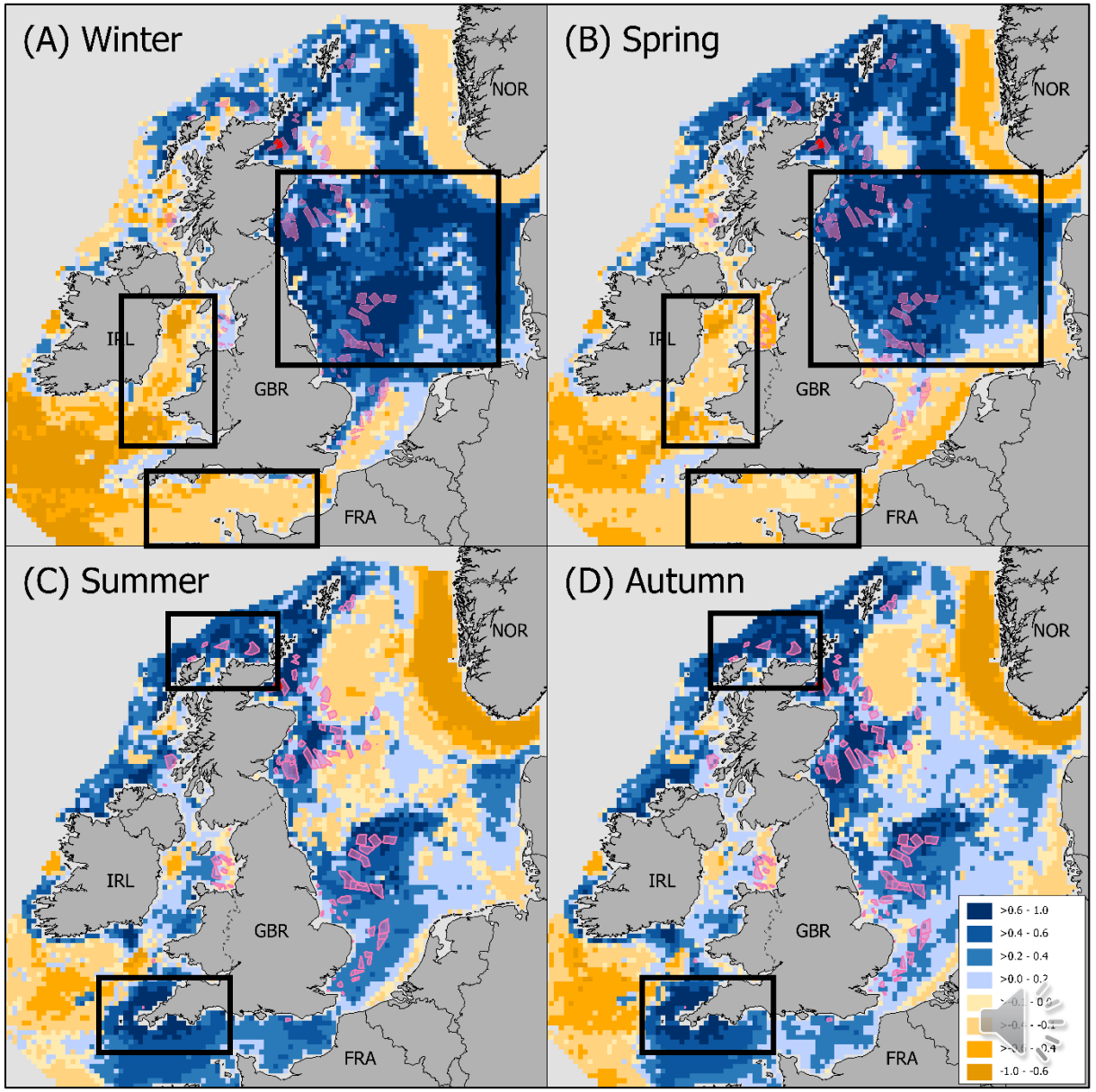
Moray Firth

Winter and Spring:

- High similarity (>0.6; blues) across most of the North Sea
- Extensive high similarity between UK, Denmark and Norway
- Dissimilar conditions (orange) in Irish Sea and southern England

Summer and Autumn

- North Sea high similarity area reduces
- High similarity remains in Scotland and central North Sea
- Similarity increases in North Scottish and Southwest English waters
- More variable patterns across the region



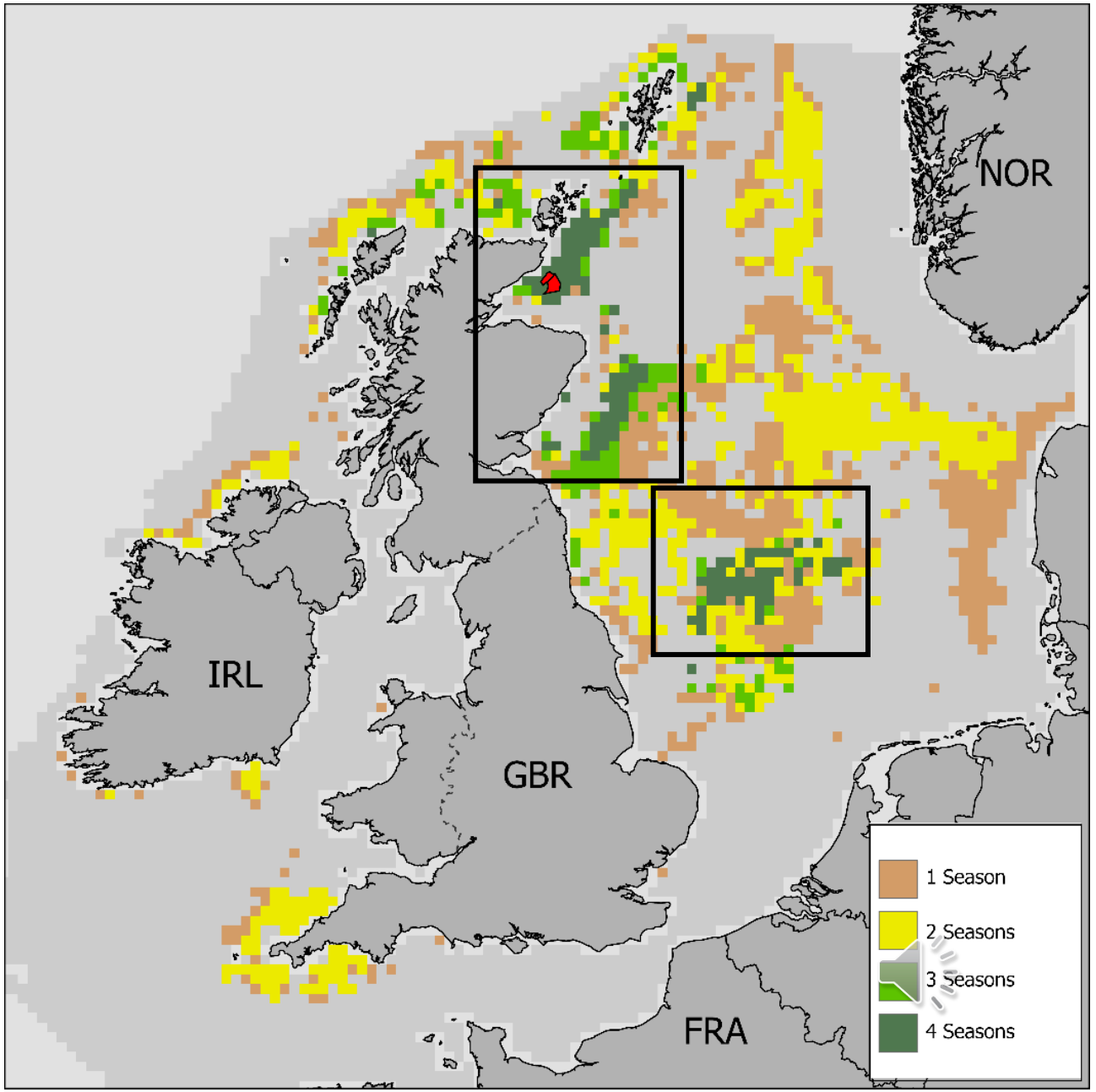
Moray Firth year-round similarity

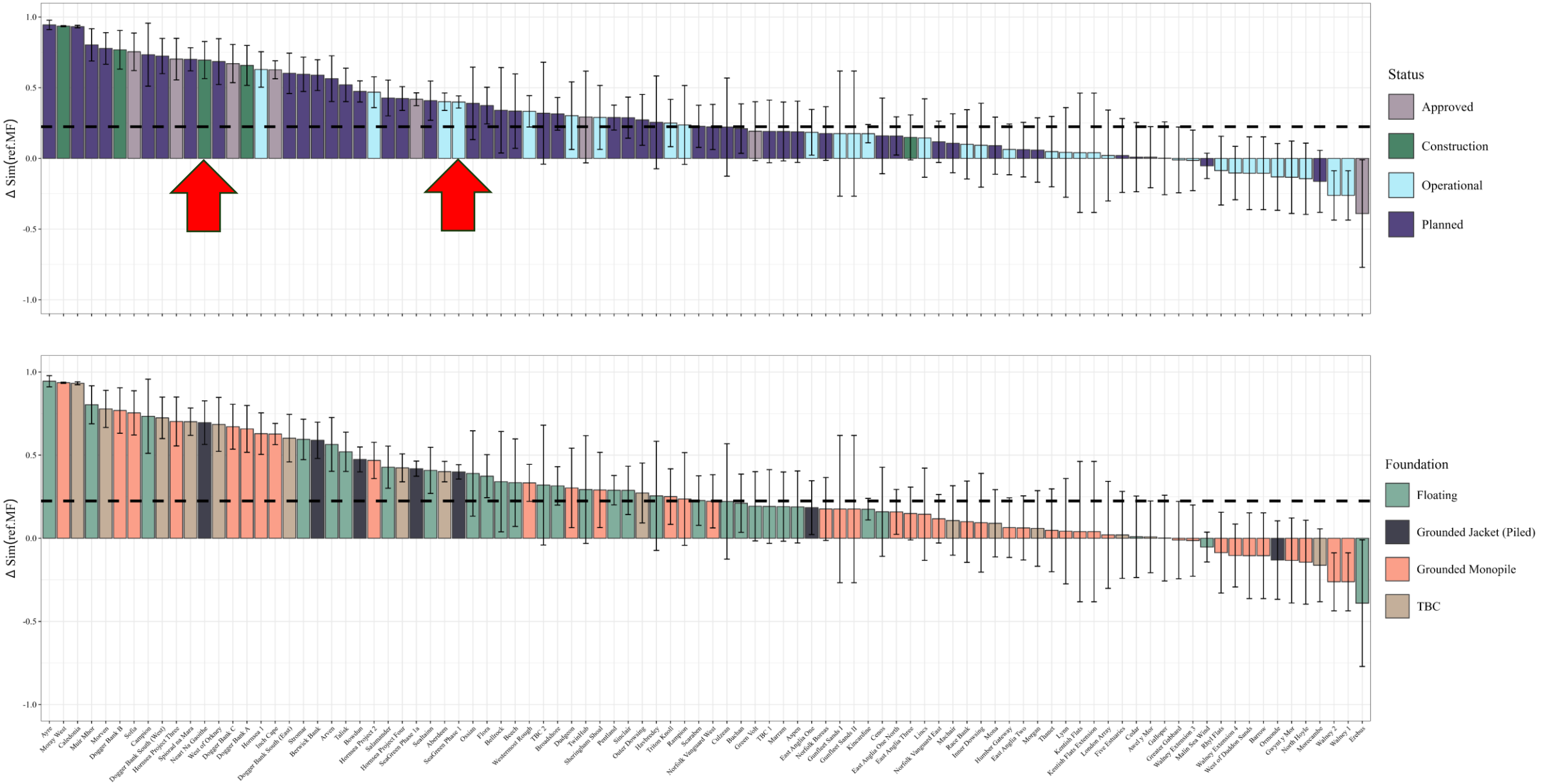
Year-round similarity

- Persistent year-round patterns: consistently high similarity (>0.6)
  1. East coast of Scotland
  2. Central North Sea (Dogger Bank)

- 3 seasons of high similarity: Northern Scotland

- 2 seasons of high similarity:
  1. North Sea
  2. Southwest England




Δ Sim(ref.MF)
1.0
0.5
0.0
-0.5
-1.0
Status
Approved
Construction
Operational
Planned
Foundation
Floating
Grounded Jacket (Piled)
Grounded Monopile
TBC
Ayre
Moray West
Caledonia
Muir Mhor
Morven
Dogger Bank B
Sofia
Campion
Dogger Bank South (West)
Hornsea Project Three
Spiorad na Mara
Neart Na Gaoithe
West of Orkney
Dogger Bank C
Dogger Bank A
Hornsea 1
Inch Cape
Dogger Bank South (East)
Stromar
Berwick Bank
Arven
Taliak
Rowdun
Hornsea Project 2
Salamander
Hornsea Project Four
SeaGreen Phase 1a
Scotlsh
Aberdeen
SeaGreen Phase 1
Ossian
Flora
Bellrock
Beech
Westermost Rough
TBC 2
Broadshore
Dudgeon
Twinhlab
Sheringham Shoal
Pentland
Sinclair
Outer Dowsing
Hevhrsley
Triton Knoll
Rampion
Scaraben
Norfolk Vanguard West
Cullecan
Buchan
Green Volt
TBC 1
Marram
Aspen
East Anglia One
Norfolk Boreas
Gunfleet Sands I
Gunfleet Sands II
Kincardine
Cenos
East Anglia One North
East Anglia Three
Norfolk Vanguard East
Machair
Race Bank
Inner Dowsing
Mona
Humber Gateway
East Anglia Two
Morgan
Thanet
Lynn
Kentish Flats
Kentish Flats Extension
London Array
Five Estuaries
Cedar
Awel y Mor
Gallopper
Greater Gabbard
Walney Extension 3
Mailn Sea Wind
Rhyl Flats
Walney Extension 4
West of Duddon Sands
Barrow
Ormonde
Gwynt y Mor
North Hoyle
Morecambe
Walney 2
Walney 1
Erebus

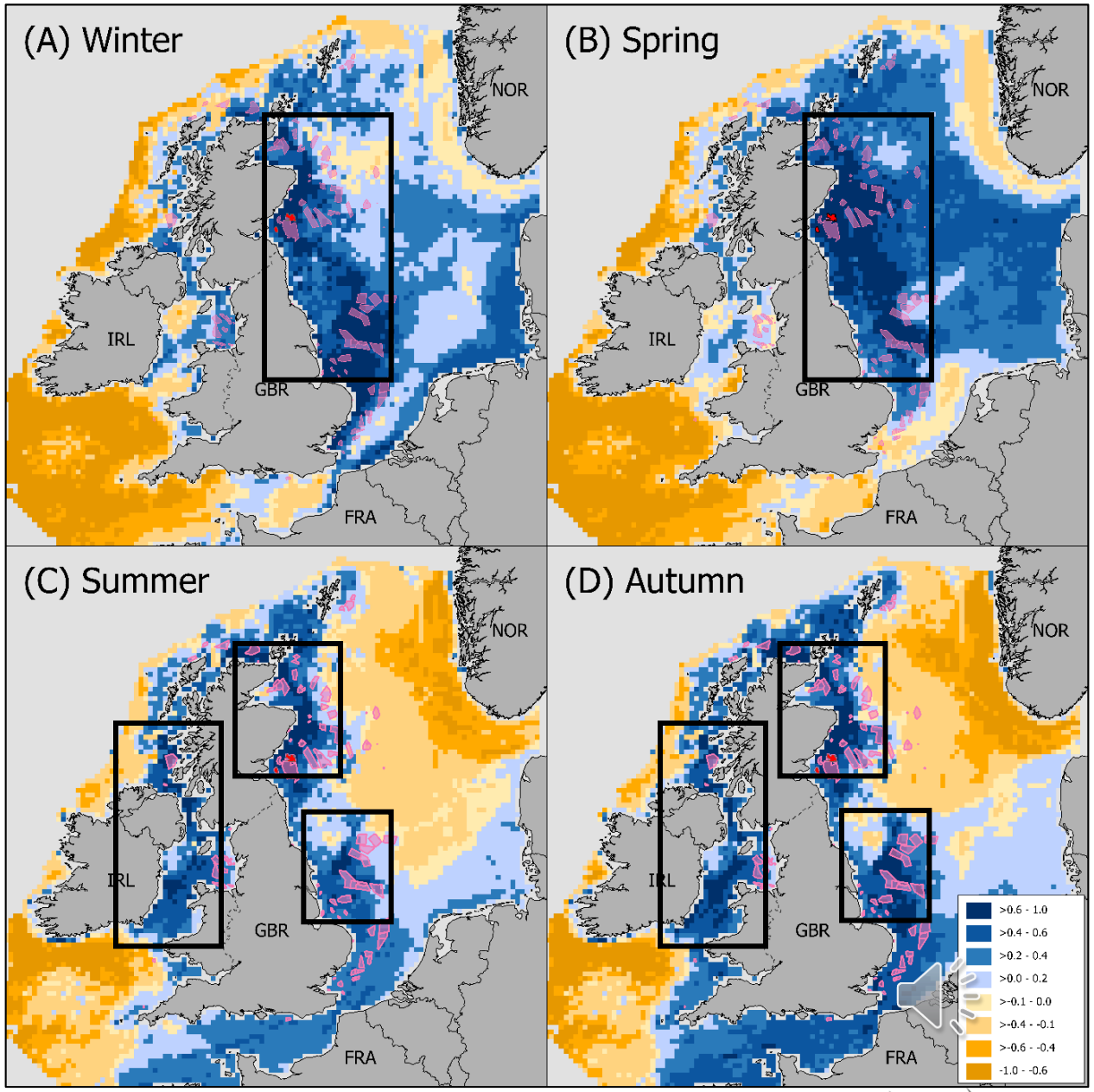
Firth of Forth

Winter and Spring:

- High similarity (>0.6, blues) extends along east coast of Scotland and northeast England
- Strong similarity pattern in immediate Eastern UK coastal waters
- Outer North Sea shows moderate similarity patterns

Summer and Autumn:

- High similarity remains concentrated along Scottish east coast
- Similarity pattern expands to include:
  - East coast of England
  - Areas of the Irish Sea
  - West coast of Scotland
- More complex and varied similarity patterns emerge compared to winter/spring

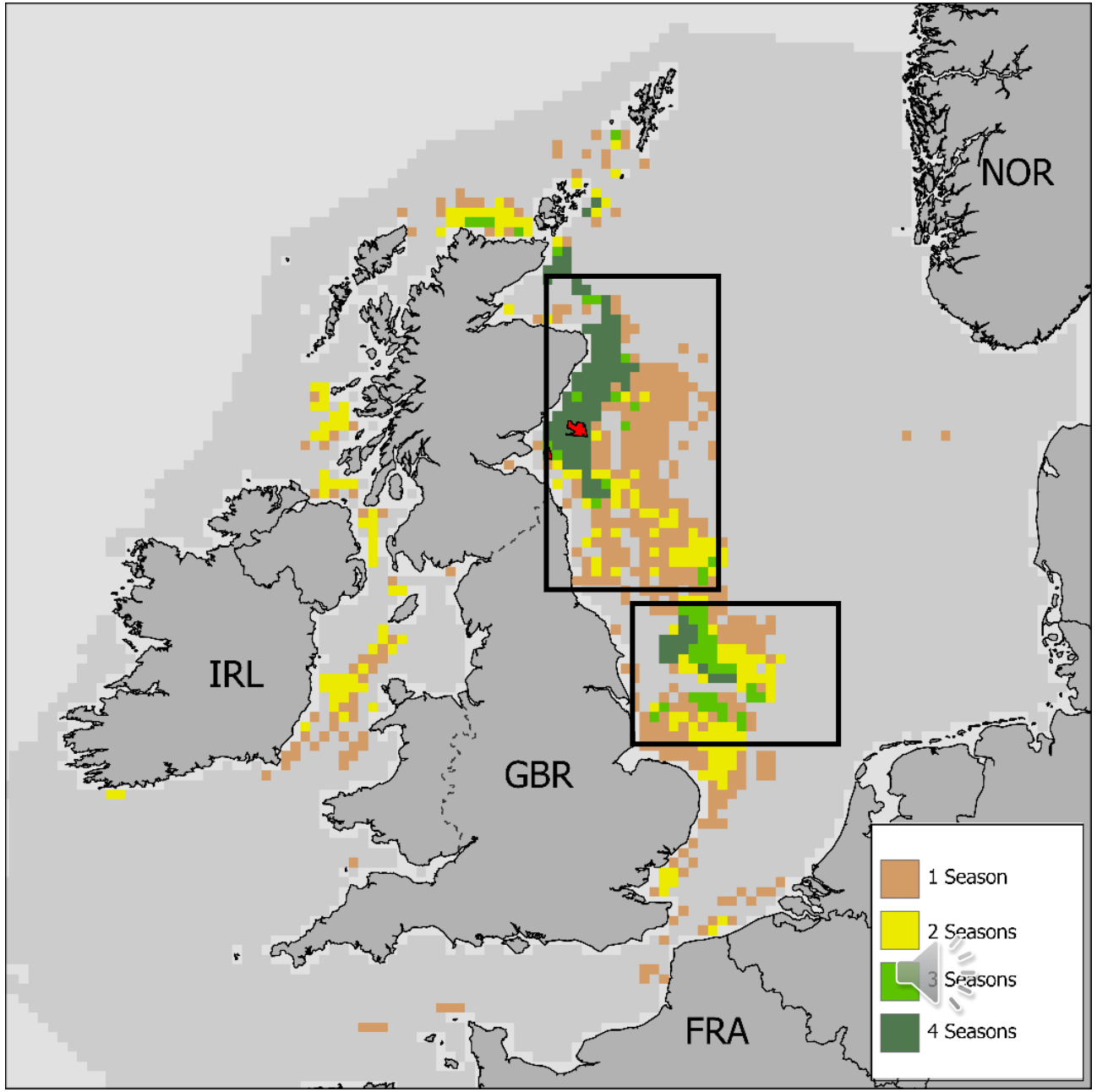


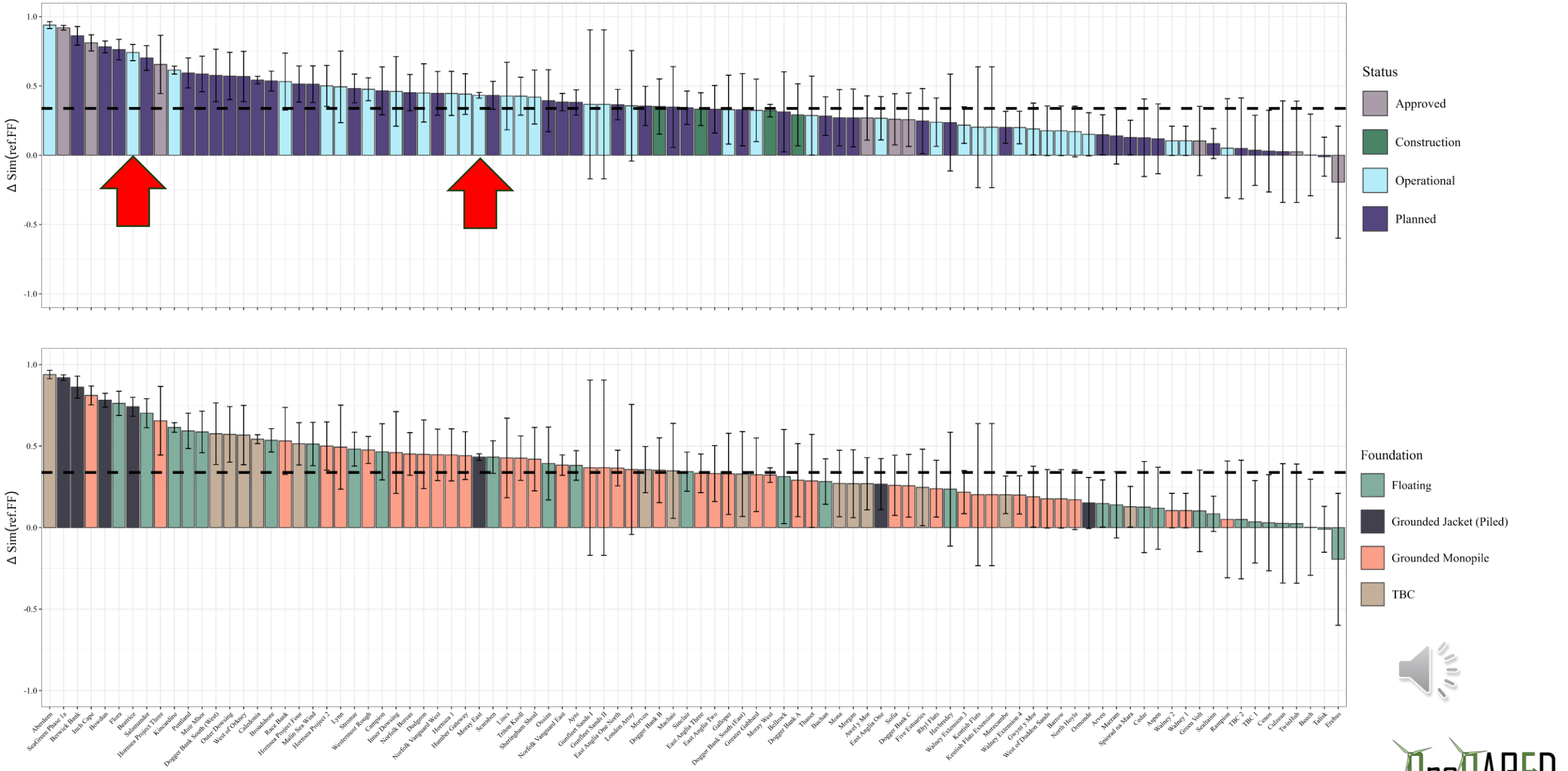
Firth of Forth year-round similarity

Year-round similarity

- Persistent year-round patterns: consistently high similarity (>0.6)
  1. East coast of Scotland
  2. Central North Sea

- 2 seasons of highly similar:
  1. Northern Scotland
  2. Eastern England
  3. Irish Sea

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West of Orkney
Caledonia
Broadshore
Race Bank
Hornsea Project Four
Mainstream Sea Wind
Hornsea Project 2
Lynn
Stronsar
Westermost Rough
Cumpton
Inner Dowsing
Norfolk Boreas
Dudgeon
Norfolk Vanguard West
Hornsea 1
Humber Gateway
Moray East
Scanbeen
Lincs
Triton Knoll
Sheringham Shoal
Ossian
Norfolk Vanguard East
Ayre
Gunfleet Sands I
Gunfleet Sands II
East Anglia One North
London Array
Morven
Dogger Bank B
Marchar
Sinclair
East Anglia Three
East Anglia Two
Gallopper
Dogger Bank South (East)
Greater Gabbard
Moray West
Bellrock
Dogger Bank A
Thanet
Buchan
Mona
Morgan
Awel y Mor
East Anglia One
Sofia
Dogger Bank C
Five Estuaries
Rhyl Flats
Hexbeedey
Walney Extension 3
Kentish Flats
Kentish Flats Extension
Morecambe
Walney Extension 4
Gwynt y Mor
West of Duddon Sands
Barrow
North Hoyle
Ormonde
Arven
Marram
Spioraid na Mara
Cedar
Aspen
Walney 2
Walney 1
Green Volt
Scaitains
Rampion
TBC 2
TBC 1
Cenos
Culzean
TwinHub
Beech
Talisk
Erchus

Discussion

Conclusion

- High environmental similarity exists between PrePARED sites and Scotland's east coast wind farms across all seasons
- The Dogger Bank region in the central North Sea shows consistent year-round similarity to Moray Firth sites
- Future planned wind farms demonstrate higher similarity to Moray Firth sites
- Farms with grounded jacket systems have significantly higher similarity to Firth of Forth sites

Key Take-home message

- PrePARED findings are potentially transferable to future areas of offshore wind, though caveats will always exist

Considerations & Applications

Considerations

- Uncertainty exists regarding how the foundation type might influence prey-predator assemblages
- We don't fully understand how the interactions of biogeographical variables drive ecology
- Current analysis focuses on abiotic factors only

Future

- Expand analysis to include European offshore wind farms
- Incorporate upcoming Round 5 leasing sites
- Include biotic factors alongside the environmental variables
- Potential to integrate with marine mammal and seabird distribution data

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PrePARED

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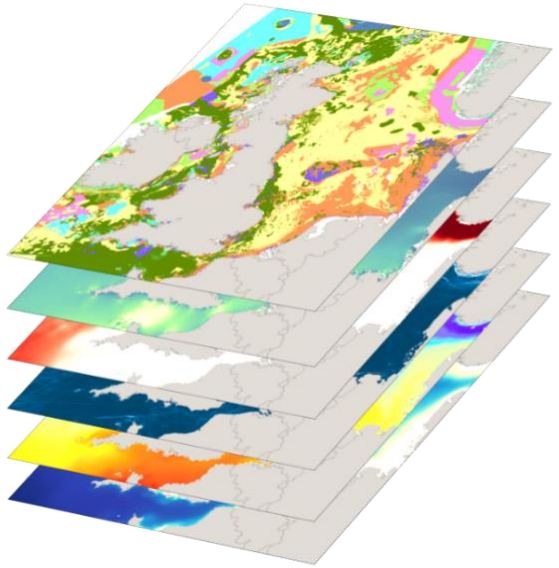
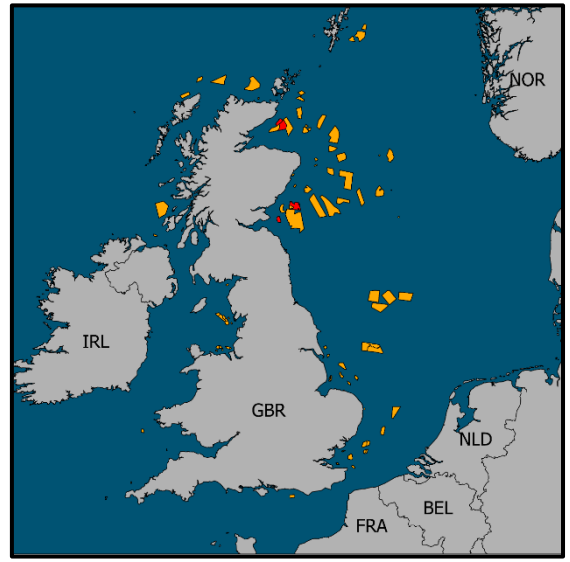
Thank you!





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