MORECAMBE OFFSHORE WIND GENERATION ASSETS NSIP ('THE PROJECT') (PROJECT REF. NO. EN010121)

SELECTED RESPONSES TO APPLICANT'S DEADLINE 4 SUBMISSIONS, EXAMINING AUTHORITY QUESTIONS (ExQ2) FOLLOW-UP AND FURTHER COMMENTARY AND SUBMISSIONS ON BEHALF OF BODORGAN MARINE LIMITED (BML)

DEADLINE 5

1 INTRODUCTION, INCLUDING PROCEDURAL MATTERS

1 BML appreciate the Examining Authority's (ExA) use of their discretion in their email dated 23 January 2025 to accept the BML D3 submission made on 22 January 2025; and, their acceptance of BML's D4 submission made on 18 February 2025 in the ExA's email dated 19 February 2025. BML do note that there is still a further 2 months until 23 April 2025 to the end of the Examination and indeed there are two further deadlines (D5 and D6), following the ExA's further Written Questions issued on 27 February 2025 and the reserve dates for further Hearings in w/c 31 March 2025.

2 This Deadline 5 (D5) submission includes in Section 3 comments on the latest 'tracked' versions of six key and highly relevant documents – the Schedule of Mitigation Rev04 (**REP4-022**); the In Principle Monitoring Plan Rev03 (**REP4-026**); the Commitments Register Rev02 (**REP4-048**); the Outline Fisheries Liaison and Co-Existence Plan Rev03 (OFLCP) (**REP4-024**); the draft DCO Rev04 (**REP4-003**); and, the Schedule of Changes to the Draft DCO Rev03 (**REP4-006**). In addition, this D5 submission comments on other selected submissions from the Applicant, such as Applicant's Comments on Deadline 3 Submissions by IPs (**REP4-058**) and Written Summaries of Oral Submissions at ISH 2, 3 and 4 (**REP4-059**).

3 Also, as in BML's D3 and D4 submissions, in the ExA's 'Initial Assessment of Principal Issues' (within the Rule 6 Letter issued on 23 September 2024, Appendix C (**PD-007**)), BML notes that it is unfortunate that co-location or aquaculture provision was not covered. BML therefore requests that these issues be considered as part of the subsequent Examination.

Structure and Content of D5 Submission

4 This D5 submission provides comments as set out below together with additional commentary of key aspects of the current DCO application, under sub-headings:

a) Section 2 – Purposes of BML's Deadline 5 Submission;
b) Section 3 – Commentary on the Applicant's Main Key Submissions at D4 (largely amendments);
c) Section 4 – Commentary on the Applicant's other relevant D4 submissions;
d) Section 5 – Responses to the ExA's two ExQ2 questions (2CF1 and 2CF2) to BML;
e) Section 6 – Update and Commentary on the Technical Engagement between BML and the Applicant; and,
f) Section 7 – Final Commentary and Questions for the ExA.

2 MAIN PURPOSES OF BML'S DEADLINE 5 SUBMISSION

5 BML would like to make five main points, as set out below to set out the purposes of this D5 submission and then elaborate on the following 5 key points in turn. These 5 points are, as follows:

a) Comments on main Applicant D4 submission documents – the Schedule of Mitigation Rev04 (**REP4-022**); the In-Principle Monitoring Plan Rev03 (**REP4-026**); the Commitments Register Rev02 (**REP4-048**); the Outline Fisheries Liaison and Co-Existence Plan Rev03 (OFLCP) (**REP4-024**); the draft DCO Rev04 (**REP4-003**); the Schedule of Changes to the Draft DCO Rev03 (**REP4-006**); and, the Planning, Development Consent and Need Statement Rev03 (**REP3-005**);

b) Comments on other relevant Applicant D4 submission documents – the Applicant's Comments on Deadline 3 Submissions by IPs (**REP4-058**) in Section 2.5 and relevant parts of the Applicant's Written Summaries of Oral Submissions at ISH 2, 3 and 4 (**REP4-059**);

c) Responses to the ExA's ExQ2 questions – comments on the two ExA questions (2CF1 and 2CF2) (**PD-015**);

d) Update and Commentary on Technical Engagement between BML and the Applicant – sets out briefly any updates and commentary of relevance; and,

e) Final Commentary and Questions for the ExA's Consideration – these are set out for the ExA's consideration to potentially be part of any further Hearings or the ExA's requests for further information.

6 This D5 submission elaborates on these 5 matters in more detail below.

7 Furthermore, as indicated above, at the end of this D5 submission it sets out the main key commentary and questions relating to this DCO application that should be of wider strategic interest, for the ExA's consideration and which are specifically requiring responses from the Applicant or action from the ExA.

3 COMMENTARIES ON THE APPLICANT'S MAIN SUBMISSIONS (AMENDMENTS)

Schedule of Mitigation (Rev04) (REP4-022)

8 Once again, the minor changes and changes in sections do not require BML's comments and so are not included below. However, the following inadequate commitments to Commercial Fisheries at Ref. Nos. 13.1 – 13.5 should be noted and the fact that no further changes have been made to these 5 commitments since D2, despite BML's technical comments at D3 and D4.

9 Also, as noted by BML within its D3 and D4 submissions, the latest version of the OFLCP does not appear to be secured within this Schedule of Mitigation for this DCO. This remains a concern. Notwithstanding this, BML has no ability, except through this DCO process, to ensure that the OFLCP is adequate or covers any provision for aquaculture or commitment to be consulted through the dML process, even through the agency of other representative bodies for aquaculture.

In-Principle Monitoring Plan Rev03 (**REP4-026**)

10 This document was reviewed by BML before in its D4 submission and relates solely to arrangements for monitoring measures and is intended to be a framework for

discussions with competent authorities, such as the MMO, SNCBs, MCA and other statutory bodies. As before, BML notes that this document is not referred to within the Schedule of Mitigation, even under Section 13 on commercial fisheries. This remains a serious omission. Furthermore, this document does not additionally provide for future activities to be monitored, only existing commercial fisheries and marine ecology.

11 Section 2.7 relates to commercial fisheries and it is noted that reporting of fish landings by port is only annually post completion. Furthermore, it is not clear if effects on commercial fisheries operations will be monitored and if deleteriously affected if any mitigating actions will be undertaken – this is considered an omission.

Commitments Register Rev02 (**REP4-048**)

12 Again, this document has not been reviewed by BML before and it is not clear how it relates to the Schedule of Mitigation or In-Principle Monitoring Plan and the relationship is not explained in any of these documents by the Applicant in any introduction. It only contains two commitments relating to commercial fisheries and none for aquaculture, i.e. fisheries liaison and the FLCP (Ref. Nos.C034 and C035).

Outline Fisheries Liaison and Co-Existence Plan Rev03 (OFLCP) (REP4-024)

13 Once again, this document continues to actively promote both co-existence and co-location throughout. However, the proposals simply amount to the largely unchanged 'Co-existence and Mitigation Measures' (Section 3.2) and a Commercial Fisheries Working Group (CFWG), in which aquaculture is not represented. All changes are considered minor and not adequate.

14 There remains very little provision for aquaculture co-existence or particularly co-location, with such provisions being restricted only to the very limited co-existence measures related only to existing commercial fisheries.

Draft DCO Rev04 (**REP4-003**) **and Schedule of Changes to the Draft DCO Rev03** (**REP4-006**)

15 The amendments in this latest version of the draft DCO and included in the Schedule of Changes to the Draft DCO (particularly Section 4 on the latest changes) do not relate to co-existence, co-location or aquaculture. There are many amendments that do not concern BML, however, it should be noted that in 'Renews' in late February 2025, it was reported that: *'Copenhagen Infrastructure Partners has signed a deal to acquire the proposed 480MW Morecambe offshore wind farm off north-west England from Cobra and Flotation Energy.'* It further noted that *'The financial terms of the transaction for the fixed-bottom Round 4 site have not been disclosed. Closing of the transaction will follow customary approvals and conditions being met. Flotation Energy will remain involved as a development partner to the project.'*

16 It is unclear if or how Article 7 (Benefit of the Order) or Article 2 (definition of 'Undertaker') will need to change to reflect this change of ownership/acquisition (and possibly shareholders); or, if it affects the DCO commitments made to date by the joint venture between Zero-E Offshore Wind S.L.U. (Spain) (a Cobra group company) and Flotation Energy Ltd (Flotation Energy). These matters should be considered by both the Applicant and ExA in the next version of the draft DCO, if necessary

17 BML notes that BML's recommended additions/changes to the draft DCO set out in its D3 submission (**REP3-098**, Section 8) and referred to in its D4 submission (REP4-068, Part 1, Paragraph 22) have not been included (refer particularly to the draft Schedules 2 and 6).

4 COMMENTS ON OTHER RELEVANT APPLICANT D4 SUBMISSION DOCUMENTS

Introduction

18 In addition to Section 3 above, BML have restricted itself to commenting only on the relevant Applicant documents and have not commented on other IP submissions at D4. Furthermore, only two important documents require BML's comments, as set out below.

Applicant's Comments on Deadline 3 Submissions by IPs (REP4-058)

19 The Applicant's responses to BML's D3 submission are contained in Section 2.5, pages 130-135, which is merely 6 pages and follows BML's D3 submission of 24 pages, plus five Annexes – the Applicant's justification for not undertaking a point-by-point response is BML's lack of status as an IP, which in BML's view is a weak argument. Nevertheless, the content is reviewed below, its length still indicates a serious lack of thorough consideration, which matched with the Applicant's lack of verbal/correspondence technical engagement, clearly indicates completely inadequate engagement in this written response and more generally – this is considered a serious deficiency.

20 The Applicant has divided its Section 2.5 into four sub sections: Section 2.5.1 covers introduction/general comments; Section 2.5.2 covers planning policy matters; Section 2.5.3 covers consultation; and, Section 2.5.4 covers the Applicant's consideration of BML's submission. These are responded to in turn below.

21 Section 2.5.1 Introduction – the Applicant stresses that BML does not hold any seabed licencing rights or accompanying consents, with no evidence of such rights. The Applicant further stresses that BML have not undertaken surveys or EA work. These statements are correct, however, the compelling and justifiable reasons for not undertaking any of this consents work are covered in BML's D4 submission (**REP4-068**) in Part 1 and in Part 3, Section 6.

22 The Applicant further describes the BML proposals as being embryonic with limited detail and not requiring consideration under planning policy or EIA requirements, revisited further in their Paragraph 22. BML contends that the proposals to co-locate aquaculture assets within the OWF should be considered under current policy, as set out in both its D3 submission (**REP3-098** in Section 4) and in its **REP4-068** in Section 4. It is the nature of DCO applications that they are 'outline' or 'parameter based', i.e. not in detail. This is reserved for subsequent more detailed approval, using 'Requirements' and Control Plan documentation, like the Applicant's own Schedule 2 and other commitments proposals and BML's proposals follow this 'outline' approach. The suggestion that BML's proposals are insufficiently defined or advanced enough to allow for robust assessment is not correct. Ample detail has already been provided by BML. Offshore mussel aquaculture is neither a complex nor a new practice. It currently takes place on a co-located basis within OWF development in Europe. Its demands and its effects

are not unknown. Certainly, had the Applicant undertaken sufficient consultation with 'representatives of the fishing industry' (which would and should have included shellfish industry operators, and in particular those clustered around Bangor University, then it would not be able to say that insufficient detail exists at this point. It is notable that the Applicant has not indicated what detail or information is missing, that is needed to progress its consideration of BML's proposals. BML will be happy to provide that information when it is identified by the Applicant.

23 The Applicant then states that there is uncertainty about the Crown Estate providing a seabed lease beyond the 12nm limit under UNCLOS and the Energy Act 2004 and that no such licences have been granted beyond the 12nm limit – again, BML discounts this point in its **REP4-068**, Part 3, Section 4. Furthermore, NPS EN-3 confirms in Paragraph 2.3.11 '*As well as owning the rights to explore and utilise waters up to 12nm, the Energy Act 2004 gives The Crown Estate rights to issue leases for development beyond the territorial limit and within the REZ.*' This is further confirmed in NPS EN-1 Section 4.3 and in NPS EN-3 Section 2.6 and Paragraph 2.8.3.

24 Very weakly, the Applicant points out BML's lack of response to its statutory consultation, again dealt with by BML in its D3 submission (**REP3-098**) in Sections 1 and 9 and in its D4 submission (**REP4-068**) in Part 3, Section 7.

25 The Applicant stresses how robustly it has considered and dealt with commercial fisheries. However, BML contends that it has not considered existing or future aquaculture activities or its knowledgeable representatives (refer to BML's D3 submission **REP3-098** in Section 9 and its D4 submission (**REP4-068** in Part 3, Section 7) concerning the Applicant's lack of adequate consultation and engagement with aquaculture representatives. There is no doubt that the Applicant would have become aware of the existence of proposals to co-locate aquaculture assets within OWFs had they consulted more widely, and adequately. The failure to carry out this consultation is significant in policy terms: it means that the ExA cannot be satisfied that the Applicant has designed the proposal having consulted 'representatives of the fishing industry with the intention of minimising the loss of fishing opportunity…' (NPS EN-3 Paragraph 3.8.322). Because offshore aquaculture is not currently taking place, it comprises a 'fishing opportunity', which would be 'lost' if the project were to be consented without the Requirement and modifications that BML promote. These are simple matters and it is regrettable that the Applicant did not take steps early in project development to consult the aquaculture industry and that it is failing to explain why, even at this stage, it is not possible for the project design (which is far from being at the final stage) cannot incorporate measures that would facilitate this sustainable form of marine development.

26 Section 2.5.2 NPS-EN-1 and EN-3 – the Applicant maintains that its own detailed policy assessment is correct and it has satisfied all policy requirements. BML contends the opposite, as set out in its D3 (**REP3-098**) and D4 (**REP4-068**) submissions, both in Sections 4. The Applicant further cites its assessment of compliance with the relevant North West Inshore and North West Offshore Marine Plan, which BML has dealt with below in Section 5 in response to the ExA's EXQ2 Question 2CF2. Also, the Applicant's cites its collaborative working with other developers and sea users in order to comply with policy, unfortunately the Applicant did not deal with any existing or future aquaculture operators or any experts in that

field, as indicated in BML's D3 submission (**REP3-098**) in its Preamble, Paragraph Section 9.

27 The Applicant's interpretation of BML's comments regarding 'enhancement' states that it is only necessary to enhance only if it is part of mitigation; and, as BML's proposals are not developed sufficiently it cannot mitigate against such embryonic proposals and consequently should not enhance. However, BML contend that enhancement is necessary in its own right (to create opportunities and to be maximised) and cannot and should not be ignored. The policy imperative in NPS EN-3 Paragraph 2.8.251 to deliver enhancement (where reasonably possible) of 'any' benefits, including 'potential benefits', over the 'medium and long term', clearly encompasses aquaculture, which is a form of medium to long term benefit to 'the fishing industry'. In other words, since fishery mitigation is needed (and there is no dispute that it is needed here), there is no reason in principle why that mitigation should not comprise measures which facilitate and enhance aquaculture within the project. That would then be an enhancement (because no such aquaculture is taking place at the moment) and it would have medium to long term benefits to the fishing industry. However, BML contends that the Applicant has not included any enhancement, even relating to the mitigation it has proposed.

28 The Applicant cites NPS EN-3 Paragraph 2.8.319 stating that only 'recognised fishing activities' should be considered – BML believe the Applicant should have referred to Paragraph 2.8.309 not 2.8.319. The full text of that paragraph is: *'The Secretary of State should consider the extent to which the proposed development occupies any recognised important fishing grounds and whether the project would prevent or significantly impede protection of sustainable commercial fisheries or fishing activities'*. BML would draw the ExA's attention also to NPS EN-3 Paragraph 2.8.146, which acknowledges that: *'…..other fishing activities….. may be able to take place within operational wind farms without unduly disrupting or compromising navigational safety.'* BML submit that aquaculture is one such 'fishing activity' (also refer to the examples set out in BML's D4 submission (**REP4-068** in Section 6, Paragraph 78). The Applicant is refusing to make any accommodation within the project, or the DCO, to facilitate aquaculture as a fishing activity and only deals with existing fishing activities. That in itself is contrary to the relevant statement of policy. Furthermore, BML contends that the words ***'sustainable commercial fisheries or fishing activities'*** in the latter part of Paragraph 2.8.309 is not qualified to only existing and may include future activities. In any case, aquaculture is clearly a recognised and compatible fishing activity and the Applicant's statement in Paragraph 29 is considered a 'red herring'.

29 Section 2.5.3 Consultation – the Applicant defends its consultation and engagement record and cites its compliance with the PA2008 and its Consultation Report (**REP1-002**) as evidence, although it should be noted that BML has questioned its adequacy in its D4 submission (**REP4-068** in Section 7, Paragraph 80). Then, the Applicant refers to a report by the MMO (MMO1184) stating that no strategic areas for aquaculture were identified beyond the 12nm limit. BML has responded to that comment in its D4 submission (**REP4-068** in Section 5).

30 The Applicant continues to further characterise the BML proposals as 'not reasonably foreseeable' within the Order Limits during the operation of the project, which has a lifespan of 60 years. This is clearly wrong, extremely unambitious and fanciful.

31 The Applicant cites the validity of its two rounds of consultation and the associated events and its concurrence with other OWF consultations, implying that BML should have engaged then both informally and formally. BML's position/explanation on this was set out in its D3 submission (**REP3-098** in Section 1) and such late engagement in no way implies that it is not valid, despite the Applicant's criticism – confirmed by the ExA in its acceptance of both BML's D3 and D4 submissions and its attendance and involvement at the ISH3 Hearing and the ExA's further ExQ2 questions (Ref. Nos. 2CF1 and 2CF2).

32 Section 2.5.4 Consideration of Submission – the Applicant asserts it is unable to consider any opportunities at this stage for co-location given the lack of detail in BML's proposals and its late engagement. This is an unreasonable approach, as all that has been requested has been 3 additions to the draft DCO documentation: a new paragraph in the OFLCP, amendments to Schedule 6 and a new Requirement in Schedule 2.

33 The Applicant suggests that EIA Scoping is the most appropriate stage for BML to introduce its proposals. There is no reason in terms of the legislation why that is correct, and even if it was correct, why the matter should not be considered at a later date, as and when sufficient information was made available. It further criticises BML's proposals stating a lack of evidence (clearly not correct) and lacking detail (despite the Applicant's own parameter 'outline' application).

34 Although the Applicant's final Paragraph 47 is encouraging, it however offers no timetable or confirmation of its acceptance that aquaculture is a compatible use within OWFs. It appears to BML to be very much a delaying tactic to avoid dealing with BML's proposals until an unspecified time in the future.

BML's Conclusions

35 The Applicant appears to conveniently ignore the following critical matters: the wealth of published evidence about the value of aquaculture and its compatibility with OWFs; the distinction between co-existence and the more important co-location; the successful practice of aquaculture projects in OWF in several countries in Europe; the need to change TCE leasing practices and TCE's own recent policy change; the lack of engagement with aquaculture representatives or experts in that field; and, the need for strengthening food security in respect of aquaculture. All significant points made by BML in its previous two submissions.

36 The Applicant is extremely dismissive of BML proposals or position on key matters throughout, allowing no opportunity for future engagement – this is in spite of BML's efforts to undertake engagement with the Applicant (refer to its D4 submission in Section 7 and Section 6 below). Furthermore, the Applicant tries to reinforce its complete 'lock-out' of its Order Limits sole usage for some 60 years. That is significant because as set out above it means that a 'reasonably possible' form of 'enhancement' to the 'fishing industry' in the 'medium to long term' is simply being locked out and sterilised, instead of facilitated.

37 Finally, BML has tried in its D4 submission (**REP4-068**) in Part 1 'Opening Observations', to demonstrate all the problems with the Applicant's approach and to set out the 'Catch -22' that BML finds itself in on all these matters – consistency across all 3 OWF DCO applications, Marine Licencing smokescreen and 'lock-out', TCE's participation, the OFLCP, the DCO as a One-Stop-Shop', competence issues and the position of aquaculture under the UN Convention of the Sea, 1982.

Applicant's Written Summaries of Oral Submissions at ISH 2, 3 and 4 (**REP4-059**)

38 Section 2 sets out the Applicant's 'written summary' of ISH3 and Item 4 deals with Commercial Fisheries, with only Pont 7 (Pages 49-51) dealing with BML.

39 This written summary largely is the original summary of the Applicant's comments on BML's D3 submission, as reviewed above, all of which were dealt with in BML's D4 submission. Unreasonably, all points have been largely dismissed by the Applicant as not valid points. Notwithstanding this, the Applicant has only presented their side of the discussion (in a rather one-sided manner) and has not included the points made by the BML representatives, which are contained in its D4 submission (REP4-068 in Section 5, Paragraphs 66 – 70).

40 The Applicant has, however, confirmed in their sub-points 25 and 26 in the 'Notes' column, that the FLCP is flexible, allowing the Fisheries Liaison Officer to determine the validity of any changes of any fishing activities during construction. However, the Applicant stresses that BML would need evidence of leasing rights during construction, where the primary impacts to fisheries will occur. Clearly though, this is not possible as referred to in Paragraphs 19 – 33 above. The Applicant clearly only considers mitigation, compensation or enhancement being necessary during construction, a point with which BML completely disagrees.

5 RESPONSES TO ExA ExQ2 QUESTIONS

Commercial Fisheries (CF)		
Compliance with Policy		
2CF1.	BML	**Compliance with NPS EN-3** Paragraph 2.8.154 of NPS EN-3 states that *"Applicants should undertake early consultation with a cross-section of the fishing industry……. and actively encourage input from **active** fishers to provide evidence of their use of the area to support the impact assessments."* (emphasis added). Paragraph 2.8.197 of NPS EN-3 states that "*Where a potential offshore wind farm……. has the potential to affect activities **for which a licence has been issued** by government, the applicant should undertake an assessment of the potential effects of the proposed development on such **existing or permitted** infrastructure or activities"* (emphasis added). In your D4 submission you acknowledge that you are not currently in a position to apply for a marine licence and that "*co-located aquaculture needs to follow OWF development*" [REP4-068, paragraph 8]. Without repeating arguments or submissions already made, can you therefore explain why you consider the applicant has failed to comply with the above requirements of NPS EN-3 given your aquaculture activities are not actively being carried out and you have no existing licence or consent that allows those activities to take place?

ExQ2 2CF1. BML Response:

Introduction

There are parts of the two Paragraphs in the above ExQ2 questions that are acknowledged as referring to 'active fishers and 'activities that have a marine licence' and under those requirements it is accepted that the Applicant is not required to consider future aquaculture provision. However, as you are aware, the NPS must be considered 'in the round', not taken selectively and so should take into account all other relevant requirements/provisions and in the process undertake the widest possible engagement – these matters will be covered below.

As to NPS EN-3 Paragraph 2.8.154, the first part of the policy refers to the need for applicants to 'undertake early consultation with a cross-section of the fishing industry…to identify impacts.' A cross-section of the fishing industry would include those interested in

operating offshore aquaculture. There has been a breach of this element of the policy. The next part of the policy says that applicants should 'actively encourage input from active fishers…'. This is a separate part of the policy dealing with the need for 'early consultation' rather than with 'active encouragement of input'. The qualification 'active fishers' applies only to the second part of the policy. The current debate between BML and the Applicant illustrates starkly the reason why there is a need in terms of NPS EN-3 to engage early with a cross-section of the fishing industry, and is also why NPS EN-3 Paragraph 2.8.322 is clear that the Secretary of State should be satisfied that the Applicant sought to design the proposal having consulted 'representatives of the fishing industry with the intention of minimising the loss of fishing opportunity': that is precisely what should have happened here, aquaculture being a form of 'fishing opportunity' that would be removed by the Project's design and by the DCO as currently drafted.

The above question acknowledges **REP4-068** Paragraph 8 and the reasons why BML cannot yet apply for a marine licence and Section 6 of that BML D4 submission sets out BML's understanding of the consenting/marine licence processes and requirements. It is not BML's understanding that this is at issue here. However, what is at issue here is whether the Applicant has complied with all other NPS EN-3 policy requirements 'in the round', as set out in BML's D4 submission (**REP4-068**) in Section 4 (Paragraphs 2.5.2, 2.8.19, 2.8.47–2.8.48, 2.8.158 and 2.8.250–2.4.8.251), in particular, i.e. that the Applicant has not complied with those cited paragraphs that seek to 'maximise, create opportunities, engage with stakeholders, collaborate and have detailed consultations to provide, achieve greater co-location and finally mitigation should enhance long-term benefits'.

Other NPS Relevant Policies 'in the Round'

Clearly, all the above-mentioned NPS EN-3 requirements are relevant here. In addition, Paragraph 2.8.154 recommends 'early consultation is recommended with a cross section of the fishing industry……'; and this is further developed in Paragraphs 2.8.250 and 2.8.251 so that mitigation is designed to enhance benefits to the fishing industry. Consequently, BML contends that the Applicant's consultation/engagement omitted the established centre of aquaculture excellence in and around the Menai Straits comprising: a) the School of Ocean Sciences at Bangor University with European-level expertise in aquaculture; b) a concentration of mussel and oyster farmers; and, c) a newly minted Several Order and management organisation for the Menai Straits mussel fishery. Furthermore, Paragraph 2.8.158 recommends *'Applicants will be expected to undertake dialogue with the fishing industry during the planning and design of individual offshore wind farm and transmission proposals* ***to maximise the potential for co-existence/co-location*** *and reduce potential displacement.*' (emphasis added). BML contend that engagement with the aquaculture industry has been lacking, as has a realisation of the potential of aquaculture. It is quite plain that the need to 'maximise the potential for co-location' involves the adoption of all of the measures promoted by BML. If such measures are not adopted, there would be policy conflict. Furthermore, and as set out above, there is also a policy imperative in NPS EN-3 Paragraph 2.8.251 to deliver enhancement (where reasonably possible) of 'any' benefits, including 'potential benefits', over the

‘medium and long term’. This clearly encompasses aquaculture, which is a form of medium to long term benefit to ‘the fishing industry’. In other words, since fishery mitigation is needed (and there is no dispute that it is needed here), there is no reason in principle why that mitigation should not comprise measures which facilitate aquaculture within the project. That would be an enhancement (because no such aquaculture is taking place at the moment) and it would have medium to long term benefits to the fishing industry. Furthermore, the Applicant appears to have failed to note the legitimacy of aquaculture that the core UK legislative framework that determines commercial fisheries activity is the Fisheries Act, 2020 (Fisheries Act 2020) that incorporates aquaculture in its scope. In the EU, a similar coverage is provided within the Common Fisheries Policy (Common fisheries policy (CFP) - European Commission) for commercial fisheries and aquaculture. **Conclusions** BML consider that only to consider NPS EN-3 Paragraphs 2.8.154 and 2.8.197 effectively omits consideration of other very relevant policies/requirements. BML maintains that the Applicant has failed to comply with clear consultation/engagement requirements that should have included the aquaculture industry and has not considered the policy requirements of the need to maximise co-location possibilities and create and enhance opportunities for co-location. Also, Paragraph 2.8.154 refers clearly to the need for early consultation with a cross section of the fishing industry and only refers to ‘active fishers’ in order to provide evidence of their use in the area – the two points are not linked. Finally, Paragraph 2.8.197 only relates to other existing operational offshore infrastructure or other marine licenced activities and is therefore not relevant to BML’s proposals.		
2CF2.	The applicant BML	**Compliance with North West Inshore and Offshore Marine Plan 2021** Paragraph 2.8.319 of NPS EN-3 states that “*The Secretary of State should consider the extent to which the proposed development occupies any recognised important fishing grounds, and whether the project would prevent or significantly impede protection of sustainable commercial fisheries or fishing activities.”* Policy NW-AQ-1 of the North West Inshore and Offshore Marine Plan 2021 (NWMP) seeks to protect both existing aquaculture operations as well as potential future opportunities for aquaculture **within spatially defined strategic areas of sustainable aquaculture production** (emphasis added). The Technical Annex that supports the NWMP adds that if sited within existing or potential strategic areas of sustainable aquaculture production (as identified in the similarly named layer on the Explore Marine

		Plans digital service), proposals will need to demonstrate how they will avoid significant adverse effects. If significant effects cannot be avoided than measures should be identified to minimise and mitigate such effects. To the applicant and BML: a) given no aquaculture activity is taking place within the footprint of the wind farm site or within ICE 36E6, does aquaculture constitute a commercial fishery and fishing for the purposes of NPS EN-3 and does the proposal site constitute a *"recognised important fishing ground"*? b) as the proposed development lies outside a strategic area of sustainable aquaculture as identified within the NWMP, does Policy NW-AQ-1 apply in this case? To BML: c) if Policy NW-AQ-1 does apply, how has the applicant failed to apply the mitigation hierarchy correctly in terms of avoiding potential significant adverse effects on aquaculture if no such activity exists? In other words, if no aquaculture activity is taking place why would mitigation and enhancement be necessary (having regard to paragraph 2.8.251 of NPS EN-3)?

ExQ2 2CF2. BML Response:

Introduction

NPS EN-3 Paragraph 2.8.319 and the references to Policy NW-AQ-1 in the North West Inshore and Offshore Marine Plan 2021 (NWMP) are acknowledged, particularly the latter in relation to the requirements of NPS EN-3 Paragraphs 2.8.16 – 2.8.19 and NPS EN-1 Section 4.5. However, that section of the NPS EN-3 on 'Impacts' does further state in Paragraphs 2.8.321 – 2.8.323 additional requirements which the Applicant has failed to meet. These paragraphs are set out (with emphasis added) and then with BML commentary following each paragraph:

*'The Secretary of State should consider **adverse or beneficial impacts on different types of commercial fishing** on a case-by-case basis.'* (emphasis added) – aquaculture is clearly a type of commercial fishing and therefore should have been considered by the Applicant. It is a special non-conventional case of sustainable economic activity and calls for careful consideration.

*'The Secretary of State should be satisfied that the applicant has sought to design the proposal having consulted the MMO or NRW in Wales, Defra or Welsh Government in Wales and **representatives of the fishing industry with the intention of minimising the loss of fishing opportunity** taking into account effects on other marine interests. Guidance has been jointly agreed by the renewables and fishing industries on how they should liaise, with the intention of allowing the two industries to co-exist successfully.'* (emphasis added) – BML contend that aquaculture representatives should have been consulted/engaged with in order to mitigate the loss of aquaculture (as a fishing opportunity) over the entire long term 60-year operational period. This is

further emphasised in the NWMP Technical Annex in Paragraphs 191 – 196, demonstrating that many such organisation have not been consulted/engaged with by the Applicant.

*'The Secretary of State will **need to consider the extent to which disruption to the fishing industry**, whether short term during pre-construction (e.g. surveying) or construction or **long term over the operational period**, including that caused by the future implementation of any safety zones, has been mitigated where reasonably possible.'* (emphasis added) – again, this is a disruption to the aquaculture industry over the entire long term 60 years operational period is considered unacceptable to this important part of the fishing industry. None of these matters depend upon a prior finding that the Morecambe OWF area is a 'recognised important fishing ground'.

Response to 2CF2 a)

First, it is unclear to BML why Figure 5 of the NW Marine Plan Technical Annex (which is not yet included within the DCO documentation in the latest Examination Library dated 27 February 2025, but is now included in **Annex 3** below) differs from the 'Explore Marine Plans' digital service (which are considered to give greater certainty around current activities) and which plan is correct, in that the areas defined for 'Strategic Areas for Sustainable Aquaculture Production' and various types of Kelp, Dulse and Oarweed are quite different; and, it is not clear if the Applicant has recognised this mapping discrepancy and has not yet used this discrepancy in order to show the Order Limits overlaid on either mapping source in the DCO documentation, as it is not part of the DCO documentation referred to below. In addition, the term 'commercial fishery' or 'recognised important fishing ground' is not defined in the NW Marine Plan or its Technical Annex; and, although mentioned in the NPS EN-3 it is not defined either.

Given the context set out in the Introduction above, although BML's aquaculture proposals may not be considered a 'recognised important fishing ground', it is a form of commercial fishery and one which is supported by other key NWMP policies (also refer to BML's response to 2CF2 b) below).

Response to 2CF2 b)

Specifically, it is noted that within the Applicant's ES Volume 5, Chapter 13 Commercial Fisheries (**REP3-019**), its Appendix 13.1 Commercial Fisheries Technical Report (**REP2-015**) and its accompanying Figures (**APP-097**) that there is no mapping showing the Order Limits overlapping either with Figure 5 of the NW Marine Plan or the Explore Marine Plans layers for the 'Strategic Areas of Sustainable Aquaculture Production' and various types of Kelp, Dulse and Oarweed. This is considered an omission and the different area defined for 'Strategic Areas for Sustainable Aquaculture Production' needs resolution, as Figure 5 cannot yet be relied upon. Notwithstanding this mapping discrepancy, it is clear that the Explore Marine Plans mapping service allows for changes as more evidence becomes available in the future. BML contend that even if aquaculture has not yet been specifically

defined in any offshore waters, it is by virtue of the methodology used in MMO1184 Final Report and would include offshore waters, as is explained in more detail below.

The MMO1184 Report was first published in 2019 by CEFAS (as referred to in Annex 1 of BML's D3 submission (**REP3-098**)), was updated in 2021 and then published in 2023 and it is this 2023 version represents the most up-to-date version – most importantly, it was used as guidance for the NWMP and particularly was the basis for NWMP Policy NW-AQ-1.

The MMO's 2023 updated version MMO1184 Final Report (refer to **Annex 1** below) does provide two qualifications for its approach with future activities confined to the inshore. First, on Page 13 of the main report, the only paragraph on that page says: *'Distance offshore was used to constrain all data'.* Whilst not strictly a technical constraint, distance offshore is a proxy for several economic considerations, including fuel price, transit times, fish stock and price fluctuation, which can act as limiting factors to locating aquaculture developments. To ensure the outputs of this work adequately reflect the needs of the current, predominantly inshore status of the English aquaculture industry, the map outputs were limited to the inshore marine plan areas only, using the clip tool. This point is further emphasised by the paragraph at the bottom of Page 18/top Page19 – '*Although the marine plans provide support for aquaculture within the identified strategic areas, aquaculture developers are not obligated to locate their developments within either these. The project outputs can be used to inform site selection based on the detailed considerations in this report, though the primary purpose remains in supporting the implementation of AQ-1'.* It is clear therefore that development of an activity such as aquaculture can occur outside of the defined strategic resource areas.

Finally, the failure of the MMO to identify offshore waters as also being applicable for aquaculture development was based, on BML/DDL's view, on a restricted understanding of the sector. Whilst it is of course true that distance from port is a useful indicator for economic factors - this is true for every activity. Therefore, it seems a little unbalanced to restrict potential for aquaculture on this basis and not for any other sector. In addition, and also to somewhat conflict other statements made about future potential, it is true that aquaculture is broadly undertaken in the inshore NOW, but that does not mean that it cannot be located further offshore at some future point (near/medium term). One of the key requirements of extensive shellfish cultivation is access to the juvenile animals. It is really helpful if the juveniles, which are planktonic during the early life stages, can be found within the OWF area. The 2022 Paper entitled *'Evidence of Potential Synergy between Aquaculture and Offshore Renewable Energy'*, September 2022 (refer to **Annex 4**) clearly indicates that this is a plausible possibility. Furthermore, the paper also intimates that the OWF pylons themselves also provide settlement opportunities for these planktonic juveniles. This in turn may have implications for the density of settlement of mussel seed in areas that the seabed mussel sector has historically relied on as a source. Clearly, it is the future potential of aquaculture, which is used as the strategic driver here, not its current status and this has not been recognised by this or other Applicants or the OWF wind industry so far.

In addition, the DCO Order Limits are clearly within the International Council for the Exploration of the Sea (ICES) Statistical Rectangle 36E6 (also used by the DCO EIA as the local study area and part of the regional study area) (refer to the Commercial Fisheries Technical Report (**REP2-015)** in Section 2.2 and as shown in Figure 2.1 and 2.2. In BML's view, whilst not within the ambit of NPS EN-3 Paragraph 2.8.319, the entire ICES area should be considered an important opportunity for aquaculture development and considered as such. However, as indicated above in BML's response to ExQ2 Question 2CF1 there are other very relevant policies within the NPS EN-3 that support co-location and aquaculture that need to be considered 'in the round'.

With regard to the only policy referred to by the ExA in its above question, namely NW-AQ-1, there are other very relevant policies to consider 'in the round' (also refer to Table 13.5 in the Applicant's ES Volume 5, Chapter 13 Commercial Fisheries (**REP3-019**), namely: Policies NW-CO-1, **NW-AQ-2**, NW-FISH-1, NW-FISH-2, NW-FISH-3 and **NW-EMP-1** (emphasis added) (as set out in the NWMP in Table 2); and, it is clear that these policies support both co-location, aquaculture development, diversification of the fishing industry and net-increases in marine-related employment and development within OWFs. Most importantly, the NWMP policies should be considered within a mitigation hierarchy of Avoid, Minimise, Mitigate and Compensate; and, in the NWMP Table 4 it indicates for Policy NW-AQ-1 that checks on safeguarding areas for future development should be undertaken; for NW-FISH-1 and NW-AQ-2 (which aims to tackle barriers to aquaculture), NW-FISH-1 and NW-EMP-1 that checks to ensure support for diversification and employment should be undertaken.

BML would maintain two important considerations: the 'Strategic Areas of Sustainable Aquaculture Production' are not clearly mapped and not overlaid with the Order Limits in either case; and, NWMP Policy NW-AQ-1 does apply, as do other very relevant NWMP policies.

Response to 2CF2 c)

There is a policy imperative in NPS EN-3 Paragraph 2.8.251 to deliver enhancement (where reasonably possible) of 'any' benefits, including 'potential benefits', over the 'medium and long term'. This clearly encompasses aquaculture, which is a form of medium to long term benefit to 'the fishing industry'. In other words, since fishery mitigation is needed (and there is no dispute that it is needed here), there is no reason in principle why that mitigation should not comprise measures which facilitate aquaculture within the project. That would be an enhancement (because no such aquaculture is taking place at the moment), and it would have medium to long term benefits to the fishing industry. In other words:

- Mitigation is needed and furthermore mitigation in the form of enhancement is needed;
- Enhancement is a form of mitigation;
- Aquaculture would be a medium and long term benefit to the fishing industry;

- It is ‘reasonably possible’ to introduce the measures that BML are promoting; and,
- They must therefore be provided: they fall within the description of ‘any’ benefit which is ‘reasonably possible’.

The failure to accommodate the measures BML are promoting gives rise to policy conflict. However, BML contends that the Applicant has not included any enhancement, even relating to the mitigation it has proposed.

It is clear to BML that there are several key NWMP policies that do support co-location, aquaculture, diversification and employment and given that, therefore the Applicant should have provided for such future opportunities with greater vigour through the mitigation hierarchy. Consequently, it has not done this and remains deficient in this respect. In addition, the question amply demonstrates the Catch-22 point above, in that **how is it ever possible to provide for the future of aquaculture if it does not exist in the present?** The BML requests for reasonable additions/changes to the DCO documentation in three areas (refer to BML’s D3 submission (**REP3-098** in Section 8) would represent an appropriate and positive overriding of this Catch-22, it would be proactive and it would set the tone for future DCO applications for the benefit of the UK’s food security (such as ‘Seafood 2040’ – Seafood 2040 - A Strategic Framework for England — Seafish (refer to **Annex 2** below and it is also referred to in the MMO1184 Final Report (refer to **Annex 1** below). Furthermore, the reference to NPS EN-1 Paragraph 2.8.251 appears to ignore other more relevant policies referred to above; and, ignores its provision to provide for long-term benefits to the fishing industry.

Furthermore, the NWMP Technical Annex covers aquaculture in Section 5.4. This section, particularly Paragraphs 186 – 198, clearly demonstrates the need to provide for future opportunities for aquaculture, its importance and its relationship to key NWMP policies NW-AQ-1; and for Policy NW-AQ-2 Paragraphs 200 – 214 are important. It also acknowledges that the identified ‘Strategic Areas of Sustainable Aquaculture Production’ may need further refinement and may be updated.

Conclusions

Finally, BML would add that implicit within these ExQ2 questions is the problem that BML has faced in each of these OWF Examinations – that of a Catch-22 and being unable to satisfy the basics of a marine lease or being recognised as an important fishing activity, despite much evidence to the contrary (refer to **REP4-068** in Part 1). It is not clear how an aquaculture proposal could ever come into existence if it cannot obtain a marine lease until after the DCO is granted; is not a recognised important fishing ground; does not exist in the present; and, has not been provided for in the DCO effectively ‘locking-out’ any provision in these OWF areas for some 60 years – hence the Catch-22 analogy.

6 UPDATE AND COMMENTARY ON TECHNICAL ENGAGEMENT BETWEEN BML AND THE APPLICANT

Current Engagement between the Applicant and BML

41 BML remains keen to engage with the Applicant with respect to the matters set out in its D3 and D4 submissions and in Sections 3, 4 and 5 above and respectfully requests that the ExA seek further information in respect of the issues raised herein, so that the detailed issues in respect of the imperative for the Project to accommodate the co-existence and co-location of the sustainable aquaculture industry can be fully explored and understood and appropriate arrangements for co-located aquaculture secured.

42 As an update to the fact that BML spoke informally with representatives of the Applicant at the ISH3 Hearing and subsequently wrote to the Applicant in an email dated 6 February and in a reminder dated 5 March 2025. However, BML still awaits any acknowledgement or a reply, which matters of courtesy aside, clearly demonstrates an unwillingness to engage. For convenience, BML requested in that correspondence further technical engagement with the Applicant and asked 4 questions of the Applicant, as follows:

1 Will the Applicant accept the principal of accommodating aquaculture within the Order Limits and between the turbines in a way that does not impact the operation/maintenance of those turbines?

2 Will the Applicant agree to further series of technical engagement meetings to achieve a mutually agreed solution to present to ExA, possibly through a SoCG, by say D5?

3 Will the Applicant consider the proposals for a sub-lease between the Applicant and/or Crown Estate?

4 Will the Applicant consider and accept the proposals for additional wording for the OFLCP and for a new Requirement, as set out in our D3 submission in Section 8?

7 FINAL COMMENTARY AND QUESTIONS FOR THE EXA

43 In consideration of the information and commentary above and accounting for BML's D3 and D4 submissions, BML distil, summarise and set out below the 5 main questions that remain and either require the Applicant's response or, BML would submit, further actions from the ExA. These bear repeating and adjusting in light of this submission and are the following:

1 **Technical Engagement** – now technical matters have been raised in both BML's D3 and D4 submissions and at the ISH3 Hearing, these should be resolved during the Examination. Clearly though, this requires the Applicant's written support and further actions as set out in BML's D3 and D4 submissions and in view of BML's comments above. The consequence of this not being delivered remains the sterilisation of 87km2 for this project alone, preventing the valuable aquaculture sector from developing offshore (notwithstanding the 667km2 sterilisation involved in all three Irish Sea OFW project areas).

2 **DCO Securing Mechanisms** – could the ExA enquire of the Applicant as part of further information or the Applicant themselves explain the reasoning behind not adopting these 3 simple measures (straightforward additional drafting within the OFLCP, additions to Schedule 6 and a new Requirement), if the Applicant in fact continues to decline to provide these recommendations, (as set out in Section 8 of the BML D3 submission (**REP3-098**).

3 **Policy Compliance** – given the Applicant's views on its National Planning Policy compliance, BML's views are set out in Section 4 in its D4 submission (REP4-068) and in Sections 4 and 5 above), there is clear disagreement that requires resolution. It is clear from Sections 4 and 5 above that BML considers that the Project does not comply with S104(3) and (7) of the PA2008 (as covered in Section 4 above, in particular).

Furthermore, it is unclear if the Applicant considers that the proposed mitigation of commercial fisheries comprises enhancement as required by NPS EN-3 (refer to Section 4 above). It is notable that the Applicant for the Mona OFW Project has openly acknowledged that it is not delivering enhancement.

4 **Future Fishing and Aquaculture Activities –** the Applicant was keen to stress at the ISH3 Hearing that it only has considered and should consider recognised fishing activities, was clear that this did not refer to aquaculture at all. Therefore, should the Applicant now be requested to consider such proactive future proposals more favourably and be asked to set out the relevant consideration and policy/technical obstacles to embracing such a positive view?

5 **Leasing Arrangements –** it is clear that the Applicant intends to rely on its current exclusive lease agreement with TCE. Also, it is clear that TCE has not yet made any submissions to this Examination and therefore should be encouraged by the ExA to set out its position regarding leasing, alternative uses, alienation and sub-leasing, especially in light of its September 2024 policy document 'The Future of Offshore Wind', as set out in BML's D3 submission in Annex 1 (**REP3-098**).

BML would also stress that its proposals cannot be defined in detail until after construction is complete and all relevant constraints (such as cabling) can be understood and responded to.

ANNEX 1

MMO ‘Identification of Strategic Areas of Sustainable Aquaculture Production in English Waters: Final Report’, 2023 (24pp)

Marine Management Organisation

Identification of strategic areas of sustainable aquaculture production in English waters: Final Report

(MMO1184)

...ambitious for our seas and coasts

MMO1184: Identification of strategic areas of sustainable aquaculture production in English waters: Final report (updated 2021)

Report prepared by:
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1 Introduction

1.1 Aquaculture in England

English aquaculture production has significant growth potential and may provide multiple benefits, particularly the potential to contribute to domestic food production in the UK, thereby increasing food security in a way which is carbon efficient and benefits local economies. Aquaculture may directly and indirectly provide a source of employment, particularly in coastal peripheral towns and ports, as well as contribute to the diversification of the fishing sector. Biological benefits also include restocking species to conserve and recover marine biodiversity, with some cultured species providing indirect benefits through ecosystem services.

However, a lack of availability of new production sites is a key limiting factor for growth in the English aquaculture sector. Due to this, developers are not informed of optimal sites for aquaculture production, and it is not clear which areas should be protected by policy for future aquaculture production. This evidence project aims to remove this barrier by identifying sites that are the most suitable for aquaculture, and ensuring their existence is taken into account in marine license decisions.

1.2 Policy background

The UK Marine Policy Statement (MPS) sets out policy objectives for aquaculture from a planning perspective. These include:

- to take advantage of the opportunities that climate change may bring to certain marine areas, for example, …aquaculture of acceptable and commercially desirable species (MPS section 2.6.7.9)
- embrace the significant opportunities for co-existence of aquaculture and other marine activities (MPS section 3.9.6)
- seek information on possible future aquaculture operations in areas not previously used, assessing the suitability of those areas for development (MPS section 3.9.7)

The vision of Seafood 2040: A Strategic Framework for England is that by 2040, a sustainable aquaculture sector will have seen significant growth, thriving within a safe regulatory framework. As part of this, the original Seafood 2040 recommendations included the investigating the potential of establishing priority aquaculture/coastal development zones. This forms one of the key actions to fulfil the strategies' Priority 2: Grow a sustainable aquaculture sector.

The English Aquaculture Strategy identifies the marine plans as one of the major policy drivers for future aquaculture growth. As stated in the strategy; "*Marine Plans and their more detailed local interpretation will be the primary mechanism for identifying areas for potential sustainable growth in marine aquaculture production*" (p.18).

The Marine Management Organisation (MMO) has previously undertaken development of spatial models to delineate potential areas for aquaculture development. The first approach to developing spatial models for aquaculture was developed as part of MMO1040 'Spatial trends in aquaculture potential in the South and East inshore and offshore marine plan areas'. This project followed a regional approach and was instigated during the development of the South Marine Plans, also supporting the East Marine Plans.

1.3 Marine Planning in England

The Marine and Coastal Access Act 2009 established the legal basis for marine planning in the UK. Section 58(1) states that authorisation and enforcement decisions must be taken "*in accordance with the appropriate marine policy documents*". In England, the MMO is responsible for preparing marine plans, as guided by the UK Marine Policy Statement.

Marine plans aim to ensure that the right activities occur in the right place, at the right time and in the right way, placing sustainable development at the centre of all decisions to deliver the UK vision for "*clean, healthy, safe, productive and biologically diverse oceans and seas*" (p.3).

There are 11 plan areas in England, covered by 6 individual marine plans. The East Marine Plans were adopted in April 2014, the South Marine Plans in July 2018, and the North East, North West, South East and South West Marine Plans in June 2021. England now has a complete and integrated marine planning framework to guide the usage, development, protection, and enhancement our marine environment.

Each marine plan contains aquaculture policies, written to respond to unique issues, challenges and opportunities raised by regional stakeholders during the respective planning processes. The plan drafting process occasionally identifies gaps in the MMO evidence base, where new evidence is needed to ensure policies can be implemented. In these cases, a new evidence project will be commissioned to facilitate the provision of data.

1.4 MMO1184 Evidence Activity

The development of policy AQ-1 in the North East, North West, South East and South West Marine Plans raised a new evidence commission in response to one of the evidence gaps identified. The subsequent evidence report defines areas in which applicants should consider the potential for future aquaculture, referred to as "strategic areas of sustainable aquaculture production". The data is based on:

i) environmental conditions that influence or limit species' growth (biological constraints)
ii) physical conditions prohibitive to establishing aquaculture infrastructure or operations (technical constraints)

iii) other uses of the marine area that either exclude or otherwise reduce the suitability of an area for aquaculture (planning constraints)
iv) other considerations such as distance from shore.

The MMO commissioned the Centre for Environment, Fisheries and Aquaculture Science (Cefas) to inform on needs i) and ii). The resulting Cefas report titled "Identification of areas of aquaculture potential in English waters" (MMO 1184) is hereafter referred to as the commissioned report.

The MMO undertook internal work) to address iii) and iv) and integrate them with the outputs from the commissioned report to produce this report. The result is a single body of work that identifies strategic areas of sustainable aquaculture production.

1.5 This Methods report

This report, first published in 2019, updated in 2021 and published in 2023, describes the sequence of steps followed in the modelling process to generate the strategic areas. It summarises methods from the commissioned report to assist readers in understanding the full process but does not repeat detailed methods, such as the sources and treatment of environmental datasets reported there. Those interested in how the biological components of the model were developed and the process by which the technical layers were defined should refer to the commissioned report.

This report is structured as follows:

- Section 2 summaries the outputs (biological and technical constraints) of the commissioned report, placing them in the context of the wider modelling work
- Section 3 describes how planning constraints were considered in the model
- Section 4 describes the approach to modelling including the software, tools used and the construction of the models
- Section 5 defines the caveats associated with model development, the intentions of model refinement, and how the commissioned report outputs should be used to aid marine plan implementation.

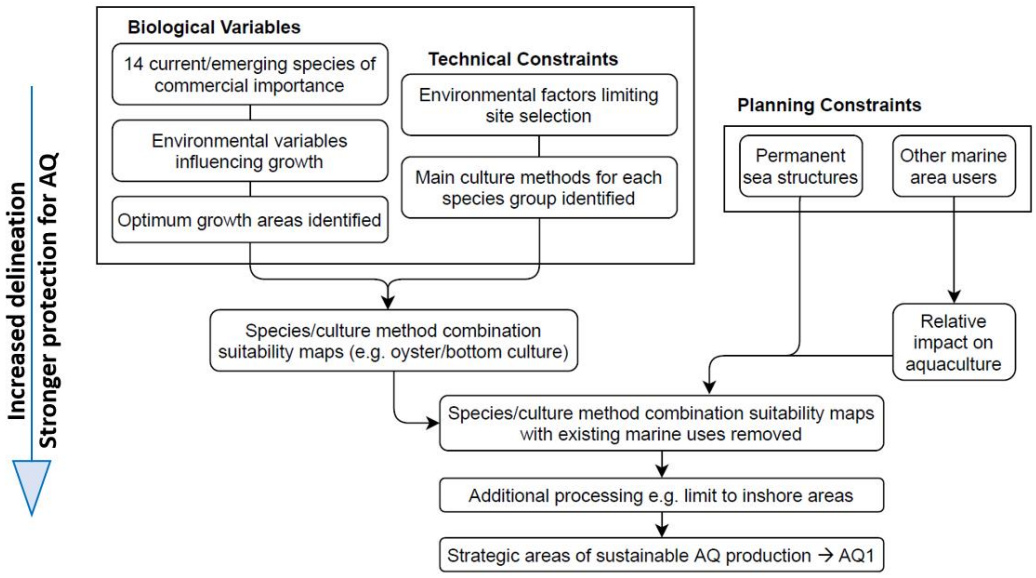
2 Biological and Technical Variables

2.1 Overview

The MMO commissioned Cefas to undertake an aquaculture mapping study to identify areas viable for growth of species in the English marine area. The work also identified technical constraints for site identification based on aquaculture infrastructure. The commissioned report is available on the gov.uk project page (Identification of areas of aquaculture potential in English waters (MMO1184)).

Figure 1 shows a flow chart that illustrates the full methodology described in this report. The box around the biological and technical variables highlights the elements of the data that were produced by Cefas in the commissioned report.

Figure 1: Complete methodology flowchart



2.2 Biological Constraint Layers

All identification, collation, manipulation and analysis of biological constraint data was conducted within the commissioned report. In summary, 14 species were selected for study:

seaweed

- Dulse (*Palmaria palmata*)
- Oarweed (*Laminaria digitata*)
- Sugar kelp (*Saccharina latissimi*)
- Winged kelp (*Alaria esculenta*)

finfish

- Atlantic cod (*Gadus morhua*)
- Atlantic salmon (*Salmo salar*)
- Rainbow trout (*Oncorhynchus mykiss*)
- Sea trout (*Salmon trutta)*

crustaceans

- European lobster (*Homarus gammarus*)

bivalve molluscs

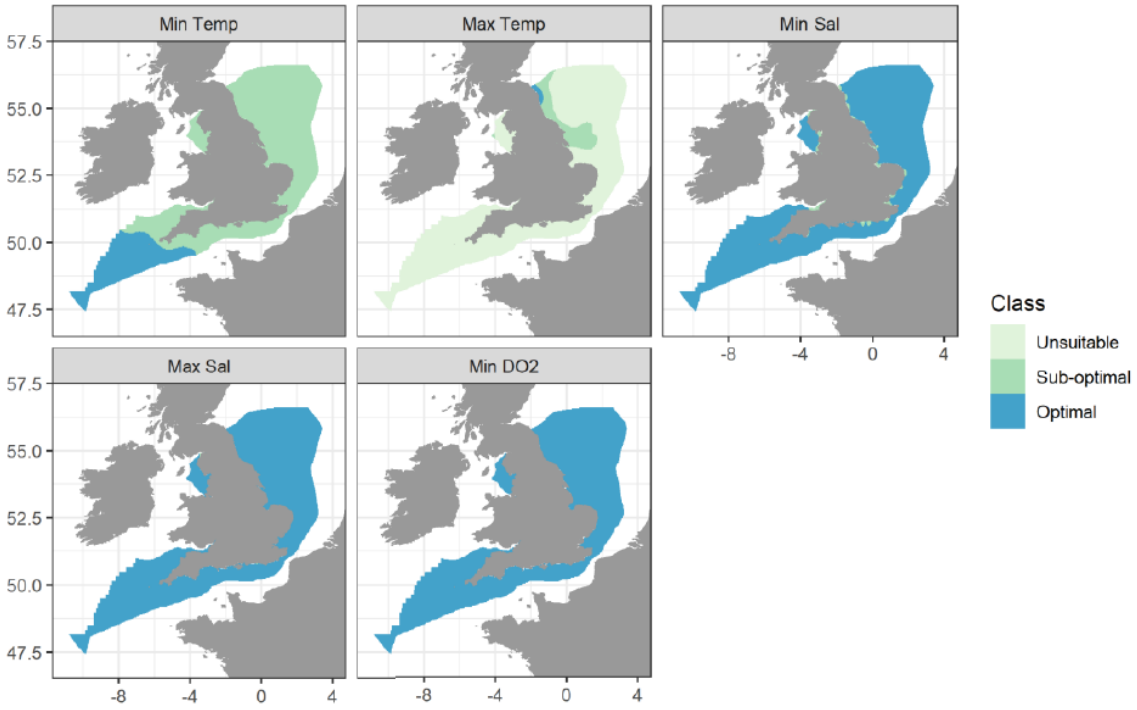
- Blue mussel (*Mytilus edulis*)
- King scallop (*Pecten maximus*)
- Manila clam (*Ruditapes philippinarum*)
- Native oyster (*Ostrea edulis*)
- Pacific oyster (*Crassostrea gigas*).

Datasets were obtained for key environmental layers that informed species distribution models:

- chlorophyll concentration
- light penetration depth
- minimum dissolved oxygen
- salinity (minimum and maximum)
- sea surface temperature (minimum and maximum)
- total oxidised nitrogen.

Environmental variables were classified in optimal, suboptimal and unsuitable ranges for each of the species investigated, based on published literature thresholds. This was conducted across the whole English marine area, where data was available (Figure 2) below. Not all environmental variables were relevant for all species.

Figure 2: Environmental constraints defined for Atlantic cod (*Gadus morhua*)



Comparison of threshold values with separately mapped data of each variable across the English marine area provided suitability maps showing areas where each species can survive or thrive according to each variable. Layers for each individual variable were combined and normalised based on the total number of variables. This

process implicitly weights each environmental variable as equally important to biological suitability and cannot account for combination effects.

This process produced 14 raster data layers showing suitability for growth, one for each species assessed. The continuous data layers were on a floating-point scale of 0 (less suitable; only sub-optimal conditions) to 1 (more suitable; all variables optimal). Areas non-viable for any one of the relevant environmental variables were excluded from the suitability maps.

The above outputs were converted by the MMO to vector layers based off suitability scores and became inputs into later modelling.

2.3 Technical Outputs

2.3.1 Outputs of the commissioned report

Table 1 lists which of the common culture types for aquaculture of different species were considered in this report.

Table 1: Species and culture combinations considered in the report

	Aquaculture Methods					
Species	Bottom culture	Bottom-secured (trestle/poles)	Rope/textile (suspended)	Bags/lantern nets (suspended)	Sea Based Container Culture	Cages
Sugar kelp			✓			
Oarweed			✓			
Winged kelp			✓			
Dulse			✓			
Atlantic Salmon						✓
Rainbow trout						✓
Sea trout						✓
Atlantic cod						✓
European Lobster	✓				✓	
Pacific oyster	✓	✓				
Flat oyster	✓	✓				
Blue mussel	✓		✓	✓		
Manila clam	✓					
King scallop	✓	✓	✓	✓		

The range of environmental and physical variables that presented technical constraints to the culture types were identified via a literature review in the commissioned report. These variables act on the ability to either deploy aquaculture

infrastructure or to undertake and maintain culture activity. Such environmental or physical variables can also influence species' biological distribution; for example, water current is necessary for water exchange around seaweed, but too much will overcome attachment. However, the physical variables above generally act as constraints on infrastructure before becoming biologically constraining.

The technical constraints identified were:

- bathymetry
- bottom substrate
- current speed
- peak wave height.

Raster data layers were used to map each of the constraints across the English marine area were. Threshold values of optimal, sub-optimal or unsuitable ranges (or classifications in the case of bottom substrate) of the constraints were included in table format within the commissioned report.

Conversion of variable data layers to suitability layers was conducted by the MMO. The rationale was to allow iterative modelling on technical constraints, to be undertaken in-house, based on stakeholder engagement and to allow for the introduction of new or improving technologies over time that might change the technical constraints and thus require the models to be re-run.

2.3.2 Preparation of species/culture type suitability layers

All modelling was conducted in ArcMap 10.2.2 and ArcPro 2.4. All data used and produced was projected in the ETRS 1989 geographic coordinate reference system with UTM Zone 30N.

All floating raster outputs from the commissioned report were converted to regular rasters, and then finally to vectors.

Vectors for the technical constraints were processed using definition queries with the aim of only displaying areas where conditions were optimal for each individual species/culture type combination, for example blue mussels/bottom culture, as per Table 1. Optimal extents were initially defined separately for each species for bathymetry, current speed, peak wave height and substrate type, based on the threshold values provided in the commissioned report. The intersect tool was then used to produce layers showing only areas where optimal conditions of all technical constraints overlapped. It should be noted that the optimal thresholds used sometimes only applied to a single species (current speed requirements were unique to sugar kelp), whereas others were common to a whole species group (peak wave height and bathymetry requirements were common to all suspended seaweed aquaculture).

The biological constraint vectors (as produced in section 2.2) were clipped using the newly produced optimal layers, therefore excluding technically suboptimal and unsuitable areas (Figure 1).

Distance offshore was used to constrain all data. Whist not strictly a technical constraint, distance offshore is a proxy for several economic considerations including fuel price, transit times, fish stock and price fluctuation, which can act as limiting factors to locating aquaculture developments. To ensure the outputs of this work adequately reflect the needs of the current, predominantly inshore status of the English aquaculture industry, the map outputs were limited to the inshore marine plan areas only, using the clip tool.

3 Planning Constraints

3.1 Definition of constraint types

The third component of the model considers other uses of the marine area, termed 'planning constraints'. Consideration of planning constraints was not in scope of the commissioned report. This section outlines the process undertaken by the MMO to identify and incorporate consideration of other activities in the marine area that may constrain the siting of an aquaculture development.

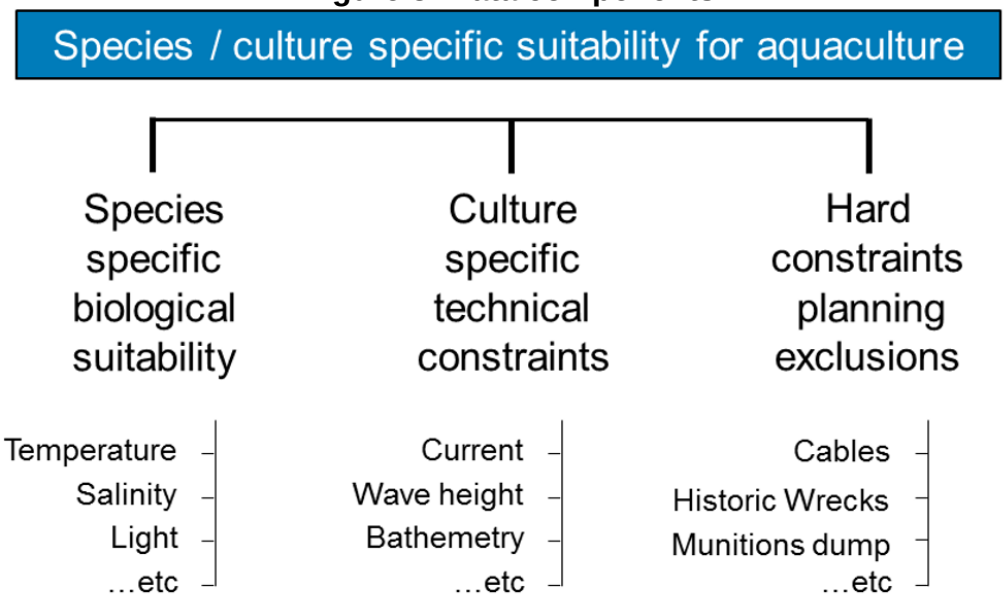
Planning constraints can be defined as either hard or soft constraints. Hard constraints exclude aquaculture from an area completely, for example in areas of fixed infrastructure for energy production, cables, or designated disposal sites. Soft constraints reduce the suitability of a particular location for aquaculture, such as International Maritime Organization (IMO) ship routes (shipping lanes), marine protected areas or areas of high recreational, commercial, or fishing vessel activity, where there may be greater competition for space.

Datasets for planning constraints fell into three categories based on the geometry type that dictated whether pre-processing of the data was required:

- point and line features e.g., wrecks, cables
- polygons e.g., Marine Protected Areas (MPAs)
- continuous datasets, e.g., Automatic Identification System (AIS).

Figure 3 demonstrates how planning constraints were considered alongside the existing biological and technical constraints in the construction of the final outputs.

Figure 3: Data components



3.2 Processing of constraints data

All data types were processed to the point that they could be treated as 'presence or absence' data. All datasets used, their sources and any treatment applied are described in Table 2.

3.2.1 Point and line features

Spatial data presented as point or line does not have a spatial footprint. Feature dependant buffers were applied around such datasets to create polygons. The extent of buffers applied depended on the dataset in question and the requirements of the relevant sector, such as accepted exclusion zones. The International Cable Protection Committee (ICPC) recommends that cables are given a buffer of 500m on either side, while a buffer of 500m is also used around offshore platforms, wind farms, cables and pipes in accordance with common practice and legislation. Buffers around (non-military) shipwrecks were based on the approach used by Cefas when producing resources for the Dorset aquaculture map of a 500m radius. Data sourced from the Oil and Gas Authority (OGA) was also processed to remove features that were either defunct, inactive or otherwise not current constraints to aquaculture development. This was informed by consulting guidance for applications for suspension of inactive wells.

3.2.2 Polygon data

Polygon data required minimal processing, this is again highlighted where relevant in Table 2, with details around buffers as described in section 3.2.1.

3.2.3 Continuous data

Data layers describing activity intensity included AIS data for commercial shipping. The same method used to produce the high density navigation routes layer as displayed on the MMO Explore Marine Plans webpage was used to map AIS data, with areas of high intensity activity or visibility considered less suitable for aquaculture, and areas of lower intensity, more suitable.

3.3 Application of constraint data

All polygons produced were combined and flattened using the merge tool to create a single presence or absence layer, which spatially represented planning constraints to aquaculture. Using the clip tool, the extent covered by this layer was removed from each of the species/culture type layers (Figure 1), ensuring that spatial constraints to aquaculture were fully accounted for in the data. Through exclusion of planning constraints from the aquaculture areas, the likelihood of future conflicts between marine users is reduced.

4 Model Building

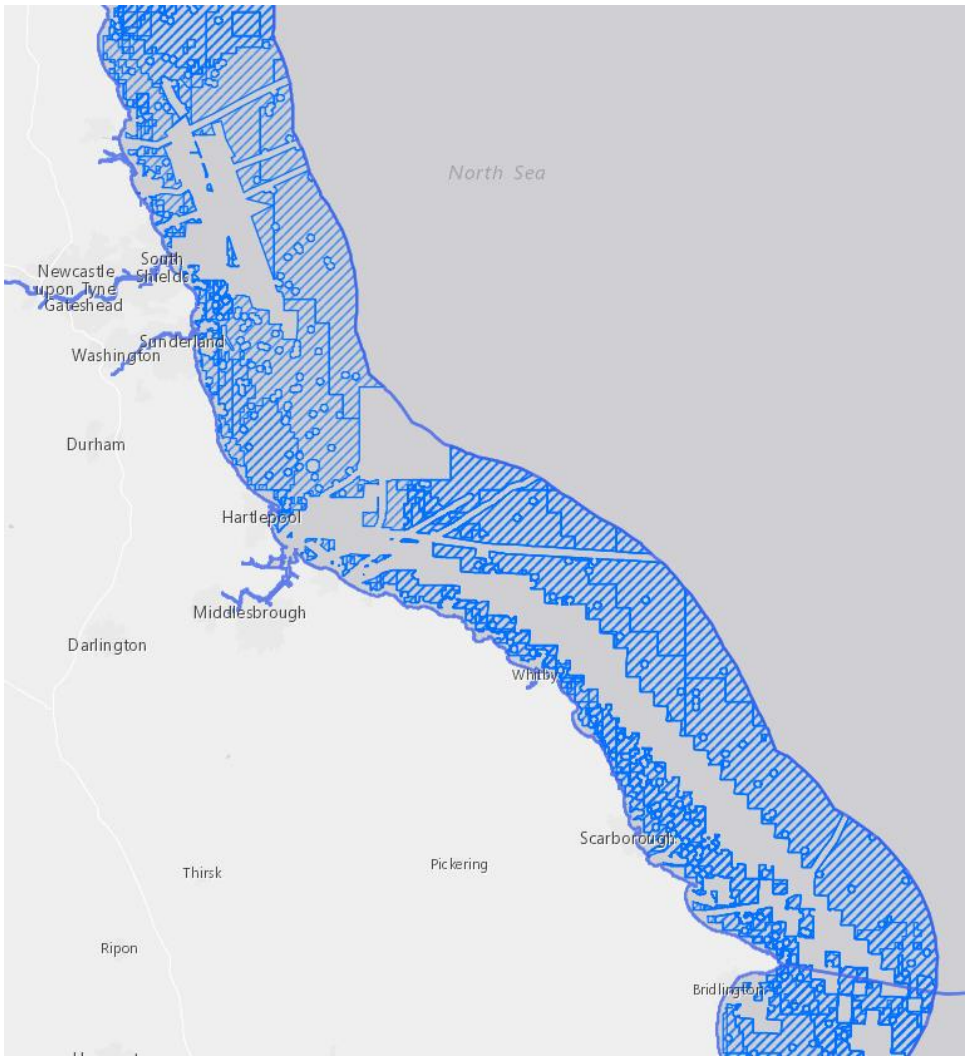
4.1 Final Aquaculture Suitability Layer

To produce the final strategic layer for use in policy AQ-1, all contributing species/culture combination files were merged.

The final list of outputs produced by this work include a single layer representing the strategic areas of sustainable aquaculture production, and a series of separate layers detailing areas where production of certain individual species, cultured via select methods (Table 1) can thrive.

Error! Reference source not found. shows a section of the final strategic layer, taken from the north east inshore marine plan area, with the full data displayed on the MMO Explore Marine Plans digital service.

Figure 4: Strategic areas of sustainable aquaculture production in the north east inshore marine plan area



5 Caveats, considerations and further actions

5.1 Caveats and cautions

This work identifies strategic areas for sustainable aquaculture production, with models returning outputs at 0.01 degrees. The resolution of input data varied given the diverse nature of datasets such as biological suitability, with a loss of precision when data was aggregated.

Important variables that influence site selection (such as water quality) were not considered as they are relevant at a finer spatial resolution than that used in this work. It would therefore be inappropriate to base any site level assessments solely on the outputs of this work.

Some soft planning constraints (Section 3.1), such as recreational and fishing activity were not excluded from the final strategic areas. While datasets can be identified to spatially represent these considerations (e.g., recreational boating areas), these activities do not necessarily exclude aquaculture from an area, and their inclusion in this work may preclude the possibility for future coexistence and sharing of space with aquaculture. The marine licensing process allows for consideration of such activities on an individual case-by-case basis.

Not all environmental variables are derived from observational data. To generate full spatial coverage of environmental variables, direct and indirect observational data was used, and, in some cases, this required further interpolation or the use of modelled data.

Data layers were treated independently of each other. This is particularly notable in biological layers where parameters classed as viable across a single variable may become non-viable in interaction with other variables. For example, temperature and dissolved oxygen tend to be inversely related with warmer temperature waters holding less oxygen. Increasing temperature also increases the biological demand for oxygen in the cultured species, thus both supply and demand pressures on dissolved oxygen may interact to reduce upper temperature tolerances.

There are biases towards including certain variables because data was available versus those for which data was poor, for example close inshore environmental data or water quality offshore or non-licensable activities distributions.

5.2 Further development, engagement and review

Models were based on the best available data at the time of publishing. The marine plan policies, which are informed by this work have a 3-year monitoring and reporting cycle, at the end of which, the need to amend policies may be considered. At present the marine plans reference strategic areas of sustainable aquaculture production in a way that enables outputs to be improved or changed independently from the plan review process, if a need is identified.

6 Implementation through marine plans

The outputs of the above modelling work support the implementation of aquaculture policies in the English marine area. The method follows an approach of identifying all optimal areas for species growth, then using various constraints to narrow these down, increasing spatial delineation to remove conflicts and identify the most strategic areas, and strengthening the protection for these through the implementation of marine plan policies in the decision-making process.

6.1 Iterative product development

A first draft of the strategic areas of sustainable aquaculture production and the associated layers was produced for publication with the draft consultation for the North East, North West, South East and South West Marine Plans, which ran between January and April 2020. Following the consultation, stakeholder feedback and additional communications with Cefas on the models were reviewed and used to refine the outputs published in April 2021. The work detailed in this report reflects the method used in producing the published layers.

6.2 Plan Implementation

The strategic areas of sustainable aquaculture production should be used to inform the implementation of policy AQ-1 in North East Marine Plans, North West Marine Plans, South East Marine Plans and South West Marine Plans. The policy requires that within existing or potential strategic areas of sustainable aquaculture production, all developers seeking to obtain a marine licence demonstrate consideration of, and compatibility with aquaculture. The data produced in this report fulfils the “potential” aspect of the policy; the wording of which applies within these areas only (i.e., not across the wider marine area). By following the wording of the AQ-1 policies, opportunities for future aquaculture are provided a degree of protection within these identified strategic areas. Through this, marine plans provide appropriate support for the aquaculture industry.

In addition to the strategic layer, individual species/culture type layers (Section 2.3.2) are also provided. Whereas the strategic layer is comprised only of optimal areas, these species layers also include suboptimal areas. These were excluded from the process of producing the strategic areas due to the much larger extent they cover. Species/culture type layers may however be of interest to potential developers, so are provided separately. It should be noted that these layers are only provided as additional information, and do not provide any weighting or influence under the aquaculture policies.

Although the marine plans provide support for aquaculture within the identified strategic areas, aquaculture developers are not obligated to locate their developments within either these. The project outputs can be used to inform site

selection based on the detailed considerations in this report, though the primary purpose remains in supporting the implementation of AQ-1.

The outputs of this report are intended to compliment and potentially inform more local investigations into aquaculture site selection; these are covered in the next section of this report.

6.3 Complimentary localised mapping approaches

The English Aquaculture Strategy identified the marine plans as one of the major policy drivers for future aquaculture growth:

> "*Marine Plans and their more detailed local interpretation will be the primary mechanism for identifying areas for potential sustainable growth in marine aquaculture production – this will enable more focused investigation and the most suitable location(s) for a particular species and/or culture method to be identified.*" (p.8)

As stated in section 5.1, the methods in this report have followed a relatively broad-scale approach, excluding more detailed localised data considerations that could not be accurately represented at this scale. Section 6.2 outlines how the data responds to the AQ-1 policy, ultimately in line with Section 58(1) of the Marine and Coastal Access Act 2009, directly informing the marine plan documents under which authorisation and enforcement decisions are made.

In addition to obtaining a marine license, there are many localised considerations to account for when obtaining the necessary permissions for an aquaculture development. To help understand these and to aid the local siting of aquaculture developments, a complimentary mapping project has been undertaken by Cefas in the Dorset and East Devon FLAG (Fisheries Local Action Group) area. The subsequent mapped outputs and report can be accessed using Dorset Council's Aquaculture Map. The data can be used by developers in the Dorset area to aid localised site selection, as it takes variables such as water quality into account. The MMO modelling described in this report and the local FLAG modelling are complimentary; fulfilling similar but subtlety different functions, and at different scales, and should be used together as part of the wider process of locating aquaculture developments.

6.4 Relation to previous evidence projects

The area of study covers the entire English marine area. This includes the east and south marine plan areas, for which strategic areas of sustainable aquaculture production[1] were defined in a previous evidence project (MMO1040). MMO1040

[1] Areas were referred to as "identified areas of potential sustainable aquaculture production" in the South Marine Plan and as "sustainable aquaculture development sites" in the East Marine Plans.

followed a similar process of spatial modelling as undertaken in this report (MMO1184), but this report updates and expands the previous models including:

- expanding the model to consider the entire English marine area
- expanding the data used in the models to improve outcomes
- providing both a single layer for use in policy implementation, and a breakdown according to individual species/culture types
- using recent data to improve timeliness of models
- utilising stakeholder feedback obtained during the marine plan consultation working at a species (rather than taxon group) resolution.

MMO1184 completely supersedes MMO1040, which will no longer be presented on the MMO Explore Marine Plans digital service. However, MMO1040 data will still be available on the Defra Data Services Platform to support transparency for legacy decision making. MMO1184 data will become applicable across all plan areas.

Table 2: Constraints represented as presence/absence data

Sector	Dataset	Originator	Updated	Source*	Treatment
AGG	Aggregate application areas	TCE	16/08/17	[internal] MMO.Aggregate_App_Areas_GB_TCE	
AGG	Offshore Minerals Aggregates Site Agreements	TCE	06/01/21	https://opendata-thecrownestate.opendata.arcgis.com/datasets/thecrownestate::offshore-minerals-aggregates-site-agreements-england-wales-ni-the-crown-estate?geometry=-1.389%2C51.309%2C3.838%2C51.906	Production Agreement Area & Exploration and Option Area
CAB	Cables	KIS_ORCA	20/12/18	[internal] Thinned Renewable Installations - Sea Fish Industry Authority (KIS-ORCA)	"STATUS" = 'Active' OR "STATUS" = 'ACTIVE' OR "STATUS" = 'INACTIVE' OR "STATUS" = 'PROPOSED' OR "STATUS" = 'UNDER CONSTRUCTION' Buffer 500m
CAB, OG	Offshore Installations (cables & pipelines)	UKHO	20/12/18	[internal] SO_OffshoreInstallations_line	Cable duplicates removed Buffer 500m
DD	UK Disposal Site Layer	Cefas	19/09/20	http://data.cefas.co.uk/#/View/407	
DEF, HER	Military Protected Wrecks	MOD	19/03/10	[internal] protected_wrecks_MOD	Buffer 500m
DEF	Munitions Disposal Sites	MOD	06/03/11	[internal] Munitions_Disposal_Disused	Buffer 1000m

DEF	Munitions dumping grounds	UKHO	05/01/15	[internal] ActivityAndLicence_A_UKHO	
HER	Protected Wreck Sites and War Graves in England	HE	16/01/15	[internal] protected_wreck_sites_HE	
HER	Shipwrecks and Obstructions	HE	11/12/20	https://datahub.admiralty.co.uk/portal/apps/sites/#/marine-data-portal/items/a46e1c0d912d459fbaf723c347ee9b78	Buffer 500m
OG	Oil & gas safety zones	CDA	01/07/15	[internal] Safety_Zones_Oil_Gas_CDA	
OG	Pipelines	UKHO	15/03/21	https://data-ogauthority.opendata.arcgis.com/datasets/pipelines-etrs89	"STATUS" = 'ACTIVE' OR "STATUS" = 'PRECOMMISSION' OR "STATUS" = 'PROPOSED' OR "STATUS" = 'NOT IN USE' Buffer 500m
OG	Subsurface Infrastructure	OGA	15/03/21	https://data-ogauthority.opendata.arcgis.com/datasets/surface-infrastructure-etrs89	"STATUS" = 'ACTIVE' OR "STATUS" = 'PRECOMMISSION' OR "STATUS" = 'PROPOSED' OR "STATUS" = 'NOT IN USE' Buffer 500m

OG	Surface Infrastructure	OGA	15/03/21	https://data-ogauthority.opendata.arcgis.com/datasets/subsurface-infrastructure-etrs89	Buffer 500m No abandoned infrastructure in English EEZ
OG	Oil and gas wells	OGA	15/03/21	https://data-ogauthority.opendata.arcgis.com/datasets/offshore-wells-etrs89	"ORIGINSTAT" = 'Present' AND "WELLOPSTAT" <> 'Suspended' Or "COMPLESTAT" = 'Plugged' Buffer 500m
PS	High Density Navigation Routes	MCA	2015	[internal] AIS	Top 10% of ship density definition query
PS	Traffic Separation	UKHO	05/01/15	[internal] Transportation and Routes (Polygon) (UKHO)	
REN	Offshore Installations (OWF cable areas)	UKHO	20/12/18	[internal] SO_OffshoreInstallations_polygon	
REN	Offshore Tidal Stream Site Agreements	TCE	12/05/20	https://opendata-thecrownestate.opendata.arcgis.com/datasets/thecrownestate::offshore-tidal-stream-site-agreements-england-wales-ni-the-crown-estate?geometry=-45.498%2C48.068%2C38.130%2C57.342	
REN	Offshore Wave Cable Agreements	TCE	12/05/20	https://opendata-thecrownestate.opendata.arcgis.com/datasets/thecrownestate::offshore-wave-cable-agreements-england-wales-ni-the-crown-estate?geometry=-5.992%2C50.197%2C-5.066%2C50.351	

REN	Offshore Wave Site Agreements	TCE	12/05/20	https://opendata-thecrownestate.opendata.arcgis.com/datasets/thecrownestate::offshore-wave-site-agreements-england-wales-ni-the-crown-estate?geometry=-12.861%2C49.164%2C1.960%2C51.615	
REN	Offshore Wind Site Agreements	TCE	13/01/21	https://opendata-thecrownestate.opendata.arcgis.com/datasets/thecrownestate::offshore-wind-site-agreements-england-wales-ni-the-crown-estate	
n/a	Nuclear Powerstations	BE	19/04/06	[internal] Nuclear_Power_Stations_GB	Buffer 500m

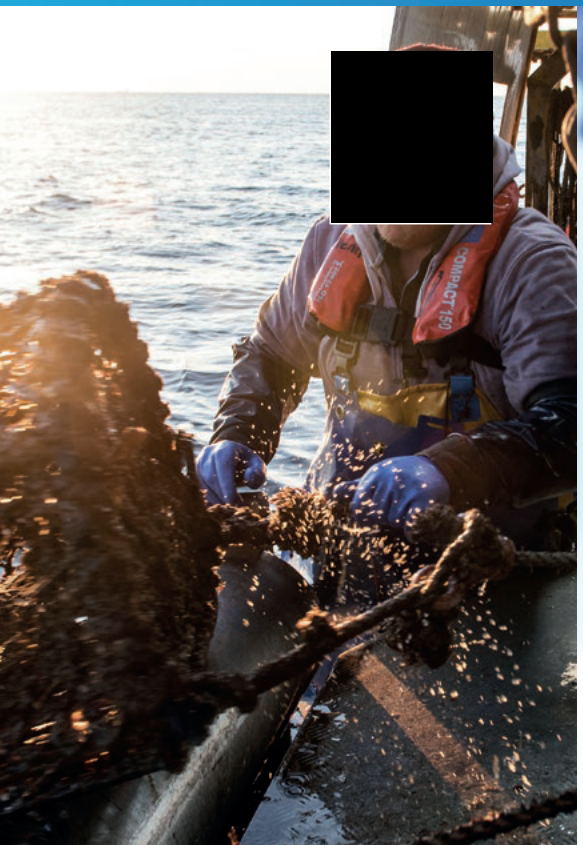
* sources include either names of internal datasets or URLs for data sourced externally

ANNEX 2

Seafood 2040 – A Strategic, Collaborative Seafood Alliance for England (32pp)

SEAFOOD 2040

A strategic, collaborative seafood initiative for England



The future is thriving and sustainable

Pictured: Female lobster found during a tagging project, Isles of Scilly.

Contents

The SF2040 Programme is facilitated by Seafish and funded through the Fisheries & Seafood Scheme managed by the Marine Management Organisation.

Minister's Foreword

Seafood is part of our national identity. The United Kingdom is surrounded by an ocean that provides incredible natural resources supporting jobs, products, and food supply. Inland, the freshwater lakes and rivers across England provide further high-quality aquatic products. We should all be proud that thousands of people work within these waters and serve as stewards of the marine and freshwater environment.

Pictured: A trawler returning to harbour, Dorset.

Without a doubt, the English seafood industry is important for economic growth and ensuring we have reliable access to a sufficient quantity of affordable, nutritious food. The Seafood 2040 (SF2040) Strategic Framework builds on this understanding and is an excellent foundation for the future security of a sustainable industry. Emerging from the impacts of COVID-19 and fully realising the opportunities resulting from our newfound status as an independent coastal State will take time. It will require resilience and adaptation. The SF2040 framework is one initiative that supports the English seafood industry as it recovers from a global pandemic and moves closer to a thriving and sustainable future. It is a collaborative initiative between government and industry, imbued with a shared vision of increased seafood consumption within England, domestic and export market growth, and building back stronger with knowledge and innovation.

In the first two and a half years, SF2040 has published an English Aquaculture Strategy, a bold and aspirational approach and delivery plan for the sustainable development of English aquaculture. The Programme delivered research on the training and recruitment challenges faced by the English seafood industry with Recommendations for improvement.

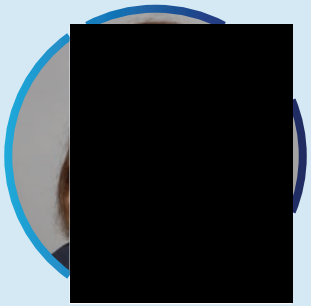
The Seafood Industry Leadership Group (SILG) ably guides the Programme and consists of members from across the entire seafood supply chain plus government. I welcome that this representation ensures a holistic view from catch and farm to plate.

The Seafood 2040 Programme is the first step in a longer journey. With their revised framework consisting of meaningful and direct action that supports the flexibility that will be required, I am confident of the English seafood industry's ongoing success.

I would like to thank the SF2040 SILG, the SF2040 Aquaculture Leadership Group, and the Sea Fish Industry Authority (Seafish) for their efforts and support. This strategic framework and its supply chain approach is an important vehicle for government and industry as they collaborate to ensure a thriving and sustainable English seafood industry.

[redacted]

Victoria Prentis
Minister for Farming, Fisheries and Food



Chair's Introduction

This is the first time that the Seafood Industry Leadership Group (SILG) has taken the Recommendations for the Seafood 2040 Programme through a refresh exercise. The original Recommendations were developed through a comprehensive consultation exercise led by the previous Chair Alison Austin OBE, and published in 2017. Since then, it is clear that there are a number of significant changes to the seafood industry both at home and abroad, not least the impacts from both Brexit and the COVID-19 pandemic.

Pictured: Boats tied up at Mevagissey, Cornwall.

In addition, the Programme has already delivered against some of the original Recommendations, necessitating some reflection on where to target resource in order to gain best impact for the sector.

We have been incredibly fortunate to have the enormous experience, expertise and foresight of the SILG to draw on in this exercise, and our thanks go to every member for their comments, input and suggestions in developing this revised delivery plan.

The SILG brings together knowledgeable government and industry representatives from across the entire English seafood supply chain. SILG members are from the fisheries, aquaculture, processing, retail and foodservice sectors, so the refresh presents a holistic view of the current priority issues in English seafood. That those priorities reflect the thoughts of both government and business is a great strength of the SF2040 Programme.

We also extend our thanks to Seafish for the ongoing support to this important work, and the many individuals within that organisation who have consistently provided high quality advice across a range of relevant topics.

There is much to do to secure long-term productivity across the seafood sector in England, and the text of the Recommendations will be developed into actions in order to enable delivery against the priorities via a series of projects and links to other work. Many partner organisations and initiatives are working in the same space, particularly Seafish and Defra, and we look forward to working with many experts across the various organisations to the benefit of business, the consumer and the environment.

The SF2040 Programme is founded on the principles of best practice, collaboration, communication, and science, innovation and technology. We all look forward to building on these foundations to secure the thriving and sustainable industry that is the aim of the Programme.

Dr Neil Auchterlonie
Chair, Seafood 2040

The Seafood 2040 Strategic Framework

The Seafood 2040[1] (SF2040) Strategic Framework is an England-only, ambitious and shared Programme with clear opportunities across the seafood supply chain. It is a collaboration between government and industry.

Stakeholders from across the English seafood supply chain, government and regulators work together through the now established Programme in pursuit of a single, compelling vision: **a thriving and sustainable English seafood industry by 2040.**

1 SF2040 Strategic Framework: www.seafish.org/article/seafood-2040

Pictured: Hauling pots, Northumberland.

The origins date back to a request from the former Fisheries Minister, George Eustice, MP, in 2016 to contribute to a Defra food and farming strategy. This was subsequently fleshed out further by Alison Austin OBE and key industry and government stakeholders into the SF2040 Strategic Framework for England. The original document sets out a vision for a thriving seafood industry, the potential size of the prize, and 25 Recommendations for implementation.

SF2040 is not an organisation, but an umbrella strategy. Its value is twofold – firstly raising awareness of seafood and keeping it in the forefront of policy makers minds, and secondly as a way of consolidating the diverse activity being driven by a wide variety of actors from private companies to industry organisations and from Defra and other government departments to other public bodies.

The SF2040 Programme acts as a thread that binds together this activity and positively frames the seafood value chain within the wider food and drink sector as well as contributing to government strategies on the economy and environment. Seafish facilitates the implementation of the framework in partnership with Defra and the English seafood industry through Marine Management Organisation grant schemes. We are thankful for the ongoing support to this crucial work.

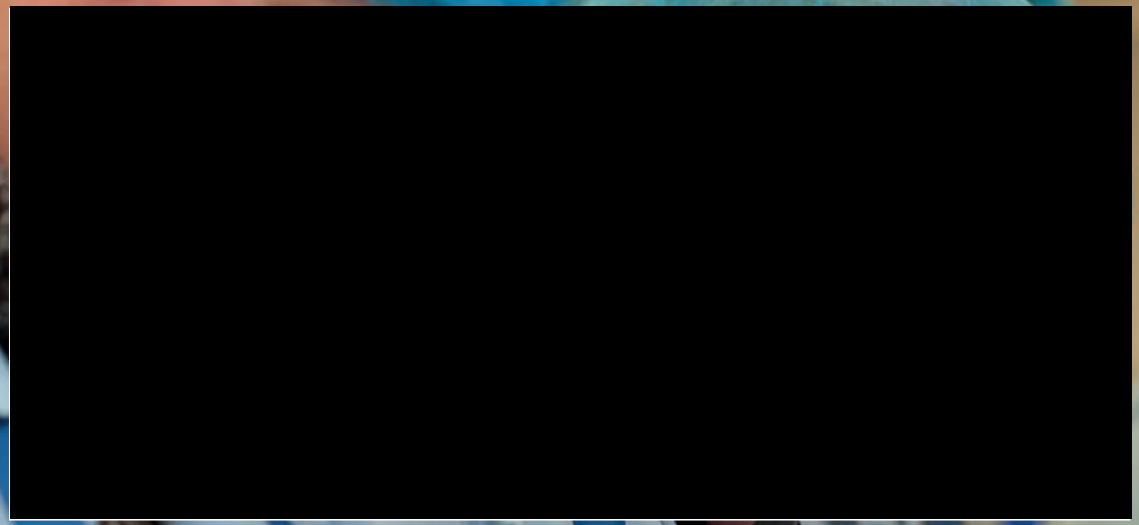
The SF2040 Refresh

In 2020, several of the original Recommendations had been achieved, such as Recommendation 1, the establishment of the Seafood Industry Leadership Group (SILG) and Recommendation 4, the development and dissemination of seafood nutritional profiles. Also, we recognised that the external landscape had significantly changed since the framework was first published in 2017.

Notwithstanding the global pandemic and the transition from an EU member to an independent coastal State, a review was necessary to ensure ongoing relevance to both industry and government and to consider new opportunities to take forward. Therefore, we reassessed the Objectives and Recommendations for 2021 in an effort to better support the English seafood industry as it emerges from COVID and the EU-Exit transition. Seafish, Defra, the SILG, the SF2040 Aquaculture Leadership Group (ALG), and industry experts were consulted. The year-long exercise culminated in a refreshed framework of 19 Recommendations that continue to support the entire English supply chain with meaningful actions. **This document is the result – the refreshed SF2040 Strategic Framework.**

The Ambition

Our ambition is to see a seafood industry that is sustainable and thriving – where a whole supply chain approach has fostered collaborative working practices, whilst celebrating the diversity of our different sectors and regions. And one where seafood is highly valued, driving consumption figures at home and export sales abroad; and where science and a supportive regulatory framework enable innovation and best practice from catch and farm to plate.



Pictured: Processing mackerel.

The Vision and Priorities

The Vision: A thriving and sustainable English seafood industry by 2040

Driving the vision are three priorities:

Priority 1

Maximise sustainable wild catch opportunities

Landing fish.

Priority 2

Grow a sustainable aquaculture sector

Farmed trout, courtesy of ChalkStream Trout Ltd.

Priority 3

Enable business growth

Staff from Dorset Cleaner Fish Ltd at work, courtesy of Dorset Coast Forum and Butterfly Effect Films.

The Objectives and Foundations

By achieving the following Objectives, the SF2040 vision of a sustainable and thriving English seafood industry can be realised.

Objective 1 (Primary)

Seafood consumption increases towards recommended levels with recognition of seafood's nutritional benefits

Objective 2

Wild catch fisheries are verifiably sustainable and productive, supporting coastal community resilience.

Objective 3

Significant growth has occurred in freshwater and marine aquaculture in production volume, jobs and numbers of farms.

Objective 4

Business growth is enabled by infrastructure improvements across the supply chain.

Objective 5

Opportunities for exports and imports have increased as a result of improvements in international market access.

Objective 1 (Primary)

The most recent data available from the Defra Family Food datasets states that England's seafood consumption was 161 grams per person per week in 2019[2]. NHS England recommends 280 grams per person, per week[3], or two portions per person, per week.

Thus, there is further work to encourage families and households to eat more seafood protein and this framework is one such mechanism alongside other long-term initiatives like Love Seafood by Seafish[4] and the development of an England National Food Strategy.

Objectives 2-5 (Secondary)

The SF2040 framework supports fisheries, aquaculture and processing growth. Both import and export markets are recognised as valuable for all sectors. There is room for increased seafood consumption across England including the increase of domestic fish consumption as well as improving the opportunities for export and import seafood expansion.

Policy discussions and planning for global and domestic food security are already occurring. The need for equitable access to healthy, sustainable food, which should include fish and other seafood products, will only increase. England's seafood industry has a role to play.

The Foundations

SF2040 is founded on collaboration. Research, projects, and conversations are already underway via government and industry to support the English seafood industry. It is important to make best use of limited budgets and avoid duplication of effort where possible.

In addition, best practice, and science, innovation and technology, are important foundations both domestically and internationally. Our industry is reliant on imports and exports as well as a knowledge economy which is also exported internationally. There are Recommendations that specifically encourage these elements, and the Seafish Expert Panel Chair has a permanent seat on the SILG.

Over the course of the first three years of the SF2040 Programme, it became apparent that communication of the work already underway and connecting it to the vision of a thriving and sustainable seafood industry is an important part of what we do. Therefore, we added it as one of the Programme's foundations.

- Collaboration
- Best Practice
- Science, Innovation, and Technology
- Communication

2 Family food datasets – GOV.UK. The 161 grams is the summation of UK household seafood purchases + UK eating out seafood purchases. The current data includes up to 2019. The 2020 data are available October 2021: **www.gov.uk/government/statistical-data-sets/family-food-datasets**

3 Fish and shellfish – NHS: **www.nhs.uk/live-well/eat-well/fish-and-shellfish-nutrition**

4 Love Seafood: **www.loveseafood.co.uk**

Delivering the SF2040 Programme

Pictured: Unloading a catch of mackerel, Newlyn, Cornwall.

The Secretariat

The Programme is led by the SF2040 Secretariat, Dr Neil Auchterlonie, Chair, and Kimberly Cullen, Manager. The Secretariat is the custodian of the SF2040 Programme and the Recommendations, and is responsible for delivery. The Secretariat connects organisations working for mutual benefit in support of the SF2040 Recommendations.

Seafood Industry Leadership Group (SILG)

SILG represents all the English seafood sectors, as well as public bodies, and oversees Programme delivery. The value of this group is in its broad representation, providing the strategic ambition to drive SF2040 in partnership with Seafish, Defra, and other public and private organisations in order to achieve the vision of a truly thriving seafood industry.

The SF2040 Seafood Industry Leadership Group

Chair: Dr Neil Auchterlonie

SF2040: Kimberly Cullen

Catching: Chloe Rogers, UK Association of Fish Producers Organisations; Paul Trebilcock, Cornish Fish Producers Organisation (until July 2021); and Andrew Locker, National Federation of Fishermen's Organisations

Catching – Wild shellfish: Jim Portus MBE, South Western Fish Producers Organisation

Aquaculture: James Fox Davies, Fowey Shellfish Ltd & SF2040 Aquaculture Leadership Group Chair

Processing: Stuart Price, Nomad; Nathan de Rozarieux, Falfish Ltd; and Nigel Edwards, Hilton Food Group

Retail: Ally Dingwall, Sainsbury's

Science: Dr Mark Berry, Seafish Expert Panel Chair

Young Seafood Leaders Network: Cameron Moffat, Youngs Seafood

Government: Nicola Robinson, Marine & Fisheries Division, Department for the Environment, Food & Rural Affairs (Defra)

Non-Departmental Public Body: The Sea Fish Industry Authority (Seafish) Executive team

Foodservice: Sarah Phillips, M & J Seafood

The SF2040 Aquaculture Leadership Group (ALG)

The purpose of the ALG is to champion and progress the SF2040 Recommendations relating to aquaculture and the actions within the English Aquaculture Strategy on behalf of the SILG.

The value of this group is in:

1. providing the strategic and operational drive to advance SF2040 in partnership with Seafish, government and other relevant organisations in order to reduce bureaucratic and regulatory barriers to aquaculture growth, innovation and productivity;
2. focusing on aquaculture improvements that are pragmatic in the short and long-term;
3. driving localised land and sea stakeholder engagement; and
4. enabling real change to support the shellfish industry to expand within realistic conditions.

The SF2040 Aquaculture Leadership Group

Chair: James Fox Davies, Fowey Shellfish, Ltd

SF2040: Kimberly Cullen

Finfish: Oliver Robinson, British Trout Association

Shellfish: David Jarrad, Shellfish Association of Great Britain; John Holmyard, Offshore Shellfish, Ltd; and Kelsey Thompson, Morecambe Bay Oysters

Aquaculture industry: Martin Syvret, AquaFish Solutions, Ltd

Macroalgae: Angela Mead, Biome Algae, Ltd

Government: Ruth Allin & Sara Catahan, Department for the Environment, Food & Rural Affairs (Defra); and Dr Stuart McLanaghan, The Sea Fish Industry Authority (Seafish)

Regulator: Roger Covey & Robert Whiteley, Natural England; Michael Gubbins, Centre for the Environment, Fisheries and Aquaculture Sciences (Cefas); and Dr Christopher Sweeting (Evidence), Jennifer Ford (Licensing), and Benjamin Coppin (Marine Planning), Marine Management Organisation

Aquaculture academia: Dr Lewis Le Vay, Bangor University

Delivering the SF2040 Ambition

The SF2040 Programme has been active since September 2018. Throughout this time, and with the support of the SILG and the ALG, progress has been made against the original 25 Recommendations. The seafood industry is highly dynamic, and with the obvious impacts of a changing world due to events like the COVID pandemic and the EU-Exit, the Programme is required arguably now more than ever to facilitate long term, strategic development.

This 20-year framework is of the utmost importance, and often overlooked, when an industry suffers from the challenging impacts in the here and now. Many of the SF2040 Recommendations are to be realised over a decades-long timescale, therefore, it can be easy to disregard such work when the very real priorities of producing and selling seafood during a pandemic and the EU-Exit transition require the full attention of many of our colleagues. This SF2040 refresh during a difficult time makes the contributions of those on SILG and ALG – industry and government – all the more valuable. Their meaningful contributions to updating the Recommendations help to secure the relevance of the SF2040 Programme and the longer-term sustainability of our industry.

In addition to those more obvious impacts we also have a range of other more recent factors including the publication of the Fisheries Act in 2020 (providing opportunities for how the UK will manage fisheries and aquaculture as an independent coastal State), the development of a National Food Policy, Blue Growth agenda (both in the UK and abroad), climate change mitigation and carbon net zero targets, and a widespread recognition of the importance of aquatic protein both in terms of diet and low comparative environmental impact. All this, and more, fed into the SF2040 Recommendations refresh exercise.

The Refreshed Recommendations

All 25 original Recommendations were reviewed throughout 2020 to ensure the Programme continues to be relevant to both government and industry. Stakeholder engagement with SILG and ALG, Defra and Seafish teams, and industry experts guided the Secretariat in consolidating down to 19, losing nothing of our coverage in doing so. The SF2040 Secretariat will continue to work with SILG, ALG and other government and industry partners to progress these Recommendations and integrate where work is already underway. The refreshed 19 Recommendations are meaningful actions that support the English seafood industry as they move toward a thriving and sustainable future.

Foundation Recommendations

(best practice, science, nutrition, environment)

1

Maintain the Seafood 2040 Programme to continue supporting England's industry toward a sustainable and thriving future by 2040.

1. Expand SF2040's value of supply chain alignment and government and industry collaboration through facilitation, communication and bringing separate work streams into one vision.
2. Continue to progress the delivery plan within the Strategic Framework and ensure relevance.
3. Work with the SF2040 SILG and ALG and a range of stakeholders to develop and enhance relationships with government representatives to improve awareness and understanding of England's seafood industry.

Further information:

- Participants: SF2040 – SILG, ALG and Secretariat.

2

Progress the activities identified by stakeholders as important for the development and improved understanding of the England seafood industry's science, innovation and technological needs.

1. Identify and map research and innovation needs across England's seafood supply chain.
2. Engage with academia and funding bodies to communicate industry research and innovation needs, highlight topics of industry importance, engage relevant funding bodies and target key academic institutions to help deliver.
3. Secure funding to support business growth within England's seafood supply chain, especially through the adoption of innovation and new technology.
4. Improve awareness of public sector funding opportunities within the seafood industry; encourage industrial organisations to form collaborative partnerships with academia and funding bodies.

Further information:

- Will require funding to achieve the activities.
- Participants: SF2040 SILG and Secretariat, and the Seafish Expert Panel.

3

Consult industry and other relevant parties to map best practice across the English seafood supply chain for catching, aquaculture and processing activities and identify gaps and assess importance. In particular, highlight industry practice that supports the sustainability agenda and resilience in continuity of supply. The purpose of the exercise is to provide evidence that encourages England's supply chain to commit to and employ best practice.

1. The assessment of best practice should include the following: operational efficiency of all production processes, food safety, training, safety, environmental sustainability, and traceability; include reference to current industry standards and other relevant benchmarks; and be advisory in nature rather than mandatory.

Further information:

- Will require funding to commission mapping exercise.
- Outputs to include a series of benchmarking and guidance reports providing information on the industry's activities (and future activities via horizon-scanning) including suggestions / recommendations for change over time where that may be beneficial.
- Approach should take into account examples of best practice from around the world, identify what may be appropriate for the English industry and seek to apply that knowledge.
- Participants: Fisheries, Aquaculture, and Processing sectors; Wholesalers and retailers; Standard bodies; Seafish; Defra.
- Linked to Recommendation 15.

4

Review and compare the nutritional benefits of English wild catch and aquaculture to other protein-rich foods (e.g. beef, pork, lamb, poultry) and include processed foods containing new protein ingredients such as plant-based and cell-culture proteins. A fact-based narrative of seafood's nutritional benefits is important to understand and track in order to communicate its role in a healthy lifestyle.

Further information:

- Funding required to commission and achieve the review.
- The resulting output should include where seafood sits in an overall healthy diet supported by science.
- Linked to Recommendations 6 and 7.
- Participants: SF2040 SILG and the SF2040 Secretariat.

5

Provide an overview of the environmental performance of English seafood production for national fisheries, aquaculture and processing sectors. This work will support progress towards carbon neutrality in the English seafood industry and UK Government's drive to bring all greenhouse gas emissions to net zero by 2050. Using the LCA-type (Life Cycle Assessment) approach that addresses broad areas of environmental impacts, this will cover fish stocks in English waters, aquaculture systems in England, processing, and distribution.

The LCA approach will take a standard approach that looks at:

- Raw Material supply
- Manufacturing & Processing
- Transportation
- Usage & Retail
- Waste Disposal

Further information:

- The analysis should look at factors that affect GHG emissions and other impacts including energy consumption, water use, chemicals use, etc., through product life cycles taking the recognised "cradle-to-grave" approach.
- Outputs to be a series of reports of the analyses undertaken. This information will be used to provide detail of how domestic seafood product compares to the performance of other products in the marketplace, communicated in support of achieving both increased consumption of domestic product, as well as progress towards the two portions of seafood consumption per week target. Opportunities for improvements should be identified, and where appropriate plans made to address these specific areas.
- Funding is required and could come from multiple potential sources, including: FaSS, Research Councils and Defra.
- Possible partners include: universities, Seafish, Cefas, CIEL, processors, and retailers.

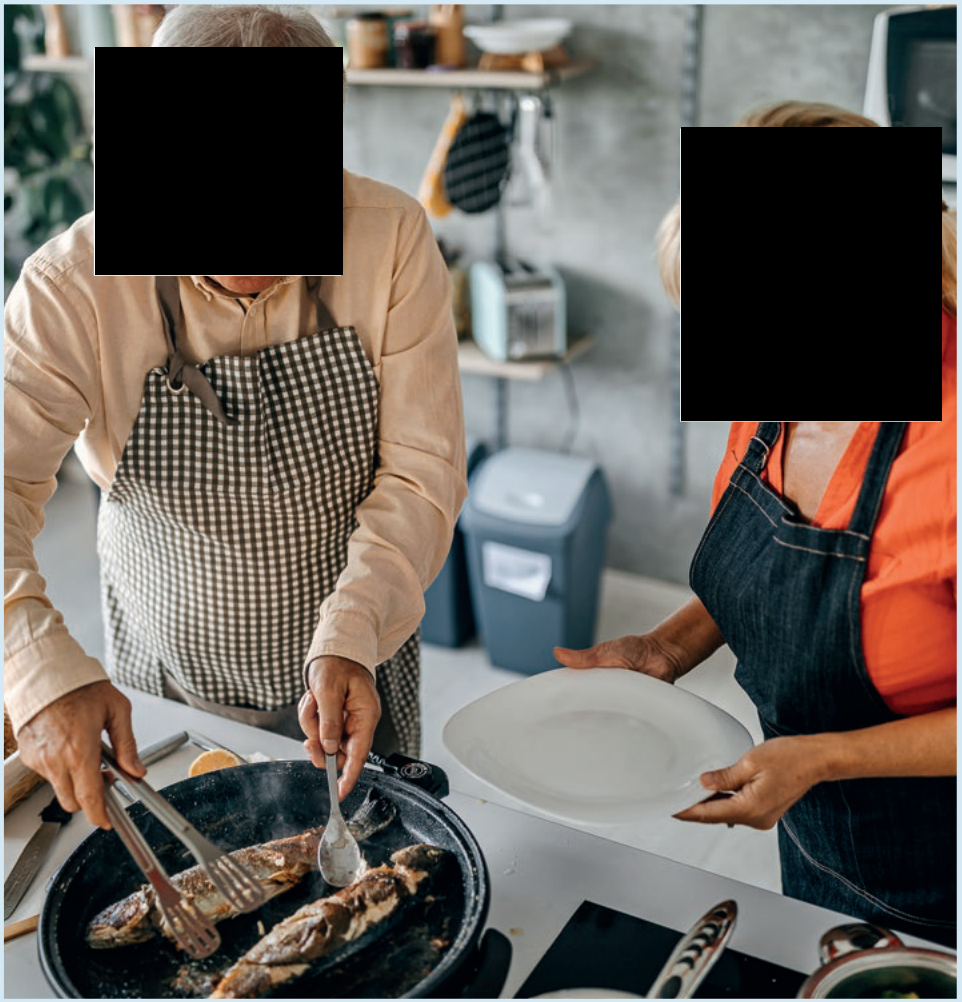
6

Estimate the socio-economic impacts (e.g. government budgets and population health) of a shift to consumption rate of two portions of seafood a week in England. Impacts to include changes in the leading causes of death in England, e.g. cardiovascular health, dementia, etc.

1. Validate and build on the research already delivered against Recommendation 6 in 2020 for cancer and Type-2 diabetes.
2. Investigate effects of increased seafood consumption, by demographic group, in relation to a range of wellness indicators.

Further information:

- Linked to Recommendations 4 and 7.
- Funding required to commission and achieve the research.
- Participants: SF2040 SILG and the SF2040 Secretariat.



Marketing Recommendations

7

Continue to build on the shared understanding of the barriers and opportunities around seafood consumption growth as developed by Seafish and communicate the findings with partners. Support Love Seafood by Seafish with English national, regional and / or local-level initiatives, projects and campaigns that promote the seafood industry including any government or industry export strategies.

Further information:

- Linked to Recommendations 4 and 6.
- Participants: SF2040 SILG and the SF2040 Secretariat, Seafish.
- Possible partners: Local Enterprise Partnerships, Local Councils, Producer Organisations, etc.

8

Explore options that will support a domestic market demand for a wider variety of English-caught species and farmed fish and shellfish.

1. Investigate potential domestic market opportunities for underutilised and undervalued species in the UK market.
2. Develop a common approach to marketing less well-known species where consumer acceptance could be achieved, working with retail, foodservice and public sectors.
3. Explore whether mutual benefit between the tourism and heritage sectors and the primary fishing and seafood sectors can be achieved.

Further information:

- Linked to Recommendations 7 and 15.
- Funding required to commission and achieve the research.
- Outputs include detailed reports providing an overview of the issues, including recommendations for where domestic market opportunities may be strengthened.
- Participants: SF2040 SILG and the SF2040 Secretariat, Seafish.

Catching and Aquaculture Recommendations

9

Help to maximise the potential benefits of the economic link license condition* for coastal communities and the wider seafood sector by working collaboratively with Defra, MMO and wider industry to:

1. Consider what more can be done to utilise resources better and reflect on the effectiveness of the changes being introduced from 2022; and
2. Identify what opportunities there may be to extend the existing framework and support investment in measures to enhance the sector such as skills and training, scientific research, and new entrants.

Further information:

- This Recommendation is primarily led by Defra. The SF2040 Programme will support government in their efforts.
- Participants: Defra, Producer Organisations (POs).

* The economic link license condition requires vessels fishing against the UK allocation of quota to demonstrate a real economic link, or benefit, to the UK by for example, landing their catch into UK ports. Defra held a public consultation in 2020 seeking views on a new proposal to strengthen the economic link condition in England.

10

Support England's seafood industry and government implementation of the Fisheries Act 2020.

1. Facilitate and support the aims of the Fisheries Act in relation to fisheries and aquaculture management. Collaborate with government and industry and help to maintain a platform for ongoing engagement including the identification of funding sources and the commission of projects.
2. Encourage co-management between the catching sector, aquaculture sector, regulators, government, and the supply chain.

Further information:

- The SF2040 Programme can organise and facilitate workshops across government and industry as well as compile and communicate information and findings.
- Participants: Defra, Seafish, industry and SF2040 SILG and Secretariat.

11

Work with Producer Organisations (POs) to build on their strengths, and improving where necessary and exploring potential for new responsibilities

1. Where appropriate, consult POs on negotiations and agreements impacting fishing opportunities.
2. Ensure fit for purpose regulation and effective enforcement underpins a level playing field and high standards.
3. Consider the potential of extending the role of POs beyond what is set out in the CMO Regulation. Broaden the conversation across the supply chain as all have an interest in POs. Work to determine with partners and supply chain what a potential extended role could look like e.g. increasing accountability, transparency, marketing, and making public how they manage their quota.

Further information:

- This Recommendation is Defra led and the SF2040 Programme offers support.
- Linked to Recommendations 8, 9, 10, 13, 15 and 16.
- Participants: Defra and the Association of Fish Producer's Organisations.

12

Enhance the now established SF2040 Aquaculture Leadership Group (ALG) in its efforts to more widely represent English aquaculture, to encourage innovation and technology, and to support export and domestic growth. Provide strategic vision and support to enable the expansion of aquaculture. Aim to strengthen relationships between academia, industry, government, and regulators, and encourage collaboration.

1. Support and encourage English Aquaculture Strategy (EAS) progress. In particular:
    a. Commission project work where appropriate and deemed important within the delivery plan (ALG and SF2040 Secretariat).
    b. Support the Government review of current regulation impacting on shellfish aquaculture and further reviews e.g. freshwater (Defra Working Group, ALG and SF2040 Secretariat). Determine a project with a regional approach that identifies potential areas of aquaculture across the English coast, including co-location opportunities. Build on any relevant mapping work e.g. the Marine Plans and the CEFAS / Dorset and East Devon FLAG project. Secure funding and commission the work (ALG, Seafish, Defra, MMO, Regulators).
2. Maintain an awareness of the challenges and opportunities within aquaculture and raise anything that may impact positively and negatively on the English industry over the timescale of the SF2040 Programme. Facilitate discussion on opportunities and risks at events, Parliamentary meetings, workshops, etc. (SF2040 Secretariat and ALG).
3. Feed into and support discussions and projects that ensure the shellfish testing regime is fit for purpose to reduce duplication across different agencies, reduce costs and grow public confidence in shellfish aquaculture (ALG, Seafish, Defra, Shellfish Stakeholder Working Group and industry).

Further information:

- The SF2040 Secretariat and ALG will work toward the achievement of the English Aquaculture Strategy delivery plan as well as this Recommendation.
- Linked to Recommendations 8, 10, 13, 15 and 16.
- Participants are listed in the Recommendation.

Enabling Business Growth Recommendations

(infrastructure, training, supply chain resilience, maximizing seafood resource)

13

Facilitate the growth of the English seafood industry through the mapping of existing supply chain facilities and infrastructure against current and future needs including domestic aquaculture production. Consult the industry to develop a stock-take of where facility / infrastructure restrictions to efficient business exist. Analyse what further investment is required in 10-20 years (e.g. more temperature-controlled facilities) and include links to relevant development bodies such as LEPs to utilise the support they can provide in regional economic growth. Review seafood facility / infrastructure good practice in similar countries.

1. Within this assessment identify the specific barriers to maintaining and improving key infrastructure and facilities within English ports. Include the following in the English port assessment: depuration facilities, deep water berths, ice production, vessel new build and maintenance, physical and virtual auctions, digital connectivity, distribution and storage and which ports to invest in so a bigger class of boats can land in England.

Further information:

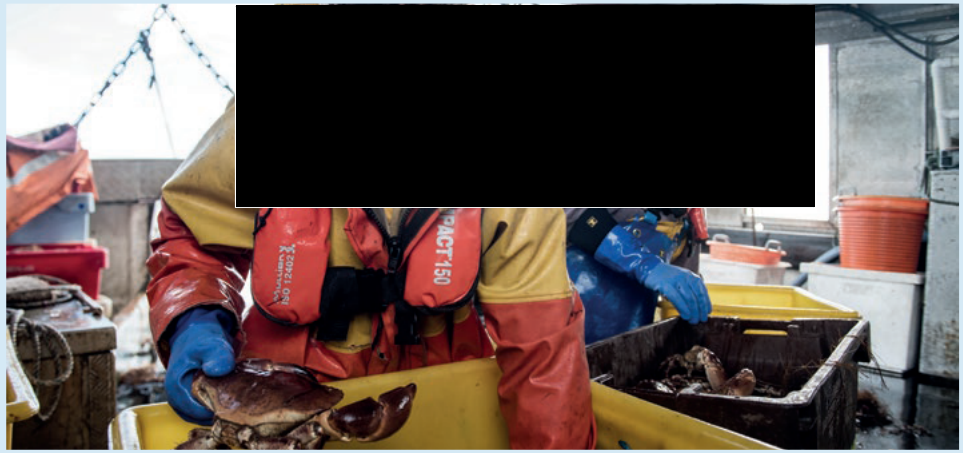
- Secure funding and commission work.
- Linked to Recommendations 15 and 19.
- Participants: Defra, SF2040 SILG, ALG & Secretariat, British Ports Association, Local Councils, private port owners, the National Federation of Fisherman's Organisations, Producer's Organisations, Shellfish Association of GB, aquaculture industry, British Trout Association, etc.

14

Deliver a single cross-sector seafood training and skills plan based on identified needs and requirements including aquaculture. Ensure Post-16 skills plans are included and that they have work-based learning opportunities and meet the needs of the seafood supply chain.

Further information:

- The SF2040 Programme will support Seafish's efforts to achieve the Recommendation.
- Participants: Seafish, industry.



15

Improve resilience across England's seafood supply chain to enhance flexibility and endurance during market demand and supply disruption and reduce impact on market access and price.

1. Evaluate the current ability of the supply chain to meet business requirements and identify the domestic, import, and export trade barriers to determine where the risks exist. Highlight the major gaps and the local, national and global (if relevant) opportunities. Within this evaluation:
    a. Disaggregate the supply chain into sectors and include exports and imports. Different sectors will have different scenarios and solutions.
    b. Include recommendations and possible interventions that will help to secure seafood product supply. Ensure they include digital solutions and opportunities within coastal communities and also reflect the diversity of the supply chain.

2. Where possible, support the work of other organisations in the improvement of knowledge exchange throughout the supply chain about the demands of the market (for example, Corporate Social Responsibility (CSR), the expectations of consumers, nutritional benefits of seafood, and increasing supply chain surplus (profit) to make seafood value chains more efficient and end product more affordable).
3. Promote and engage pre-competitive research into product development to support improved economic value of England's seafood product.

Further information:

- Requires funding to commission the evaluation.
- Linked to Recommendations 8, 16 and 19.
- Participants: Industry, Government.

16

Maximise the value of the seafood resource that is going to uses other than human consumption alongside reducing food waste. Investigate opportunities to both reduce fish waste and create additional value in other non-food related sectors for that waste. Identify prospects for creating high-value by-products from residual resources for other industries (e.g. pharmaceutical, cosmetics, etc.) and determine the potential 'size of the prize'.

1. Signpost the industry to existing information and tools to help address opportunities to reduce waste and maximise yield and value in production.
2. Maximise the value of fish meal, fish oil and by-products from seafood and freshwater fisheries, for fishmeal, health and other markets such as nutraceuticals.
3. Exploit potential markets for verifiably sustainable under-utilised species.
4. Quantify socio-economic importance of fishmeal sector in protein to better inform policy and decision making within the seafood value chain.

Further information:

- Requires funding to achieve the actions.
- Linked to Recommendations 8, 15 and 19.
- Possible participants: Seafish Expert Panel.

17

Ensure English seafood is fully factored in the Government's export growth and promotion activities including Free Trade Agreements.

1. Establish an England Seafood Exporter's Group comprised of industry and government. This group will discuss export business process in a pre-competitive environment, liaise with government regarding export activities and agreements, and support regional industry seafood export strategies and food initiatives.
2. Examine the seafood export industry post EU-Exit through an analysis of gaps and areas for improvement that will build English export resilience and generate further global opportunities. In this examination, develop an understanding of what the end market is using English seafood exports for and how can these be positioned as a premium for provenance and quality. To include the examination of the potential for free ports to support business aims.

Further information:

- The SF2040 Secretariat can facilitate meetings with Defra, Seafish and DIT involved in the planning.
- Linked to Recommendations 15 and 19.
- Participants: Defra, Seafish, DIT.

18

Support and encourage the UK Government in the ongoing facilitation of favourable international free trade and preferential tariff agreements.

1. Assess the current and future tariff environment and future for the processing sector from both export and import perspectives.
2. Discuss measures of success with Government. For example, how will a FTA be determined beneficial to the English seafood industry? What would be the opportunities and gains for English importers and exporters?

Further information:

- Defra communication regarding FTAs and tariffs is ongoing through specific channels and teams. The SF2040 Programme will support their work and facilitate workshops and / or meetings.
- The assessment exercise of the current and future tariff environment will require funding to achieve.
- Linked to Recommendation 17 and 18.
- Participants: Defra, DIT, Seafish and industry.

19

Examine the seafood import industry post EU-Exit through an analysis of gaps and areas for improvement that will build English import resilience and generate further global opportunities. Include the ongoing reviews of the tariff free quotas adopted from the EU and the implications of Rules of Origin (ROO). Ensure government and industry collaboration to facilitate seamless, transparent import processes into England that meet the seafood requirements of industry and consumers.

Further information:

- Will require funding to achieve the activities.
- Linked to Recommendations 13, 17 and 18.
- Participants: Defra, Seafish, SF2040 SILG, and industry (e.g. Seafood Industry Alliance).

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SEAFOOD 2040

The SF2040 Programme is facilitated by Seafish and funded through the Fisheries & Seafood Scheme managed by the Marine Management Organisation.

ANNEX 3

North West Inshore and North West Offshore Marine Plan – Technical Annex, June 2021 (Section 5.4 ‘Aquaculture’) (12pp)

5.4 Aquaculture

Policy Code	Policy Wording
NW-AQ-1	Proposals within existing or potential strategic areas of sustainable aquaculture production must demonstrate consideration of and compatibility with sustainable aquaculture production. Where compatibility is not possible, proposals that may have significant adverse impacts on sustainable aquaculture production must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts on sustainable aquaculture production so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding.
NW-AQ-2	Proposals enabling the provision of infrastructure for sustainable aquaculture and related industries will be supported.

What is aquaculture?

171. **Aquaculture** refers to the controlled rearing of aquatic shellfish, finfish and the cultivation of aquatic plants and algae. Aquaculture can take place in both the inshore and offshore marine environment and can be broadly grouped according to water type (marine or freshwater), species type (finfish, shellfish or plants) and intensity (intensive, semi-intensive or extensive) (Future Brief: Sustainable Aquaculture).

172. **Sustainable aquaculture** considers environmental, economic and social sustainability. The specifics of this concept cannot be generalised and may vary according to species, location, farming methods and management techniques (Sustainable Aquaculture), among other factors.

173. Environmental sustainability in aquaculture requires operating in consideration of the wider ecosystem and in accordance with relevant environmental legislation, helping to achieve conservation objectives. It involves, but is not limited to (Future Brief: Sustainable Aquaculture):

- appropriate management of invasive non-native species: restricting their introduction and spread
- minimising disruptions to ecosystems (such as seafloor disturbance) and impacts on biodiversity (through the management of escapees)
- avoiding adverse impact on water quality, controlling organic pollution and the release of nutrient waste, pesticides, pharmaceuticals and antifoulants
- reducing pressures on wild stocks by diversifying food sources
- utilising methods that ensure the well-being of the cultured species, including minimising the spread of disease and parasites

174. Economic sustainability involves supporting long-term economic growth to help meet increased customer demand through viable businesses with good long-term prospects.

175. Social sustainability involves operating responsibly and positively impacting surrounding communities and social well-being through the creation of jobs and businesses.

176. **Infrastructure for aquaculture** includes both marine and land-based structures and facilities. Since aquaculture is a variable industry, the infrastructure used is highly dependent on the system. Marine infrastructure may include bottom-anchored methods, such as trestle tables and poles, techniques that are suspended from buoys or long-line systems (such as rope culture), sea-based container culture systems or moored sea cages (Identification of areas of aquaculture potential in English waters (MMO1184)). Shoreside infrastructure to consider includes, but is not limited to:

- all ports and harbours and associated landing and offloading facilities
- markets, including infrastructure that helps build supply chain resilience
- repair and chandlery facilities
- storage and processing facilities (including depuration plants for shellfish and storage for wet fish, dry goods and other produce)
- transport of produce to shore and once on shore (logistics companies)

Why is sustainable aquaculture important?

177. Aquaculture has the potential to become an important industry in the north west inshore marine plan area, with production values and industry statistics available at Fishery statistics. The Marine Plan - Sustainability Appraisal Scoping Report notes important wild shellfish beds for cockles and mussels in Morecambe Bay, the Dee Estuary, the Ribble Estuary and the Solway Estuary. There is also an oyster hatchery on the north coast of Morecambe Bay which is Europe's largest oyster nursery, being an important source of oyster seed for farms across the UK and also in Ireland (Publications, The Seafish Guide to Who's Who in UK Aquaculture). There is currently no marine finfish aquaculture in the north west inshore marine plan area.

178. Although aquaculture accounts for 0.01% employment in the north west region, it may provide future employment in coastal areas, or those with limited alternative employment options (where the employment base may be ageing, emigrating or transitioning from traditional occupations), helping to maintain communities' traditions and social identities (Evidence Supporting the Use of Environmental Remediation to Improve Water Quality in the South Marine Plan Areas (MMO1105)). It is seen as an industry where development could occur particularly at local levels (integrating aquaculture within local communities), and is, therefore, a means of increasing or maintaining employment levels in the north west and realising the associated social and economic benefits.

179. Aquaculture industries employ people across several different skill sets. In particular, aquaculture requires knowledge and skills similar to those found in the fisheries (eg boat builders/handlers and processors) and, therefore, may support the

diversification of the fishing industry. The establishment of supporting agencies protecting the surrounding environment and monitoring the quality of output can also create jobs. The integration of aquaculture with other coastal activities can also extend the benefits of the sector to the wider community and across other marine activities (Social impacts of fisheries, aquaculture, recreation, tourism and marine protected areas (MPAs) in marine plan areas in England (MMO1035)).

180. In order to facilitate sustainable aquaculture production, provision and maintenance of accompanying infrastructure is required, without which the potential value of aquaculture cannot be realised. Provision and maintenance of infrastructure would include ensuring sufficient facilities are available to receive, process, store and transport incoming produce. The north west marine plan areas are busy with many demands on the space available; therefore, new or improved infrastructure is increasingly restricted for space. Provision of sufficient and appropriate infrastructure for aquaculture can also be combined with infrastructure to support fisheries since they can share much of the same shoreside infrastructure for landing and processing.

181. When discussing aquaculture, the aspect of sustainability is of key relevance. When aquaculture developments are well-managed through exemplary practice, the social and economic benefits of the sector can be realised with minimal negative environmental impacts and can even provide environmental benefits. However, depending on the management approach, unsustainable aquaculture practices can result in various negative environmental impacts, with awareness of those increasing (Environmental economics, Background information for sustainable aquaculture development, addressing environmental protection in particular (2015)). As part of this, it should be noted that the popularly-cultured Pacific oyster is classified in the UK as an invasive non-native species. Originally introduced to the UK at scale to supplement native oyster stocks, increasing water temperatures encouraged recruitment of farmed stocks, leading to some establishment of natural beds (Pacific oysters on the south coast of England). There is concern that wild beds of Pacific oyster compromise local ecosystems and conservation status, so inhibiting the spread of invasive non-native species is an important aspect of sustainable aquaculture management. Climate change may continue to aid the settlement of invasive non-native species.

182. When managed sustainably, aquaculture can be a means to conserve and recover marine biodiversity through restocking native species. Large populations of species, such as native oysters, provide ecosystem services (water filtering and stabilising shorelines) through the establishment of biogenic reefs (in the form of successive generations of oysters). These reefs also act as hotspots where biodiversity is greater than that of surrounding sediments and are, therefore, of high importance to the ecological functioning of the surrounding area (Identifying sites suitable for marine habitat restoration or creation (MMO1135)). Restocked species and the resulting higher biodiversity can also support commercial and recreational fishing, thereby supporting the livelihoods of local fishermen.

183. Seaweed aquaculture also presents some emerging opportunities. Research into the applications of seaweed shows that farms, aside from having a role in carbon sequestration and as fish nursery grounds, have a product that has applications in food and livestock feed, biofuels, cosmetics, pharmaceuticals and medicines (Chapter Ten - Enzymatic Recovery of Metabolites from Seaweeds: Potential Applications). Seaweed farming also requires minimal artificial inputs (as an unfed system), making them potentially good examples of sustainable aquaculture.

184. As a rapidly growing marine activity, aquaculture is a key area for development due to its potential to contribute to the sustainability and security of the UK's food supply, 80% of which is imported from overseas sources. These sources may not be viable over longer time scales, particularly due to increasing global demand (Planning for sustainable growth in the English Aquaculture Industry). The vision of the Seafood 2040: A strategic framework for England framework is that by 2040, a sustainable aquaculture sector will have seen significant growth thriving within a safe regulatory framework. Further, Sustainable aquaculture: the United Kingdom multiannual national plan (MANP) (published in 2015) describes how the government will encourage growth in the aquaculture sector, and how marine planning will be used to achieve sustainable development.

185. The aquaculture policies within the North West Marine Plan give a clear policy direction for aquaculture, which fulfils one of the key requirements to achieve the goals of Seafood 2040. As with the multiannual national plan, the policies highlight the government's commitment to aquaculture, emphasises its relevance to environmental, societal and economic issues, and ensures data and evidence bases are continually strengthened. Sustainable aquaculture offers substantial potential to increase its contribution to the UK economy, and through contributing to domestic food production, it will help the country meet the requirements of health and food security agendas.

Policy NW-AQ-1 Aquaculture

Proposals within existing or potential strategic areas of sustainable aquaculture production must demonstrate consideration of and compatibility with sustainable aquaculture production. Where compatibility is not possible, proposals that may have significant adverse impacts on sustainable aquaculture production must demonstrate that they will, in order of preference:

a) avoid
b) minimise
c) mitigate
- adverse impacts on sustainable aquaculture production so they are no longer significant.

If it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding.

Policy aim

186. The policy recognises that aquaculture is an important industry with the potential to grow, contributing to food supply and security. NW-AQ-1 seeks to protect both existing aquaculture operations as well as potential future opportunities for aquaculture within spatially defined strategic areas of sustainable aquaculture production. These strategic areas have been spatially defined for species of commercial importance by considering environmental factors, technical constraints, planning constraints and other users of the sea.

187. The policy does not prevent non-aquaculture developments or activities; it supports sustainable aquaculture production by spatially defining areas where all proposals are required to demonstrate consideration of and compatibility with sustainable aquaculture. If this cannot be achieved, the policy stipulates proposals that may have significant adverse impacts on sustainable aquaculture should follow the steps in the mitigation hierarchy through avoiding, minimising or mitigating these impacts, before being allowed to proceed if the Regulator agrees with the proponent's overriding justification. While protecting opportunities for sustainable aquaculture production, the policy makes allowances for both non-significant adverse impacts on aquaculture and significant adverse impacts that are outweighed by the benefits of the proposal.

188. Policy NW-AQ-1 applies to the inshore and offshore marine plan areas.

How will this policy be implemented?

189. NW-AQ-1 refers to areas of existing aquaculture production and those defined as potential strategic areas of sustainable aquaculture production, the latter of which have been spatially defined by the Marine Management Organisation in Identification of areas of aquaculture potential in English waters (MMO1184). All areas where this policy applies can be viewed in Figure 5 and on the Explore Marine Plans digital service.

190. At the time of plan publication, MMO1184 has identified potential strategic areas of sustainable aquaculture production for 14 species (four seaweed, four finfish, one crustacean and five shellfish), selected based on their current contributions to English aquaculture, their importance as commercial fish species, or potential future importance. For each species, the areas are defined by overlaying the following spatial data layers: optimal species growth rates in relation to environmental factors, technical constraints, (ie where the culture method can occur based on physical factors), and planning constraints (ie other users of the sea). Should further evidence become available to allow for refinement of the strategic areas of sustainable aquaculture production, these data layers will be updated and/or added to Explore Marine Plans.

Proponents

191. To locate strategic areas of sustainable aquaculture production in which this policy applies, proponents should consult Figure 5 or the equivalent layers on the Explore Marine Plans digital service. It may be beneficial to consult relevant organisations to determine whether there are existing aquaculture developments (or proposals) in the

area, and the potential impacts of the proposal on sustainable aquaculture production. Examples of relevant organisations are:

- the Centre for Environment, Fisheries and Aquaculture Science who can advise on water quality, wider species requirements and seafood safety standards
- the Fish Health Inspectorate, as the regulator of Aquaculture Production Business Authorisations (Public register of Aquaculture Production Businesses in England and Wales)
- the Inshore Fisheries and Conservation Authorities if the proposal is within 0 to 6nm
- Marine Management Organisation Marine Licensing, from whom pre-application advice can be requested regarding site checks for any existing aquaculture operations or proposals in the area
- The Crown Estate for seabed leases or if a proposal is outside 6nm as they will be aware of any aquaculture lease proposals in the area

192. More information on the relevant organisations that should be consulted to determine potential effects of proposals on existing and future aquaculture development are listed in the Aquaculture Regulatory Toolbox for England. Engagement should be as early as possible in the planning process, and evidence should be provided within the proposal. Early engagement will improve compatibility and may increase support for proposals.

193. If sited within existing or potential strategic areas of sustainable aquaculture production (as identified in the similarly named layer on the Explore Marine Plans digital service), all proposals must first demonstrate how they will avoid significant adverse impacts on sustainable aquaculture production. Where significant adverse impacts cannot be avoided, proposals must demonstrate how they will minimise significant impacts so they are no longer significant. Where significant adverse impacts cannot be minimised, proposals must demonstrate how they will mitigate significant adverse impacts so they are no longer significant. Where significant adverse impacts cannot be mitigated, proposals must state the case for proceeding, explaining why the benefits of the proposal outweigh the significant adverse impacts caused. Proposals will likely apply a mixture of measures to avoid, minimise and mitigate significant adverse impacts. Proposals must demonstrate how they have satisfied a) before moving to b), and so on.

194. Avoidance of significant adverse impacts might involve the relocation of the development outside strategic areas of sustainable aquaculture production. Minimisation may include demonstrating how physical obstructions to sustainable aquaculture production or significant adverse impacts on production (such as relating to water quality or culture species) would be reduced. Mitigation may include proponents allowing space within their proposal area for co-location with sustainable aquaculture.

195. As part of the above, proponents must also demonstrate that they have considered potential significant adverse impacts on:

- the culture species and its immediate environment – more information on culture species can be found in Aquaculture Profiles - Web Tool
- the wider water column – for example, whether pollutants, increased chlorophyll or invasive species released by a proposal might flow towards an aquaculture site
- water quality within the site where common adverse impacts could include pollutant release or increases in turbidity

196. Inclusion of this information does not indicate that approval of the proposal will follow by default. In deciding whether to grant approval, the decision-maker will have regard to other material considerations that may include, for example, other policies within the North West Marine Plan and other regional and national plans.

Decision-makers

197. Decision-makers will apply this policy when determining decisions on proposals in strategic areas of sustainable aquaculture production. Given the uncertainty on the exact location of future aquaculture developments, the policy makes allowance for the possibility of other, competing developments to proceed under particular circumstances, as outlined in the mitigation hierarchy.

198. Decision-makers should assess the potential impacts that other proposals may have on strategic areas of sustainable aquaculture production, and measures taken into account that promote co-existence and compatibility (UK Marine Policy Statement Section 3.9.6 and NW-CO-1). The potential importance and relative contributions of areas of aquaculture potential should also be considered. Decision-makers should have regard to evidence of consultation with relevant organisations concerning existing aquaculture businesses and areas of potential future sustainable aquaculture.

199. Figure 5 shows the strategic areas of sustainable aquaculture production as defined by Identification of areas of aquaculture potential in English waters (MMO1184).

Policy NW-AQ-2 Aquaculture

Proposals enabling the provision of infrastructure for sustainable aquaculture and related industries will be supported.

Policy aim

200. NW-AQ-2 aims to tackle barriers to aquaculture by encouraging the provision, maintenance and development of marine and land infrastructure to support sustainable aquaculture and related industries. This policy supports sustainable aquaculture projects by encouraging the direct development of infrastructure, as well as supporting connectivity between marine operations and land infrastructure, which will ensure that opportunities for aquaculture are realised. Due to the overlap between some shoreside aquaculture and fisheries infrastructure, NW-AQ-2 supports the integration of aquaculture with the fishing industry through the sharing of infrastructure and the diversification of fishers. This policy will also benefit employment and the development of skills in coastal communities.

201. Policy NW-AQ-2 applies to the inshore and offshore marine plan areas.

How will this policy be implemented?

202. The aquaculture introductory text includes examples of infrastructure relevant to sustainable aquaculture and related industries. This policy can be applied in any area in which such infrastructure can be sited, subject to the marine licensing process. Within the north west inshore marine plan area, the major port for fisheries landings is Whitehaven, which also has supply chain connections to smaller ports. Barrow, Fleetwood and Liverpool docks are also important to fisheries. The Solway Firth contains a series of small but active ports with docks and associated infrastructure. A coastal railway links the port towns of Whitehaven, Workington and Maryport.

Proponents

203. Proponents should consider the impacts of their proposals on the infrastructure of sustainable aquaculture and related industries and should provide evidence of how support can be given via the proposed development. Positive impacts on such infrastructure will be supported under this policy. In addition to providing infrastructure to directly support cultured species, positive impacts might include infrastructure that supports new businesses, and the provision of facilities to process incoming produce. The sharing of infrastructure to support integration with fisheries is also encouraged.

204. If siting new aquaculture infrastructure, proponents may find it useful to refer to the strategic areas of sustainable aquaculture production layer in Figure 5 or on Explore Marine Plans. This layer does not delineate areas where policy NW-AQ-2 applies, rather it indicates optimum areas for sustainable aquaculture (refer to policy NW-AQ-1) that may also be of interest to proponents. The project methodology is available at Identification of areas of aquaculture potential in English waters (MMO1184). Also of interest are the individual species suitability maps that are shown under the same category, and the aquaculture communications and consultation layer that indicates areas that may require additional engagement with relevant parties during the pre-proposal process, eg marine protected areas or offshore wind farms.

205. Proposals enabling the provision of infrastructure for sustainable aquaculture should focus on how they are fulfilling the sustainability aspect of the policy in reference to, but not limited by, the definitions given in the aquaculture introductory text. Consideration and adequate provision should be given to matters of biosecurity (in line with policy NW-INNS-1), ecosystem health and maintaining biodiversity; during both construction and ongoing management. Examples might include the use of raised cages within the water column (anchored by several points) to reduce direct building on the seabed, and ensuring that marine litter is not released. Developments that are not considered to be enabling sustainable infrastructure will not be supported under this policy. Proponents should consider consulting with other organisations, with potential impacts of proposals and evidence of engagement identified in the proposal. Organisations to consult with may include, but are not limited to:

- Fish Health Inspectorate – to ensure that aquaculture production businesses are compliant with all relevant aquatic animal health legislation
- Inshore Fisheries and Conservation Authorities – will have detailed knowledge of existing users, including aquaculture operations in their district
- Seafish – to advise on the distribution and requirements of the aquaculture industry
- Shellfish Association of Great Britain – can offer advice on shellfish specific aquaculture requirements

206. Proponents whose proposals include marine infrastructure to facilitate species growth should refer to Regulatory Requirements and Guidance for Aquaculture Businesses in England in the Aquaculture Regulatory Toolbox for England. This resource forms a comprehensive guide on regulatory and legislative requirements for aquaculture businesses. Proponents should also review the guidance on how to make a marine licence application and should refer to government guidance on fish, shellfish or crustacean farm authorisation, including the controls of fish and shellfish diseases in England and Wales. Proponents should also comply with shipping regulations, including The Merchant Shipping (Distress Signals and Prevention of Collisions) Regulations 1996 (which implements the International Regulations for Preventing Collisions at Sea 1972) and the United Nations Convention on the Law of the Sea, in relation to safe navigation.

207. Infrastructure that supports aquaculture may result in adverse impacts on biodiversity, the surrounding ecosystem and other users of the north west marine plan areas. Individual developments of the scale likely to cause impact should include inbuilt mitigation to ensure the proposal complies with all the relevant legislation and policies in the North West Marine Plan. Proponents should also demonstrate an awareness of and attempt to co-exist with other marine activities (both existing and planned; viewable on Explore Marine Plans). Organisations to consult regarding potential impacts of proposals may include, but are not limited to:

- the Centre for Environment, Fisheries and Aquaculture Science who can advise on water quality, wider species requirements and seafood safety standards
- the Fish Health Inspectorate, as the regulator of Aquaculture Production Business Authorisations (Public register of Aquaculture Production Businesses in England and Wales)
- Environment Agency – to advise on water quality requirements and migratory fish
- Historic England – to advise on scheduled monuments / archaeological interests
- local fishers and representative groups, including the National Federation of Fishermen's Organisations and Inshore Fisheries and Conservation Authorities
- local marine conservation groups and wildlife groups – to advise on protected species and habitats in the area

- local planning authority (including the Area of Outstanding Natural Beauty department if applicable) – to advise on other users, legislation and all impacts
- Marine Management Organisation Marine Licensing, from whom pre-proposal advice can be requested for guidance on designated sites, other users and regulation
- Maritime and Coastguard Agency – to advise on navigational concerns
- Natural England/the Joint Nature Conservation Committee (beyond 12nm) who are responsible for management agreements in marine protected areas for activities that are likely to damage the protected features
- other marine users – Harbour Authorities, Ministry of Defence, other marine developments (eg offshore wind farms, aggregate dredging, maintenance dredging and cables), and recreational users, eg Royal Yachting Association
- The Crown Estate (or relevant landowner) – to advise on seabed leases in the inshore and offshore marine plan areas of marine developments
- Trinity House – to advise on marking and lighting requirements

208. Early engagement with all stakeholders that may be impacted by the development is encouraged. Potential impacts and proof of engagement should be included in proposals, with comments taken into consideration and the proposal amended accordingly.

209. Proposals enabling the provision of infrastructure for sustainable aquaculture and related industries must consider the conservation objectives set out by the statutory nature conservation bodies and comply with the statutory assessments for marine conservation zones under the Marine and Coastal Access Act 2009, sites of special scientific interest under the Wildlife and Countryside Act 1981, and special protection areas, special areas of conservation and Ramsar sites under The Conservation of Habitats and Species Regulations 2017[15] and The Conservation of Offshore Marine Habitats and Species Regulations 2017[16]. Where proposals have been determined to have a likely significant effect on a special protection area, special area of conservation or Ramsar site through a Habitats Regulations Assessment, an Appropriate Assessment will be required.

210. Proposals should also ensure cohesion with Local Planning Authorities and terrestrial plans when concerned with the provision and use of infrastructure to support aquaculture. As part of this, the provision and use of infrastructure for aquaculture should also consider the opportunity to influence and improve local employment opportunities.

211. The inclusion of the above information does not indicate that approval of the proposal enabling the provision of infrastructure for sustainable aquaculture will follow by default. In deciding whether to grant approval, decision-makers will have regard to other material considerations, which may include, but are not limited to,

[15] As amended by The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019

[16] As amended by The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019

other policies within the North West Marine Plan and other marine users. Proposals should, therefore, demonstrate consistency with all other policies in the Plan.

Decision-makers

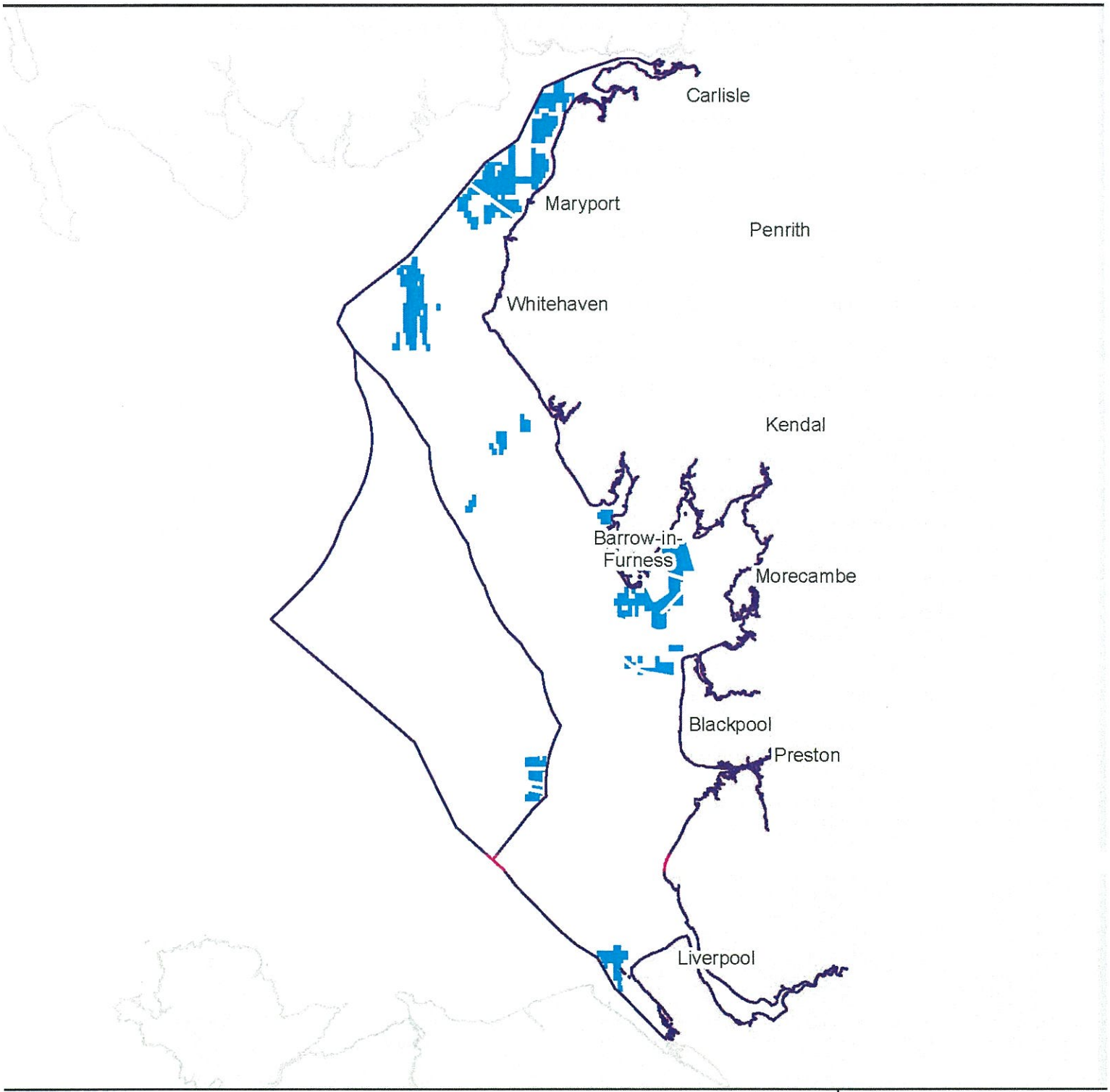
212. Decision-makers with functions capable of influencing infrastructure should support proposals that result in positive impacts on infrastructure for sustainable aquaculture. Considerations could include ensuring that sufficient facilities are available to support the growth of sustainable aquaculture in the north west marine plan areas and that facilities are fully operational and accessible to operators.

213. Proposals should include provisions to ensure environmental, economic and social sustainability with respect to, but not necessarily limited by, the definitions in the aquaculture introductory text. Proposals will only be supported if they align with these definitions and with the conservation objectives of the designated sites, and if they comply with the relevant legislation and policies in the North West Marine Plan.

214. Decision-makers should ensure that infrastructure does not impede other interests and that proponents provide proof of engagement and consultation with relevant organisations and stakeholders as part of demonstrating the positive impacts on infrastructure for sustainable aquaculture, ensuring that issues are resolved early. Decision-makers should also refer to Aquaculture Guidance for Regulators in England in the Aquaculture Regulatory Toolbox for England. Furthermore, A Coastal Concordat for England sets out how regulatory bodies can co-ordinate the separate processes for coastal development consent, including aquaculture, while paragraphs 24 to 27 of the National Planning Policy Framework highlight methods for effective co-operation and joint working between authorities.

Marine Management Organisation

Figure 5 | Strategic areas of sustainable aquaculture production



North West Marine Plan Areas

Strategic areas of sustainable aquaculture production

Policy map
This map is to be used for reference only. Please refer to Explore Marine Plans for a detailed view of the data and to interrogate plan policies.

Date of Publication: August 2020
Coordinate System: ETRS 1989 UTM Zone 30N
Projection: Transverse Mercator
Datum: ETRS 1989

ANNEX 4

‘Evidence of Potential Synergy between Aquaculture and Offshore Renewable Energy’, September 2022 (9pp)

Evidence of potential synergy between aquaculture and offshore renewable energy

J. Demmer, M. Lewis, P. Robins and S. Neill

***Abstract*—Worldwide increased demand for offshore renewable energy (ORE) industries and aquaculture requires developing efficient tools to optimize the use of the offshore space, reducing anthropic pressure. The synergetic development of marine renewable energy infrastructure with mariculture has been hypothesized as a way to reduce costs through shared infrastructure. In the Irish Sea, blue mussels (*Mytilus edulis L.*) represent 40 - 50 % of the total gross turnover of Welsh shellfish industries and the industry has been operating sustainably for over 50 years in North Wales. However, the region is also attractive for tidal energy projects, with strong tidal currents (> 2m/s) occurring, and offshore wind farms, with shallow waters (approx. 50 m) and consistent winds. In this context, it is of scientific and economic interest to study the potential impact of ORE on shellfish larvae recruitment. A numerical approach has been developed using an Eulerian hydrodynamic model coupled with a Lagrangian particle tracking model, which allowed the simulation of tidal currents, wind-driven currents and larval dispersal. Results show: 1) interannual variability of density distribution of larvae; and 2) strong connectivity between commercial shellfish beds and ORE sites. This study shows the importance of ORE site selection in order to: 1) reduce biofouling on ORE infrastructures and 2) develop multi-use platforms at sea to combine needs for ORE and for mariculture.**

***Keywords*—Aquaculture, Connectivity, Larvae, Numerical model, Offshore renewable energy,.**

I. Introduction

The Irish Sea is host to numerous activities such as renewable energy, tourism, aquaculture and maritime transport, resulting in an increase of offshore human infrastructures and pressure on marine sea space with implications for wildlife [1]. One option, to ease the demand for space, is the development of multi-use platforms at sea, where co-location of industries such as aquaculture and offshore renewable energy projects can exist without detrimental feedbacks – or even benefit from one another [2].

Offshore renewable energy (ORE) in the Irish Sea is predicted to occupy approximately 14% (6,564 km^2) of the sea space in the future, assisting the UK government ambition of Net Zero carbon emission (Fig. 1). The highest concentration of ORE is located in the eastern Irish Sea, which is also an important region for shellfish aquaculture (Fig. 1). In the UK, blue mussel cultivation represents 95% of production and 82% of imputed value [3]. The mussel industry in North Wales represents one third of the UK production (valued at ~ £15M), which makes shellfisheries aquaculture economically significant to the area, hence the concern that it could be impacted by the development of other industries [3].

The connectivity between distinct shellfish populations within the Irish Sea has been studied by Robins et al. [4], who showed variable connectivity according to the site of release and larvae behaviour (e.g. larvae that are passively transported by currents or which vertically migrate at diurnal timescales). However, that study did not include the connectivity with ORE sites. It has been calculated that each turbine within the North Hoyle wind farm contains 1,000 - 1,300kg of attached marine life, with *Mytilus edulis* the dominant species [5] and [6]. Furthermore, Inger *et al.* [7] showed that offshore marine renewable energy infrastructures can be both detrimental (e.g. habitat loss and/or spread of invasive species) and beneficial (e.g. acting as an artificial reef and/or fish aggregation devices) on biodiversity. In this context, we seek to understand the potential impacts of ORE developments in the Irish Sea on larval connectivity amongst aquaculture sites.

A key aim of this study is to use modelling to : 1) study the interannual (2014 and 2018) dispersal of mussel larvae from 6 commercial mussel beds according to two plausible

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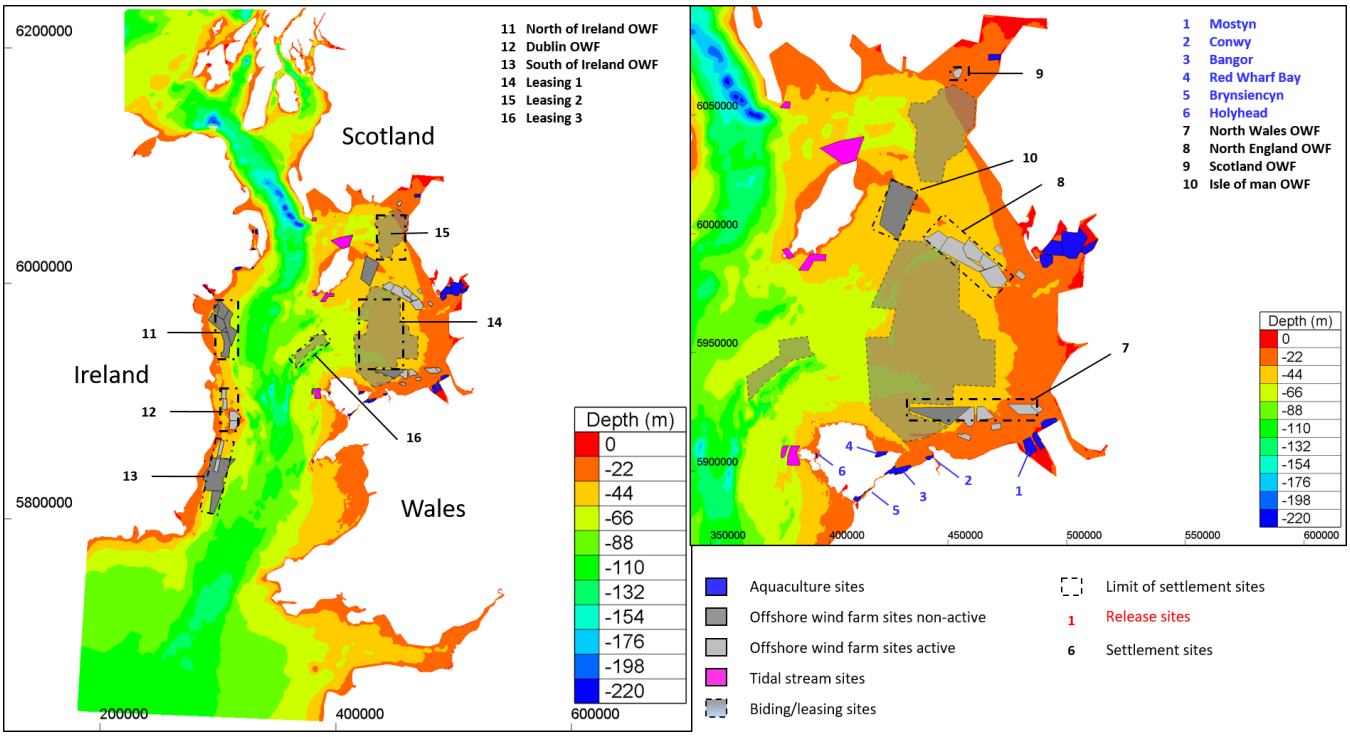

Fig. 1. Domain of study showing the Irish Sea hydrodynamic model domain (WGS84 coordinates in m) and bathymetry (m relative to MSL), the larval release and sink sites (1-6 in blue), plus additional sink sites only (black dashed-dotted area 7-16).

larval behaviours (i.e. larvae remain at the surface or larvae travel in the mid-water column); 2) qualify the density distribution; and 3) qualify and quantify the connectivity between ORE (10 Sites) and aquaculture (6 Sites).

II. MATERIAL AND METHODS

A. *Study area*

The Irish Sea connects Ireland and Great Britain, coverings approximately 47,000 km² with a volume of 2,430 km³, connecting to the Atlantic Ocean via the Celtic Sea in the southwest by St George's Channel and via the North Channel in the north [8] and [9] (Fig. 2). The Irish Sea is approximately 300 km in the northwards direction and varies from 75 km to 200 km in the eastwards direction reducing to 30 km in the North Channel [8]. The topography consists of a deeper channel in the west (30-50 km wide, 300 km long and up to 175 m deep) but depths remain generally shallow, especially in the eastern Irish Sea, with a mean depth of 60 m [10] (Fig. 1).

The Irish Sea circulation is primarily controlled by an energetic tidal regime, which creates an annual average net flux northward of 2.5 Sverdrups [11]. Tidal velocities are governed by local bathymetry and tidal range, which varies from over 10 m in Liverpool Bay and the Bristol Channel, to amphidromic points (near zero tidal amplitude) southeast of Ireland and northeast of Northern Ireland [8]. Tidal currents exceed 1 m/s at spring tides throughout St Georges Channel and the North Channel, and can locally exceed 2 m/s in regions such as around headlands (e.g. Pembrokeshire, Llyn Peninsula and northwest Anglesey), and through tidal channels (e.g. the Menai Strait). Areas of weaker tidal currents (less than 0.5 m/s) can be found in shallower and sheltered bays (e.g. Cardigan Bay, Liverpool Bay and along the Cumbrian coast).

Significant residual flows are observed: 1) directed southward along the east coast of Ireland; 2) westward from South Wales towards Ireland along St. George's Channel: the Celtic Sea front; 3) directed southward from Llyn peninsula to Cardigan Bay; and 4) directed westward along the north Wales coast: Liverpool bay front [12] (Fig. 2). Due to high energy, most of the Irish Sea remains well mixed throughout the year. However, stratification over the summer months occurs in the east and west of the Isle of Man and in Cardigan Bay due to weaker tidal currents in these areas.

All these observations show that both barotropic (gravity-driven; e.g., tides or wind) and baroclinic (densitydriven; e.g., tidal mixing fronts) components have a fundamental roles in the water circulation in the Irish Sea and consequently may influence larval dispersal [4].

B. *Irish Sea hydrodynamic model and validation*

Telemac-2D depth averaged model (V7p2, www.opentelemac.org) has been applied as the unstructured finite-element method is well suited to resolve complex tidal flow in coastal areas [13] and [14]. The mesh density varied from 30 m in the coastal regions to 5,000 m in deeper offshore regions. The domain covered an area of 165,000 km², and contains 206,413 nodes, which correspond to the whole Irish Sea as previous studies show that larvae can potentially travel up to 300 km [15].

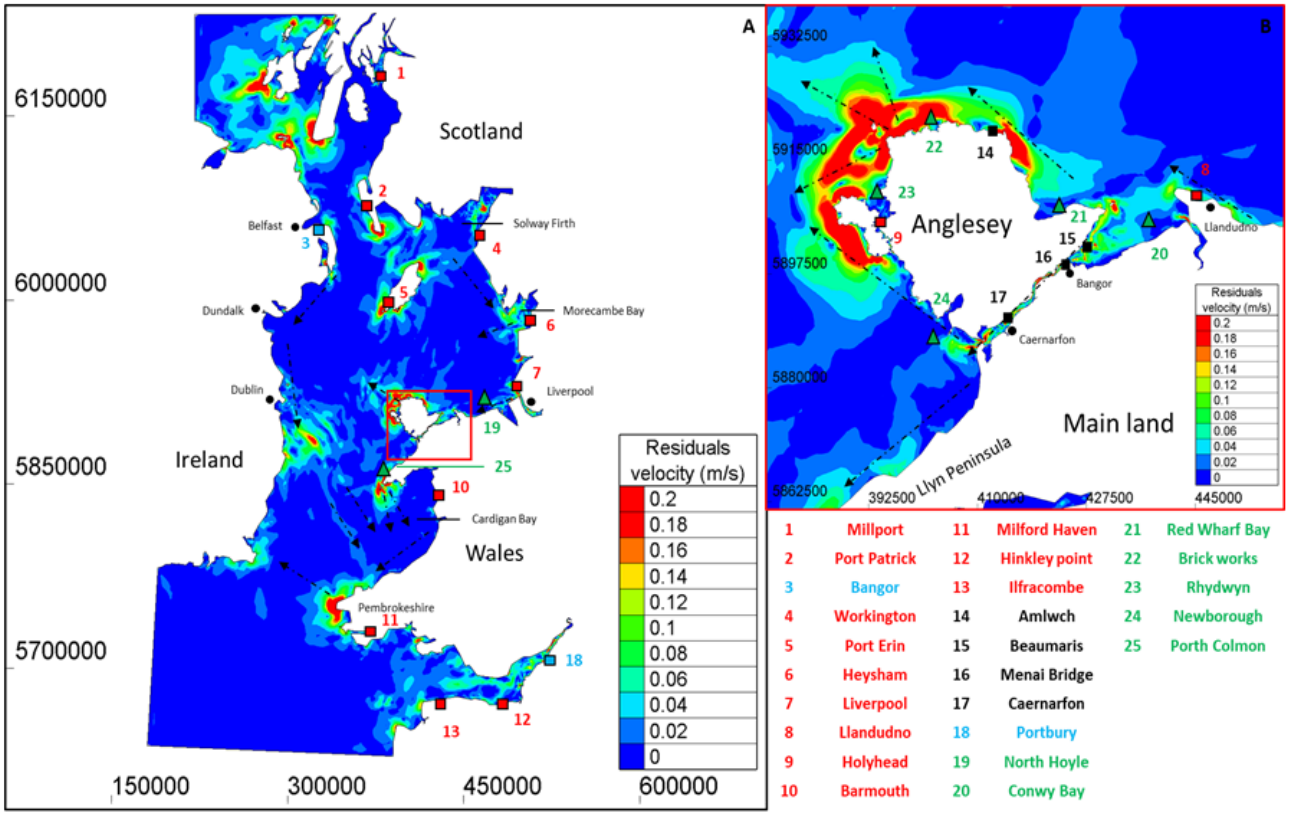

Fig. 2. Contour map showing the simulated residuals (m/s) in the Irish Sea, using the model described here, with direction of the main residuals plotted (black arrows). Tide gauge sites (red, black and blue squares) and ADCP velocity sites (green triangles) used for model validation are shown.

The computational grid was mapped onto bathymetric data comprising an assemblage of: 1) multi-beam data collected during 2012 (high resolution: ~5 m); 2) LiDAR data collected during 2013 (high resolution: ~2 m); and 3) Admiralty bathymetric data of the offshore regions at both end of the Strait (interpolated onto a 200 m horizontal resolution grid) [16]. To ensure stability, models ran with a 2 seconds time-step and models outputs (velocity and water elevation) were stored every 30 minutes. A constant coefficient friction of 0.1 was implemented in Nikuradse's law of bottom friction, which correspond to a bottom composed mostly by sand, i.e. the composition of the majority of the sea bed of the Irish Sea [17].

Validation was based on the Root Mean Square Error (RMSE) and the Normalized Root Mean Square Error (NRMSE), between the observations and model outputs: (1) for water elevation (14 tide gauge sites); (2) for velocity (7 sites for velocity magnitude and direction); and (3) for tidal analysis was (16 sites on the primary semi-diurnal lunar tidal constituent (M_2)); as shown on Fig. 2.

C. *Particle tracking model simulations*

A Lagrangian particle tracking model (PTM) was developed for this study to predict the likely dispersal of *M. edulis* larvae from six released sites (Fig. 1). Parameters and assumptions used for this study of larvae dispersal in the Irish Sea were as follows:

- Simulate dispersal using both advective and diffusive processes [18]; [19] and [4].
- 7,000 particles per site scattered in an area of 0.2 km^2 during 45 days.
- No larval swimming behaviour was simulated as the strong tidal currents in the region (up to 3 m/s) are vertically homogenous, and so any vertical migration behaviour of the larvae would have minimal impact on their horizontal dispersal [20].
- The Irish Sea is considered well mixed during the period of study [8].
- No mortality was considered as this would reduce the data size for the statistical analysis [21].
- Linear interpolation of velocity data: 1) temporally from 30 min (Telemac output) to 5 min (PTM output); and 2) spatially to individual particle positions in order to represent the continuity of the velocity field.
- Particles advected onto land are reflected back to their previous position, maintaining the maximum number of particles throughout the simulated period [22] and [23].
- Simulations were performed using wind data from 3 local meteorological stations downloaded from the Centre for Environmental Data Analysis (CEDA). The simulated trajectories from each wind scenario every year were combined. The approximation of the surface current and wind impact was made based on Proctor *et al.* [14].

D. *Analysis methods*

Spatial density distribution of dispersed particles (or 'heat maps') were calculated every week (i.e. weekly cumulative dispersal) as the percentage of all released particles per 25 km² grid cell. This procedure was repeated for both larval behaviours (i.e. transported at mid water depth or at the surface) and for both years studied (i.e. 2014 and 2018).

Connectivity and self-recruitment were calculated every week (i.e. 6 weeks in total) for all simulations. In this study, 16 sites were studied: 1) six sites will be used as source and sink and are located in North Wales; and 2) 10 settlement sites representing ORE sites (Fig. 1). Connectivity has been adapted from the method used in [4] to obtain results in percentage (%). The calculation gave the proportion of larvae that successfully settle after the PLD. Particles were assumed to have settled when they were present within the boundary of one of the 16 sites of interest. Every particle that reached one of the sites of interest during the whole week was counted as a settler. The surface of settlement area was defined according to the site of interest to create deterministic results (Fig. 1).

TABLE 1
SUMMARY OF MODEL VALIDATION FOR: (1) SURFACE ELEVATION; (2) VELOCITY DIRECTION; (3) VELOCITY MAGNITUDE; AND (4) TIDAL ANALYSIS FOR M2 TIDAL CONSTITUENT.

Surface elevation		
RMSE (m)	NRMSE (%)	R^2
0.45	~6	0.92
Velocity direction		
RMSE (degree)	NRMSE (%)	R^2
36.27	~11	0.84
Velocity magnitude		
RMSE (m/s)	NRMSE (%)	R^2
0.07	~10	0.88
Tidal analysis		
Difference (%)		
- 4		

III. RESULTS

E. *Validation*

Results showed the NRMSE for water elevation was 5.7%, on average for the 14 sites, and for velocity magnitude and direction were 9.8% and 11.2% respectively, on average for seven sites (Table 1). Tidal

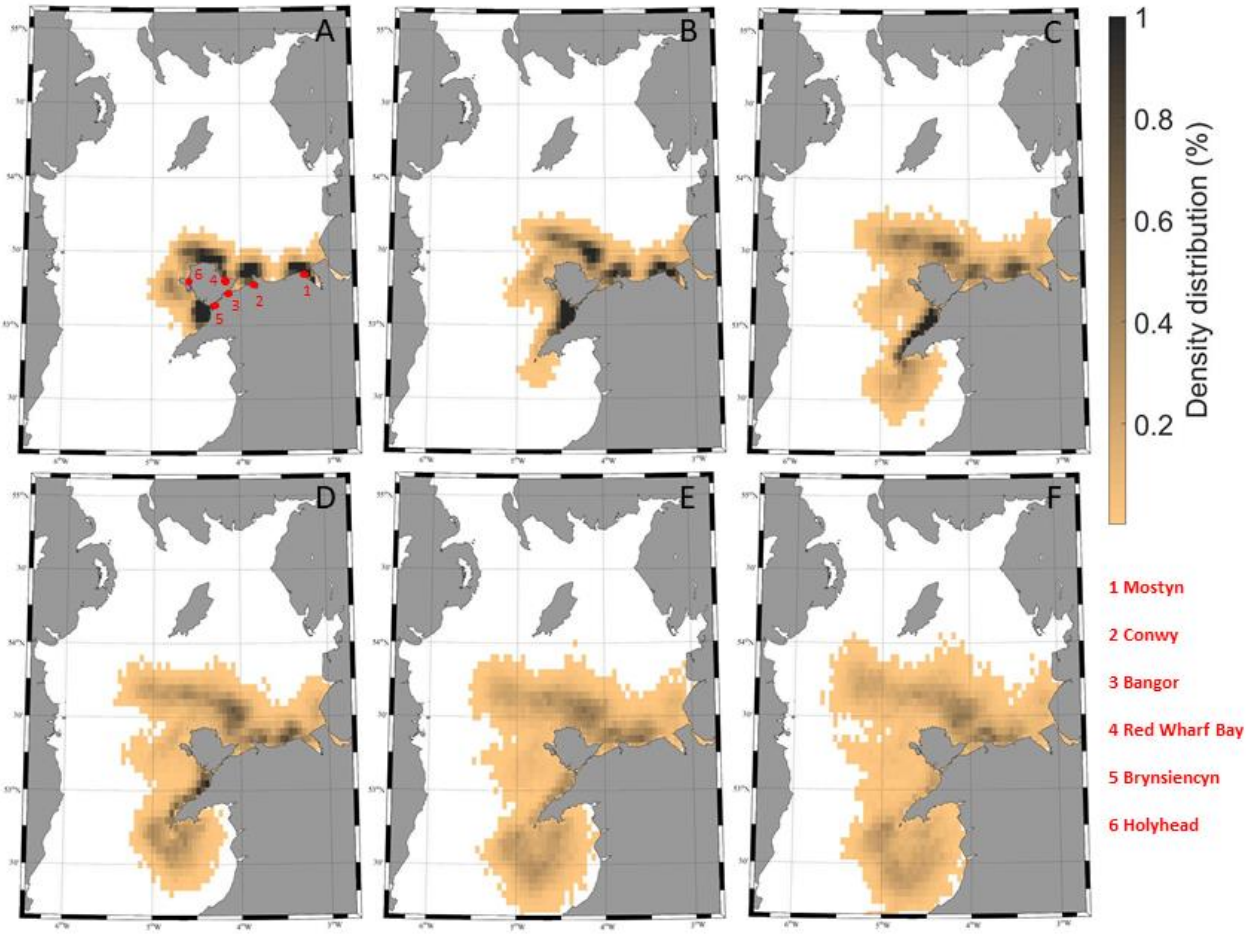

Fig. 3. Maps showing the density distribution of mussel larvae released at the midwater column in March-April 2018 (advected by tide only) from 6 released areas (red dots) during: (A) week 1; (B) week 2; (C) week 3; (D) week 4; (E) week 5 and (F) week 6.

analysis showed that the model underestimate the M2 tidal constituent by 4.3% on average for 16 sites (Table 1).

F. Density distribution

1) Mid-water depth dispersal

Larvae originated from the Menai Strait (Brynsiencyn and Bangor, Wales) are mostly found along the Llyn Peninsula and south of the Llyn Peninsula. Finally, mussel larvae from Holyhead are mostly observed in the middle of the Irish Sea.

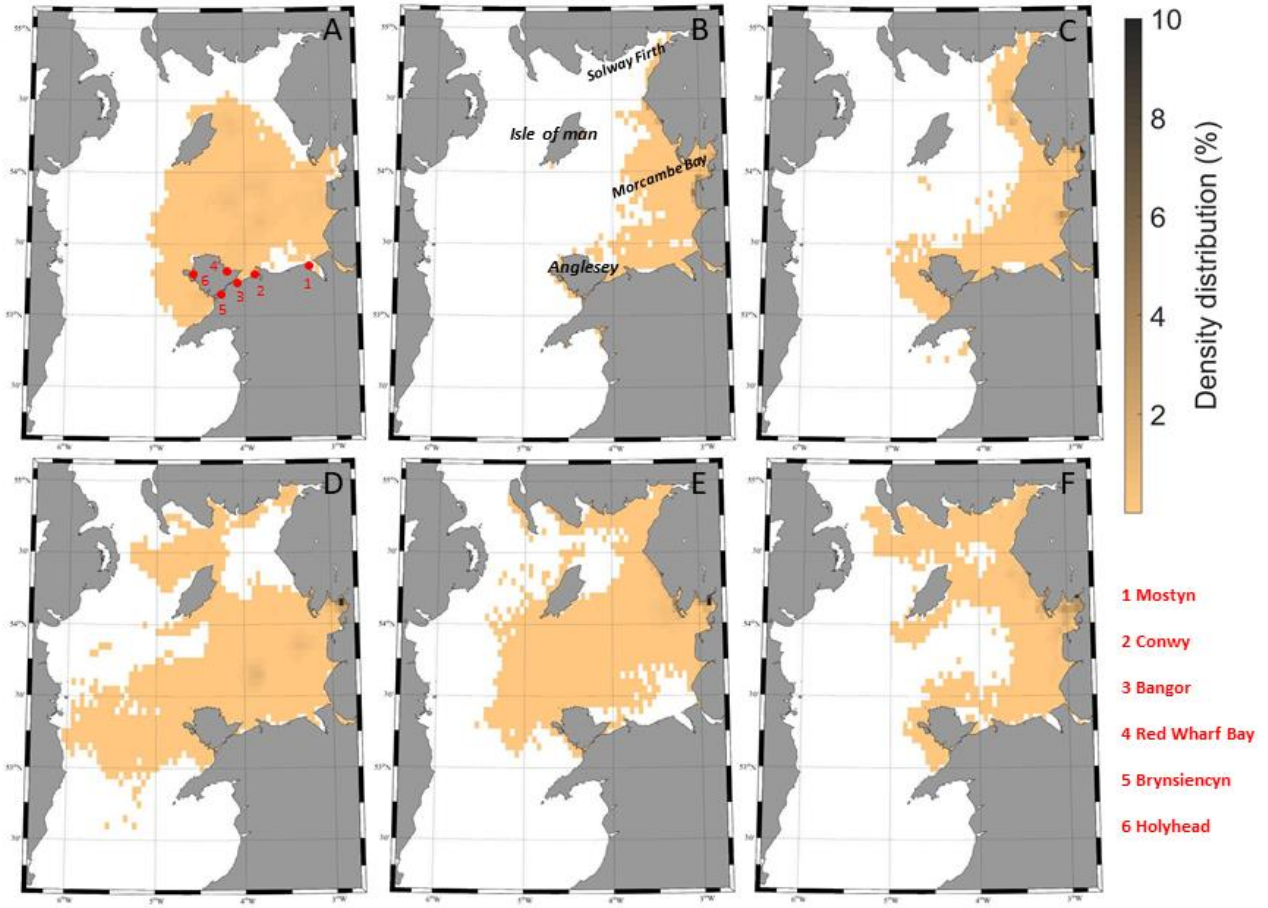

Fig. 4. Maps showing the density distribution of mussel larvae released at the surface in March-April 2014 from 6 released areas (red dots) during: (A) week 1; (B) week 2; (C) week 3; (D) week 4; (E) week 5 and (F) week 6.

Very similar results were obtained for particles released at mid-water depth during spring 2014 and 2018. Consequently, only the results of density distribution during spring 2018 are shown.

Density distribution of larvae varied temporally and spatially. The highest density distribution of larvae is found at the southwestern approach to the Menai Strait at week 1 and week 2 on average for all sites (5% and 3% respectively; Fig. 3A and 3B). After, 3 and 4 weeks of simulation 2% of larvae are found along the Llyn peninsula on average for all release sites (Figure 3C and 3D. The last two weeks simulated (week 5 and week 6) showed that the larvae are more likely to be found (1%) between Anglesey and the Isle of Man on average for all sites (Fig. 3E and 3F).

Larvae released from Mostyn are mainly found between Llandudno and Mostyn along the coast after 6 weeks of simulation (2%). Mussel beds located in Conwy and Red Wharf Bay contribute mostly to the larval density between Anglesey and Isle of Man (1.8% and 2.5%, respectively).

2) Surface dispersal in spring 2014

For all sites together, the highest density of larvae is located at the southwestern approach to the Menai Strait after one week (3%; Fig. 4A). From week two to six, the highest density of mussel larvae is found in Morecambe Bay, with values reducing from 19.5% to 8.7% between the second and the sixth week for all released sites (Fig. 4B, 4C, 4D, 4E and 4F). However, results showed that larvae dispersed in most of the eastern Irish Sea after one week, four week and five week during spring 2014 (Fig. 4A, 4D and 4E).

3) Surface dispersal in spring 2018

As previously observed for the year 2014, the highest density of larvae is located at the southwestern approach to the Menai Strait after one week during spring 2018 (3.5%; Fig. 5A). After two weeks, mussel larvae are mostly present in the western Irish Sea (Irish coast 2.5%; Fig. 5B). From week three to five, results showed that larvae are mainly located offshore on average for all sites, varying from 1.5% to 0.6% (Fig. 5C, 5D and 5E). At the end of the

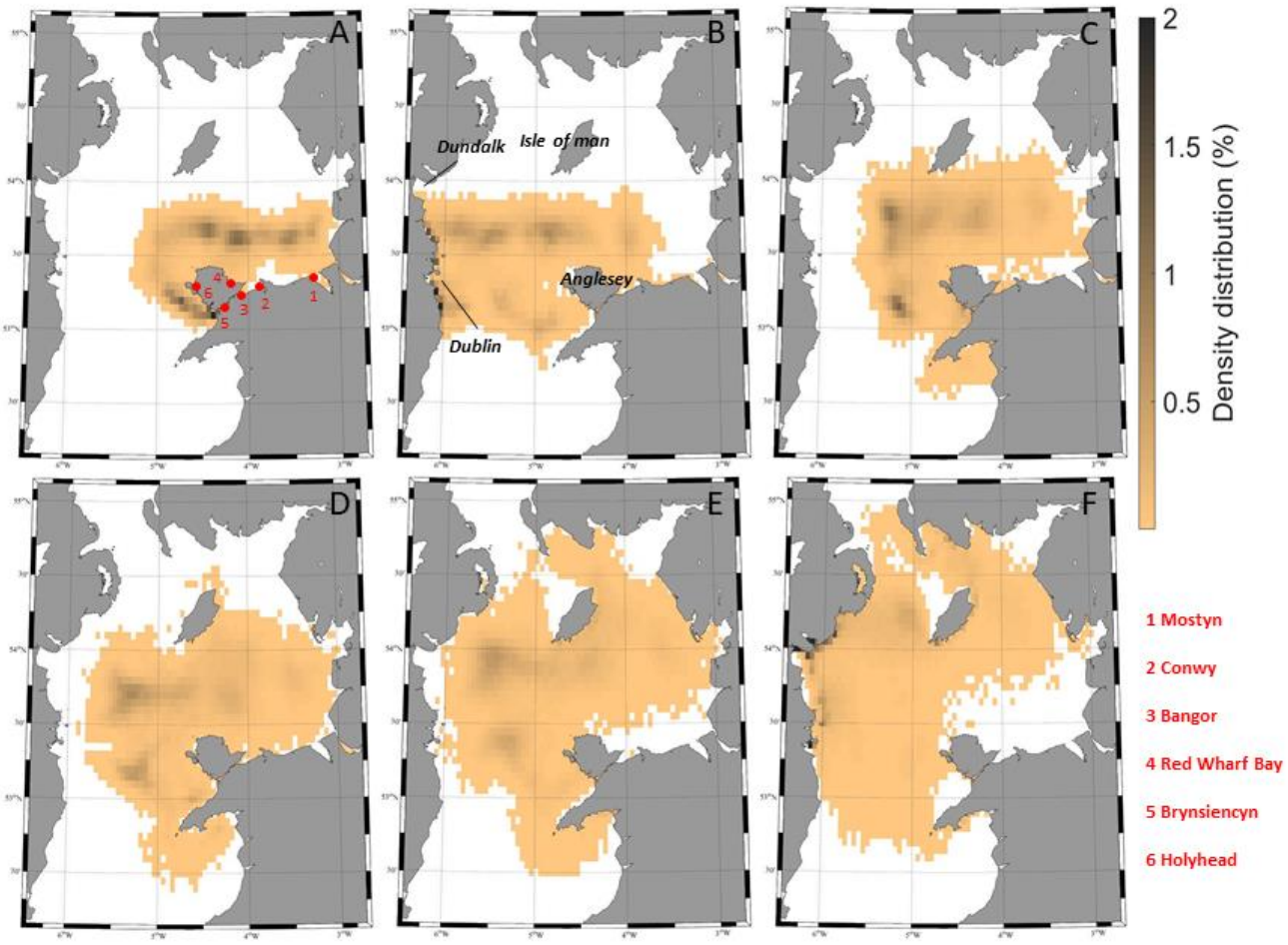

Fig. 5. Maps showing the density distribution of mussel larvae released at the surface in March-April 2018 from 6 released areas (red dots) during: (A) week 1; (B) week 2; (C) week 3; (D) week 4; (E) week 5 and (F) week 6.

simulation (week 6), 3.5% of the larvae are located on the Irish coat again (3.5%) (Fig. 5F).

G. Connectivity

4) Midwater depth dispersal

Leasing 1 (sink site 14) was connected with Conwy (46% on average for all the weeks), Red Wharf Bay (41% on average for all the weeks) and Holyhead (6% on average for all the weeks) (Figure 6.1). The connectivity between Mostyn and Leasing 1 increased from 3% (week 2) to 36% (week 6) (Fig. 6.1.b and 6.1.f). In addition, Conwy showed an increase of connectivity with North Wales offshore windfarms (OWF) from week 1 (3% on average for both sites) to week 6 (19% on average for both site). Bangor (Wales) and Brynsiencyn showed no connectivity with ORE sink sites selected (Fig. 6.1). From week 3, Red wharf bay and Holyhead showed connectivity (2% on average for both sites and all weeks) with Leasing 3 (sink site 16). No significant connectivity is observed between the source sites and the sink sites located on the Irish coast (north of Ireland, Dublin and south of Ireland), Isle of Man OWF, north England OWF and Scotland OWF.

5) Surface dispersal in spring 2014

Leasing 1 is connected with all source sites with weekly variability. On average for all weeks, the highest connectivity is observed with Conwy and Bangor, Wales (23%) followed by Red Wharf Bay (18%); Brynsiencyn and Hoyhead (13%) and Mostyn (6.5%) (Fig. 6.2). No connectivity was observed between source sites and sink sites located on the Irish coast (north of Ireland OWF, Dublin OWF and south of Ireland OWF); Leasing 3 and Scotland OWF. North Wales OWF is mostly connected with Bangor and Brynsiencyn (1.8% on average for all weeks and both sites). On average for all weeks, North England OWF is connected mainly with Mostyn (3%).

6) Surface dispersal in spring 2018

North Wales OWF showed connectivity with Mostyn (15%) and Conwy (19%) at week 1, and then no connectivity was observed during the rest of the simulation (Figure 6.3). In addition, North England OWF, Scotland OWF, Leasing 2 and South of Ireland OWF showed no connectivity during spring 2018 with the source sites (Fig. 6.3). Mostyn and Conwy are highly connected with Leasing 1 (33% for both on average for all weeks), with the highest connectivity at week 1 and week

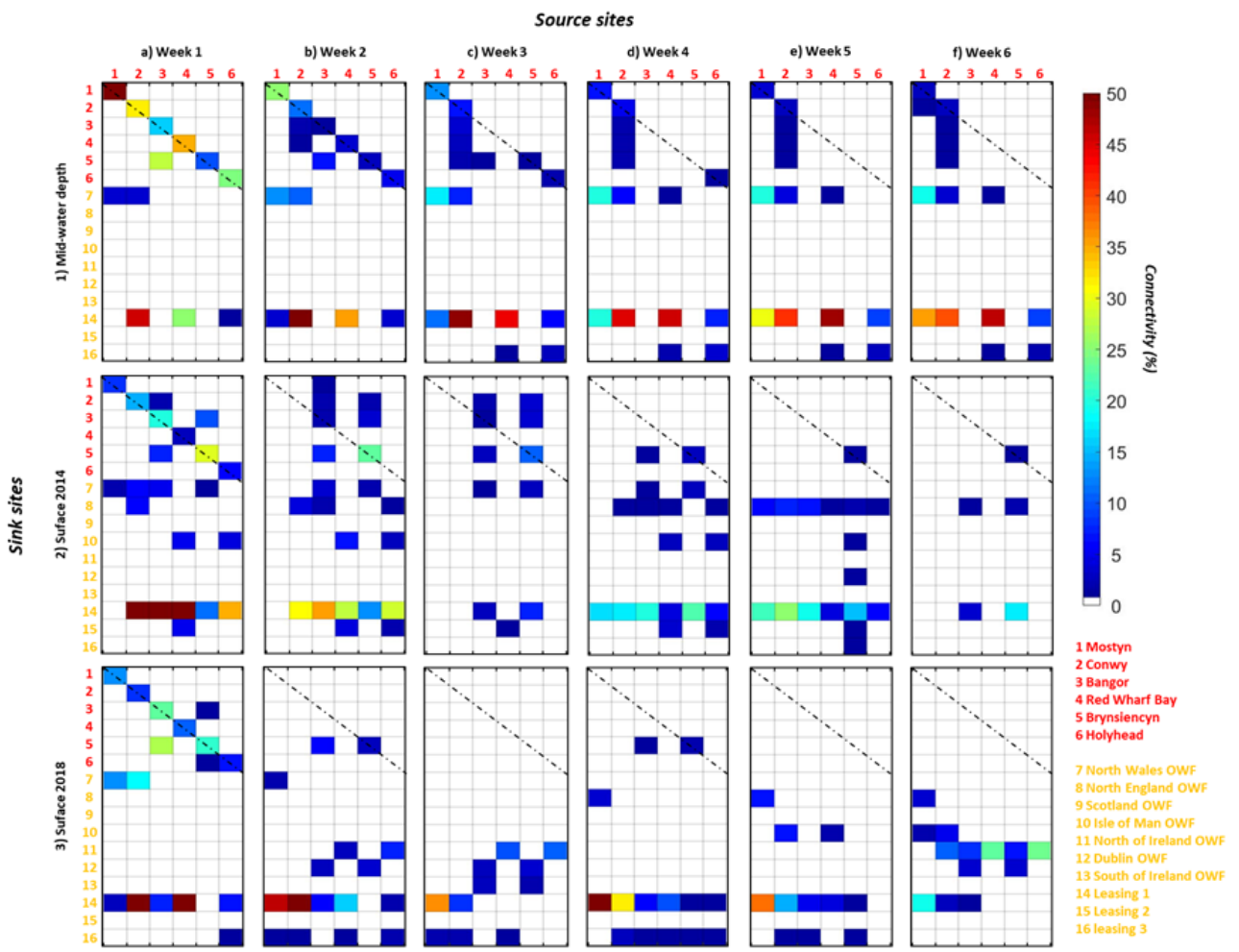

Fig. 6. Connectivity matrices for particles when released from 6 sources site (1-6) at: 1) midwater depth; 2) surface during March and April in 2014; and 3) surface during March and April in 2018. Results are presented per week: (a) week 1; (b) week 2; (c) week 3; (d) week 4; (e) week 5; and (f) week 6. Connectivity between larvae from a source (column) with a sink (row) is highlighted by colour scale with high connectivity in red, low connectivity in blue and no connectivity in white. Self-recruitment (e.g. retention within the release site) is indicated by cells that cross the diagonal dashed line. Sites are colour coded as: red = source and sink sites and orange = sink sites only.

2 for Conwy (68%) and highest connectivity at week 4 for Mostyn (62%) (Fig. 6.3.a and 6.3.d). The Isle of Man showed a low connectivity at week 6 with Mostyn and Conwy (< 5% for both) (Fig. 6.3.f). Dublin showed connectivity with Bangor, Wales (3.4%) and Brynsiecyn (3.7 %) at week 3 and week 6 (Fig. 6.3.c). After six weeks of simulation, north Ireland OWF showed connectivity with: (1) Holyhead and Red Wharf Bay (23% for both); (2) Bangor, Wales and Brynsiencyn (7.3% for both); and (3) Conwy (10%) (Fig. 6.3).

IV. Discussion

The simulated dispersal scenarios were chosen to represent two extreme cases of larvae behaviour (e.g. larvae travelled at the surface and larvae travelled in mid-waters with no vertical swimming) and, hence, capture a wide range of potential dispersal distributions, in order to define the best area for co-location between mussel aquaculture and offshore wind farms. Indeed, if particles stay at mid-water depth, they are only submitted to tidal advection, whereas when larvae are at the surface, they encountered stronger currents (e.g. wind driven currents) which increase their dispersal [24] and [25]. In addition, previous studies showed the importance of circulation patterns on interannual variability of larvae recruitment and eggs/larvae dispersal [26] and [27]. In order to resolve interannual variability in mussel larvae dispersal, simulations occurred during two contrasting years (e.g. 2014 and 2018). Indeed, the wind during March and April 2014 and 2018 were different in strength and direction and consequently have a different impact on surface currents (data not shown). These years were also chosen according to mussel farms harvest data, which showed that in 2014, 1,100 tonnes of seed were harvested in Morecambe Bay, whereas recruitment in 2018 was too small to be harvested.

Assuming mussel larvae are distributed throughout the water column, e.g. developing weak vertical migration, then their dispersal will be controlled by tidal currents and in particular tidal residuals [28]. These tidal residuals can be represented by the monthly-averaged velocities output from the model (Fig. 2). The same pattern of results are observed when the strength and the residual currents are compared between simulation in 2014 and 2018 (data not shown), which explains why the mussel larvae distribution is the same when released at mid-water depth.

These patterns can be used to explain the variability in the larvae dispersal simulated from the mid-water scenarios (Fig. 3). Particles released from Bangor (Wales) and Brynsiencyn dispersed south-westwards through the Menai Strait, along the Llyn Peninsula and into Cardigan Bay – in accordance with the residual tidal currents shown in Fig. 2 [29]. Consequently, the mussel larvae released in the middle of the water column from these two sites showed no connectivity with offshore renewable structures located in the eastern Irish Sea or along the Irish coast (Fig. 6). The dispersal of particles from Conwy was westwards due to westwards residual currents along the north Wales and Anglesey coasts, and south-westwards towards the Menai Strait (Fig. 2). Particles from Red Wharf Bay and Holyhead dispersed westwards then offshore and northwards in accordance with the residual currents, which explain the increase in connectivity through time with Leasing 1 (Fig. 2 and 6). The same residual currents were observed by Ward *et al.* [30] around Anglesey, especially near Holyhead where strong tidal currents occur. Mostyn showed a different pattern compared to the other release sites as particles travelled both westwards along the coast of North Wales and northwards along the English coast to Southport [31] (Fig. 2). The larvae dispersal varied in direction and distance travelled between the 6 released sites, which is the consequence of large variability of tidal current velocities which can reach 2 m/s in certain localised regions such as headlands (e.g. Llyn Peninsula and northwest Anglesey) and tidal channel (e.g. the Menai Strait) [29]. The site of larval release is of major of importance as previously demonstrated for other area and other species [32] and [33].

For the 2014 simulations, results showed that particles from all sites mostly concentrate near Morecambe Bay. This is the consequence of a persistent westerly wind during March and April which reduced the influence of residual tidal currents shown in Fig. 2. These results are correlated with previous studies [29] and [34], which showed that southwards residual currents in the Menai Strait can be reversed to northwards flow at the surface during strong and consistent wind events. For the 2018 simulations, the wind in March and April was generally weaker than March-April 2014 and the wind direction varied (data not shown). Consequently, particles were influenced by both wind-driven and tidal residuals, and the local release locations remained an important factor for dispersal. For the first time, this study showed that site's effect on dispersal could be removed if PLD occurs during strong and persistent wind events like that occurred in March-April 2014. In addition, the results support the observations made by mussel farmers in Morecambe Bay during spring/summer 2014 and 2018, suggesting that mussel larvae are mostly influenced by surface current (Fig. 4 and 5).

The results highlight the importance of the vertical position of larvae in the water column to study potential areas for of multi-use platforms at sea (MUPS). Indeed, the results indicate that Leasing 1 is connected with released sites for all scenarios tested. Consequently, the chance of bio-fouling if offshore renewable energy is installed in this area is high, which could increase the cost of maintenance and the erosion of the structure. The development of MUPS on Leasing 1 will benefit: 1) for both industry by collect mussel larvae before they settle on offshore structures; and 2) for coastal biodiversity by reducing dredging on coastal area. As leasing 1 is a large area (748 km^2), the result could be refined and adding sustainability index (e.g. Sea surface temperature, Chlorophyll-a concentration) to define the best area for co-location of offshore wind farm and aquaculture [35] and [36]. In addition, further studies are required to understand the contribution of new mussel beds installed on ORE infrastructure: 1) qualify and quantify the contribution to coastal biodiversity; and 2) study the potential impact of stepping stone effect, which could help to spread invasive species.

V. Conclusion

The overall results suggest that mussel larvae dispersal is mostly influenced by near-surface currents in the Irish Sea. In addition, the possibility of multi-use platforms at sea in the Irish Sea, co-locating mussel farms with offshore renewable energy, has been proven using numerical studies, especially in the eastern Irish Sea.

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