Report supporting Appropriate Assessment of Aquaculture in Great Island Channel SAC (Site code: 001058)

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1 PREFACE

In Ireland, the implementation of Article 6 of the Habitats Directive in relation to aquaculture and fishing projects and plans that occur within designated sites is achieved through sub-Article 6(3) of the Directive. Fisheries not coming under the scope of Article 6.3, i.e. those fisheries not subject to secondary licencing are subject to risk assessment. Identified risks to designated features can then be mitigated and deterioration of such features can be avoided as envisaged by sub-article 6.2.

Fisheries, other than oyster fisheries, and aquaculture activities are licenced by the Department of Agriculture, Food and Marine (DAFM). Oyster fisheries (in fishery order areas) are licenced by the Department of Communications Energy and Natural Resources (DCENR). The Habitats Directive is transposed in Ireland in the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. 477 of 2011). Appropriate assessments (AA) of aquaculture and risk assessments (RA) of fishing activities are carried out against the Conservation Objectives, and more specifically on the version of the Conservation Objectives that are available at the time of the Assessment, for designated ecological features, within the site, as defined by the National Parks and Wildlife Service (NPWS). NPWS are the competent authority for the management of Natura 2000 sites in Ireland. Obviously, aquaculture and fishing operations existed in coastal areas prior to the designation of such areas under the Directives. Ireland is thereby assessing both existing and proposed aquaculture and fishing activities in such sites. This is an incremental process, as agreed with the EU Commission in 2009, and will eventually cover all fishing and aquaculture activities in all Natura 2000 sites.

The process of identifying existing and proposed activities and submitting these for assessment is, in the case of fisheries projects and plans, outlined in S.I. 290 of 2013. Fisheries projects or plans are taken to mean those fisheries that are subject to annual secondary licencing or authorization. Here, the industry or the Minister may bring forward fishing proposals or plans which become subject to assessment. These Fishery Natura Plans (FNPs) may simply be descriptions of existing activities or may also include modifications to activities that mitigate, prior to the assessment, perceived effects to the ecology of a designated feature in the site. In the case of other fisheries, that are not projects or plans, data on activity are collated and subject to a risk assessment against the Conservation Objectives. Oyster fisheries, managed by DCENR, do not come under the remit of S.I. 290 of 2013 but are defined as projects or plans as they are authorized annually and therefore, should be subject to AA.

In the case of aquaculture, DAFM receives applications to undertake such activity and submits a set of applications, at a defined point in time, for assessment. The FNPs and aquaculture applications are then subject to AA. If the AA or the RA process finds that the possibility of significant effects cannot be discounted or that there is a likelihood of negative consequence for designated features then such activities will need to be mitigated further if they are to continue. The assessments are not explicit on how this mitigation should be achieved but rather indicate whether mitigation is required or not and what results should be achieved.

2 EXECUTIVE SUMMARY

2.1 THE SAC

Great Island Channel SAC is designated as a Special Area of Conservation (SAC) under the Habitats Directive. The marine area is designated for the habitat Mud and sandflats not covered by seawater at low tide. This habitat supports an intertidal sedimentary community. Conservation Objectives for this habitat were identified by NPWS (2014a) and relate to the requirement to maintain habitat distribution, structure and function, as defined by characterising (dominant) species in these habitats. Guidance on the conservation objectives is provided by NPWS (2014b; 2014c).

2.2 ACTIVITIES IN THE SAC

Within the Great Island Channel SAC aquaculture focuses on the cultivation of the Pacific oyster *Crassostrea gigas* predominantly on trestles in intertidal areas. The profile of the aquaculture industry in the SAC, used in this assessment, was prepared by BIM and is derived from the list of licence applications received by DAFM and provided to the MI for assessment in April 2018.

2.3 THE APPROPRIATE ASSESSMENT PROCESS

The function of an appropriate assessment is to determine if the ongoing and proposed aquaculture activities are consistent with the Conservation Objectives for the Natura site or if such activities will lead to deterioration in the attributes of the habitats and species over time and in relation to the scale, frequency and intensity of the activities. NPWS (2011a) provide guidance on interpretation of the Conservation Objectives which are, in effect, management targets for habitats and species in the SAC. This guidance is scaled relative to the anticipated sensitivity of habitats and species to disturbance by the proposed activities. Some activities are deemed to be wholly inconsistent with long term maintenance of certain sensitive habitats while other habitats can tolerate a range of activities. For the practical purpose of management of sedimentary habitats, a 15% threshold of overlap between a disturbing activity and a habitat is given in the NPWS guidance (NPWS 2011c). Below this threshold disturbance is deemed to be non-significant. Disturbance is defined as that which leads to a change in the characterizing species of the habitat (which may also indicate change in structure and function). Such disturbance may be temporary or persistent in the sense that change in characterizing species may recover to pre-disturbed state or may persist and accumulate over time.

The appropriate assessment process is divided into a number of stages consisting of a preliminary risk identification, and subsequent assessment (allied with mitigation measures, if necessary) which are covered in this report. The first stage of the process is an initial screening wherein activities which are deemed not to have any impact on the conservation features, because they do not spatially overlap with a given habitat or have a clear pathway for interaction. These activities are excluded from further consideration. The next phase is the Natura Impact Statement (NIS) where interactions (or risk of) are identified. Further to this, an assessment on the significance of the likely interactions between activities and conservation features is conducted. Mitigation measures (if necessary) will be introduced in situations where the risk of significant disturbance is identified. In situations where there is no obvious mitigation to reduce the risk of significant impact, it is advised that caution should be applied in licencing decisions. Overall the Appropriate Assessment is both the process and the assessment undertaken by the competent authority to effectively validate this

report and/or NIS. It is important to note that the screening process is considered conservative in that activities which may overlap with habitats but which may have very benign effects are retained for full assessment.

2.4 DATA SUPPORTS

Distribution of habitats and species population data are provided by NPWS[1]. Scientific reports on the potential effects of various activities on habitats and species have been compiled by the MI and provide the evidence base for the findings. The profile of aquaculture activities was provided by BIM. The data supporting the assessment of individual activities vary and provides for varying degrees of confidence in the findings.

2.5 FINDINGS

Aquaculture and Habitats/Species:

In the Great Island Channel SAC there are 2 valid oyster production licences using bag and trestle method. The company operating these 2 sites have applied to amalgamate them into one site and have applied to also grow the oysters in floating bags, in the deeper parts of the site. They are also planning to cultivate two native red seaweeds, namely *Porphyra sp.* and *Palmaria palmata*.

An initial screening exercise resulted in one habitat feature being excluded from further consideration. This habitat was Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) (1330) and none of the aquaculture activities (existing and/or proposed) overlaps or likely interacts with this feature and therefore it was excluded from further consideration in the assessment:

- 1140 Mudflats and Sandflats not covered by seawater at low tide

Table 2.1 - Community types recorded in Great Island Channel SAC and the Annex I habitats of (1140) Mudflats and sandflats not covered by seawater at low tide that overlap with overlap with current and existing aquaculture activities

Feature	Community Type	Overlap with intertidal oyster trestle cultivation activities*
Mudflats and Sandflats not covered by seawater at low tide (1140)	Mixed sediment to sandy mud with polychaetes and oligochaetes community complex.	✓

2.5.1 Habitats

A full assessment was carried out on the likely interactions between existing and proposed culture operations and the Annex 1 habitats of 1140 Mudflats and Sandflats not covered by seawater at low

[1] NPWS Geodatabase Ver: September 2015 - http://www.npws.ie/mapsanddata/habitatspeciesdata/

tide. Furthermore, the constituent community 'Mixed sediment to sandy mud with polychaetes and oligochaetes community complex' of habitat 1140 was considered.

Based upon the scale of spatial overlap of current and proposed intertidal oyster aquaculture activities (including access route activity) and the relatively high tolerance levels of the habitats and associated species, the general conclusion is that current and proposed intertidal culture activities are non-disturbing to the Qualifying Interests and their constituent community types.

The subtidal relaying and dredging of Native oysters subtidally, either individually or in-combination with aquaculture activities, are considered non-disturbing to the Qualifying Interest and its constituent community types.

2.5.2 Other considerations

Based upon experience elsewhere, the introduction of '½ grown' or 'wild' oyster or mussel seed stock into aquaculture plots (both within and proximate to the SAC) from outside of Ireland does pose a clear risk of establishment of non-native species in the SAC. In order to mitigate the risk of introduction of alien species into the SAC as a result of aquaculture activities all movement of stock in and out of the Great Island Channel SAC should adhere to relevant legislation and follow best practice guidelines.

Furthermore, the culture on non-sterile Pacific oysters (in contained systems and subtidally un-contained on the seafloor) in the SAC presents as risk of successful reproduction and recruitment of this species within the SAC. It is recommended that triploid *C. gigas* oysters be used in a contained fashion only in licenced aquaculture areas.

3 INTRODUCTION

This document assesses the potential ecological interactions of aquaculture activities within the Great Island channel SAC (Site code 001058) on the Conservation Objectives (COs) of the site. The information upon which this assessment is based is a list of applications and extant licences for aquaculture activities administered by the Department of Agriculture Food and Marine (DAFM) and forwarded to the Marine Institute; as well as aquaculture and fishery profiling information provided on behalf of the operators by Bord Iascaigh Mara. The spatial extent of aquaculture licences is derived from a database managed by the DAFM[2] and shared with the Marine Institute.

4 CONSERVATION OBJECTIVES FOR GREAT ISLAND CHANNEL SAC

The appropriate assessment of aquaculture and fisheries in relation to the Conservation Objectives for Great Island channel SAC is based on Version 1.0 of the objectives (NPWS 2014a - Version 1 June 2014) and supporting documentation (NPWS 2014b - Version 1 May 2014, NPWS 2014c - Version 1 May 2014). The spatial data for conservation features was provided by NPWS[3].

4.1 THE SAC EXTENT

The Great Island Channel stretches from Little Island to Midleton, with its southern boundary being formed by Great Island. It is an integral part of Cork Harbour which contains several other sites of conservation interest. Geologically, Cork Harbour consists of two large areas of open water in a limestone basin, separated from each other and the open sea by ridges of Old Red Sandstone. Within this system, Great Island Channel forms the eastern stretch of the river basin and, compared to the rest of Cork Harbour, is relatively undisturbed. Within the site is the estuary of the Owennacurra and Dungourney Rivers. These rivers, which flow through Midleton, provide the main source of freshwater to the North Channel. The full extent of the SAC is shown in **Figure 4.1** below.

4.2 QUALIFYING INTERESTS (SAC)

The SAC is designated for the following habitats and species (NPWS 2014a), as listed in Annex I and Annex II of the Habitats Directive:

- 1140 Mudflats and Sandflats not covered by seawater at low tide
- 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)

The spatial extent of the Annex 1 Qualifying Interest Mudflats and Sandflats not covered by seawater at low tide (1140) is illustrated in **Figure 4.2** and **Figure 4.3,** respectively (from NPWS 2014b).

Constituent communities and community complexes recorded within the Annex 1 habitats of Mudflats and Sandflats not covered by seawater at low tide (1140) are listed in NPWS (2014b), presented in **Table 4.1** below and illustrated in **Figure 4.4**.

[2] DAFM Aquaculture Database version Aquaculture: March 2015
[3] NPWS Geodatabase Ver: June 2015 - http://www.npws.ie/mapsanddata/habitatspeciesdata/

Table 4.1 - The community types recorded in Great Island Channel SAC and the Annex I habitats in which they occur (NPWS 2014b).

Community Type	Annex I Habitats
	Mudflats and Sandflats (1140)
Mixed sediment to sandy mud with polychaetes and oligochaetes community complex	✓

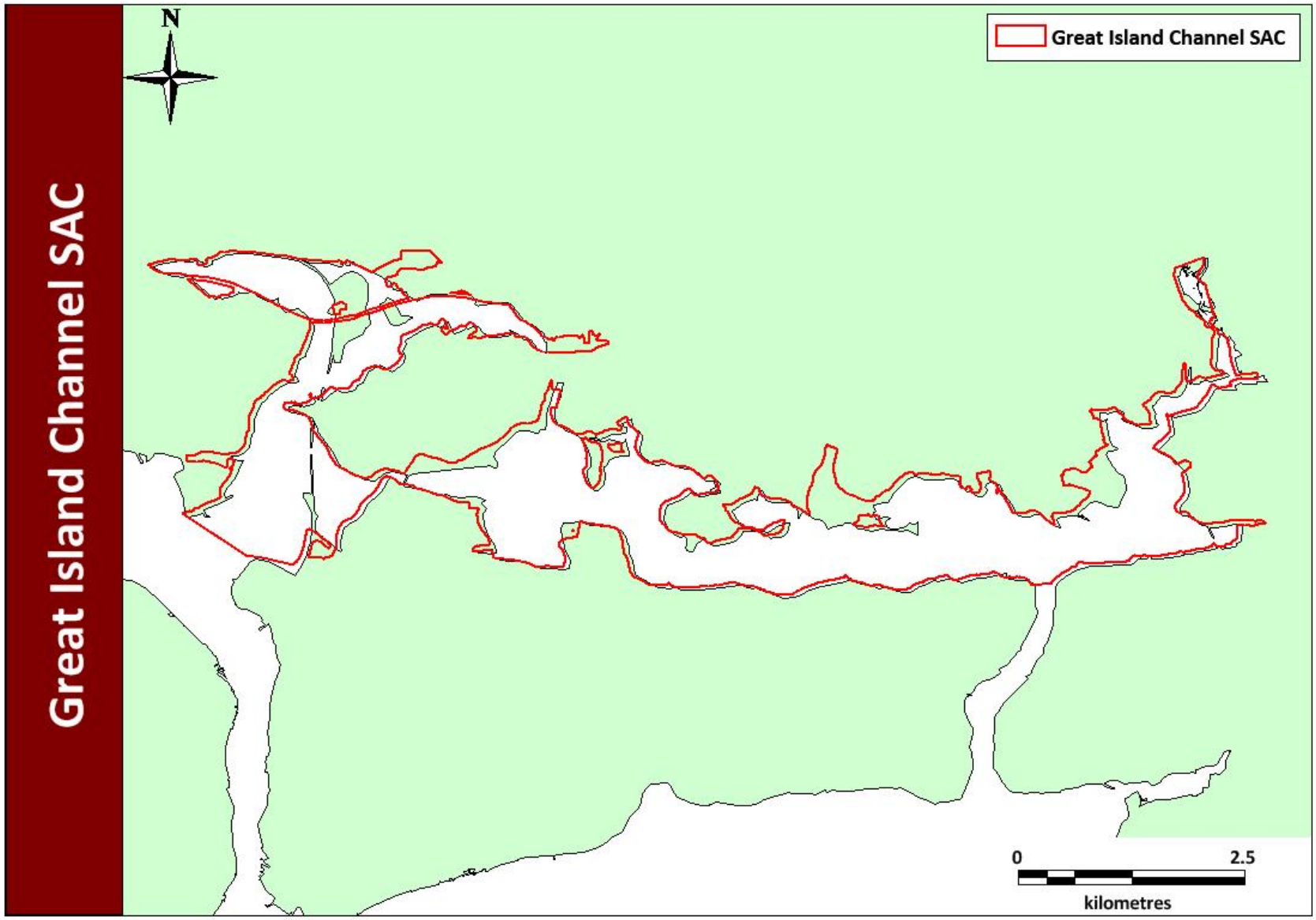

Figure 4.1 - The extent of the Great Island Channel SAC.

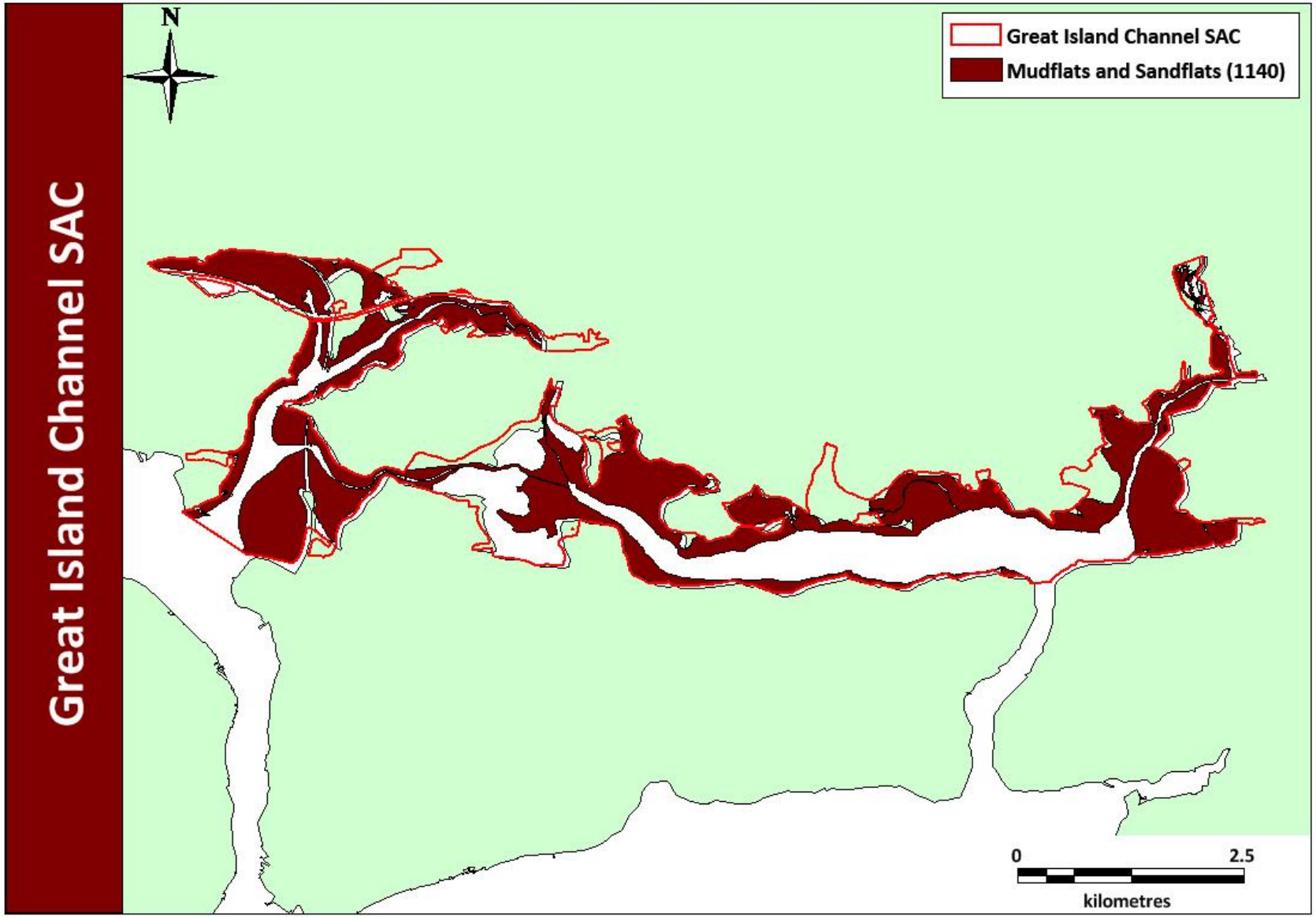

Figure 4.2 - The extent of the marine Annex I Qualifying Interest of (1140) Mudflats and Sandflats not covered by seawater at low tide within the Great Island Channel SAC.

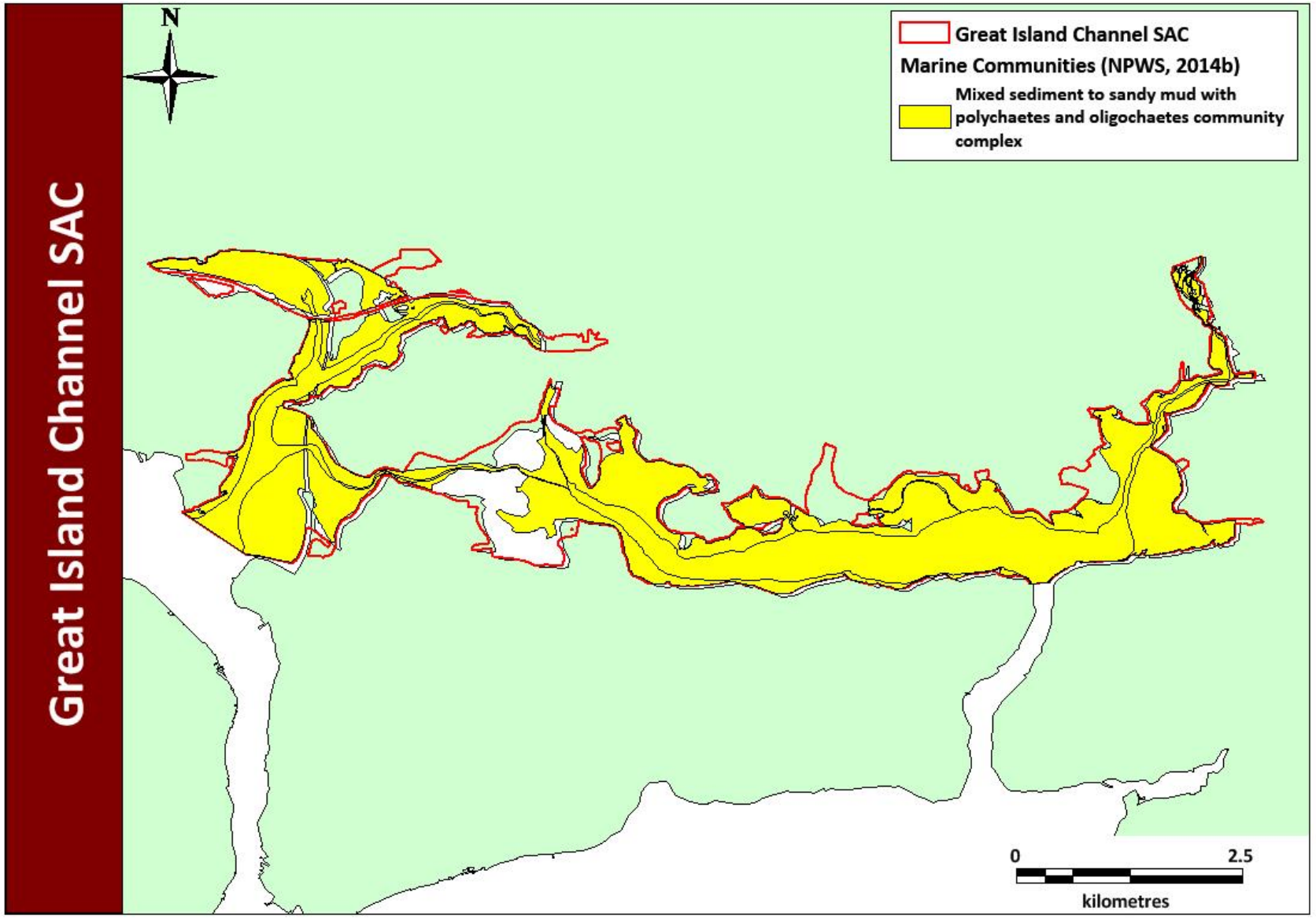

Figure 4.3 - Principal benthic communities recorded within the marine Annex I Qualifying Interests of (1140) Mudflats and Sandflats not covered by seawater at low tide within the Great Island Channel SAC (NPWS 2014b).

4.3 CONSERVATION OBJECTIVES FOR GREAT ISLAND CHANNEL SAC

The Conservation Objectives for the Qualifying Interests for the SAC were prepared by NPWS (NPWS 2014a). The natural condition of the designated features should be preserved with respect to their area, distribution, and extent and community distribution. Habitat availability should be maintained for designated species and human disturbance should not adversely affect such species. The features, objectives and targets of each of the Qualifying Interests within the SAC are listed in **Table 4.2** below.

Table 4.2 - Conservation Objectives and targets for marine habitats and species in Great Island Channel SAC (NPWS 2014a, 2014b). Annex I and II features listed in **bold**.

Feature (Community Type)	Objective	Target(s)
Mudflats and sandflats not covered by seawater at low tide (1140)	Maintain favourable conservation condition	723ha: estimated using OSI data. The target is to ensure the permanent habitat area is stable or increasing, subject to natural processes. Conserve the community type in a natural condition: mixed sediment to sandy mud with polychaetes and oligochaetes community complex. Based on intertidal and subtidal surveys undertaken in 2006 (AQUAFACT, 2007) and 2011 (EcoServe, 2012; MERC, 2012)
(Mixed sediment to sandy mud with polychaetes and oligochaetes community complex.)	Maintain favourable conservation condition	723ha; Likely area derived from intertidal surveys carried out in 2006 and 2011, along with a subtidal survey in 2011.
Atlantic salt meadows (1330)	Restore favourable conservation condition	18.90ha; Based on Saltmarsh Monitoring Project (McCorry and Ryle, 2009). No decline or change in habitat distribution, subject to natural processes. Maintain/restore natural circulation of sediments and organic matter, without any physical obstructions

4.4 SCREENING OF ADJACENT SAC FOR *EX-SITU* EFFECTS

The nearest SACs to the Great Island Channel SAC, are the Ballymacoda (Clonpriest and Pillmore) SAC (Site Code IE000077) and the Courtmacsherry Estuary SAC (Site Code IE001230). The former is 24.6km east and the latter is 54.6km southwest of the Great Island Channel SAC and as a result are screened out.

5 DETAILS OF THE PROPOSED PLANS AND PROJECTS

5.1 DESCRIPTION OF AQUACULTURE ACTIVITIES

Aquaculture activities within the Great Island Channel SAC focus on the intertidal cultivation of Pacific oysters (*Crassostrea gigas*). This assessment focuses on aquaculture activities which occur within the Qualifying Interests of (1140) Mudflats and Sandflats not covered by seawater at low tide for which the Great Island Channel SAC is designated. Descriptions of spatial extents of existing and proposed intertidal oyster aquaculture activities (provided below) within the Qualifying Interest were calculated using coordinates of activity areas in a GIS (**Figure 5.1**). The spatial extent of the cultivation activities (current and proposed) overlapping the Qualifying Interests of (1140) Mudflats and Sandflats not covered by seawater at low tide are presented in **Table 5.1 to 5.2**, while **Table 7.1 to 7.2** presents spatial overlap on constituent communities of the Qualifying Interests of 1140. In the calculation of these overlaps, where multiple species are proposed one site, the activity deemed more disturbing at a site is the activity assessed for that site *e.g.,* mussel longline culture is more disturbing that seaweed culture using longlines.

5.1.1 Intertidal Oyster Cultivation

5.1.1.1 Current activity

In the North Channel there is one company (Fota Oyster Farm) actively farming two bag and trestle Pacific oyster sites (see Figure 5.1). They have applied to amalgamate these two sites into one site totalling 9 hectares, aiming to increase production to 700 tonnes, from a current base of 50 to 100 tonnes. These half grown triploid oysters are transferred for maturation from a sister site in Gweedore, Co. Donegal.

Pacific oyster production has a life cycle from seed input to harvest for market of 2½ years. Oysters are sold fully grown at a size range from 60-140 grams. The oyster seed or half grown are either bought in from other farms in Ireland, or oyster nurseries in Ireland the UK and France.

Pacific oysters are predominantly grown in trestles and bags. Trestles are typically 0.6m-1m in height, 3 metres long and carry 5-6 bags, but this can vary. Seed is generally imported in the spring and in the autumn of each year, or as half grown. The intake size ranges, packed in oyster bags at a predetermined density and taken to the inter-tidal zone, where the bags are attached to trestles for the growing process to begin. Packing densities of seed is individually determined by each producer. Oysters are thinned out and graded as the oysters grow. As the oysters grow, they are taken to a handling / sorting facility or foreshore area for splitting and re-packing and returned to the trestles. The seed will be split following a few months once growth starts. Producers generally split the oysters either once or twice over the growth cycle. Again the density following splitting varies from producer to producer.

Producers generally turn each bag on site once a month. Turning takes place when the oysters are growing. This means turning takes place from March up to Oct/Nov depending on growth. Both spring tides of each month are generally used by producers to get out to their sites. The trestles are arranged in rows and blocks on site. Rows are often set out in pairs with sufficient gap between pairs for flat-bottomed vessels or tractors to pass, allowing servicing.

5.1.1.2 Proposed Activity

There are no applications to licence any new sites in the SAC. The company licensed for the above 2 Pacific oyster sites have applied to also grow the oysters in floating bags, in the deeper parts of the site. The floating oyster bags would be attached to a longline which is moored to the seabed. This would allow the operator to utilise the deeper parts of their site which are too deep for bag and trestle culture. They are also planning to cultivate two native red seaweeds, namely *Porphyra sp.* and *Palmaria palmata*, with seed being purchased from an Irish hatchery, aiming to produce 2 to 4 tonnes of wet seaweed annually.

The overlap of intertidal oyster cultivation activities with the Qualifying Interests of 1140 is presented in **Table 5.1** below. **Table 7.1** presents spatial overlap on constituent communities of the Qualifying Interests of 1140.

5.1.2 Access Routes

The site is accessed directly from the road which leads straight onto the licenced aquaculture site. The access point can be seen in Figure 5.1. As there is no access route between the road and the aquaculture site, there is no additional spatial overlap on constituent communities of Qualifying Interests of 1140 above the overlap from the licenced site itself.

Table 5.1 - Spatial extent (ha) of intertidal oyster aquaculture areas overlapping with the Qualifying Interest of Mudflats and sandflats not covered by seawater at low tide [1140] in the Great Island Channel SAC (Site Code 001058). Spatial extent of licenced areas presented according to Qualifying Interest and license status.

Licence Status	Culture Species	Qualifying Interest 1140 (722.24 ha)
		% Overlap (Overlap ha)
Licensed	Oysters Trestles	0.25% (1.77ha)
Total		**0.25% (1.77ha)**

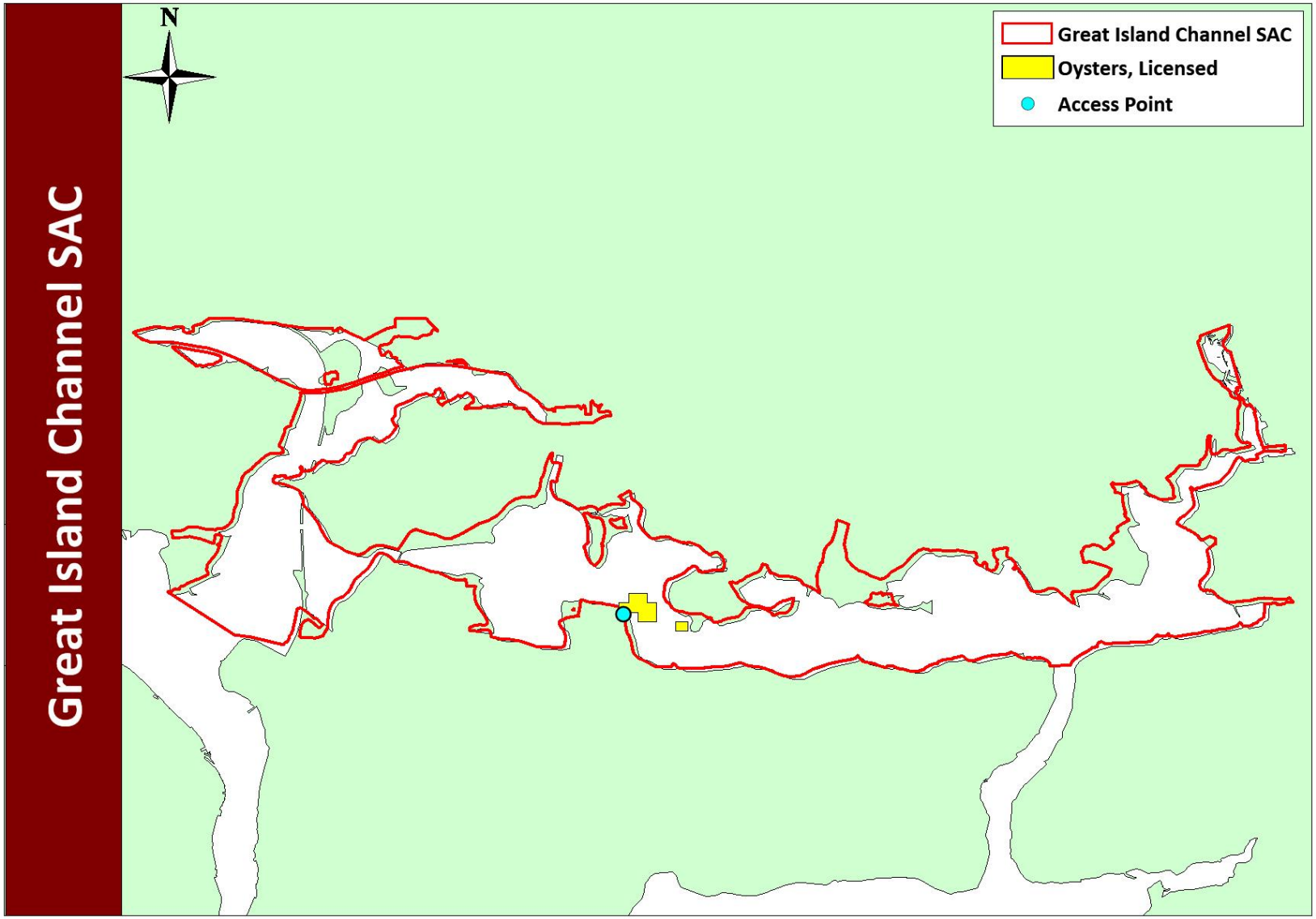

Figure 5.1- Aquaculture sites in the Great Island Channel SAC Bay.

6 NATURA IMPACT STATEMENT FOR THE PROPOSED ACTIVITIES

The potential ecological effects of activities on the Conservation Objectives for the site relate to the physical and biological effects of aquaculture cultivation structures and activities and human activities on designated species, intertidal habitats and invertebrate communities, and biotopes within those broad habitat types. The overall effect on the conservation status will depend on the spatial and temporal extent of fishing and aquaculture activities during the lifetime of the proposed plans and projects and the nature of each of these activities in conjunction with the sensitivity of the receiving environment. Bottom cultivation and harvesting of shellfish can, like fishing, alter the surrounding environment, both physically and biologically, not only due to the presence of the culture organisms (e.g. increased deposition, disease, shading, fouling, alien species) but also due to the activities associated with the culture mechanisms (e.g. structures resulting in current alteration, dredging, sediment compaction), the extraction of commercial and natural populations and the physical effects of dredging. In assessing the impact of the proposed aquaculture activities, the most disturbing activity at a site is brought forward for consideration e.g. intertidal clam culture is more destructive than oyster culture and the cuboidal cage system for oyster culture exerts more of a pressure than bag and trestle culture.

Aquaculture activities within the SAC focus on the intertidal (bags and trestle) cultivation of the Pacific oyster, *C. gigas*. Details of the potential biological and physical effects of this aquaculture activity on the habitat features, their sources and the mechanism by which the impact may occur are discussed below and summarised in **Table 6.1** below. The impact summaries identified in the table are derived from published primary literature and review documents that have specifically focused upon the environmental interactions of mariculture (e.g. Black 2001; McKindsey *et al.,* 2007; NRC 2010; O'Beirn *et al.,* 2012; Cranford *et al.,* 2012; ABPMer 2013a-h).

6.1 BIOLOGICAL EFFECTS OF AQUACULTURE – ALL CULTURE METHODS

Habitat/Sediment Disturbance - Suspended culture

Oysters, being suspension feeding bivalve molluscs, feed at the lowest trophic level feeding largely as herbivores, relying primarily on ingestion of phytoplankton. Therefore, the culture process does not rely on the input of feedstuffs into the aquatic environment. Suspension feeding bivalves filter suspended matter from the water column and the resulting faeces and pseudofaeces (non-ingested material) are then deposited onto the seafloor, this is known as biodeposition and is a component of a greater process called benthic-pelagic coupling. This deposition can accumulate on the seafloor beneath aquaculture installations (intertidal trestle and cage culture) and can alter the local sedimentary habitat type in terms of organic content and particle size which has, in certain circumstances been shown to alter the infaunal community therein.

Moderate enrichment due to deposition can lead to increased diversity due to increased food availability; however further enrichment can lead to a change in sediment biogeochemistry (e.g. oxygen levels decrease and sulphide levels increase) which can result in a reduction in species richness and abundance resulting in a community dominated by specialist species. In extreme cases of protracted organic enrichment anoxic conditions may occur where no fauna survives and the sediment may become blanketed by a bacterial mat. Changes to the sedimentary habitat due to deposition are indicated by a decrease in oxygen levels, increased sulphide reduction, decrease in REDOX depth and particle size changes.

Several factors can affect the rate of deposition onto the seafloor; these include structure and culture density, site hydrography and site history. Oysters and clams have a “plastic response” to increased levels of suspended matter in the water column and can modify their filtration rate accordingly and thus increase the production of pseudofaeces which results in an increase in transfer of particles to the seafloor. The degree to which the material disperses away from the footprint of the culture system (e.g. trestles & bags etc.) is governed by the density of oysters on the system, the depth of water and the water currents in the vicinity. It is likely that some overlap in effect will be realised. The duration and extent to which culture has been conducted on site may lead to cumulative impacts on the seabed, especially in areas where assimilation or dispersion of faeces/pseudofaeces is not rapid. A number of features of the site and culture practices will govern the speed at which faeces/pseudofaeces are assimilated or dispersed by the site. These relate to:

- Hydrography (residence time, tidal range, residual flow) govern how quickly the wastes disperse from the culture location and the density at which they will accumulate on the seafloor i.e. the greater the tidal range and residual flow then the greater the rate of dispersion and therefore the risk of accumulation is reduced.

- Turbidity in the water-the higher the water turbidity the greater the production of pseudo-faeces/faeces by the suspension feeding animal (“plastic response“) and therefore greater the risk of accumulation on the seafloor.

- Density of structures-high density of culture structures (e.g. cuboidal system cages, trestles & bags etc.) can result in the slowing of water currents/impediment of water flow (baffling effect), slow it down and cause localised deposition of material on the seafloor.

- Density of culture-the greater the density organisms the greater the risk of accumulations of material, suspended culture is considered a dense culture method with high densities of culture organisms over a small area. The density of culture organisms is a function of:

    - depth of the site (shallow sites have shorter droppers and hence fewer culture organisms),

    - husbandry practices – proper maintenance will result in optimum densities on the lines as well as ensuring a reduced risk of drop-off of culture animals to the seafloor as well as ensuring a sufficient distance among the longlines to reduce the risk of cumulative impacts in depositional areas.

Seston filtration - All culture methods

Suspension feeding bivalves such as oysters have a large filtration capacity and in confined areas, have been shown to alter the phytoplankton and zooplankton community abundance and structure and therefore potentially impact on the production of an area. This method of feeding may reduce water turbidity hence increasing light penetration, which may increase phytoplankton production and therefore food availability. This increase in light penetration can have positive effects on light sensitive species such as maerl, seagrass and macroalgae.

Shading - Suspended culture

The structures associated with suspended culture (e.g. trestles & bags, baskets & cages etc.) can prevent light penetration to the seabed and therefore potentially impact on light sensitive species such as maerl, seagrass and macroalgae.

Fouling/Habitat creation - All culture methods

The structures associated with aquaculture, and the culture organisms themselves provide increased habitat for fouling species to colonise and therefore increase diversity; results in increased secondary production and increased nekton production.

Introduction of Non-native species - All culture methods

Movement and introduction of bivalve shellfish can be a vector for the introduction and spread of non-native/alien species. In some instances the introduced species may proliferate rapidly and compete with and in some cases replace the native species. Recruitment of *C. gigas* has been documented in a number of bays in Ireland and appears to have become naturalised (i.e. establishment of a breeding population) in two locations (Kochmann *et al.,* 2012; 2013) and may compete with the native species for space and food.

Another means is the unintentional introduction of non-native species/diseases which are associated with the imported target culture species, and their subsequent spread and establishment. These associated species are referred to as ”hitch-hikers” and include animals and plants and/or parasites and diseases that potentially could cause outbreaks within the culture species or spread to other local species.

The introduction and establishment of non-native species can result in loss of native biodiversity due to increased competition for food and habitat and also predation and/or disease.

Disease risk - All culture methods

Due to the nature of the culture methods the risk of transmission of disease from cultured to wild stocks is high, e.g. the introduction of the parasitic protozoan *Bonamia ostreae*, which has caused the mass mortality within Irish native Oyster Beds. This risk can be limited by compiling a bio security plan, screening all introduced stock prior to transferring to on growing site and also good animal husbandry. Disease risk associated with movement of shellfish is governed by Fish health legislation on the movement of shellfish stocks into and out of culture areas and will not be considered further in this assessment.

By-catch mortality-Bottom culture

Mortality of organisms captured or disturbed during the harvest and damage to structural fauna or reefs.

Nutrient Exchange - All culture methods

By their suspension feeding nature, removing particulate matter from the water column and releasing nutrients in solid and dissolved forms, bivalves influence benthic-pelagic coupling of organic matter and nutrients. Intensive bivalve culture can cause changes in ammonium and dissolved inorganic nitrogen resulting in increased primary production. The removal of nitrogen from the system is caused by both removal via harvest or denitrification at sediment surface.

6.2 PHYSICAL EFFECTS OF AQUACULTURE

Current alteration - Suspended culture

The structures used in aquaculture (e.g. trestles & bags, baskets & cages etc.) can alter the hydrodynamics of an area i.e. increase/decrease water flow, this is known as the "Baffling effect". An increase in water flow will result in scouring of the seafloor leading to an increase in coarse sediment while a decrease in current flow will result in an increase in the amount of fine particles being deposited. Both result in a change in the sedimentary habitat structure and therefore can lead to change in the composition of the benthic infaunal community.

Surface disturbance-All culture methods

All aquaculture activities physically alter the receiving habitat, but the level of this disturbance depends on the culture method employed. The culture of bivalves on the seabed (on-bottom) in an uncontained fashion involves the dredging of the seafloor at various stages in the culture process i.e. laying of seed, routine maintenance, removal of predators ("mopping"), stock movements and finally harvesting. The frequency of dredging activity depends on site management and how often stock is moved to new ongrowing areas to maximise growth and minimise predation prior to harvest. This dredging activity physically disturbs the seafloor and the organisms therein, and has been demonstrated to cause habitat and community changes.

The intertidal culture of bivalves (e.g. bags & trestles, baskets & cages) does not require dredging and therefore is less damaging (physically) to the seafloor than the bottom culture method. However, the intertidal habitat can be affected by the presences of cages directly on the seabed and ancillary activities on-site i.e. servicing, vehicles on shore; human traffic and boat access lanes, causing an increased risk of sediment compaction resulting in sediment changes and associated community (infaunal and epifaunal) changes. Such activities can result in shallow and/or deep physical disturbance causing burrows to collapse, deeply burrowed organisms to die due to smothering and/or preventing siphon connection to the sediment surface or by directly crushing the animal.

Shading - Suspended culture

The structure associated with suspended culture (e.g. trestles & bags, baskets & cages etc.) have the potential to prevent light penetration to the seabed and therefore potentially impact on light sensitive species such as maerl, seagrass and macroalgae.

Table 6.1 - Potential indicative environmental pressures of aquaculture activities within the Qualifying Interests of Mudflats and sandflats not covered by seawater at low tide [1140] of the Great Island Channel SAC .

Activity	Pressure category	Pressure	Potential effects	Equipment / Gear	Duration (days)	Time of year	Factors constraining the activity
Intertidal Oyster Culture	Physical	Current alteration	Structures may alter the current regime and resulting increased deposition of fines or scouring.	Trestles and bags, baskets and cages and service equipment	365	All year	At low tide only
		Surface disturbance	Presence of cages directly on the seabed and ancillary activities at sites, e.g. servicing, transport increase the risk of sediment compaction resulting in sediment changes and associated community changes.				
		Shading	Prevention of light penetration to seabed potentially impacting light sensitive species				
	Biological	Non-native species introduction	Potential for non-native species (*C. gigas*) to reproduce and proliferate in SAC. Potential for alien species to be included with culture stock (hitch-hikers).				
		Disease risk	In event of epizootic the ability to manage disease in uncontained subtidal oyster populations is compromised.				
		Organic enrichment	Faecal and pseudofaecal deposition on seabed potentially altering community composition				
	Physical	Current alteration	Structures may alter the current regime and resulting increased deposition of fines or scouring.				

7 SCREENING OF AQUACULTURE ACTIVITIES

A screening assessment is an initial evaluation of the possible impacts that activities may have on the Qualifying Interests. The screening process is a filter, which may lead to exclusion of certain activities or Qualifying Interests from further assessment, thereby simplifying the process. Screening is a conservative filter that minimises the risk of false negatives.

In this report, screening of the Qualifying Interests against the proposed activities is based primarily on spatial overlap i.e. if the Qualifying Interests overlap spatially with the proposed activities then impacts due to these activities on the Conservation Objectives for the Qualifying Interests is not discounted (not screened out) except where there is absolute and clear rationale for doing so. Conversely, if there is no spatial overlap and no obvious interaction is likely to occur, then the possibility of significant impact is discounted and further assessment of possible effects is not deemed necessary.

Table 5.1 to **Table 5.3** highlights the spatial overlap between (existing and proposed) intertidal oyster aquaculture activities, and the habitat features of (1140) Mud sand sandflats not covered by seawater at low tide, while **Table 7.1** and **Table 7.2** presents spatial overlap on constituent community types of the habitat features of 1140.

7.1 AQUACULTURE ACTIVITY SCREENING

Where the overlap between intertidal oyster aquaculture activities and a feature is zero and there is no likely interaction of risk identified, it is screened out and not considered further. Therefore, the following habitats and species are excluded from further consideration in this assessment:

- 1330 Atlantic salt meadows (*Glauco-Puccinellietellia maritimae*)

When overlap was observed it was quantified in a GIS application and presented on the basis of coverage of specific activity representing different pressure types (i.e. intertidal oyster cultivation [bags and trestles] and subtidal oyster cultivation) and licence status (licenced or application) intersecting with designated conservation features and/or sub-features (community types) (see **Table 7.1**).

Intertidal oyster cultivation

Table 7.1 below provides an overview of overlap of aquaculture activities and specific marine community types (identified from Conservation Objectives (i.e. NPWS 2014a; b) within the broad habitat features of (1140) Mud and sandflats not covered by seawater at low tide.

Intertidal oyster aquaculture activities overlap the community type listed under the habitat feature of Mud and sandflats not covered by seawater at low tide (1140), Mixed sediment to sandy mud with polychaetes and oligochaetes community complex (see **Table 7.1**).

Access Routes

As the access point is within the licenced site there is no additional spatial overlap from access routes above the overlap from the licenced site.

Table 7.1- Habitat utilisation i.e. spatial overlap in percentage and hectares (given in parentheses) of intertidal oyster cultivation activity over community types within the Qualifying Interest 1140 Mudflats and sandflats not covered by seawater at low tide in the Great Island Channel SAC Spatial data based on licence database provided by DAFM. Habitat data provided in NPWS 2014b.

Licence Status	Culture Species / Method	Qualifying Interest 1140 (722.24 ha)
		Community Type
		Mixed sediment to sandy mud with polychaetes and oligochaetes community complex (722.24ha)
		Overlap % (Overlap ha)
Licensed	Oysters Trestles	0.25% (1.77ha)
Total		**0.25% (1.77ha)**

8 ASSESSMENT OF AQUACULTURE ACTIVITIES

8.1 DETERMINING SIGNIFICANCE

The function of an appropriate assessment is to determine if the ongoing and proposed aquaculture activities are consistent with the Conservation Objectives for the Natura site or if such activities will lead to deterioration in the attributes of the habitats and species over time and in relation to the scale, frequency and intensity of the activities. NPWS (2013b) provide guidance on interpretation of the Conservation Objectives which are, in effect, management targets for habitats and species in the SAC. This guidance is scaled relative to the anticipated sensitivity of habitats and species to disturbance by the proposed activities. Some activities are deemed to be wholly inconsistent with long term maintenance of certain sensitive habitats while other habitats can tolerate a range of activities. For the practical purpose of management of sedimentary habitats a 15% threshold of overlap between a disturbing activity and a habitat is given in the NPWS guidance. Below this threshold disturbance is deemed to be non-significant. Disturbance is defined as that which leads to a change in the characterising species of the habitat (which may also indicate change in structure and function). Such disturbance may be temporary or persistent in the sense that change in characterising species may recover to pre-disturbed state or may persist and accumulate over time.

The significance of the possible effects of the proposed activities on habitats, as outlined in the Natura Impact Statement (**Section 6**) and subsequent screening exercise (**Section 7**), is determined here in the assessment. The significance of effects is determined on the basis of Conservation Objective guidance for constituent habitats and species (**Figures 4.4** and NPWS 2013a; b).

Within the Great Island Channel SAC the qualifying habitats/species considered subject to potential disturbance and, therefore, carried further in this assessment are:

- 1140 Mudflats and sandflats not covered by seawater at low tide

For broad habitats and community types (**Figures 4.2, 4.3, 4.4**) significance of interaction is determined in relation to, first and foremost, spatial overlap (see **Section 5**; **Table 5.1)** and **Section 7**; **Table 7.1)**. Subsequent disturbance and the persistence of disturbance are considered as follows:

1. The degree to which the activity will disturb the Qualifying Interest. By disturb is meant change in the characterising species, as listed in the Conservation Objective guidance (NPW,S 2014b) for constituent communities. The likelihood of change depends on the sensitivity of the characterising species to the activities in question. Sensitivity results from a combination of intolerance to the activity and/or recoverability from the effects of the activity (see **Section 8.2** below).

2. The persistence of the disturbance in relation to the intolerance of the community. If the activities are persistent (high frequency, high intensity) and the receiving community has a high intolerance to the activity (i.e. the characterising species of the communities are sensitive and consequently impacted) then such communities could be said to be persistently disturbed.

3. The area of communities or proportion of populations disturbed. In the case of community disturbance (continuous or ongoing) of more than 15% of the community area it is deemed

to be significant. This threshold does not apply to the sensitive habitat *Zostera* where any spatial overlap of activities should generally be avoided.

Effects will be deemed to be significant when cumulatively they lead to long term change (persistent disturbance) in broad habitat/features (or constituent communities) resulting in an impact greater than 15% of the area.

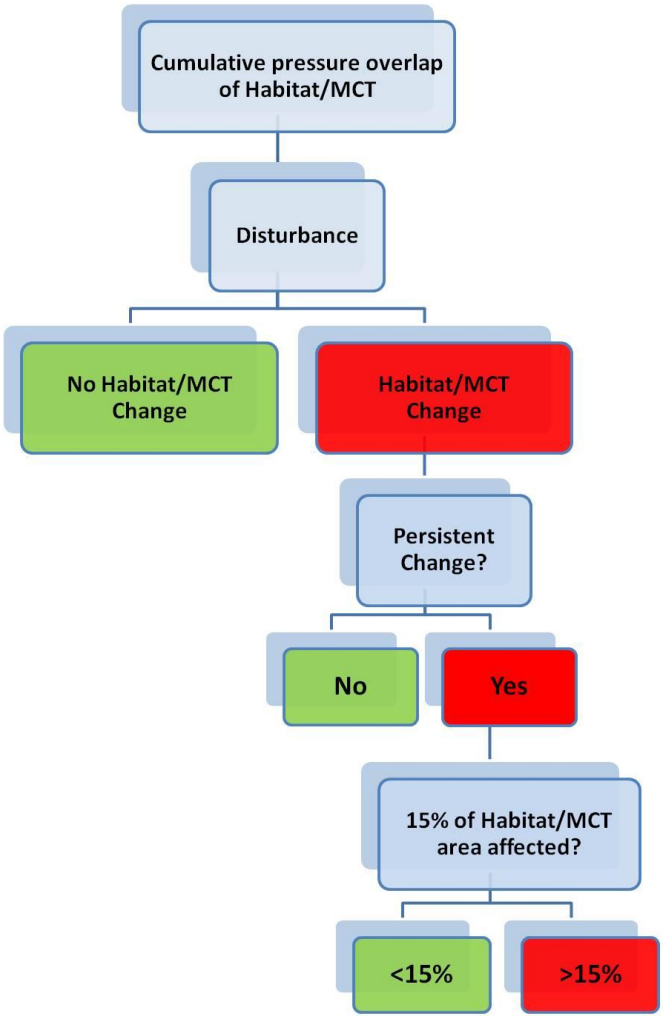

Figure 8.1 - Determination of significant effects on community distribution, structure and function for sedimentary habitats (following NPWS, 2014b).

8.2 SENSITIVITY AND ASSESSMENT RATIONALE

This assessment used a number of sources of information in assessing the sensitivity of the characterising species of each community recorded within the benthic habitats of Great Island Channel SAC. One source of information is a series of reviews commissioned by the Marine Institute which identify habitat and species sensitivity to a range of pressures likely to result from aquaculture and fishery activities (ABPMer 2013a-h). These reviews draw from the broader literature, including the MarLIN Sensitivity Assessment (Marlin.ac.uk) and the AMBI Sensitivity Scale (Borja *et al.,* 2000) and other primary literature. It must be noted that NPWS have acknowledged that given the wide range of community types that can be found in marine environments, the application of conservation targets to these would be difficult (NPWS 2013b). On this basis, NPWS have proposed

broad community complexes as management units. These complexes (for the most part) are very broad in their description and do not have clear surrogates which might have been considered in targeted studies and thus reported in the scientific literature. On this basis, the confidence assigned to likely interactions of the community types with anthropogenic activities are by necessity relatively low, with the exception of community types dominated by sensitive taxa, e.g. Maerl and *Zostera*. Other literature cited in the assessment does provide a greater degree of confidence in the conclusions. For example, the output of a recent study has provided greater confidence in terms of assessing likely interactions between intertidal oyster culture and marine habitats (Forde *et al.,* 2015). Sensitivity of a species to a given pressure is the product of the intolerance (the susceptibility of the species to damage, or death, from an external factor) of the species to the particular pressure and the time taken for its subsequent recovery (recoverability is the ability to return to a state close to that which existed before the activity or event caused change). Life history and biological traits are important determinants of sensitivity of species to pressures from aquaculture.

In the case of species, communities and habitats of conservation interest, the separate components of sensitivity (intolerance, recoverability) are relevant in relation to the persistence of the pressure:

- For persistent pressures i.e. activities that occur frequently and throughout the year recovery capacity may be of little relevance except for species/habitats that may have extremely rapid (days/weeks) recovery capacity or whose populations can reproduce and recruit in balance with population damage caused by aquaculture. In all but these cases and if sensitivity is moderate or high then the species/habitats may be negatively affected and will exist in a modified state. Such interactions between aquaculture and species/habitat/community represent persistent disturbance. They become significantly disturbing if more than 15% of the community is thus exposed (NPWS 2013b).

- In the case of episodic pressures i.e. activities that are seasonal or discrete in time both the intolerance and recovery components of sensitivity are relevant. If sensitivity is high but recoverability is also high relative to the frequency of application of the pressure then the species/habitat/community will be in Favourable Conservation Status for at least a proportion of time.

The sensitivities of the community types (or surrogates) found within the Great Island Channel SAC to pressures similar to those caused by aquaculture (e.g. smothering, organic enrichment and physical disturbance) are identified in **Table 8.1**. The sensitivities of species which are characteristic (as listed in the Conservation Objective supporting document) of benthic communities to pressures similar to those caused by aquaculture (e.g. smothering, organic enrichment and physical disturbance) are identified, where available, in **Table 8.2**. The following guidelines broadly underpin the analysis and conclusions of the species and habitat sensitivity assessment:

- Sensitivity of certain taxonomic groups such as emergent sessile epifauna to physical pressures is expected to be generally high or moderate because of their form and structure (Roberts *et al.,* 2010). Also high for those with large bodies and with fragile shells/structures, but low for those with smaller body size. Body size (Bergman and van Santbrink, 2000) and fragility are regarded as indicative of a high intolerance to physical abrasion caused by fishing gears (i.e. dredges). However, even species with a high intolerance may not be sensitive to the disturbance if their recovery is rapid once the pressure has ceased.

- Sensitivity of certain taxonomic groups to increased sedimentation is expected to be low for species which live within the sediment, deposit and suspension feeders; and high for those sensitive to clogging of respiratory or feeding apparatus by silt or fine material.

- Recoverability of species depends on biological traits (Tillin *et al.,* 2006) such as reproductive capacity, recruitment rates and generation times. Species with high reproductive capacity, short generation times, high mobility or dispersal capacity may maintain their populations even when faced with persistent pressures; but such environments may become dominated by these (r-selected) species. Slow recovery is correlated with slow growth rates, low fecundity, low and/or irregular recruitment, limited dispersal capacity and long generation times. Recoverability, as listed by MarLIN, assumes that the impacting factor has been removed or stopped and the habitat returned to a state capable of supporting the species or community in question. The recovery process is complex and therefore the recovery of one species does not signify that the associated biomass and functioning of the full ecosystem has recovered (Anand and Desrocher, 2004) cited in Hall *et al.,* 2008).

8.3 ASSESSMENT OF THE EFFECTS OF AQUACULTURE PRODUCTION ON THE CONSERVATION OBJECTIVES FOR HABITAT FEATURES IN THE GREAT ISLAND CHANNEL SAC

Aquaculture pressures on a given habitat are related to vulnerability (spatial overlap or exposure of the habitat to the equipment/culture organism combined with the sensitivity of the habitat) to the pressures induced by culture activities. To this end, the location and orientation of structures associated with the culture organism, the density of culture organisms, the duration of the culture activity are all important considerations when considering risk of disturbance of intertidal oyster cultivation activity to habitats and species. Similarly, important aspects of intertidal clam cultivation that must be considered include location, organism, the density of clam culture beds, and the duration of the culture activity and harvesting (i.e. dredging).

NPWS (2014b) provide lists of species characteristic of benthic communities occurring within Annex I features that are defined in the Conservation Objectives.

The constituent communities identified in the broad Annex 1 feature of (1140) Mudflats and sandflats not covered by seawater at low tide:

- Mixed sediment to sandy mud with polychaetes and oligochaetes community complex.

For **(1140) Mudflats and sandflats not covered by seawater at low tide** there are a number of attributes (with associated targets) relating to the following broad habitat features as well as constituent community types;

1. **Habitat Area -** it is unlikely that the activities proposed will reduce the overall extent of permanent habitat within the feature (1140) Mudflats and sandflats not covered by seawater at low tide. The habitat area is likely to remain stable.

2. **Community Distribution - (conserve a range of community types in a natural condition) -** this attribute considered interactions with the community types listed above. **Table 8.1** below indicates the community types, found within the Qualifying Interests of 1140 that

are considered further as part of the assessment (i.e. community types which overlap with current and existing aquaculture activities).

Table 8.1 - Community types recorded in Great Island Channel SAC and the Annex I habitats of (1140) Mudflats and sandflats not covered by seawater at low tide that overlap with overlap with current and proposed aquaculture activities

Feature	Community Type	Overlap with intertidal oyster trestle cultivation activities
Mudflats and Sandflats not covered by seawater at low tide (1140)	Mixed sediment to sandy mud with polychaetes and oligochaetes community complex.	✓

For community types listed under 1140 **Table 8.2** lists the habitats and **Table 8.3** lists the constituent taxa and both provide a commentary of sensitivity to a range of pressures. The risk scores are derived from a range of sources identified above. The pressures are listed as those likely to result from intertidal oyster culture (bags & trestle) and subtidal dredging for oysters within the SAC.

The likely interactions between (existing and proposed) intertidal oyster cultivation aquaculture activities and the broad habitat feature of 1140 and their constituent community types are described in **Table 8.5** together with a broad conclusion and justifications on whether the activities in isolation and/or cumulatively are considered disturbing to the feature in question. It must be noted that the sequence of distinguishing disturbance is as highlighted above, whereby activities with spatial overlap on habitat features are assessed further for their ability to cause persistence disturbance on the habitat. If persistent disturbance is likely then the spatial extent of the overlap is considered further.

Intertidal oyster cultivation

The combined spatial overlap of current oyster trestle cultivation (there is no new applications) occurs in the only constituent community type identified for the Qualifying Feature habitat of (1140) Mud and sandflats not covered by seawater at low tide (see **Table 7.1**). The spatial overlap of licensed oyster trestle culture activities with this community types is 0.25%. Also, published literature (Forde *et al.,* 2015; O'Carroll *et al.,* 2016) suggests that the presence of bags on trestles is considered non-disturbing to sedimentary habitats.

Consequently, adverse impacts of activities occurring at oyster cultivation sites within the Qualifying Interests of (1140) Mud and sandflats not covered by seawater at low tide **can be discounted** (see **Table 8.5**).

Introduction of non-native species

As already outlined oyster culture may present a risk in terms of the introduction of non-native species as the Pacific oyster (*Crassostrea gigas*) itself is a non-native species. Recruitment of *C. gigas* has been documented in a number of Bays in Ireland and appears to have become naturalised (i.e. establishment of a breeding population) in two locations (Kochmann *et al.,* 2012; 2013) and may

compete with the native species for space and food. In addition to having large number of oysters in culture, Kochmann *et al.,* (2013) identified long residence times and large intertidal areas as factors likely contributing to the successful recruitment of oysters in Irish bays. The risk of Pacific oysters naturalising in Great Island Channel **cannot be discounted.**

While there is minimal risk associated with the introduction of hitchhiker species with hatchery reared oyster seed, the risk posed by the introduction of '½-grown' or 'wild' seed originating from another jurisdiction (e.g. Britain, France) **cannot be discounted**.

8.3.1 Conclusion Summary

In summary, it is concluded (based primarily upon the spatial overlap and sensitivity analysis) current intertidal oyster aquaculture activities individually and in-combination **do not pose a risk** of significant disturbance to the conservation habitats (1140 and constituent marine community type) in the Great Island Channel SAC.

In addition, the contained subtidal cultivation of native oysters **does not pose** a significant risk to the Conservation Objectives of marine benthic habitat features for which the SAC is designated.

The risk posed by the introduction of seed stock (e.g. ½ grown oysters or seed) from outside of the jurisdiction **cannot be discounted**.

The risk of successful Pacific oyster reproduction in Great Island SAC (and Cork Harbour) posed by the culture of non-triploid (reproductively sterile) oysters **cannot be discounted** on the basis of the area having long residence times and large intertidal areas.

Table 8.2 - Matrix showing the characterising habitats sensitivity scores x pressure categories for habitats (or surrogates) in Great Island Channel SAC (ABPMer 2013a-h) (**Table 8.4** provides the code for the various categorisation of sensitivity and confidence.)

Community Type (Surrogate [EUNIS code])	Surface Disturbance	Shallow Disturbance	Deep Disturbance	Trampling – access by foot	Trampling – access by vehicle	Extraction	Siltation (addition of fine sediments, pseudofaeces, fish food)	Smothering (addition of materials biological or non-biological to the surface)	Changes to sediment composition- increased coarseness	Changes to sediment composition- increased fine sediment proportion	Changes to water flow	Increase in turbidity/suspended sediment	Decrease in turbidity/suspended sediment	Organic enrichment-water column	Organic enrichment of sediments-sedimentation	Increased removal of primary production-phytoplankton	Decrease in oxygen levels- sediment	Decrease in oxygen levels-water column	Introduction of non-native species	Removal of Target Species	Removal of Non-target species	Introduction of antifoulants	Introduction of medicines	Introduction of hydrocarbons	Prevention of light reaching seabed/features
Mixed sediment to sandy mud with polychaetes and oligochaetes community complex. (Polychaete/bivalve-dominated muddy sand shores [A2.24]/ Infralittoral medium sand [A5.24])	NS (***)	L (*)	L (***)	NS (*)	L (*)	L-M (*)	L-M (*)	L-M (*)	L-M (*)	NS (*)	L-M (*)	NS	NS (*)	NS (*)	NS (*)	NS (*)	L (*)	L (*)	H (***)	NS (*)	NS (*)	NS (*)	NS (*)	L (*)	NS (*)

Table 8.3 - Matrix showing the characterising species sensitivity scores x pressure categories for species in Great Island Channel SAC (ABPMer 2013a-h) (**Table 8.4** provides the code for the various categorisation of sensitivity and confidence.)

Community Type (Surrogate [EUNIS code])	Species (characterizing species identified from NPWS 2014b)	Surface Disturbance	Shallow Disturbance	Deep Disturbance	Trampling – access by foot	Trampling – access by vehicle	Extraction	Siltation (addition of fine sediments, pseudofaeces, fish food)	Smothering (addition of materials biological or non-biological to the surface)	Changes to sediment composition- increased coarseness	Changes to sediment composition- increased fine sediment proportion	Changes to water flow	Increase in turbidity/suspended sediment	Decrease in turbidity/suspended sediment	Organic enrichment-water column	Organic enrichment of sediments-sedimentation	Increased removal of primary production-phytoplankton	Decrease in oxygen levels- sediment	Decrease in oxygen levels-water column	Introduction of non-native species	Removal of Target Species	Removal of Non-target species	Introduction of antifoulants	Introduction of medicines	Introduction of hydrocarbons	Prevention of light reaching seabed/features
Mixed sediment to sandy mud with polychaetes and oligochaetes community complex. (Polychaete/bivalve-dominated muddy sand shores [A2.24]/ Infralittoral medium sand [A5.24])	*Hediste diversicolor*	NS (*)	L-M (**)	L-H (**)	NS (*)	L (*)	L-H (*)	NS (***)	L-M (*)	M-H (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (**)	NS (**)	NS (*)	NS (**)	NS (**)	L-M (*)	L-M (*)	NS (*)	NS (*)	M-H (**)	M-H (**)	NS (*)
	Nephtys hombergii	NS (*)	L (*)	L (***)	NS (*)	L (*)	L (*)	NS (**)	NS (*)	L (*)	NS (*)	NS (**)	NS (*)	NS (*)	NS (*)	NS (**)	NS (*	NS (***)	NS (***)	NS (*)	M (*)	NS (*)	NS (**)	NEv	M (***)	NS (*)
	Peringia ulvae	L-NS (*)	L (***)	L (*)	L-NS (*)	L-NS (*)	M (*)	NS (***)	L (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (***)	NS (*)	L (*)	L (*)	L (*)	Ns (*)	NS (*)	NEv	NEv	M (*)	NS (*)
	Tubificoides benedii	NS (*)	NS (*)	L (**)	L (*)	L (*)	M (*)	NS (*)	L (*)	NS (*)	NS (*)	NS (***)	NS (*)	NS (*)	NS (***)	NS (***)	NS (*)	NS (***)	NS (***)	NS (*)	NS (*)	NS (*)	NS (**)	NEv	NEv	NS (**)
	Scrobicularia plana	NS (*)	NS (**)	M-H (*)	NS (**)	L (**)	M-H (*)	NS-L (*)	M-H (*)	M-H (*)	NS (*)	NS (*)	L (*)	NS (*)	M (*)	M (*)	NS(*)	NS (*)	NS (*)	M (*)	NS (*)	NS (*)	NS (*)	NA	L (*)	NS (*)

Table 8.4 - Codes of sensitivity and confidence applying to species and pressure interactions presented in **Tables 8.2** and **8.3**.

Pressure interaction codes for Table 8.1 and 8.2	
NA	Not Assessed
NEv	No Evidence
NE	Not Exposed
NS	Not Sensitive
L	Low
M	Medium
H	High
VH	Very High
*	Low confidence
**	Medium confidence
***	High Confidence

Table 8.5 - Interactions between current and proposed oyster aquaculture activities and constituent communities of the habitat features of (1140) Mudflats and sandflats not covered by seawater at low tide with a broad conclusion on the interactions.

Licence Status	**Culture Species / Method**	**Qualifying Interest 1140 (722.24 ha)** **Community Type** **Mixed sediment to sandy mud with polychaetes and oligochaetes community complex (722.24ha)**
Licensed	Oyster - Trestles	**Disturbing: No** **Justification:** The spatial overlap with the community type is 0.25%. Published literature (Forde *et al.,* 2015) suggests that activities occurring at trestle culture sites are not disturbing.
Cumulative Impact Licenced and Proposed Activity		**Disturbing: No** **Justification:** The spatial overlap with the community type is 0.25%. Published literature (Forde *et al.,* 2015) suggests that activities occurring at trestle culture sites are not disturbing

9 IN-COMBINATION EFFECTS OF AQUACULTURE, FISHERIES AND OTHER ACTIVITIES

9.1 FISHERIES

9.1.1 Habitats

Putative fishery activities occurring in the marine benthic habitat of the SAC are limited to subtidal oyster cultivation.

9.1.1.1 Subtidal Oyster Cultivation

There are two Oyster Fishery Orders within the North Channel. Within these Orders oysters can be cultivated on the bottom. This is primarily for Native oyster production although at times Pacific oysters are fattened on the bottom. Pacific oysters to be fattened would typically be 1-2 years old prior to being placed on the bottom to be dredged for grading. Native oysters have been traditionally bred in the summer and then harvested and sold oysters in the winter months. The spatting ponds in the North Channel are used in the summer.

The seed for the Native oyster production are hatched on Brick Island (also within Cork Harbour). The ponds are filled with seawater in May / June, and then parent oysters are fished from the North Channel and are placed into the ponds. As they grow, mussel shell is placed into the ponds to catch the larvae. Once the larvae have stuck to the shells, then the mussel shell, with the spat attached are put to sea, in the oyster order areas in the North Channel at the end of the summer. They use the good oyster ground in the middle of the channel, from Brick Island in the west to Brown Island to the east. The spat are completely undisturbed, until they are harvested by boat about 3 years later, when they are harvested for the market, between September and April. Only one boat is used to harvest the oysters by dredging the oysters from the bottom. The beds are used in rotation in the North Channel, so some years' activity would be at the western end of the area, and some years there would be more activity to the east.

In 1987 the native stock were infected with *Bonamia ostrea* which caused large scale mortalities, upwards of 98%, over the next twenty years of spawnings, breeding from survivors the company successfully produced a *Bonamia* resistant native oyster. Production continues and between 2015 and 2016, 20 million seed were produced and laid down in the North Channel.

In 2002 the Food Safety Authority required that the active fishery within the Oyster Fishery Order at the eastern end of the North Channel be closed down until such time as the water could be pronounced safe for direct sales of oysters. This continues until today. Oysters are still held for shellfish testing purposes.

The Fishery Order overlaps with 9.62% of habitat 1140 and 9.62% of the constituent marine community types 'Mixed sediment to sandy mud with polychaetes and oligochaetes community complex' (see **Table 9.1**).

The activity of relaying seed oysters onto subtidal habitats constitutes a disturbance by virtue of the fact that the activity may lead to a shift in community composition.

Monoculture - Bottom culture

The relaying of oysters on the seabed may alters the infaunal community in terms of number of individuals and number of species present. If the density of oysters is high, the habitat may be dominated by single species and thus may lead to the transformation of an infaunal dominated community to an epifaunal dominated community.

Cork Harbour has an estimated residence time of 21 days (Dabrowski, 2011). A long residence time (21 days or greater) has been identified as one of the risk factors that would contribute to the successful reproduction of the non-native Pacific oyster, of *Crassostrea gigas* in an embayment (Kochmann et al 2013). This risk if further exacerbated if the oysters are uncontained on the seafloor where removal of all stock is not possible in the event of successful spawning or an epizootic.

Sensitivities to dredging

Mixed sediment communities, as identified above, have high level of resistance and resilience to the pressure resulting from an oyster dredge (ABPMer 2013f). In addition, the low frequency of dredging (once every 3 years) will contribute to this resilience (ABPMer 2013f).

9.1.1 Conclusion

Based on the level of overlap (less than the 15% threshold) and the resilience of the community types (and associated species) with oyster bottom culture and dredging, significant disturbance **could be discounted** for the following constituent habitat of Qualifying Interests (1140) Mudflats and sandflats not covered by seawater at low tide: Mixed sediment to sandy mud with polychaetes and oligochaetes community complex. In addition, as oyster trestles are considered non-disturbing they will have no in-combination effect with other activities.

Consequently, in-combination effects of fisheries with intertidal trestle aquaculture activities on designated habitats (and constituent community types) can be discounted.

Bottom culture of *C. gigas* presents a risk of successful reproduction of this species individually and in-combination with intertidal culture of oysters.

Table 9.1- Spatial extent (ha) of subtidal oyster aquaculture areas overlapping with the Qualifying Interest of Mudflats and sandflats not covered by seawater at low tide [1140] in the Great Island Channel SAC (Site Code 001058). Spatial extent of licenced areas presented according to Qualifying Interest and license status.

Licence Status	Culture Species	Qualifying Interest 1140 (722.24 ha)	Constituent Habitat Mixed sediment to sandy mud with polychaetes and oligochaetes community complex (722.24ha)
		% Overlap (Overlap ha)	% Overlap (Overlap ha)
Licenced	Fishery Order	9.62% (69.49ha)	9.62% (69.49ha)
Total		**9.62% (69.49ha)**	**9.62% (69.49ha)**

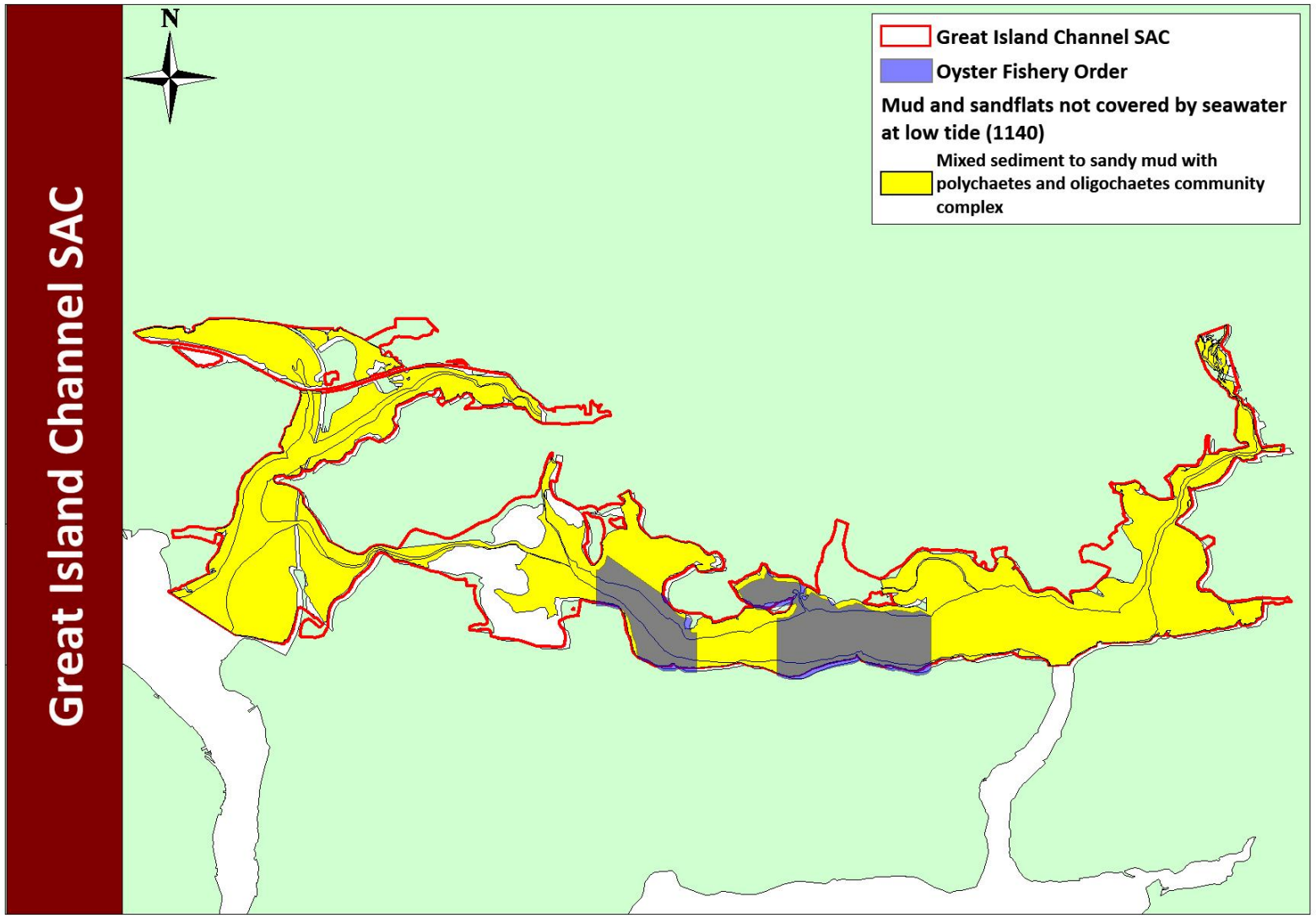

Figure 9.1 – Fisheries relative to principal benthic communities recorded within the marine Annex I Qualifying Interest of (1140) Mud and sandflats not covered by seawater at low tide of the Great Island Channel SAC (NPWS 2014a).

9.2 POLLUTION PRESSURES

There are a number of activities which are terrestrial in origin that might result in impacts on the conservation features of the Great Island Channel SAC. Primary among these are point source discharges from domestic sewage outfalls distributed along the coastline and municipal urban waste water treatment plants. The pressure derived from these point sources may impact upon levels of dissolved nutrients, suspended solids and some elemental components e.g. aluminium in the case of water treatment facilities.

9.2.1 Conclusion

Pressures resulting from aquaculture activities are primarily localised compaction of sediment along access routes. It was, therefore, concluded that given the pressure resulting from point discharge location such as the urban waste-water treatment and/or combined sewer outfalls would likely impact on physico-chemical parameters in the water column, any in-combination effects with aquaculture activities are considered to be **minimal or negligible**.

10 SAC AQUACULTURE CONCLUDING STATEMENT

10.1 ASSESSMENT REPORT CONCLUDING STATEMENT

Current and proposed aquaculture activities occurring in the Great Island Channel SAC focuses on the cultivation of oysters (using bags & trestles) and the subtidal bottom cultivation of Native oysters. Based upon this and the information provided in the aquaculture profiling report (**Section 5**), the likely interaction between these culture methodologies and conservation features (habitats and species) of the SAC were considered.

10.1.1 Habitats

An initial screening exercise resulted in the following habitat features being excluded from further consideration by virtue of the fact that no spatial overlap of the culture activities was expected to occur; Atlantic salt meadows (*Glauco-Puccinellietellia maritimae*) (1330).

A full assessment was carried out on the likely interactions between existing and proposed culture operations and the feature Annex 1 habitats of 1140 Mudflats and Sandflats not covered by seawater at low tide.

The likely effects of the aquaculture activities (species, structures, access routes) were considered in light of the sensitivity of constituent habitats and species of the Annex 1 habitat 1140 Mudflats and Sandflats not covered by seawater at low tide. The Annex I 1140 constituent community considered was limited to 'Mixed sediment to sandy mud with polychaetes and oligochaetes community complex'.

Based upon the scale of spatial overlap of current and proposed intertidal oyster aquaculture activities (including access route activity) and the relatively high tolerance levels of the habitats and associated species, the general conclusion is that current and proposed intertidal culture activities are non-disturbing to the Qualifying Interests and their constituent community types.

The subtidal relaying and dredging of Native oysters, either individually or in-combination with aquaculture activities, are considered non-disturbing to the Qualifying Interest and its constituent community types.

10.1.2 Other considerations

Based upon experience elsewhere, the introduction of '½ grown' or 'wild' oyster stock into aquaculture plots (both within and proximate to the SAC) from outside of Ireland does pose a clear risk of establishment of non-native species in the SAC. In order to mitigate the risk of introduction of alien species into the SAC as a result of aquaculture activities all movement of stock in and out of the Great Island Channel SAC should adhere to relevant legislation and follow best practice guidelines.

Furthermore, the culture on non-sterile Pacific oysters (in contained systems and subtidally un-contained on the seafloor) in the SAC presents as risk of successful reproduction and recruitment of this species within the SAC. It is recommended that triploid *C. gigas* oysters be used in a contained fashion only in licenced aquaculture areas.

11 REFERENCES

ABPMer. 2013a. Tools for appropriate assessment of fisheries and aquaculture activities in Marine and Coastal Natura 2000 sites. Report VIII: Vegetation dominated communities (Saltmarsh and Seagrass). Report No. R. 2053 for Marine Institute, Ireland.

ABPMer. 2013b. Tools for appropriate assessment of fisheries and aquaculture activities in Marine and Coastal Natura 2000 sites. Report VI: Biogenic reefs (*Sabellaria*, Native oyster, Maërl). Report No. R. 2068 for Marine Institute, Ireland.

ABPMer. 2013c. Tools for appropriate assessment of fisheries and aquaculture activities in Marine and Coastal Natura 2000 sites. Report I: Intertidal and Subtidal Muds. Report No. R. 2069 for Marine Institute, Ireland.

ABPMer. 2013d. Tools for appropriate assessment of fisheries and aquaculture activities in Marine and Coastal Natura 2000 sites. Report II: Intertidal and Subtidal Sands. Report No. R. 2070 for Marine Institute, Ireland.

ABPMer. 2013e. Tools for appropriate assessment of fisheries and aquaculture activities in Marine and Coastal Natura 2000 sites. Report III: Intertidal and Subtidal muddy sands and sandy muds. Report No. R. 2071 for Marine Institute, Ireland.

ABPMer. 2013f. Tools for appropriate assessment of fisheries and aquaculture activities in Marine and Coastal Natura 2000 sites. Report IV: Intertidal and Subtidal mixed sediments. Report No. R. 2072 for Marine Institute, Ireland.

ABPMer. 2013g. Tools for appropriate assessment of fisheries and aquaculture activities in Marine and Coastal Natura 2000 sites. Report IV: Intertidal and Subtidal coarse sediments. Report No. R. 2073 for Marine Institute, Ireland.

ABPMer. 2013h. Tools for appropriate assessment of fisheries and aquaculture activities in Marine and Coastal Natura 2000 sites. Report VII: Intertidal and Subtidal reefs. Report No. R. 2074 for Marine Institute, Ireland.

AQUAFACT. 2007. A survey of intertidal mudflats and sandflats in Ireland. Unpublished report to NPWS.

Bergman, M.J.N. and van Santbrink, J.W. 2000. Mortality in megafaunal benthic populations caused by trawl fisheries on the Dutch continental shelf in the North Sea 1994. ICES Journal of Marine Science 57(5), 1321-1331.

Black, K.D. (2001). Environmental impacts of aquaculture. Sheffield Biological Sciences, 6. Sheffield Academic Press: Sheffield. 214 pp

Borja, A., Franco, J. & Pérez, V. 2000. A marine biotic index of establish the ecological quality of soft-bottom benthos within European estuarine and coastal environments. Marine Pollution Bulletin. 40: 1100 – 1114.

Cranford, Peter J., Pauline Kamermans, Gesche Krause, Alain Bodoy, Joseph Mazurié, Bela Buck, Per Dolmer, David Fraser, Kris Van Nieuwenhove, Francis X. O'Beirn, Adoración Sanchez-Mata, Gudrun G. Thorarinsdóttir, and Øivind Strand. 2012. An Ecosystem-Based Framework for the Integrated Evaluation and Management of Bivalve Aquaculture Impacts. Aquaculture Environment Interactions. 2:193-213

Dabrowski, T. 2011. Short report on residence times calculations of coastal embayments. Marine Institute Unpublished Report. 5pp

EcoServe. 2012. Intertidal benthic survey of Great Island Channel SAC and Cork Harbour SPA. Unpublished report to the Marine Institute and NPWS.

Forde, J., F. O'Beirn, J. O'Carroll, A. Patterson, R. Kennedy. 2015. Impact of intertidal oyster trestle cultivation on the Ecological Status of benthic habitats. Marine Pollution Bulletin 95, 223–233. doi:10.1016/j.marpolbul.2015.04.013

Hall, K., Paramor, O.A.L., Robinson L.A., Winrow-Giffin, A., Frid C.L.J., Eno, N.C., Dernie, K.M., Sharp, R.A.M., Wyn, G.C.& Ramsay, K. 2008. Mapping the sensitivity of benthic habitats to fishing in Welsh waters- development of a protocol. CCW [Policy Research] Report No: [8/12], 85pp.

Kochmann J, Carlsson J, Crowe TP, Mariani S (2012) Genetic evidence for the uncoupling of local aquaculture activities and a population of an invasive species—a case study of Pacific oysters (Crassostrea gigas). Journal of Hereditary 103:661–671

Kochmann, J. F. O'Beirn, J. Yearsley and T.P. Crowe. 2013. Environmental factors associated with invasion: modeling occurrence data from a coordinated sampling programme for Pacific oysters. Biological Invasions DOI 10.1007/s10530-013-0452-9.

McKindsey, CW, Landry, T, O'Beirn, FX & Davies, IM. 2007. Bivalve aquaculture and exotic species: A review of ecological considerations and management issues. Journal of Shellfish Research 26:281-294.

McCorry, M.; Ryle, T. 2009. Saltmarsh monitoring project 2007-2008. Unpublished report to NPWS.

Moore, P. G. 2003. Seals and fisheries in the Clyde Sea area (Scotland): traditional knowledge informs science. Fisheries Research, 63, 51-61

National Research Council, 2010. Ecosystems Concepts for Sustainable Bivalve Culture. National Academy Press, Washington, DC.

NPWS. 2014a. Conservation Objectives: Great Island Channel SAC 001058. Version 1. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht.

NPWS. 2014b. Great Island Channel SAC (site code: 1058) Conservation objectives supporting document - Marine Habitats Version 1 May 2014

NPWS. 2014c. Great Island Channel SAC (site code 1058) Conservation objectives supporting document -coastal habitats Version 1 May 2014.

O'Beirn, F.X., C. W. McKindsey, T. Landry, B. Costa-Pierce. 2012. Methods for Sustainable Shellfish Culture. 2012. pages 9174-9196 In: Myers, R.A. (ed.), Encyclopedia of Sustainability Science and Technology. Springer Science, N.Y.

O'Carroll J, Quinn C, Forde J, Patterson A, O'Beirn F.X, Kennedy R. Accepted Impact of prolonged storm activity on the Ecological Status of intertidal benthic habitats within oyster (*Crassostrea gigas*) trestle cultivation sites. Marine Pollution Bulletin.

Roberts, C., Smith, C., Tillin, H., Tyler-Walters, H. 2010. Evidence. Review of existing approaches to evaluate marine habitat vulnerability to commercial fishing activities. Report SC080016/R3. Environment Agency,UK. ISBN 978-1-84911-208-6.

Tillin, H.M., Hiddink, J.G., Jennings, S and Kaiser, M.J. 2006. Chronic bottom trawling alters the functional composition of benthic invertebrate communities on a sea basin scale. Marine Ecology progress Series, 318, 31-45.