ANNEX 1:

Appropriate Assessment of Fisheries and Aquaculture in Lough Swilly (SAC 002287)

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1 Introduction

This document assesses the potential ecological impacts of aquaculture activities within Lough Swilly (site code 002287) Special Area of Conservation (SAC) on the Conservation Objectives of the site (COs).

The information upon which this assessment is based is a definitive list of applications and extant licences for aquaculture received by the Department of Agriculture Food and Marine (DAMF) and forwarded to the Marine Institute as of end of April 2012; and also the 5 year Fishery Nature Plan (FNP) for Native oysters in Lough Swilly (LSWOSL, 2012). The activities include bottom culture of mussels and the bottom and suspended culture (BST long lines, bags & trestles) of oysters (native & pacific).

2 Conservation Objectives for Lough Swilly (SAC 002287)

The appropriate assessment of aquaculture in relation to the Conservation Objectives for Lough Swilly is based on version 1.0 of the objectives as produced by NPWS (2011a).

The SAC extent

Lough Swilly is a long sea inlet situated on the west side of the Inishowen Peninsula in north Co. Donegal, it extends from below Letterkenny to just north of Buncrana. The site is estuarine in character, with shallow water and intertidal sand and mud flats being the dominant habitats. The main rivers flowing into the site are the Swilly, Lennan and Crana. At low tide, extensive sand and mud flats are exposed, especially at the mouths of the Swilly and Lennan rivers. The boundary of the SAC is shown in Figure 1 below.

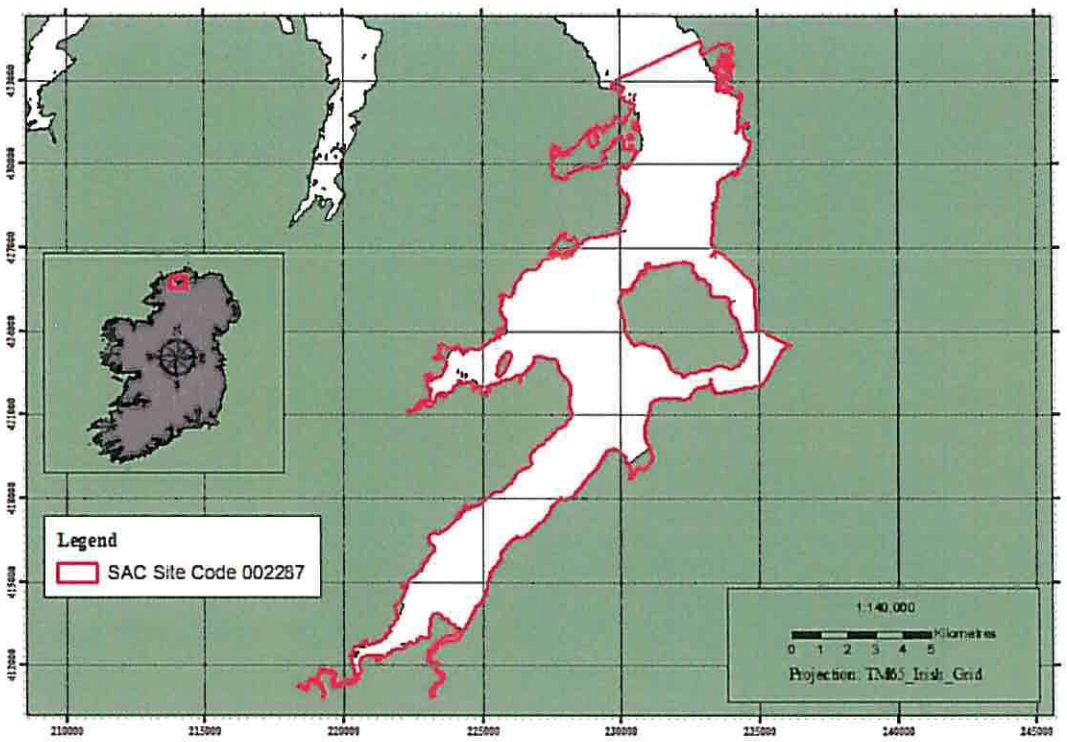


Figure 1: The extent of Lough Swilly SAC (site code 002287).

Qualifying interests (SAC)

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

- 1130 Estuaries
- 1150 Coastal lagoons (priority habitat under Habitat Directive)
- 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)
- 1355 Otter (*Lutra lutra*)
- 91A0 Old sessile oak woods with Ilex and Blechnum in the British Isles

Constituent communities and community complexes recorded within the qualifying interest Estuaries (1130) are listed in NPWS (2011a) and illustrated in Figure 2:

1130 Estuaries

- Fine sand community complex
- Intertidal mixed sediment with polychaetes
- Subtidal mixed sediment with polychaetes and bivalves
- Muddy fine sand with *Thyasira flexuosa*
- Mud community complex
- *Ostrea edulis* dominated community

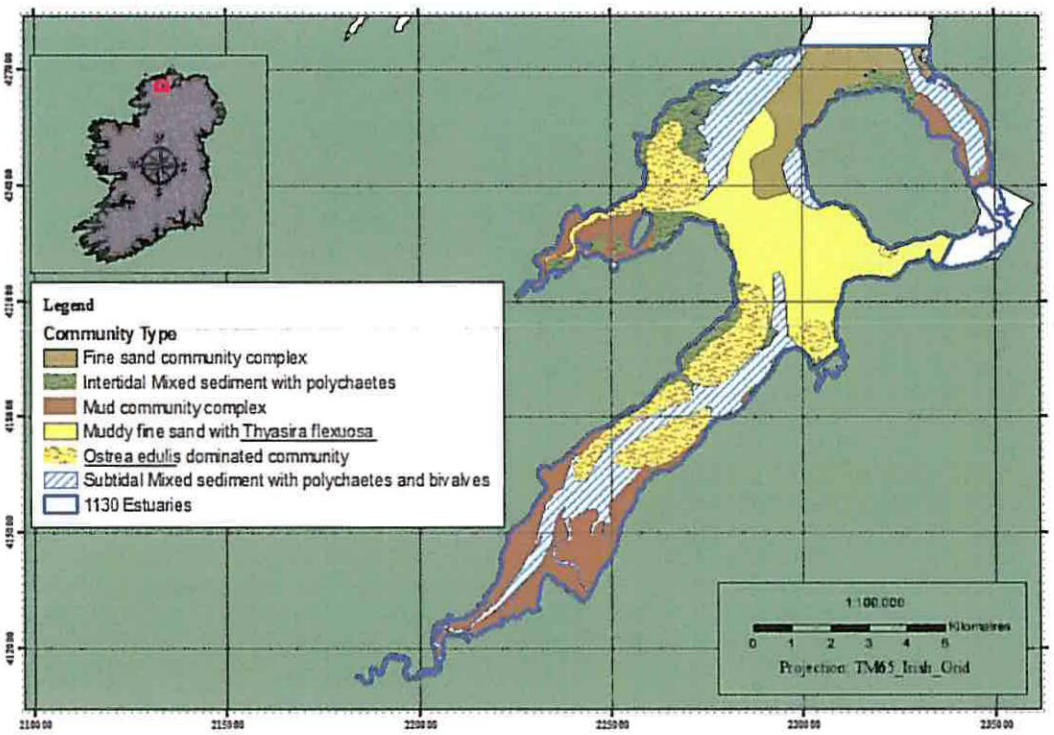


Figure 2: Principal benthic communities recorded within the qualifying interest Estuaries within Lough Swilly SAC (site code 002287) (NPWS 2011a).

Conservation objectives for Lough Swilly SAC

The conservation objectives for the qualifying interests (SAC) were identified by NPWS (2011a). The natural condition of the designated features should be preserved with respect to their area, distribution, 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 1. Specifically, for marine habitats and species, the attributes listed in Tables 1 should be conserved.

Table 1: Conservation objectives and targets for marine habitats and species in Lough Swilly SAC (site code 002287) (NPWS 2011Apr.Ver. 1)

FEATURE	OBJECTIVE	TARGET
Estuaries	Maintain favourable conservation condition	6118ha, permanent habitat is stable or increasing, subject to natural processes
Fine sand community complex	Maintain favourable conservation condition	583ha, Conserved in a natural condition, persistent disturbance to ecology <15% of area
Intertidal mixed sediment with polychaetes	Maintain favourable conservation condition	655ha, Conserved in a natural condition, persistent disturbance to ecology <15% of area
Subtidal mixed sediment with polychaetes and bivalves	Maintain favourable conservation condition	1314ha, Conserved in a natural condition, persistent disturbance to ecology <15% of area
Muddy fine sand with *Thyasira flexuosa*	Maintain favourable conservation condition	1320ha, Conserved in a natural condition, persistent disturbance to ecology <15% of area
Mud community complex	Maintain favourable conservation condition	1127ha, Conserved in a natural condition, persistent disturbance to ecology <15% of area
Ostrea edulis dominated community	Maintain favourable conservation condition	906ha, Conserved in a natural condition, persistent disturbance to ecology <15% of area
Otter (*Lutra lutra*)	Restore the favourable conservation condition	Maintain distribution, 88% positive survey sites
		839ha, No significant decline in extent of marine habitat
		Couching sites and holts, No significant decline and minimise disturbance
		Fish biomass, No significant decline in marine fish species in otter diet
		Barriers to connectivity, No significant increase

3 Details of the proposed plans and projects

Aquaculture

Aquaculture activities are widespread in Lough Swilly and comprises of shellfish (mussel and oyster) and finfish (salmon) culture. Mussel (*Mytilus edulis*) & oyster (*Crassostrea gigas* & *Ostrea edulis*) production is carried out within the SAC & SPA boundaries. However, no aquaculture occurs in Blanket Nook Lough or Inch Lough. This assessment focuses on aquaculture activities which fall within the qualifying interest of Estuary (1130) for which the site is designated. methods of shellfish cultivation carried out within the feature Estuary include bottom culture, longlines, BST longlines and bags & trestles. The aquaculture activities considered in this assessment can be broadly divided according to species cultured and method of culture as well as licence status (licensed or application). Within the boundary of the qualifying interest (Estuary 6118ha) the total area currently licensed for shellfish production is 1771.4ha; this comprises of oyster cultivation (86.1ha), mussel cultivation (511.6ha) and dual mussel and oyster cultivation (1173.8ha). Currently (May 2012) applications are submitted for another 861.2ha, comprising bottom culture of mussels (549ha), bottom culture of oysters (280.3ha) and suspended culture of oysters employing BST Longlines (17.9ha) and Bags & Trestles (14ha).

3.1.1 Mussel Culture

Mussel (*Mytilus edulis*) culture occurs throughout the Lough Swilly SAC, but the majority occurs in inner Lough Swilly south of Rathmullan. Bottom culture is the sole method of cultivation employed within this area covered by this assessment (i.e. Estuary); other culture methods (Longlines) are employed outside of the extent of the qualifying interest and the SAC boundary. Within the qualifying interest (Estuary) of Lough Swilly SAC there are currently 7 sites licensed for bottom culture of mussels and 13 applications pending (Figure 3). There are also three sites licensed for the bottom culture of mussels and oysters together. Currently the total area, within the boundary of the qualifying interest, under licensed mussel cultivation is 511.6ha with a further 549ha being subject to application. There are also three sites (1173.8ha) licensed for the bottom culture of oysters and mussels together (Figure 4).

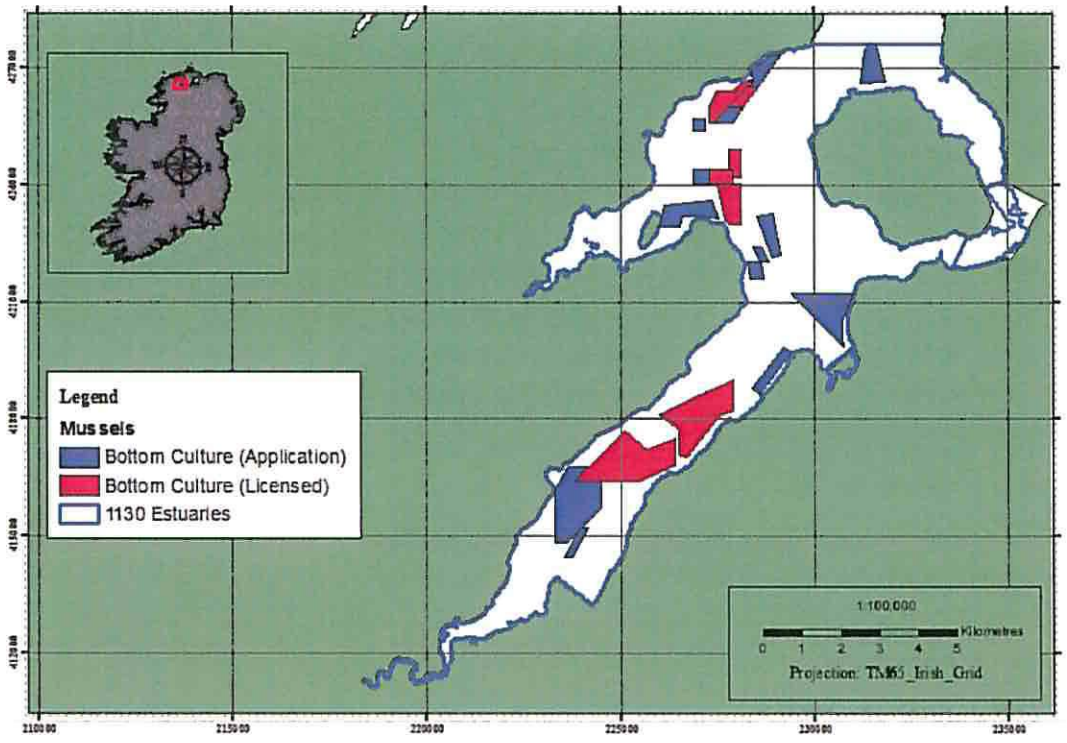


Figure 3: Proposed and existing bottom mussel culture activity within the qualifying interest Estuaries of Lough Swilly SAC.

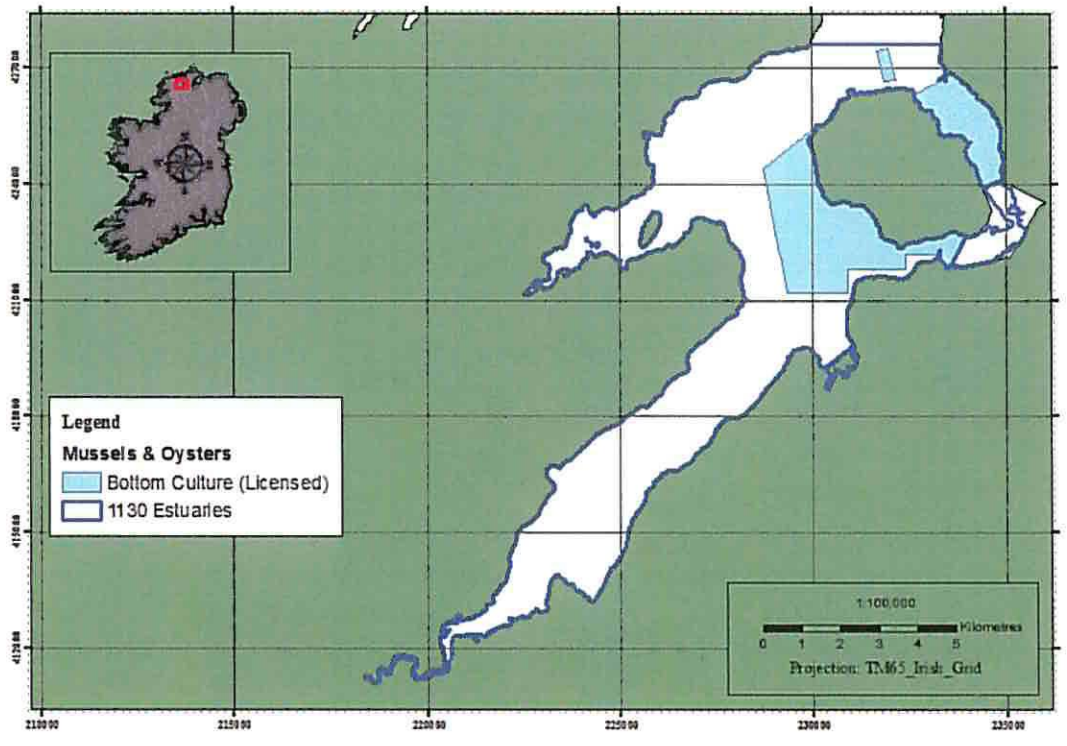


Figure 4: Existing bottom mussel and oyster culture activity within the qualifying interest Estuaries of Lough Swilly SAC.

Bottom Mussel Culture

With bottom mussel culture, seed is transplanted to licensed areas where the mussels are placed directly onto the seafloor. No structures are used for the culture of mussels on the seafloor, mussels are placed in an uncontained fashion on the seabed; most of the beds are sub-tidal. In Lough Swilly, techniques vary among producers from simply transferring seed to licensed sites, where they remain until they reach harvest size to very mobile stocks which can be moved 3-4 times from nursery to ongrowing sites during their life cycle. When the mussels reach commercial size 9-18 months later, they are harvested using dredges. Mussel vessels operating in Lough Swilly use between 2 and 4 dredges depending on vessel size. The types of dredge used on all vessels are 2m mussel dredges with a flat bar that are designed to skim the surface of the sea bed and separate mussels from the underlying sediment of the substrate.

Seed Source and Collection

Mussel see is sourced from both within the Lough and as part of the National Seed Allocations. Mussel seed sources for Lough Swilly come both from within the bay and from the managed Irish Sea Fishery. The main local seed area is to the west of Inch Island stretching from Drum Point to Hawke's Nest. When first introduced into the Lough from other areas (in accordance with seed allocations) mussel seed is placed in the deeper water of the licensed areas for a short time to become accustomed to the environment. Depending on the robustness of this seed, it may remain here (deeper water) for the remainder of the on-growing period. During this time the stock is carefully monitored and if necessary (i.e. poor growth, high mortality) may be transplanted to shallower waters.

Nursery Areas

When native seed is collected it is immediately transferred to nursery areas, usually in the intertidal. The co-op's nursery areas are in the Farland Creek and Fahan Creek. For other licensed sites, the nursery area may comprise the shallower parts of the site. Stocks remain in the nursery areas for 12-18 months, at which stage they have reached a size of approximately 35mm, the stock is then transplanted to deeper ongrowing sites.

Ongrowing Stage

Stock is moved using dredges from the nursery areas to deeper waters within the licensed site, and remains here for 6-9 months until harvest. In many bottom culture regimes the mussels would remain on the same plot until harvest, however, as a result of predation by starfish and local hydrodynamic conditions, mussels grown in Lough Swilly can be moved 3-4 more times prior to harvest (Table 2). This is especially true for the co-op licensed area (one large licensed site adjacent to Inch Island) as the management regime allows for greater flexibility for movement between the individually allocated ongrowing plots within the licensed area.

Table 2: Frequency of activity associated with the bottom culture of mussels within Lough Swilly, BIM.

				Year 1												Year 2												Year 3											
	High Tide	Low Tide	Day	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Mussel Spawning								X																														
Seed Mussel Fishery	X		X								L	L	H																									
Nursery	X		X										H	L	L	L	L	L	L	L	L	L	L	H	X	X	X	X	X	X								
Starfish Control	X Mop	X Hand Picking	X										H	L	L																							
Ongrowing																								H	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Stock Movements																														X	X	X						
Harvesting			X																											X	X	X	X	X	X	X	X	X

Harvesting

Harvest is generally conducted 18-27 months after initial seeding, from February through to December.

3.1.2 Oyster Culture

Oyster culture, native (*Ostrea edulis*) and pacific (*Crassostrea gigas*), within Lough Swilly is concentrated to the west and south of Inch Island (Figure 5). Oyster farming within Lough Swilly is a form of intensive culture which has been taking place since the early 1990s. Culture methods employed are both intertidal and subtidal in bags & trestles and BST longlines for *Crassostrea gigas* and bottom culture for *Crassostrea gigas and Ostrea edulis*. Within the extent of the qualifying interest, there are currently 3 sites licensed for the sole culture of oysters (2-Bags & Trestles, 1-Bags & Trestles and BST Longlines) and 7 applications pending (3-Bags & Trestles, 2-BST Longlines, 2-Bottom Culture). Currently the total area, within the boundary of the qualifying interest, under licensed oyster culture is 86.1ha with a further 312.2ha being subject to application. The licensed area comprises of Bag & Trestle (26.3ha) and Bags & Trestles and BST longline (59.8ha) culture. In applications pending bottom culture (280.3ha) is the predominant method of culture, with BST Longlines (17.9ha) and Bags & Trestles (14ha) also. It should be noted that there are two instances of overlap where areas already licensed for mussel bottom culture (T12/293; T12/298) are also subject to an application for oyster bottom culture (T12/339a; T12/339B), this overlap comprises an area of 175.180477ha (Figure 6 Area of overlap).

There are three sites, covering an extensive area (1173.8ha), that are licensed for the bottom culture of oysters and mussels together (Figure 4).

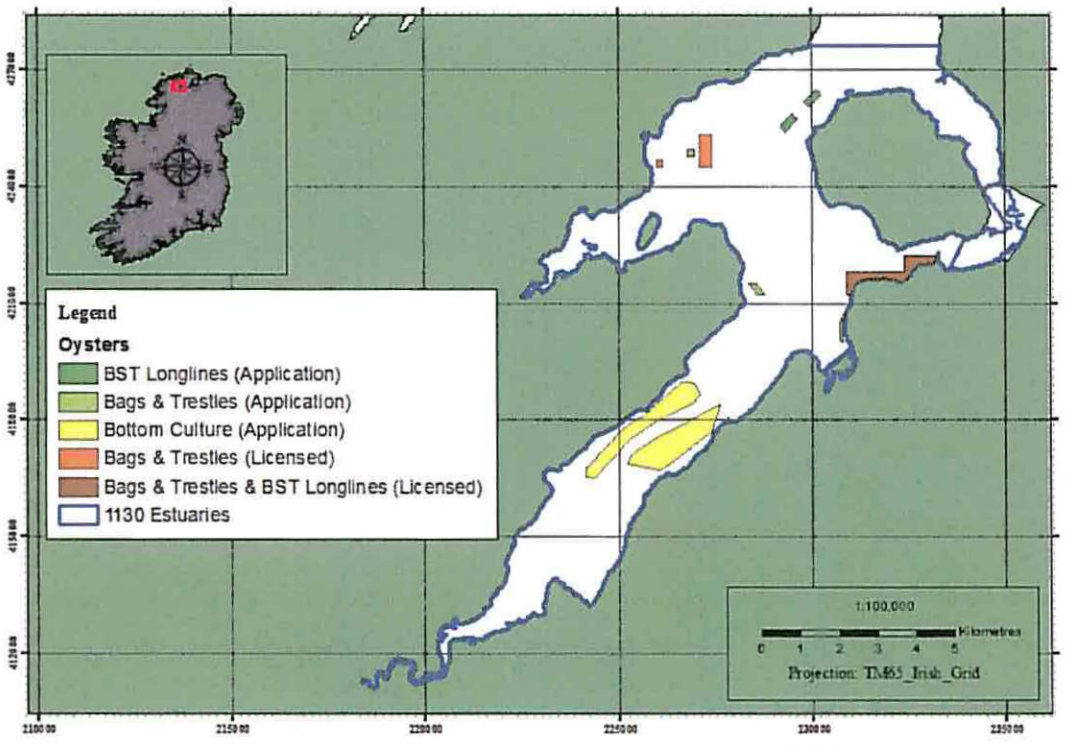


Figure 5: Proposed and existing oyster culture activity within the qualifying interest Estuaries of Lough Swilly SAC.

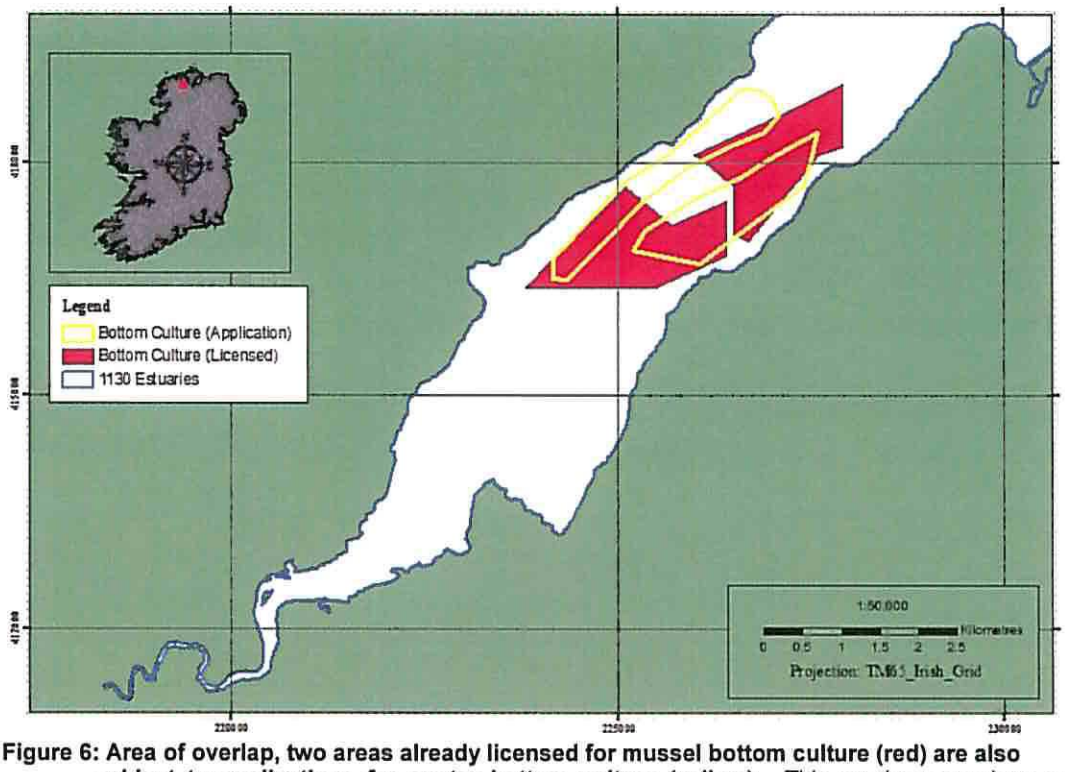


Figure 6: Area of overlap, two areas already licensed for mussel bottom culture (red) are also subject to applications for oyster bottom culture (yellow). This overlap comprises an area of 175.180477ha.

Suspended Oyster Culture (Bags & Trestles, BST Longlines)

Oysters cultured in the intertidal areas of Lough Swilly are grown in plastic mesh bags secured to metal trestles predominantly on sedimentary habitat. Bags are made of a plastic mesh and are fastened to trestles using rubber straps and hooks. Bags vary in mesh size depending on oyster stock grade (6mm, 9mm and 14mm).

Oyster culture also takes place on the BST longline system at one site (T12/37D). This method of culture appears to be more effective for oysters in the lower inter-tidal environments. Cylindrical baskets (6mm, 12mm and 16mm mesh size) are suspended from longlines rigged to the seabed by poles at either end.

Intertidal sites within Lough Swilly are positioned between Mean Low Water Spring and Mean Low Water Neap, allowing 2.5 to 3.5 hours exposure each day depending on prevailing weather conditions. This translates to approximately 15% visual exposure during day light hours over a typical month. (In total there is 0.15% of the Lough licensed to oyster farming, of which only an estimated 18% is currently being utilised).

Seed source

Seed or 'spat' oysters are purchased from hatcheries. They are available in a variety of size grades, usually from 4mm – 30 mm shell length. Seeding is generally carried out in spring-time when seed (>5g) becomes available from hatcheries. In Lough Swilly the production cycle begins in the spring when seed (8-10 mm) is introduced from UK (Seasalter) and French (Naisain) hatcheries. More recently the majority of oyster seed introduced into the lough is triploid which has the commercial advantage of generally maintaing higher condition throughout he year a consequence of reduced reproductive output.

Access

Sites are accessed at low tide using a tractor and trailer and more recently by the use of purpose built flat bottom barges. The farms on the east shore are accessed by tractor and by foot from a dedicated access point with associated work areas and land storage. The oyster farms on the west shore are accessed by barge and only occasionally by tractor. A larger barge has a crane and grading equipment onboard. The smaller barges serve only to access sites and operate as work platforms. Outboard engines on these only operate when entering and leaving the site once daily.

Bottom Culture of Oysters

This culture method involves the placement of oysters (Native and Pacific) in an uncontained fashion on the seabed after a nursery phase in the intertidal zone. In the area around Inch Island the Lough Swilly Shellfish Growers Co-op society is licensed to bottom culture both mussels and oysters in this fashion.

It is proposed that suitably sized oysters (> 15g) are spread within the licensed area. Oysters are checked periodically when the progress (growth and mortality) of the oysters are monitored and intervention will be necessary if anomalies are discovered. For example, oysters may need turning-over if excessive fouling or siltation is noted on the animals. Such intervention, as well as harvesting (when oysters are approximately 100g), is carried out using oyster dredges deployed from boats. The dredges are typically 1.5m wide and have contact with the substrate via a flat blade.

Harvesting

Harvesting is carried out between October and April, 12-18 months after initial seeding. The stock is harvested when they attain suitable size and condition. This can be from 75g (>85mm) upwards. It can take 2.5–3 years to first harvest.

Fisheries

3.2.1 History of the native oyster fishery -

The following information and fishery data is taken from the Fishery Natura Plan for oysters (LSWOSL, 2012: Appendix I) which details the fishery plan for the native oyster in Lough Swilly from 2012 to 2017. Wild oyster (*Ostrea edulis*) was first documented in Lough Swilly in 1604 when the British Admiralty report identified that oysters existed in commercial quantities in the bay. There has been a traditional native oyster fishery in the bay ever since. In 1904 the first comprehensive survey was conducted and documented in the "Brown Report" which stated that "there are two natural oyster beds in Lough Swilly one on the north side between Ballygreen Point and Ardrummon, in the Letterkenny Rural District and the other on the south side of the Lough between Drumbiy and Ballyaghan". A private bed on the north shore adjoining the public bed at Ardrummon has also been recorded. In the mussel survey carried out by E. Edwards in 1969 there was no mention of oysters but naturally occurring mussel beds were observed at the locations of the oyster beds noted by Brown. In July of 1991 a dredge survey was carried out in Lough Swilly by M. O'Toole (BIM). Eight dredges were taken in the area of Farland Creek, south of Inch Island (now part of the co-op licence) and no oysters were found. Once again mussels were found in the area between Ballygreen Point and Ardrummon.

3.2.2 Current status of native oyster stocks and fisheries in Lough Swilly

In 2011, two surveys of the oyster populations within Lough Swilly were undertaken by the Marine Institute and BIM. The first survey (March 2011), excluded sites already licensed for aquaculture, indicated that the wild oyster population was at a low level and that previous fishing may have removed a high proportion of larger

oysters (>76mm). The survey also indicated that a naturalised Pacific oyster (*Crassostrea gigas*) population was established and occurred in the native oyster bed at various densities and was of multiple year classes. The second survey (November 2011), included both wild Oyster beds and aquaculture sites, confirmed and extended the conclusions of the initial survey that generally stocks were low and that Pacific oysters were widespread. The surveys also showed however that some annual recruitment was occurring and growth rates appear to be strong. The findings of these surveys and also the survey carried out by O'Sullivan and Dennis (2001) provide updated information on the distribution of native oyster beds within Lough Swilly, while local knowledge also suggests that there are additional beds not included in these surveys (Figure 7).

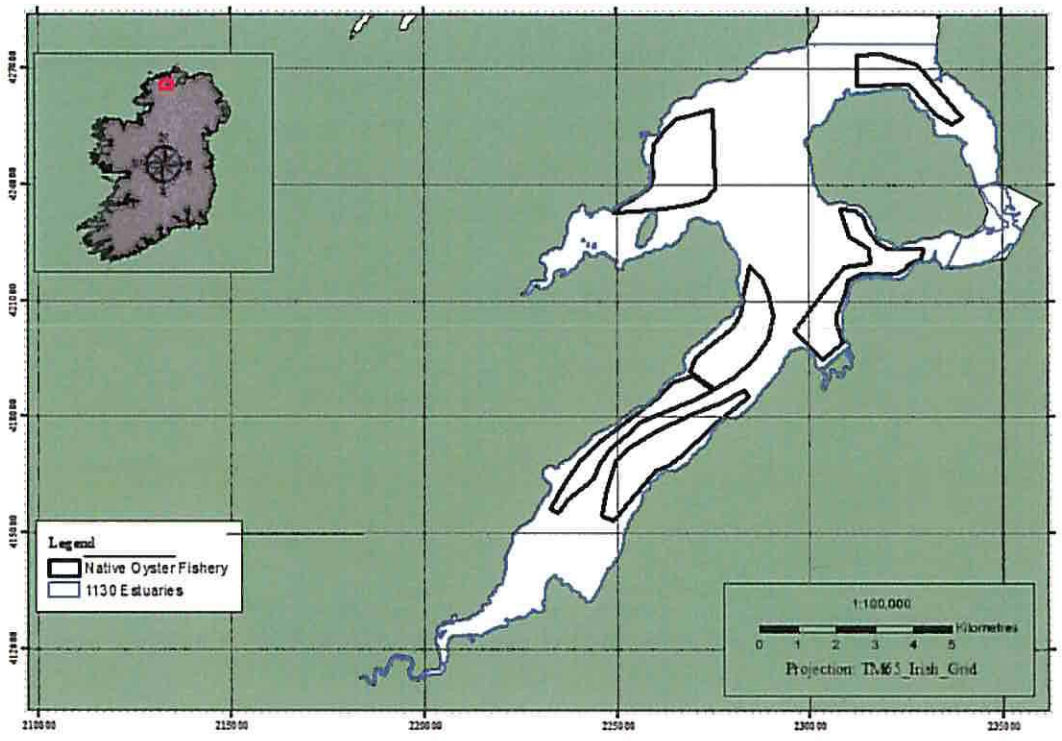


Figure 7: Distribution of native oyster beds within the qualifying interest Estuaries of Lough Swilly SAC (source: LSWOSL, 2012).

3.2.3 Current governance and regulation of oyster fisheries in L. Swilly

The Lough Swilly Wild Oyster Development Association was formed in 2000 to represent the interests of fishermen licensed to gather wild oysters on the Swilly beds. Subsequently the Lough Swilly Wild Oyster Society Limited (LSWOSL) was formed as a friendly Society registered with the Irish Co-operative Organisation Society Limited. It has 29 members from the wild oyster (*Ostrea edulis*) fishing community. The Society currently has no legal authority to manage the fishery but has been active in promoting the conservation and management of wild oyster in Lough Swilly since 2000.All oyster fishermen are required to hold dredge licences issued by Inland Fisheries Ireland (IFI) which specifies the season during which the dredge can be used. In addition the oyster fishing vessel should be registered on the National Sea Fishing Register administered by The Department of Agriculture, Food and Marine (DAFM) and hold the requisite bivalve or polyvalent capacity. In 2012, 24 oyster dredge licences were issued to inshore fishermen in the locality to dredge for oysters. The fishery is regulated

(IFI) by minimum landing size of 76mm and by a closed season from June 1st to August 30th. There is no legal mechanism currently in place that could limit the number of vessels fishing for oysters, the total fishing effort or the annual outtake. Other oyster fisheries in the country have either a fishery order which authorises the local co-op to manage the fishery or they have an aquaculture licence which gives them this same authority

Data in LSWOSL (2012) shows that output from the fishery varies annually depending on stock availability, fishing effort and market price. Annual output in recent years has varied from 40-55 tonnes. The really significant development in the fishery has been the landing of 300 tonnes of naturalised Pacific oyster in 2010, this fishery continued in 2011.

3.2.4 Proposed activity as described in the FNP (LSWOSL 2012)

The proposed plan will operate over an area of 1771ha. However the following annual restrictions and modifications are described in the plan

1. No fishing will occur in an area of 54ha which will be used as a spawning reserve
2. No fishing will occur, for years 1-3 of the plan, in an area which is to be cultched to promote spat settlement. This area is 50.5 ha. Cultching will involve spreading of clean mussel or oyster shell on the seabed to improve settlement conditions for oyster.
3. No fishing will occur where density of oysters is less than 0.25 oysters m^{-2} **and** where the proportion of Pacific oysters is <50%, as determined by a 2012 survey. This area is 257ha and applies for the first year of the plan. The area will be reviewed annually following annual surveys.
4. Areas where >80% of oysters are <55mm will not be fished. Data from the 2011 survey indicate a cluster of stations at Fahan creek where this condition applies.
5. In combination and accounting for spatial overlaps between 1-4, and for the first year of the plan, the measures in 1-4 above sum to an area of approximately **350ha** which will be **closed** to fishing in 2012 ()
6. The area **open** to the fishery in 2012 will be **1421 ha.** In much of the open area *O. edulis* densities are less than the cut off for closure (<0.25m^{-2}) but the percentage of oysters that are *C. gigas* in these areas is >50% and therefore these areas come under the control programme for *C. gigas* described in the management plan. Otherwise these areas would also be closed.
7. Undersized oysters (<76mm) captured in areas where the control programme for *C. gigas* operates will be transplanted to the spawning reserve so they are not subject to repeat contact with dredges.
8. The fishery will occur annually for the period Sept 19th to March 31st in the areas that are open in any given year
9. The plan aspires to limiting the number of vessels in the fishery and indicates the number of permits that have been annually since 2006. Other input controls include restrictions on dredge design and a limited fishing season as described above. As indicated in the plan neither the proposers nor the existing legislation for this fishery allows for the number of licences to be limited.
10. Outtake will be limited by restricting the exploitation to 33% of the spawning stock biomass in the areas open to the fishery and including any landings of native oyster originating from the control programme for *C. gigas*.

Spatial Extent of Aquaculture and Fishery Activities.

Spatial extents of existing and proposed activities within the qualifying interest (Estuaries) of Lough Swilly were calculated using coordinates of activity areas in a GIS. The spatial extent of the various aquaculture activities (current and proposed) is presented in Table 3.

Table 3: Spatial extent (ha) of aquaculture and fisheries activities within the qualifying interest (Estuaries) of Lough Swilly, presented according to species, method of cultivation or fishing and license status.

Species	Culture/Fishing Methods	Licence Status	Spatial Extent (ha)
Mussels	Bottom Culture	Licensed	511.60
Mussels	Bottom Culture	Application	548.97
Oyster	Bags & Trestles	Licensed	26.25
Oyster	BST Longlines & Bags & Trestles	Licensed	59.82
Oyster	BST Longlines	Application	17.92
Oyster	Bags & Trestles	Application	14
Oyster	Bottom Culture	Application	280.27*
Oyster & Mussel	Bottom Culture	Licensed	1173.75
Native Oyster Fishery	Dredging	Licensed†	1771**

*There are two instances of overlap where areas licensed for mussel bottom culture (T12/293; T12/298) are also subject to an application for oyster bottom culture (T12/339a; T12/339B), this overlap comprises an area of 175.18ha (Refer Figure 6).

† Dredges Licensed by Inland Fisheries Ireland (IFI) and vessels licenced by DAFM.

**Total area over which the proposed oyster fisheries plan will operate.

4 Natura Impact Statement for the proposed activities

Potential Ecological Effects of aquaculture

The potential ecological effects on the conservation objectives for the site relate to the physical and biological effects of aquaculture structures, fishing activity and associated human activities on designated species, intertidal and subtidal habitats and invertebrate communities and biotopes of those habitats. The potential ecological effects of aquaculture and fisheries on the qualifying interests of the site depend primarily on the type of species being cultured or fished the system of culture and fishing and the properties of the receiving habitat. Both extensive and intense aquaculture and fishing practices can 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 natural populations and the physical effects of fishing.

Within the qualifying interest of Lough Swilly, the species cultured are bivalve mussels (*Mytilus edulis*) and oysters (*Crassostrea gigas*, *Ostrea edulis*) and the main culture methods are bottom culture (uncontained on seafloor) and suspended culture (contained in bags & trestles and/or BST longlines) and fishing with dredges. Details of the potential biological and physical effects of these aquaculture and fishing activities, their sources and the mechanism by which the impact may occur are discussed below and summarised in Table 4 below. The impact summaries below are extracted from a variety of review documents (and references contained therein) that have specifically focused upon the environmental interactions of shellfish culture (e.g. McKindsey et al. 2007; NRC 2010; O'Beirn et al 2012; Cranford et al 2012).

Biological Effects of Aquaculture

4.1.1 Deposition/Organic enrichment- All culture methods

Mussels and 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 (suspended and intertidal culture) and can alter the local sedimentary habitat type in terms of organic content and particle size which has the potential to alter the infaunal community therein; in the case of bottom culture this deposition results in the formation of 'mussel mud' directly beneath the mussels themselves.

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 mussels 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. Longlines, BST Longlines, floats, trestles & bags etc.) is governed by the density of mussels/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. Longlines, BST Longlines, floats, 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:

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

b. 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.

4.1.2 Seston filtration-All culture methods

Suspension feeding bivalves such as mussels and 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.

4.1.3 Shading-Subtidal-Suspended culture

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

4.1.4 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.

4.1.5 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. A recent survey of Lough Swilly (2011) has documented that the pacific oyster (*C. gigas*), introduced for culture purposes, is now established within the native oyster beds and is widespread throughout the Lough (Kochmann, 2012; Kochman et al., in press).

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.

4.1.6 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.

4.1.7 Monoculture-Bottom culture

The relaying of mussels on the seabed also alters the infaunal community in terms of number of individuals and number of species present. As the habitat is dominated by single species this may lead to the transformation of an infaunal dominated community to an epifaunal dominated community and also cause alteration of sediment type and chemistry due to the production of mussel 'mud' (see 6.2.9 below).

4.1.8 By-catch mortality-Bottom culture

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

4.1.9 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.

Physical effects of aquaculture

4.1.10 Current alteration-Suspended culture

The structures used in aquaculture (e.g. Longlines, BST Longlines, floats, trestles & bags 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.

4.1.11 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. the collection of seed mussels and relaying of spat, routine maintenance, removal of predators ('mopping'), stock movements and finally harvesting. The frequency of dredging activity depends 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. BST Longlines, Bags & trestles) 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 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.

4.1.12 Shading-Suspended culture

The structure associated with suspended culture (e.g. Longlines, BST Longlines, floats, trestles & bags 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.

Potential Effects of fisheries

4.1.13 Biological effect of the oyster FNP

The objectives of the FNP are to increase the standing stock (density and biomass) of native oyster in native oyster beds. As such certain biological effects, namely increased deposition of organic material, seston filtration, nutrient exchange, extraction of the target species (native oyster) and by-catch mortality may be expected. Physical effects of dredging involves seabed surface and sub-surface disturbance summarized above and below in Table 4..

Table 4: Potential indicative environmental pressures of aquaculture and fishery activities within the qualifying interest (Estuary) of Lough Swilly.

CULTURE METHOD	PRESSURE CATEGORY	PRESSURE	POTENTIAL EFFECTS	EQUIPMENT	DURATION (DAYS)	TIME OF YEAR	FACTORS CONSTRAINING THE ACTIVITY/EFFECTS
Suspended - Bags & trestles; BST longlines (Oysters)	**Biological**	Deposition	Faecal and pseudofaecal deposition on seabed potentially altering sediment and community composition		365	All year	Hydrography, Turbidity, Culture/structure density
		Seston filtration	Alteration of phyto/zooplankton communities and potential impact on carrying capacity		365	All year	Culture density, Turbidity
		Shading	Prevention of light penetration to seabed potentially impacting light sensitive species		365	All year	Culture/structure density
		Fouling	Increased secondary production on structures and culture species. Increased nekton production		365	All year	Culture/structure density
		Introduction of non-native species	Potential for non-native culture and 'hitchhiker' species become naturalized				Screening/ Culture method/ Introduce biosecurity plan
		Disease risk	Potential for disease introduction and uncontrolled spread				Screening/ Introduce biosecurity plan
		Monoculture	Habitat dominated by single species; Potential transformation of infaunal dominated community to epifaunal dominated community.				
		Nutrient exchange	Changes in ammonium and dissolved inorganic nitrogen				Culture density

CULTURE METHOD	PRESSURE CATEGORY	PRESSURE	POTENTIAL EFFECTS	EQUIPMENT	DURATION (DAYS)	TIME OF YEAR	FACTORS CONSTRAINING THE ACTIVITY/EFFECTS
			resulting in increased primary production. N_2 removal at harvest or denitrification at sediment surface.				
	Physical	Current alteration	Structures may alter the current regime resulting in increased deposition of fines or scouring therefore changing sedimentary composition	Long lines, Baskets, Bags, Trestles, Floats etc	365	All year	Culture/structure density
		Surface disturbance	Ancillary activities at sites increase the risk of sediment compaction resulting in sediment changes and associated community changes.	Site services, human & vehicular traffic			
		Shading	Structures prevent light penetration to the seabed and therefore potentially impact on light sensitive species	Long lines, Baskets, Bags, Trestles, Floats etc	365	All year	Culture/structure density
Bottom (Mussels, Oysters)	Biological	Deposition	Faecal and pseudofaecal deposition on seabed potentially altering sediment and community composition		365	All year	Hydrography, Turbidity, Culture/structure density
		Seston filtration	Alteration of phyto/zooplankton communities and potential impact on carrying capacity		365	All year	Culture density, Turbidity
		Fouling	Increased secondary production on culture species. Increased nekton production		365	All year	Culture density

CULTURE METHOD	PRESSURE CATEGORY	PRESSURE	POTENTIAL EFFECTS	EQUIPMENT	DURATION (DAYS)	TIME OF YEAR	FACTORS CONSTRAINING THE ACTIVITY/EFFECTS
		Introduction of non-native species	Potential for non-native culture and 'hitchhiker' species become naturalized				Screening, Culture method
		Disease risk	Potential for disease introduction and uncontrolled spread				Screening
		Nutrient exchange	Changes in ammonium and dissolved inorganic nitrogen resulting in increased primary production. N_2 removal at harvest or denitrification at sediment surface.		365	All year	Culture density
	Physical	Surface disturbance	Ancillary activities at sites increase the risk of sediment compaction resulting in sediment changes and associated community changes.	Site services, human & vehicular traffic	365?	All year	Good Site practices
		Surface disturbance	Abrasion at the sediment surface and redistribution of sediment	Dredge 'Mop'	Variable depends on predator numbers	Mar-May; Sept-Nov	Predation control Refer to Table 2
		Sub-surface disturbance	Shallow and deep disturbance, Epifaunal and infaunal community disturbance	Dredge	Seed collection, relaying spat, acclimatisation, stock movements and harvesting	Aug-Oct; Oct-Sept;	Refer to Table 2
Oyster fishery plan	Biological	Deposition, Seston filtration and nutrient exchange as described above		Oyster dredges		Sept to March	Conditions in the FNP

CULTURE METHOD	PRESSURE CATEGORY	PRESSURE	POTENTIAL EFFECTS	EQUIPMENT	DURATION (DAYS)	TIME OF YEAR	FACTORS CONSTRAINING THE ACTIVITY/EFFECTS
		Extraction	Removal of target species	Oyster dredges		Sept to March	Conditions in the FNP
	Physical	Surface and sub-surface disturbance	Surface and shallow sub-surface disturbance of epifauna and infauna	Oyster dredges		Sept to March	Conditions in the FNP

5 Appropriate Assessment Screening

An appropriate assessment screening is an initial evaluation of the possible impacts that activities may have on the qualifying interests. The screening, is a filter, which may lead to exclusion of certain activities from appropriate assessment proper, thereby simplifying the assessments, if this can be justified unambiguously using limited and clear cut criteria. Screening is a conservative filter that minimises the risk of false negatives.

In this assessment screening of the qualifying interests against the proposed activities is based solely on spatial overlap i.e. if the qualifying interests overlap spatially with the proposed activities then significant 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. Where there is relevant spatial overlap appropriate assessment proper is warranted. Likewise if there is no spatial overlap then the possibility of significant impact is discounted and further assessment of possible effects is deemed not to be necessary. Table 5 provides spatial overlap extent between designated habitats and aquaculture activities within the qualifying interests of Lough Swilly SAC.

Aquaculture Activity Screening

- Table 5 provides an overview of overlap of aquaculture activities and habitat features (identified from Conservation Objectives).
- None of the aquaculture activities overlap with 1150 (Coastal Lagoons-Blanket Nook Lough and Inch Lough), 1330 (Atlantic salt meadows), 91AO (Old sessile oak woods with Ilex and Blechnum in the British Isles).
- Where the overlap between an aquaculture activity and a feature is zero it is screened out and not considered further.
- Table 6 lists the percentage overlap of aquaculture activity (species, by status and location) and habitat/community. Each shaded cell (aquaculture activity – benthic community/designated species combination) in Table 6 is assessed separately and in combination in Section 6.

Table 5: Habitat utilisation (spatial overlap by ha) by Aquaculture and fishing activities within the qualifying interest of Lough Swilly based on licence database provided by DAFM and the FNP (Appendix I).

		Aquaculture or fishing activity								
Code	**Designation**	*Mussel Culture- Bottom Culture (licensed)*	*Mussel Culture- Bottom Culture (application)*	*Oyster Culture Bags & Trestles (licensed)*	*Oyster Culture Bags & Trestles (application)*	*Oyster Culture Bags & Trestles; BST Longlines (licensed)*	*Oyster Culture BST Longlines (application)*	*Oyster Culture Bottom Culture (application)*	*Oyster/Mussel Culture- Bottom Culture (licensed)*	*Native Oyster fishery*
1130	**Estuaries**									
	Fine sand community complex	0	40.93	0	0	0	16.36	0	111.49	71.74
	Intertidal Mixed sediment with polychaetes	24.94	46.13	18.19	4.71	13.48		3.15	53.89	167.1
	Mud community complex	6.00	68.75						136.02	71.86
	Muddy fine sand with *Thyasira flexuosa*	48.10	164.40		4.34	46.35	1.56		628.87	263.4
	Ostrea edulis dominated community	200.56	40.05	5.70	4.95			244.64	5.90	877.9
	Subtidal Mixed sediment with polychaetes and bivalves	232.01	188.72	2.36				32.48	237.54	218.5
1150	**Coastal Lagoons**	0	0	0	0	0	0	0	0	0
1330	**Atlantic salt meadows**	0	0	0	0	0	0	0	0	0
1355	**Otter *(Lutra lutra)***	All activities potentially overlap with all designated species but the spatial overlap is not fixed and therefore cannot be calculated								
91AO	**Old sessile oak woods with Ilex and Blechnum in the British Isles**	0	0	0	0	0	0	0	0	0

Table 6: Aquaculture activity (species, by status and location) and habitat overlap. Shaded cells are those taken further in appropriate assessment. Numbers in italics represent the percentage overlap of activity with relevant habitat.

Species	Culture / fishing Method	Licence Status	Fine sand community complex	Intertidal mixed sediment with polychaetes	Mud community complex	Muddy fine sand with *Thyasira flexuosa*	*Ostrea edulis* dominated community	Subtidal Mixed sediment with polychaetes and bivalves
Extent (ha) of marine habitat within qualifying interest (Estuary):			**582.6261**	**655.3023**	**1126.9168**	**1320.4796**	**905.9781**	**1314.0290**
Mussels	**Bottom Culture**	**Licensed**	0	24.94	6.00	48.09	200.56	232.01
				3.81	*0.53*	*3.64*	*22.14*	*17.66*
Mussels	**Bottom Culture**	**Application**	40.93	46.13	68.75	164.40	40.05	188.72
			7.02	*7.04*	*6.10*	*12.45*	*4.42*	*14.36*
Oysters	**Bags & Trestles**	**Licensed**	0	18.2	0	0	5.70	2.36
				2.78			*0.63*	*0.18*
Oysters	**Bags & Trestles**	**Application**	0	4.71	0	4.34	4.95	0
				0.72		*0.33*	*0.55*	
Oysters	**Bags & Trestles; BST Longlines**	**Licensed**	0	13.48	0	46.35	0	0
				2.06		*3.51*		
Oysters	**BST Longlines**	**Application**	16.36	0	0	1.56	0	0
			2.81			*0.12*		
Oysters	**Bottom Culture**	**Application**	0	3.15	0	0	244.64	32.48
				0.48			*27.00*	*2.47*
Oysters/Mussels	**Bottom Culture**	**Licensed**	111.49	53.90	136.02	628.87	5.90	237.54
			19.14	*8.22*	*12.07*	*47.62*	*0.65*	*18.08*
Native oyster fishery	**Dredging**	**Licensed**	71.74	167.1	71.8	263.4	877.9	218.5
			12.31	*25.50*	*6.37*	*19.95*	*96.90*	*16.63*

6 Assessment

Determining significance

The significance of the possible effects of the proposed activities on habitats, as outlined in the Natura Impact statement, is determined here in the appropriate assessment. The significance of effects is determined on the basis of Conservation Objective guidance for constituent habitats (NPWS 2011b) (Figure 8).

Habitats that are key contributors to biodiversity and which are sensitive to disturbance should be afforded a high degree of protection i.e. thresholds for impact on these habitats is low and any significant anthropogenic disturbance should be avoided. Within the Lough Swilly SAC the qualifying habitats are

1. Estuaries (1130)
2. Coastal Lagoons (1150)
3. Atlantic salt meadows (1330)
4. Old sessile oak woods with Ilex and Blechnum in the British Isles (91AO)

Significant disturbance is interpreted in this assessment as indicated in Figure 8. For broad sedimentary communities significance of impact is determined in relation to spatial overlap, disturbance and the persistence of disturbance 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 (NPWS 2011b) for constituent communities. The likelihood of change depends on the sensitivity of the characterising species to the aquaculture activities. Sensitivity results from a combination of intolerance to the activity and recoverability from the effects of the activity (see section 8.1.3 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.

In relation to designated species the capacity of the population to maintain itself in the face of anthropogenic induced disturbance or mortality at the site will need to be taken into account in relation to the Conservation Objectives (CO's) on a case by case basis.

Effects will be deemed to be significant when cumulatively they lead to long term change in communities in greater than 15% of the area of any constituent community listed.

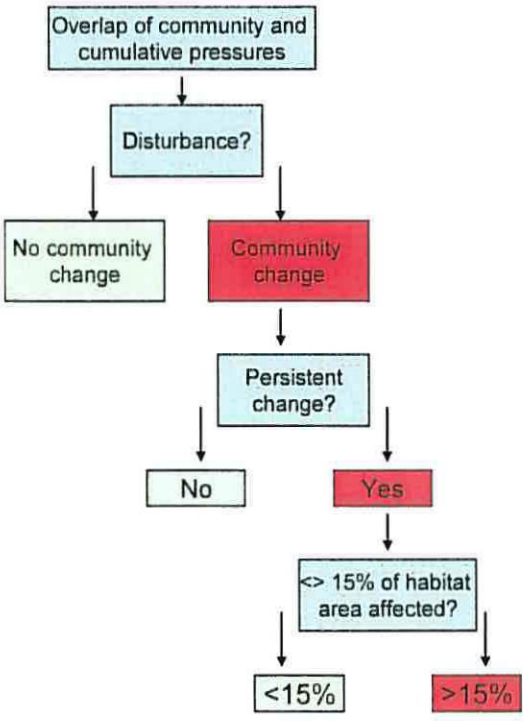


Figure 8: Determination of significant effects on community distribution, structure and function (following NPWS 2011b).

6.1.1 Supporting evidence and confidence in conclusions

There are various levels of supporting evidence and therefore confidence for conclusions on the effects of activities on the conservation objectives for each qualifying interest. The degree of confidence with respect to findings of significant or no significant effects is categorised as high, medium or low (Table 7).

Table 7: Level of confidence, based on supporting evidence, in relation to significance of effects and the implication for management decisions.

Level of confidence	**Supporting evidence**	**Implication in relation to significance**	
		Where effects are found to be **significant** (>15% of any community type is persistently disturbed)	Where effects are found to be **insignificant** (<15% of any community type is persistently disturbed or where the activity occurs on >15% of the area but is not persistent or activity that is persistent in >15% of the area but is not considered disturbing)
High	Direct measurement of effects at the site	The impacting activity is unlikely to be allowed until the effects can be mitigated (i.e. brought below agreed thresholds)	The activities can proceed without mitigation
Moderate	Effects deduced from similar activities at similar sites		The activities can proceed but precautionary mitigation may be introduced.
Low	Expert judgement, ecological theory and expectation	The impacting activity may not be allowed until direct measurements of effects at the site shows evidence of non-significant effects	The activities can proceed but only with significant precautionary mitigation and agreement to provide direct evidence of non-significant effects within an agreed time scale

6.1.2 Sensitivity assessment rationale

This assessment primarily employed two sources of information in assessing the sensitivity of the characterising species of each community recorded within the Estuarine habitat of Lough Swilly - the MarLIN Sensitivity Assessment (Marlin.ac.uk) and the AMBI Sensitivity Scale (Borja *et al.*, 2000). The former assessment lists the sensitivity of species/habitat/community to a range of pressures while the latter lists the sensitivity of a species to the pressure of organic enrichment predominantly. 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-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.

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 intolerance is moderate or high then the species 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 2011b).
- 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 intolerance 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 species which are characteristic (as listed in the COs) of benthic communities to pressures similar to those caused by aquaculture (e.g. smothering, organic enrichment and physical disturbance) are listed, where available, in Tables 8, 9 and 10. In cases where the sensitivity of a characterising species (NPWS 2011b) has not been reported this appropriate assessment adopts the following guidelines

- Intolerance 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.
- Intolerance 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 & Desrocher, 2004) cited in Hall *et al.*, 2008).

Sensitivity of benthic species and communities in relation to potential disturbance by individual aquaculture activities

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 and the type of activity are all important considerations when considering risk of disturbance to habitats.

NPWS (2011b) provide lists of species characteristic of benthic communities that are defined in the Conservation Objectives. Different species and habitats will have different tolerance to the pressures associated with shellfish aquaculture activities (pressures as discussed in Chapter 6).

6.2.1 Mussel Bottom Culture

Mussel Bottom Culture (licensed) covers 511.6ha of the qualifying interest (Estuary) within the Lough Swilly SAC (Figure 9).

Mussel Bottom Culture (applications) covers 549ha of the qualifying interest (Estuary) within the SAC in (Figure 9).

This aquaculture type overlaps all of the six different community types found within the qualifying interest of Lough Swilly SAC.

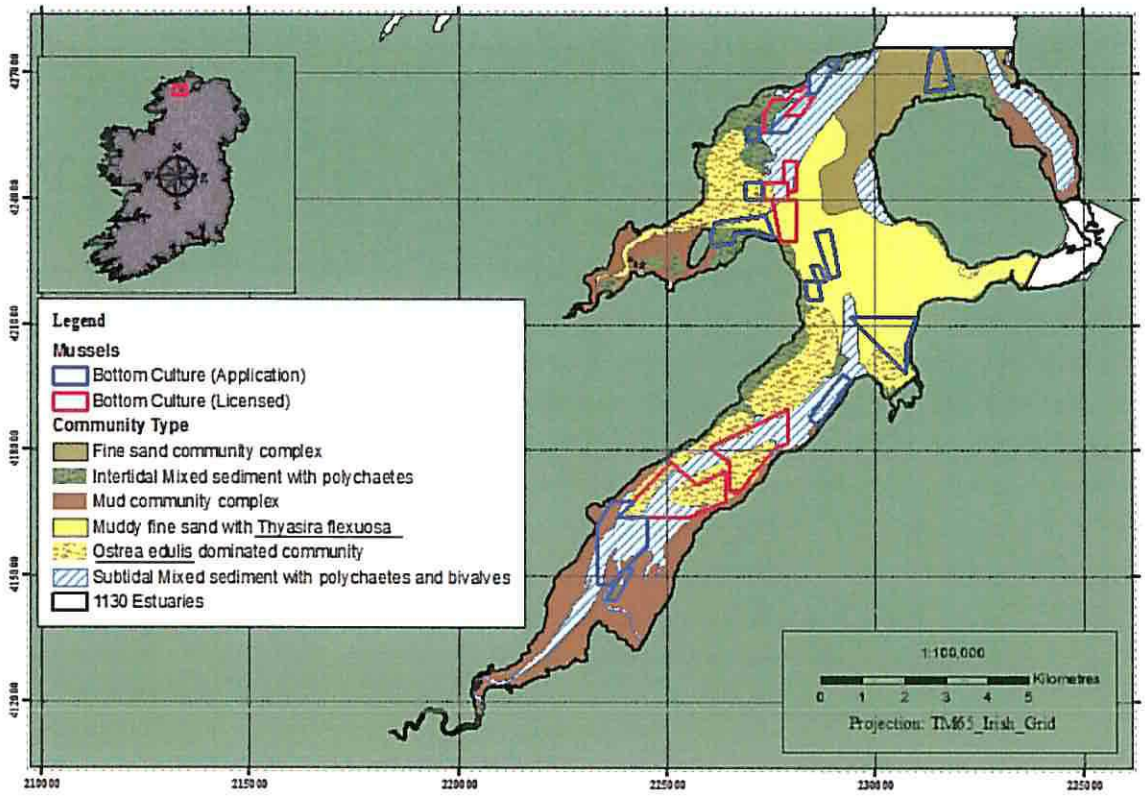


Figure 9: Spatial overlap between bottom mussel culture sites (Applications-blue; Licensed red) and habitats within the qualifying interest of Lough Swilly SAC.

The potential impacts of the bottom mussel culture on the sedimentary communities of Lough Swilly are:

- **Biodeposition** on the seabed of mussel faeces and pseudofaeces can lead to organic enrichment and smothering. The bottom culture of mussels on the seafloor alters the sedimentary habitat and leads to the development of 'mussel mud' beneath the mussel bed as the filtration and feeding activities of the mussels increase sedimentation rates. These deposits are composed of dead shells, silt and pseudofaeces, which can persist in excess of 18mths after the mussels have been removed (Kaiser and Beadman, 2002). Deposition can therefore result in a change in sediment type which in turn can result in changes to the biological communities within. The production of biodeposits by mussels is a function of, (1) The level of seston in the water column (Tenore and Dunstan 1973; Kautsky and Evans 1987; Navarro and Thompson 1997) and, (2) the size of the mussel, such that larger mussels will produce greater quantities of bio-deposits in absolute terms (Callier *et al.* 2006). The duration of the activity is year-round resulting in a risk of chronic organic enrichment of the seafloor. Benthic responses to organic enrichment have been described by Pearson & Rosenberg (1978) and Gray (1981). Moderate enrichment can lead to increased diversity however as enrichment increases diversity will decline and the community will become dominated by fewer species tolerant of organic enrichment.
- **Physical disturbance:** The dredging activities (seed relaying, stock movements, predator control and harvesting) associated with this culture practice are deemed to be disturbing to the physical habitat and to the resident faunal community. Such physical disturbance can lead to the removal and/or destruction of infaunal species and changes to sediment composition. Although some individual species are deemed to have a high recoverability from this pressure (based on biological traits) this assumes the pressure has

ceased and is not ongoing. In Lough Swilly dredging occurs on a number of occasions throughout the year (refer Table 1) and may be classed as a persistent disturbance. A study carried out by Dernie *et al.* (2003) demonstrated a strong relationship between the rate at which the physical structure of soft sediment habitats was restored and the rate at which the biological components of the system recover. Recovery was shown to be most rapid for clean sand habitats, intermediate for mud habitats and longest for muddy-sand habitats.

- **Monoculture:** The location of large numbers of a single epifaunal species onto sedimentary habitats characterised by infaunal communities can smother existing fauna and/or result in a change to the habitat and thereby the biological community contained therein. Sessile epifaunal species would also be affected, and some would not survive such smothering. The duration of the activity is year-round resulting in continuous disturbing impact upon the resident community from this pressure.
- **Disease risk:** Due to the uncontained fashion by which the culture organisms are relayed on the seafloor, complete removal may not be possible if required in the event of disease outbreak.
- **Introduction of non-native species:** There is a risk associated with the introduction seed from outside Ireland although the risk of introduction of listed diseases in the target organism are monitored and mitigated under legislation (Council Directive 2006/88/EC which deals with the health of aquaculture animals and the prevention and control of certain aquatic diseases). However, this practice presents the risk of establishment and spread of species that are associated with the introduced bivalves (Carlton 1989, 1999). These species may include both "hitchhiking" species i.e., animals and plants that grow associated with the bivalves and both listed and potentially non-listed diseases or parasites that may cause outbreaks in the same or other species (Barber 1996). If non-native species become established habitat structure and function may change.

Community Type: Fine Sand Community Complex

- Applications for the bottom culture of mussels overlap with 40.92ha of the Fine sand community complex; this overlap constitutes 7.02% of the habitat area for this community type within the qualifying interest.
- This community complex is characterized by a range of infaunal species-the polychaetes *Spiophanes bombyx*, *Lumbrineris latreilli*, *Pygospio elegans*, *Nemertea* spp., *Nephtys hombergii*, *Scoloplos armiger*; the oligochaete *Tubificoides benedii*; the bivalves *Angulus tenuis, Donax vittatus, Thracia papyracea* and *Phaxas pellucidus* and the amphipods *Bathyporeia pilosa* and *B. elegans*. There are three variants of this community recorded within Lough Swilly, however only Variant 3 is present within the boundary of the Annex 1 habitat. This variant is characterised by the polychaetes *Spiophanes bombyx*, *Lumbrineris latreilli*, *Nephtys hombergii*, and the bivalves *Thracia papyracea* and *Phaxas pellucidus*.
- The species characterising this community complex (variant 3) are typically infaunal polychaetes and bivalves. The latter are deemed sensitive to organic enrichment (Table 8), but none of the characterising species are considered sensitive to smothering (≤5cm sedimentation) as they are mobile and can migrate up through any additional sediment (Table 9).
- These characteristic infaunal species would likely be extirpated from the footprint of the area covered by the culture organism and would only recover if the culture organism was removed and settlement occurred from adjacent communities.
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e.

dredging). However their recoverability (based on biological traits) is classed as high to very high therefore their sensitivity to the pressure is low (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (mussel bottom culture) the pressure is continuous and ongoing and therefore recoverability may be affected.

- **The percentage of the community that will be thus affected is 7.02%.**

Conclusion: Considering the range of impacts identified above and the persistent nature of the pressure, this activity is considered disturbing on Fine Sand Community Complex.

Community Type: Intertidal Mixed Sediment with Polychaetes

- Sites licensed for the bottom culture of mussels overlap with 24.9ha of the Intertidal Mixed Sediment with Polychaetes community; this overlap constitutes 3.8% of the habitat area for this community type within the qualifying interest. Applications for this culture method also overlap this community type by 46.1ha which is a 7% overlap. In total, therefore, this culture method (applications & licensed) overlaps 71ha (10.8%) of the Intertidal Mixed Sediment with Polychaetes community.
- This community is characterized by a range of infaunal polychaetes *Pygospio elegans* (tube dwelling) *Eteone* sp., *Scoloplos armiger*, *Glycera tridactyla*, *Anaitides mucosa*, *Euclymene oerstedii*, the oligochaete *Tubificoides benedii* and the bivalve *Cerastoderma edule*.
- These characteristic infaunal species would likely be extirpated from the footprint of the area covered by the culture organism and would only recover if the culture organism was removed and settlement occurred from adjacent communities.
- The species characterising this community are typically infaunal polychaetes and bivalves tolerant/indifferent of organic enrichment, with the exception of *Euclymene oerstedii* which is sensitive (Table 4.1). *T. benedii* is an opportunistic (first order) species which proliferates in reduced environments. Species present have no/low sensitivity to smothering by sedimentation (Table 9)
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However depending on their recoverability their sensitivity to it varies, the bivalve *C. edule* is deemed to have an intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (mussel bottom culture) the pressure is continuous and ongoing and therefore recoverability may be affected.
- **The percentage of the community that will be thus affected is 10.8%.**

Conclusion: Considering the range of impacts identified above and the persistent nature of the pressure, this activity is considered disturbing on Intertidal Mixed Sediment with Polychaetes community.

AMBI Classification/	Sensitive (I)	Indifferent (II)	Tolerant (III)	Second-order opportunistic (IV)	First-order opportunistic (V)
Community	**Characterising species**				
Fine Sand Community Complex (Variant 3)	*Thracia papyracea* *Phaxas pellucidus*	*Lumbrineris latreilli* *Nephtys hombergii*	*Spiophanes bombyx*		
Intertidal Mixed Sediment with Polychaetes	*Euclymene oerstedii*	*Glycera tridactyla*	*Pygospio elegans* *Scoloplos armiger* *Eteone* sp. *Cerastoderma edule*		*Tubificoides benedii*
Subtidal Mixed Sediment with Polychaetes and Bivalves	*Timoclea ovata* *Venerupis senegalensis* *Parvicardium exiguum* *Ampharete lindstroemi* *Diplocirrus glaucus* *Leptochiton cancellatus*	*Lumbrineris latreilli* *Pomatoceros triqueter*	*Abra alba* *Scoloplos armiger*		*Capitomastus minima*
Muddy Fine Sand with *Thyasira flexuosa*	*Euclymene oerstedii* *Ampelisca brevicornis* *Phaxas pellucidus* *Thracia papyracea* *Nucula nitidosa*	*Nephtys hombergii* *Ophiodromus flexuosus*	*Scoloplos armiger* *Notomastus latericeus* *Scalibregma inflatum* *Abra nitida* *Thyasira flexuosa* *Abra alba*	*Prionospio fallax*	
Mud Community Complex		*Nephtys hombergii*	*Corophium volutator* *Pygospio elegans* *Etone sp.* *Hediste diversicolor* *Macoma balthica* *Scrobicularia plana* Nematoda sp.		*Tubificoides benedii* *Tubificoides pseudogaster*
Ostrea edulis Dominated Community	Refer to communities 2 and 3 above *Ostrea edulis*				

Table 8: Sensitivities to organic enrichment (based on the AMBI classification) of species characteristic of communities which have spatial overlap with aquaculture activities within the Annex 1 Habitats of Lough Swilly SAC.

Table 9: Sensitivity assessment to increased smothering (≤5cm; permeable material) (as reported in www.marlin.ac.uk) of characterising species (numerically dominant) of communities which have spatial overlap with aquaculture activities within the Annex 1 Habitats of Lough Swilly SAC.

	Characterising species						Dominant taxonomic groups			
Community	1	2	3	4	5	6	1	2	3	4
Fine Sand Community Complex (Variant 3)	*Spiophanes bombyx*	*Thracia papyracea*	*Phaxas pellucidus*	*Nephtys hombergii*	*Lumbrineris latreilli*		Polychaetes	Bivalves		
Intertidal Mixed Sediment with Polychaetes	*Pygospio elegans*	*Eteone* sp.	*Scoloplos armiger*	*Glycera tridactyla*	*Tubificoides benedii*	*Cerastoderma edule*	Polychaetes	Oligochaetes	Bivalves	
Subtidal Mixed Sediment with Polychaetes and Bivalves	*Pomatoceros triqueter*	*Lumbrineris latreilli*	*Capitomastus minima*	*Scoloplos armiger*	*Abra alba*	*Timoclea ovata*	Polychaetes	Bivalves		
Muddy Fine Sand with *Thyasira flexuosa*	*Thyasira flexuosa**	*Scoloplos armiger*	*Nephtys hombergii*	*Euclymene oerstedii*	*Ampelisca brevicornis*	*Phaxas pellucidus*	Bivalves	Polychaetes	Amphipods	
Mud Community Complex	*Tubificoides benedii*	*Macoma balthica*	*Scrobicularia plana*	*Corophium volutator*	*Hydrobia ulvae/ventrosa*	*Nephtys hombergii*	Oligochaetes	Bivalves	Amphipods	Polychaete
Ostrea edulis Dominated Community	**Refer to communities2 and 3 above**	*Ostrea edulis*								

Sensitivity code :

Low = Low/Intermediate intolerance, High recoverability	Not sensitive=Tolerant/Low intolerance, Not relevant/Immediate recoverability
Very High = High intolerance, Very low recoverability	Moderate = High intolerance/High recoverability

Table 10: Sensitivity assessment to **physical disturbance** (as reported in www.marlin.ac.uk) of characterising species (numerically dominant) of communities which have spatial overlap with aquaculture activities within the Annex 1 Habitats of Lough Swilly SAC.

	Characterising species						Dominant taxonomic groups			
Community	1	2	3	4	5	6	1	2	3	4
Fine Sand Community Complex (Variant 3)	*Spiophanes bombyx*	*Thracia papyracea*	*Phaxas pellucidus*	*Nephtys hombergii*	*Lumbrineris latreilli*		Polychaetes	Bivalves		
Intertidal Mixed Sediment with Polychaetes	*Pygospio elegans*	*Eteone* sp	*Scoloplos armiger*	*Glycera tridactyla*	*Tubificoides benedii*	*Cerastoderma edule*	Polychaetes	Oligochaetes	Bivalves	
Subtidal Mixed Sediment with Polychaetes and Bivalves	*Pomatoceros triqueter*	*Lumbrineris latreilli*	*Capitomastus minima*	*Scoloplos armiger*	*Abra alba*	*Timoclea ovata*	Polychaetes	Bivalves		
Muddy Fine Sand with *Thyasira flexuosa*	*Thyasira flexuosa*	*Scoloplos armiger*	*Nephtys hombergii*	*Euclymene oerstedii*	*Ampelisca brevicornis*	*Phaxas pellucidus*	Bivalves	Polychaetes	Amphipods	
Mud Community Complex	*Tubificoides benedii*	*Macoma balthica*	*Scrobicularia plana*	*Corophium volutator*	*Hediste diversicolor*	*Nephtys hombergii*	Oligochaetes	Bivalves	Amphipods	Polychaetes
Ostrea edulis Dominated Community	*Refer to communities 2 and 3 above*	*Ostrea edulis*								

Sensitivity to code :

Low = Low/Intermediate intolerance, Very/High recoverability	Not Sensitive= Tolerant/Low intolerance, Not relevant/Immediate recoverability.
Moderate = High intolerance, High recoverability	High = Intermediate intolerance, Low recoverability

Community Type: Subtidal Mixed Sediment with Polychaetes and Bivalves

- Sites licensed for the bottom culture of mussels overlap with 232ha of the Subtidal Mixed Sediment with Polychaetes and Bivalves; this overlap constitutes 17.7% of the habitat area for this community type within the qualifying interest. Applications for this culture method also overlap this community type by 188.7ha which is a 14.4% overlap. In total, therefore, this culture method (applications & licensed) overlaps 420.7ha (32.1%) of the Subtidal Mixed Sediment with Polychaetes and Bivalves community.
- A high number of distinguishing species were recorded for this community; the following were present in medium to high abundance: the polychaetes *Pomatoceros triqueter, Lumbrineris latreilli, Capitomastus minima* and *Scoloplos armiger* and bivalves *Abra alba* and *Timoclea ovata.*
- The bivalves *Timoclea ovata*, *Venerupis senegalensis* and *Parvicardium exiguum* recorded within this community are deemed sensitive to organic enrichment (Table 8); *C. minima* is an opportunistic (first order) species which proliferates in reduced environments. The tube worm *P. triqueter* is deemed sensitive to smothering (Table 9).
- These characteristic infaunal species would likely be extirpated from the footprint of the area covered by the culture organism and would only recover if the culture organism was removed and settlement occurred from adjacent communities.
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However depending on their recoverability their sensitivity to it varies, the bivalve *A. alba* is deemed to have an intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (mussel bottom culture) the pressure (mussel bottom culture) is continuous and ongoing and therefore recoverability may be affected.
- **The percentage of the community that will be thus affected is 32.1%.**

Conclusion: Considering the range of impacts identified above and the persistent nature of the pressure, this activity is considered disturbing on Subtidal Mixed Sediment with Polychaetes and Bivalves community.

Community Type: Muddy Fine Sand with *Thyasira flexuosa*

- Sites licensed for the bottom culture of mussels overlaps with 48.1ha of the Muddy Fine Sand with *Thyasira flexuosa* community; this overlap constitutes 3.6% of the area for this community type within the qualifying interest. Applications for this culture method also overlap this community type by 164.4ha which is a 12.5% overlap. In total, therefore, this culture method (applications & licensed) overlaps 212.5ha (16.1%) of the Muddy Fine Sand with *Thyasira flexuosa* community.
- This community is characterized by the infaunal bivalve *Thyasira flexuosa*. The polychaetes *Scoloplos armiger*, *Nephtys hombergii* and *Euclymene oerstedii,* the amphipod *Ampelisca brevicornis* and the bivalve *Phaxas pellucidus* are also commonly present.
- Three of these distinguishing species (*Euclymene oerstedii, Ampelisca brevicornis, Phaxas pellucidus*) and the bivalves *Thracia papyracea* and *Nucula nitidosa* are sensitive to organic enrichment (Table 8); Species present are not deemed sensitive to smothering (Table 9).

- These characteristic infaunal species would likely be extirpated from the footprint of the area covered by the culture organism and would only recover if the culture organism was removed and settlement occurred from adjacent communities.
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However, depending on their recoverability their sensitivity to it varies. The bivalve *T. flexuosa* is deemed to have intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (mussel bottom culture) the pressure is continuous and ongoing and therefore recoverability may be affected.
- **The percentage of the community that will be thus affected is 16.1%.**

Conclusion: Considering the range of impacts identified above and the persistent nature of the pressure, this activity is considered disturbing on Muddy Fine Sand with *Thyasira flexuosa* community.

Community Type: Mud Community Complex

- Sites licensed for the bottom culture of mussels overlaps with 6ha of the Mud Community Complex; this overlap constitutes 0.5% of the area for this community type within the qualifying interest. Applications for this culture method also overlap this community type by 68.7ha which is a 6.1% overlap. In total, therefore, this culture method (applications & licensed) overlaps 74.7ha (6.6%) of the Mud Community Complex.
- This community is characterized by the oligochaete *Tubificoides benedii*, the bivalves *Macoma balthica* and *Scrobicularia plana*, the amphipod *Corophium volutator* and the polychaetes *Pygospio elegans, Eteone* sp., *Nephtys hombergii* and *Hediste diversicolor.*
- The characterizing species is an opportunistic species (1st order) indicative of an environment under stress/ which proliferates in reduced environments; all other characterising species are tolerant/indifferent to organic enrichment (Table 8). Species present are deemed to have a low sensitivity to smothering (Table 9).
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However, depending on their recoverability their sensitivity to it varies. The bivalve *Macoma balthica* is deemed to have intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 4.3). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (mussel bottom culture) the pressure is continuous and ongoing and therefore recoverability may be affected.
- **The percentage of the community that will be thus affected is 6.6%.**

Conclusion: Considering the range of impacts identified above and the persistent nature of the pressure, this activity is considered disturbing on Mud Community Complex.

Community Type: *Ostrea edulis* dominated community

- Sites licensed for the bottom culture of mussels overlaps with 201ha of the *Ostrea edulis* dominated community; this overlap constitutes 22.1% of the area for this community type within the qualifying interest. Applications for this culture method also overlap this community type by 40ha which is a 4.4% overlap. In total, therefore, this culture method (applications & licensed) overlaps 241ha (26.5%) of the *Ostrea edulis* dominated community.
- This community occurs in those areas described as an Intertidal mixed sediment with polychaetes and a Subtidal mixed sediment with polychaetes and bivalves and therefore its distinguishing fauna is a combination of both. This community is therefore characterized by a wide range of species, those present in moderate to high numbers include the polychaetes *Capitomastus minima, Eteone* sp., *Euclymene oerstedii*, *Glycera tridactyla*, *Lumbrineris latreilli, Pygospio elegans, Scoloplos armiger*, *Pomatoceros triqueter,* the oligochaete *Tubificoides benedii* and the bivalves *Abra alba, Cerastoderma edule* and *Timoclea ovata*.
- The species characterising this community are typically infaunal polychaetes and bivalves tolerant/indifferent of organic enrichment, with the exception of *E. oerstedii* and *T. ovata* which are sensitive (Table 8). *T. benedii* is an opportunistic (first order) species which proliferates in reduced environments. Species listed have no/low sensitivity to smothering (Table 9). However continuous deposition would be detrimental to sessile fixed epifauna such as *Ostrea edulis* which has a very high sensitivity to the pressure.
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However depending on their recoverability their sensitivity to it varies, the bivalves *C. edule* and *A. Alba* are deemed to have an intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (mussel bottom culture) the pressure is continuous and ongoing and therefore recoverability may be affected. The native oyster *Ostrea edulis* has a high sensitivity to the physical disturbance.
- Monoculture may lead to changes to the infaunal community which is characterized by bivalves and polychaetes; and also may result in the smothering of resident epifaunal species i.e. *O. edulis*.
- The introduction of diseases and non-native species associated with bivalve culture has been known to severely impact the native oyster (Sewell & Hiscock, 2005). The non-native copepod parasite *Myticola intestinalis*, a parasite initially of mussels, which now infects oysters, is a threat to the native oyster beds. According to MarLIN this community has a very high sensitivity to the introduction of non-native species and to the introduction of parasites/pathogens.
- **The percentage of the community that will be thus affected is 26.5%.**

Conclusion: Considering the range of impacts and habitat and species sensitivities identified above and the persistent nature of the pressure, this activity is considered disturbing on *Ostrea edulis* dominated community.

6.2.2 Oyster Bottom Culture

There are no licenses granted to date solely for the bottom culture of oysters (*Ostrea edulis* and *Crassostrea gigas* combined) within Lough Swilly.

Oyster Bottom Culture (applications) covers 280.3ha* of the qualifying interest (Estuary) within the SAC in (Figure 10). (*It should be noted that 175ha of these applications occur in an area that is already licensed for the bottom culture of mussels (considered above). Given these overlaps, the viability of these applications should be but has not been fully addressed. Therefore the real cover of featured habitat is 105ha (see Figure 10).

This aquaculture type overlaps three of the six different community types found within the qualifying interest of Lough SAC.

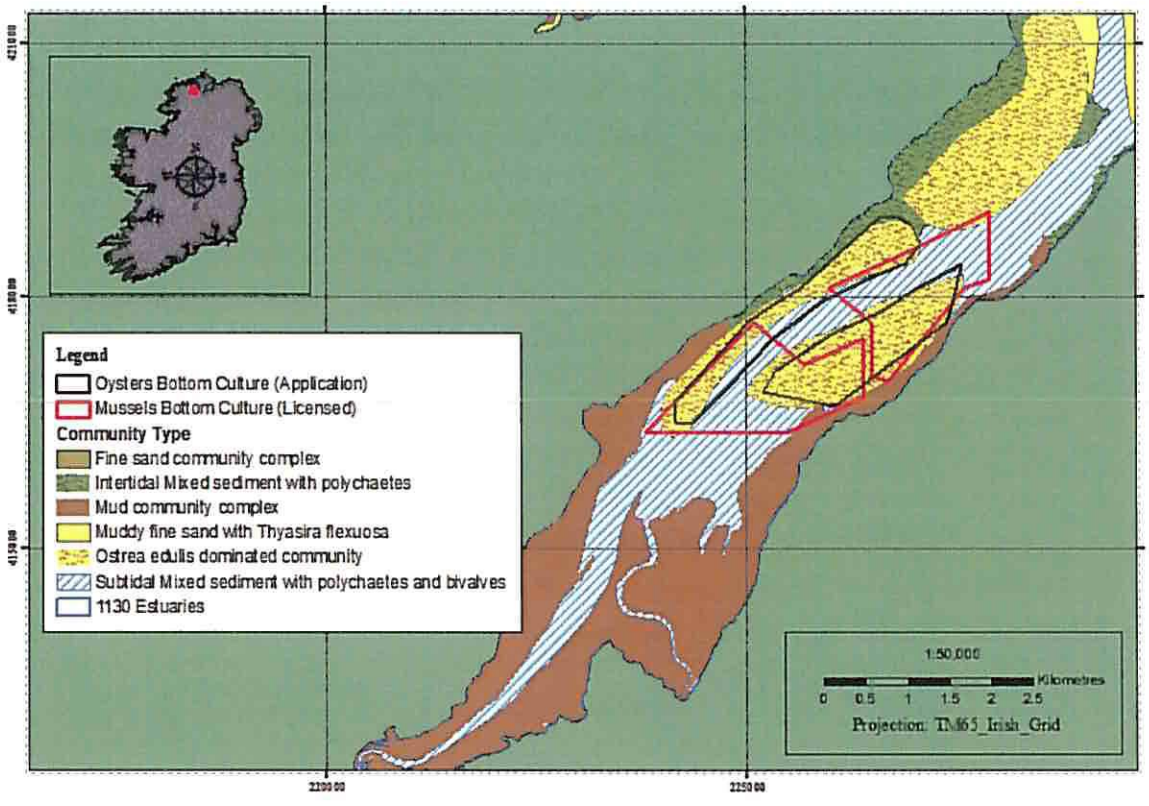


Figure 10: Spatial overlap between bottom oyster culture sites (applications) and habitats within the qualifying interest of Lough Swilly SAC. (Area of overlap with licensed bottom mussel culture (red) is highlighted).

The potential impacts of the operation on the sedimentary communities of Lough Swilly are:

- **Organic** and **sediment deposition**, **physical disturbance** and **monoculture** - these are discussed in detail above (8.2.1)
- **Introduction of non-native species** Oyster culture poses a significant risk in terms of the introduction of non-native species and diseases as the widely cultivated species pacific oyster (*Crassostrea gigas*) is a non-native species. Lough Swilly contains a number of native oyster beds which are considered scarce throughout Ireland and the UK, and are deemed at risk from disease and competition from non-native species. The introduction of non-native species is a serious cause for concern for native oyster beds, as there is the risk that the widely cultivated introduced species (*C. gigas*) may become naturalised (i.e. establishment of a breeding population) and compete with the native species for space and food. The use of triploid stock (non-reproducing) is

the main method employed to eliminate this problem. However, it has being reported that the pacific oyster (*C. gigas*) has become established as a self-seeding population in Lough Swilly and their distribution suggests that they are already a threat to wild oyster stocks and habitat (MI 2012).

- **Disease:** Due to the nature of the culture methods the risk of transmission of disease from cultured to wild/native stocks is high.

Community type: Intertidal Mixed Sediment with Polychaetes

- Applications for this culture method also overlap this community type by 3.2 ha which is a 0.5% overlap.
- This community is characterized by a range of infaunal polychaetes, oligochaetes and bivalves that are tolerant/indifferent of organic enrichment, with the exception of *Euclymene oerstedii* which is sensitive (Table 8). *T. benedii* is an opportunistic (first order) species which proliferates in reduced environments. Species present have no/low sensitivity to smothering (Table 9)
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However depending on their recoverability their sensitivity to it varies, the bivalve *C. edule* is deemed to have an intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (bottom oyster culture) the pressure is episodic and therefore recoverability may be affected.
- **The percentage of the community that will be thus affected is 0.5%.**

Conclusion: Considering the range of impacts and habitat and species sensitivities identified above and the persistent nature of the pressure, this activity is considered disturbing on Intertidal Mixed Sediment with Polychaetes.

Community Type: Subtidal Mixed Sediment with Polychaetes and Bivalves

- Applications for this culture method overlap this community type by 32.5ha* (-22ha) which is a 2.5%* (-1.7%) overlap. (*It should be noted that 1.7% (22ha) of these applications occur in an area that is already licensed for the bottom culture of mussels and therefore one would assume these applications are not viable. Therefore the real potential overlap is 0.8% and 10.5ha)
- A high number of distinguishing species were recorded for this community; the following were present in medium to high abundance: the polychaetes *Pomatoceros triqueter, Lumbrineris latreilli, Capitomastus minima* and *Scoloplos armiger* and bivalves *Abra alba* and *Timoclea ovata.*
- The bivalves *Timoclea ovata*, *Venerupis senegalensis* and *Parvicardium exiguum* recorded within this community are deemed sensitive to organic enrichment (Table 8); *C. minima* is an opportunistic (first order) species which proliferates in reduced environments. The tube worm *P. triqueter* is deemed sensitive to smothering (Table 9).
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However depending on their recoverability their sensitivity to it varies, the bivalve *A. alba* is deemed to have an intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes

the pressure has ceased, however due to the nature of the activity (oyster bottom culture) the pressure is episodic and therefore recoverability may be affected.

- **The percentage of the community that will be thus affected is 0.8%.**

Conclusion: Considering the range of impacts and habitat and species sensitivities identified above and the persistent nature of the pressure, this activity is considered disturbing on Subtidal Mixed Sediment with Polychaetes.

Community Type: *Ostrea edulis* dominated community

- Applications for this culture method overlap with 245ha*(-153ha see below) of the *Ostrea edulis* dominated community; this overlap constitutes 27%* of the area for this community type within the qualifying interest. (*It should be noted that 17% (153ha) of these applications occur in an area that is already licensed for the bottom culture of mussels and therefore one would assume these applications are not viable. Therefore the real potential overlap is 10% and 92ha)
- This community occurs in those areas described as an Intertidal mixed sediment with polychaetes and a Subtidal mixed sediment with polychaetes and bivalves and therefore its distinguishing fauna is a combination of both. This community is therefore characterized by a wide range of species, those present in moderate to high numbers include the polychaetes *Capitomastus minima, Eteone* sp., *Euclymene oerstedii*, *Glycera tridactyla*, *Lumbrineris latreilli, Pygospio elegans, Scoloplos armiger*, *Pomatoceros triqueter,* the oligochaete *Tubificoides benedii* and the bivalves *Abra alba, Cerastoderma edule* and *Timoclea ovata*.
- The epifaunal native oyster *Ostrea edulis* and the polychaete *E. oerstedii* and the bivalve *T. ovata* are sensitive to organic enrichment (Table 8). Other species characterising this community, typically infaunal polychaetes and bivalves, are tolerant/indifferent of organic enrichment, with the exception of T. *benedii* is an opportunistic (first order) species which proliferates in reduced environments.
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However depending on their recoverability their sensitivity to it varies, the bivalves *C. edule* and *A. Alba* are deemed to have an intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (bottom culture) the pressure is episodic/repeated and therefore recoverability may be affected. The native oyster *O. edulis* has an intermediate intolerance and a low recoverability and therefore is highly sensitive to physical disturbance.
- Non-native species introduced within the oyster farming industry (as the culture organism and along with the culture organism) that have caused major mortalities to native oyster beds include the slipper limpet *Crepidula fornicata* and the parasitic protozoan *Bonamia ostreae*. According to MarLIN this community has a very high sensitivity to the introduction of non-native species and to the introduction of parasites/pathogens.
- **The percentage of the community that will be thus affected is 10%*.**

Conclusion: Considering the range of impacts and habitat and species sensitivities identified above ,the persistent nature of the pressure, this activity (i.e. culture of native and non-native oyster species) is considered disturbing on *Ostrea edulis* dominated community.

6.2.3 Suspended Oyster Culture

Suspended Oyster Culture within Lough Swilly includes the use of Bags and trestles and also BST Longlines; at some sites both methods of culture are employed.

Suspended oyster culture using bags & trestles (licensed) covers 26.3ha and applications for same covers 14ha of the qualifying interest (Estuary) within the Lough Swilly SAC (Figure 11).

An area of 59.8 ha is under the dual culture methods of bags & trestles and BST longlines (licensed) while applications for BST Longlines covers 17.9ha of the qualifying interest (Estuary) within the SAC in (Figure 11).

This aquaculture type overlaps five of the six different community types found within the qualifying interest of Lough SAC (see below).

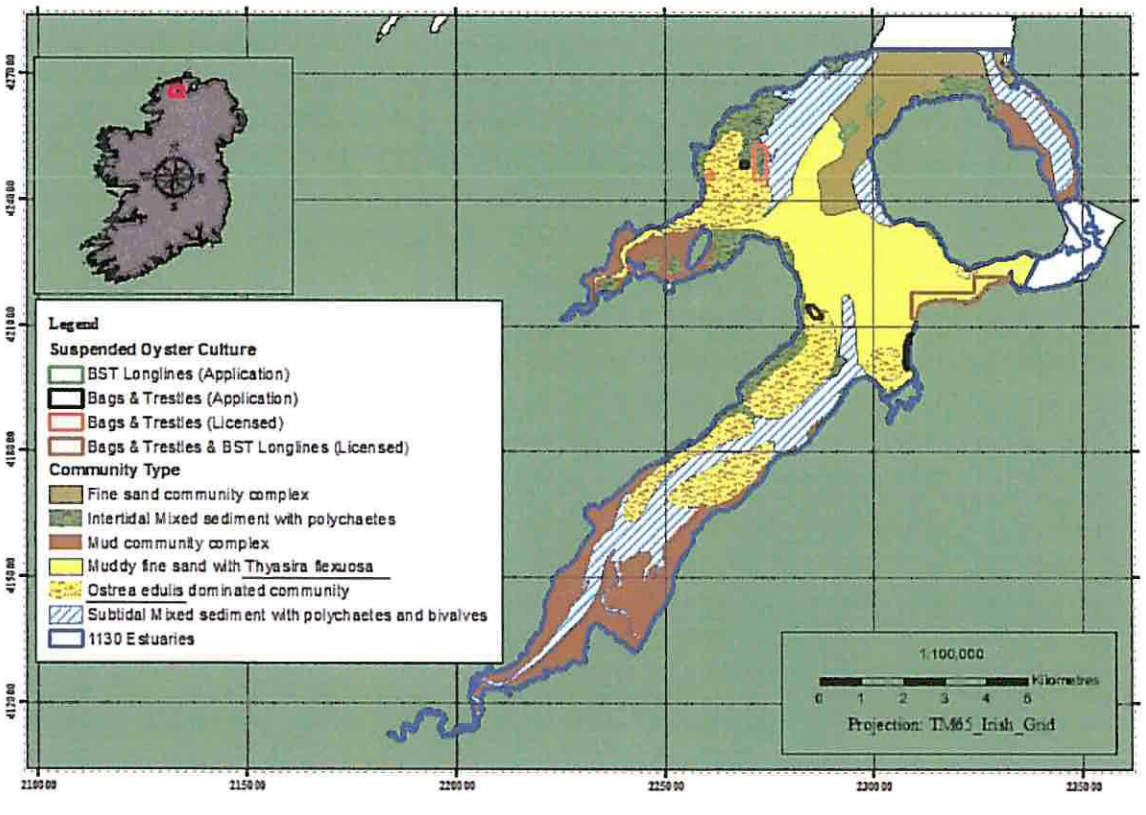


Figure 11: Spatial overlap between suspended oyster culture sites and habitats within the qualifying interest of Lough Swilly SAC.

The potential impacts of the operation on the sedimentary communities of Lough Swilly are:

- **Deposition** on the seabed of oyster faeces and pseudofaeces can lead to organic enrichment and can result in a change in sediment type which in turn can result in changes to the biological communities within. The degree of deposition depends on the culture density, the baffling effect caused by the culture structures, exposure of the site. The physical presence of the trestles and bags are responsible for reducing water flow and allowing suspended material (silt, clay as well as faeces and pseudo-faeces) to fall out of suspension to the seafloor. The build-up of material will typically occur directly beneath the trestle structures and can result in accumulation of fine,

organically rich sediments. These sediments may result in the development of infaunal communities distinct from the surrounding areas. However, suspended oyster culture typically has a moderate and localised (usually under the footprint of the culture activity) effect on inter-tidal benthos (Bouchet and Sauriau 2008; Forrest *et al.* 2009).

- **Physical disturbance:** Dredging is not involved in this culture method but sedimentary habitats may be subject to varying degrees of surface disturbance due to human traffic and vehicular movements. In Lough Swilly, suspended cultivation sites are accessed by flat bottom barges and by tractor and trailers on low tide. The latter activity would be result in the risk of compaction on the sedimentary habitats of the area.
- **Introduction of non-native species** Oyster culture poses a significant risk in terms of the introduction of non-native species and diseases as the widely cultivated species pacific oyster (*Crassostrea gigas*) is a non-native species. The introduction of diseases and non-native species associated with bivalve culture has been known to severely impact the native oyster (Sewell & Hiscock, 2005). Lough Swilly contains a number of native oyster beds which are considered scarce throughout Ireland and the UK, and are deemed at risk from disease and competition from non-native species. The introduction of non-native species is a cause for concern for the native oyster fishing industry, as *C. gigas* has become naturalised (i.e. establishment of a breeding population) in the bay and may compete with the native species for space and food. The use of triploid stock (non-reproducing) is the main method employed to mange this issue.
- **Disease:** Due to the nature of the culture methods (high density) there is a risk of transmission of disease from cultured to wild/native stocks.

Community Type: Fine Sand Community Complex

- Applications for the suspended culture of oysters (BST Longlines) overlap with 16.4ha of the Fine sand community complex; this overlap constitutes 2.8% of the habitat area for this community type within the qualifying interest.
- This community complex is characterized by a range of infaunal species (refer above). There are three variants of this community recorded within Lough Swilly, however only Variant 3 is present within the boundary of the Annex 1 habitat. This variant is characterised by the polychaetes *Spiophanes bombyx*, *Lumbrineris latreilli*, *Nephtys hombergii*, and the bivalves *Thracia papyracea* and *Phaxas pellucidus*
- The bivalves characterising this community complex (variant 3) are deemed sensitive to organic enrichment (Table 8), but none of the characterising species are considered sensitive to smothering (≤5cm sediment) as they are mobile and can migrate up through any additional sediment (Table 9).
- The percentage of the community that will be thus affected is 2.8%.

Conclusion: Impact of suspended culture of oysters on Fine Sand Community Complex can be discounted for the following reasons:

- Stock is contained and therefore complete removal of can be achieved in the event of a disease outbreak
- The characterising species are not particularly sensitive to sedimentation.

- The activity occurs on less than 15% of the Fine Sand Community Complex which is below the threshold for significant effects.

Community Type: Intertidal Mixed Sediment with Polychaetes

- Sites licensed for suspended oyster culture overlaps with 31.7ha of Intertidal Mixed Sediment with Polychaetes community; this overlap constitutes 4.8% of the habitat area for this community type within the qualifying interest. This includes the following culture methods Bags & trestles (18.2ha; 2.8%) and Bags & trestles and BST longlines (13.5ha; 2%)
- Applications for suspended oyster culture (Bags & trestles) overlap with 4.7ha of Intertidal Mixed Sediment with Polychaetes community; this overlap constitutes 0.7% of the habitat area for this community type within the qualifying interest.
- The total overlap of suspended oyster culture with this habitat type is therefore 36.4ha (5.5%).
- This community is characterized by a range of infaunal polychaetes and bivalves (refer above) which are deemed tolerant/indifferent to organic enrichment, with the exception of *Euclymene oerstedii* which is sensitive (Table 8).
- The mixed sediment nature of the site would suggest that superficial fines (as a consequence of sedimentation) will likely not persist and will be dispersed easily.

Conclusion: Impact of suspended culture of oysters on the Intertidal Mixed Sediment with Polychaetes community can be discounted for the following reasons:

- Stock is contained and therefore complete removal of can be achieved in the event of a disease outbreak
- The characterising species are not likely exposed to or are tolerant of the primary impacts
- The activity occurs on less than 15% of the Intertidal Mixed Sediment with Polychaetes community which is below the threshold for significant effects.

Community Type: Subtidal Mixed Sediment with Polychaetes and Bivalves

- Sites licensed for suspended oyster culture (Bags & trestles) overlap with 2.4ha of Subtidal Mixed Sediment with Polychaetes and Bivalves community; this overlap constitutes 0.18% of the habitat area for this community type within the qualifying interest
- A high number of distinguishing species were recorded for this community (refer above).
- The bivalves *Timoclea ovata*, *Venerupis senegalensis* and *Parvicardium exiguum* recorded within this community are deemed sensitive to organic enrichment (Table 8); *C. minima* is an opportunistic (first order) species which proliferates in reduced environments. The tube worm *P. triqueter* is deemed sensitive to smothering (Table 9).
- The mixed sediment nature of the site would suggest that superficial fines (as a consequence of sedimentation) will likely not persist and will be dispersed easily.
- The percentage of the community that will be thus affected is 0.18%.

Conclusion: Impact of suspended oyster culture on the Subtidal Mixed Sediment with Polychaetes and Bivalves community can be discounted for the following reasons:

- The activity occurs on less than 15% of the community which is below the threshold for significant effects.

- Stock is contained and therefore complete removal of can be achieved in the event of a disease outbreak.
- The characterising species are not likely exposed to or are tolerant of the primary impacts

Community Type: Muddy Fine Sand with *Thyasira flexuosa*

- Sites licensed for suspended oyster culture (Bags & trestles and BST longlines) overlaps with 46.3ha of Muddy Fine Sand with *Thyasira flexuosa* community; this overlap constitutes 3.5% of the habitat area for this community type within the qualifying interest.
- Applications for suspended oyster culture (Bags & trestles; BST longlines) overlap with 5.9ha of Muddy Fine Sand with *Thyasira flexuosa* community; this overlap constitutes 0.45%.
- The total overlap of suspended oyster culture with this habitat type is 52.2ha (4%).
- This community is characterized by the infaunal bivalve *Thyasira flexuosa*, polychaetes, amphipods and bivalves (refer above).
- A number of distinguishing species (*Euclymene oerstedii, Ampelisca brevicornis, Phaxas pellucidus, Thracia papyracea* and *Nucula nitidosa*) are sensitive to organic enrichment (Table 8); Species present are not deemed sensitive to smothering (Table 9).

Conclusion: Impact of suspended culture of oysters on the Muddy Fine Sand with *Thyasira flexuosa* Community can be discounted for the following reasons:

- The activity occurs on less than 15% of the community which is below the threshold for significant effects.
- Stock is contained and therefore complete removal of can be achieved in the event of a disease outbreak.

Community Type: *Ostrea edulis* dominated community

- Sites licensed for suspended oyster culture (Bags & trestles) overlaps with 5.7ha of *Ostrea edulis* dominated community; this overlap constitutes 0.63% of the habitat area for this community type within the qualifying interest. Applications for same overlap with 5ha of the community; this overlap constitutes 0.5%.
- This community occurs in those areas described as an Intertidal mixed sediment with polychaetes and a Subtidal mixed sediment with polychaetes and bivalves and therefore its distinguishing fauna is a combination of both. This community is therefore characterized by a wide range of species (refer above) and dominated by the native oyster *Ostrea edulis*.
- The species characterising this community are typically infaunal polychaetes and bivalves tolerant/indifferent of organic enrichment, with the exception of *O. edulis*, *E. oerstedii* and *T. ovata* which are sensitive (Table 8). *T. benedii* is an opportunistic (first order) species which proliferates in reduced environments.
- Most species present have no/low sensitivity to smothering (Table 9). However the native oyster due to its sessile habit has a high intolerance to smothering and its recoverability is deemed very low.
- Due to its epifaunal habit *O. edulis* would be sensitive to physical damage due vehicular and human traffic.

- The introduction of diseases and non-native species associated with bivalve culture has been known to severely impact the native oyster (Sewell & Hiscock, 2005). Non-native species introduced within the oyster farming industry that have caused major mortalities to native oyster beds include the slipper limpet *Crepidula fornicata* and the parasitic protozoan *Bonamia ostreae*. According to MarLIN this community has a very high sensitivity to the introduction of non-native species and to the introduction of parasites/pathogens.
- The total overlap of suspended oyster culture with this habitat type is 10.7ha (1.1%).

Conclusion: Impact of suspended oyster culture on the *Ostrea edulis* dominated community is considered disturbing and cannotbe discounted for the following reasons:

- The dominant species *O. edulis* is highly sensitive to smothering and sensitive to organic enrichment and to activities associate with suspended culture (e.g. compaction).
- Native oyster beds (*O.edulis*) beds are considered scarce
- The community is highly sensitive to the introduction of non-native species and also parasites/pathogens.

6.2.4 Bottom culture of oysters and mussels

The Bottom Culture of oysters and mussels (licensed) covers 1173.8ha of the qualifying interest (Estuary) within the Lough Swilly SAC (Figure 12).

This aquaculture type overlaps all of the six different community types found within the qualifying interest of Lough SAC.

The potential impacts of the operation on the sedimentary communities of Lough Swilly are listed in sections 8.2.1 and 8.2.2 above.

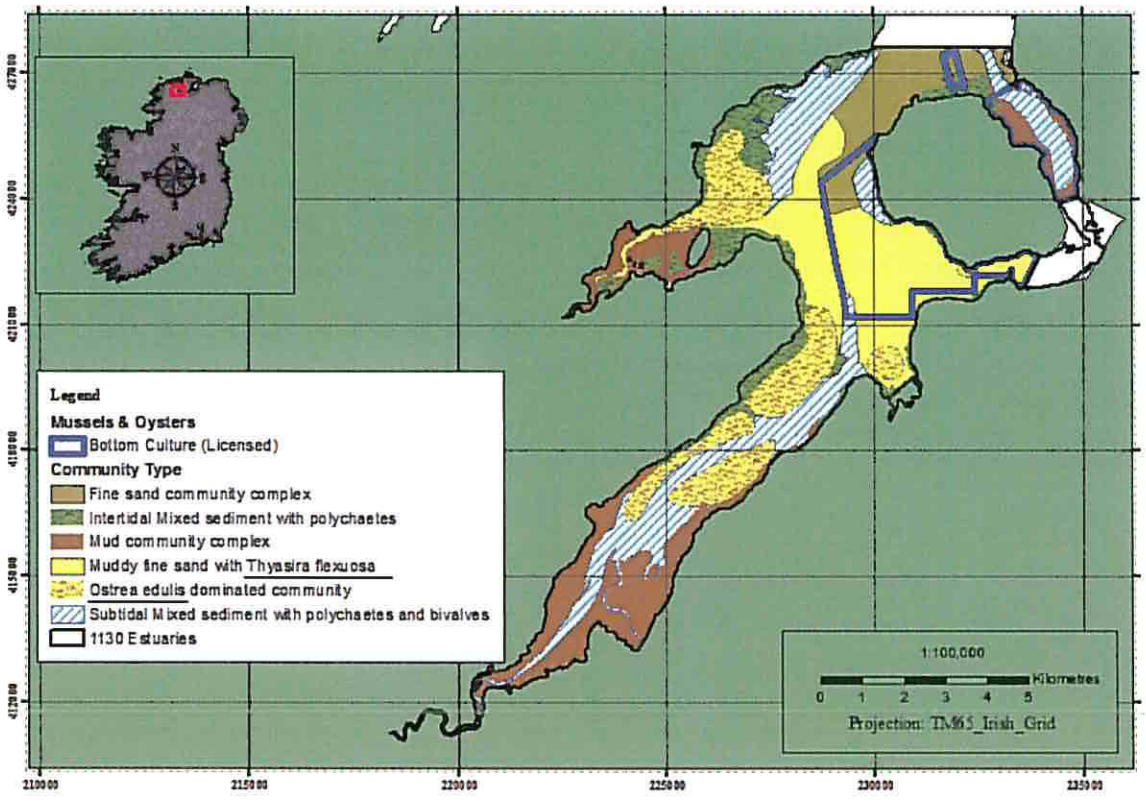


Figure 12: Spatial overlap between bottom oyster & mussel culture sites and habitats within the qualifying interest of Lough Swilly SAC.

Community type: Fine sand community complex

- Sites licensed for the bottom culture of oysters and mussels overlap with 112ha of the Fine sand community complex; this overlap constitutes 19% of the habitat area for this community type within the qualifying interest.
- The species characterising this community complex (variant 3) are typically infaunal polychaetes and bivalves (refer above).
- The characterising bivalves are deemed sensitive to organic enrichment (Table 8), but none of the characterising species are considered sensitive to smothering (≤5cm sedimentation) as they are mobile and can migrate up through any additional sediment (Table 9).
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However their recoverability (based on biological traits) is classed as high to very high therefore their sensitivity to the pressure is low (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (mussel bottom culture) the pressure is episodic and therefore recoverability may be affected.
- **The percentage of the community that will be thus affected is 19%.**

Conclusion: Impact of bottom culture of mussels and oysters on Fine Sand Community Complex is considered disturbing and CANNOT be discounted for the following reasons:

- The overlap of the activity and community exceeds the threshold area of 15%.
- Activity is continuous and ongoing.
- Some species present are sensitive to biological changes to sediments type due to deposition i.e. organic enrichment.
- Physical disturbance (dredging) of the seabed is deemed significantly disturbing (≥15%).
- Monoculture may lead to changes to the infaunal community which is characterized by bivalves and polychaetes.

Community Type: Intertidal Mixed Sediment with Polychaetes

- Sites licensed for the bottom culture of oysters and mussels overlap with 54ha of the Intertidal Mixed Sediment with Polychaetes; this overlap constitutes 8.2% of the habitat area for this community type within the qualifying interest.
- This community is characterized by a range of infaunal polychaetes, oligochaetes and bivalves that are tolerant/indifferent of organic enrichment, with the exception of *Euclymene oerstedii* which is sensitive (Table 8). *T. benedii* is an opportunistic (first order) species which proliferates in reduced environments. Species present have no/low sensitivity to smothering (Table 9)
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However depending on their recoverability their sensitivity to it varies, the bivalve *C. edule* is deemed to have an intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (bottom oyster culture) the pressure is episodic and therefore recoverability may be affected.
- **The percentage of the community that will be thus affected is 8.2%.**

Conclusion: Impact of bottom culture of mussels and oysters on Intertidal Mixed Sediment with Polychaetes is considered disturbing and CANNOT be discounted for the following reasons:

- Activity is continuous and ongoing.
- Some species present are sensitive to biological changes to sediments type due to deposition i.e. organic enrichment.
- Physical disturbance (dredging) of the seabed is deemed significantly disturbing.
- Monoculture may lead to changes to the infaunal community which is characterized by bivalves and polychaetes.

Community type: Subtidal Mixed Sediment with Polychaetes and Bivalves

- Sites licensed for the bottom culture of mussels and oysters overlap with 238ha of the Subtidal Mixed Sediment with Polychaetes and Bivalves; this overlap constitutes 18.1% of the habitat area for this community type within the qualifying interest.
- A high number of distinguishing species were recorded for this community; the following were present in medium to high abundance: the polychaetes *Pomatoceros triqueter, Lumbrineris latreilli, Capitomastus minima* and *Scoloplos armiger* and bivalves *Abra alba* and *Timoclea ovata*. .
- The bivalves *Timoclea ovata*, *Venerupis senegalensis* and *Parvicardium exiguum* recorded within this community are deemed sensitive to organic enrichment (Table 8); *C. minima* is an

opportunistic (first order) species which proliferates in reduced environments. The tube worm *P. triqueter* is deemed sensitive to smothering (Table 9).

- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However depending on their recoverability their sensitivity to it varies, the bivalve *A. alba* is deemed to have an intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (bottom culture) the pressure is episodic and therefore recoverability may not be possible.
- **The percentage of the community that will be thus affected is 18.1%.**

Conclusion: Impact of bottom culture of mussels and oysters on the Subtidal Mixed Sediment with Polychaetes and Bivalves community is considered disturbing and CANNOT be discounted for the following reasons:

- The overlap of the activity and community exceeds the threshold area of 15%.
- Activity is continuous and ongoing.
- Some species present are sensitive to biological changes to sediments type due to deposition i.e. organic enrichment.
- Physical disturbance (dredging) of the seabed is deemed disturbing
- Monoculture may lead to changes to the infaunal community which is characterized by bivalves and polychaetes.

Community Type: Muddy Fine Sand with *Thyasira flexuosa*

- Sites licensed for the bottom culture of oysters and mussels overlap with 629ha of the Muddy Fine Sand with *Thyasira flexuosa* community; this overlap constitutes 48% of the habitat area for this community type within the qualifying interest.
- This community is characterized by the infaunal bivalve *Thyasira flexuosa* and polychaetes, amphipods and other bivalves (refer above).
- Three of these distinguishing species (*Euclymene oerstedii, Ampelisca brevicornis, Phaxas pellucidus*) and the bivalves *Thracia papyracea* and *Nucula nitidosa* are sensitive to organic enrichment (Table 8); Species present are not deemed sensitive to smothering (Table 9).
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However depending on their recoverability their sensitivity to it varies. The bivalve *T. flexuosa* is deemed to have intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (mussel bottom culture) the pressure is episodic and therefore recoverability may be affected.
- **The percentage of the community that will be thus affected is 48%.**

Conclusion: Impact of bottom culture of mussels and oysters on the Muddy Fine Sand with *Thyasira flexuosa* community is considered disturbing and CANNOT be discounted for the following reasons:

- The overlap of the activity and community at 48% significantly exceeds the threshold area of 15%.

- Activity is continuous and ongoing.
- Some species present are sensitive to biological changes to sediments type due to deposition i.e. organic enrichment.
- Physical disturbance (dredging) of the seabed is deemed significantly disturbing
- Monoculture may lead to changes to the infaunal community which is characterized by bivalves and polychaetes.

Community Type: Mud Community Complex

- Sites licensed for the bottom culture of oysters and mussels overlap with 136ha of the Mud Community Complex; this overlap constitutes 12% of the habitat area for this community type within the qualifying interest.
- This community is characterized by oligochaetes, bivalves, amphipods and polychaetes (refer above).
- The characterizing species (*Tubificoides benedii*) is an opportunistic species (1st order) indicative of an environment under stress/ which proliferates in reduced environments; all other characterising species are tolerant/indifferent to organic enrichment (Table 8). Species present are deemed to have a low sensitivity to smothering (Table 9).
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However depending on their recoverability their sensitivity to it varies. The bivalve *Macoma balthica* is deemed to have intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (mussel bottom culture) the pressure is episodic and therefore recoverability may be affected.
- **The percentage of the community that will be thus affected is 12%.**

Conclusion: Impact of bottom culture of mussels and oysters on Mud Complex community is considered disturbing and CANNOT be discounted for the following reasons:

- Activity is continuous and ongoing.
- Some species present are sensitive to biological changes to sediments type due to deposition i.e. organic enrichment.
- Physical disturbance (dredging) of the seabed is deemed significantly disturbing
- Monoculture may lead to changes to the infaunal community which is characterized by bivalves and polychaetes.

Community Type: *Ostrea edulis* dominated community

- Sites licensed for the bottom culture of oysters and mussels overlap with 5.9ha of the *Ostrea edulis* dominated community; this overlap constitutes 0.65% of the habitat area for this community type within the qualifying interest.
- This community occurs in those areas described as an Intertidal mixed sediment with polychaetes and a Subtidal mixed sediment with polychaetes and bivalves and therefore its distinguishing fauna

is a combination of both. This community is therefore characterized by a wide range of species (refer above).

- The species characterising this community are typically infaunal polychaetes and bivalves tolerant/indifferent of organic enrichment, with the exception of *E. oerstedii* and *T. ovata* which are sensitive (Table 8). *T. benedii* is an opportunistic (first order) species which proliferates in reduced environments. Species listed have no/low sensitivity to smothering (Table 9). However continuous deposition would be detrimental to sessile fixed epifauna such as *Ostrea edulis* which has a very high sensitivity to the pressure.
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and are therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However depending on their recoverability their sensitivity to it varies, the bivalves *C. edule* and *A. Alba* are deemed to have an intermediate intolerance but high recoverability and therefore a low sensitivity to physical disturbance (Table 10). This high recoverability assessment assumes the pressure has ceased, however due to the nature of the activity (mussel bottom culture) the pressure is episodic and therefore recoverability may be affected. The native oyster *Ostrea edulis* has a high sensitivity to physical disturbance.
- The introduction of diseases and non-native species associated with bivalve culture has been known to severely impact the native oyster (Sewell & Hiscock, 2005). The non-native copepod parasite *Myticola intestinalis*, a parasite initially of mussels, which now infects oysters, is a threat to the native oyster beds. This community has a very high sensitivity to the introduction of non-native species and to the introduction of parasites/pathogens (MarLIN).
- **The percentage of the community that will be thus affected is 0.65%.**

Conclusion: Impact of bottom culture of mussels and oysters on the *Ostrea edulis* dominated community is considered disturbing and CANNOT be discounted for the following reasons:

- The dominant species *O. edulis* is highly sensitive to smothering and sensitive to organic enrichment
- Native oyster beds (*Ostrea edulis*) beds are considered scarce
- The community is highly sensitive to the introduction of non-native species and also parasites/pathogens.

6.2.5 The Fishery Natura Plan for native oyster

The proposed FNP for native oysters in L. Swilly (Annex I) includes a number of separate activities that may have effects on benthic communities. These are:

1. Fishing native oysters with dredges
   Oysters will be fished by bottom oyster dredge fitted with a blade but no teeth. Dredge width will be limited to 150cm. Dredges will be towed by vessels 7-12m in length typical of the Irish inshore fleet. The conditions (including oyster densities) under which fishing will occur are described in the FNP and involve avoiding areas of low oyster density (<0.25m^{-2}) as indicated by annual oyster surveys.
2. Fishing for Pacific oysters.

Using dredges similar to that described above. This unrestricted activity will occur in areas where Pacific oysters comprise more than 50% of all oysters. It is expected that the areas involved will decrease annually during the lifetime of the plan due to this control programme.

3. Establishing a spawning reserve
   This will involve transplanting oysters caught in the fishery to an area of 54ha and therefore the establishment of higher density of oysters on the seabed than currently exists.
4. Spreading cultch
   This involves relaying of dead shell, originating from L. Swilly or elsewhere, onto an area of 50 ha to increase the shelliness of the benthic habitat and improve conditions for settlement of oyster

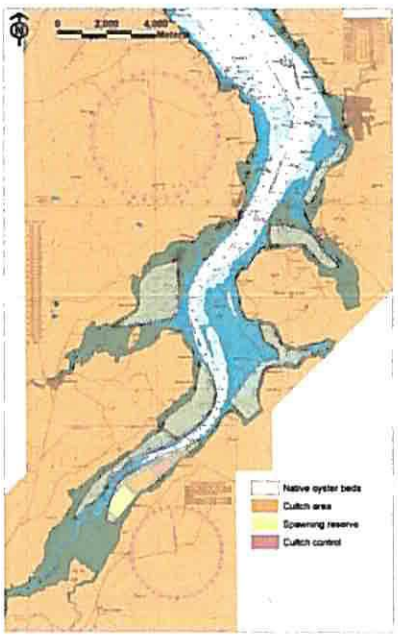


Figure 13. Overall distribution of the proposed fishery natura plan for native oysters in L. Swilly.

6.2.6 Effects of fishing for *O. edulis* and *C. gigas* (activities 1 and 2 above)

Community type: Fine sand community complex

- The oyster FNP overlaps with 71ha (12.1%) of the fine sand community complex (total area 582ha) in the qualifying interest Estuary (Fig. 14). Within this 71ha , in 2011, the area where density of *O. edulis* is >0.25m^{-2} is approximately 12ha and the area where the proportion of *P. gigas* is >0.5 is approximately 3.7ha. There are only minor overlaps between these areas. The effective overlap of the proposed fishery in the first year of the FNP is therefore (12+3.7)/582 or 2.7% of the intertidal mixed sediment community.
- Dredging for oysters represents a physical surface and sub-surface pressure on the fine sand community._Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). However, their recoverability (based on biological traits) is classed as high to very high therefore their sensitivity to the pressure is low (Table 10). This high recoverability assessment assumes the pressure is intermittent rather than persistent. The oyster fishing season is proposed from Sept 19th to March 31st. Recoverability of species is

highest during spring and summer due to recruitment processes. This period is closed to fishing. Although not explicit in the FNP fishing will not be persistent during the fishing season and will cease when oyster densities are <0.25m^{-2} or when exploitation rate reaches 33%.

Conclusion

- As the % overlap between the proposed fishery and the fine sand community is below the threshold of 15%, as physical disturbance caused by dredging will be intermittent, as recoverability of characterising species is high and as limits on the exploitation of oyster are included in the FNP significant impacts of the activity on the fine sand community **can** be discounted.

Community Type: Intertidal Mixed Sediment with Polychaetes

- The oyster FNP overlaps with 167ha (25.5%) of the Intertidal mixed sediments with polychaetes community (total area 655ha) in the qualifying interest Estuary (Fig. 14). Within this 167ha, in 2011, the area where density of *O. edulis* is >0.25m^{-2} is approximately 40ha and the area where the proportion of *P. gigas* is >0.5 is approximately 70ha. Both of these areas overlap completely. The effective overlap of the proposed fishery in the first year of the FNP is therefore 75/655 or 11% of the intertidal mixed sediment community.
- Dredging for oysters represents a physical surface and sub-surface pressure on the fine sand community. Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). Recoverability of these species is generally moderate or high (Table 10) to pressures that are intermittent such as seasonal fisheries and their sensitivity therefore is low or moderate.

Conclusion

- As the % overlap between the proposed fishery and the fine sand community is below the threshold of 15%, as physical disturbance caused by dredging will be intermittent, as recoverability of characterising species is high and as limits on the exploitation of oyster are included in the FNP significant impacts of the activity to the intertidal mixed sediment community **can** be discounted.

Community type: Subtidal Mixed Sediment with Polychaetes and Bivalves

- The oyster FNP overlaps with 218ha (16.6%) of the sub-tidal mixed sediments with polychaetes and bivalves community (total area 1314ha) in the qualifying interest Estuary (Fig. 14). Within 218ha the area where density of *O. edulis* is >0.25m^{-2} is approximately 40ha and the area where the proportion of *P. gigas* is >0.5 is approximately 75ha. These areas do not overlap substantially. The effective overlap of the proposed fishery in the first year of the FNP is therefore (40+75)/1314 or 8.7% of the sub-tidal mixed sediment with polychaetes and bivalves community.
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). Recoverability of these species is generally moderate or high (Table 10) to pressures that are intermittent such as seasonal fisheries and their sensitivity is therefore low or moderate

Conclusion

- As the % overlap between the proposed fishery and the sub-tidal mixed sediment community is below the threshold of 15%, as physical disturbance caused by dredging will be intermittent, as recoverability of characterising species is moderate or high and as limits on the exploitation of oyster are included in the FNP significant impacts of the activity to the intertidal mixed sediment community **can** be discounted.

Community Type: Muddy Fine Sand with *Thyasira flexuosa*

- The oyster FNP overlaps with 263ha (20%) of the muddy fine sand with *Thyasira flexuosa* community (total area 1320ha) in the qualifying interest Estuary (Fig. 14). Within this 263ha, in 2011, the area where density of *O. edulis* is >0.25m^{-2} is approximately 45ha and the area where the proportion of *P. gigas* is >0.5 is approximately 2ha. These latter areas overlap. The effective overlap of the proposed fishery in the first year of the FNP is therefore 45/1320 or 3.4% of the muddy fine sand with *T. flexuosa* community.
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). Recoverability of these species is generally moderate or high (Table 10) to pressures that are intermittent, such as seasonal fisheries, and their sensitivity is therefore low or moderate.

Conclusion

- As the % overlap between the proposed fishery and the sub-tidal mixed sediment community is below the threshold of 15%, as physical disturbance caused by dredging will be intermittent, as recoverability of characterising species is moderate or high and as limits on the exploitation of oyster are included in the FNP significant impacts of the activity to the intertidal mixed sediment community **can** be discounted.

Community Type: Mud Community Complex

- The oyster FNP overlaps with 72ha (6.4%) of the mud community complex (total area 1127ha) in the qualifying interest Estuary. Within this 72ha, in 2011. the area where density of *O. edulis* is >0.25m^{-2} is approximately 21ha and the area where the proportion of *P. gigas* is >0.5 is approximately 1.6ha. These latter areas overlap. The effective overlap of the proposed fishery in the first year of the FNP is therefore 21/1127 or 1.8% of the mud community complex
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). Recoverability of these species is generally moderate or high (Table 10) to pressures that are intermittent such as seasonal fisheries, and their sensitivity is therefore low or moderate.

Conclusion

- As the % overlap between the proposed fishery and the sub-tidal mixed sediment community is below the threshold of 15%, as physical disturbance caused by dredging will be intermittent, as recoverability of characterising species is moderate or high and as limits on the exploitation of

oyster are included in the FNP significant impacts of the activity to the intertidal mixed sediment community **can** be discounted.

Community Type: *Ostrea edulis* dominated community

- Fishing activity in the oyster FNP overlaps with 878ha (97%) of the *O. edulis* dominated community (total area 906ha) in the qualifying interest Estuary (Fig. 14). Within this 878ha, in 2011, the area where density of *O. edulis* is >0.25m^{-2} is approximately 371ha and the area where the proportion of *P. gigas* is >0.5 is approximately 270ha. These latter areas overlap by 115ha. Activities 3 and 4 (closed area and cultch area) will not be fished and involve 104ha.The effective overlap of the proposed fishery in the first year of the FNP is therefore (371+270-115-104)/906 or 46% of the *O. edulis* dominated community
- Characterising species of this complex are deemed fragile (i.e. soft bodied organism/fragile shell) and therefore have a degree of intolerance to physical disturbance that would penetrate the sediment (i.e. dredging). Recoverability of these species is generally moderate or high (Table 10) to pressures that are intermittent such as seasonal fisheries.
- *O. edulis* is sensitive to physical disturbance. Regular contact with dredges can cause mortality of oysters that are actively growing and can stunt growth in surviving oysters (Waugh 1972). Commercial dredging activity leads to shell breakage and gradual homogenisation of habitat and loss of small scale structural relief (Sewell *et al.*. 2007, Thrush *et al.*. 1998, 2001, Collie *et al.*. 1996, Kaiser *et al.*. 2000, Langton and Robinson 1990). These changes may be contrary to the physical and topographic conditions required for larval settlement. Although unsilted substrate is important the angle of presentation of the substrate and small scale 3D relief on the seabed may be important in providing suitable hydrodynamic conditions at very local scale that stimulate larvae to settle (Cranfield 1968). Increasing and maintaining habitat complexity, shelliness and relief is therefore important. The impact of dredging on these habitat characteristics depends on the intensity and frequency of the activity.
- Currently, as evidenced by oyster survey data (MI 2011), O. edulis is not a dominant characterising species in '*O. edulis* habitat' in L. Swilly. As such, and also given the high(er) densities of the introduced species *C. gigas* in the habitat and the description of the COs for this habitat as '*O. edulis* dominated' , the current conservation condition of this habitat must be regarded as unfavourable. The removal and control of *C. gigas* is a necessary first step for the restoration of the COs for this habitat. This will involve intensive dredging in some areas followed by habitat restoration involving provision of shell for *O. edulis* settlement if necessary.
- Dredging and removal of *O. edulis* in areas where densities are >0.25m^{-2} is proposed in the FNP. Limits are imposed on exploitation in this area; only oysters greater than 76mm will be taken, the exploitation rate on oysters above 76mm will be limited. The proportion of the oyster population removed, therefore, will and considering 2011 data, generally be less than 20% in the initial years of this plan.
- Fishing is proposed in areas where oyster density is >0.25m^{-2}. Considering that the twin objectives of the FNP are to maintain a commercial fishery and in parallel to build the biomass and density of *O. edulis*, the 0.25m^{-2} harvest control rule in the FNP must be considered to be a limit (to be avoided) rather than a target to be achieved i.e. fishing down to densities of 0.25m^{-2} is not the

objective. Considering the collective conservation measures in the FNP and the stated objectives and if the FNP is implemented then it is expected that oyster density will increase as a result of the plan. This is consistent with the COs for oyster habitat.

- Annual monitoring and evaluation of how the objectives, as laid out in the FNP, are being achieved will be necessary and some annual adaptation of the plan, based on monitoring results, and to ensure that the continued development of the fishery remains consistent with the COs, could be envisaged.

Conclusion

- Although the proposed fishery overlaps with >15% of *Ostrea* habitat, given that the activity is intermittent, that a number of conservation or control measures are included in the FNP that limits exploitation and that the stated objectives of the FNP are to rebuild Ostrea stocks the FNP will progress this habitat towards favourable conservation status. Significant negative impact of the FNP on this habitat **can** be discounted.

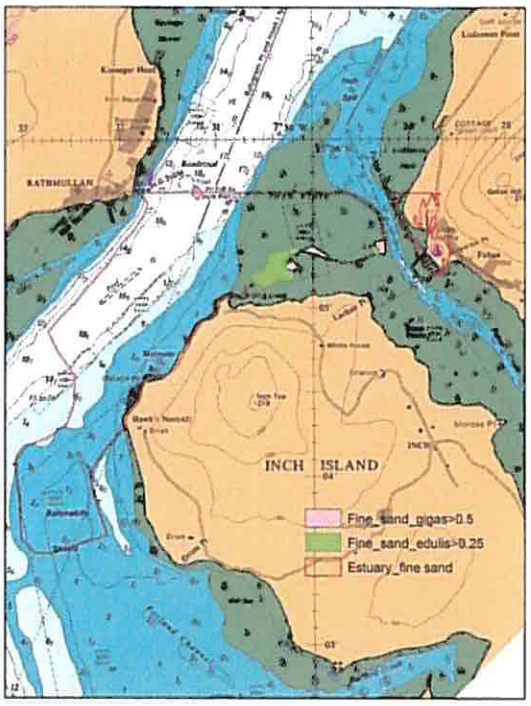
6.2.7 Effects of re-stocking closed areas and relaying cultch (activities 3 and 4 above)

- The objective of these activities is to increase oyster density in the closed area and oyster settlement (and ultimately density) in the cultch area. As such they are consistent with recovering this habitat to favourable conservation status (*Ostrea* dominated) and could be deemed to be positive and necessary management measures for the conservation of the habitat
- Two separate areas (Fig. 13) are described in the FNP one which will be closed to fishing and restocked with native oysters and a second where cultch (shell) will be relayed in a trial to determine if it increases the settlement of native oysters to the seabed.
- The cultch relay area (50ha) effectively overlaps with *O. edulis* habitat only. The total overlap is approximately 50ha of 906ha or 5.5% of *O. edulis* habitat (Fig 13 and Figs in Annex I).
- Part of the spawning reserve (37.8ha) overlaps with 3.7% of the sub-tidal mixed sediments with polychaetes biotope and 16.2ha overlaps represents 1.4% intertidal mud community complex
- The main effect of both activities initially is to increase the shell content and cover on the seabed. In the case of the closed area this will be through transplanting live native oysters into the area and in the cultch area through the spreading of dried shell of mussels, pacific oysters or native oysters. In the spawn reserve there is expected to be some increase in organic enrichment due to increased density of oysters.
- Increasing shell content in the cultch area followed by increased settlement and oyster density may lead to smothering of infauna depending on the density of cultch achieved. Increase in density of live oyster in the spawn reserve area may lead to changes in fauna due to enrichment.

Conclusion

- In *O. edulis* habitat cultching can be deemed necessary for the conservation of *Ostrea* in that it promotes spawning activity and habitat restoration. However, increasing shell content and restoring oyster from very low density to higher densities is expected to lead to some change in existing infauna.
- Overlap of the spawning area with intertidal mud and sub-tidal mixed sediment habitats is <15%. Nevertheless increasing oyster density within these areas may have persistent and significant effects on existing infauna

- The proposed activities represent an experiment to see if it is viable to increase oyster recruitment in oyster habitat and with some overlap with other intertidal and subtidal habitats and as such are important in determining how native oyster habitat can be conserved and managed at the site.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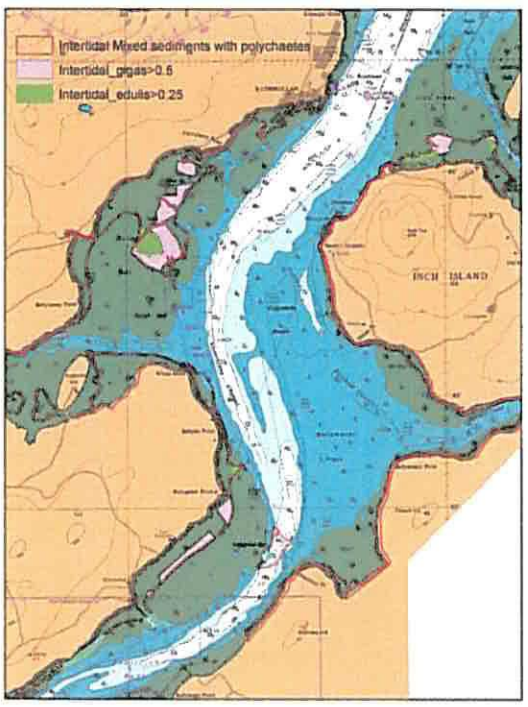
Estuary_fine sand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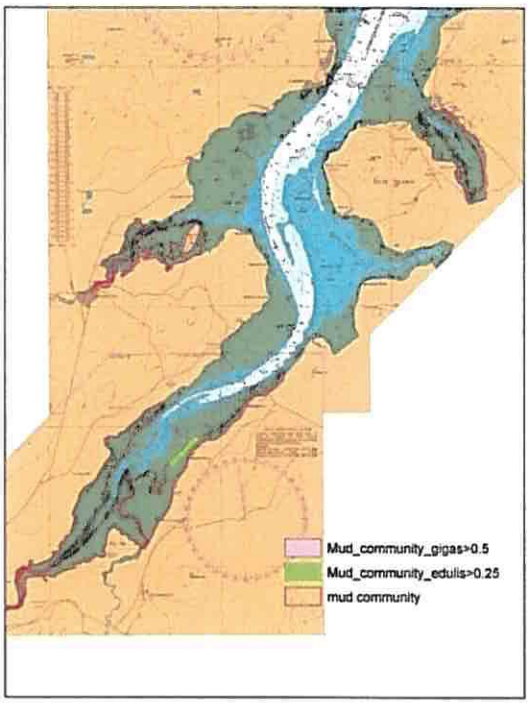
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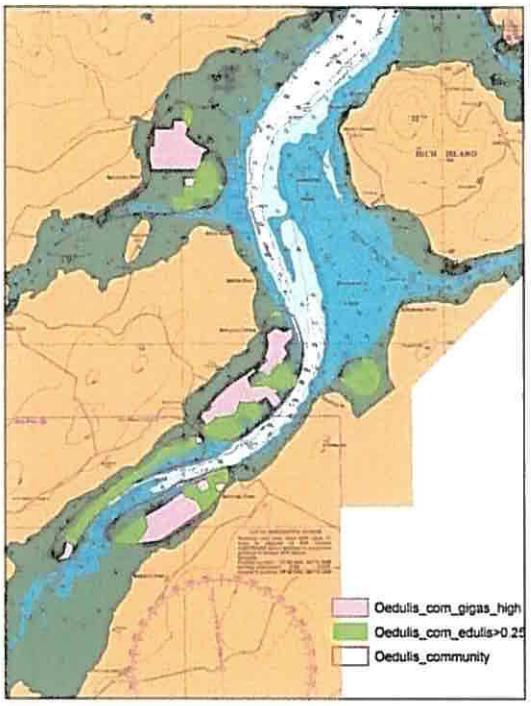
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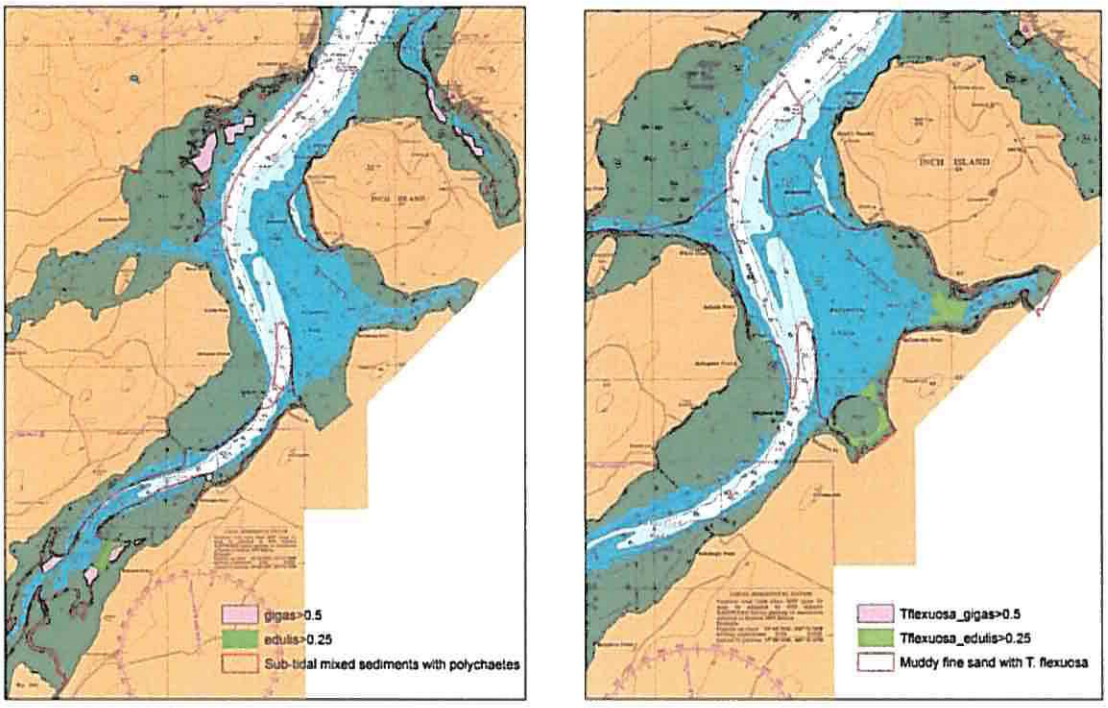

Fig. 14. Overlap of individual benthic communities and fishing for native and pacific oyster in L. Swilly.

In-combination effects of activities on individual community types.

Section 6.2 details the likely impact aquaculture activities have on the qualifying feature Estuaries and more specifically, the likely interaction between the activities and the constituent benthic community type that are found within the SAC. Each activity and community type combination was considered and a conclusion as to whether the activity presented a disturbance risk to the community type was proffered. While the cumulative effects (spatial extent) of each activity were considered and presented in Section 6.2, the in-combination (different activities combined together) effects were not.

This section considers in-combination effects among different aquaculture activities and other activities on the features and communities of the SAC.

6.3.1 Aquaculture in-combination effects

Table 11 details the combination of activities considered disturbing on individual community types and provides a combined estimate of the spatial extent of each community type that will likely be impacted. These values represent the in-combination effects on each of the community types.

These combined values range from 18.7% to 63.72% overlap between activities and individual community types. All values exceed the 15% threshold identified (NPWS 2011) as the spatial extent to which conduct of activities must be examined more closely and a cautious approach to licencing adopted. Table 12 partitions the combined spatial overlap of activities based upon the status of licencing. It is apparent that existing activities (19.14%-51.26%) exceed the threshold value (15%) for precaution in 4 of the 6 community types and for the other two types the spatial overlap (approx. 12%) approaches the 15% threshold (Table 12).

The assessment considers the impacts of aquaculture activities with the boundary of the feature of conservation interest (Estuary)

6.3.2 Aquaculture and fisheries in-combination effects

The proposed activities associated with the management and exploitation of the native oyster in the Lough (Annex I) while having some compatibility with conservation objectives for oyster habitat in the SAC will likely be antagonistic to existing and proposed aquaculture activities in the Lough. In "Ostrea edulis dominated community' which describes the majority of native oyster habitat in Lough Swilly SAC, the objective of the FNP is to increase the density of native oyster. The objective of bottom mussel and Pacific oyster culture is to increase the density of Pacific oyster and mussels. These objectives cannot be simultaneously achieved in the same area. It would be irrational therefore to evaluate the ecological in-combination effects of these activities as economically and operationally they are incompatible and antagonistic with each other. This part of the assessment is therefore incomplete as it has not taken the full set of fishery and aquaculture proposals at face value in providing an assessment of in-combination effects.

Other Aquaculture activities outside the conservation feature area (Estuary)

Given the total area of the Lough Swilly SAC extends beyond the boundary for the designated feature Estuary, there is other aquaculture activities licensed (or proposed) within the SAC that should be considered in terms of cumulative and in-combination effects. Within this area there are four aquaculture activities considered, three areas are licenced for the production of mussels using longlines and are 24, 22 and 12 ha in spatial extent, respectively. There is currently one application (30ha) pending for the extensive (on-bottom) production of mussels.

In short, these activities have no spatial overlap with community types described for the feature of conservation interest and while they may have some impact on the seafloor, the effect is likely to be localised and will not extend into the qualifying interest. Therefore there are no in-combination impacts to assess.

Table 11: Extent (ha) of aquaculture (species, culture method and licence status) in Lough Swilly SAC. Shaded cells are those activities considered disturbing (from Section 6.2). Values in italics represent the percentage overlap of activity with relevant habitat. In-combination values represent the total extent of activities considered disturbing on the six community type found within the SAC.

			Community Type					
Species	**Culture method**	**Licence Status**	**Fine sand community complex**	**Intertidal mixed sediment with polychaetes**	**Mud community complex**	**Muddy fine sand with *Thyasira flexuosa***	***Ostrea edulis* dominated community**	**Subtidal Mixed sediment with polychaetes and bivalves**
Extent (ha) of communities within qualifying interest (Estuary)			**582.63**	**655.30**	**1126.92**	**1320.48**	**905.98**	**1314.03**
Mussels	**Bottom Culture**	**Licensed**	0.00	24.94	6.00	48.09	200.56*	232.01*
				3.81	*0.53*	*3.64*	*22.14*	*17.66*
Mussels	**Bottom Culture**	**Application**	40.93	46.13	68.75	164.40	40.05	188.72
			7.02	*7.04*	*6.10*	*12.45*	*4.42*	*14.36*
Oysters	**Bags & Trestles**	**Licensed**	0.00	18.19	0.00	0.00	5.70	2.36
							0.63	
Oysters	**Bags & Trestles**	**Application**	0.00	4.71	0.00	4.34	4.95	0.00
							0.5	
Oysters	**Bags & Trestles/BST**	**Licensed**	0.00	13.48	0.00	46.34	0.00	0.00
Oysters	**BST Longlines**	**Application**	16.36	0.00	0.00	1.56	0.00	0.00
Oysters	**Bottom Culture**	**Application**	0.00	3.15	0.00	0.00	244.64**	32.48**
				0.48			*27.00*	*2.47*
Oysters/Mussel	**Bottom Culture**	**Licensed**	111.49	53.89	136.02	628.87	5.90	237.54
			19.14	*8.22*	*12.07*	*47.62*	*0.65*	*18.08*
In-combination (%) overlap of disturbing aquaculture activities on communities:			***26.16***	***19.55***	***18.70***	***63.72***	***38.41***	***50.91***

Note: Two aquaculture applications (**) overlap two licensed areas (*) which represent 153.44ha (16.9360%) and 21.74ha (1.6547%) of ***Ostrea edulis* dominated community** and **Subtidal Mixed sediment with polychaetes and bivalves community**, respectively. A correction has been introduced to the in-combination totals presented in the table (i.e. reduction in percentage overlap) under the assumption that only one of the disturbing activities (licensed activity) is likely to occur on the community types.

Table 12: Summary of spatial overlap of potentially disturbing activities on six community types according to activity type and licence status.

	Community Type					
Licence Status	**Fine sand community complex**	**Intertidal mixed sediment with polychaetes**	**Mud community complex**	**Muddy fine sand with *Thyasira flexuosa***	***Ostrea edulis* dominated community**	**Subtidal Mixed sediment with polychaetes and bivalves**
Aquaculture - Licenced (% Overlap)	19.14	12.03	12.6	51.26	23.42	35.74
Aquaculture - Application (% Overlap)	7.02	7.52	6.10	12.45	14.98*	15.16*
Cumulative Aquaculture (% overlap)	26.16	19.55	18.70	63.72	38.41	50.91

Note: Two aquaculture applications (**) overlap two licensed areas (*) which represent 153.44ha (16.9360%) and 21.74ha (1.6547%) of ***Ostrea edulis* dominated community** and **Subtidal Mixed sediment with polychaetes and bivalves community**, respectively. A correction has been introduced to the in-combination totals presented in the table (i.e. reduction in percentage overlap) under the assumption that only one of the disturbing activities (licensed activity) is likely to occur on the community types.

Assessment of the effects of shellfish production and in combination effects on the Conservation Objectives for Otter and Salmon Statement for AA

As the shellfish production activities within the SAC spatially overlap with Otter (*Lutra lutra*), and Salmon (*Salmo salar*) these activities may have negative effects on the abundance and distribution of populations of these species.

Otter (*Lutra lutra*)

Lough Swilly is designated for the Otter (*Lutra lutra*); the conservation objectives for such are listed in Chapter 4. The risk of negative interactions between aquaculture operations and aquatic mammal species is a function of:

1. The location and type of structures used in the culture operations- is there a risk of entanglement or physical harm to the animals from the structures?

2. The schedule of operations on the site – is the frequency such that they can cause disturbance to the animals?

Bottom Culture, harvesting and fishing

Given that this culture type does not entail any structures and operations are likely to be carried out in daylight hours, while the otter foraging is primarily crepuscular, the interaction with bottom culture operators/operations with the otter is likely to be minimal. It is unlikely that this culture type poses a risk to otter populations in Lough Swilly. Impacts can be discounted.

Oyster culture (suspended)

Given the intertidal location of the structures and activities associated this form of oyster culture it is unlikely that the marine mammals will have any negative interaction with this culture method. Impacts can be discounted.

The proposed activities will not lead to any modification of the following attributes for otter:

- Extent of terrestrial habitat,
- Extent of marine habitat or
- Extent of freshwater habitat.
- The activity involves net input rather than extraction of fish biomass so that no negative impact on the essential food base (fish biomass) is expected
- The number of couching sites and holts or, therefore, the distribution, will not be directly affected by aquaculture and fisheries activities.
- National surveys of otter in Ireland in 2006 found that 65% of sites surveyed in the north-west of Ireland showed signs of otter occupancy. There are no specific data on otter population size in Lough Swilly although they are present throughout the area.
- Shellfish production activities are unlikely to pose any risk to otter populations through entrapment or direct physical injury.
- Disturbance associated with vessel and foot traffic could potentially affect the distribution of otters at the site. However, the level of disturbance is likely to be very low given the likely encounter rates will be low dictated primarily by tidal regime .

Salmon (*Salmo salar*)

Salmon populations run into the River Leannan which flows into Lough Swilly. Current estimates have the numbers of adult salmon returning to the River Leannan at 28% of the conservation limits based upon 2009 returns (SSCWSS 2010). Consequently there is no estimated surplus. Based upon an extensive review the status of the stocks in the river and the supporting habitats it has been concluded that a number of issues present in relation to water and habitat quality in the broader catchment and in particular tributaries (Inland Fisheries Ireland, 2011).

Notwithstanding the issues highlighted above which appear to be confined the freshwater portion of the catchment, it is concluded that shellfish production and fisheries activities in the Lough Swilly SAC do not pose any risk to the following salmon attributes:

- Distribution (in freshwater)
- Fry abundance (freshwater)
- Population size of spawners (fish will not be impeded or captured by the proposed activity)
- Smolt abundance (out migrating smolts will not be impeded or captured by the proposed activity)
- Water quality (freshwater)

The appropriate assessment in relation to effects on otter and salmon is summarised in Table 13.

Table 13. Concluding Appropriate Assessment in relation to effects of all activities on salmon and otter.

Activity	Relevant ecological effects (from statement of AA)	Species affected	Attributes	Attribute following proposed activity	Significance of impact	Rationale	Supporting evidence	Confidence
All activities	Activities may affect the abundance and distribution of the species concerned	Salmon, Otter	All	No change	None	No spatial overlap with attributes or no direct or indirect impact envisaged	GIS	High

7 SAC Appropriate Assessment Concluding Statement and Recommendations

Some aquaculture (mussel and oyster culture) activities that are carried out in the Lough Swilly SAC have been considered as disturbing on habitats. The extent of existing and proposed aquaculture activities are presented in Table 12 above, wherein existing licenced activities account for greater than the 15% threshold of interaction in four of the six habitat types found in the feature of conservation interest (i.e. Estuary). When applications are considered, in-combination with licenced activities, threshold values are exceeded in all communities identified (Table 12). As indicated previously, oyster fishery activities/plans within the bay are not compatible with aquaculture activities by virtue of the species targeted i.e., oysters as opposed to mussels for on-bottom culture methods, as well as the risk of interference with structures used for aquaculture (e.g. float and ropes and bags and trestles). The oyster fishery proposal as reflected in the Fishery Natura Plan (Annex1), however, is broadly compatible with the conservation of *'Ostrea edulis dominated community'* that constitutes approx 906ha of the conservation feature of the SAC (i.e. 15% of Estuary). While the ultimate goal of the plan is to increase the standing stock of native oysters in the Lough, to a level which can sustain fishery activity, this is considered a beneficial management proposal to the overall status of the native oyster, and native oyster habitat, in the Lough.

Given the findings identified in Chapter 6 it is concluded that the *status-quo* relating to aquaculture activities (i.e. existing licences) presents a risk of not achieving of good conservation status for habitats within the SAC. This is manifest in two ways; (1) the threshold value for considering disturbing activity of 15% is exceeded for a number of different habitat types and also constitutes 28.6% of Estuary, the overall feature of conservation interest. When considering the cumulative values of current licences and applications, the threshold values are exceeded in all habitat types and constitute 39.7% of the feature Estuary and, (2) the incompatibility of native oyster fishing and shellfish culture. As indicated previously and specifically in relation to oyster habitat, the objective of the Fishery plan for native oysters is to increase the density of native oyster, whereas the objective of bottom mussel and Pacific oyster culture is to increase the density of Pacific oyster and mussels, both of which are considered disturbing activities. These objectives cannot be simultaneously achieved in the same area; operationally these activities are incompatible. Therefore, as the oyster fishing plan is considered more compatible with the COs for '*Ostrea edulis* dominated community' than aquaculture activities oyster fishing would have precedence over aquaculture activities in this habitat on this basis alone. Following are a number of recommendations relating to Aquaculture and Fisheries activities that might ensure sustainable levels of both activities within the bays while allowing the Natura site to attain good conservation status.

Aquaculture

In relation to aquaculture licencing, a goal of achieving no greater than 15% disturbing activities in habitats must be achieved. To achieve this 'goal' aquaculture activities may be managed in a number of different ways, some mechanisms are suggested below that might be considered in isolation or in-combination:

1. Revoke inactive licences as per the Fisheries (Aquaculture) Act 1997 (Section 69-Subsections 1 and/or 2) wherein licenced areas unused for a period greater than 2 years can be revoked by the Minister).
2. No new licences should be issued in Lough Swilly unless the type of activity proposed is considered non-disturbing to habitats of conservation interest.
3. No aquaculture activities should be carried out in 'Ostrea edulis dominated community', as they are all considered disturbing to this habitat type.

4. A *pro-rata* reduction of licenced areas be applied in order to reduce the spatial overlap between individual habitats and aquaculture activities to 15% or lower, which is consistent with that identified in the conservation objectives. To this end, Table 14 (below) identifies the specific overlap between licenced (as well applied for) areas and individual habitat types. These data may aid in the selection of specific areas where reductions in aquacultures activities might be targeted.

Fisheries

1. Rationalizing aquaculture licenced areas down to 15% overlap with individual habitat will represent significant reduction in extent of such activities. Some of the proposed activities in the oyster fishing plan also occurs in non-oyster habitat thereby making it more difficult for aquaculture to reduce to the 15% in-combination threshold. As the existing extent of habitat defined as oyster habitat includes areas where oyster is at very low density and given that only a proportion of it is fished and given the uncertainty regarding how feasible it is to restore oyster stocks the activities associated with the oyster fishery plan should only occur in *'Ostrea edulis dominated community'* and not in other habitats. The main activity affected will be the location of the spawning reserve for oyster which should be moved into the '*Ostrea edulis dominated community*' This may be a reasonable compromise, considering the very significant reductions in aquaculture activity required to bring aquaculture activity below the 15% overlap threshold with habitats.
2. It will be necessary to implement all of the measures outlined in the oyster fishery plan and where necessary to give these measures legislative support, if it is to achieve its objective and therefore be compatible with the conservation objectives for *'Ostrea edulis dominated community* .
3. An implementation plan for the oyster fishery proposal should be developed with the relevant stakeholder groups

Table 14. Spatial information on individual aquaculture licences considered potentially disturbing and overlap (ha and proportion in italics) with each habitat in L. Swilly.

License ID	Status	Species	Total License Area (ha)	Fine sand community complex		Intertidal mixed sediment with polychaetes		Mud community complex		Muddy fine sand with *Thyasira flexuosa*		*Ostrea edulis* dominated community		Subtidal mixed sediment with polychaetes and bivalves	
Extent (ha) of marine habitat within qualifying interest (Estuary):				**582.63**		**655.30**		**1126.92**		**1320.48**		**905.98**		**1314.03**	
				Area	% *habitat*	Area	% *habitat*	Area	% *habitat*	Area	% *habitat*	Area	% *habitat*	Area	% *habitat*
T12/251A	Licensed	Mussels	24.00							0.34	*0.03*	8.33	*0.92*	15.32	*1.17*
T12/251B	Licensed	Mussels	43.50			24.88	*3.80*							18.62	*1.42*
T12/273A	Licensed	Mussels	48.05							45.23	*3.42*			2.76	*0.21*
T12/278A	Licensed	Mussels	19.00							2.52	*0.19*			16.48	*1.25*
	Licensed	Mussels	16.25											16.25	*1.24*
T12/293	Licensed	Mussels	196.00					5.86	*0.52*			110.12	*12.15*	80.02	*6.09*
T12/298	Licensed	Mussels	164.80					0.14	*0.01*			82.11	*9.06*	82.55	*6.28*
T12/037A	Licensed	Oysters & Mussels	304.26	0.10	*0.02*	12.07	*1.84*	136.02	*12.07*					156.07	*11.88*
T12/037B	Licensed	Oysters & Mussels	844.03	94.09	*16.15*	33.71	*5.14*			628.87	*47.62*	5.90	*0.65*	81.47	*6.20*
T12/037C	Licensed	Oysters & Mussels	25.42	17.30	*2.97*	8.12	*1.24*								
T12/297	Licensed	Oysters	2.25									2.25	*0.25*		
T12/311A[1]	Licensed	Oysters	24.00									3.45	*0.38*		
Total area (or proportion) of habitat occupied by potentially disturbing licenced aquaculture (ha)				**111.49**	***19.14***	**78.77**	***12.02***	**142.02**	***12.60***	**676.96**	***51.27***	**212.16**	***23.42***	**469.55**	***35.73***

				Area	% habitat	Area	% habitat	Area	% habitat	Area	% habitat	Area	% habitat	Area	% habitat
T12/328A	Application	Mussels	44.50	40.93	7.02	3.57	0.55								
T12/328B	Application	Mussels	34.53			1.29	0.20	0.56	0.05					32.68	2.49
T12/328C	Application	Mussels	166.93					52.95	4.70			2.30	0.25	111.68	8.50
T12/328D	Application	Mussels	13.96							13.96	1.06				
T12/330A	Application	Mussels	17.99											17.99	1.37
T12/330B	Application	Mussels	60.64			26.84	4.10	1.99	0.18	22.56	1.71	9.25	1.02		
T12/330C	Application	Mussels	35.04							35.04	2.65				
T12/341A	Application	Mussels	9.00			8.08	1.23							0.92	0.07
T12/341B	Application	Mussels	27.88			6.32	0.96							21.55	1.64
T12/341C	Application	Mussels	16.62									16.62	1.83		
T12/344/1A	Application	Mussels	7.94							7.94	0.60				
T12/379A	Application	Mussels	97.83			0.03	0.00			84.91	6.43	11.88	1.31	1.01	0.08
T12/398B	Application	Mussels	16.32					13.42	1.19					2.91	0.22
T12/339A[2]	Application	Oysters	135.24			3.15	0.48					65.50	7.23	10.74	0.82
T12/339B[2]	Application	Oysters	145.03									25.71	2.84		0.00
Suspended Culture (Bags & Trestles)															
T12/317A[1]	Application	Oysters	2.25									1.04	0.11		
T12/343A[1]	Application	Oysters	6.00									3.91	0.43		
Total area *(or proportion)* of habitat occupied by potentially disturbing aquaculture (ha)				**152.41**	***26.16***	**128.05**	***19.54***	**210.94**	***18.72***	**841.36**	***63.72***	**348.37**	***38.45***	**669.02**	***50.91***

NOTES: **1:** The sites considered here are intertidal culture of oysters using bag and trestles. This activity is considered non-disturbing to all bar one ('Ostrea' dominated) community type. The values in the table reflect the interaction with this community type only.

2: These sites overlap with exisiting licenced areas for a portion of the area applied; the values presented in table represent that area that does not overlap with existing licenced areas.

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