Evidence on the distribution and population structure of whiting (*Merlangius merlangus*) in Welsh waters

Report No: 998

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Contents

About Natural Resources Wales 1

Evidence at Natural Resources Wales 1

Distribution list 2

Recommended citation for this volume: 2

Contents 3

List of figures 4

List of tables 6

Crynodeb gweithredol 7

Executive summary 9

1 Introduction 11

2 Evidence review methodology 13

2.1 Literature search 13

2.2 Online data sources and data handling 14

2.2.1 Common data sources 15

3 Synthesis of evidence 20

3.1 Historical data and information 20

3.2 Summary of evidence sources reviewed 23

3.3 Population distribution 23

3.3.1 Life stage – eggs 24

3.3.2 Life stage – larvae 27

3.3.3 Life stage – juveniles 30

3.3.4 Life cycle process – nursery grounds 34

3.3.5 Life stage – adults 37

3.3.6 Life cycle process – spawning grounds 41

3.4 Population and genetic structure 43

3.4.1 Genetic studies 43

3.4.2 Tagging and movement studies 44

3.4.3 Synthesis of population and genetic structure 45

3.5 Summary of uncertainties and gaps 46
4 Conclusions and discussion 46
4.1 General trends in life stages and spatial distribution 47
4.2 Spatial coverage and data strengths 47
4.3 Limitations and key uncertainties 47
4.4 Recommendations 48
5 References 50
Appendix 1: Literature search terms used 54
Appendix 2: Literature confidence scores 55
Appendix 3: Population distribution datasets 60
Appendix 4: Data archive appendix 118

List of figures

Figure 1. Map of the Welsh Zone and adjacent waters, including ICES areas 7a, f and g. 12
Figure 2. Olsen's Piscatorial Atlas – whiting distribution. Whiting distribution is depicted using qualitative shading to indicate *general distribution*, *where caught in abundance*, and *spawning localities* (Source: Olsen, 1883). 22
Figure 3 Synthesis map for whiting eggs in Welsh and surrounding waters (Sources: Ellis et al., 2024; Cefas, 1995; 2000; 2006; 2008; 2010). Legend units are numbers of eggs per sample. 26
Figure 4. Synthesis map for whiting larvae in Welsh and surrounding waters (Sources: Cefas, 1995; 2000; 2006; 2008; 2009; 2010; Ellis *et al.*, 2012). Legend units are numbers of larvae per sample. 29
Figure 5. Synthesis map for whiting juveniles in Welsh and surrounding waters (Sources: ICES, 2025a; Natural Resources Wales, 2025; Ellis *et al.*, 2012; Campanella and van der Kooij (2021). Legend units are numbers of juveniles per sample for ICES 2025a, Ellis et al. 2012 and Natural Resources Wales 2025. 33
Figure 6. Synthesis map for whiting nursery grounds in Welsh and surrounding waters (Sources: Marine Directorate, 2023; Coull *et al.,* 1998; Ellis *et al.*, 2012; Marine Institute, 2018) 37
Figure 7. Synthesis map for whiting adults in Welsh and surrounding waters (points) (Sources: ICES, 2025a; NRW, 2025; OBIS, 2025). Legend units are numbers of adults per sample. 40
Figure 8. Synthesis map for whiting adults in Welsh and surrounding waters (rasters) (Sources: Campanella and van der Kooij, 2021; Cefas/ABPmer, 2010). 41
Figure 9. Synthesis map for whiting spawning grounds in Welsh and surrounding waters (Sources: Campanella and van der Kooij, 2021; Coull *et al.*, 1998; Ellis *et al.*, 2012; Marine Institute, 2018). 43
Figure 10. Whiting egg distribution (Source: Ellis *et al.*, 2012) 61

Figure 11. Whiting egg distribution (Source: Cefas, 1995; 2000).....63
Figure 12. AEPM sampling stations from 1995 and 2000 surveys (Source: Cefas, 1995; 2000).....64
Figure 13. Whiting egg abundance and distribution in Irish Sea Fish Egg Production Surveys 2006, 2008, 2010 (Source: Cefas, 2006; 2008; 2010). 65
Figure 14. Stage IA whiting egg abundance (eggs m^{-2} sea surface area) in the Irish Sea in (a) early March (Survey 1); (b) late March (Survey 2); (c) early April (Survey 3); (d) late April (Survey 4) (Source: Heffernan *et al.*, 2004). 66
Figure 15. Whiting larvae samples (Source: Cefas, 2023).....68
Figure 16. Distribution of abundance of whiting larvae in Welsh and surrounding waters. Black crosses denote sampling stations (Source: Ellis *et al.*, 2012). 70
Figure 17. Whiting larvae recorded in AEPM 1995 and 2000 surveys (Source: Cefas 1995; 2000).....72
Figure 18. Relative abundance of whiting larvae across Irish Sea Fish Egg Production Surveys (Cefas, 2006; 2008; 2010). 74
Figure 19. Juvenile whiting maximum abundance recorded at each station (left) and presence value (right). 1 = presence in 1 or more tows at each station 50 = present in over 50% of tows at each station 70 = present in over 70% of tows at each station. (Source: Ellis *et al.*, 2012). 76
Figure 20. Hotspot map of juvenile whiting in Welsh and surrounding waters in Q4 (left) and Q1 (right) (Source: Campanella and van der Kooij, 2021). 77
Figure 21. Points graduated in size by counts of juvenile (<19 cm) whiting in survey hauls found within the DATRAS database (Source: ICES, 2025a).....79
Figure 22. Number of juvenile (≤19 cm) whiting caught and recorded in Sea Angling Diary data (2016 – 2024) (Source: Cefas, 2025).....81
Figure 23. Juvenile whiting recorded at sites in Welsh estuaries (Source: NRW, 2025).....82
Figure 24. Whiting nursery areas (Source: Coull *et al.*, 1998). 85
Figure 25. Areas of high and low whiting nursery ground intensity (Source: Ellis *et al.*, 2012).....87
Figure 26. Whiting nursery grounds (Marine Institute, 2018) 89
Figure 27. Modelled whiting nursey areas (Source: Marine Directorate, 2023). 91
Figure 28. Adult whiting recorded at sites in Welsh estuaries (Source: NRW, 2025).....93
Figure 29. Spatial distribution and abundance of whiting from ICES DATRAS records, 2000 – 2024 (Source: ICES, 2025a).....94
Figure 30. Hotspot map of adult whiting in Welsh and surrounding waters in Q4 (Source: Campanella and van der Kooij, 2021).....96
Figure 31. OBIS whiting occurrence points. Red points are graduated in size by individual count, where available. Green points represent occurrence where no counts were recorded. (Source: OBIS, 2025) 98
Figure 32. Distribution of whiting by ICES statistical rectangle, based on fisheries-independent groundfish survey data. Values represent average abundance (CPUE) per one-hour tow derived from GOV otter trawl surveys, aggregated to the ICES rectangle scale (Source: CEFAS, 2010).....100
Figure 33. Abundance of whiting per hour tow using beam trawl (left) and Portuguese high headline trawl (right) (Source: Cefas, 2010). 101
Figure 34. Aggregated landings and discards of whiting by ICES sub-rectangle, 2014 to 2024 (Source: MMO, 2025). 102

Figure 35. Total number of adult whiting caught, 2016 – 2024, by ICES rectangle (Cefas, 2025)..... 104
Figure 36. Total number of unmeasured whiting caught, 2016 – 2024, by ICES rectangle (Source: Cefas, 2025)..... 105
Figure 37. Distribution of UK and Irish whiting fisheries in the 1960s. 1 – Rockabill: Lambay in August and September; 2 – Chickens: French fish here all year; 3 – spring fishery February to April (Source: Brander, 1977)..... 107
Figure 38. Spawning grounds of whiting with higher, lower and undetermined intensity. (Source: Coull *et al.*, 1998)..... 109
Figure 39. High and low intensity spawning areas (Source: Ellis *et al.*, 2012)..... 111
Figure 40. Hotpot map of adult whiting in Welsh and surrounding waters in Q1 coinciding with their known spawning period (Source: Campanella and van der Kooij, 2021)..... 113
Figure 41. Whiting spawning grounds (Source: Marine Institute, 2018)..... 115
Figure 42. Modelled whiting spawning areas (Source: Scottish Marine Directorate, 2023). 117

List of tables

Table 1. Summary of common data sources providing evidence of occurrence for whiting in Welsh waters. 18
Table 2. Source of digital spatial data collated from online source / data portals summarised by lifecycle and process stage for whiting. “A” represent absence of evidence and “P” represent presence of evidence. 23
Table 3. Number of juvenile (≤19 cm) whiting caught and recorded in Sea Angling Diary data by ICES rectangle (2016 – 2024)..... 80
Table 4. Number of adult (>19 cm) whiting caught and recorded in Sea Angling Diary data by ICES rectangle (2016 – 2024)..... 103

Crynodeb gweithredol

Mae gan ddyfroedd Cymru ystod amrywiol o gynefinoedd gwely'r môr a cholofn ddŵr sy'n cynnal llawer o rywogaethau o bysgod morol o werth cadwraethol, ecolegol, masnachol a hamdden. Er mwyn llywio ein cyngor ar gadwraeth natur, mae Cyfoeth Naturiol Cymru (CNC) yn anelu at ddefnyddio'r dystiolaeth orau sydd ar gael ynghylch ble i ddod o hyd i'r rhywogaethau pysgod hyn, ble mae'r ardaloedd pwysig i'r rhywogaeth, a sut y mae'r rhywogaethau yn defnyddio dyfroedd Cymru ar draws eu cylchred oes.

Mae'r adroddiad hwn wedi adolygu a syntheseiddio'r dystiolaeth sydd ar gael ar ddosbarthiad a strwythur poblogaeth gwyniaid môr (*Merlangius merlangus*) o fewn dyfroedd Cymru. Mae'r adroddiad yn darparu sylfaen dystiolaeth wedi ei choladu ar gyfer y rhywogaeth hon i'w defnyddio gan CNC, ac y mae hefyd yn nodi bylchau allweddol yn y dystiolaeth.

Dewiswyd y rhywogaeth hon fel un â blaenoriaeth gychwynnol yn seiliedig ar ein hanghenion o ran cyngor cadwraeth, ac fel y'i rhestrir o dan adran 7 o Ddeddf yr Amgylchedd (Cymru) 2016 Rhestr Adran 7: rhywogaethau a chynefinoedd o bwysigrwydd pennaf yng Nghymru | LLYW.CYMRU. Gall y dystiolaeth sydd yn yr adroddiad hwn fod yn ddefnyddiol hefyd i sefydliadau eraill wrth reoli gwyniaid môr yn nyfroedd Cymru, neu asesu'r effeithiau arnynt.

Mae'r adroddiad wedi cyfuno adolygiad systematig o lenyddiaeth academaidd gyhoeddedig ac adroddiadau technegol, wedi ei ategu gan ddadansoddiad pwrpasol o setiau data arolygon sy'n annibynnol ac yn ddibynnol ar bysgodfeydd sy'n bodoli eisoes, a thystiolaeth anecdotaidd pan fo ar gael. Mae'r setiau data arolwg sydd wedi eu dadansoddi yn cynnwys rhaglenni arolwg rhyngwladol sy'n mynd rhagddynt ac a gydlynir gan Gyngor Rhyngwladol Archwilio'r Môr (ICES) a rhaglenni arolwg cenedlaethol a gydlynir gan Ganolfan Gwyddorau'r Amgylchedd, Pysgodfeydd a Dyframaethu (CEFAS) a CNC, yn ogystal â setiau data hanesyddol.

Mae'r adolygiad wedi canolbwyntio ar ddyfroedd Cymru ac ardaloedd cyffiniol Môr Iwerddon, y Môr Celtaidd a Môr Hafren, gan gydnabod pwysigrwydd cysylltedd rhanbarthol. Mae'r dystiolaeth wedi ei dadansoddi a'i chyflwyno yn ôl camau bywyd allweddol a phrosesau cylchred oes (wyau, larfâu, pysgod ifanc, meithrinfeydd, oedolion a silio) er mwyn caniatáu cymhariaeth rhwng camau bywyd a rhywogaethau.

Mae dosbarthiad cyfnodau cynnar bywyd gwyniaid môr yn nyfroedd Cymru yn dangos cydlyniant gofodol cryf, gan nodi Môr Iwerddon, yn enwedig oddi ar arfordir Gogledd Cymru, fel ardal lle maent yn silio ac yn dod yn rhan o'r boblogaeth o bysgod sy'n cael eu rheoli. Cofnodwyd yr wyau gwyniaid môr mwyaf cyson rhwng aber afon Dyfrdwy a dwyrain Ynys Môn, sy'n dangos bod y rhanbarth hwn yn ganolfan bwysig ar gyfer cynhyrchu wyau. Gostyngodd toreithrwydd yr wyau i'r gogledd a'r gogledd-orllewin o Ynys Môn, ac roedd yn gyffredinol isel ar hyd arfordir Gorllewin Cymru, Bae Aberteifi, a'r Môr Celtaidd, er y gallai ymdrech arolygu gyfyngedig yn y rhanbarthau hyn gyfrannu at brinder o ran cofnodion.

Roedd dosbarthiadau cynrhonaidd yn adlewyrchu patrymau silio yn agos. Roedd y crynodiadau cynrhonaidd uchaf yn ardaloedd ysgafell ddwyreiniol a gorllewinol Môr

Iwerddon, yn enwedig rhwng aber afon Dyfrdwy ac Ynys Môn, ac roedd nifer is yn nyfroedd dyfnach canolog Môr Iwerddon. Roedd larfâu yn llai cyffredin ar hyd arfordir Gorllewin Cymru ac ym Mae Aberteifi, er bod crynodiadau cymedrol i'w gweld yn lleol ym Mae Caernarfon, de Bae Ceredigion, ac oddi ar y môr yn ne-orllewin Sir Benfro.

Roedd toreth o wyniaid ifanc ym Môr Iwerddon, yn enwedig o amgylch aber afon Dyfrdwy, Bae Lerpwl, ardal Ynys Manaw, ac arfordir Gogledd Cymru. Mae ardaloedd meithrin a 'recriwtio' ychwanegol wedi eu nodi ym Môr Hafren, Bae Caerdydd, a systemau aberol afon Taf, afon Wysg, afon Gwy ac afon Hafren. Mae tystiolaeth yn awgrymu strategaeth feithrin dau gam. Mae pysgod sero oed yn meddiannu cynefinoedd bas ar y glannau, a physgod ifanc hŷn yn ymestyn i gynefinoedd trawsnewidiol alltraeth ehangach.

Roedd y gwyniaid môr llawndwf i'w canfod yn eu crynodiadau uchaf mewn dau ardal allweddol: arfordir Gogledd Cymru, ac oddi ar yr arfordir i'r de-orllewin o Sir Benfro. Cofnodwyd gwyniaid môr llawndwf yn rheolaidd hefyd ym Môr Hafren, baeau arfordirol, ac amgylcheddau aberol. At ei gilydd, mae dosbarthiad y gwyniaid môr yn nyfroedd Cymru yn adlewyrchu newidiadau ontogenetig o ran cynefinoedd, rhwng silfeydd mewn dŵr dyfnach, swyddogaethau meithrinfa ar gyfer pysgod ifanc sy'n gysylltiedig â chynefinoedd arfordirol ac aberol bas, a defnydd ehangach o ecosystemau arfordirol ac alltraeth gan bysgod llawndwf dan ddylanwad ffactorau megis dyfnder, swbstrad, tymheredd, a mudo tymhorol.

Mae poblogaethau gwyniaid môr yn nyfroedd Cymru yn rhan o fetaboblogaeth y Môr Celtaidd–Môr Iwerddon wedi ei chysylltu'n eang, a nodweddir gan wahaniaethu genetig gwan, cysylltedd cryf yng nghyfnod cynnar bywyd, a 'recriwtio' amrywiol yn ofodol. Mae'r broses o strwythuro poblogaethau yn cael ei hysgogi'n bennaf gan brosesau ymddygiadol ac ontogenetig yn hytrach nag ynysu genetig, ac mae cynefinoedd meithrin Cymru yn cyfrannu at stociau pysgod llawndwf ar draws yr ecosystem rhanbarthol ehangach.

Canfuwyd bod cwmpas ac ansawdd y dystiolaeth a nodwyd yn ystod yr adolygiad yn amrywio yn ofodol. Mae Môr Iwerddon (gan gynnwys Bae Lerpwl) yn gymharol gyfoethog o ran data ynghylch gwyniaid môr, ac mae setiau data lluosog yn dangos patrymau cyson mewn llawer o achosion. Mewn cyferbyniad, mae gwybodaeth o fewn Bae Ceredigion, Môr Hafren a'r Môr Celtaidd yn fwy cyfyngedig. Yn gyffredinol, nid yw cynefinoedd bas, ar y glannau neu anodd eu samplu wedi eu cynrychioli cystal yn y data. Mae cwmpas amseryddol y data yn amrywio, gyda llawer o arolygon blynyddol yn cael eu cynnal yn ystod tymor penodol yn unig bob blwyddyn, sy'n cyfyngu ar ddealltwriaeth o amrywioldeb tymhorol a rhyngflynyddol, ac ychydig o arolygon sy'n darparu cyfres amser gyflawn a pharhaus o ddata. Yn olaf, mae ansicrwydd ynghylch union leoliad a maint y silfeydd, sy'n adlewyrchu gwahaniaethau mewn ffynonellau data a dulliau.

At ei gilydd, mae'r adroddiad yn darparu tystiolaeth sy'n nodi ardaloedd pwysig o fewn dyfroedd Cymru ar gyfer gwyniaid môr, yn enwedig ar gyfer camau cynnar bywyd. Mae'r adroddiad wedi tynnu sylw at fylchau clir mewn tystiolaeth a data ar gyfer dyfroedd Cymru o ran y rhywogaeth hon, gan gynnwys mewn ardaloedd a thymhorau sydd wedi eu samplu'n ddigonol. I lenwi'r bylchau hyn, byddai angen gwaith monitro cyson a hirdymor wedi ei dargedu, a gellid ei integreiddio wedyn â gwybodaeth amgylcheddol ehangach.

Executive summary

Welsh waters have a diverse range of seabed and water column habitats that support many marine fish species of conservation, ecological, commercial and recreational value. To inform our nature conservation advice, Natural Resources Wales (NRW) aims to use the best-available evidence on where these fish species occur, where important areas for the species are located and how the species use Welsh waters across their life cycles .

This report has reviewed and synthesised the available evidence on the distribution and population structure of whiting (*Merlangius merlangus*) within Welsh waters. The report provides a collated evidence base for this species for use by NRW, and also identifies key evidence gaps.

This species was selected as an initial priority species based on our conservation advice needs and as it is listed under Section 7 of the Environment (Wales) Act 2016 Section 7 list: species and habitats of principal importance in Wales | GOV.WALES. The evidence contained within this report may also be useful for other organisations when managing, or assessing impacts upon, whiting in Welsh waters.

The report has combined a systematic review of published academic literature and technical reports, supported by targeted analysis of existing fisheries-independent and dependent survey datasets, and anecdotal evidence where available. The survey datasets that have been analysed include ongoing international survey programmes coordinated by the International Council for the Exploration of the Sea (ICES) and national survey programmes coordinated by Centre for Environment, Fisheries and Aquaculture Science (Cefas) and NRW, as well as historical datasets.

The review has focused on Welsh waters and adjacent areas of the Irish Sea, Celtic Sea, and Bristol Channel, recognising the importance of regional connectivity. The evidence has been analysed and presented by key life stages and life cycle processes (eggs, larvae, juveniles, nursery grounds, adults and spawning) to allow comparison between life stages and species.

The distribution of whiting early life stages in Welsh waters shows strong spatial coherence, identifying the Irish Sea, particularly off the North Wales coast, as a spawning and recruitment area. Whiting eggs were most consistently recorded between the Dee Estuary and eastern Anglesey, indicating this region as a major centre of egg production. Egg abundance declined north and northwest of Anglesey and was generally low along the West Wales coast, Cardigan Bay, and the Celtic Sea, although limited survey effort in these regions may contribute to the scarcity of records.

Larval distributions closely mirrored spawning patterns. Highest larval concentrations occurred in the eastern and western shelf areas of the Irish Sea, particularly between the Dee Estuary and Anglesey, with lower abundance in deeper central Irish Sea waters. Larvae were less common along the West Wales coast and in Cardigan Bay, although moderate concentrations were observed locally in Caernarfon Bay, southern Cardigan Bay, and offshore south-west Pembrokeshire.

Juvenile whiting were most abundant in the Irish Sea, especially around the Dee Estuary, Liverpool Bay, the Isle of Man region, and the North Wales coast. Additional nursery and recruitment areas are identified in the Bristol Channel, Cardiff Bay, and the Taff, Usk, Wye, and Severn estuarine systems. Evidence suggests a two-stage nursery strategy, with age-0 fish occupying shallow inshore habitats and older juveniles extending into broader offshore transitional habitats.

Adult whiting exhibited highest concentrations in two key areas: the North Wales coast and offshore waters south-west of Pembrokeshire. Adults were also regularly recorded in the Bristol Channel, coastal bays, and estuarine environments. Overall, whiting distribution in Welsh waters reflects ontogenetic habitat shifts, between deeper water spawning grounds, juvenile nursery functions associated with shallow coastal and estuarine habitats, and broader adult utilisation of coastal and offshore ecosystems influenced by depth, substrate, temperature, and seasonal migrations.

Whiting populations in Welsh waters form part of a broadly connected Celtic Sea–Irish Sea metapopulation, characterised by weak genetic differentiation, strong early-life-stage connectivity, and spatially variable recruitment. Population structuring is driven primarily by behavioural and ontogenetic processes rather than genetic isolation, with Welsh nursery habitats contributing to adult stocks across the wider regional ecosystem.

The coverage and quality of evidence identified during the review has been found to vary spatially. The Irish Sea (including Liverpool Bay) is relatively rich in data for whiting, with multiple datasets showing consistent patterns in many cases. In contrast, information within Cardigan Bay, the Bristol Channel and the Celtic Sea is more limited. Shallow, inshore or difficult to sample habitats are also generally less well represented within the data. Temporal coverage of the data varies, with many annual surveys only carried out during a specific season each year which limits understanding of seasonal and interannual variability, and with few surveys providing a complete and ongoing time-series of data. Finally, there is uncertainty in the precise location and extent of spawning grounds, reflecting differences in data sources and methods.

Overall, the report provides evidence identifying important areas within Welsh waters for whiting, particularly for early life stages. The report has highlighted clear gaps in evidence and data for Welsh waters for this species including in under sampled areas and seasons. To fill these gaps, consistent and long-term targeted monitoring would be necessary which could then be integrated with wider environmental information.

1 Introduction

Welsh waters, encompass parts of the Irish Sea, Celtic Sea, Bristol Channel, St George's Channel and Cardigan Bay, and ICES areas 7a, 7f and 7g (Figure 1). They support a diverse assemblage of marine fish species that are integral to the functioning of marine ecosystems and the sustainability of marine fisheries. Seabed and water column habitats in Welsh waters encompass a wide range of environmental conditions and support many different marine fish species of conservation, ecological and commercial value.

To inform our nature conservation advice, Natural Resources Wales (NRW) aims to use the best-available evidence on where these fish species occur, where important areas for the species are located and how the species use Welsh waters across their life cycles.

To provide a collated evidence base for use by NRW, and identify evidence gaps, this report has reviewed and synthesised the available evidence on the distribution and population structure of whiting (*Merlangius merlangus*) within Welsh waters.

This species is listed under Section 7 of the Environment (Wales) Act 2016 Section 7 list: species and habitats of principal importance in Wales | GOV.WALES and was selected by NRW as an initial priority species based on a combination of its conservation, ecological and commercial value, as well as relevance to current NRW conservation advice needs.

Whiting has depleted populations in Welsh waters and is under pressure from multiple factors, including climate change, habitat degradation, and fishing mortality. The species fulfils an important trophic role and position in marine food webs, including as a key prey species for a range of predators such as piscivorous fish, seabird, and marine mammal species. Finally, the species is of commercial and recreational importance in fisheries in Welsh and wider UK waters.

The report presents the results of the analysis of identified literature and data sources, which have been reviewed and synthesised to present evidence on the distribution and population structure of whiting in Welsh waters. The evidence has been analysed and presented for the species by key life stages and life cycle processes (eggs, larvae, juveniles, nursery grounds, adults and spawning) to allow comparison between life stages.

Welsh inshore waters have been defined in this report as fully-marine and estuarine waters within 12 nautical miles of baselines, and Welsh offshore waters have been defined in this report as all waters outside 12 nautical miles of baselines to the limit of the Welsh Zone. Both Welsh inshore and offshore waters are shown on Figure 1.

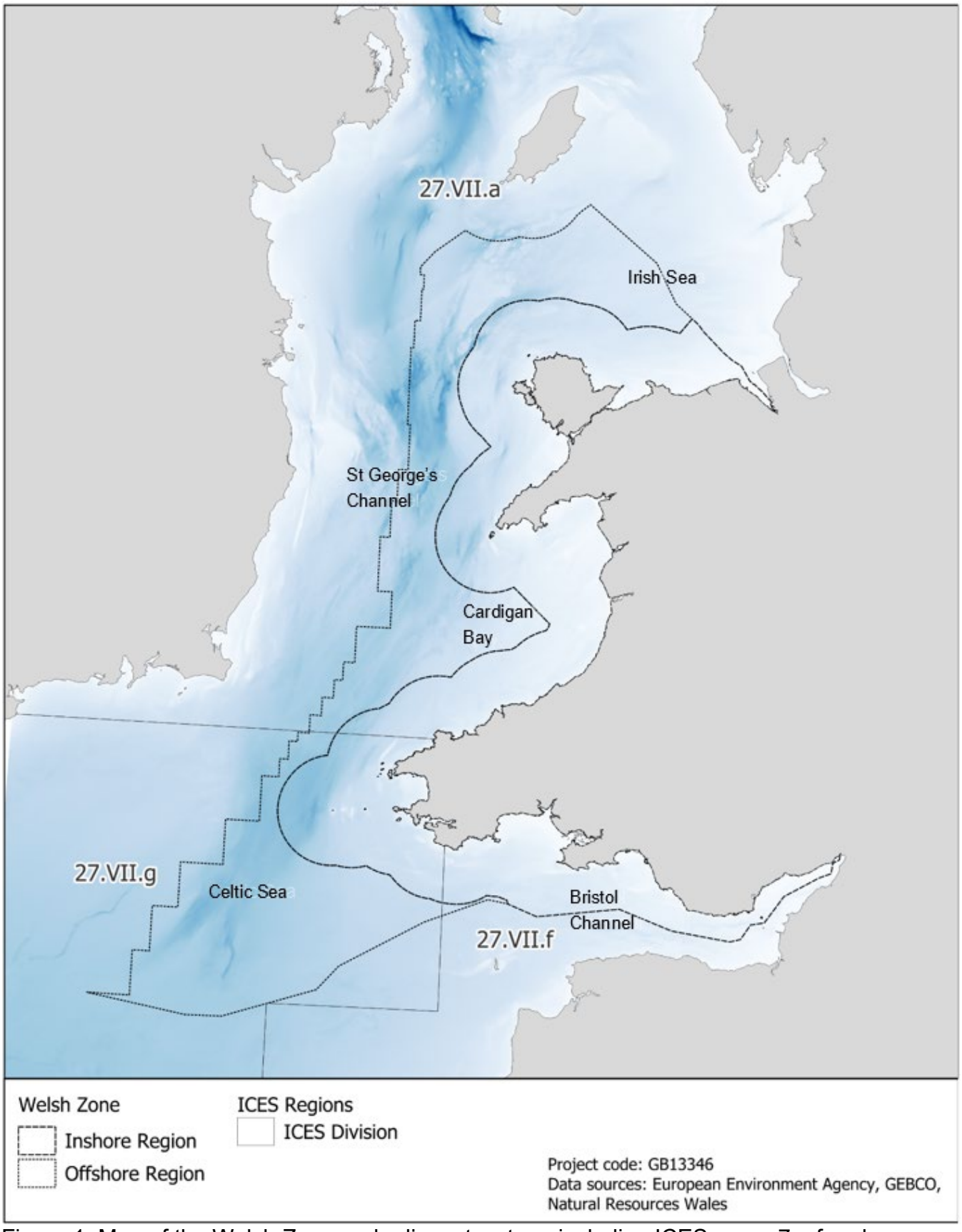


Figure 1. Map of the Welsh Zone and adjacent waters, including ICES areas 7a, f and g.

2 Evidence review methodology

2.1 Literature search

A literature review was conducted to identify published evidence sources relevant to whiting in Welsh waters. All literature searches were undertaken using Google Scholar. Search strings were developed to capture key biological, ecological, behavioural, environmental, and fisheries-related themes relevant to each species. The full list of search terms used is provided in Appendix 1.

Five distinct search strings were applied for the literature search. For each search string, the first 50 search results were downloaded. Each search result was tagged according to the search string from which it was identified to retain information on search provenance.

All search results were imported into a Zotero reference library. Duplicate records were identified and removed based on title matching. Where duplicate records were identified across multiple search strings, tags were merged to ensure that papers captured by more than one search string retained all relevant search term identifiers.

Records were then screened sequentially by title and abstract to assess their relevance to the project. During screening, studies were considered relevant if they

(i) focused on populations within the assessment area (Irish and Celtic Seas recognising the importance of regional connectivity);

(ii) provided biological, ecological, behavioural, or fisheries-related information applicable to the life stages included in this study; or

(iii) addressed themes directly aligned with the project objectives (e.g. spatial distribution, habitat use and environmental drivers).

Studies lacking geographical, stock-specific, life-stage, or thematic alignment were excluded at this stage.

All search results that passed title and abstract screening were subsequently reviewed in full. Relevant information was extracted and synthesised, with findings incorporated into the report under the appropriate thematic sections. No formal meta-analysis was undertaken; instead, the review aimed to provide a structured synthesis of the available evidence to support interpretation and discussion of species distributions at various life stages.

Within the project Zotero database developed to support the literature review, references were tagged according to search origin and search strategy. References cited within the report have been provided separately in Appendix 2 with associated confidence scores based on a defined confidence assessment scoring framework.

Confidence was assessed using two criteria:

(1) type and quality of source, and

(2) applicability of the evidence to Welsh waters.

Source type and quality was categorised as either High (peer-reviewed literature or official government scientific publications), Medium (scientific grey literature), or Low (non-scientific sources such as media or blog content).

Applicability of the evidence was categorised as either High (data collected specifically within Welsh waters or at a scale explicitly including Welsh waters), Medium (data from adjacent or ecologically comparable waters), or Low (broad NE Atlantic-scale data where Welsh waters form only a small component and spatial resolution limits direct inference).

Each confidence category was assigned a numerical score (High = 5, Medium = 3, Low = 1) and scores were summed to produce an overall confidence rating of Low, Medium, or High.

2.2 Online data sources and data handling

Data on the distribution of whiting in Welsh waters was identified through targeted searches of online data repositories, supplemented by information shared by NRW. Key sources included fisheries landings and recreational sea-angling data, NRW estuarine fish survey datasets, the Cefas Data Hub, Marine Scotland Directorate data, Marine Institute data, ICES data repositories (Database of Trawl Surveys (DATRAS) and egg and larvae datasets), and AquaMaps. These sources provide a mixture of fishery-dependent, and fisheries-independent data, monitoring datasets and environmental observations covering Welsh waters and adjacent areas.

ICES DATRAS data were accessed using the ICES Datras R package (ICES, 2024). Surveys intersecting Welsh waters from the database (including Beam Trawl Survey (BTS), Irish Groundfish Survey (IE-IGFS), Northern Ireland Groundfish Survey (NIGFS), Évaluation Halieutique de l'Ouest Européen (EVHOE), Scottish West Coast Groundfish Survey (SCOWCGFS), and Scottish West Coast Bottom Trawl Survey (SWC-IBTS)) were downloaded for the period 2000–2025, covering all available quarters of the year. Both haul-level and length-frequency data were retrieved for the target species. Haul positions were spatially filtered to a broad bounding box encompassing Welsh waters (longitude −8° to −2°, latitude 50° to 56°) to ensure consistency.

Length data from all datasets were used to classify individuals into juvenile and adult life stages using size thresholds reported by Campanella and van der Kooij (2021): with juveniles being classified as having a total length of ≤19 cm for whiting. This approach allowed for a consistent separation of life stages across datasets where length information was available.

Spatial outputs derived from data sources were summarised using simple aggregations appropriate to the structure of each dataset. Several datasets and publications report sampling periods with reference to the quarter in which the samples were taken. To ensure consistency, we use calendar Quarters throughout this report: Quarter 1 (Q1) spans January–March, Quarter 2 (Q2) April–June, Quarter 3 (Q3) July–September, and Quarter 4 (Q4) October–December. For DATRAS data, haul-level information was summarised by

quarter and aggregated across all available years to illustrate broad seasonal spatial patterns. Where egg or larval data included developmental stages, these were mapped separately. Finally, where data were reported only by period or quarter, spatial outputs reflect those reporting structures.

Where possible, original source data were mapped directly in QGIS. In some instances, data were first processed in R to combine and/or summarise inputs before mapping. The content and resolution of spatial data and mapping varied depending on the underlying data source, with outputs designed to reflect the level of detail supported by the data.

Egg and larval data were also explored through ICES web query tools (ICES, 2025b), with additional plankton survey datasets relevant to the Celtic Sea, Irish Sea, and Bristol Channel identified (including the English Channel and Celtic Sea Sardine and Anchovy plankton survey, Eastern Irish Sea (EIS) Smart Buoy Samples Project Plankton Survey and Zooplankton abundance data derived from the Plankton Imager system from the Western English Channel and Eastern Irish Sea from 2016 to 2019). However, coverage for the target species within Welsh waters was extremely limited within these data. Available records were sparse, sometimes spatially inconsistent, and in several cases lacked species-level resolution or associated length or developmental information. As a result, these datasets were not analysed further for the project.

Spatial data for the project is provided in Appendix 4.

2.2.1 Common data sources

There are several data sources that are used for multiple lifestages in this report. These data sources are primarily the results of surveys conducted in or around Welsh waters. The surveys may have been single year surveys, or conducted across multiple years using the same data collection principles each time to allow changes over time to be identified. The spatial and temporal coverage of these overarching data sources are provided in Table 1, and described as follows:

- **Fisheries spawning and nursery areas in British waters (Coull *et al.*, 1998)** – This dataset provides GIS layers of the main spawning and nursery grounds for 14 commercially important species (including cod, haddock, whiting, herring, mackerel, plaice, sole, sandeels, sprat, and Norway lobster) around the UK. The maps were compiled from data collected by Fisheries Research Services (FRS) and Cefas during the 1990s and represented the widest known distribution of spawning and nursery areas based on egg, larval, juvenile, and adult fish surveys, sediment sampling, and acoustic techniques at the time. Data are presented at ICES rectangle resolution and include species-specific spawning periods and indicative nursery grounds, alongside additional layers on fishing effort and relative economic value.
- **Spawning and nursery grounds of selected fish species in UK waters (Ellis *et al.*, 2012)** – This dataset updates and complements the original Fisheries Sensitivity Maps in British Waters (Coull *et al.*, 1998) by incorporating more recent ichthyoplankton and groundfish survey data and expanding coverage to additional

species of commercial and conservation interest. There are GIS layers for spawning and nursery grounds of 21 species, including cod, herring, whiting, plaice, sole, mackerel, sandeels, and several elasmobranchs (e.g. spurdog, tope, skates, rays). Spawning grounds were inferred from egg and larval distributions in ichthyoplankton surveys, while nursery grounds were identified from juvenile occurrence and catch rates in fishery-independent trawl surveys. Data are mapped at half ICES statistical rectangle resolution, with additional layers indicating sites of higher importance where evidence permitted.

- **Spawning and nursery grounds of forage fish in Welsh and surrounding waters (Campanella and van der Kooij, 2021)** – This study used fisheries-independent acoustic and trawl survey data from 2008–2020 to map key spawning and nursery areas of forage fish across Welsh and adjacent marine waters (Irish Sea, Celtic Sea, western English Channel). A hotspot approach combined multiple surveys and years in Quarters 1 and 4, to identify persistent areas where adults and juveniles were repeatedly recorded, producing indices maps of spawning and nursery grounds.
- **Species spawning and nursery areas (Marine Institute, 2018; revised 2024)** – This dataset provides polygonal locations of spawning and nursery grounds for commercially important species, including cod, herring, haddock, mackerel, monkfish and whiting. Methodological details on how the areas were determined are not provided.
- **Annual Egg Production Method (AEPM) surveys 1995 and 2000 (Cefas 1995; 2000)** – Surveys in 1995 and 2000 collected plankton samples across the Irish Sea to estimate stock size using counts of fish eggs and larvae. They mapped spawning activity of key species (e.g. cod, sole, plaice, whiting) and provide historical evidence on species distribution.
- **Highly mobile fish species distributions in UK waters (Cefas / ABPmer, 2010)** – This dataset provides mapped distributions for 40 taxa (22 teleosts, 17 elasmobranchs, and leatherback turtle) in UK waters, collating data from multiple fishery-independent groundfish and beam-trawl surveys conducted around the UK using GOV trawl, Portuguese High Headline Trawl (PHHT), and 4-m beam trawl gears. The surveys cover a long time-series, from the early 1980s to the late 2000s (e.g. 1982–2008 depending on survey and area), and the dataset includes presence/absence by ICES rectangle for all three gear types, relative abundance (mean individuals per one-hour tow) using GOV trawl at rectangle level, and species abundance per hour tow using PHHT and beam trawl at quarter-rectangle level.
- **Assessment of potential predators of plaice eggs and larvae in the Irish Sea (Cefas, 2023)** – This dataset originates from a Cefas-led study examining potential predators of plaice *(Pleuronectes platessa)* eggs and larvae on a well-defined spawning ground off the north Wales coast in the Irish Sea during February 2008 and 2009. The study combined vertically hauled plankton sampling, acoustic surveys, and targeted trawl sampling to characterise both early life stages and the associated fish community present on the spawning grounds. Plankton samples were preserved and systematically sorted to identify fish eggs and larvae, while

trawl data provided information on the composition and spatial distribution of potential predator and co-occurring fish species. Survey coverage extended across coastal waters within the 12-nautical-mile boundary of north Wales and into adjacent Irish Sea waters off the coast of Ireland.

- **Irish Sea Fish Egg Production Surveys (ISFEPS) (Cefas, 2010)** – This data source combines Cefas-led surveys conducted in the Irish Sea in 2006, 2008, and 2010. The surveys were carried out on a planned sampling grid covering the full Irish Sea, including waters within the 12-nautical-mile boundary of north Wales, and involved systematic plankton sampling at fixed stations during multiple research vessel cruises. The dataset provides station-level counts of fish eggs and larvae, together with associated positional data and volumes filtered.
- **Sea Angling Diary catch records 2016-2024 (Cefas, 2025)** – This dataset comprises raw recreational sea angling diary records provided by Cefas. The data consist of individual fishing-session records submitted by volunteer anglers through the Sea Angling Diary programme and include information at the event level, including year (2016 – 2024), fishing session ID, fishing platform, gear type, ICES rectangle of capture, session length (hours), species recorded, whether fish were kept or returned, and reported lengths. The dataset represents primary catch records and associated fishing effort information at the scale of individual angling trips. The Sea Angling Diary survey is not designed to collect data at the ICES rectangle spatial resolution and so may not be spatially representative, so results should be treated as indicative only.
- **Commercial fisheries landings and discards data (MMO, 2025)** – This dataset contains species-level weights of retained and, where available, discarded catch for whiting from fisheries operating within Welsh waters over the most recent 10-year period (2014–2024). The data are disaggregated by year, month, gear type, vessel characteristics (particularly vessel length), catch position (at ICES statistical sub-rectangle level), and landing port. No raising of these data has been conducted with the discards data presented as supplied from the MMO.
- **DATRAS Fisheries-independent trawl survey data (ICES, 2025a)** – This database includes demersal and pelagic trawl fisheries-independent surveys using consistent survey designs, gear specifications, and haul protocols, primarily conducted under the ICES International Bottom Trawl Survey framework. Data typically span multiple decades (generally from the early 1980s onwards, depending on survey and area) and provide haul-level information on species composition, abundance (numbers and weight per haul), length-frequency distributions, survey timing, gear type, and precise spatial location (latitude–longitude and ICES statistical rectangles).
- **WFD Transitional fish surveys** (**NRW, 2025**) – This dataset comprises individual length measurements for whiting collected through WFD sampling programmes across Welsh marine waters. Sampling was conducted at over 100 unique sites using a range of gears, including otter trawls, beam trawls, fyke nets, and seine nets. Each record includes site identifiers, sampling date, species name, and measured fish length, with associated metadata on sampling effort and gear characteristics.

- **Essential Fish Habitats project data (Marine Directorate, 2023)** – This dataset provides spatial predictions of Essential Fish Habitats (EFH) for 17 fish and shellfish species and life stages in Scottish waters. Offshore EFH distributions were derived using species distribution models calibrated with scientific survey catch data and environmental predictors (e.g. temperature, salinity), while inshore areas were assessed using habitat proxies based on EUNIS habitat types and expert review. Modelled and proxy-derived predictions were validated against independent survey data and expert feedback.
- **AquaMaps standardized species distribution maps (Reygondeau *et al.*, 2025)** – This database contains basic range data for fish species based their environmental "envelope" as provided by Aqua-X at the Rosenstiel School of Marine, Atmospheric, and Earth Science at the University of Miami, Florida.
- **Species occurrence records in Welsh waters (OBIS, 2025)** – The Ocean Biogeographic Information System (OBIS) is a global repository of georeferenced marine species occurrence records compiled from scientific surveys, museum collections, and citizen science observations. Records include species identification, observation date, and location (latitude–longitude), providing fisheries-independent evidence of species presence. For this study, OBIS data for whiting were extracted within Welsh waters using spatial queries, and filtered to remove DATRAS survey records to avoid double-counting with other survey datasets.

Table 1. Summary of common data sources providing evidence of occurrence for whiting in Welsh waters.

Source	Years	Spatial Coverage of Welsh waters	Purpose
Coull *et al.* (1998)	<1998	All Welsh waters	To produce maps of spawning and nursery areas.
Ellis *et al.* (2012)	1990 – 2008	All Welsh waters	To produce maps of spawning and nursery areas.
Campanella and van der Kooij (2021)	2008 to 2020	All Welsh waters	To produce maps of spawning and nursery areas.
Marine institute (2024)	-	All Welsh waters	To produce maps of spawning and nursery areas.
Cefas (1995; 2000)	1995 and 2000	Irish Sea (Cardigan Bay only in 1995)	To improve stock assessment for cod and plaice.
Cefas / ABPmer (2010)	1982 – 2008	All Welsh waters	To aid the selection of Marine Conservation Zones (MCZs) in England and Wales.
Cefas (2023)	2008 – 2009	Irish Sea	To provide data on fish counts, lengths and stomach contents analysis from fish caught in the Irish Sea in 2008 and 2009.
Cefas (2010)	2006, 2008, 2010	Irish Sea	To determine the distribution and abundance of cod, haddock, and plaice eggs.
Cefas (2025)	2016 – 2024	All Welsh waters	To estimate the number of sea anglers, how often they fish and their catch.

Source	Years	Spatial Coverage of Welsh waters	Purpose
MMO (2025)	2014 – 2024	All Welsh waters	To report commercial fish catch.
ICES (2025a)	2000 – 2024	All Welsh waters	To provide fisheries independent metrics of species abundance.
NRW (2025)	1997 – 2024	Welsh Estuaries	To provide data on estuarine fish species presence and abundance.
Marine Directorate (2023)	-	All Welsh waters	To provide spatial layers of Essential Fish Habitats.
AquaMaps (2025)	-	All Welsh waters	To provide species distributions based on environmental parameters.
OBIS (2025)	1912 – 2022	All Welsh waters	To provide information about the distribution and abundance of living species in the ocean.

3 Synthesis of evidence

This section presents the available evidence identified on the distribution and population structure of whiting in Welsh waters. It begins with a summary of historical information on the species and general species context, followed by a summary of the evidence sources reviewed. Subsequent sections describe population distribution within Welsh waters for life stages and associated life-cycle processes, including eggs, larvae, juveniles, nursery grounds, adults, and spawning grounds. Each life stage subsection includes relevant ecological background, spatial distribution, and supporting literature or survey data. Population and genetic structuring is addressed next, followed by key results and a summary of important uncertainties and knowledge gaps.

3.1 Historical data and information

Historical records of fish and fishing in Welsh and surrounding waters provide more limited evidence of whiting compared to other fish species such as herring and cod which are well-documented in Welsh waters before the 20th century. Moore *et al.* (2024), in their study of century-scale changes in fish and fisheries around the Irish Sea coast of Wales, do not mention whiting specifically, although they do note that other gadoids were targeted by various gears throughout the 1800s.

Records of whiting in Welsh waters date back centuries: an early reference to whiting being fished off the south-west coast can be found in George Owen's 1603 Description of Pembrokeshire (Gubbay, 2009; Moore *et al*., 2024). Whiting were also noted as part of fisheries at Caernarfon in north Wales by Morris (1748), indicating that whiting were sufficiently common in the mid-18th century to be noted among principal local species. Even earlier evidence can be found in the stone sea weirs, locally termed *goredi*, of the Menai Strait and Cardigan Bay, where whiting may have been caught at least as early as the 15th Century (Jones, 1983; Kowaleski, 2003).

Historical accounts from west Wales describe whiting trade at St Dogmaels (Ceredigion) operating from the medieval period persisting into the early 20th century, indicating sustained commercial exploitation. Cartographic evidence further supports this historical presence. Figure 2 reproduces George Owen's *Piscatorial Atlas* (Olsen, 1883), which depicts much of the Welsh maritime zone as an area where whiting were "caught in abundance", with areas of low or possibly no occurrence in the upper parts of the Bristol Channel. In all of these areas, however, whiting were but one target of broader, multi-species fisheries, characterised by more important species, particularly herring (Kowaleski, 2003; Smylie, 2015; Moore *et al.*, 2024).

At the start of the 20th Century, whiting were common around the Welsh coast (Gubbay, 2009). Despite exploitation throughout the 20th Century, surveys conducted in the Irish Sea during the 1990s found that whiting remained "relatively abundant" (Gubbay, 2009), with long-term groundfish survey analyses identifying recurrent areas of relatively high abundance within ICES Division VIIa, including grounds off north Wales (Bergmann *et al.*, 2003). The proportion of whiting collected in trawl samples in the Irish Sea was found to have increased between the 1900s and the 1990s (Rogers & Ellis, 2000), although whiting

biomass declined in the region during the late 20th Century, with stock recruitment declining, potentially in relation to increases in sea temperatures (Bentley *et al.*, 2020). Earlier work further indicates that age-0 whiting settle in shallow demersal nursery areas before dispersing offshore with increasing age, demonstrating structured use of inshore and offshore habitats within the wider Irish Sea system (Bowers, 1954).

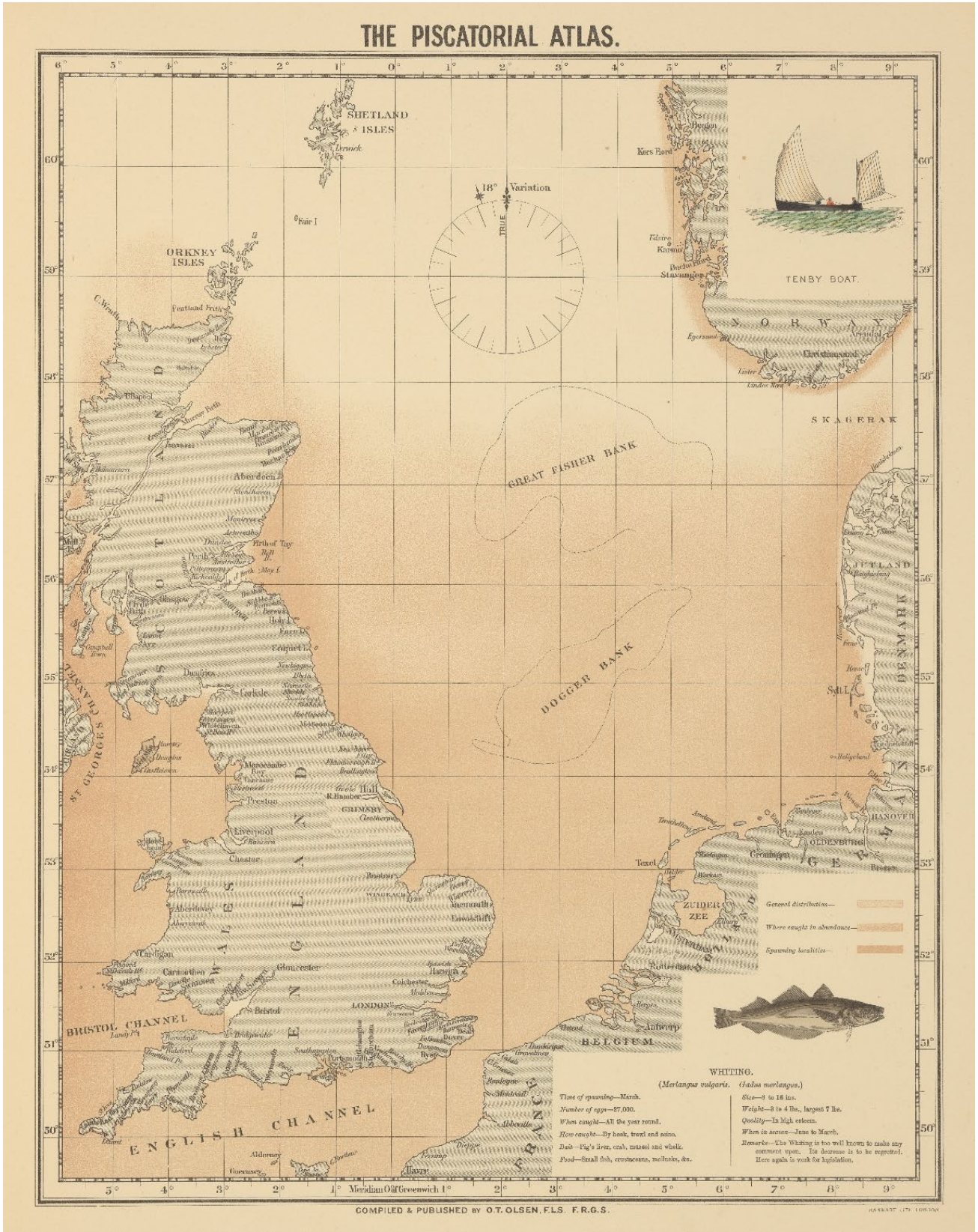


Figure 2. Olsen's Piscatorial Atlas – whiting distribution. Whiting distribution is depicted using qualitative shading to indicate *general distribution*, *where caught in abundance*, and *spawning localities* (Source: Olsen, 1883).

3.2 Summary of evidence sources reviewed

The literature review initially identified a 250 academic and grey literature papers relating to the defined search terms for whiting (Appendix 1). After removing 125 duplicates, 125 unique records remained. Screening by title excluded a further 59, and abstract screening reduced the list to 19 papers considered likely to contain information relevant to this study. A PRISMA flowchart documenting this process is provided in Appendix 1. Four additional sources were identified for review by NRW and incorporated to supplement the evidence base and address identified information gaps. Sources of digital spatial data used in this study have been summarised by life cycle and process in Table 2.

Table 2. Source of digital spatial data collated from online source / data portals summarised by lifecycle and process stage for whiting. “A” represents absence of evidence and “P” represents presence of evidence.

Source	Egg	Larvae	Juvenile	Nursery	Adult	Spawning
Fisheries spawning and nursery areas in British waters (Coull et al., 1998)	A	A	A	P	A	P
Spawning and nursery grounds of selected fish species in UK waters (Ellis et al., 2012)	P	P	P	P	A	P
Spawning and nursery grounds of forage fish in Welsh and surrounding waters (Campanella and van der Kooij, 2021)	A	A	P	A	P	P
Species spawning and nursery areas (Marine Institute, 2018; revised 2024)	A	A	A	P	A	P
Annual Egg Production Method (AEPM) surveys 1995 and 2000 (Cefas 1995; 2000)	P	P	A	A	A	A
Highly mobile fish species distributions in UK waters (Cefas / ABPmer, 2010)	A	A	A	A	P	A
Assessment of potential predators of plaice eggs and larvae in the Irish Sea (Cefas, 2023)	A	P	A	A	A	A
Irish Sea Fish Egg Production Surveys (ISFEPS) (Cefas, 2010)	P	P	A	A	A	A
Sea Angling Diary catch records 2016-2024 (Cefas, 2025)	A	A	P	A	P	A
Commercial fisheries landings and discards data (MMO, 2025)	A	A	A	A	P	A
DATRAS Fisheries-independent trawl survey data (ICES, 2025a)	A	A	P	A	P	A
WFD Transitional fish surveys (NRW, 2025)	A	A	P	A	P	A
Essential Fish Habitats project data (Marine Directorate, 2023)	A	A	A	P	A	P
AquaMaps standardized species distribution maps (AquaMaps, 2025)	A	A	A	A	A	A
Species occurrence records in Welsh waters (OBIS, 2025)	A	A	A	A	P	A

3.3 Population distribution

This section describes the whiting population distribution in Welsh and surrounding waters in the Irish and Celtic Seas. The evidence is presented through sequential life stages and life cycle processes.

3.3.1 Life stage – eggs

Whiting are batch spawners, releasing multiple batches of eggs over a prolonged spawning season that can extend from January to September, with peak spawning in summer in Irish and British waters (Campanella & van der Kooij, 2021). Maturity is reached at around two years, and by four years of age, a single female can produce over 400,000 eggs, which are pelagic, released into the upper water column.

Jaworski (2020) found that adult whiting in the Irish Sea and the adjacent Celtic Sea do not form distinct spawning shoals. Mature and pre-mature whiting are often found together, with spawning timing closely linked to temperature and latitude. As latitude increases, spawning occurs later and generally peaks between January and June, although spawning activity may extend into late summer in parts of the Irish Sea (Campanella & van der Kooij, 2021).

This extended spawning period results in egg production across Welsh and adjacent Irish Sea waters being spread over a relatively long time period through the year. This may influence local recruitment dynamics in Welsh waters.

Data related to the distribution of whiting eggs in Welsh waters were identified through three geospatial datasets as well as a report by Heffernan et al. (2004). The datasets reviewed comprise of:

- Spawning and nursery grounds of selected fish species in UK waters (Ellis et al., 2012);
- Annual Egg Production Method (AEPM) surveys 1995 and 2000 (Cefas 1995; 2000); and
- Irish Sea Fish Egg Production Surveys (ISFEPS) (Cefas, 2010).

Further detail on each dataset is provided in Appendix 3.

3.3.1.1 Synthesis of eggs

There is broad consistency across the available evidence sources on the distribution of whiting eggs in Welsh waters in identifying the North Wales coast, and the Irish Sea more broadly, as a principal area of whiting egg occurrence (Figure 3).

The highest and most consistent egg concentrations were observed in both Welsh inshore waters and Welsh offshore waters along the North Wales coast between the Dee Estuary and eastern Anglesey. Thus, this likely represents a key region for whiting egg production. Lower concentrations of whiting eggs were observed in Welsh waters directly north and north-west of Anglesey.

Whiting eggs were rarely observed along the West Wales coast, in Caernarfon Bay and Cardigan Bay. The scarcity of records of whiting eggs in this region may be influenced by the paucity of surveys, with only Ellis *et al.* (2012) and Cefas (1995, 2000) having sampled the area, and not as consistently as on the North Wales coast.

Whiting eggs were also rarely observed in the Celtic Sea. Only Ellis *et al.* (2012) sampled this region, with no samples collected in the Bristol Channel east of the Gower Peninsula, which may have influenced the scarcity of whiting egg records. Nonetheless, the samples which were collected observed low numbers of whiting eggs, in contrast to the higher concentrations recorded on the North Wales coast.

Key results:

- **Whiting eggs are consistently recorded off the North Wales coast, particularly between the Dee Estuary and Anglesey, identifying this as a key egg production area within Welsh waters and the wider Irish Sea.**
- **There are records of whiting eggs in Cardigan Bay and the Bristol Channel and Celtic Sea, although limited survey coverage in these regions limit the ability to identify important areas in Welsh waters.**

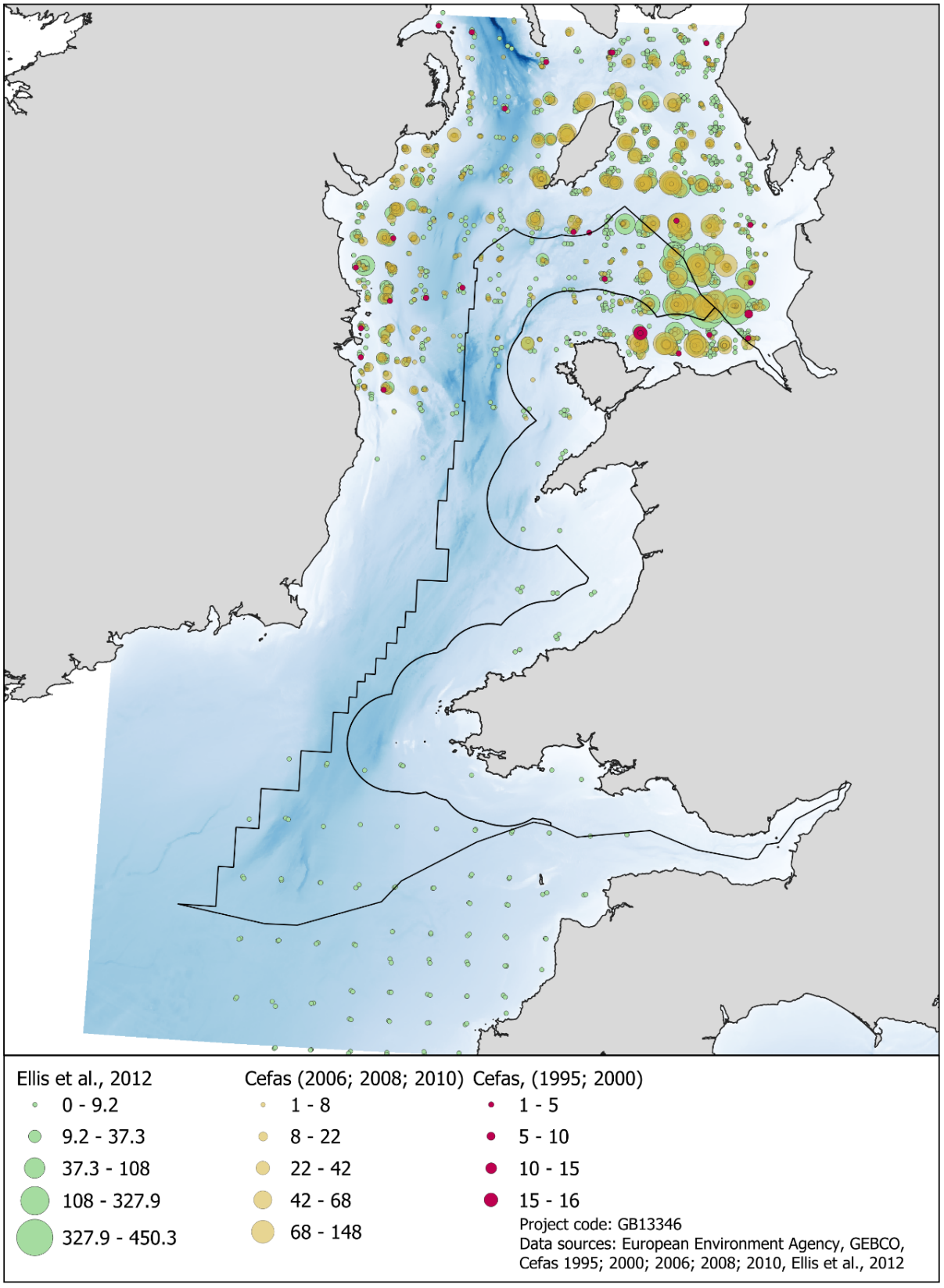


Figure 3 Synthesis map for whiting eggs in Welsh and surrounding waters (Sources: Ellis et al., 2024; Cefas, 1995; 2000; 2006; 2008; 2010). Legend units are numbers of eggs per sample.

3.3.2 Life stage – larvae

Jaworski (2020) found that in their early life stage, whiting larvae spend their first few months in the pelagic environment before settling to the seabed. Larval development and survival is highly influenced by environmental conditions, including temperature and prey availability. Growth during the larval stage is quick and individuals can reach approximately 19 cm by the end of their first year though there is significant variability in growth between individuals, which can affect survival and recruitment success. This variability may contribute to the observed differences in whiting abundance across the Irish Sea and Celtic Sea, including waters adjacent to Wales, and between years.

Bentley *et al.* (2020) found recruitment of whiting was strongly influenced by spawning stock biomass (SSB) and environmental variables, including sea surface temperature and the Atlantic Multidecadal Oscillation (AMO). Recruitment declines were observed at low SSB, and models incorporating temperature significantly improved predictions of recruitment success.

Tirronen *et al.* (2023) found that whiting larvae showed pronounced prey preferences for copepods, particularly *Calanus*. This preference is similar to that of cod larvae, with both species feeding on these zooplankton even when abundances are low, such as in the Irish Sea. The seasonal peak in *Calanus finmarchicus* abundance coincides with the early larval stages of whiting and cod, supporting recruitment success and suggesting linkage to broader environmental oscillations, such as the North Atlantic Oscillation. However, given the extended spawning period of whiting, variability in recruitment success may also reflect dynamics between larval emergence and prey availability.

Data related to the distribution of whiting larvae were identified through four geospatial datasets. The datasets reviewed comprise of:

- Assessment of potential predators of plaice eggs and larvae in the Irish Sea (Cefas, 2023);
- Spawning and nursery grounds of selected fish species in UK waters (Ellis *et al.*, 2012);
- Annual Egg Production Method (AEPM) surveys 1995 and 2000 (Cefas 1995; 2000); and
- Irish Sea Fish Egg Production Surveys (ISFEPS) (Cefas, 2010).

Further detail on each dataset is provided in Appendix 3.

3.3.2.1 Larvae synthesis

Evidence on the spatial distribution of whiting larvae in Welsh waters is derived from four geospatial datasets. Across these sources, there is broad consistency in identifying the Irish Sea as an important area of whiting larvae occurrence, with data from other regions being scarcer (Figure 4).

The Irish Sea was the most consistently surveyed region, with sources in general agreement that this was an area of fairly high whiting larvae concentration, and is consistent with the high occurrence of whiting eggs in this area. Welsh waters between the Dee Estuary in the east and eastern Anglesey in the west represented the region with the highest concentrations of whiting larvae, whereas concentrations were much reduced directly north and north-west of Anglesey. Whiting larvae concentrations in this area appear to be influenced by water depths with lower concentrations in deeper waters of the central Irish Sea, and higher concentrations in the shallower shelf sections in the western and eastern Irish Sea.

Lower concentrations of whiting larvae were generally observed along the West Wales coast, albeit with higher concentrations in Caernarfon Bay and southern Cardigan Bay than in northern Cardigan Bay. Cardigan Bay was, however, sampled with less intensity than the North Wales coast, with only Cefas (1995; 2000) and Ellis *et al.* (2012) sampling this region. Welsh offshore waters in Cardigan Bay and St George's Channel were particularly under-sampled, with observations only being made close to the boundary with Welsh inshore waters.

Only Ellis *et al.* (2012) sampled the South Wales coast, and with low intensity. Moderate concentrations of whiting larvae were, however, recorded within Welsh offshore waters south-west of Pembrokeshire, whereas only very low concentrations were observed within Welsh inshore waters. No samples were taken east of the Gower Peninsula.

Key results:

- **Whiting larvae show a distribution broadly aligned with egg records, particularly off the North Wales coast and central-eastern Irish Sea.**
- **Whiting larvae are consistently recorded by multiple sources of evidence off the North Wales coast.**
- **In the Bristol Channel, Ellis *et al.* (2012) records large number of whiting larvae beyond the Welsh zone in English waters north of Trevose Head, with a small number recorded in Welsh waters.**
- **There are records of whiting larvae in Cardigan Bay and the Bristol Channel and Celtic Sea, although limited survey coverage in these regions limit the ability to identify important areas in Welsh waters.**

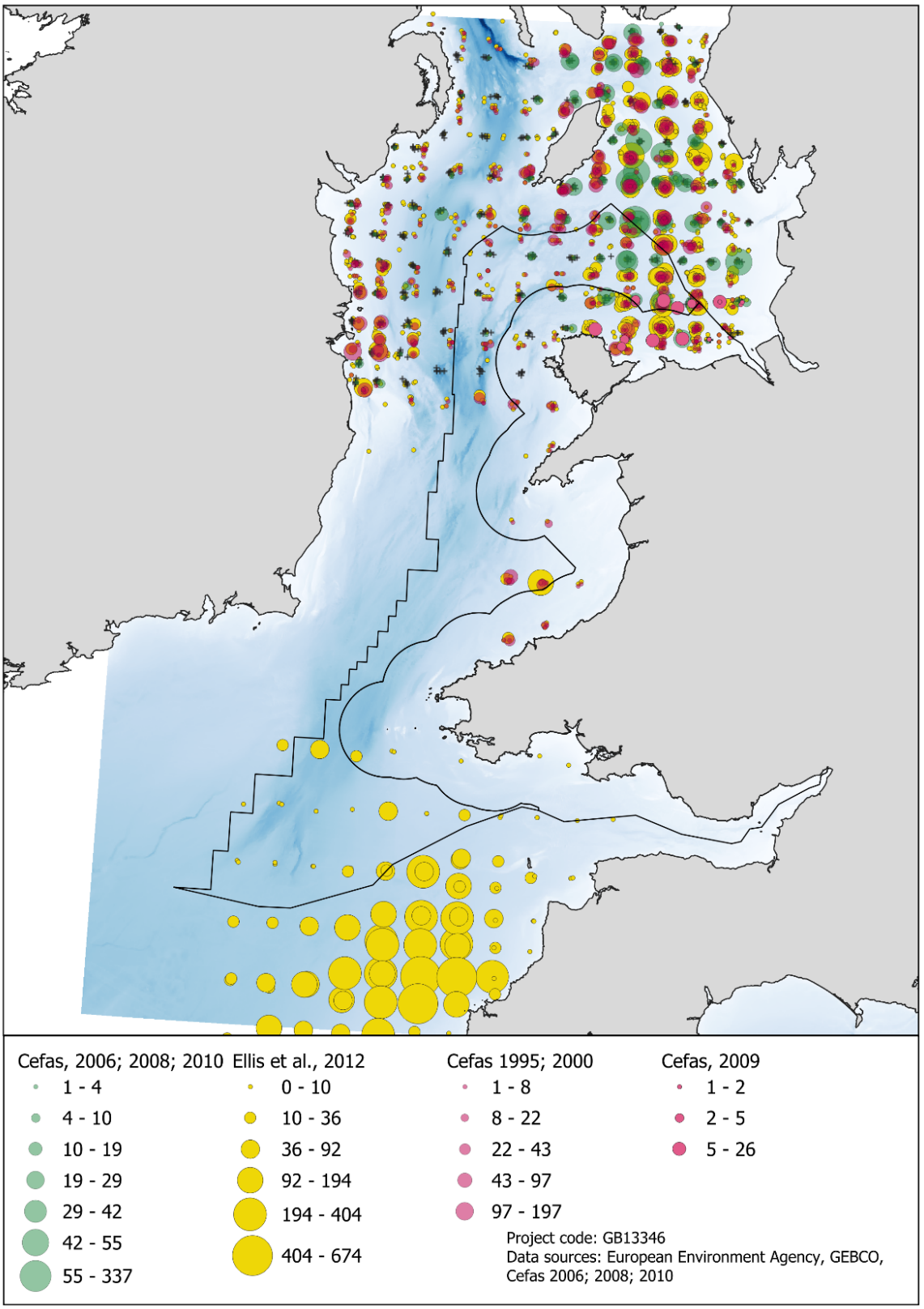


Figure 4. Synthesis map for whiting larvae in Welsh and surrounding waters (Sources: Cefas, 1995; 2000; 2006; 2008; 2009; 2010; Ellis *et al.*, 2012). Legend units are numbers of larvae per sample.

3.3.3 Life stage – juveniles

Wheeler (1969) and Jaworski (2020) found that juvenile whiting occupy inshore waters (5–30 m depth), often overlapping with other gadoid juveniles such as cod and haddock. Juvenile whiting are key prey for larger predators and serve as an important forage component in the Irish Sea and Celtic Sea ecosystems.

Walker-Milne *et al.* (2025) found that juvenile whiting primarily occupy nearshore, shallow waters during their early demersal life stage, and habitat use is strongly influenced by fine-scale seabed structure. Juveniles showed reduced presence within gravel patches, with probability of occurrence declining further inside these habitats, indicating that gravel substrates are sub-optimal for this life stage. Whiting presence peaked at habitat edges, particularly along margins of algal patches. Although the algal habitats themselves are not a suitable habitat for juveniles, patch edges seemingly offer improved foraging opportunities and is therefore likely linked to prey aggregation.

Kempf *et al.* (2022) examined trends in demersal fish abundance in the Celtic Sea. Juvenile whiting recruitment in the Irish Sea and Celtic Sea has been influenced by both historical fishing pressure and climate variability. The study identified a positive relationship between the abundance of the copepod *Calanus finmarchicus* and whiting catches. As the Celtic Sea serves as an important nursery area, larvae and juveniles feed on multiple life stages of calanoid copepods, suggesting that plankton availability directly influences recruitment success.

Data related to the distribution of juvenile whiting were identified through five geospatial datasets as well as four reports. The datasets reviewed comprised of:

- Spawning and nursery grounds of selected fish species in UK waters (Ellis *et al.*, 2012);
- Spawning and nursery grounds of forage fish in Welsh and surrounding waters (Campanella and van der Kooij, 2021);
- DATRAS Fisheries-independent trawl survey data (ICES, 2025a);
- Sea Angling Diary catch records 2016-2024 (Cefas, 2025); and
- WFD Transitional fish surveys (NRW, 2025).

The published literature reviewed comprised of:

- Spatial distribution of discards in mixed fisheries: species trade-offs, potential spatial avoidance and national contrasts (Robert *et al*. 2019);
- Single-species quotas drive discards by multi-species trawlers in the Celtic Seas ecoregion when their relative abundance fluctuates (Browne *et al*. 2024);
- A long-term study of whiting, *Merlangius merlangus* (L) recruitment and population regulation in the Severn Estuary (Henderson and Bird, 2010); and
- Motile fauna of sub-tidal *Zostera marina* meadows in England and Wales (Peters *et al*., 2015).

Further detail on each dataset is provided in Appendix 3.

3.3.3.1 Synthesis of juveniles

There is broad consistency between the datasets reviewed regarding the distribution of juvenile whiting in Welsh waters (Figure 5).

The sources generally agree on the Irish Sea as having the highest concentrations of juvenile whiting, although with higher observed abundances outside Welsh waters than within. Ellis *et al.* (2012) and ICES (2025a) recorded high numbers of juvenile whiting within Welsh offshore waters of the Irish Sea directly south of the Isle of Man. Campanella & van der Kooij (2021), did not identify this area as a particular hotspot, instead identifying more inshore waters in Liverpool Bay and the Dee Estuary. All sources noted the presence of moderate numbers of juvenile whiting within Welsh inshore waters on the North Wales coast, in particular within and adjacent to the Dee Estuary. Sea Angling Diary records support this pattern, with the highest numbers of juvenile whiting recorded in ICES rectangles 35E5 and 35E6 along the North Wales coast, largely comprising pre-adults (15–19 cm). Juvenile whiting distribution from sea angling records, concentrated around Anglesey and the North Wales coastline generally support the information available on known areas where sea angling can regularly capture the species. Whiting are a commonly caught fish in the winter months around Wales from the shore, with high numbers noted as being caught around the Llŷn Peninsula including Trefor Pier and Porth Neigwl, and in the Menai Strait and along the North Wales coast including Llandudno Pier.

There is also general agreement regarding the relatively lower numbers of juvenile whiting recorded in Cardigan Bay, with only small numbers being recorded within either Caernarfon Bay or Cardigan Bay, but this area was also sampled less. Sea Angling Diary data similarly record lower numbers of juveniles in Cardigan Bay (33E5 and 34E5), consistent with this broader pattern, though they are still regularly caught across Cardigan Bay.

Some degree of agreement between sources is also found along the South Wales coast, where Ellis *et al.* (2012) and ICES DATRAS recorded moderate numbers of juvenile whiting within Welsh inshore waters off south Pembrokeshire and in Carmarthen Bay. Sea Angling Diary records indicate relatively high juvenile occurrence in ICES rectangle 32E6 along the Vale of Glamorgan coast, with lower numbers of records from Pembrokeshire (32E4) and the inner Bristol Channel (32E7). Juvenile whiting distribution from sea angling records, concentrated in the Bristol Channel generally support the information available on known areas where sea angling can regularly capture the species. Whiting are a commonly caught fish in the winter months around Wales from the shore, with particular abundance in the Bristol Channel. Campanella & van der Kooij (2021) put additional emphasis on Welsh waters of the Bristol Channels area, also identifying areas west and south of Pembrokeshire as being the most intense and extensive hotspot for juvenile whiting in the Irish and Celtic Seas. NRW WFD estuarine sampling data recorded large numbers of juvenile whiting in Welsh inshore waters in the Bristol Channel, in particular within Cardiff Bay and the Taff, Usk, and Wye Estuaries. This was corroborated to a degree by Campanella & van der Kooij (2021), who recorded this area as being a moderate hotspot for juvenile whiting, while Henderson and Bird (2010) identified whiting as a significant contributor to the fish community biomass of the Severn Estuary. Long-

term sampling in the Bristol Channel and Severn Estuary further demonstrates the importance of this area for whiting juveniles as a nursery and recruitment zone (Henderson *et al.*, 2019).

Key results:

- **Juvenile whiting are widely distributed in Welsh coastal and estuarine waters, with higher concentrations than in shallow waters.**
- **Juvenile distributions reflect a two-stage nursery pattern: small age-0 juveniles occupy shallow inshore "core" nursery areas, while larger pre-adult juveniles (15–20 cm) appear to use a broader range of habitats further offshore as well as inshore areas.**
- **Juvenile whiting have been recorded in highest abundance in the Irish Sea and are consistently recorded along the North Wales coast, including around the Dee and Conwy Estuaries.**
- **Juvenile whiting are generally recorded in low numbers along the West Wales coast, with only small numbers recorded in Caernarfon Bay and Cardigan Bay, although limited sampling may underestimate presence.**
- **Moderate to high juvenile abundance occurs along the South Wales coast, particularly off south Pembrokeshire and within Carmarthen Bay; Campanella & van der Kooij (2021) identify a persistent juvenile hotspot in this region, suggesting it may represent an area of regionally important nursery habitat within Welsh waters.**
- **Long-term monitoring confirms the Bristol Channel and Severn Estuary as key nursery and recruitment areas for juvenile whiting in Welsh waters.**

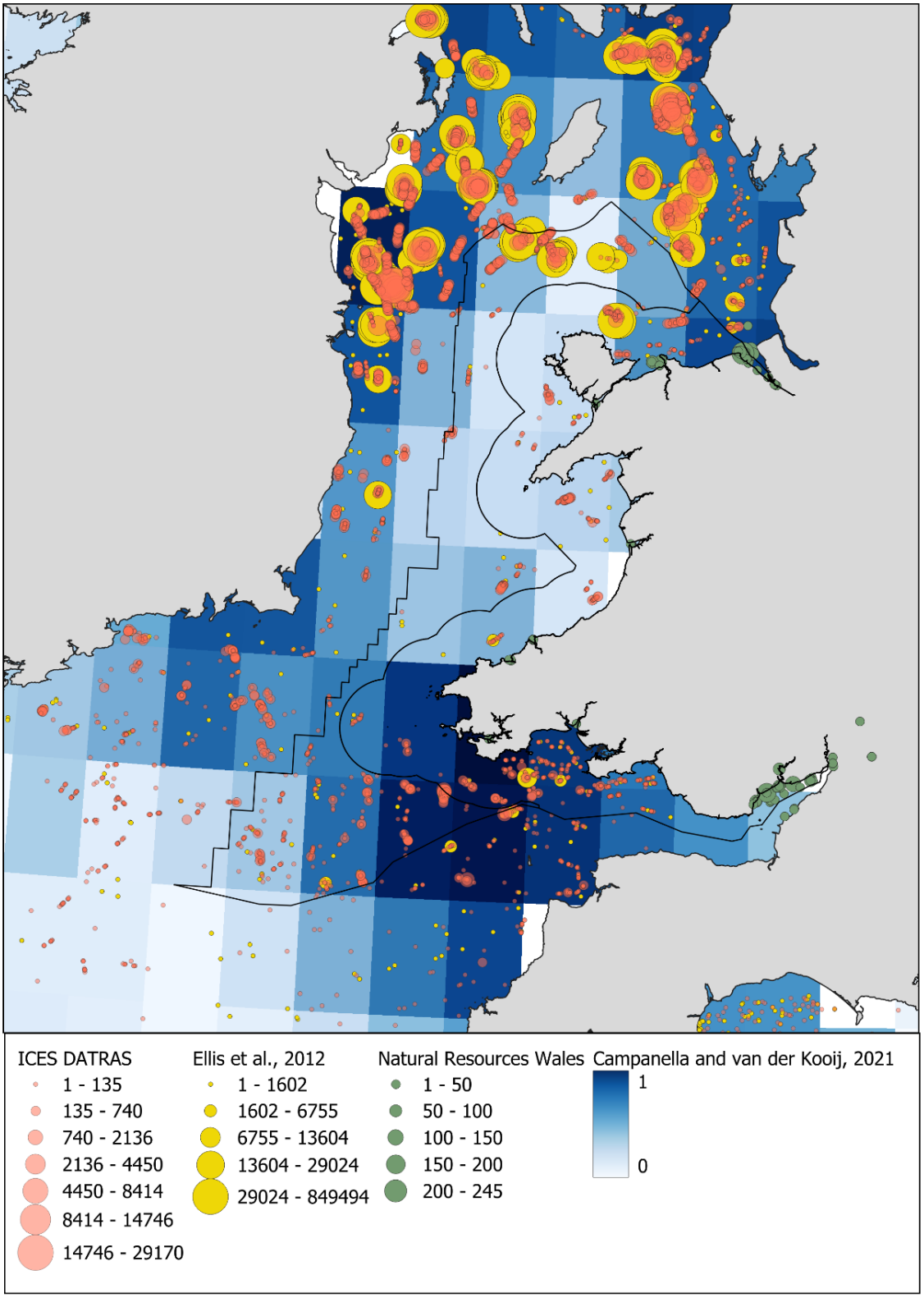


Figure 5. Synthesis map for whiting juveniles in Welsh and surrounding waters (Sources: ICES, 2025a; Natural Resources Wales, 2025; Ellis *et al.*, 2012; Campanella and van der Kooij (2021). Legend units are numbers of juveniles per sample for ICES 2025a, Ellis et al. 2012 and Natural Resources Wales 2025.

3.3.4 Life cycle process – nursery grounds

Van der Kooij *et al.* (2021) state that juvenile whiting in Welsh waters are primarily found in coastal areas and bays where they function as forage fish. Walker-Milne *et al.* (2025) states that nearshore coastal waters are important nursery areas for whiting, particularly during the early demersal phase. Nursery habitat use is structured by fine-scale seabed characteristics, with juvenile whiting showing strong spatial responses to seabed patch type and patch boundaries rather than to habitat extent alone.

Robert *et al.* (2019) identified from discards that clusters of undersized (below 27 cm MCRS) whiting co-occur with haddock and cod in nearshore areas of the northeastern Celtic Sea and along the Welsh coast. Ecosystem modelling by Hernvann *et al.* (2020) indicated that coastal bays and the inner Bristol Channel provide suitable habitats for juvenile whiting, co-occurring with other gadoid species. These semi-enclosed areas offer foraging opportunities and relative protection, reinforcing their role as essential nursery habitats in Welsh waters. Seasonal variations and environmental drivers such as temperature further influence the distribution and productivity of juvenile whiting in these areas.

Data related to the distribution of whiting nursery ground were identified through five geospatial datasets as well as a paper by Burns *et al*. (2020). The datasets reviewed comprise of:

- Spawning and nursery grounds of forage fish in Welsh and surrounding waters (Campanella and van der Kooij, 2021);
- Fisheries spawning and nursery areas in British waters (Coull et al., 1998);
- Spawning and nursery grounds of selected fish species in UK waters (Ellis *et al.*, 2012);
- Species spawning and nursery areas (Marine Institute, 2018; revised 2024); and
- Essential Fish Habitats project data (Marine Directorate, 2023).

Further detail on each dataset is provided in Appendix 3.

3.3.4.1 Synthesis of nursery grounds

Welsh coastal waters, including the inner Bristol Channel and nearshore bays and estuaries, are identified as important nursery grounds for juvenile whiting. These habitats are characterised by their shallow depths, variety of demersal substrates, and the co-occurrence of other juvenile gadoid species.

Evidence on the spatial distribution of whiting nursery grounds in Welsh waters is derived from four geospatial datasets. Agreement between these sources is, however, limited (Figure 6). Much of the apparent spatial disagreement between sources can be attributed to the definition of nursery grounds (length and age classes of juveniles included) and reflect different components of the juvenile whiting life history within Welsh waters of both

early inshore nursery areas and broader transitional habitat use by older pre-adult juveniles.

Differences in survey coverage and analytical approach (empirical catch data versus habitat suitability modelling) also influence variation between sources. For example, broader definitions that include larger age-1 to age-2 juveniles approaching maturity will extend further offshore and across wider areas, whereas definitions focused on smaller age-0 juveniles are more likely to identify shallow, inshore “core” nursery grounds. This implies a two-stage nursery system, comprising early inshore habitat for smaller juveniles and more extensive transitional habitat for older pre-adult juveniles prior to recruitment to the adult stock.

The area in which sources agreed most consistently on the presence of whiting nursery grounds is within Welsh inshore waters on the North Wales coast, where Coull *et al.* (1998), Ellis *et al.* (2012), and the Marine Directorate (2023) all identified nursery grounds. The Marine Directorate (2023) modelled these nursery grounds as extending between north-eastern Anglesey and The Great Orme, whereas both Coull *et al.* (1998) and Ellis *et al.* (2012) observed them as extending far further up to the edge of Welsh waters in the Dee Estuary and beyond, into adjacent English waters. In contrast, the Marine Institute (2018) has not recorded this region as hosting whiting nursery grounds.

The Marine Directorate (2023), using a habitat suitability modelling approach rather than direct juvenile catch records, identified nursery grounds along the west Wales coast (extending from Caernarfon Bay, around the Llŷn Peninsula, and into the northern part of Cardigan Bay) not highlighted by sources with direct observation (other than Ellis *et al.* 2012 who classify extensive areas of the Celtic and Irish sea as low intensity). Neither Coull *et al.* (1998) nor the Marine Institute (2018) recorded any evidence of whiting nursery grounds along the West Wales coast. A second Marine Directorate (2023) modelled whiting nursery ground in this region, extending from Aberystwyth in southern Cardigan Bay along to the westernmost point of Pembrokeshire. Again, this area was not supported by direct observation sources other than Ellis *et al.* (2012), who note the entirety of Cardigan Bay as low intensity whiting nursery grounds.

The lack of direct observation may be influenced by limited survey sampling coverage in parts of Cardigan Bay in earlier datasets. Mapping approaches based primarily on recorded juvenile catches may therefore under-represent presence of nursery grounds in this region. Given the availability of suitable shallow, soft-sediment habitat and the limited records of juvenile whiting within the available juvenile distribution evidence presented previously (insufficient to delineate nursery grounds based on empirical observation), the modelled outputs presented by the Marine Directorate (2023) are considered to be ecologically plausible and may partly address spatial sampling bias.

Further differences are evidenced for the Bristol Channel and Celtic Sea. In Welsh offshore waters south-west of Pembrokeshire, the Marine Institute (2018) record the presence of whiting nursery grounds, and Ellis *et al.* (2012) record the area as low intensity whiting nursery grounds, consistent with use by larger pre-adult juveniles rather than high densities of early age-0 fish. The Marine Directorate (2023) also modelled this area as a low confidence whiting nursery ground. However, much of this offshore area includes

relatively deep water (e.g. the Celtic Deeps), which is less characteristic of core nursery habitat for age-0 juveniles. Aggregations recorded in these areas may therefore represent older juveniles undertaking seasonal movements between inshore nursery grounds and offshore feeding areas or in preparation for spawning at age-2. Within Welsh inshore waters whiting nursery grounds modelled by Coull *et al.* (1998) and the Marine Directorate (2023) extend between Milford Haven and the Gower Peninsula. Whilst Coull *et al.* (1998) modelled these nursery grounds as extending eastwards into the Bristol Channel and as far east as the Severn Estuary, the Marine Directorate (2023) modelled the presence of whiting nursery grounds extending west around Pembrokeshire and then north into Cardigan Bay. By contrast, direct observation sources provided by the Marine Institute (2018) found no evidence of whiting nursery grounds along the south Wales coast. Furthermore, Ellis *et al.* (2012) recorded the entire area as low intensity whiting nursery grounds entirely.

Key results:

- **Core nursery grounds for juvenile whiting in North Wales inshore waters, including the Dee Estuary and bays around Anglesey, are consistently identified.**
- **Observational sources indicate low-intensity nurseries in Cardigan Bay and the Bristol Channel, while modelled studies suggest plausible presence in these and other areas, including Cardigan Bay, off the Pembrokeshire coast, Milford Haven, and the Bristol Channel.**
- **Variations between sources largely reflect differences in juvenile size classes, survey coverage, and methodologies. Overall, shallow coastal, estuarine, and soft-sediment habitats are key as nursery grounds in Welsh waters for juvenile whiting recruitment.**

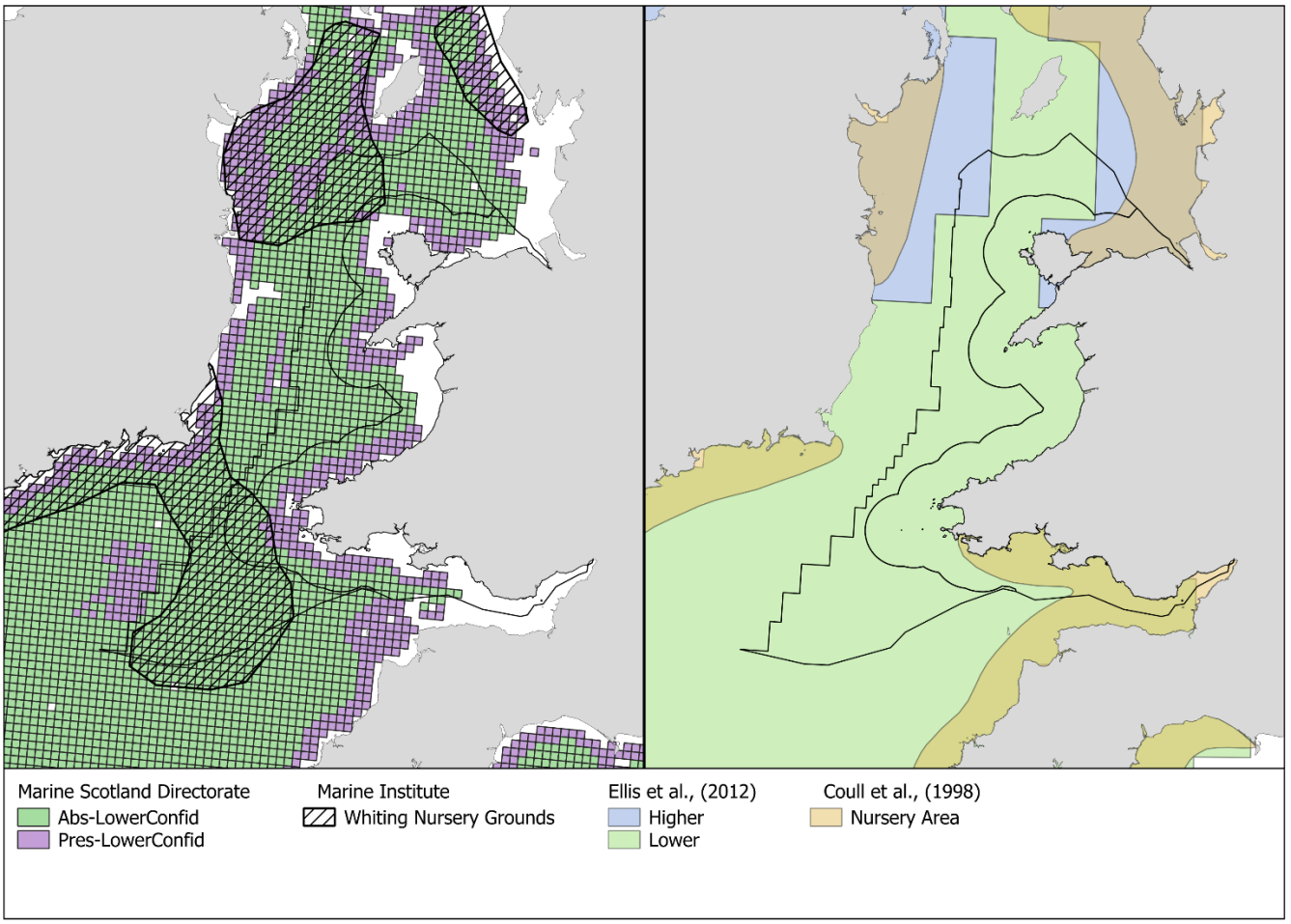


Figure 6. Synthesis map for whiting nursery grounds in Welsh and surrounding waters (Sources: Marine Directorate, 2023; Coull *et al.,* 1998; Ellis *et al.*, 2012; Marine Institute, 2018).

3.3.5 Life stage – adults

Adult whiting are most commonly found in mixed shoals of demersal fish in waters between 20 and 100m depth (Wheeler, 1969). Jaworski (2020) found that adult whiting use a broad depth down to 200 m and are active predators. Diet composition shifts with size, where juveniles feed on crustaceans and adults feed on fish and benthic invertebrates. Adult growth is slower than juvenile growth, with high variability: a 30 cm individual can be between one year to six years old. Adults are distributed across the Irish Sea, Celtic Sea, and West of Scotland, with seasonal movements influenced by prey availability and environmental conditions.

Data related to the general distribution of adult whiting were identified through seven geospatial datasets as well as papers by Hernvann *et al*. (2020), Brander (1977) and Robert *et al*. (2019). The datasets reviewed comprise of:

- WFD Transitional fish surveys (NRW, 2025);
- DATRAS Fisheries-independent trawl survey data (ICES, 2025a);

- Spawning and nursery grounds of forage fish in Welsh and surrounding waters (Campanella and van der Kooij, 2021);
- Species occurrence records in Welsh waters (OBIS, 2025);
- Highly mobile fish species distributions in UK waters (Cefas/ABPmer, 2010);
- Sea Angling Diary catch records 2016-2024 (Cefas, 2025); and
- Commercial fisheries landings and discards data (MMO, 2025).

Further detail on each dataset is provided in Appendix 3.

3.3.5.1 Synthesis of adults

Adult whiting in Welsh waters inhabit coastal bays, the inner Bristol Channel, and nearshore areas of the Celtic Sea and Irish Sea. Their distribution is influenced by environmental conditions (temperature, depth, substrate), and seasonal migration patterns.

Adults co-occur with other gadoid species and overlap in habitat use with juveniles in some areas, particularly pre-adults. Whiting are known to show temporal and age-related variation in distribution, Daan *et al*. (1990) highlights a potential seasonal migration from deeper to shallower waters between winter and summer as well as breeding related aggregations. This may be related to sea temperature and the availability of food resources.

There was general consistency between the evidence sources reviewed regarding locations with high concentrations of adult whiting, with two particular regions of high concentration, off the North Wales coast and Welsh offshore waters south-west of Pembrokeshire (Figure 7 and Figure 8).

Generally, adult whiting are found in higher concentrations in English and Irish waters in the Irish Sea off the north Wales coast, but moderate numbers of adult whiting are recorded both in Welsh offshore waters directly south of the Isle of Man and in Welsh inshore waters around the mouth of the Dee Estuary.

Concentrations of adult whiting along in Cardigan Bay and St George's Channel were generally lower. When using GOV trawls, Cefas (2010) found slightly higher numbers of adult whiting in Caernarfon Bay than in Cardigan Bay.

High numbers of adult whiting were observed in catch records in Welsh offshore waters south-west of Pembrokeshire. Campanella & van der Kooij (2024) found the area to be a moderate hotspot for adult whiting, but less so than adjacent Irish waters; and using GOV trawls, Cefas (2010) found only a low concentration of adult whiting in the region.

Along the South Wales coast sources have differing signals in occurrence of adult whiting. ICES DATRAS and NRW (2025) observe moderate numbers of adult whiting in Welsh inshore waters between Milford Haven and the Gower Peninsula, which is corroborated by beam trawls conducted by Cefas (2010). In contrast, Campanella & van der Kooij (2021) described this area as lacking Q4 adult whiting persistence hotspots, and low numbers are recorded here in GOV trawls conducted by Cefas (2010). Relatively few adult whiting are recorded in the Bristol Channel east of the Gower Peninsula where sampling has occurred,

such as by NRW WFD estuarine sampling. Noting a limited ability to sample the shallower habitat of the area.

Adult whiting distribution from sea angling records are similar to juvenile whiting distribution, concentrated in the Bristol Channel and around Anglesey and the North Wales coastline but with wider distribution around the whole Welsh coast, and generally support the information available on known areas where sea angling can regularly capture the species. Whiting are a commonly caught fish in the winter months around Wales from the shore, with particular abundance in the Bristol Channel, but also regularly caught across Cardigan Bay, around the Llŷn Peninsula including Trefor Pier and Porth Neigwl, and in the Menai Strait and along the North Wales coast including Llandudno Pier.

Key results:

- **Whiting in both the Irish Sea and Celtic Sea have a life cycle characterised by inshore-offshore connectivity and seasonal shifts in habitat use.**
- **Adult whiting are present in Welsh coastal bays, the inner Bristol Channel, and nearshore areas of the Irish Sea and Celtic Sea, with distribution influenced by water depth, water temperature, substrate, and prey availability, and they show a wider distribution in the winter potentially reflecting seasonal movements into deeper water in winter.**
- **Highest concentrations of adult whiting have been in the Irish Sea off the North Wales coast, including offshore waters south of the Isle of Man and inshore around the Dee Estuary. In the Celtic Sea, high numbers have been recorded in offshore areas southwest of Pembrokeshire. Lower numbers have been recorded in Cardigan Bay.**

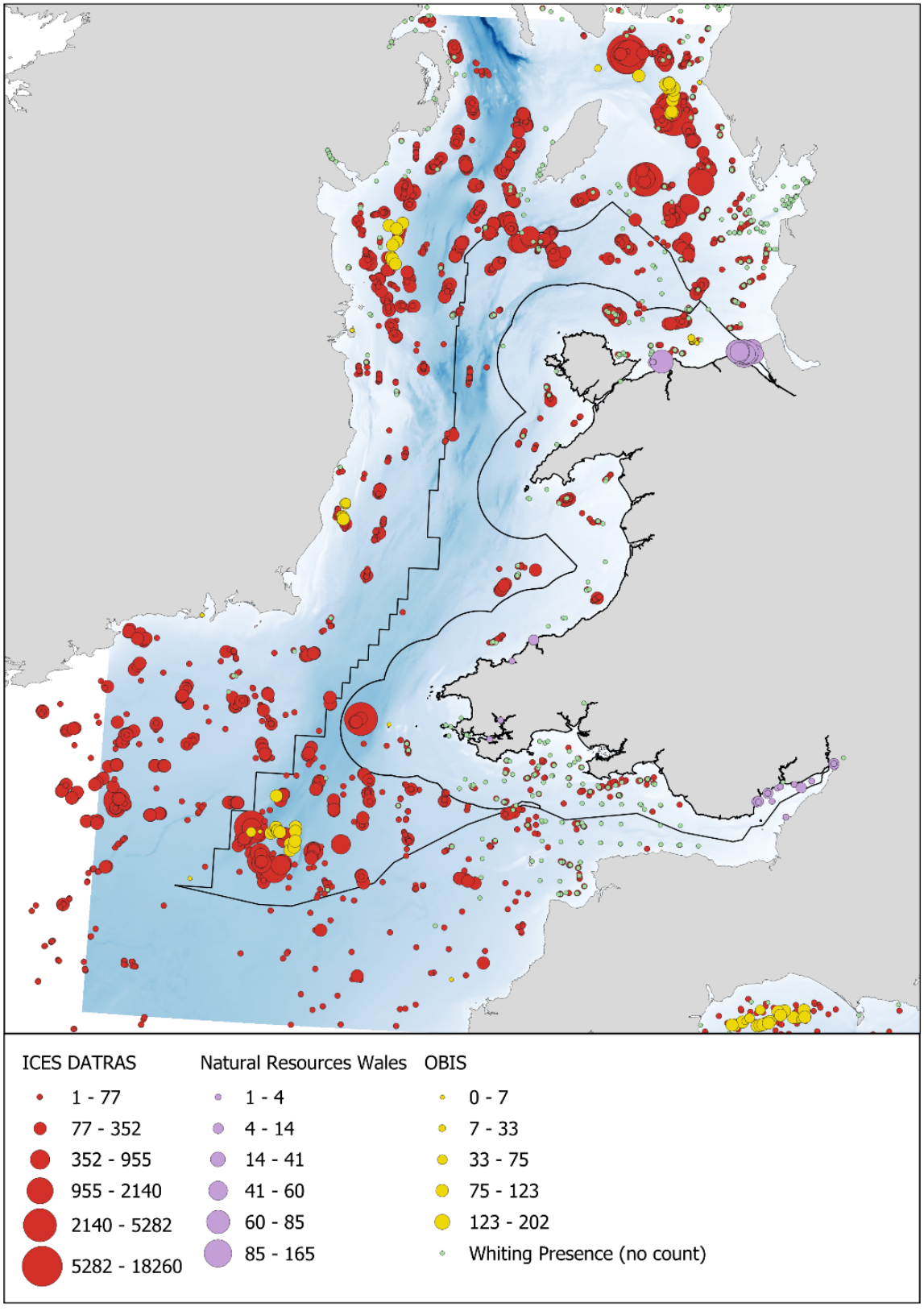


Figure 7. Synthesis map for whiting adults in Welsh and surrounding waters (points) (Sources: ICES, 2025a; NRW, 2025; OBIS, 2025). Legend units are numbers of adults per sample.

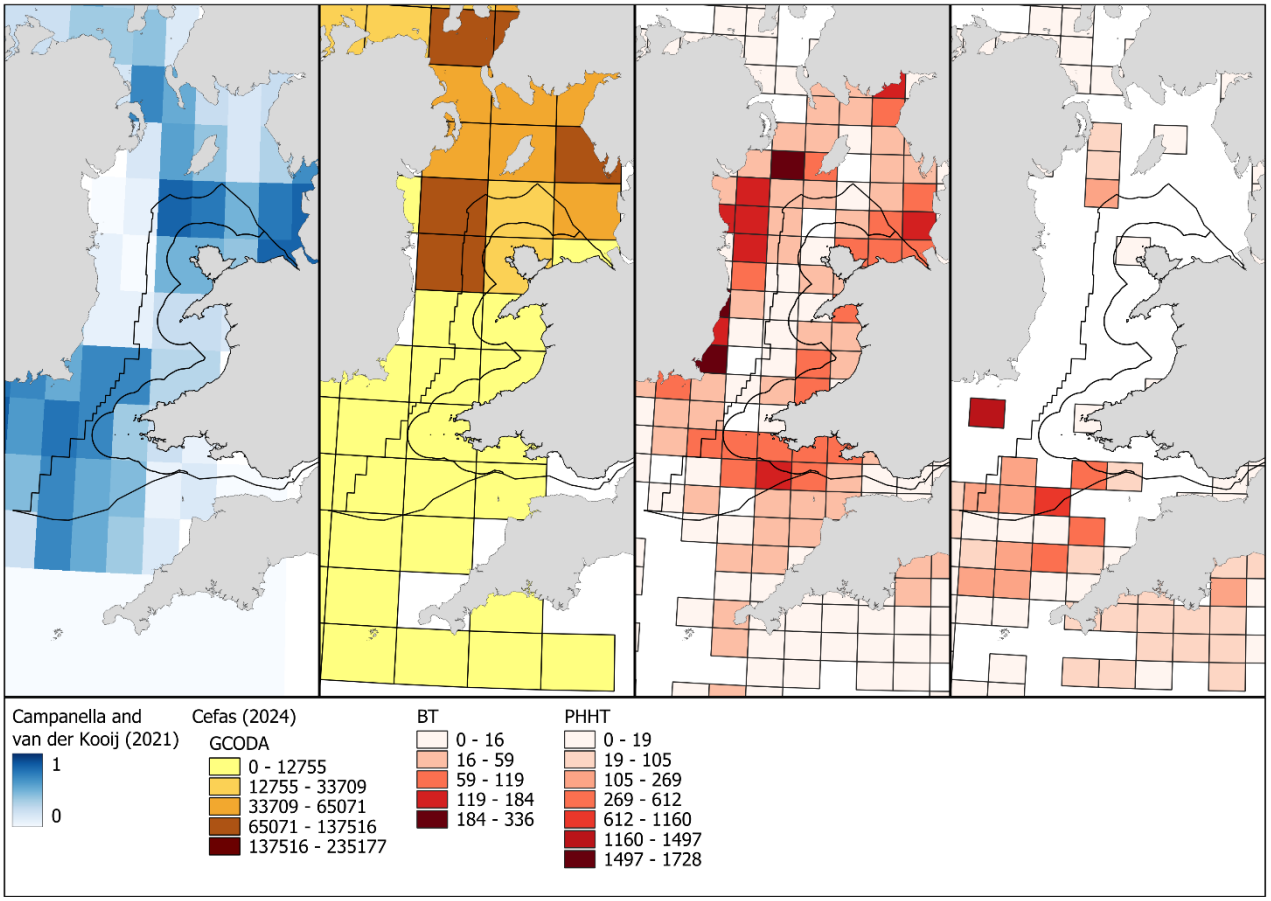


Figure 8. Synthesis map for whiting adults in Welsh and surrounding waters (rasters) (Sources: Campanella and van der Kooij, 2021; Cefas/ABPmer, 2010).

3.3.6 Life cycle process – spawning grounds

Jaworski (2020) state that adult spawning is geographically widely distributed. Juvenile nursery areas encourage recruits to adult spawning aggregations, connecting shallow inshore habitats to offshore spawning activity.

Data related to the general distribution of whiting spawning grounds were identified through five geospatial datasets. The datasets reviewed comprised of:

- Fisheries spawning and nursery areas in British waters (Coull *et al.*, 1998);
- Spawning and nursery grounds of selected fish species in UK waters (Ellis *et al.*, 2012);
- Spawning and nursery grounds of forage fish in Welsh and surrounding waters (Campanella and van der Kooij, 2021);
- Species spawning and nursery areas (Marine Institute, 2024); and
- Essential Fish Habitats project data (Marine Directorate, 2023).

Further detail on each dataset is provided in Appendix 3.

3.3.6.1 Synthesis of spawning grounds

Evidence on the spatial distribution of whiting spawning grounds in Welsh waters is derived from five geospatial datasets. Across these sources, there are areas of spatial alignment but also differences (Figure 9).

On the North Wales coast, the Marine Institute (2018) identify a whiting nursery ground within both Welsh inshore waters and Welsh offshore waters between the River Clwyd and Anglesey, extending north beyond Welsh waters to the Isle of Man and west towards Ireland and Northern Ireland. This is corroborated to an extent by Coull *et al.* (1998), who describe a low intensity whiting spawning ground overlapping with this in the Welsh outer zone north of The Great Orme. Ellis *et al.* (2012) also identify this area as a low intensity whiting spawning ground. The Marine Directorate (2023), however, modelled the absence of whiting spawning grounds from the North Wales coast with high confidence. This contrasts with evidence from egg, larval, and adult sampling during the spawning season in Welsh Irish Sea waters, which indicates spawning activity does occur in the region.

Ellis *et al.* (2012) identifies Cardigan Bay as a low intensity spawning ground. Coull *et al.* (1998) also identifies the presence of a small, high-intensity spawning ground, buffered by a slightly larger, low-intensity spawning ground, within Welsh inshore waters off New Quay, in the south of Cardigan Bay. The Marine Directorate (2023) however did not identify spawning grounds in Cardigan Bay, although this report did identify the presence of low confidence spawning grounds in Welsh offshore waters in this region. The Marine Institute (2018) did not identify whiting spawning grounds in Cardigan Bay.

The Marine Institute (2018) and the Marine Directorate (2023) align with regards to the presence of a whiting spawning ground in Welsh offshore waters west of Pembrokeshire in the Celtic Sea, although the former record this as extending into Welsh inshore waters and into Welsh offshore waters south-west of Pembrokeshire. There was general agreement regarding the absence of whiting spawning grounds from Welsh waters east of Milford Haven, indicating the likely source of juveniles to the Bristol Channel and Severn Estuary come from the Trevose Head spawning ground off the north coast of Cornwall.

Key results:

- **Evidence for whiting spawning grounds in Welsh waters has partial agreement between sources.**
- **Inshore and offshore waters off the North Wales coast, between the River Clwyd and Anglesey, are identified as low-intensity spawning areas by several sources.**
- **Presence of whiting spawning grounds in Cardigan Bay remains uncertain. Habitat-based modelling indicates an absence of spawning activity, whereas models incorporating empirical species occurrence data suggest spawning occurs. Among these occurrence-based models, one identifies a discrete area in the southern part of Cardigan Bay off the coast of New Quay and Aberaeron, while another characterises the entire Bay as supporting low-intensity spawning grounds.**

- **In inshore and offshore waters of the Celtic Sea and Bristol Channel, each source reviewed identifies some form of spawning ground, but the extent, intensity and distance offshore of these spawning grounds vary.**

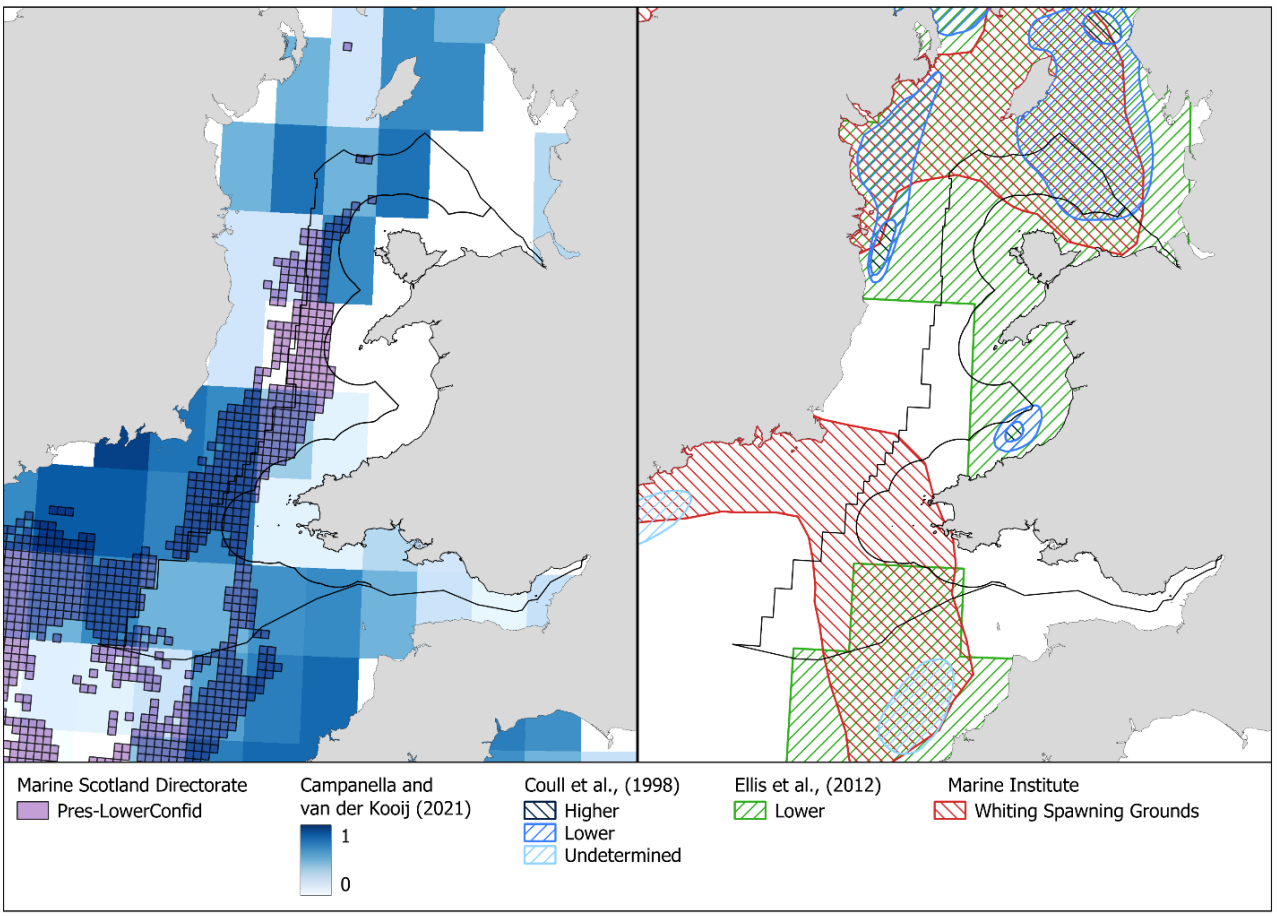


Figure 9. Synthesis map for whiting spawning grounds in Welsh and surrounding waters (Sources: Campanella and van der Kooij, 2021; Coull *et al.*, 1998; Ellis *et al.*, 2012; Marine Institute, 2018).

3.4 Population and genetic structure

This section describes whiting population and genetic structure in Welsh and surrounding waters.

3.4.1 Genetic studies

Genetic evidence suggests the large-scale differentiation across the Northeast Atlantic is limited. Barrios *et al.* (2017) indicate that whiting generally exhibit an indistinct genetic structure, consistent with a wide-ranging population, however there is the exception of the North Sea, where some degree of sub-structuring has been found (Charrier *et al.*, 2007). In contrast, whiting in the Celtic Sea, Irish Sea and Bay of Biscay, are treated as separate

ICES stock assessment units, however they show genetic similarity consistent with a single stock or metapopulation. This suggests that current management and stock boundaries do not fully reflect whiting's biological population structure.

3.4.2 Tagging and movement studies

This limited genetic differentiation is supported by evidence of whiting movement and connectivity from otolith microchemistry.

Tagged adult whiting have been shown to be highly active, travelling distances of over 500 km in 77 days, although most tagged fish remained within 100 km of their release site (Tobin *et al*., 2010). Tagging experiments in Scottish waters suggest that this species does not move far from inshore waters, with recaptured fish never found more than 30 miles from shore (Hislop & McKenzie 1976). Although genetic differences have been recorded from different areas of the North Atlantic, it is not clear whether this indicates the presence of separate stocks. (Rico *et al*., 1997). Some connectivity between spawning areas has been shown in Scottish waters for this species, with exchange of juveniles between regions demonstrated (Tobin, 2010).

Burns *et al.* (2020) found substantial connectivity between nursery areas and adult fishing grounds across the Irish Sea, Firth of Clyde and Scottish west coast. Young juvenile whiting (age-0) originating from the eastern and north-eastern Irish Sea contribute recruits to adult populations far beyond their natal areas, including the Firth of Clyde and further north along the Scottish west coast. Conversely, age-1 whiting in the eastern Irish Sea show a higher degree of local recruitment, indicating spatial heterogeneity in connectivity strength. Migration between Celtic Sea and Irish Sea may occur, although direct evidence is limited; tagging studies in the West of Scotland indicate that juveniles from specific nursery grounds contribute to local adult populations, suggesting partial connectivity (Jaworski, 2020).

Within the Irish Sea, evidence points to asymmetrical mixing. Eastern Irish Sea whiting appear more locally restricted, while western Irish Sea individuals have broader recruitment origins, including from the Firth of Clyde and other inshore nursery areas (Burns *et al.*, 2020). These findings suggest that key nursery grounds in the Irish Sea and adjacent inshore waters disproportionately support adult populations across multiple assessment areas.

Distribution modelling and life-stage analyses provide further evidence of ontogenetic structuring, with juveniles concentrated in inshore nursery habitats, gradually dispersing offshore as they mature (Burns *et al.*, 2019; Campanella & van der Kooij, 2021). This juvenile dispersal facilitates partial connectivity between areas currently treated as separate stocks, particularly between the Irish Sea (ICES 7a) and the Celtic Sea (7b–k). The Bristol Channel and waters around St David's Head are identified as particularly important juvenile habitats (Campanella & van der Kooij, 2021), meaning that Welsh coastal waters are contributing to the broader population despite limited evidence for long-term adult residency.

At the population level, tagging studies demonstrate that adult whiting have limited migration ranges, with low rates of repeated long-distance movement once mature (Burns *et al.*, 2020). However, this contrasts with the high connectivity that is observed in their juvenile stages. Therefore, it is possible that population structuring in whiting is driven more by early-life dispersal and recruitment pathways, than by adult migration. This pattern follows the concept of a metapopulation, whereby spatially distinct sub-units are linked through larval and juvenile exchange, rather than adult movement.

3.4.3 Synthesis of population and genetic structure

Overall, the currently available evidence supports a population structure that is characterised by:

- Weak genetic differentiation across the Celtic Sea–Irish Sea region, supporting a shared metapopulation.
- Strong connectivity at early life stages, particularly from inshore nursery areas to adult populations across multiple ICES divisions.
- Spatially variable recruitment dynamics, with some areas (e.g. eastern Irish Sea) showing higher local retention than others.
- Behavioural and ontogenetic structuring, rather than clear genetic isolation, underpinning regional population components.

In the context of Welsh waters, whiting populations cannot be considered isolated or self-contained. Instead, Welsh coastal and shelf waters form part of a broader, interconnected population network, where local nursery habitats contribute to adult stocks across the Irish Sea and Celtic Sea, while local abundances and trends may be strongly influenced by processes taking place outside Welsh waters.

Evidence from genetic studies, tagging, otolith microchemistry and spatial distribution analyses show that whiting in waters west of the British Isles form a broadly connected population with some regional structuring. This is important to consider when interpreting population dynamics and management units relevant to Welsh waters.

Key results:

- **There is weak genetic differentiation across the Celtic Sea–Irish Sea region, supporting a shared metapopulation.**
- **There is strong connectivity at early life stages, particularly from inshore nursery areas to adult populations across multiple ICES divisions.**
- **Whiting have spatially variable recruitment dynamics, with some areas such as the eastern Irish Sea showing higher local retention than others.**
- **Behavioural and ontogenetic structuring, rather than clear genetic isolation, underpin regional whiting population components.**

3.5 Summary of uncertainties and gaps

This section describes the uncertainties and evidence gaps identified during the review of whiting population distribution and structure evidence. Important uncertainties and evidence gaps identified are:

- Offshore trawl surveys are often unable to adequately sample early juvenile whiting due to gear limitations.
- Inshore waters and estuaries are poorly represented in available datasets with the exception of WFD sampling data in estuaries (NRW, 2025) and Sea Angling Diary data (Cefas, 2025).
- Depth constraints for sampling limit spatial coverage of inshore waters, with some mapped products excluding waters shallower than 20 m depth, while offshore surveys cannot operate effectively in shallow coastal zones, likely underestimating the importance of nearshore habitats.
- Survey coverage has focused more on offshore, deeper water and soft-sediment habitats, potentially under-representing inshore areas and more complex seabed habitats.
- Survey spatial coverage is fragmented, with most programmes focusing on either the Irish Sea or Celtic Sea, rarely both concurrently, and there is sparse data coverage in areas such as Cardigan Bay.
- Spatial uncertainty in spawning extent arises from differences between egg, larval, adult and model-based outputs.
- Temporal coverage of egg and larval surveys is a potential limitation, particularly for late-spawning cohorts or larvae present outside the main sampling periods (primarily Q1-Q2). While early-season surveys capture much of the spawning and pelagic larval phases, the extended spawning period of whiting means that some areas or times may be under-represented, adding uncertainty to estimates of spawning extent and larval distribution.
- Temporal variability and interannual changes in nursery habitat use have not been sufficiently captured in studies, due to time and area coverage constraints.
- Qualitative evidence from recreational sea angling indicates continued whiting presence in inshore and coastal waters across multiple seasons, but these records cannot provide quantitative estimates of abundance or recruitment.

4 Conclusions and discussion

This section synthesises the evidence collated for whiting to identify broad spatial patterns, data availability, and key uncertainties in their use of Welsh waters. This section focuses on life-stage connectivity, spatial structure, data coverage, and highlights implications for future monitoring and management.

The methodological approach taken to this review could be applied to additional species in future work. Whiting are, however, a relatively data-rich species in Welsh waters and so data gaps and uncertainties may be more significant for other species.

4.1 General trends in life stages and spatial distribution

Whiting have spawning and nursery grounds in Welsh waters of the Irish Sea and Celtic Sea indicating the importance of Welsh waters at maintaining wider Irish Sea and Celtic Sea populations.

Inshore bays, estuaries, and sheltered coastal habitats in Welsh waters of both the Irish Sea and the Bristol Channel serve as primary nursery grounds, supporting juveniles before offshore seasonal migrations commence and wider dispersal occurs in sub-adult and adults phases.

Adult densities in Welsh waters are generally lower than juvenile densities, with adults showing a wider distribution and higher abundance in deeper Irish Sea and Celtic Sea waters. Adults show seasonal movements into and through Welsh waters, reflecting broader metapopulation connectivity rather than long-term residency.

Connectivity between life stages and between areas inside and outside Welsh waters is a consistent pattern: eggs and larval movements into nursery grounds from spawning grounds is evident, along with juvenile dispersal from nursery grounds to wider adult populations across the Irish Sea and Celtic Sea.

4.2 Spatial coverage and data strengths

The Irish Sea off the North Wales coast are the well characterised regions for whiting, with alignment in evidence across multiple datasets for many of the life stages of the species reviewed.

Historical datasets and older analyses of whiting abundance and distribution complement contemporary analysis of the latest survey data, allowing insights into temporal changes in spatial distribution and also verification of conclusions through time.

Genetic, otolith, and tagging studies provide evidence of population connectivity, regional mixing, and metapopulation structure, which informs understanding of broader stock dynamics.

4.3 Limitations and key uncertainties

Survey effort and spatial coverage is uneven. Many studies only focus on parts of Welsh waters, making the ability to compare data across Welsh waters complex. Furthermore, Cardigan Bay, the Bristol Channel and the Celtic Sea are underrepresented in egg, larval, juvenile, and adult sampling compared to the Irish Sea for all the species reviewed.

Temporal and interannual replication is also limited across datasets. While surveys such as ICES DATRAS provide annual coverage, sampling is concentrated in specific quarters (primarily Q1, Q3 and Q4), with limited representation of Q2 and transitional periods. Many

other datasets provide only short-term or seasonally restricted sampling. This constrains interpretation of seasonal habitat use, larval abundance, and juvenile dispersal, particularly in Cardigan Bay and the Bristol Channel where long-term monitoring over multiple seasons is sparse.

Standard trawl-based surveys using larger vessels are limited in their ability to sample shallow or structurally complex habitats, which may lead to further underrepresentation of these areas in available datasets.

Egg-stage data exist for whiting derived from fisheries-independent sampling. However, these egg datasets are from limited sampling effort relative to larval, juvenile and adult fish.

Spawning ground mapping shows inconsistencies across sources. Differences in observed distributions may reflect methodological variation, variable survey effort, and temporal changes. Older sources may be documenting areas that were historically relevant but no longer function as key spawning grounds, which requires further investigation.

Environmental and ecological drivers such as water temperature, prey availability, and seabed substrates, are recognised as important for recruitment and dispersal of whiting but are inconsistently integrated across datasets, limiting predictive capability.

4.4 Recommendations

Overall, enhancing and expanding established long-term survey programmes and datasets, offers a robust pathway for improving stock assessments and understanding spatial population dynamics.

1. Expand survey coverage:

    - Target under-sampled regions, particularly Cardigan Bay, other inshore/estuarine areas, and areas with complex seabed habitats, for all life stages considering non-destructive sampling methods for sensitive habitats.
    - Conduct egg and larval sampling via ichthyoplankton trawls to more closely identify spawning grounds of the species.
    - Recent ichthyoplankton and fish sampling has been conducted at a local scale for development projects in the Severn Estuary, Milford Haven, Anglesey and the Dee Estuary. A recommendation to review and integrate these data is suggested.

2. Standardise life-stage mapping:

    - Develop best-practice methods for mapping spawning grounds and nursery habitats by species, integrating egg, larval and juvenile data with influencing environmental variables such as water depth, water temperature and substrate type.

3. Integrate environmental drivers:

    - Incorporate plankton abundance, temperature, hydrodynamics, and substrate type into species distribution models to improve predictions of recruitment and habitat

suitability. While some general SDMs exist, bespoke models for whiting in Welsh waters are not identified in this study.

4. Link genetic and demographic data:

    - Current ICES stock units (7a, 7b–k, etc.) provide a useful framework for assessment, but they do not fully capture localised connectivity or metapopulation dynamics.
    - Genetic evidence, tagging, and otolith microchemistry indicate populations in Welsh waters are influenced by wider Irish Sea and Celtic Sea dynamics. Integrating these data into stock benchmarking could refine management units to reflect ecological connectivity, ensuring that the contribution of nursery and juvenile habitats are properly accounted for in stock management.

5. Long-term monitoring and temporal replication:

    - Regular, multi-year surveys with spatial and temporal replication would be required to capture interannual variability in nursery ground use, larval abundance, and juvenile dispersal.
    - Ensure coverage spans key spawning periods for the species under investigation, allowing temporal comparisons and better understanding of environmental influences on recruitment.
    - Improving spatial resolution of commercial and recreational catch data would complement survey-based monitoring, helping to identify size distributions, local abundances, and areas of concentrated juvenile or adult presence.

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Browne, M., Calderwood, J., Brophy, D. and Minto, C., 2024. Single-species quotas drive discards by multi-species trawlers in the Celtic Seas ecoregion when their relative abundance fluctuates. *ICES Journal of Marine Science*, *81*(9), pp.1745-1763.

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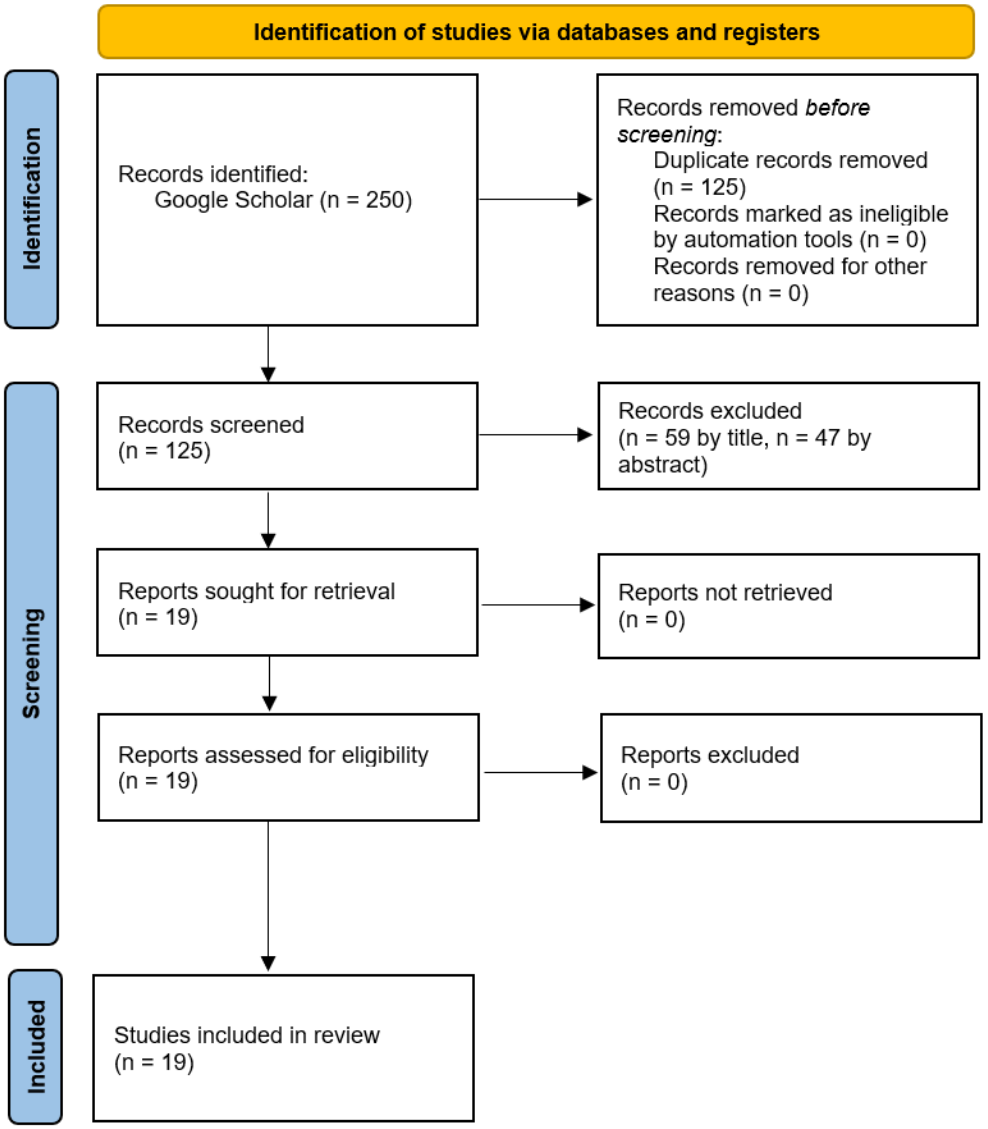
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Appendix 1: Literature search terms used

Whiting *(Merlangius merlangus)*
(Whiting OR *Merlangius merlangus*) AND ("Wales" OR "UK" OR "Celtic" or "Irish" OR "VII") AND "distribution"
(Whiting OR *Merlangius merlangus*) AND ("Wales" OR "UK" OR "Celtic" or "Irish" OR "VII") AND ("egg" OR "larvae" OR "juvenile" OR "adult")
(Whiting OR *Merlangius merlangus*) AND ("Wales" OR "UK" OR "Celtic" or "Irish" OR "VII") AND ("spawn*" OR "nursery" OR "feeding")
(Whiting OR *Merlangius merlangus*) AND ("Wales" OR "UK" OR "Celtic" or "Irish" OR "VII") AND ("population" OR "genetic*" OR "migration" OR "home range")
(Whiting OR *Merlangius merlangus*) AND ("Survey" OR "Sampling" OR "Monitoring")



Appendix 2: Literature confidence scores

Confidence was assessed using two criteria: type and quality of source and applicability of evidence to Welsh waters. For both criteria, scores were assigned numerically as High = 5, Medium = 3, and Low = 1. The two scores were summed to give an overall confidence score (range 2–10), which was then classified as Low (2–4), Medium (5–7), or High (8–10).

Citation	Confidence - type of source (base on evidence type) and quality of source	Confidence - applicability of location	Overall confidence
Barrios, A., Ernande, B., Mahé, K., Trenkel, V. and Rochet, M.J., 2017. Utility of mixed effects models to inform the stock structure of whiting in the Northeast Atlantic Ocean. Fisheries Research, 190, pp.132-139.	High	Low	Medium
Browne, M., Calderwood, J., Brophy, D. and Minto, C., 2024. Single-species quotas drive discards by multi-species trawlers in the Celtic Seas ecoregion when their relative abundance fluctuates. ICES Journal of Marine Science, 81(9), pp.1745-1763.	High	Medium	High
Burns, N.M., Bailey, D.M. and Wright, P.J., 2019. A method to improve fishing selectivity through age targeted fishing using life stage distribution modelling. Plos one, 14(4), p.e0214459.	High	High	High
Burns, N.M., Hopkins, C.R., Bailey, D.M. and Wright, P.J., 2020. Otolith chemoscape analysis in whiting links fishing grounds to nursery areas. Communications biology, 3(1), p.690.	High	High	High
Campanella, F., & van der Kooij, J. 2021. Spawning and nursery grounds of forage fish in Welsh and surroundings waters. Cefas Project Report for RSPB. Available at: https://data.cefas.co.uk/view/21465.	High	High	High
Cefas 1995. Irish Sea Annual Egg Production Method (AEPM) plankton survey. Dataset 2633. Centre for Environment, Fisheries & Aquaculture Science (Cefas) Data Portal. Available at: https://data.cefas.co.uk/view/2633 (Accessed: 5 October 2025).	High	High	High
Cefas 2000. Irish Sea Annual Egg Production Method (AEPM) plankton survey. Dataset 2641. Centre for Environment, Fisheries & Aquaculture Science (Cefas) Data Portal. Available at: https://data.cefas.co.uk/view/2641 (Accessed: 5 October 2025).	High	High	High

Citation	Confidence - type of source (base on evidence type) and quality of source	Confidence - applicability of location	Overall confidence
Cefas 2006. Irish Sea fish egg production survey 2006. Dataset 3799. Centre for Environment, Fisheries & Aquaculture Science (Cefas) Data Portal. Available at: https://data.cefas.co.uk/view/3799 (Accessed: 5 October 2025).	High	High	High
Cefas 2008. Irish Sea fish egg production survey 2008. Dataset 3798. Centre for Environment, Fisheries & Aquaculture Science (Cefas) Data Portal. Available at: https://data.cefas.co.uk/view/3798 (Accessed: 5 October 2025).	High	High	High
Cefas 2009. Assessment of potential predators of plaice eggs and larvae in the Irish Sea (Dataset 727). Centre for Environment, Fisheries & Aquaculture Science (Cefas) Data Portal. Available at: https://data.cefas.co.uk/view/727 (Accessed: 5 October 2025).	High	High	High
Cefas 2010. Highly mobile fish species distributions in UK waters. Lowestoft: Cefas. Available at: https://data.cefas.co.uk/view/154 (Accessed: 5 October 2025)	High	High	High
Cefas 2010. Irish Sea fish egg production survey 2010. Dataset 2620. Centre for Environment, Fisheries & Aquaculture Science (Cefas) Data Portal. Available at: https://data.cefas.co.uk/view/2620 (Accessed: 5 October 2025).	High	High	High
Charrier, G., Coombs, S.H., McQuinn, I.H. and Laroche, J., 2007. Genetic structure of whiting *Merlangius merlangus* in the northeast Atlantic and adjacent waters. Marine Ecology Progress Series, 330, pp.201-211.	High	Medium	High
Coull, K.A., Johnstone, R. and Rogers, S.I., 1998. Fisheries sensitivity maps in British waters. Published and distributed by UKOOA Ltd, 9. Available at: https://data.cefas.co.uk/view/149	High	High	High
Ellis, J.R., Milligan, S.P., Readdy, L., Taylor, N. and Brown, M.J. 2012. Spawning and nursery grounds of selected fish species in UK waters. Sci. Ser. Tech. Rep., Cefas Lowestoft, 147: 56 pp. Available at: https://data.cefas.co.uk/view/153	High	High	High
Gubbay, S. 2009. A selective review of historical information about the marine environment around Wales. A report to WWF Cymru.	Medium	High	High

Citation	Confidence - type of source (base on evidence type) and quality of source	Confidence - applicability of location	Overall confidence
Heffernan, O. A., Danilowicz, B. S., & Milligan, S. P. 2004. Determination of species-specific spawning distributions of commercial finfish in the Irish Sea using a biochemical protein-based method. Marine Ecology Progress Series, 284, 279-291.	High	High	High
Henderson, P. A., & Bird, D. J. 2010. Fish and macro-crustacean communities and their dynamics in the Severn Estuary. Marine pollution bulletin, 61(1-3), 100-114.	High	High	High
Henderson, P. A. 2019. A long-term study of whiting, *Merlangius merlangus* (L) recruitment and population regulation in the Severn Estuary, UK. Journal of Sea Research, 155, 101825.	High	High	High
Hernvann, P.Y., Gascuel, D., Grüss, A., Druon, J.N., Kopp, D., Perez, I., Piroddi, C. and Robert, M., 2020. The Celtic Sea through time and space: Ecosystem modeling to unravel fishing and climate change impacts on food-web structure and dynamics. Frontiers in Marine Science, 7, p.578717.	High	High	High
Hyder, K., Edwards, W and Radford, Z. 2024. Sea Angling Diary Catch, Participation and Economic Estimates 2016-2021. Cefas, UK. V1. doi: https://doi.org/10.14466/CefasDataHub.151	High	High	High
ICES. 2024. icesDatras R package, version 1.4.1. Available from CRAN. URL: https://github.com/ices-tools-prod/icesDatras (Accessed: 27/10/2025).	High	High	High
ICES, 2025a. ICES Database on Trawl Surveys (DATRAS), ICES, Copenhagen, Denmark. https://datras.ices.dk	High	High	High
ICES (2025b) Eggs and larvae dataset. Available at: https://eggsandlarvae.ices.dk (Accessed: 5 October 2025	High	High	High
ICES. 2025c. Whiting (*Merlangius merlangus*) in Division 7.a (Irish Sea). In Report of the ICES Advisory Committee, 2025.	High	High	High
ICES. 2025d. Whiting (*Merlangius merlangus*) in divisions 7.b-c and 7.e-k (southern Celtic Seas and eastern English Channel). In Report of the ICES Advisory Committee, 2025. ICES Advice 2025, whg.27.7b-ce-k. https://doi.org/10.17895/ices.advice.2720295	High	High	High

Citation	Confidence - type of source (base on evidence type) and quality of source	Confidence - applicability of location	Overall confidence
Kempf, J., Breen, P., Rogan, E. and Reid, D.G., 2022. Trends in the abundance of Celtic Sea demersal fish: Identifying the relative importance of fishing and environmental drivers. Frontiers in Marine Science, 9, p.978654.	High	Medium	High
Kowaleski, M., 2003. The commercialization of the sea fisheries in medieval England and Wales. International Journal of Maritime History, 15(2), pp.177-231.	High	High	High
Marine Institute 2018. Species spawning and nursery areas. Available at: https://atlas.marine.ie (Accessed: 27/10/2025).	High	High	High
Moore, A. B., Brander, K., Evans, S., Holm, P., & Hiddink, J. G. 2024. Century-scale loss and change in the fishes and fisheries of a temperate marine ecosystem revealed by qualitative historical sources. Fish and Fisheries, 25(5), 876-894.	High	High	High
Natural Resources Wales (2025) NRW Marine Fish Surveys 1997–2024: Species counts and length measurements. Available at: https://datamap.gov.wales/layergroups/geonode:nrw_marine_fish_surveys (Accessed: 30 January 2026).	High	High	High
OBIS 2025. Ocean Biodiversity Information System. Intergovernmental Oceanographic Commission of UNESCO. Available at: https://obis.org (Accessed: 27/10/2025).	Medium	High	High
Olsen, S. 1883. The piscatorial atlas of the North Sea, English Channel and St George's Channel. Fishing News (Books) Ltd, London.	High	High	High
Peters, J. R., McCloskey, R. M., Hinder, S. L., & Unsworth, R. K. F. 2015. Motile fauna of sub-tidal Zostera marina meadows in England and Wales. Marine Biodiversity, 45(4), 647-654.	High	High	High
Reygondeau, G., Egorova, Y., Boerder, K., Tittensor, D.P., Kaschner, K., Kesner-Reyes, K., Bailly, N. and Cheung, W.W., 2025. AquaX: An enhanced and revised AquaMaps framework to model marine species distributions and biodiversity. bioRxiv, pp.2025-10.	High	Medium	High
Robert, M., Calderwood, J., Radford, Z., Catchpole, T., Reid, D.G. and Pawlowski, L., 2019. Spatial distribution of discards in mixed fisheries: species trade-offs, potential spatial avoidance and national contrasts. Reviews in Fish Biology and Fisheries, 29(4), pp.917-934.	High	High	High

Citation	Confidence - type of source (base on evidence type) and quality of source	Confidence - applicability of location	Overall confidence
Rogers, S.I. and Ellis, J.R., 2000. Changes in the demersal fish assemblages of British coastal waters during the 20th century. iCES Journal of marine Science, 57(4), pp.866-881.	High	Medium	High
Scottish Government, Marine Directorate. 2023. Essential Fish Habitats Project Data. doi: 10.7489/12450-1	High	High	High
Smylie, M., 2015. The perilous catch: a history of commercial fishing. The History Press.	Medium	Medium	Medium
Tirronen, M., Depestele, J. and Kuparinen, A., 2023. Can regime shifts in reproduction be explained by changing climate and food availability?. Frontiers in Marine Science, 10, p.1167354.	High	Medium	High
Walker-Milne, N., Elliott, S.A.M., Wright, P.J. and Bailey, D.M., 2025. Seascape ecology of juvenile gadoid nursery areas. Royal Society Open Science, 12(9).	High	Medium	High

Appendix 3: Population distribution datasets

A3.1. Life stage - eggs

A3.1.1. Spawning and nursery grounds of selected fish species in UK waters (Ellis et al., 2012)

Spatial coverage: All Welsh waters, excluding close inshore and estuaries.

Ellis et al. (2012) indicates that whiting eggs were recorded in high concentrations along the North Wales coast, with lower concentrations in Cardigan Bay and the Bristol Channel (Figure 10). Surveys were conducted between January and June, encompassing the main spawning period for whiting. In the Irish Sea, high concentrations of whiting eggs were recorded within Welsh waters and adjacent English and Irish waters. Only low concentrations are recorded in Cardigan Bay and the Bristol Channel and Celtic Sea, although there are fewer sampling stations in Cardigan Bay, of which two are in Welsh offshore waters.

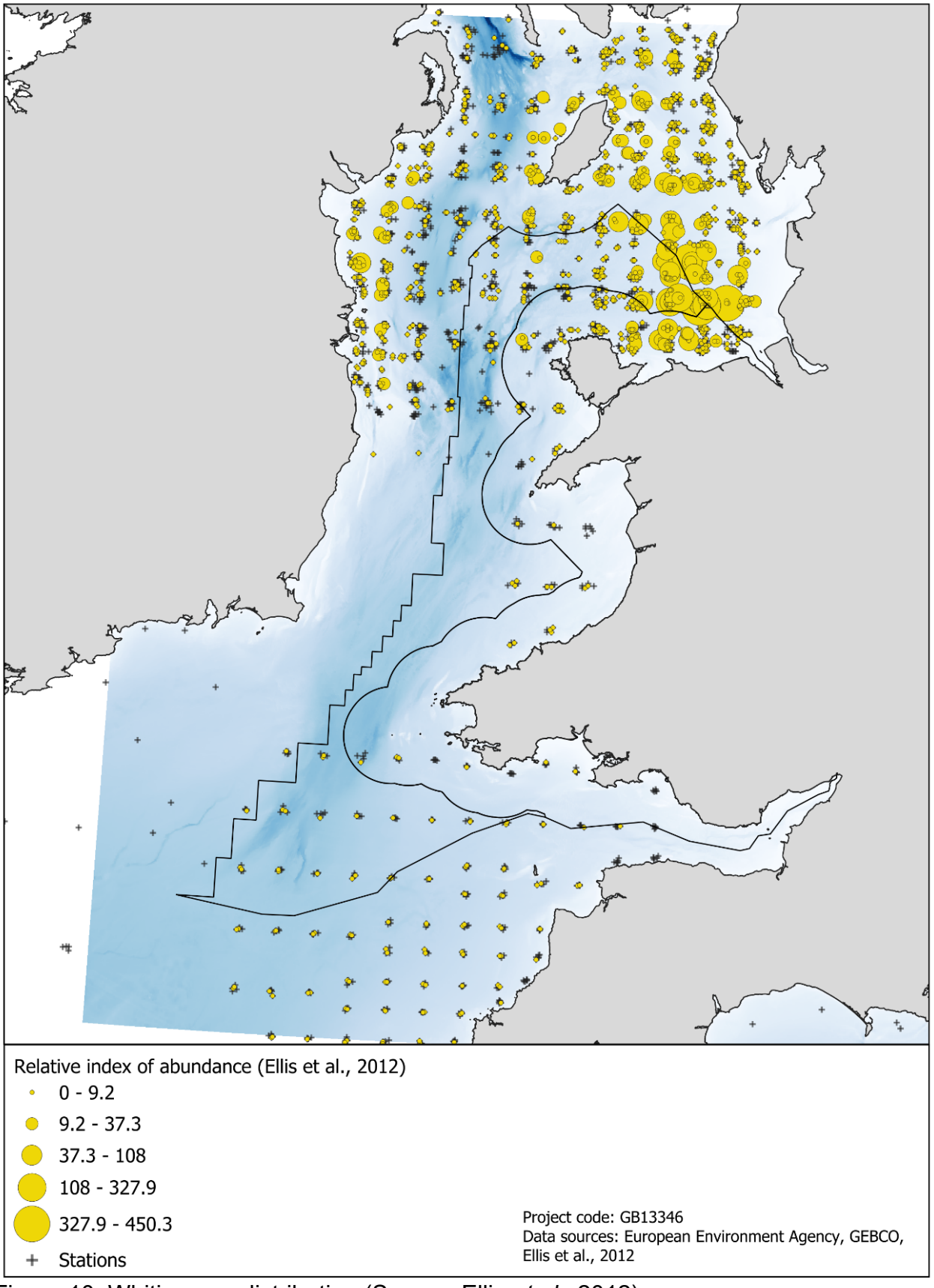


Figure 10. Whiting egg distribution (Source: Ellis *et al.*, 2012).

A3.1.2. Annual Egg Production Method Survey (AEPM) (Cefas, 1995; Cefas, 2000)

Spatial coverage: Irish Sea (and Cardigan Bay in 1995 only)

Cefas (1995; 2000) recorded low numbers of whiting eggs in inshore Welsh waters off the North Wales coast and in Liverpool Bay, offshore Welsh waters of the Irish Sea and adjacent English and Irish waters, but in low numbers (Figure 11). Surveys were conducted between February and June, overlapping with the main spawning period for whiting.

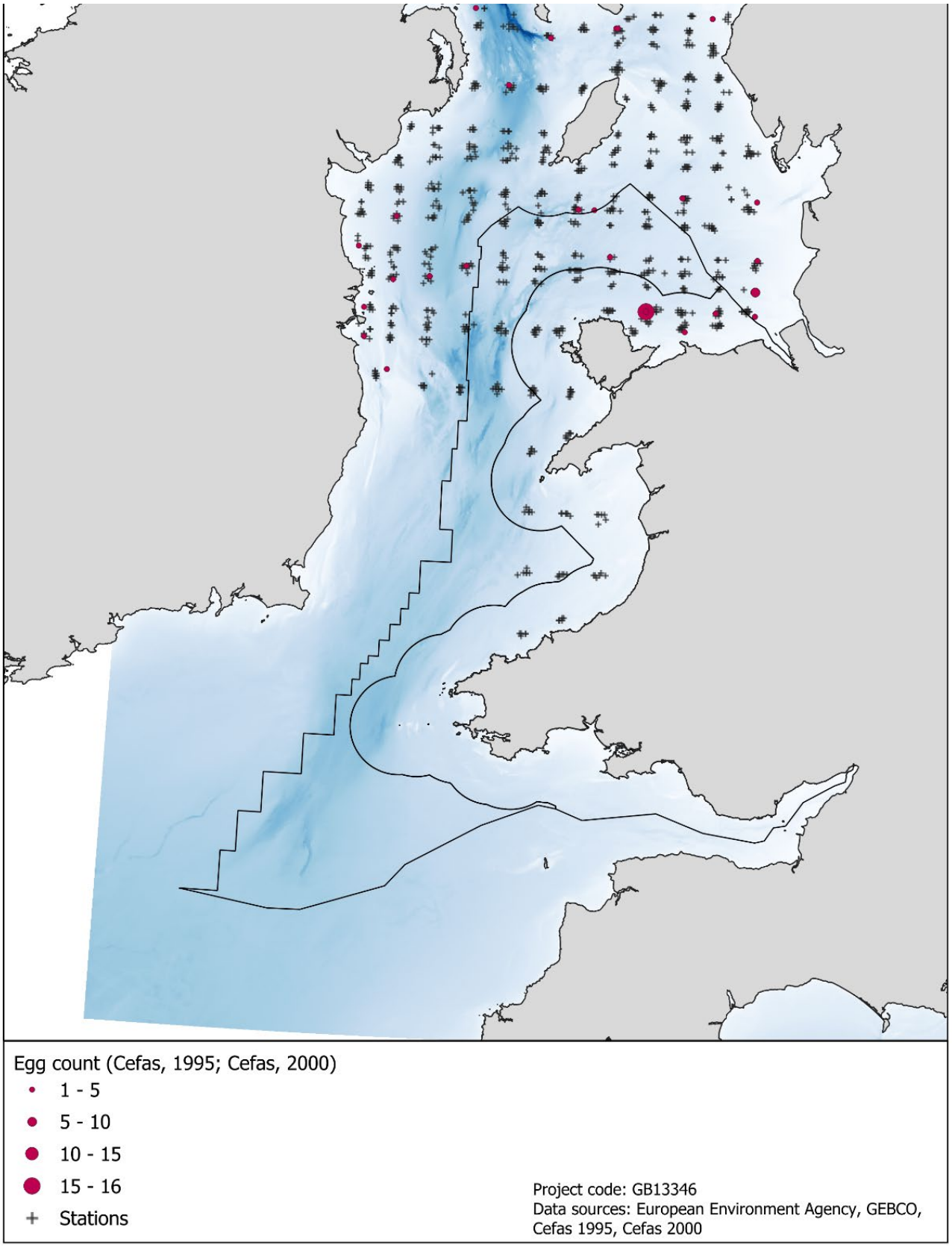


Figure 11. Whiting egg distribution (Source: Cefas, 1995; 2000).

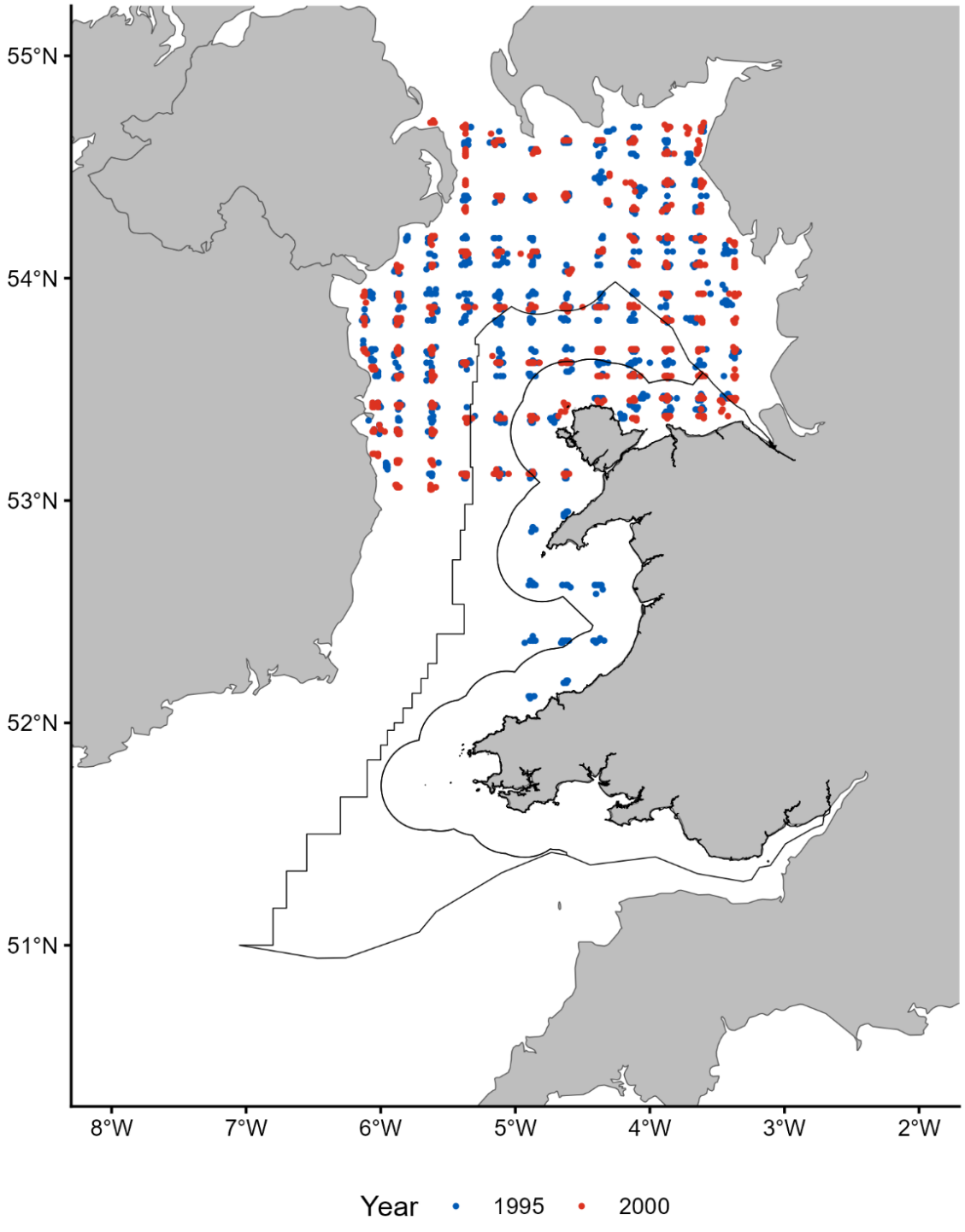


Figure 12. AEPM sampling stations from 1995 and 2000 surveys (Source: Cefas, 1995; 2000).

A3.1.3. Irish Sea Fish Egg Production survey (ISFEPS) (2006, 2008, 2010)

Spatial coverage: Irish Sea

The Irish Sea Fish Egg Production Surveys in 2006, 2008, and 2010 consistently recorded whiting eggs throughout both Welsh inshore waters and Welsh offshore waters along the North Wales coast, as well as in adjacent English and Irish waters (Figure 13). The highest egg numbers were consistently identified between Anglesey and the Dee Estuary, whereas sampling stations in Welsh waters to the north and west of Anglesey recorded lower numbers of whiting eggs.

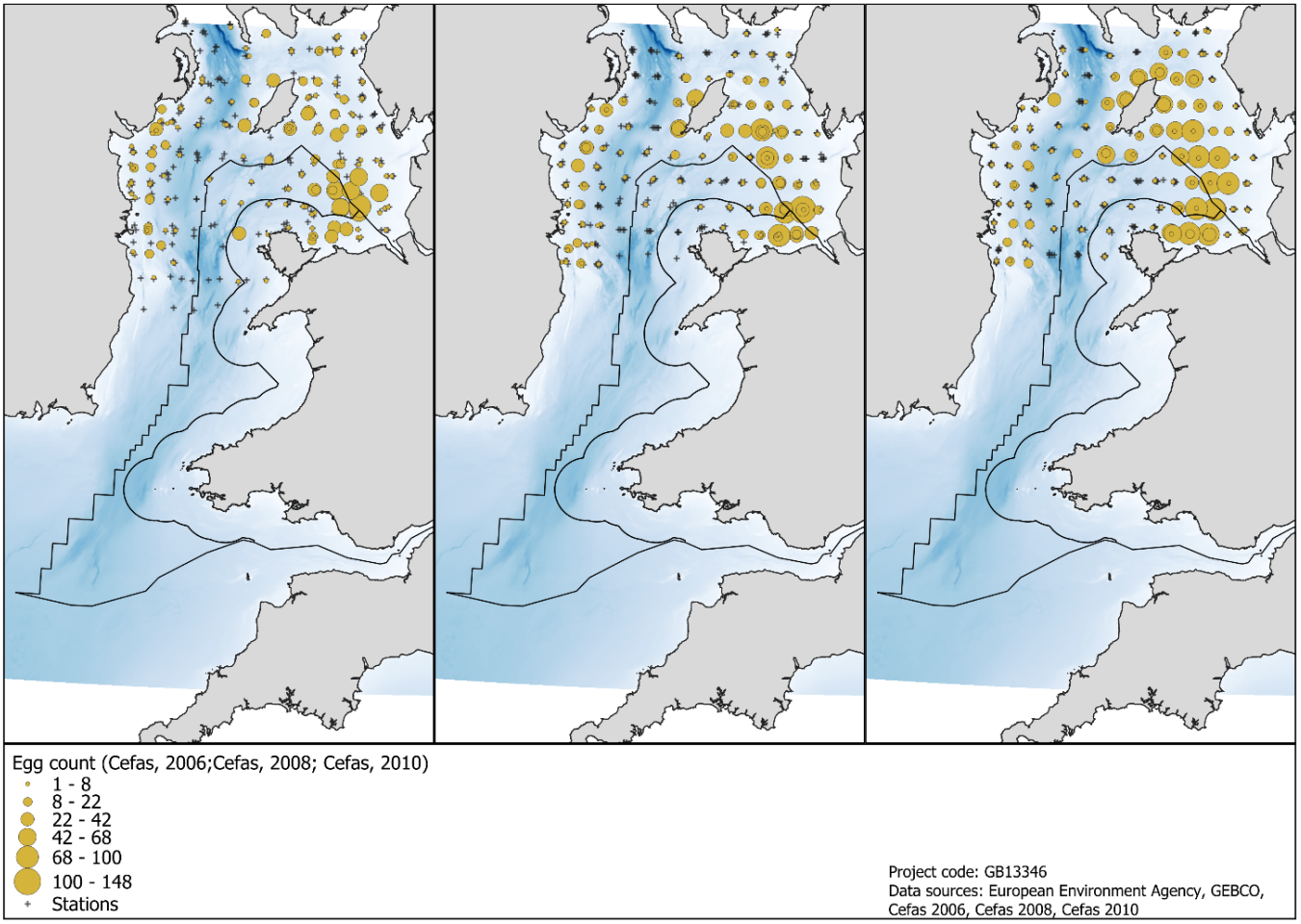


Figure 13. Whiting egg abundance and distribution in Irish Sea Fish Egg Production Surveys 2006, 2008, 2010 (Source: Cefas, 2006; 2008; 2010).

A3.1.4. Determination of species-specific spawning distributions of commercial finfish in the Irish Sea using a biochemical protein-based method (Heffernan et al. 2004)

Spatial coverage: Irish Sea

During six ichthyoplankton surveys of the Irish sea from February to May 2000, pelagic fish eggs were sampled from 105 ICES rectangle-based stations and identified through iso-electric focusing and histochemical staining of isozymes (Heffernan *et al.*, 2004). Stage IA whiting eggs were identified through four survey periods: early March, late March, early April and late April.

Their relative abundance was spatially mapped at each of these time periods by Kriging (Figure 14). These data show that in early March whiting eggs are at their highest density off the Great Orme extending north to the Isle of Man in moderate densities. By late March, the highest densities are distributed in several patches between the North Wales coast and the Isle of Man. In early April a single concentrated patch of high-density eggs is seen southeast of the Isle of Man and a moderate density patch to the west of Anglesey. In late April, moderate densities appear to the north east of Anglesey and a high-density is seen south east of the Isle of Man.

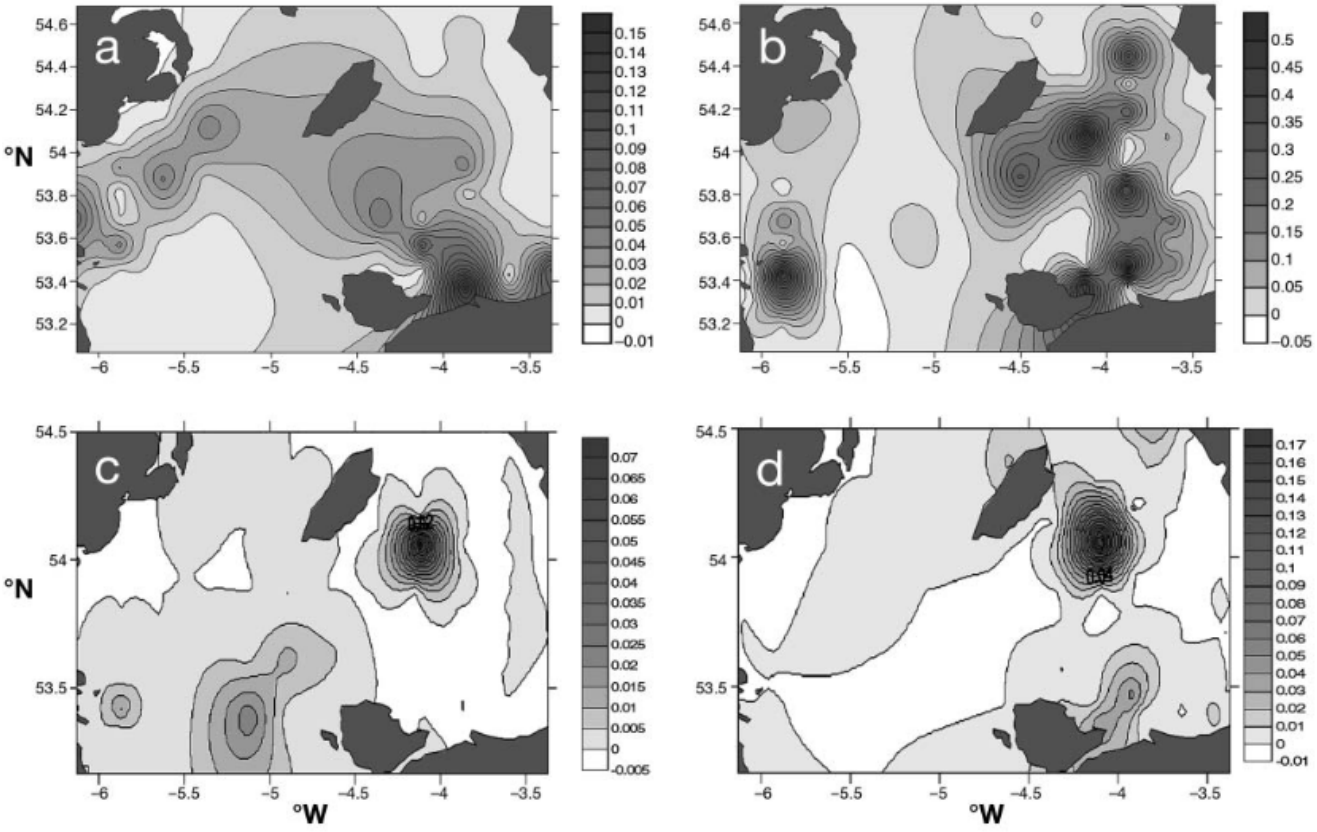


Figure 14. Stage IA whiting egg abundance (eggs m^{-2} sea surface area) in the Irish Sea in (a) early March (Survey 1); (b) late March (Survey 2); (c) early April (Survey 3); (d) late April (Survey 4) (Source: Heffernan *et al.*, 2004).

A3.2. Life stage - larvae

A3.2.1. Assessment of potential predators of plaice eggs and larvae in the Irish Sea (Cefas, 2023)

Spatial coverage: Irish Sea

Whiting larvae were recorded in samples collected along the North Wales coast, and into adjacent English waters. (Figure 15). The samples were collected within Welsh inshore waters and also a short distance into Welsh offshore waters. Whiting larvae were recorded at higher concentrations off the Great Orme and eastern Anglesey than they were off the Dee Estuary.

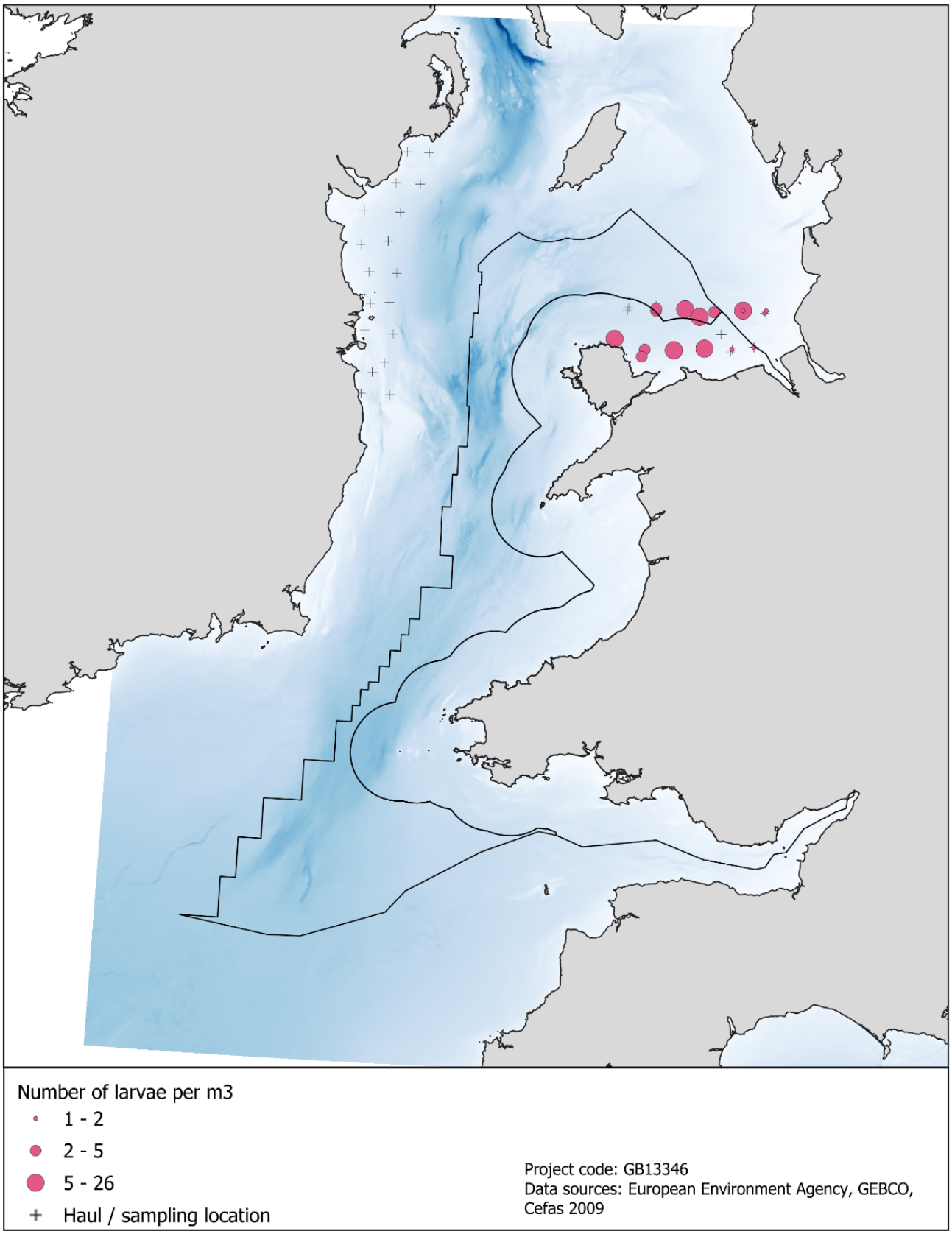


Figure 15. Whiting larvae samples (Source: Cefas, 2023).

A3.2.2. Spawning and nursery grounds of selected fish species in UK waters (Ellis et al., 2012)

Spatial coverage: All Welsh waters, excluding close inshore and estuaries.

Ellis *et al*. (2012) reports that whiting larvae were recorded in samples taken around Wales, with the highest relative abundance being recorded in the Irish Sea (Figure 16). Off the North Wales coast, whiting larvae were recorded at their highest relative abundance between Anglesey and the Dee Estuary, both within Welsh inshore waters and Welsh offshore waters. Relative abundance was lower off northern and western Anglesey, as well as in Cardigan Bay. Off Pembrokeshire and South Wales coasts, the relative abundance of whiting larvae was low within Welsh inshore waters but was higher in Welsh offshore waters. In waters outside Wales, the relative abundance of whiting larvae was high off the north-western coast of England and the eastern coast of Ireland and was highest in the Celtic Sea off the northern coast of Cornwall consistent over the Trevose Bank spawning ground.

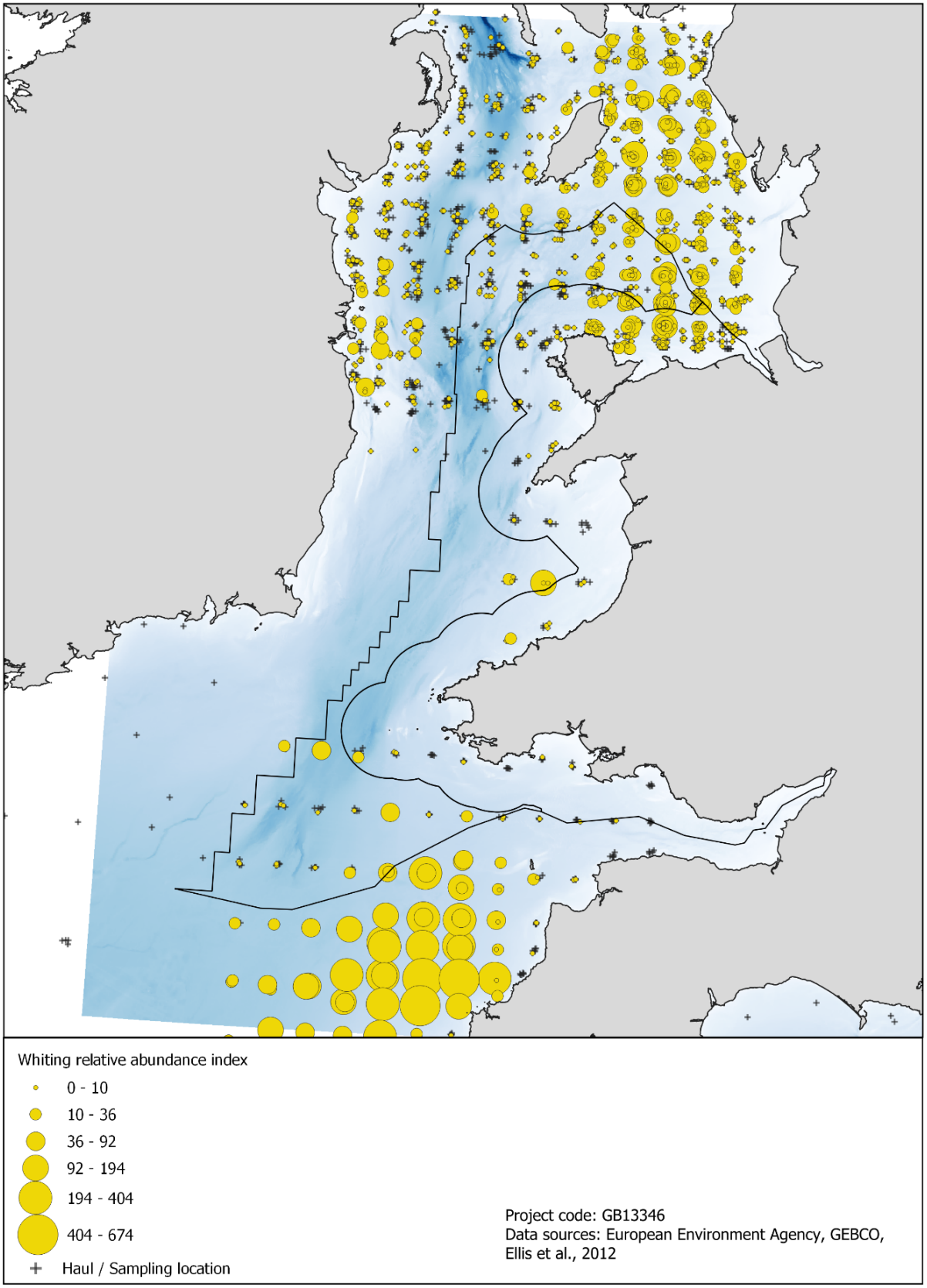


Figure 16. Distribution of abundance of whiting larvae in Welsh and surrounding waters. Black crosses denote sampling stations (Source: Ellis *et al.*, 2012).

A3.2.3. Annual Egg Production Method Survey (AEPM) (Cefas, 1995; Cefas, 2000)

Spatial coverage: Irish Sea (and Cardigan Bay in 1995 only)

High concentrations of whiting larvae were recorded in the Irish Sea, east of the Isle of Man and Anglesey and also along the eastern coast of Ireland. In Welsh waters, whiting larvae concentrations were highest between Anglesey and the Great Orme, both within Welsh inshore and offshore waters. Slightly lower concentrations of whiting larvae were recorded to the north and west of Anglesey and in northern Cardigan Bay. In Cardigan Bay, high concentrations of whiting larvae were recorded, although there were fewer sampling sites here than off the North Wales coast (Figure 17).

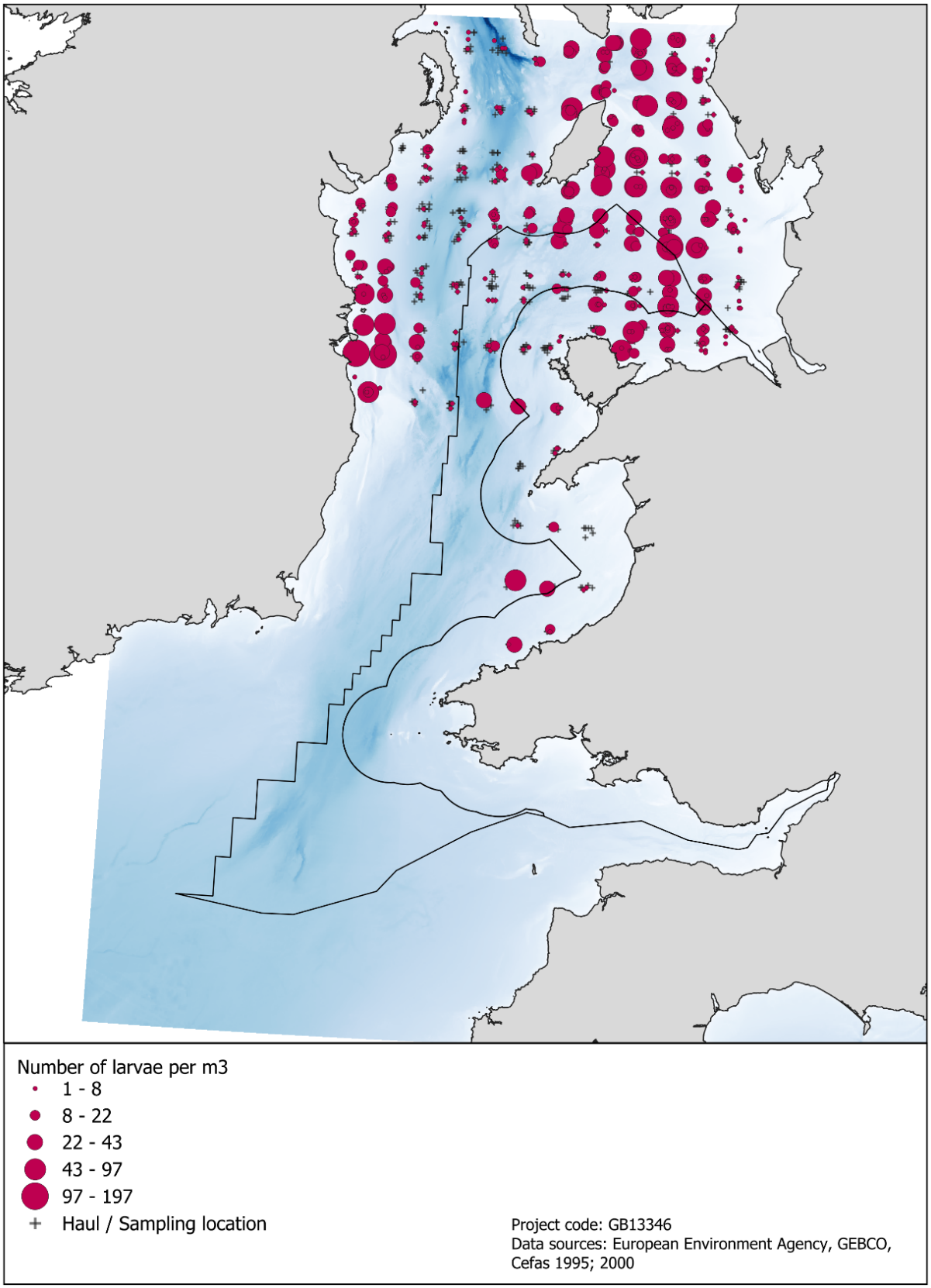


Figure 17. Whiting larvae recorded in AEPM 1995 and 2000 surveys (Source: Cefas 1995; 2000).

A3.2.4. Irish Sea Fish Egg Production survey (ISFEPS) (Cefas, 2010)

Spatial coverage: Irish Sea

The Irish Sea Fish Egg Production Surveys recorded whiting larvae across the Irish Sea, including in Welsh waters. The relative abundance of whiting larvae was greatest off the eastern and south-eastern coasts of the Isle of Man, including in Welsh offshore waters. Relative abundance decreased from Welsh offshore waters into Welsh inshore waters on the North Wales coast. Relative abundance was greater to the north-east and east of Anglesey than to the north or west (Figure 94).

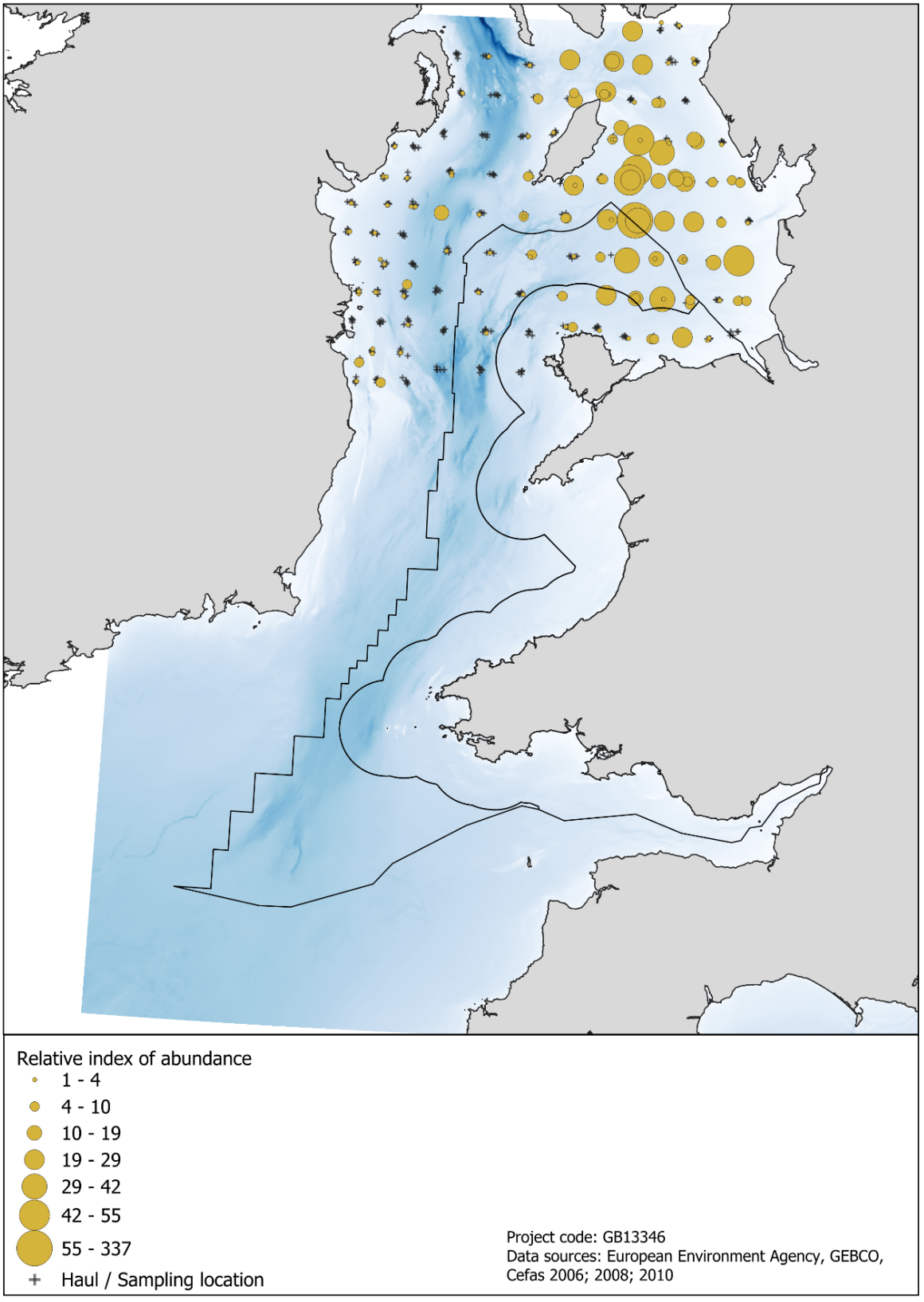


Figure 18. Relative abundance of whiting larvae across Irish Sea Fish Egg Production Surveys (Cefas, 2006; 2008; 2010).

A3.3. Life stage - juveniles

A3.3.1. Spawning and nursery grounds of selected fish species in UK waters (Ellis et al., 2012)

Spatial coverage: All Welsh waters, excluding close inshore and estuaries.

Sampling conducted throughout the Irish and Celtic Seas recorded the presence of juvenile whiting throughout Welsh waters (Figure 19). Off the North Wales coast, juvenile whiting were found in high abundance in Welsh inshore waters off north-eastern Anglesey, as well as in Welsh offshore waters north of Anglesey. High levels of juvenile whiting abundance were also recorded in adjacent English and Irish waters throughout the Irish Sea.

The presence of juvenile whiting was recorded throughout Cardigan Bay, albeit at low abundance, with some additional records of juvenile whiting from Welsh offshore waters in St George's Channel.

On the south Wales coast, juvenile whiting were consistently present in samples collected between Pembrokeshire and the Gower Peninsula in higher numbers, as well as in several samples collected from Welsh offshore waters in the Celtic Sea. In these regions, however, the abundance of juvenile whiting was generally lower than on the North Wales coast. Additional records of juvenile whiting were collected from adjacent Irish and English waters in the Celtic Sea, again at low abundance.

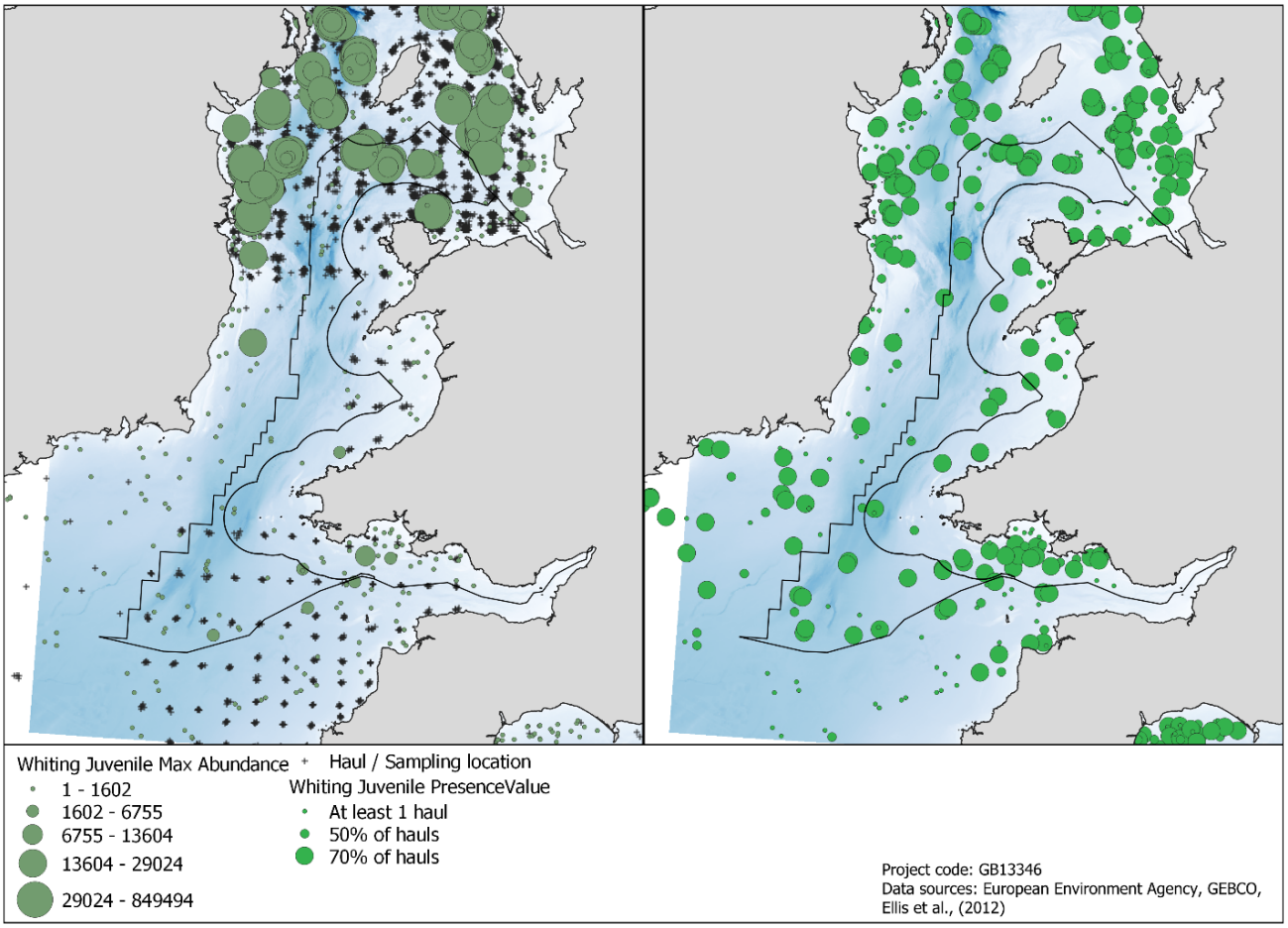


Figure 19. Juvenile whiting maximum abundance recorded at each station (left) and presence value (right). 1 = presence in 1 or more tows at each station 50 = present in over 50% of tows at each station 70 = present in over 70% of tows at each station. (Source: Ellis *et al.*, 2012).

A3.3.2. Spawning and nursery grounds of forage fish in Welsh and surrounding waters (Campanella and van der Kooij, 2021)

Spatial coverage: All Welsh waters, excluding close inshore and estuaries.

Campanella and van der Kooij (2021) identified juvenile whiting (<19 cm) hotspots in the Irish Sea, Celtic Sea, and Bristol Channel during Q1 (left) and 4 (right) (Figure 20). A higher hotspot index reflects more consistent hotspot presence through time.

In Q1, juvenile whiting hotspots in Welsh waters occur in the inshore waters off the North Wales coast, particularly around the Dee Estuary, and a more persistent Q1 hotspot is located on the western and southern coasts of Pembrokeshire, primarily within inshore waters but also extending into Welsh offshore waters and adjacent English waters. This area may reflect settlement of larvae transported from the Trevose Bank spawning ground given the predominant tidal current flows from the spawning ground into the Bristol Channel.

In Q4, the most persistent hotspot for juvenile whiting in the Irish Sea is within Welsh inshore waters on the North Wales coast, centred on the Dee Estuary. Waters off the western and, in particular, southern coasts of Pembrokeshire also reflect a prominent hotspot, both within Welsh inshore waters and in adjacent English waters on the North Wales coast of Devon. The inner Bristol Channel also serves as an important juvenile whiting hotspot.

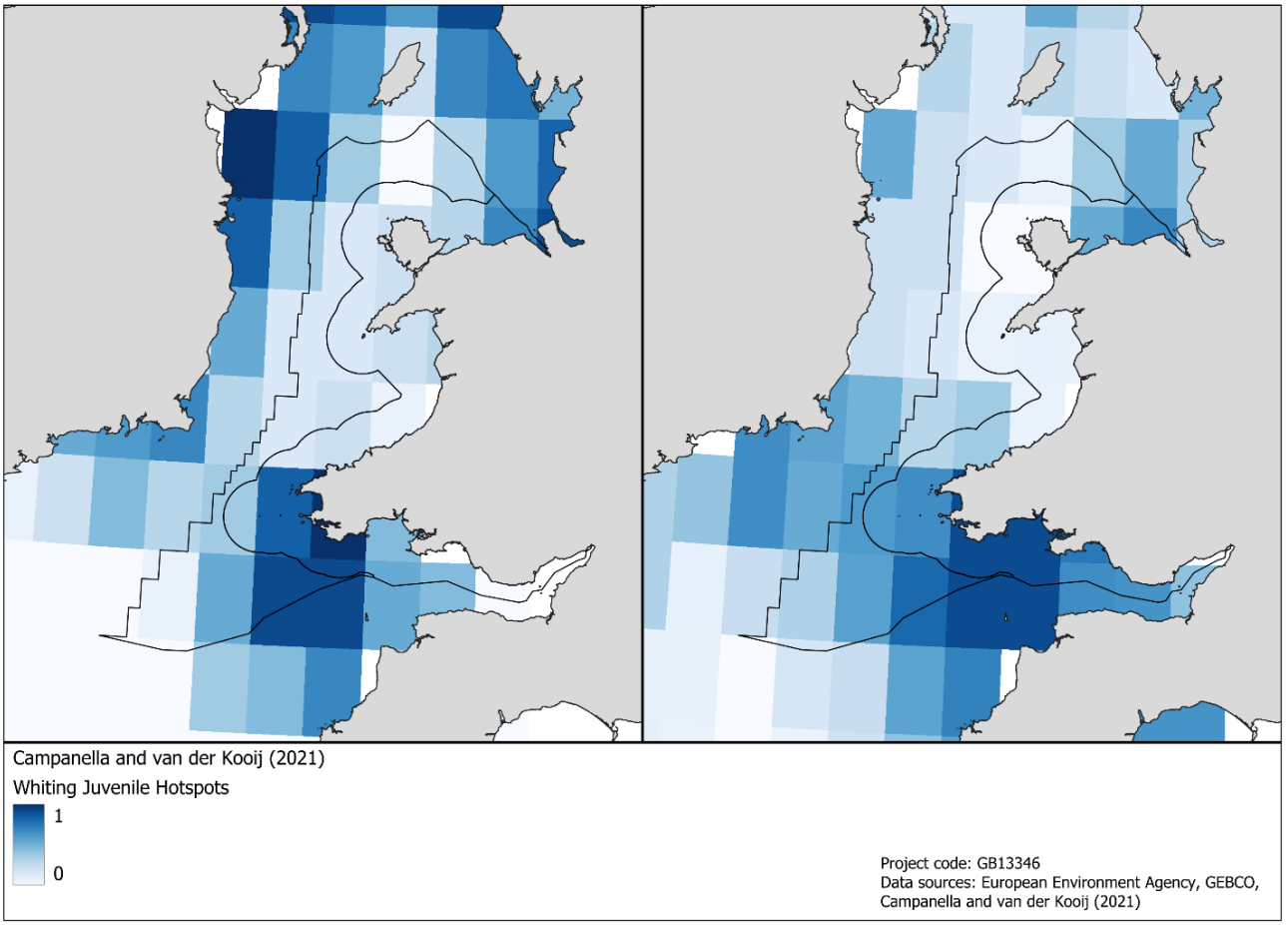


Figure 20. Hotspot map of juvenile whiting in Welsh and surrounding waters in Q4 (left) and Q1 (right) (Source: Campanella and van der Kooij, 2021).

A3.3.3. DATRAS Fisheries-independent trawl survey data (ICES, 2025a)

Spatial coverage: All Welsh waters, excluding close inshore and estuaries.

Within Welsh waters, the number of juvenile whiting recorded from samples is generally lower than the higher numbers recorded in adjacent English and Irish waters, such as the Solway Firth and off Barrow and Dublin (Figure 21). However, juvenile whiting in substantial abundance are still recorded within Welsh inshore waters off The Great Orme and eastern Anglesey, and slightly higher numbers in Welsh offshore waters directly south of the Isle of Man.

Off the west Wales coast, relatively lower numbers of juvenile whiting are recorded in Cardigan Bay, primarily within inshore waters, although few samples were collected in Welsh offshore waters in this region.

In the Bristol Channel, juvenile whiting are recorded from numerous sampling locations within Welsh offshore waters south-west of Pembrokeshire and within Welsh inshore waters between the south Pembrokeshire and Gower peninsulas. Additional sampling stations in adjacent Irish and English waters in the Celtic Sea record similarly low numbers of juvenile whiting.

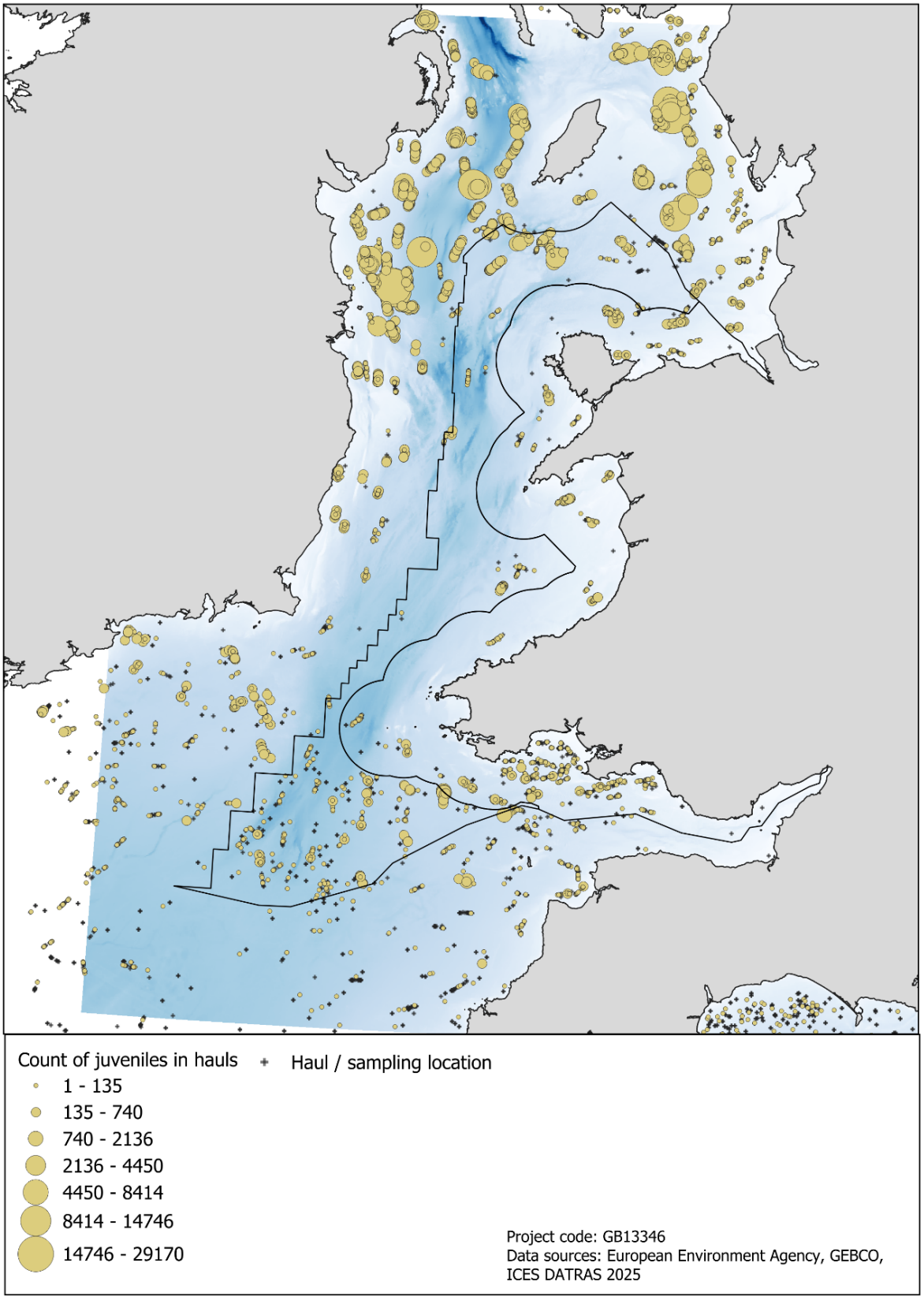


Figure 21. Points graduated in size by counts of juvenile (<19 cm) whiting in survey hauls found within the DATRAS database (Source: ICES, 2025a).

A3.3.4. Sea Angling Diary catch records 2016-2024 (Cefas, 2025)

Spatial coverage: All Welsh waters

Sea Angling Diary data record 764 juvenile whiting (<19 cm) across several ICES rectangles (Table 3 and Figure 22), accounting for approximately 8.7% of total recorded whiting catches in Wales (n = 8,803) between 2016 and 2024. Most individuals fall within the 10–19 cm length range, with very few fish recorded below 10 cm and only two less than 5 cm. Overall, the spatial pattern shows a concentration of juvenile whiting records along the North Wales coast and in the Bristol Channel and Severn Estuary, with lower occurrence in Carmarthen Bay and Pembrokeshire.

ICES rectangles 35E5 and 35E6 around the North Wales coast and Anglesey contain the highest numbers of juveniles, dominated by 15–19 cm individuals. They also occur in lower numbers in Cardigan Bay (33E5 and 34E5). Along the south Wales coast, ICES rectangle 31E6 around the Vale of Glamorgan coast records high numbers of juveniles, while around Pembrokeshire (32E4) and in the inner Bristol Channel and Severn Estuary (32E7) contain relatively few individuals.

Table 3. Number of juvenile (≤19 cm) whiting caught and recorded in Sea Angling Diary data by ICES rectangle (2016 – 2024).

Length Class (cm)	31E6	31E7	32E4	32E5	32E6	32E7	33E5	34E5	35E5	35E6
[0, <5)	0	0	0	2	0	0	0	0	0	0
[5, <10)	5	0	0	0	0	4	0	0	0	3
[10, <15)	64	0	0	3	28	8	8	0	64	34
[15, ≤19)	155	0	6	31	53	8	23	12	120	133

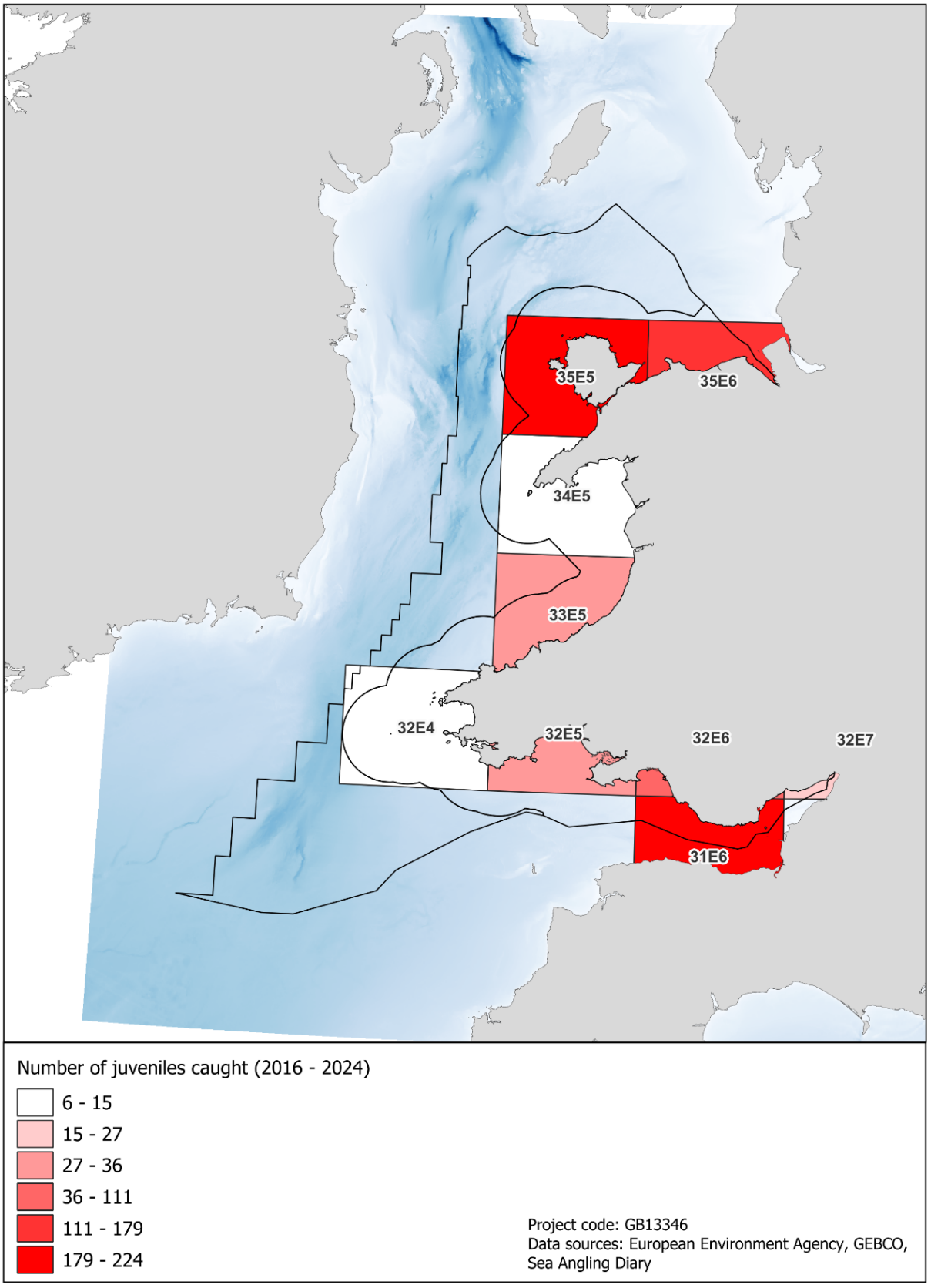


Figure 22. Number of juvenile (≤19 cm) whiting caught and recorded in Sea Angling Diary data (2016 – 2024) (Source: Cefas, 2025).

A3.3.5. WFD Transitional fish surveys (NRW, 2025)

Spatial coverage: Welsh estuaries

NRW WFD surveys in Welsh estuaries recorded the presence and abundance of juvenile whiting in several Welsh estuaries: the Teifi and Nevern Estuaries in Pembrokeshire and Ceredigion, the Conwy and Dee Estuaries in North Wales, and the Bristol Channel including the Usk and Wye Estuaries (Figure 23).

Low numbers of juvenile whiting were recorded in the Teifi and Nevern Estuaries in Pembrokeshire. Slightly higher numbers of juvenile whiting were recorded in the Conwy Estuary and in the eastern part of Conwy Bay, while higher numbers were recorded within Welsh inshore waters at the mouth of the Dee Estuary. Consistently high numbers of juvenile whiting were recorded within Welsh inshore waters in the Severn Estuary between Lavernock Point and the Wye Estuary, with particularly high numbers recorded at the mouth of the River Taff. Both the Usk and the Wye Estuaries were also found to host juvenile whiting in low numbers.

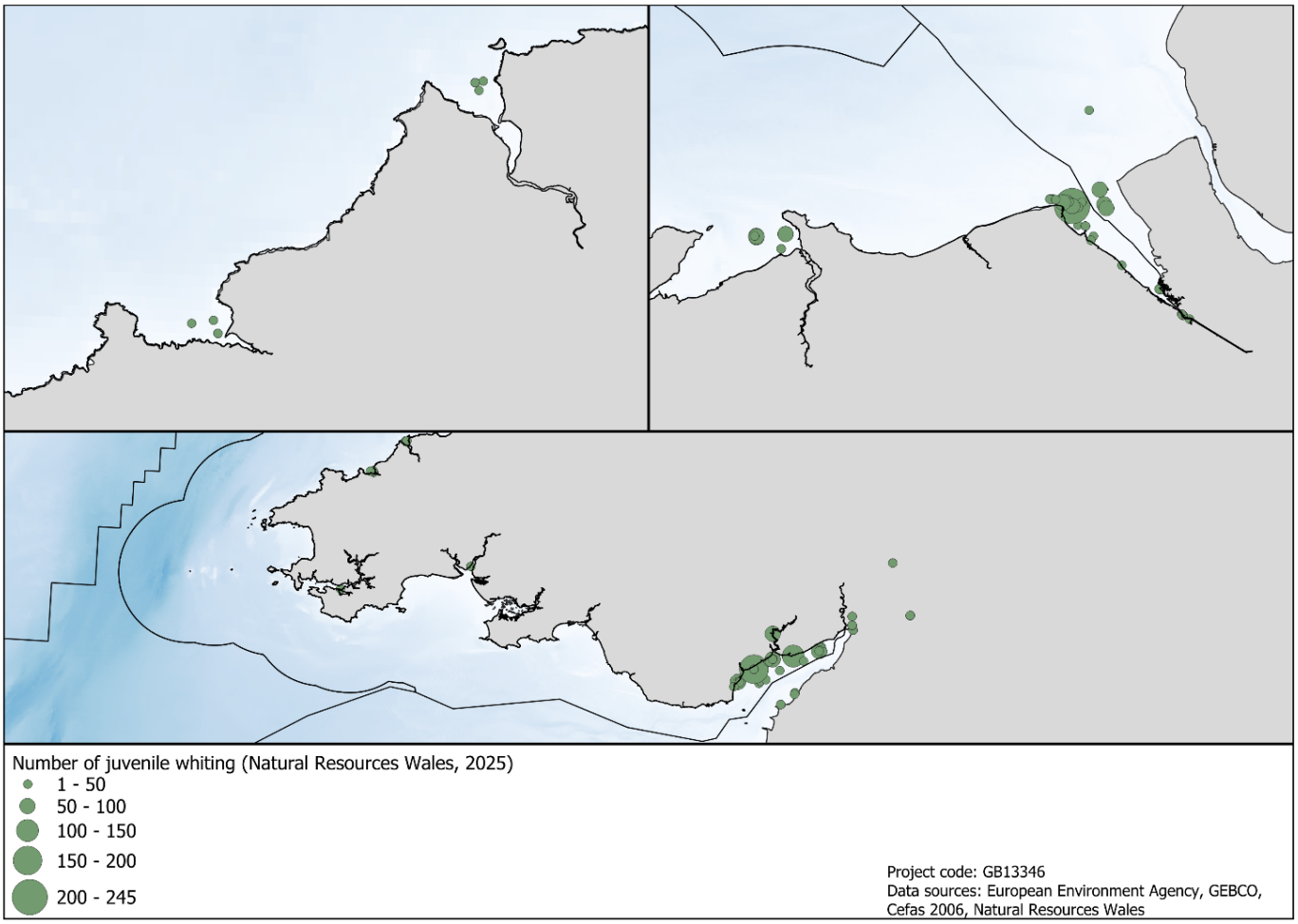


Figure 23. Juvenile whiting recorded at sites in Welsh estuaries (Source: NRW, 2025).

A3.3.6. Spatial distribution of discards in mixed fisheries: species trade-offs, potential spatial avoidance and national contrasts (Robert et al. 2019)

Spatial coverage: Celtic Sea

This study analysed the spatial distribution of undersized discards in mixed fisheries, highlighting occurrences of juvenile whiting with haddock, cod, and other species. In the northeastern Celtic Sea, particularly in the northern part of ICES Division VIIg (approximately 50–51°N; 6–7°W), west of the Bristol Channel, clusters of undersized whiting were consistently identified, suggesting localised concentrations of juveniles.

Depth and substrate type were identified as important drivers of spatial distribution (though the latter to a lesser extent), with undersized whiting predominantly occurring in coastal waters. This study also identified persistent discard “hot spots” where juvenile whiting and haddock occurred, supporting the idea of nearshore areas as important nursery habitats. While gear and mesh size may influence observed patterns, the clustering of undersized whiting in specific coastal zones indicates spatial structuring of juvenile populations and potential areas of management interest.

A3.3.7. Single-species quotas drive discards by multi-species trawlers in the Celtic Seas ecoregion when their relative abundance fluctuates (Browne et al. 2024)

Spatial coverage: Celtic Sea

Browne *et al.* (2024) analysed discard rates of whiting from multi-species trawlers in the Celtic Sea ecoregion. Discards of undersized whiting were highest in areas fished by the Nephrops mixed fishery. The study indicates that juvenile whiting are highly susceptible to discarding in mixed fisheries, demonstrating continued pressure on nursery populations in coastal and offshore areas of the Celtic Sea, including waters adjacent to Wales.

A3.3.8. A long-term study of whiting, Merlangius merlangus (L) recruitment and population regulation in the Severn Estuary (Henderson and Bird, 2010)

Spatial coverage: Severn Estuary

This long-term study reviewed fish and macro-crustacean communities in the Severn Estuary using a 30-year time series of standardised sampling at Hinkley Point in Bridgwater Bay. Whiting are identified as one of the three most abundant fish species in the estuary and exhibited consistent seasonal cycles in abundance, with peaks in late summer and autumn corresponding to the arrival of new recruits using the estuary as a nursery area.

Whiting show no clear long-term trend in abundance despite broader community-level changes potentially linked to warming temperatures, salinity shifts, and the North Atlantic

Oscillation. The seasonal influx of juvenile recruits is noted as highlighting the role of the Severn Estuary as an important nursery habitat, with regular tidal and seasonal migrations structuring population dynamics.

A3.3.9. Motile fauna of sub-tidal Zostera marina meadows in England and Wales (Peters et al., 2015)

Spatial coverage: Tremadog Bay and Llŷn Peninsula

A study using BRUVs identified whiting presence in shallow (3–6 m) sea-grass meadows (Peters *et al.*, 2015). Sampling took place in October 2012, and June and July of 2013 and whiting were found in 50% and 33% of samples taken from Porthdinllaen and Tremadog Bay in North Wales, respectively.

A3.4. Life cycle process – nursery grounds

A3.4.1. Fisheries spawning and nursery areas in British waters (Coull et al., 1998)

Spatial coverage: All Welsh waters

Whiting nursery areas are identified by Coull et al. (1998) in coastal waters throughout much of the Irish and Celtic Seas (Figure 24). A large whiting nursery area is recorded, extending from the southern Rhins of Galloway in Scotland, along the north-western coast of England, and through Welsh inshore waters between the Dee Estuary and the eastern coast of Anglesey.

A further whiting nursery area is recorded as extending along the South Wales coast, from the Milford Haven in the west, through the Bristol Channel, and into the Severn Estuary. This area is contiguous with whiting nursery habitat in English waters in the Bristol Channel and along the northern coasts of Somerset, Devon, and Cornwall. Two further relevant whiting nursery habitats are recorded in Irish waters, firstly between Strangford Lough and Wicklow Head on the eastern Irish coast; and secondly along the southern Irish coast.

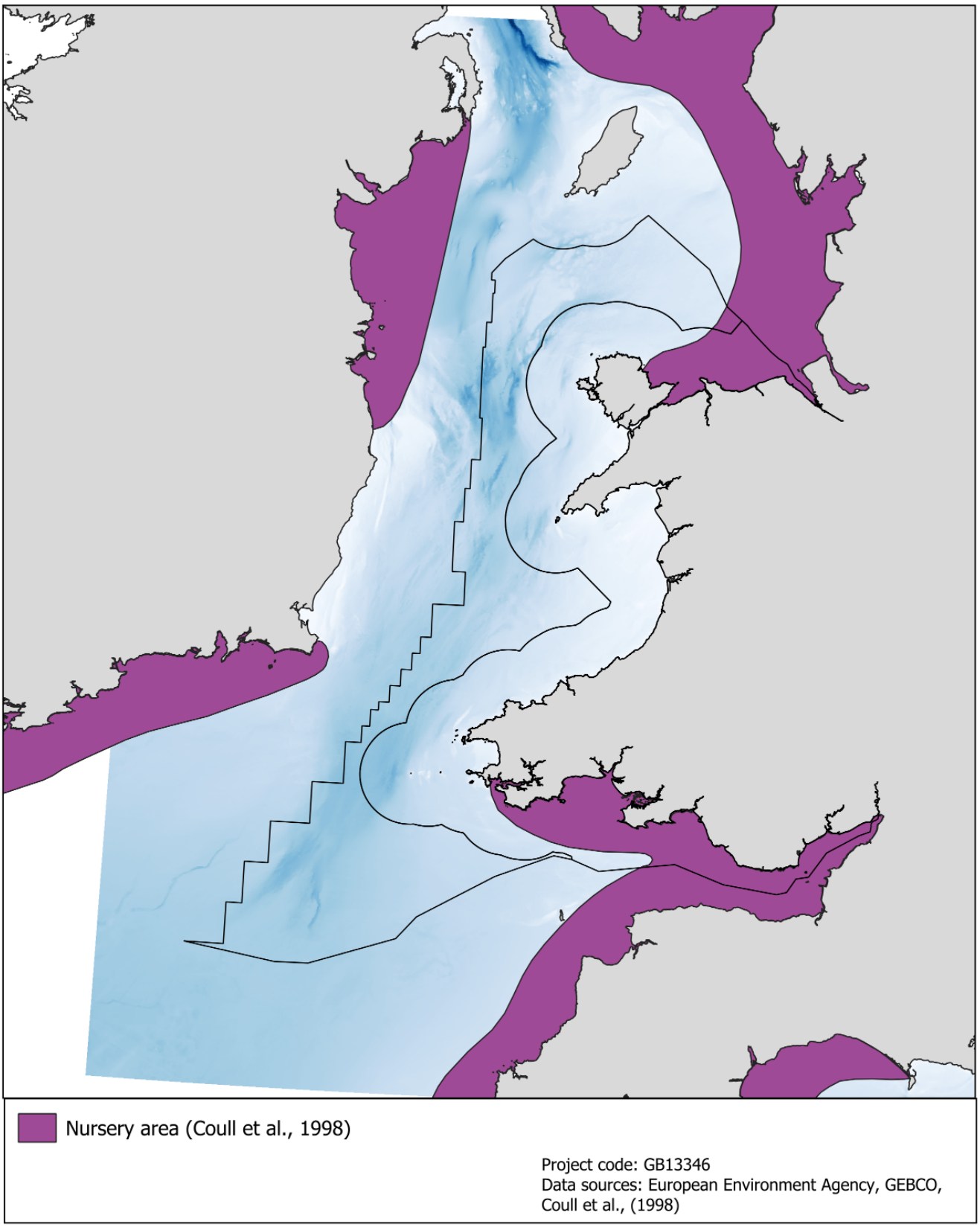


Figure 24. Whiting nursery areas (Source: Coull *et al.*, 1998).

A3.4.2. Spawning and nursery grounds of selected fish species in UK waters (Ellis et al., 2012)

Spatial coverage: All Welsh waters

Ellis *et al.* (2012) identified whiting nursery grounds in the Irish and Celtic Seas, dividing these between high and low intensity areas (Figure 25). High intensity whiting nursery grounds are identified on the eastern side of the northern Irish Sea, extending from the Isle of Whithorn in Scotland, along the north-west coast of England, and into Welsh inshore waters from the Dee Estuary to the eastern coast of Anglesey and the Menai Strait. A further high intensity whiting nursery ground is identified on the eastern Irish coast, extending from Strangford Lough in the north to Wicklow Head in the south.

The remainder of the Irish Sea and Celtic Sea is classified as a low intensity whiting nursery ground, including Welsh waters from the western coast of Anglesey, south through Cardigan Bay, around the coast of Pembrokeshire and along the South Wales coast to the Severn Estuary.

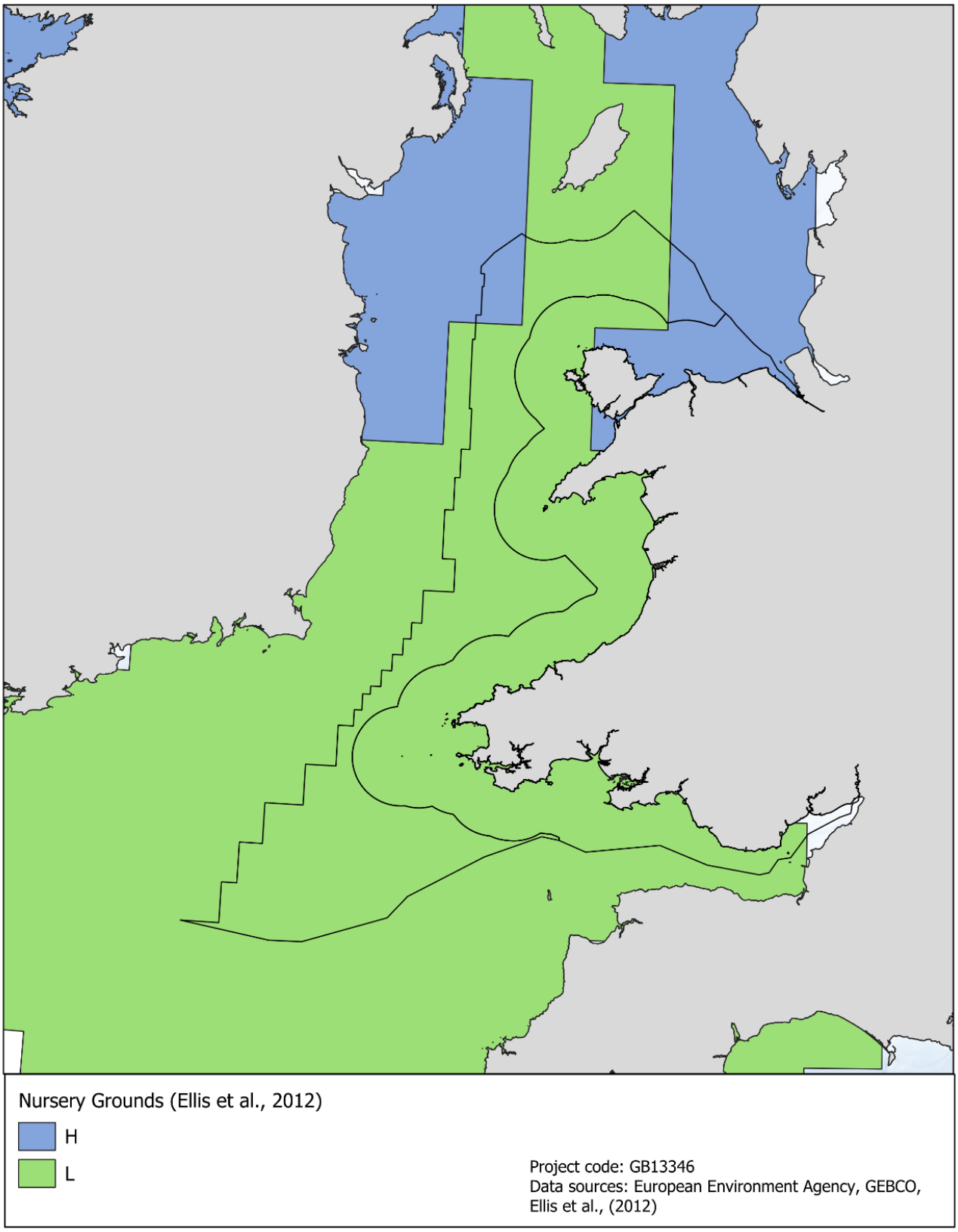


Figure 25. Areas of high and low whiting nursery ground intensity (Source: Ellis *et al.*, 2012).

A3.4.3. Species spawning and nursery areas (Marine Institute, 2018; revised 2024)

Spatial coverage: All Welsh waters

The Marine Institute (2018) identified whiting nursery areas in the Irish and Celtic Seas, some of which were recorded within Welsh waters (Figure 26). Welsh offshore waters north-west of Anglesey host part of a large whiting nursery area, extending into Irish waters. A further whiting nursery area is identified in Welsh inshore waters and Welsh offshore waters off the south-western coast of Pembrokeshire, extending into adjacent English and Irish waters.

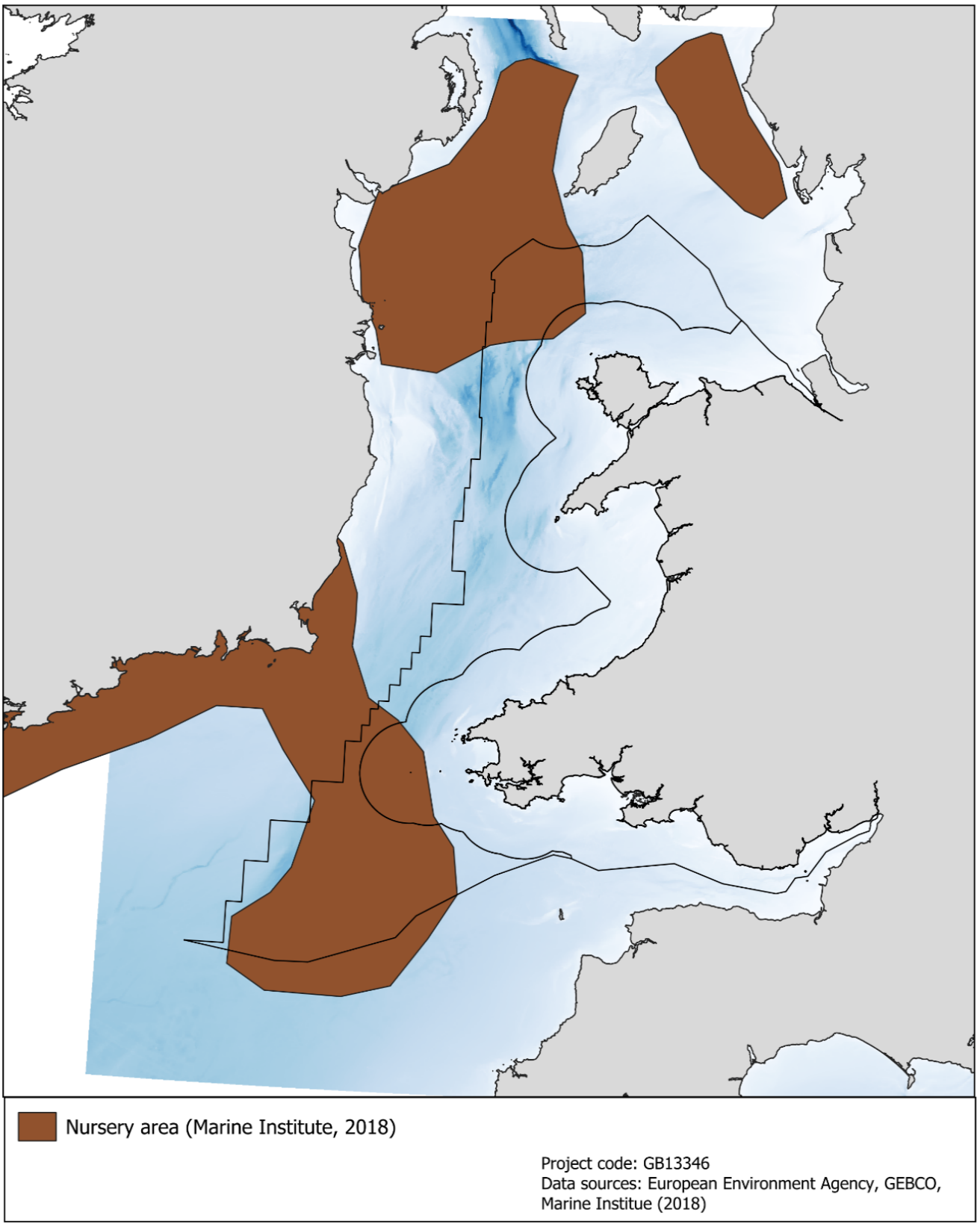


Figure 26. Whiting nursery grounds (Marine Institute, 2018)

A3.4.4. Essential Fish Habitats project data (Marine Directorate, 2023)

Spatial coverage: All Welsh waters

The Marine Directorate (2023) recorded whiting aggregation frequency in the Celtic Sea through a series of surveys from 2010 to 2020 and subsequently modelling the presence or absence of whiting within the Irish and Celtic Seas (Figure 27). Whiting aggregations are observed within Welsh offshore waters off the south-western coast of Pembrokeshire, primarily at low frequency but with two sampling sites at higher frequency.

The Marine Directorate reported, with low confidence, modelled presence of whiting in several regions along the Welsh coast in inshore coastal waters: within inshore waters on the North Wales coast, between northern Anglesey and the Great Orme; within inshore waters along the northern, western, and southern coasts of the Llŷn Peninsula; and within inshore waters along the Ceredigion, Pembrokeshire and and South Wales coasts, extending contiguously from Aberystwyth in Cardigan Bay, around Pembrokeshire, and as far east as the Gower Peninsula. The Marine Directorate reported, also with low confidence, the absence of whiting nursery areas from the entire outer Welsh zone, as well as from much of the remaining area of Welsh inshore waters.

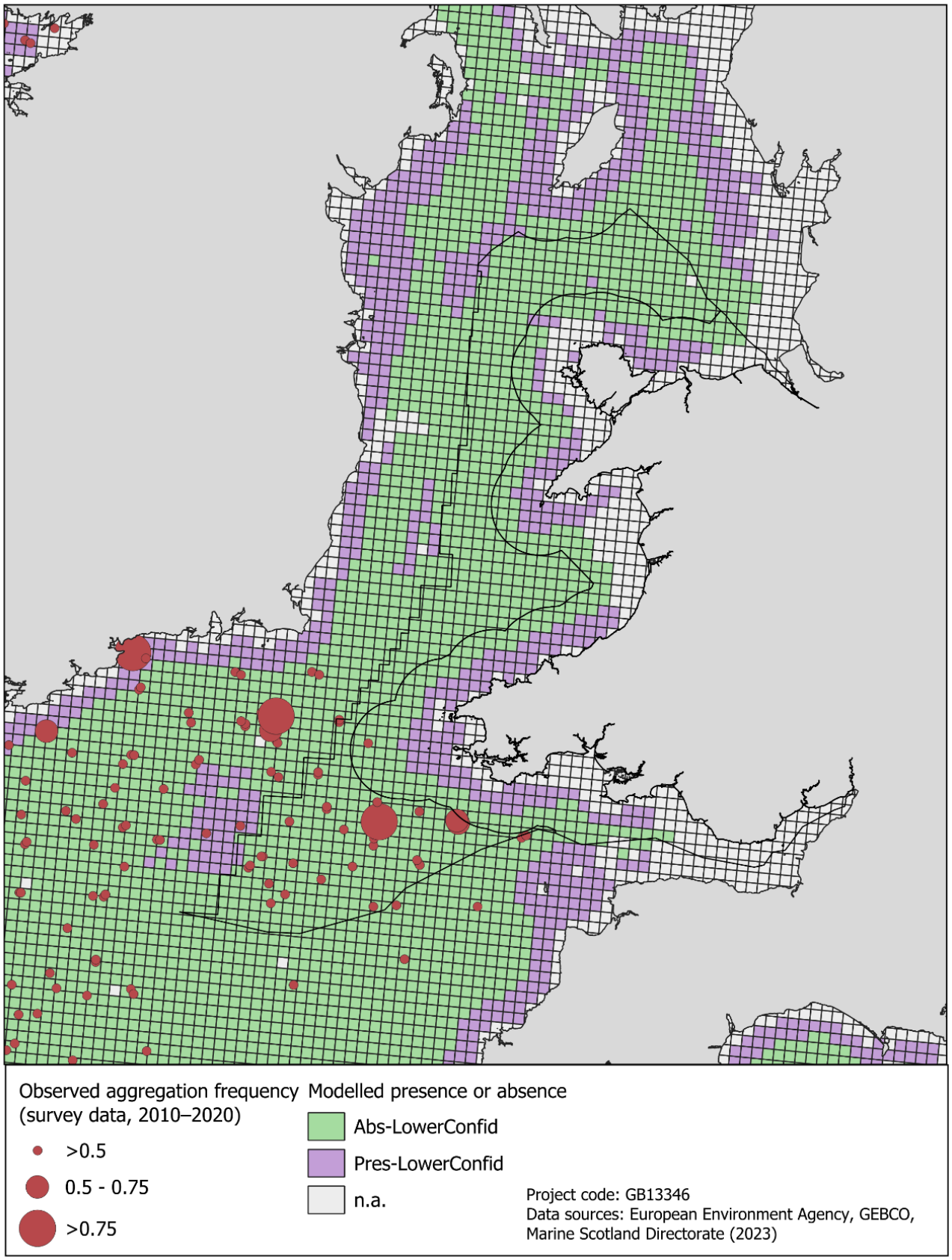


Figure 27. Modelled whiting nursey areas (Source: Marine Directorate, 2023).

A3.4.5. Otolith chemoscape analysis in whiting links fishing grounds to nursery areas (Burns et al., 2020)

Spatial coverage: Irish Sea

Inshore areas of the Irish Sea and Firth of Clyde are important nursery habitats. Juvenile whiting from these areas significantly contribute to adult populations along the Scottish west coast. Furthermore, west Irish Sea nurseries show the most widespread contribution to age-1 whiting, while eastern Irish Sea nurseries remain more localised. The study highlights the importance of connectivity between inshore nurseries and offshore spawning grounds, which may extend to the Celtic Sea and areas off the Welsh coast.

A3.5. Life stage - adults

A3.5.1. WFD Transitional fish surveys (NRW, 2025)

Spatial coverage: Welsh estuaries

Whiting adults (>19 cm) have been sampled in several Welsh estuaries: coastal waters and estuaries of Pembrokeshire (top-left), the Conwy and Dee Estuaries in North Wales (top-right), and Welsh inshore waters of the Bristol Channel (bottom) (Figure 28).

High numbers of adult whiting were recorded within Welsh inshore waters at the mouth of the Dee Estuary, alongside lower numbers of adult whiting in adjacent English inshore waters. Moderate numbers of adult whiting were recorded at the mouth of the Conwy Estuary and in the eastern part of Conwy Bay.

Low numbers of adult whiting were recorded at several other sites in Welsh inshore waters in the Bristol Channel, ranging from Cardiff Bay in the west to the mouth of the River Severn in the east. Records of adult whiting in the Taff, Usk, and Wye Rivers were localised to waters adjacent to the estuary mouths in the inshore Bristol Channel region.

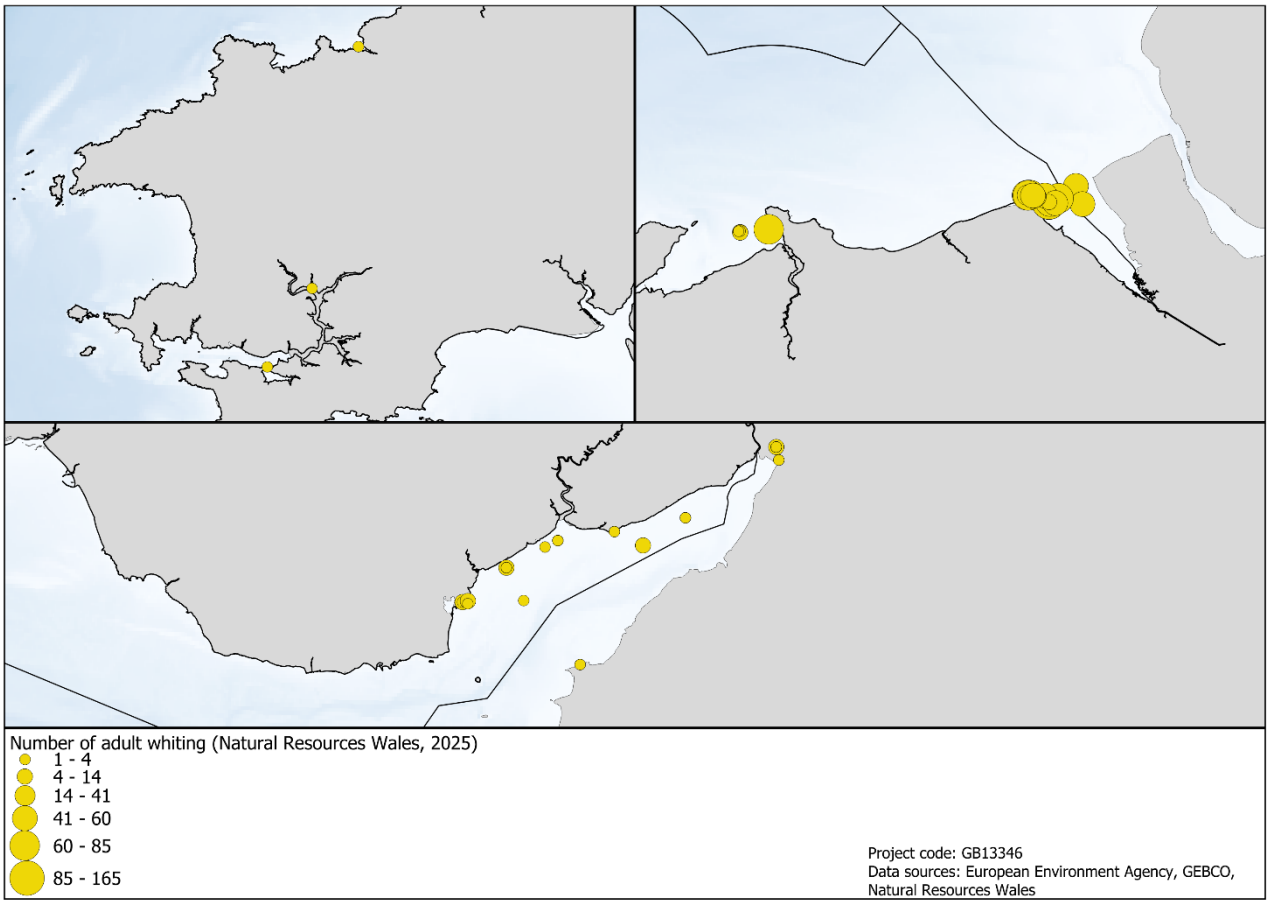


Figure 28. Adult whiting recorded at sites in Welsh estuaries (Source: NRW, 2025).

A3.5.2. DATRAS Fisheries-independent trawl survey data (ICES, 2025a)

Spatial coverage: All Welsh waters, excluding close inshore and estuaries.

Adult whiting are recorded throughout Welsh waters, as well as in adjacent English and Irish waters (Figure 29). On the North Wales coast, adult whiting are recorded in moderate numbers within Welsh inshore waters and in Welsh offshore waters between Anglesey and The Great Orme. High numbers of adult whiting are recorded within Welsh offshore waters directly south of the Isle of Man, and adjacent English waters. Only low numbers of adult whiting were recorded within Welsh waters of Cardigan Bay, although few samples were collected from Welsh offshore waters in this region.

The highest numbers of adult whiting recorded in Welsh waters were located in Welsh offshore waters to the south-west of Pembrokeshire, while more records, typically of lower numbers of adult whiting, were recorded from Welsh inshore waters along the South Wales coast, between Pembrokeshire and the Severn Estuary. Moderate numbers of adult whiting were also recorded in Irish waters in the Celtic and Irish Seas, whilst low numbers of adult whiting were recorded in English waters in the Celtic Sea.

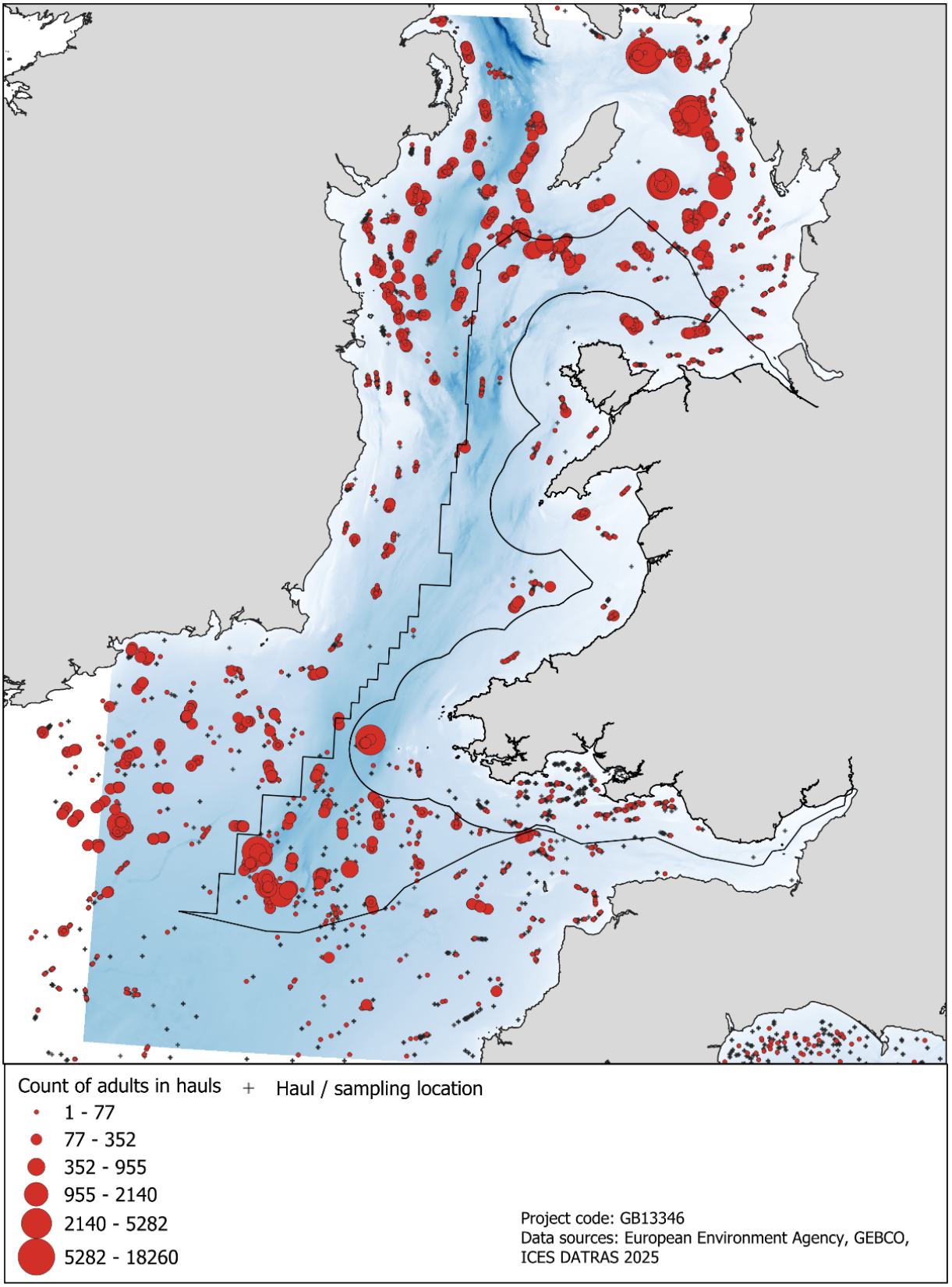


Figure 29. Spatial distribution and abundance of whiting from ICES DATRAS records, 2000 – 2024 (Source: ICES, 2025a).

A3.5.3. Spawning and nursery grounds of forage fish in Welsh and surrounding waters (Campanella and van der Kooij, 2021)

Spatial coverage: All Welsh waters, excluding close inshore and estuaries.

Figure 30 is a modelled output using fisheries-independent survey data by Cefas, conducted between 2008 and 2020, which identifies adult whiting hotspots in Q4 in the Irish Sea, Celtic Sea, and Bristol Channel. The highest hotspot index spanned English and Welsh inshore waters in the Dee Estuary, whilst a further high hotspot of adult whiting is recorded in Welsh offshore waters, to the south of the Isle of Man. A low hotspot index is recorded for Cardigan Bay. A moderate hotspot index is recorded for Welsh offshore waters on the western and south-western coast of Pembrokeshire, primarily in Welsh offshore waters, but extending slightly into Welsh inshore waters, as well as extensively into Irish waters.

The low hotspot index in Q4 for the majority of the South Wales coast, including the entire Welsh coast east of the Gower Peninsula, is likely reflecting seasonal offshore movements during the autumn–early winter period. The authors note that while peak spawning occurs in summer, adults are widely distributed in waters beyond 100 m during Q4, with concentrations in the central and southern Irish Sea, Liverpool Bay, and northern Celtic Sea. The high hotspot index in the Dee Estuary and moderate offshore hotspots off Pembrokeshire may therefore indicate both overwintering aggregations and movement away from inshore summer habitats, consistent with known seasonal redistribution of adult whiting.

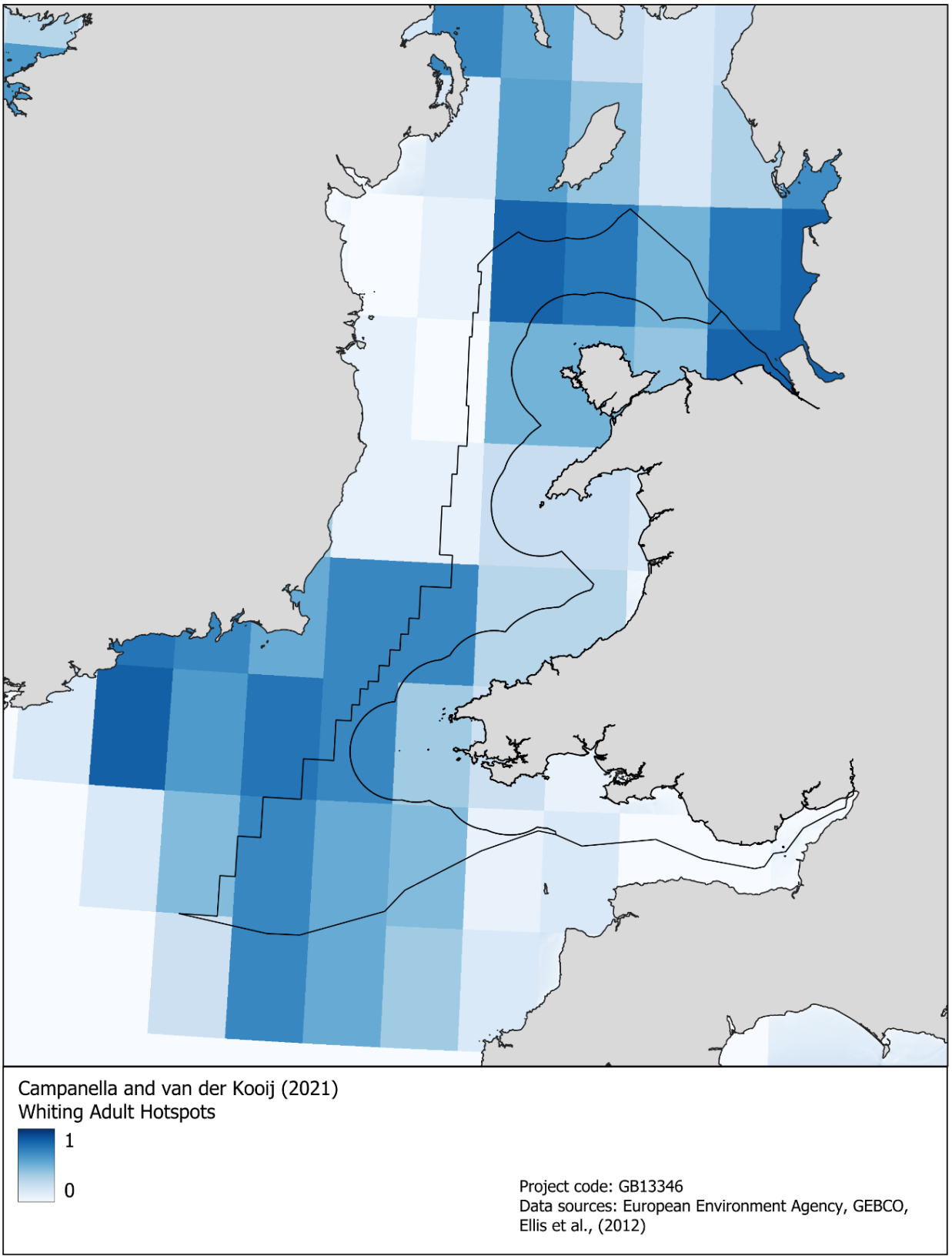


Figure 30. Hotspot map of adult whiting in Welsh and surrounding waters in Q4 (Source: Campanella and van der Kooij, 2021).

A3.5.4. Species occurrence records in Welsh waters (OBIS, 2025)

Spatial coverage: All Welsh Waters

Records of adult whiting occur throughout Welsh waters, although the majority do not have associated records of the number encountered (Figure 31). One record with a moderate number of adult whiting was collected from the North Wales coast, within inshore waters, north-east of the Great Orme. Numerous other reports with no recorded count were collected from the North Wales coast, primarily between the eastern coast of Anglesey and the Dee Estuary, within both Welsh inshore waters and Welsh offshore waters.

Some records of adult whiting, without counts, were recorded from Cardigan Bay, primarily within Welsh inshore waters. A large number of adult whiting were recorded in samples collected in Welsh offshore waters to the south-west of Pembrokeshire. Numerous records of adult whiting, without counts, were also collected along the South Wales coast, within inshore waters, from St Brides Bay in the west to Swansea Bay in the east (Figure 31).

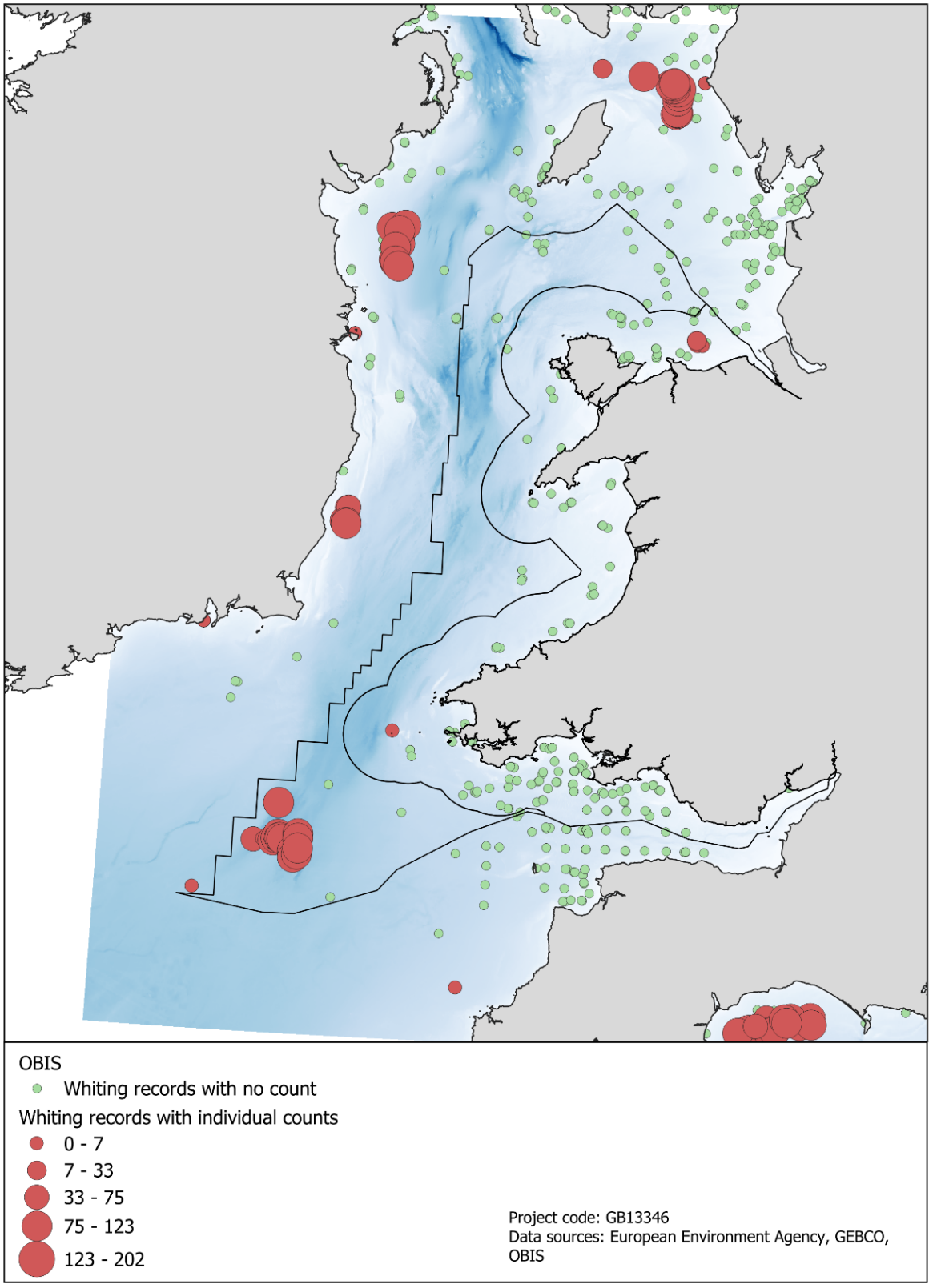


Figure 31. OBIS whiting occurrence points. Red points are graduated in size by individual count, where available. Green points represent occurrence where no counts were recorded. (Source: OBIS, 2025)

A3.5.5. Highly mobile fish species distributions in UK waters (Cefas/ABPmer, 2010)

Spatial coverage: All Welsh waters

The average abundance of adult whiting within ICES rectangles in the Irish and Celtic Seas are recorded based on CPUE from fishery-independent otter trawls (Figure 32). The highest abundance of adult whiting is recorded in English waters off Barrow, and along the eastern Irish coast between Strangford Lough and Wicklow Head. The latter of which extended into adjacent waters in Welsh offshore waters, to the north-west and west of Anglesey. Moderate adult whiting abundance is recorded within Welsh inshore waters surrounding Anglesey and in Welsh offshore waters directly south of the Isle of Man. Low abundance of adult whiting is recorded in Welsh inshore waters in the Dee Estuary, as well as in Welsh inshore waters and Welsh offshore waters in Cardigan Bay, and around Pembrokeshire. Further records of low adult whiting abundance occur along the South Wales coast, between the south Pembrokeshire peninsula and the Gower Peninsula, extending into adjacent English waters.

In Portuguese high headline trawls (Figure 33), adult whiting occurrence is rare within Welsh waters, being found only in very low numbers off north-western Anglesey, off western Pembrokeshire, and in Cardiff Bay. Slightly higher numbers of adult whiting occur in Welsh offshore waters south to the south-west of Pembrokeshire, as well as in adjacent Irish and English waters, with Portuguese high headline trawls.

In beam trawls (Figure 33), adult whiting are found consistently throughout Welsh waters. High numbers of adult whiting are recorded within Welsh inshore waters on the North Wales coast between the Dee Estuary and eastern Anglesey, in the south of Cardigan Bay, and along the South Wales coast to the west of the Gower Peninsula. High numbers of adult whiting are also recorded around the boundary between Welsh inshore waters and Welsh offshore waters to the south-west of Pembrokeshire. Low numbers of adult whiting are recorded from elsewhere within the surveyed area, including off the western coast of Anglesey, in northern Cardigan Bay, and in the Bristol Channel. Beyond Welsh waters, the highest numbers of adult whiting are recorded along the eastern coasts of Ireland and Northern Ireland, off the southern coast of the Isle of Man, and at the mouth of the River Mersey.

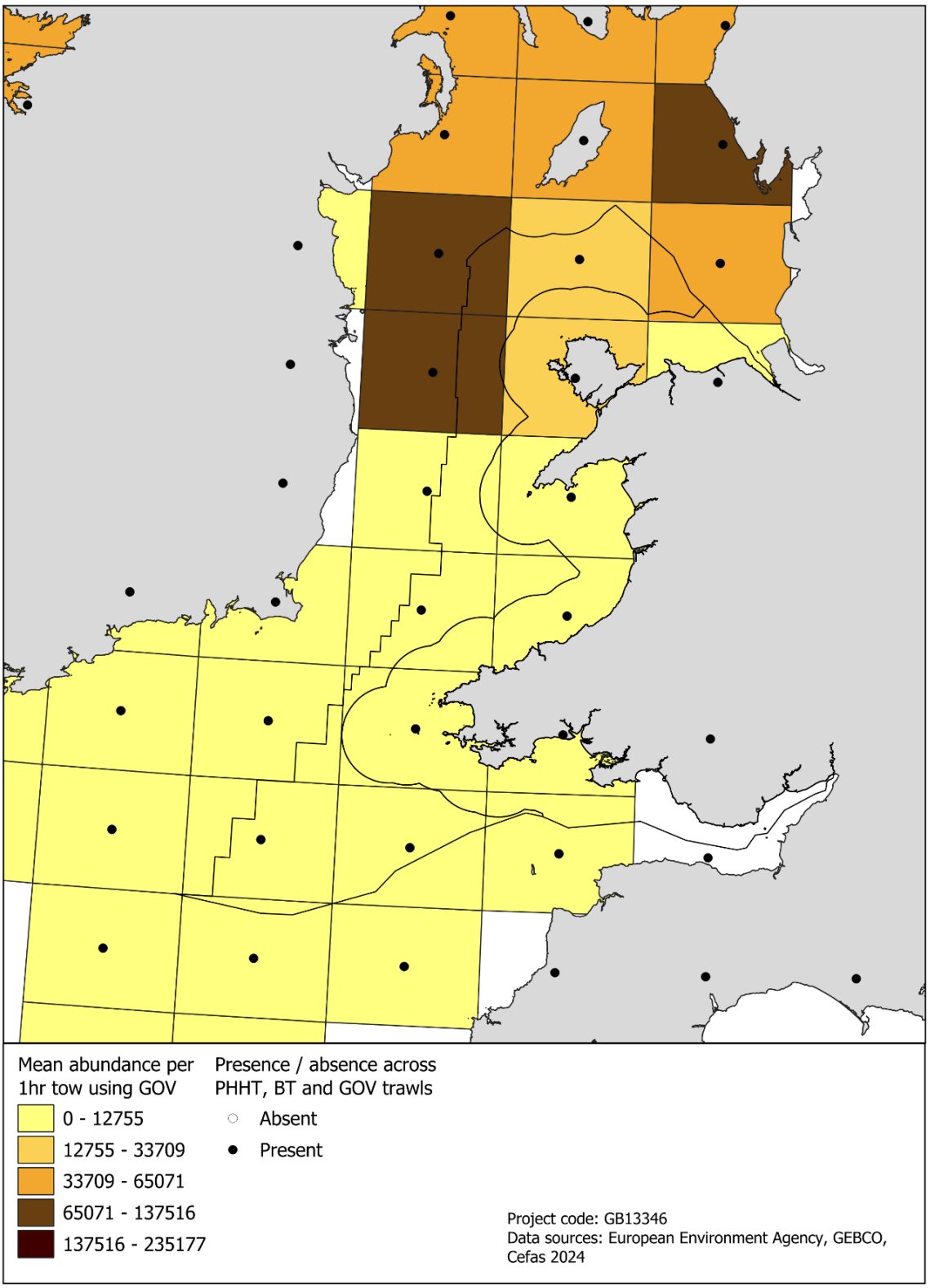


Figure 32. Distribution of whiting by ICES statistical rectangle, based on fisheries-independent groundfish survey data. Values represent average abundance (CPUE) per one-hour tow derived from GOV otter trawl surveys, aggregated to the ICES rectangle scale (Source: CEFAS, 2010).

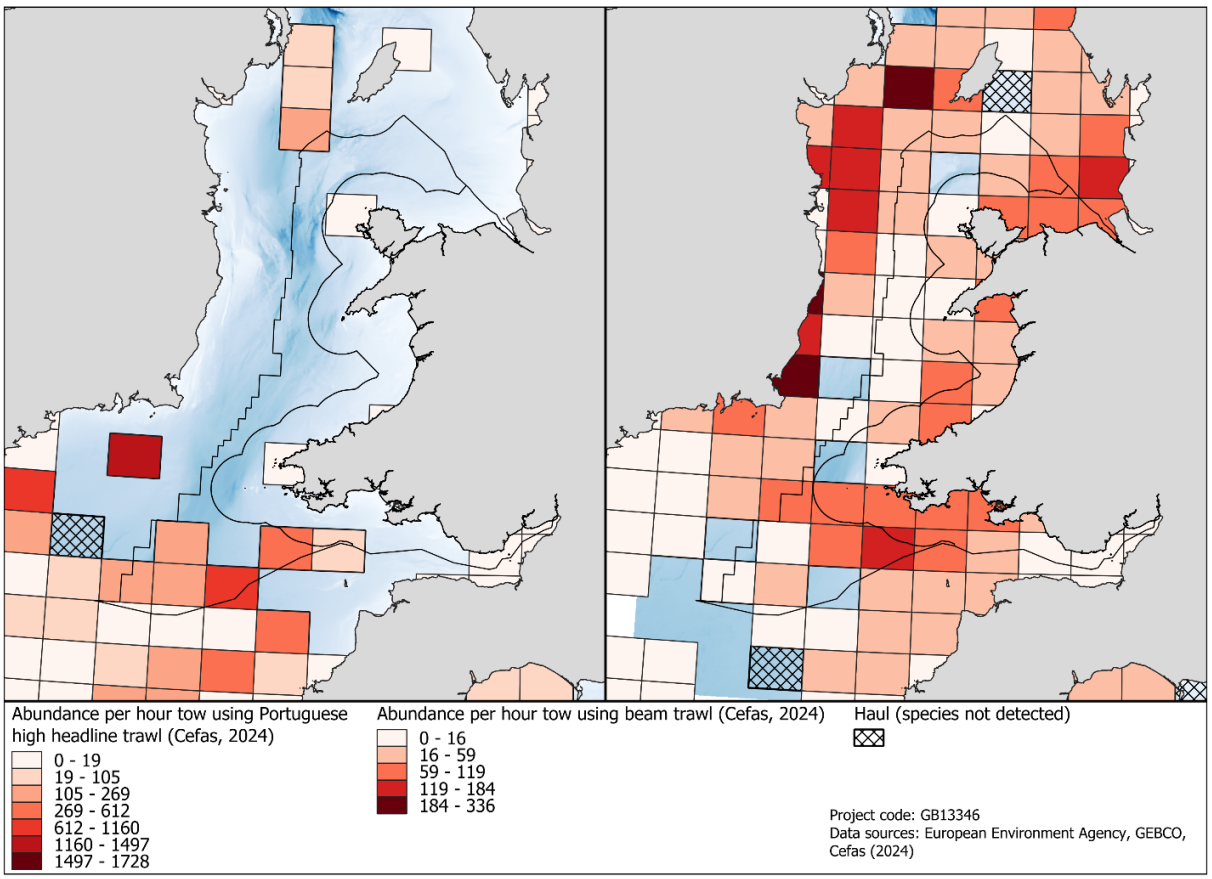


Figure 33. Abundance of whiting per hour tow using beam trawl (left) and Portuguese high headline trawl (right) (Source: Cefas, 2010).

A3.5.6. Commercial Landings and Discards (MMO, 2025)

Spatial coverage: All Welsh Waters

Commercial landings and discards of adult whiting are sparse around most of the Welsh coast (Figure 34). This reflects that the Irish Sea whiting fishery (FAO 27.7.a) is closed to directed fishing and any catches are bycatch only (ICES, 2025c). Low or no landings and discards are recorded as occurring along the North Wales coast, in Caernarfon Bay, or in Cardigan Bay. High landings and discards of adult whiting are recorded in Welsh offshore waters to the north-west of Anglesey, likely bycatch in mixed fisheries.

Similarly, there have been high landings and discards of adult whiting in both Welsh inshore waters and Welsh offshore waters to the west and south-west of Pembrokeshire where the Celtic Sea fishery (FAO 27.7.f and 7.g) was open for part of the 2016–2024 period. ICES advice for this stock has been zero-catch since 2024 (ICES, 2025d) and a bycatch-only TAC is currently in operation. More recent catches in this area are therefore likely to reflect bycatch in mixed fisheries rather than targeted landings. Low landings and discards are recorded at the edge of Welsh inshore waters between the south Pembrokeshire peninsula and the Gower Peninsula. Low or no landings and discards of adult whiting are recorded along the South Wales coast to the east of the Gower Peninsula.

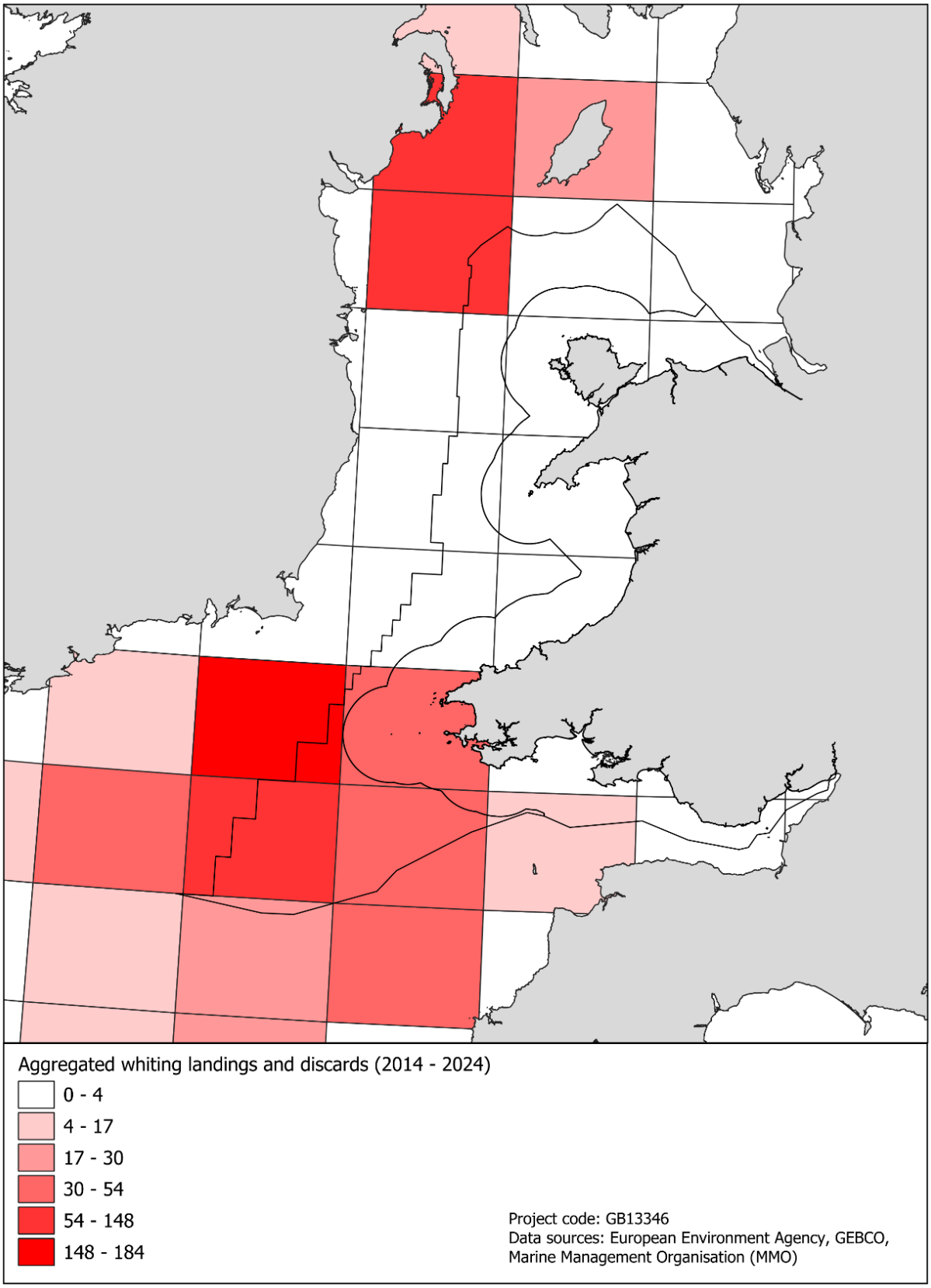


Figure 34. Aggregated landings and discards of whiting by ICES sub-rectangle, 2014 to 2024 (Source: MMO, 2025).

A3.5.7. Sea Angling Diary catch records 2016-2024 (Cefas, 2025)

Spatial coverage: All Welsh waters

Sea Angling Diary data from 2016 to 2024 contain records of adult whiting (>19 cm) from 10 ICES rectangles around Wales (Figure 35). Across all rectangles, smaller length classes (20–35 cm) dominate reported catches, with relatively few individuals recorded above 40 cm (Table 4). Overall, the spatial pattern indicates a clear concentration of adult whiting along the North Wales coast, with reduced but widespread occurrence across West and South Wales. It should be noted that the number of unmeasured whiting records exceeds the number of measured adults across most rectangles (Table 4). Despite the absence of length data, the spatial distribution of these unmeasured records broadly mirrors that of measured adult catches, with highest counts concentrated along the North Wales coast and lower but widespread occurrence elsewhere (Figure 35 and Figure 36).

The highest numbers of adult whiting are recorded along the North Wales coast, particularly in ICES rectangle 35E6 (1,135 individuals) and 35E5 (620 individuals), located around Anglesey, and along to the Dee Estuary within Welsh Territorial Waters. Outside the North Wales rectangles, recorded catches decrease but remain comparatively high in some areas. ICES rectangle 32E6 records 490 individuals, representing the next highest number of reported adult whiting after 35E6 and 35E5. In contrast, the Pembrokeshire peninsula (32E4) records 108 individuals. In the upper Bristol Channel (32E7), only 10 adults are recorded; while low in number, this confirms at least occasional adult presence in this more constrained estuarine environment.

In Cardigan Bay (rectangles 33E5 and 34E5), a combined total of 404 adult whiting are recorded (237 and 167 respectively), indicating moderate catch relative to southern areas and substantially lower than peak concentrations off North Wales.

Table 4. Number of adult (>19 cm) whiting caught and recorded in Sea Angling Diary data by ICES rectangle (2016 – 2024).

Length classes (cm)	31E6	31E7	32E4	32E5	32E6	32E7	33E5	34E5	35E5	35E6
[20, <25)	151	0	14	81	197	3	87	67	137	318
[25, <30)	88	0	51	75	163	7	72	66	172	454
[30, <35)	53	0	38	35	123	0	78	34	203	236
[35, <40)	25	0	0	1	6	0	0	0	106	118
[40, <45)	1	0	5	8	1	0	0	0	1	0
[45, <50)	0	0	0	0	0	0	0	0	1	9
[50, <55)	1	0	0	0	0	0	0	0	0	0
Total measured	**319**	**0**	**108**	**200**	**490**	**10**	**237**	**167**	**620**	**1135**
Unmeasured	580	0	137	191	401	0	154	219	1553	1518

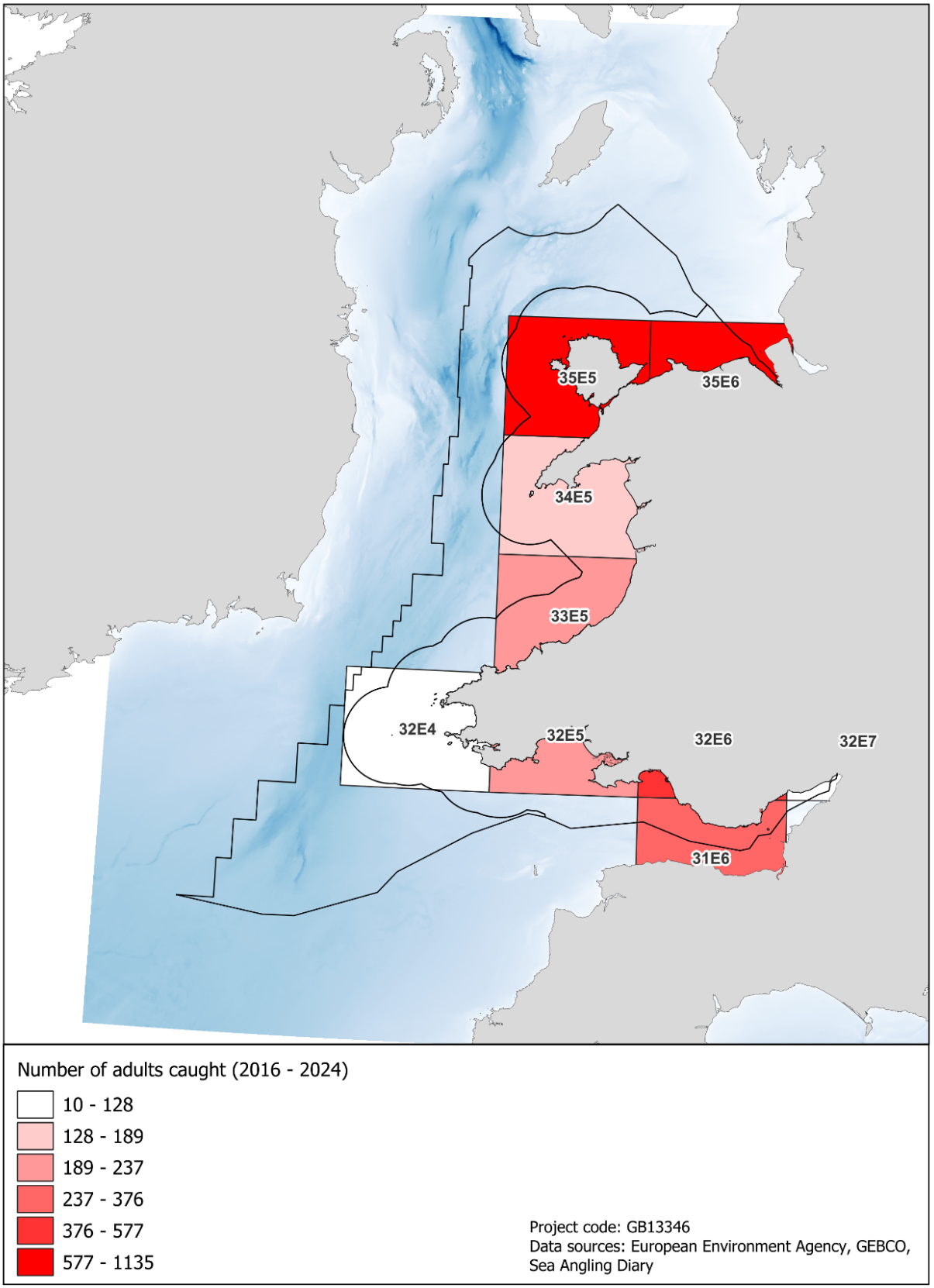


Figure 35. Total number of adult whiting caught, 2016 – 2024, by ICES rectangle (Cefas, 2025).

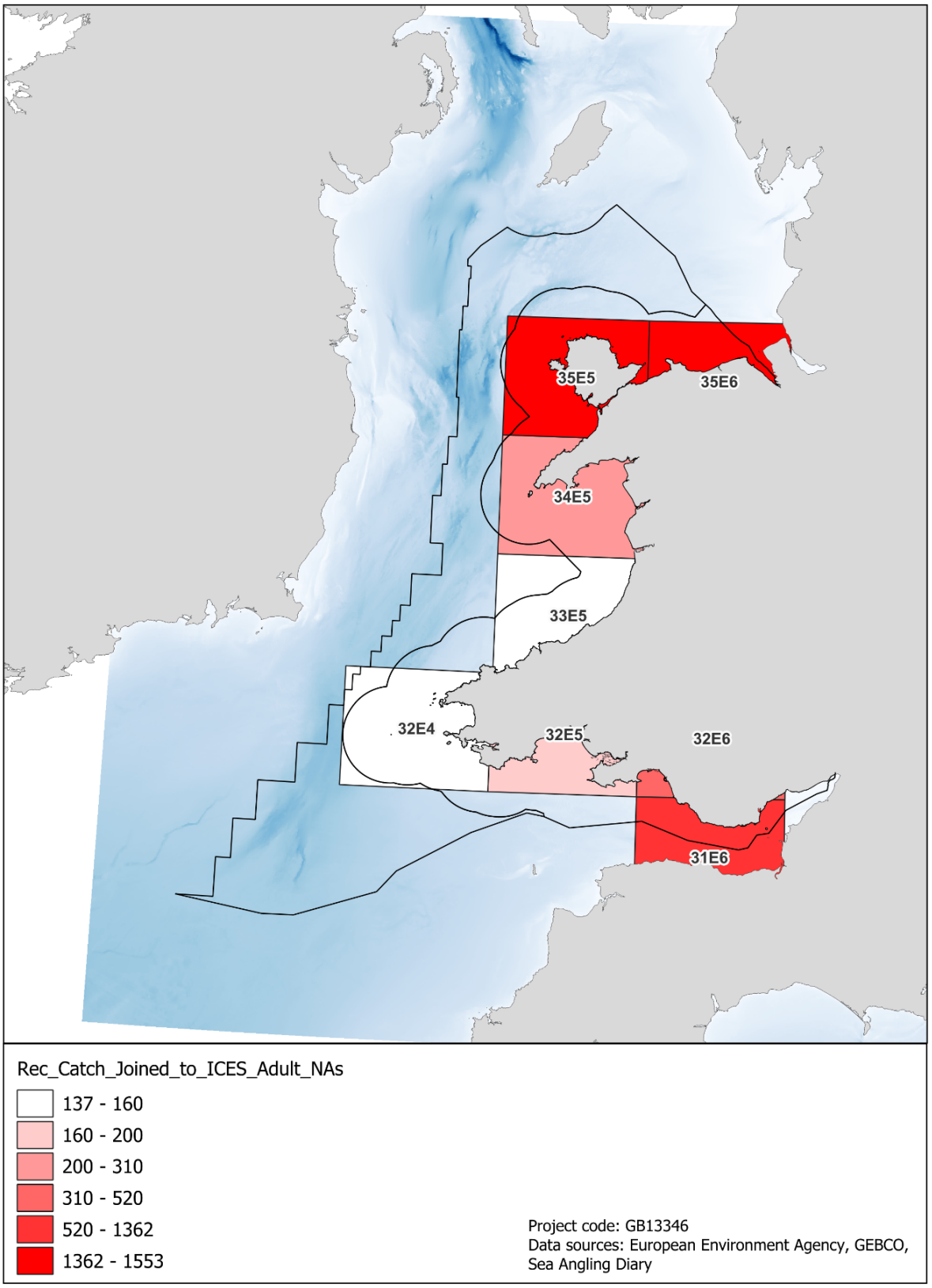


Figure 36. Total number of unmeasured whiting caught, 2016 – 2024, by ICES rectangle (Source: Cefas, 2025).

A3.5.8. The Celtic Sea through time and space: Ecosystem modelling to unravel fishing and climate change impacts on food-web structure and dynamics (Hernvann et al. 2020)

Spatial coverage: Bristol Channel

Hernvann *et al.* (2020) found that adult whiting are a major component of higher trophic levels in coastal bays and the inner Bristol Channel, co-occurring with sea bass and other gadoid species. In colder central and northwestern Celtic Sea areas, moderate depths and mixed sediment types supported assemblages of whiting, cod, haddock and hake.

A3.5.9. The Management of Irish Sea Fisheries – A Review (Brander, 1977)

Spatial coverage: Irish Sea

Brander (1977) illustrates the seasonal distribution of UK and Irish whiting fisheries in the 1960s (Figure 37), identifying three principal concentration areas. Of particular relevance to Welsh waters is Area 3, which supported a directed spring fishery between February and April. This indicates a historical seasonal concentration of whiting within Welsh waters during late winter and early spring, likely associated with the adult component of the stock given the timing of the fishery. The Conwy spring fishery had largely disappeared as a directed fishery by the early 1970s, highlighting historical shifts in the spatial focus and economic importance of whiting fisheries in North Wales. While reflecting historical fishing activity rather than contemporary stock structure, this evidence provides context on the past seasonal use of Welsh waters by adult whiting.

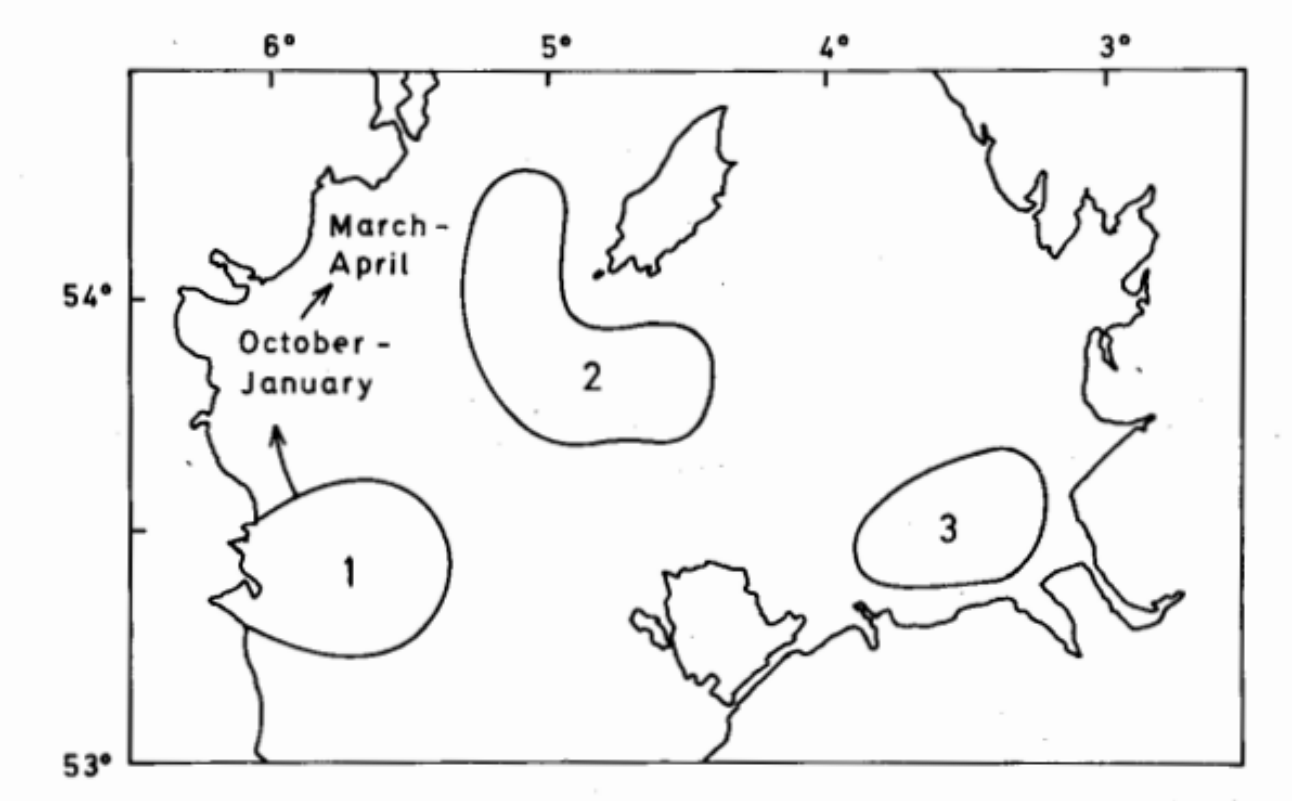


Figure 37. Distribution of UK and Irish whiting fisheries in the 1960s. 1 – Rockabill: Lambay in August and September; 2 – Chickens: French fish here all year; 3 – spring fishery February to April (Source: Brander, 1977).

A3.5.10. Spatial distribution of discards in mixed fisheries: species trade-offs, potential spatial avoidance and national contrasts (Robert et al. 2019)

Spatial coverage: Celtic Sea

Robert *et al.* (2019) analysed discards and mixed fisheries indicating that adult whiting co-occur with other gadoids such as haddock and cod in nearshore Celtic Sea waters. Depth, substrate, and localised fishing contribute to adult spatial distribution, with persistent “hot spots” reflecting areas of high fishing interaction and potential demographic structuring.

A3.6. Life cycle process – spawning grounds

A3.6.1. Fisheries spawning and nursery areas in British waters (Coull et al., 1998)

Spatial coverage: All Welsh waters

The intensity of whiting spawning grounds is recorded by Coull *et al.* (1998) (Figure 38) and the spawning period is reported to be February to June. A low intensity whiting spawning ground is identified in Welsh offshore waters off the North Wales coast, as far

west as Anglesey, extending into adjacent English and Isle of Man waters. A high intensity whiting spawning ground is recorded within Welsh inshore waters in the south of Cardigan Bay, west of New Quay. This is noted to be surrounded by a small, lower intensity whiting spawning ground. No further whiting spawning grounds are recorded within Welsh waters. Beyond Welsh waters, a high intensity spawning ground, surrounded by lower intensity spawning ground, is recorded on the eastern Irish coast, near Dublin Bay.

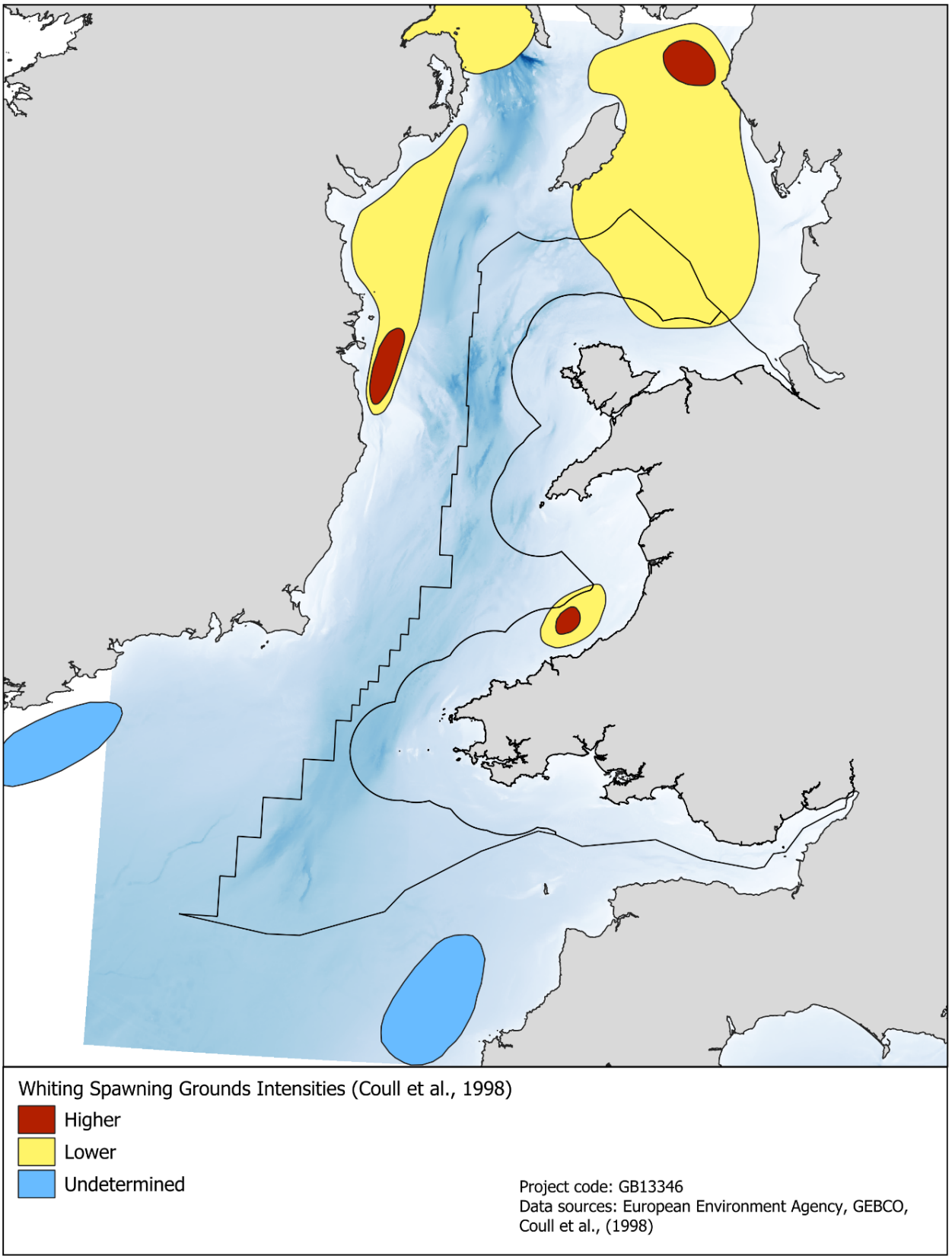


Figure 38. Spawning grounds of whiting with higher, lower and undetermined intensity. (Source: Coull *et al.*, 1998).

A3.6.2. Spawning and nursery grounds of selected fish species in UK waters (Ellis et al., 2012)

Spatial coverage: All Welsh Waters

The intensity of whiting spawning ground use was recorded by Ellis *et al.* (2012) (Figure 39). A low intensity spawning ground is recorded across the northern Irish Sea, extending throughout Welsh waters on the North Wales coast. This same spawning ground extended in both Welsh inshore waters and Welsh offshore waters along western Anglesey and in Caernarfon Bay, then within Welsh inshore waters in Cardigan Bay. Another low intensity spawning ground is recorded off the north coast of Cornwall off Trevose Head in English waters, extending into Welsh offshore waters south-west of Pembrokeshire.

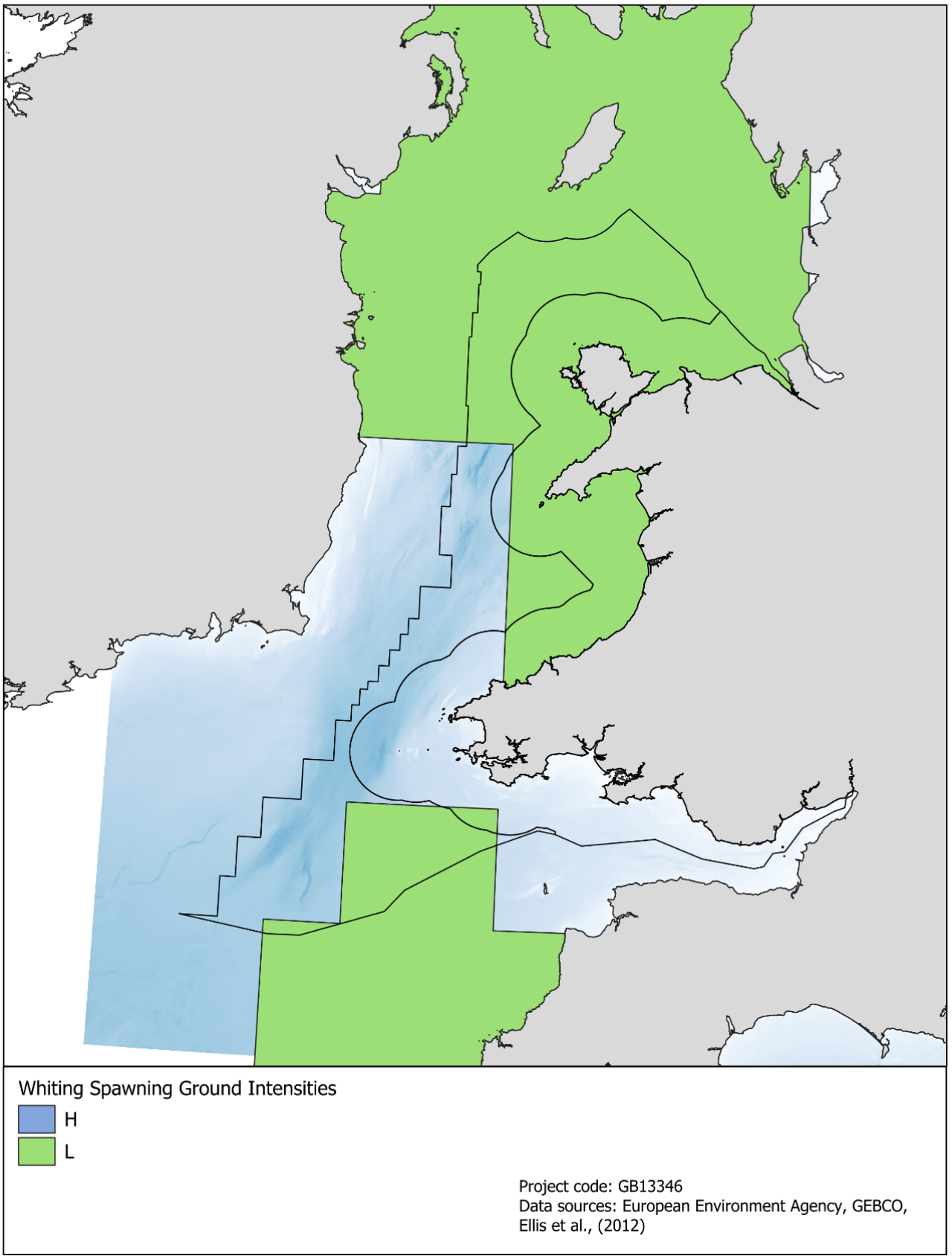


Figure 39. High and low intensity spawning areas (Source: Ellis *et al.*, 2012).

A3.6.3. Spawning and nursery grounds of forage fish in Welsh and surrounding waters (Campanella and van der Kooij, 2021)

Spatial coverage: All Welsh waters, excluding close inshore and estuaries

Hotspots of whiting adults during their spawning period are recorded by Campanella and van der Kooij (2021) (Figure 40). A low-level whiting adult hotspot was recorded on the north-western English coast, from the edge of Morecambe Bay in the north to the Dee Estuary in the south, where it extends into Welsh inshore waters. A more persistent whiting hotspot during their spawning period is recorded primarily in Welsh offshore waters, but extending into Welsh inshore waters, around the northern and western coasts of Anglesey, contiguous with a larger hotspot around the Isle of Man. No whiting spawning period hotspots are recorded in Cardigan Bay, although a low-level hotspot is recorded in Welsh inshore waters around the entire coast of Pembrokeshire. The Celtic Sea is identified as a large whiting spawning hotspot, stretching from the southern Irish coast to the northern coasts of Devon and Cornwall, which occupied Welsh offshore waters south-west of Pembrokeshire. Further low-level whiting spawning hotspots are recorded along the South Wales coast in Carmarthen Bay, Swansea Bay, and the Severn Estuary.

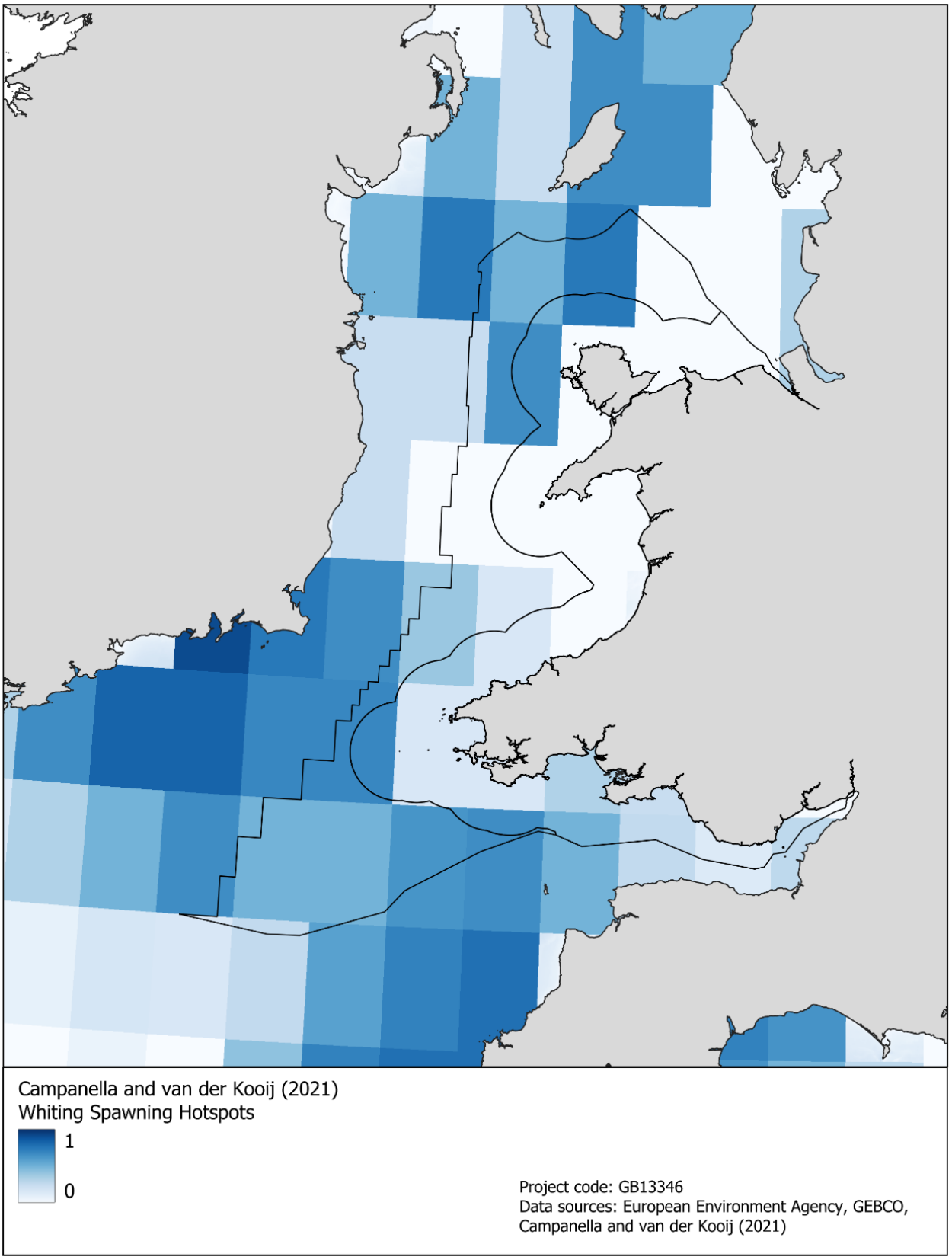


Figure 40. Hotspot map of adult whiting in Welsh and surrounding waters in Q1 coinciding with their known spawning period (Source: Campanella and van der Kooij, 2021).

A3.6.4. Species spawning and nursery areas (Marine Institute, 2018; revised 2024)

Spatial coverage: All Welsh waters

Whiting spawning grounds in the Irish and northern Celtic Seas are recorded by the Marine Institute (2018) (Figure 41). A large whiting spawning ground is recorded in the northern Irish Sea spanning almost the entire width of the Irish Sea from the coast of the Island of Ireland, and encompassing the Isle of Man, and extending south into Welsh waters. Within Welsh waters, the ground covers offshore Welsh waters to the north-west, north, and north-east of Anglesey, as well as into Welsh inshore waters along the North Wales coast, between Anglesey in the west and the mouth of the River Clwyd in the east. An additional whiting spawning ground is recorded along the southern Irish coast, extending across the southern Irish Sea and into Welsh waters west of Pembrokeshire and also English waters off the North Cornwall coast.

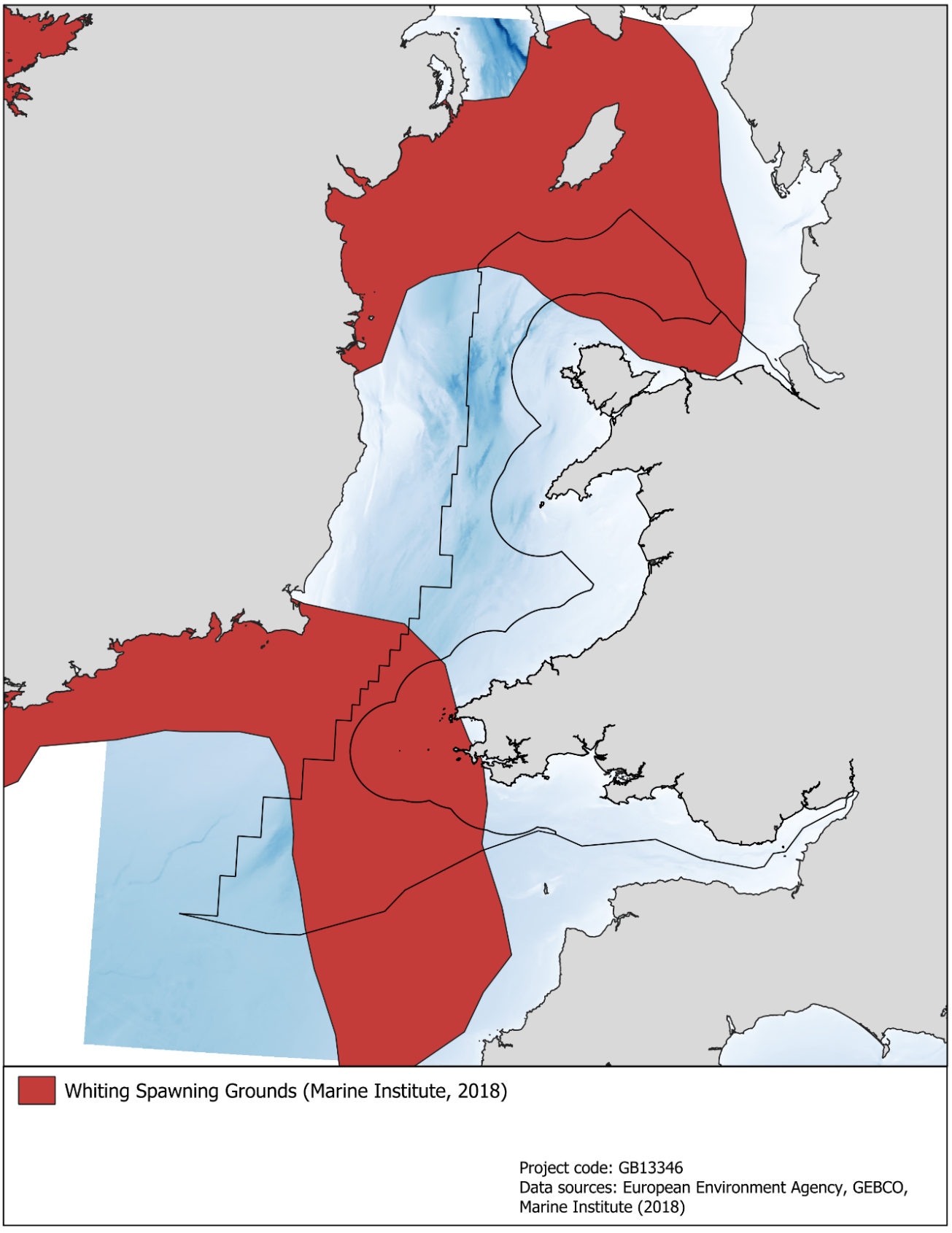


Figure 41. Whiting spawning grounds (Source: Marine Institute, 2018).

A3.6.5. Essential Fish Habitats project data (Marine Directorate, 2023)

Spatial coverage: All Welsh waters

The Scottish Marine Directorate used data collected between 2010-2020 from the Irish and northern Celtic Seas and the Bristol Channel to model the presence or absence of whiting spawning areas in this region (Figure 42). The Marine Directorate reported in high confidence that whiting spawning areas are almost entirely absent from Welsh inshore waters, with only a small area west of Pembrokeshire modelled as a spawning area. In Welsh offshore waters, the Marine Directorate report low confidence of the presence of a whiting spawning area extending from waters west of Anglesey in the north to Welsh offshore waters south-west of Pembrokeshire in the south.

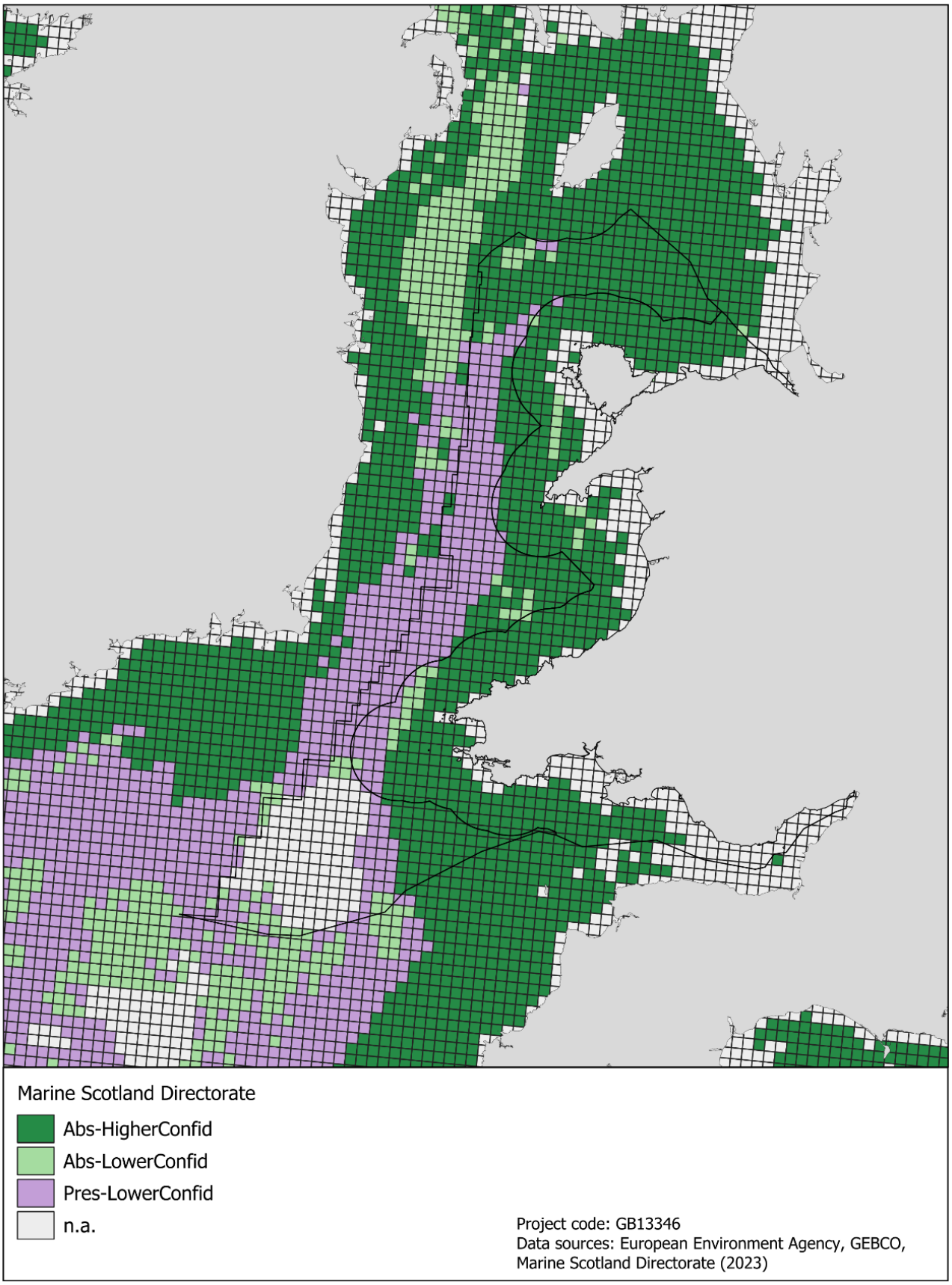


Figure 42. Modelled whiting spawning areas (Source: Scottish Marine Directorate, 2023).

Appendix 4: Data archive appendix

Data outputs associated with this project are archived on server–based storage at Natural Resources Wales, in NRW's internal GIS folders with metadata number NRW_DS161645.

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] A GIS geodatabase containing the spatial datasets reviewed in the report.

Metadata for this project is publicly accessible through Natural Resources Wales' Data Discovery Service https://metadata.naturalresources.wales/geonetwork/srv (English version) and https://metadata.cyfoethnaturiol.cymru/geonetwork/cym/ (Welsh Version). The metadata is held as record no NRW_DS161645.

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