The Tollesbury and Mersea Native Oyster Company Limited
Renewal of Fisheries Several Order

Appropriate Assessment, Management and Monitoring Plan

Nature Conservation Designations: Proposed work is based within the Essex Estuaries SAC and Blackwater, Crouch, Roach and Colne Marine Conservation Zone. Mid -Essex Coast SPA

Contents

List of Abbreviations

AA - Appropriate assessment

BOA - Blackwater Oysterman's Association

CEFAS - Centre for Environment Fisheries and Aquaculture Science

ENORI - Essex Native Oyster Restoration Initiative

EU - European Union

FOCI - Features of Conservation Importance

Ha - Hectare

HRA - Habitats Regulation Assessment

JNCC - Joint Nature Conservation Committee

K&EIFCA - Kent and Essex Inshore Fisheries and Conservation Authority

LSE - Likely Significant Effect

MCZ - Marine Conservation Zone

MPA - Marine Protected Area

NE - Natural England

NGO - Non-Governmental Organisation

PSA - Particle Size Analysis

SAC - Special Area of Conservation

SO - Several Order

SPA - Special Protected Area

T&MOCo -Tollesbury and Mersea Native Oyster Company Limited

TLSE - Test of Likely Significant Effect

1. Introduction

1.1 Ecology and Reproduction

The historical range of *Ostrea edulis* stretches throughout Europe from Norway to the Black Sea (Laing *et al*, 2004) inhabiting shallow, sheltered, productive marine environments such as bays, inlets, creeks and estuaries at depth between 0m - ≥ -4m depth (Laffoley and Hiscock, 1993).

The species are known as sequential hermaphrodites meaning that following every successful breeding season the individual has the ability to change from one complete gonadal cycle to the other. Fertilised females retain the eggs in a brood chamber for up to 10 days where the initial cleavage develops into trochophore, and then into a shelled veliger.

Veligers are ejected into the water column and become free floating in the plankton for up to 15 days (Hedgecock *et al.*, 2007). Studies have indicated that the overall time a veliger spends in its planktonic phase can be directly correlated with diet (Marshall *et al*, 2010) and temperature (Filgueira *et al*, 2015). One further metamorphosis occurs, the development of a muscular foot changing the veliger into a Pediveliger immediately before settlement. Once settlement has taken place and the individual has cemented itself to a hard, clean surface it can no longer move or change position.

1.2 Habitats & Ecosystems

All oyster species are known to settle on and attach to many different types of substrata but have a particular ecological preference for settlement of hard substrates and are known to favour gregarious settlement (whereby subsequent cohorts settle on the shell of existing settled individuals). Pawlik (1992) suggests that settlement inducing compounds released by post metamorphosed individuals stimulate settlement of larvae. The shell itself also acts as a habitat, providing a firm substratum for attachment of epifauna (Wells, 1961), further increasing community structure and biodiversity (Mills, 1969). Studies show that the benefits of a healthy and robust population and bed structure of *O. edulis* provides increased species diversity, (Menge and Lubchenco, 1981, Bolam *et al*, 2002, Taniguchi *et al*, 2003) and that fish biomass increases with the size of oyster beds, (Wells, 1961; Zimmerman, 1989; Coen *et al*, 1999;Posey *et al*, 1999, Gutiérrez *et al*, 2003).

Water clarity through filtration is increased in areas surrounding oyster beds, (Zu Ermgassen *et al*, 2013; Zu Ermgassen *et al*, 2013a) and that nutrient uptake and assimilation of organic nitrogen into inorganic nitrogen gas is a process that is elevated with increased numbers of filter feeding bivalves (Ryther and Dunstan, 1971; Newell, 2004; Newell *et al*, 2005). Furthermore, large numbers of oysters can act as coastal sea defences, (Meyer *et al*, 1997; Piazza *et al*, 2005' Beck *et al*, 2011).

Coastal habitats can be modified by the presence of certain key species inhabiting the area. The presence of larger oyster beds can, through dissipation of wave energy, temper extreme environments, creating more stable conditions. For example, the dissipation of wave energy over oyster beds reduces water velocity in such a way that promotes the development of Zostera beds another significantly important marine habitat (Murie, 1911, Beck *et al* ., 2011)

1.3 The importance of *O.edulis* as a fishery

Proposals for the cultivation and managed extraction of *O.edulis* around the UK are becoming more frequent, e.g. The Solent, the Mumbles fishery, The Blackwater, Loch Ryan, Strangford Lough. It is necessary that exploitation is managed in such a way that stock security and future production are not jeopardised (Donnan & Heritage, 2007). Sustainable management of a fishery is key to its long-term success. Areas such as the Solent, which until recently had no management plan or harvesting restrictions quickly become depleted. Other areas such as the Blackwater, The Fal and Loch Ryan fisheries have been enhanced through a series of operational practices. These operational plans restore habitats (through reinstatement of subtidal mixed sediment to promote settlement of juveniles), secure stock areas, remove pests (i.e. non-native or invasive species) and manage disease (Woolmer *et al*, 2011). Fisheries management is based around two main concepts, limits and targets (Laing, 2005). Limits are restrictive measures designed to maintain stock, these include catch quotas and fishing effort or returns of undersized individuals. Targets are positive conservation management, they define clear desirable outcomes and are designed to actively increase stock density and limit impacts to non-target species. It is important for a fishery to have prescriptive management outcomes and clear objectives to relay to those working in the fishery (Laing, 2005)

2. The Tollesbury & Mersea Native Oyster Fishery Company Ltd.

2.1 History of the existing Several Order

In 1876 the oystermen in West Mersea and Tollesbury formed the Tollesbury & Mersea Native Oyster Fishery Co. Ltd (T&MOCo) and obtained a Several Order (SO) for the cultivation of *O. edulis* as an aquaculture target species for a large part of the River Blackwater (

Figure **1**). This enabled them to restrict dredging to their own members giving the incentive to limit dredging to protect the stocks if necessary. It also encouraged them to "cultivate" the area, removing pests (non-native and invasive species detrimental to the cultivation of *O. edulis*) and preparing the "cultch" on the seabed to receive the spat when it settled from its planktonic stage.

The dream from that time has lasted until this day and following long-term problems with weather conditions (the 1963 winter causing over 90% mortality with sea temperatures as low as -1.8°C) and the oyster disease *B. ostreae (Bonamia)* which caused similar mortalities in the 1990's, there is now slowly increasing success (Table 1). The reduction in individual oysters landed during the survey in 2018 is due to the length of tow being reduced to 100m from 400m.

Table 1 Number of individuals recorded during stock assessment of the T&MOCo grounds. Plus the number of individual *O.edulis* removed and sold during that time.

Year	No. of Individuals	No. of individuals removed through fishing.
1997	4231	13,808
2003	5947	
2003-2015	-	Approx 237,000
2015-2018	-	35,170
2018	3061	-

This faith in the future was shown by the decision taken by the Blackwater Oysterman's Association (BOA) in 1984 to purchase the majority shareholding in "The Company" owned by Macfisheries who had long made their profit from the river by selling the oysters to their Company at Whitstable – the Seasalter Oyster Fishery Co. The individual oystermen had, after both the above disasters, continued by relaying oysters from Cornwall initially, and later the Solent in the creeks to fatten.

These provided a breeding stock which spawned and, after 1984, aided by the efforts of the "new" Company to 'clean' the riverbed in selected areas for several years there were increasing spat falls, which unfortunately did not thrive and spawn due to the accidental introduction of the haplosporidian parasite B. ostreae (Bonamia) during the early 1980s.

2.2 Fisheries Management practices

It is understood that fishing activities need to be managed effectively both spatially and temporally to ensure stocks are not depleted. If full recovery of native oyster stocks is to be achieved then more resource intensive management, stock assessments and monitoring will be required (See Section 14 - Management and monitoring Plan).

The SO is to encourage the establishment or improvement of the shell fishery in this location primarily for the production of native oysters.

The request for all bivalve shellfish over and above *O. edulis* to be included in the SO is for management purposes and is vital in order to prevent unregulated boats from fishing the area of the SO. This ensures protection of the native oyster species from unregulated harvesting as well as the SAC and MCZ features. Should other species such as the Pacific oyster (*C. gigas*) begin to encroach subtidally then the intention is to remove them from the native oyster beds as a management measure. If the Pacific oysters removed are of marketable size then they will be sold to the culinary market, if they are not, they will be removed and destroyed.

2.3 Proposed method of cultivation

Due to the ecology of the Native Oyster, harvesting is undertaken sub tidally through the use of seven licenced vessels fitted with 2x 1.2m ladder dredges (Figure 7) fitted with a 65mm lightweight mesh in order to catch 70mm sized individuals. Harvesting occurs between March and June, and is limited to Monday – Friday for no longer than six hours per day. In addition, limited amounts of hand gathering for Pacific oysters are permitted from the intertidal in an effort to control the spread of the invasive species (additional information available in Section 14 Management and monitoring plan).

2.4 Current cultivation practices

2.4.1 Cleaning

As stated previously *O.edulis* are known to be gregarious settlers, preferentially seeking to settle on the shell of an adult or on a suitable substratum located in close proximity to the existing adult populations. We also know that larval production and survival is directly linked to existing oyster biomass (Rimler, 2014). In simple terms, more adult oysters produce more veligers, which in turn have an increased likelihood of settlement and survival. For the successful sustainable cultivation of *O.edulis* it is critical that existing populations are maintained in order to maximise veliger production and the recruitment. In order to maximise the recruitment and survival of veligers produced by the existing population it is vital that the habitat adjacent to existing oyster beds is optimal for settlement and that enough suitable settlement substratum is available within these veliger transport and dispersal routes to enable the continued colonisation to existing oyster stocks. Several studies have sought to understand the relationship between larval supply, the availability of suitable substratum and settlement. (Crisp, 1976; Burke, 1986; North *et al,* 2013; Rimler, 2014; D'Aloia *et al,* 2015) all conclude a positive relationship exists between larval supply and suitable substratum in increasing a population. Following 12-15 days planktonic dispersal period *O.edulis* larvae must locate a suitable substratum on which to settle or they will not survive. In a low energy highly sedimentary estuarine environment such as the Blackwater (Chesman et al, 2006) suitable sediment substratum such as subtidal mixed sediment is a relatively infrequent feature, making up only 8.6% area compared to subtidal mud and subtidal sand, which make up 16.8% and 32.7% respectively (Data taken from Natural England Supplementary advice Essex Estuaries SAC accessed October 2017). The limited availability of suitable substrate in the Blackwater reduces the potential for successful O.edulis settlement.

Current practices undertaken by the Blackwater Oystermen in the SO include a programme of cleaning and cultivation of the seabed to increase the available substrate in order to maximise potential veliger settlement.

2.4.2 Harvesting

It is generally well recognised that high levels of harvesting resulting in the removal of individual oysters over 70mm in size will reduce the spawning population and therefore affects population size and age structure of subsequent cohorts, It is therefore the policy of the T&MOCo to undertake a stock assessment prior to harvesting, and only harvest when a good population of individuals over 70mm are present. In previous years the calculation of 'good' and therefore commencement of harvesting has been done through a mixture of stock assessment and anecdotal evidence, based on

many years of experience of the ground and the species. Going forward the assessment will be made based on the results of studies undertaken by the University of Essex on the health of the oysters, the age class demographic of the resident population and overall numbers of breeding adults (those over 70mm in size). Traditionally the oysters removed from the fishery were all sold on the market, however in recent years they have been sold to the Essex Native Oyster Restoration Initiative (ENORI) and relayed in the estuary outside the SO in an attempt to develop brood stock areas for the recolonization of natives in the remaining proportion of the MCZ. Further plans for the purchase of *O.edulis* by ENORI from the T&MOCo are underway with the incorporation of brood stock areas in the conservation management plan and HRA assessment 2017 – 2020.

The Blackwater SO native oyster season runs from the 1st September to the 31st April and the fishery will operate within the boundary shown in Figure 1. This boundary is slightly reduced based on the current boundary of the Tollesbury & Mersea (Blackwater Fishery) Order 1999. Extraction of target species will take place sub tidally through the use of licenced dredges.

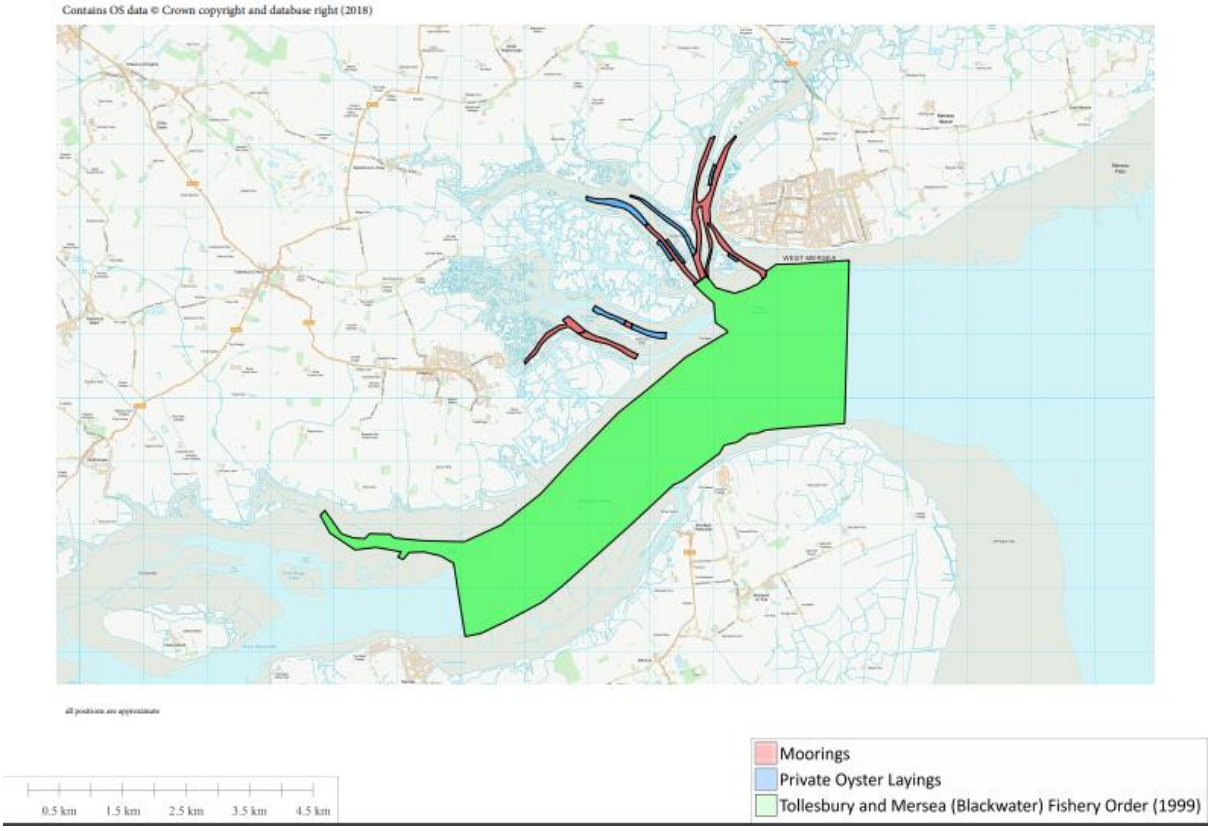

Figure 1 Location and boundary of the existing Tollesbury & Mersea Native Oyster Fishery Ltd Several Order and location and extent of private oyster layings .

Fishing for shellfish species;

1. Native/European Oyster *(O. edulis)*
2. Pacific Oyster *(C. gigas)*
3. American Hard shell Clam (*M. mercinaria)*
4. Blue Mussel (*M. edulis*)
5. Common Cockle (*C. edule)*

It is important to note that the species 3,4 & 5 of bivalve listed above are for inclusion in the SO application, but there is no desire to actively fish these species and their inclusion in this HRA application is to allow better management of the fishing activity within the SO area.

The inclusion of Pacific Oyster (*C. gigas)* is for the active management of the beds for *O. edulis,* any *C.gigas* found to be encroaching on the subtidal will be removed.

The number of licenced oyster dredges employed on the SO currently stands at 7. Licence holders must supply monthly catch returns. For the inclusion of species 3 & 4 & 5 the application is to facilitate the management of the fishery by restricting access to the SO from nomadic boats wishing to exploit alternative shellfish stocks within the SO footprint. Inclusion of species 2 (*C.gigas*) is to remove subtidal encroachment of *C.gigas* onto *O.edulis* beds.

Small amounts of cultch (dead shell) have historically been laid on the seabed within the SO area, this is a standard practice for *O. edulis* cultivation to ensure enough hard substratum is available within the system to receive veligers from consecutive cohorts (Laing *et al*, 2005). In addition to cultch relaying the standard aquaculture management practice of harrowing or bagless dredging is employed to remove macrophytes, fluidise any accumulated silts and redistribute cultch. This activity provides a more favourable substrate for oyster spat settlement. This practice is coming under increased scrutiny (Bromley et al, 2015) the benefits of which are currently being reviewed with regard to bearing on both the subtidal mixed sediment and the species and communities which inhabit this biotope. There is currently a lack of empirical evidence on which to base decisions in regard to impact of this activity, either positive (native oyster reef establishment and all the associated ecosystem benefits associates with this) or negative. But given that the SO and aquaculture practices involved are taking place within the footprint of the Essex Estuaries SAC it is important to try and quantify this. As such the T&MOCo are working in conjunction with the University of Essex to quantify impact to the subtidal mixed sediment biotope and communities, this study will include recovery time of associated species and communities after cleaning and harvesting.

2.4.3 Location of oyster grounds

3 Nature Conservation Designations:

3.1 Blackwater Estuary (A component of the phased Mid-Essex Coast SPA).

This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive (Figure 2).

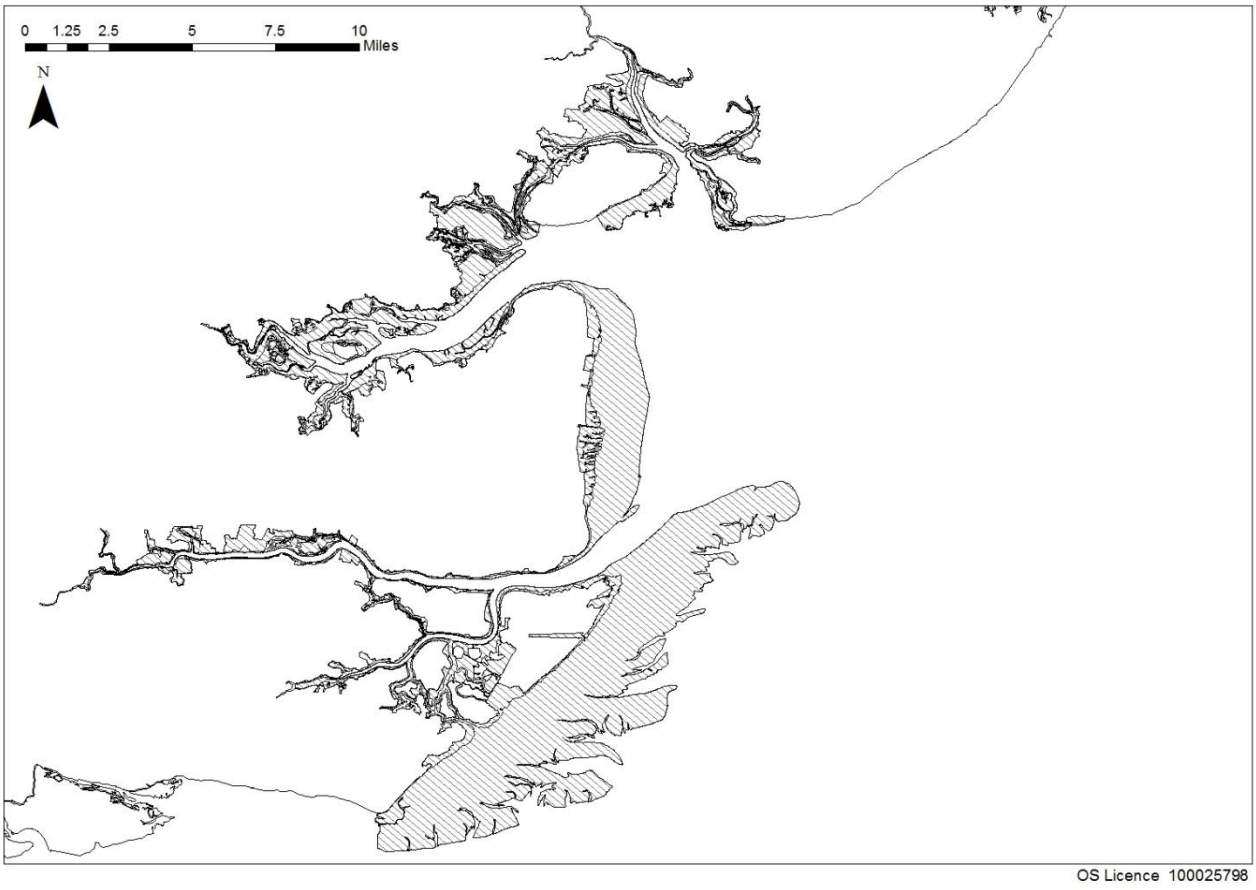

Figure 2 Mid Essex Coast SPA (including Blackwater Estuary) location and extent

3.1.1 Qualifying Features

Table 2 Mid Coast Estuaries Phase 1-5 qualifying features

Features	(Phase number[1])	Qualifying status
wintering species	All	Internationally important waterfowl assemblage
Avocet	5	Internationally important populations of regularly occurring Annex 1 species
Bar tailed Godwit	1, 5	Nationally/internationally important populations of regularly occurring migratory bird
Black-tailed godwit	1, 2, 4	Nationally/internationally important populations of regularly occurring migratory bird
Common tern	5	Internationally important populations of regularly occurring Annex 1 species
Cormorant	2, 4	Nationally important populations of regularly occurring migratory bird species
Curlew	2, 4, 5	Nationally important populations of regularly occurring migratory bird species AND Nationally important BREEDING populations of regularly occurring migratory bird species
Dark-bellied Brent geese	All	Internationally important populations of regularly occurring migratory bird
Dunlin	1, 2, 4, 5	Nationally/internationally important populations of regularly occurring migratory bird
Goldeneye	2, 4	Nationally important populations of regularly occurring migratory bird species
Grey plover	1, 2, 4, 5	Nationally/internationally important populations of regularly occurring migratory bird
Knot	1, 5	Internationally important populations of regularly occurring migratory bird species
Little tern	2, 4, 5	Internationally important populations of regularly occurring Annex 1 species
Mute Swan	2	Nationally important populations of regularly occurring migratory bird species
Oystercatcher	5	Internationally important populations of regularly occurring migratory bird
Redshank	2, 4, 5	Nationally/internationally important populations of regularly occurring migratory bird
Ringed plover	2, 4, 5	Nationally important populations of regularly occurring migratory bird species
Sanderling	2	Nationally important populations of regularly occurring migratory bird species
Sandwich tern	5	Internationally important populations of regularly occurring Annex 1 species
Shelduck	2, 4, 5	Nationally important populations of regularly occurring migratory bird species
Teal	4	Nationally important populations of regularly occurring migratory bird species

Table 3 Supporting habitats of Mid Essex Coast SPA

Feature	Generic sub-feature	Site specific sub-feature
Importance of internationally important populations of the regularly occurring Annex 1 species	Intertidal gravel and sand	Intertidal gravel and clean sand communities
	Intertidal mud and sand	Intertidal mudflat and sandflat communities (excluding seagrass bed communities)
	Saltmarsh spp, Salicornia and Seablite	Saltmarsh
	Estuarine fish community	Shallow coastal waters
Internationally important assemblage of waterfowl	Intertidal mud and sand	Intertidal mudflat and sandflat communities (excluding seagrass bed communities)
	Estuarine rock (boulder, cobble and bedrock)	Boulder and cobble shores
	Saltmarsh spp, Salicornia and Seablite	Saltmarsh
	Estuarine fish community	Shallow coastal waters
	Seagrass (SPAs)	Eelgrass bed communities
Internationally important populations of regularly occurring migratory bird species	Intertidal mud and sand	Intertidal mudflat and sandflat communities (excluding seagrass bed communities)
	Estuarine rock (boulder, cobble and bedrock)	Boulder and cobble shores
	Saltmarsh spp, Salicornia and Seablite	Saltmarsh
	Seagrass (SPAs)	Eelgrass bed communities

3.1.2 Site Overview

Mid Essex Coast SPA was established in a phased approach, where six estuaries with a very strong ecological connectivity or similarities were added in five phases;

- Phase 1: Dengie, 24 March 1994
- Phase 2: Colne Estuary, 28 July 1994
- Phase 3: Crouch and Roach Estuaries, 24 March 1995 and 22 July 1998
- Phase 4: Blackwater Estuary, 12 May 1995
- Phase 5: Foulness, 4 October 1996

Each phase has slightly different bird features and/or supporting features, but there is sufficient connectivity between the estuaries to include them in a single SPA site (JNCC, 2015). In total, the five SPAs cover an area of 229.38 Km^2 (Figure 3).

3.1.3 Conservation objectives

Ensure that the integrity of the site is maintained, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining;

- The extent and distribution of the habitats of the qualifying features
- The structure and function of the habitats of the qualifying features
- The supporting processes on which the habitats of the qualifying features rely
- The population of each of the qualifying features, and,
- The distribution of the qualifying features within the site.

3.2 Essex Estuaries: Special Area Conservation (SAC)

Figure 3 Essex Estuaries SAC location and extent

3.2.1 Qualifying features

Table 4 Essex Estuaries SAC qualifying features

Feature	Generic sub-feature	Site specific sub-feature
H1330 Atlantic salt meadows	Saltmarsh spp, Salicornia and Seablite	Saltmarsh
H1420 Mediterranean and thermo-Atlantic halophilous scrub	Saltmarsh spp, Salicornia and Seablite	Saltmarsh
H1310 Salicornia and other annuals colonizing mud and sand	Saltmarsh spp, Salicornia and Seablite	Saltmarsh
H1320 Spartina swards (*Spartinion maritimae*)	Saltmarsh spp, Salicornia and Seablite	Saltmarsh
H1140 Mudflats and sandflats not covered by sea at low tide	Intertidal mud and sand	Intertidal mudflats
	Intertidal mud and sand	Muddy sand communities
	Intertidal mud and sand	Intertidal mixed sediment communities
H1130 Estuaries	Estuarine rock (boulder, cobble and bedrock)	Rocky Shore
	Subtidal mud	Subtidal mud communities
	Subtidal muddy sand	Subtidal mud communities
	Subtidal mixed sediments	Subtidal mixed sediment communities
	Intertidal mud	Intertidal mudflat and sandflat communities
	Seagrass (SACs)	Eelgrass bed communities
1110 Sandbanks which are slightly covered by sea water all the time	Subtidal sand (high energy)	Subtidal sandbanks

3.2.2 Site overview

Essex Estuaries SAC is a 472 km^2 site which was initially designated for six Annex I habitat features under the EU habitats directive. The seventh feature, subtidal sandbanks, is present as a qualifying feature but not a primary reason for selection of this site. Thirty percent of the SAC is comprised of marine areas and sea inlets, 56.5% is tidal rivers, estuaries, mud flats, sand flats, and lagoons (including saltwork basins), 11% is saltmarshes, salt pastures and salt steppes, 2% is improved grassland and the remaining 0.5% is composed of shingle, sea cliffs and islets (JNCC, 2015).

H1330, H1420, H1310 and H1320: Saltmarshes - Saltmarshes nationally are under pressure from 'coastal squeeze', with coastal developments and flood defences constraining the ability of saltmarsh habitats to naturally move landward in response to sea-level rises (Natural England, 2006). Approximately 3,500 hectares, or 8%, of the UKs saltmarsh resource lies within the SAC boundaries (Natural England, 2000). Saltmarshes in Essex Estuaries contain nationally scarce species including small cordgrass (*Spartina maritima*) and smooth cordgrass (*S. alterniflora*).

H1140: Mudflats and sandflats not covered by sea at low tide This site encompasses the extensive intertidal flats of the Colne, Blackwater, Roach and Crouch, as well as the tidal flats at Foulness, Maplin and Dengie. The flat communities within this site cover a wide range of sediments, including mud, muddy sand and clean sand (Natural England, 2000). Mud communities are found in the upper reaches of the river, where variable salinity leads to impoverished communities (Natural England, 2000). Further down river, communities in sandy mud are more diverse, including marine bristle worms, Baltic tellins, cockles and mud snails. Muddy sand communities occur towards the mouth of the estuaries support a 58 hectare nationally-important bed of dwarf eelgrass (*Zostera marina*) on Maplin sands, as well as a nationally important cockle fishery (Natural England, 2000). Sand and gravel flats are often subject to a high degree of mobility and few invertebrates tolerate this environment (Natural England, 2000).

H1130: Estuaries - Estuaries are defined as partially enclosed tidal areas at least partly composed of soft tidal areas, with saline influence from the sea and fresh water influence from rivers, land run-off or seepage through embankments (Natural England, 2000). Essex Estuaries SAC is the second largest estuarine site on the east coast of England, and encompasses the major estuaries of the Colne, Blackwater, Crouch and Roach. (Natural England, 2000) A dynamic system, estuaries contain an interlinking and interdependent mosaic of habitats. Much of the estuary floor is characterised by shallow subtidal mud communities dominated by marine worms and Baltic tellins while subtidal muddy sand is dominated by bivalve molluscs (Natural England, 2000). While soft substrates such as mud and sand dominate Essex Estuaries SAC, there are also areas of hard substrate (Natural England, 2000). Areas on intertidal boulder and cobbles support diverse communities, as sedentary species including seaweeds, hydroids and sponges can gain a foothold. The long history of oyster cultivation in Essex estuaries has resulted in the presence of oyster 'cultch' (cockle or slipper limit shells) covering large areas of the seabed (Natural England, 2000).

1110: Sandbanks which are slightly covered by sea water all the time - Subtidal sandbanks in Essex estuaries are typically composed of gravelly and clean sands and are found in high energy environments.

3.2.3 Conservation objectives

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring;

- The extent and distribution of qualifying natural habitats
- The structure and function (including typical species) of qualifying natural habitats, and
- The supporting processes on which qualifying natural habitats rely

3.4 Blackwater, Crouch, Roach, Colne Marine Conservation Zone (MCZ)

Figure 4 Blackwater, Colne, Roach & Crouch MCZ location and extent

3.4.1 Qualifying Features

- Intertidal mixed sediments – Broad scale marine habitat
- Native oyster (*O. edulis*) - Beds Marine habitat
- Native oyster (*O. edulis*) - Species of marine fauna
- Clacton Cliffs and Foreshore - Feature of geological interest

3.4.2 Site overview

The Blackwater, Crouch, Roach and Colne Estuaries MCZ lies to the north of the Thames Estuary, in the southern North Sea. It compliments existing national and international designated sites, which provide protection to a mosaic of intertidal and subtidal habitats. It is the finest coastal plain estuarine system on the British North Sea coast and includes the least developed estuaries in south-east England. Furthermore, it is linked with large areas of undisturbed open coast mudflats and sandflats and subtidal sediment banks. The area contains a wide range of marine and estuarine sediment habitats and communities, as well as large areas of saltmarsh and other important coastal habitats. Subtidal areas are rich in invertebrate fauna. This includes the reef building worm *Sabellaria spinulosa* , brittlestars, crustacea, and bivalvia, including the native oyster.

The site is regarded as one of the most important areas for both wild and cultivated native oysters in the south-east of England, with native oysters distributed throughout the MCZ. Their beds provide habitat for a variety of other species, such as sea snails, crabs and sea urchins. The site encompasses both wild and cultivated native oysters and native oyster beds, however the conservation advice for the native oysters and native oyster beds does not apply to oysters cultivated in private grounds within the estuaries. To the west of Clacton-on-Sea, the MCZ extends the existing protection of the internationally important Clacton Cliffs and Foreshore into the subtidal area. This geological feature is one of the best ice age sites in the United Kingdom and contains an abundance of mollusc and mammalian fossil remains. The MCZ also includes a small area of intertidal mixed sediments, which supports a variety of infaunal communities.

The site is an important spawning and nursery ground for several fish species including both the sand-smelt and bass. The Blackwater herring (*Clupea harengus*) are a distinct breeding population, notably around Eagle Bank at the mouth of the Blackwater Estuary. Although not a protected feature, protection should be provided indirectly via direct protection of the broad-scale seabed habitats that support them.

3.4.3 Conservation Objectives

For each protected broad-scale habitat, favourable condition means that, within a zone: its extent is stable or increasing, its structure and functions, its quality, and the composition of its characteristic biological communities (including diversity and abundance of species forming part or inhabiting the habitat) are sufficient to ensure that its condition remains healthy and does not deteriorate.
Any temporary deterioration in condition is to be disregarded if the habitat is sufficiently healthy and resilient to enable its recovery.

For each species of marine fauna, favourable condition means that the population within a zone is supported in numbers which enable it to thrive, by maintaining:

The quality and quantity of its habitat, the number, age and sex ratio of its population. Any temporary reduction of numbers of a species is to be disregarded if the population is sufficiently thriving and resilient to enable its recovery.

4 Activity to assess

Renewal of the existing Tollesbury & Mersea (Blackwater) Fishery Order.

5 Supporting documents

- Scientific paper: Traditional fisheries approaches have conserved *O. edulis* populations in shallow estuaries in S.E. England

6 Rational for assessment

The purpose of this site specific assessment document is to determine if activities undertaken by the T&MOCo are likely to have a significant effect on the features of the Essex Estuaries SAC, Mid Essex Coast SPA (Blackwater Estuary) and on the Blackwater, Colne, Crouch & Roach MCZ and, on the basis of this assessment, whether or not it can be concluded that the proposed SO will not have an adverse effect on the integrity of these designated sites.

7 Documents reviewed to inform this assessment

- Reference list
- NE's conservation advice for MPA & MCZ (Annex 1)
- Site map(s) – sub-feature/feature location and extent (embedded in the body of the document)

8 Test for Likely Significant Effect (SAC)

8.1 Introduction

The proposed T&MOCo SO will be comprised of 1243ha (total area). The benthic substratum within the SO area is composed of a combination of subtidal mud and subtidal mixed sediment (See Table 6, Figure 6).

Within the 1243ha area 378ha in total are actively cleaned, maintained and harvested (Table 5 & Figure 5) using dredges and harrows. This totals 0.8% of the total area of the Essex Estuaries SAC and areas are likely to change year to year on a rotational basis to ensure areas of sea bed are left unimpacted for a period of time.

Table 5 Cultivation and harvesting areas in Hectares (within the existing several order) for the past 3 years

Area (Ha)			
Activity/Year	**2015**	**2016**	**2017**
Dredging	179	100	249
Cleaning	No Data	124	132

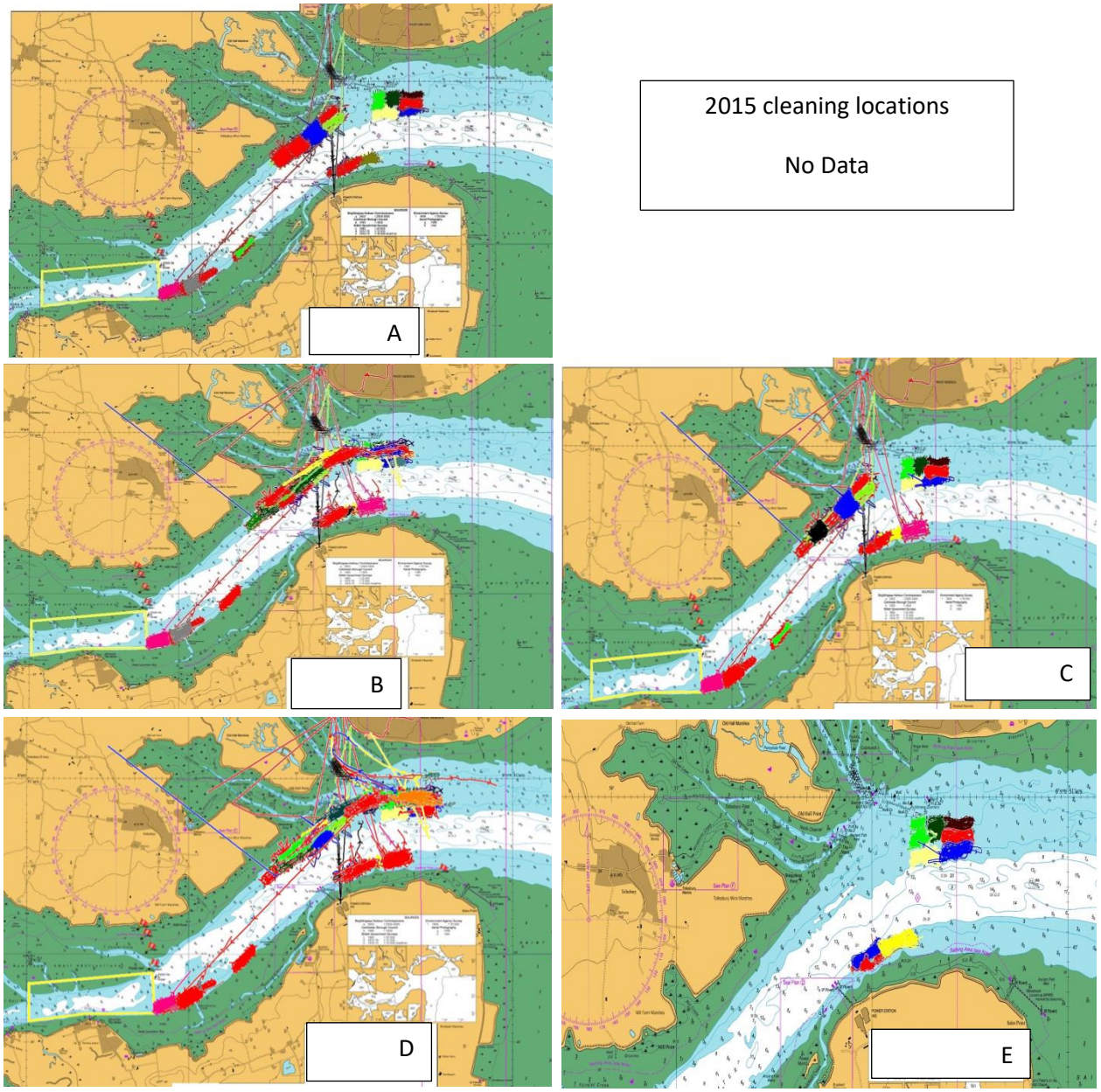

Figure 5 shows the location and extent of dredging and cleaning activities by the BOA undertaken between 2015 and 2017. (A) 2015 dredging locations covering 179ha. (B) 2016 Dredging locations covering 100ha. (C) 2016 cleaning locations covering 124ha. (D) 2017 Dredging locations covering 249ha. (E) 2017 Cleaning locations covering 132ha.

8.2 TLSE Essex Estuaries SAC

Table 6 Benthic substratum biotope areas within the existing SO and as a proportion of the whole Essex Estuaries SAC area. (data source Natural England Conservation advice package)

Habitat type	Biotope code	Substrate area within the several order	Substrate area within the cleaned area	Total SAC area (Ha)	Total (%) habitat type within several order	Total (%) habitat type within actively worked areas (As a proportion of the whole SAC habitat type area).
Subtidal mud	SS.SMu.SMuVS	82ha	65ha	7758.63	8%	**3%**
	SS.SMu.ISaMu	598ha	179ha			
Subtidal mixed sediment	SS.SMx.Imx	19ha	13ha	3981.78	14%	**2%**
	SS.SMx.SMxVS	544ha	97ha			

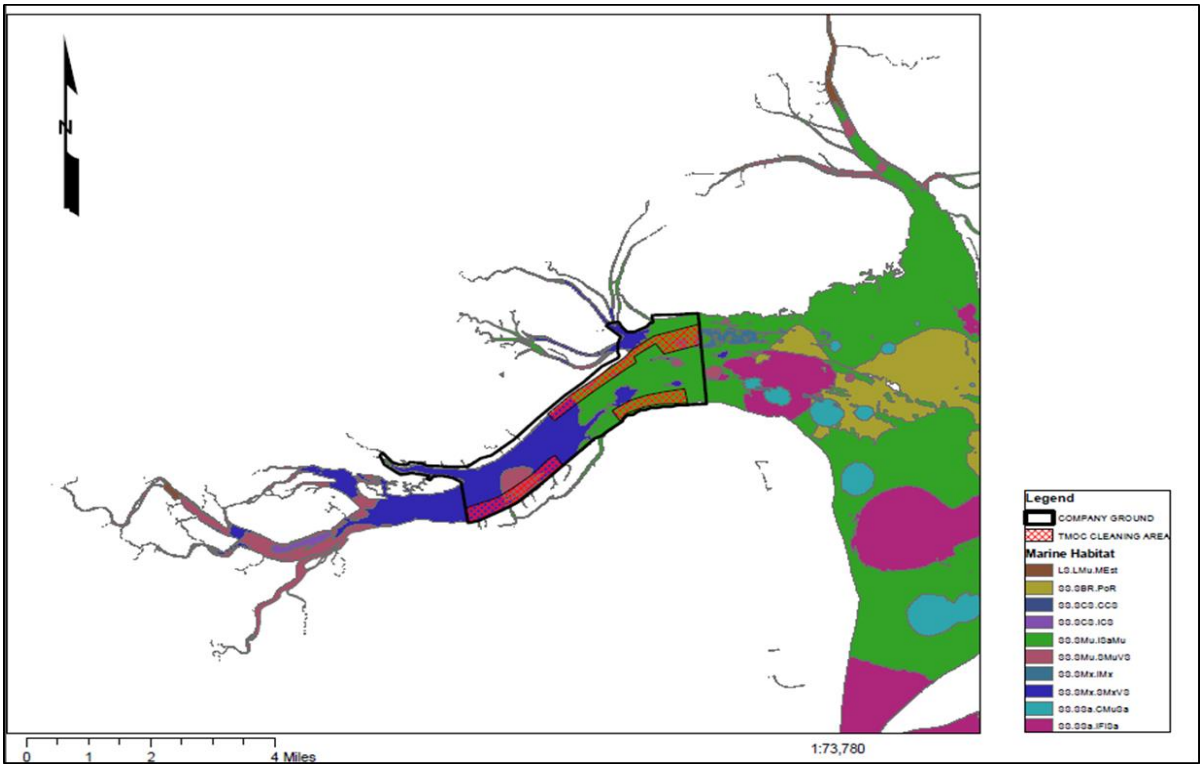

Figure 6 Location and extent of the existing SO and benthic substratum type. (Taken from NE MAGIC online resource, Accessed August 2017). Red hatched area denotes location and extent of cleaned or harvest areas and the benthic substratum biotope affected.

1. **Is the activity/activities directly connected with or necessary to the management of the site for nature conservation?** No

2. **TLSE:** Which features are affected by the works

Table 7 - Essex Estuaries SAC Summary of test of significant effect on the features of the SAC

Feature/subfeature	Does the feature occur within the footprint of the proposed works	Is the feature likely to be impacted by the proposed works	Is the integrity of the site compromised due to the proposed works
Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	N	N	N
Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)	N	N	N
Salicornia and other annuals colonising mud and sand	N	N	N
Spartina swards (*Spartinion maritimae*)	N	N	N
Sandbanks which are slightly covered by sea water all the time	N	N	N
Mudflats and sandflats not covered by seawater at low tide	N	N	N
Estuaries	Y	Y	N
Intertidal coarse sediment	N	N	N
Intertidal mixed sediment	N	N	N
Intertidal mud	N	N	N
Intertidal rock	N	N	N
Intertidal sand and muddy sand	N	N	N
Intertidal sea grass beds	N	N	N
Subtidal coarse sediment	Y	Y	N
Subtidal mixed sediment	Y	Y	N
Subtidal mud	Y	Y	N
Subtidal sand	N	N	N
Subtidal seagrass beds	N	N	N

3. **What potential pressures such as abrasion/physical loss by gear type(s) are likely to affect the interest features?** *(reference to conservation objectives)*

Table 8 Potential pressures exerted on the designated features from the assessed activity

Pressure	Exposure
1. Abrasion/disturbance of the substrate on the surface of the seabed	Y
2. Changes in suspended solids (water clarity)	Y
3. Genetic modification & translocation of indigenous species	N
4. Introduction of microbial pathogens	N
5. Introduction or spread of invasive non-indigenous species (INIS)	N
6. Penetration and/or disturbance of the substratum below the surface of the seabed,	N
7. including abrasion	N
8. Removal of non-target species	Y
9. Removal of target species	Y
10. Smothering and siltation rate changes (Light)	N
11. Visual disturbance	N
12. Deoxygenation	N
13. Hydrocarbon & PAH contamination	N
14. Introduction of light	N
15. Litter	N
16. Nutrient enrichment	N
17. Organic enrichment	N
18. Physical change (to another seabed type)	Y
19. Physical change (to another sediment	Y

8.2.1 Potential scale of pressures and mechanism of effect/ impact (if known)

NE's advice on operations concludes that subtidal mud, subtidal coarse sediment and subtidal mixed sediment habitats are sensitive to shellfish/ aquaculture/ bottom culture practices due to abrasion/disturbance of the substrate on the surface of the seabed, changes in suspended

solids/turbidity. Therefore this HRA concludes that there is a likely significant effect of the proposed activity on these habitat types.

A likely significant effect is also possible from dredging resulting in penetration of the seabed (Table 7, bullet point 6.) but this has been ruled out at this stage due to modifications of the dredge apparatus used in the cultivation of *O.edulis* in the SO. Traditionally dredges and harrows were employed to work the ground and clean the cultch. Dredges were designed to have 'teeth' (Figure 7a) to penetrate the surface of the seabed and 'rake' the shell. In 2009 the Blackwater Oystermen modified their dredges in order to clean and harvest the ground in a much less intrusive way. The modified design which incorporates a ladder rather than a toothed dredge blade and 'skegs' or skis fitted to the bottom of the dredge significantly reduces the amount of benthic interaction and does not penetrate the sea bed, A standard oyster dredge is 1.23m wide. Traditionally this dredge would have been fitted with a toothed bar of 1.23m the modification to include a smooth bar rather than a toothed dredge means that penetration of the sea bed is reduced and the addition of skegs reduces the surface area further from 1.23m to 12cm (6cm skeg fitted to either side of the dredge) (Figure 7b), reducing the surface area interacting with the seabed by 117cm. This modification significantly reduces interaction with the seabed, additional monitoring of the impacts of this type of modified dredge are being undertaken (see Section 14 management and monitoring plan). The ladder dredge (Figure 7b) is fitted with linked lightweight 'net' and is a standard size of 1.23m width. The 'ladder' and skeg dredge is now employed as the standard apparatus for cultivation and harvesting of native oysters within the SO area.

Figure 7. Modification to dredges used in cultivation of *O.edulis* in the SO area. (A) shows a traditional toothed oyster dredge. (B) Shows the modified ladder dredge employed by the oystermen in the Blackwater Estuary

9. Appropriate Assessment (SAC)

9.1 Potential risks to features

The following Appropriate Assessment table only includes those features and sub features which have been identified as having a potential impact through the TLSE effect on the SAC in Section 8 (Table 9).

Feature	**Estuaries**	
Sub-feature within footprint of the several order	Mud	Mixed sediment
Conservation Objective	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; The extent and distribution of qualifying natural habitats The structure and function (including typical species) of qualifying natural habitats, and The supporting processes on which qualifying natural habitats rely	
Potential pressure (Such as abrasion, disturbance) exerted by gear type	Dredging Deposition of cultch and relaying of oysters Cleaning	
Potential ecological impact of pressure exerted by the activity	Loss/reduction of the feature through physical abrasion Increased turbidity and/or smothering from physical disturbance Physical disturbance (deposition of cultch, changing one seabed type to another)	Increased turbidity and/or smothering from physical disturbance (dredging and harrowing) Physical disturbance through (Dredging and harrowing)

Level of exposure of the feature to pressure	An area of 860Ha (69%) of the total area of the Several order has been identified as Mud biotope type SS.SMu.SMuVS and SS.SMu.ISaMu. Of this 860Ha, 244Ha are actively cleaned, maintained and harvested from by the oyster industry. This is 28% of biotope types SS.SMu.SMuVS and SS.SMu.ISaMu within the several order affected. It is concluded that the act of dredging and harrowing within this area will have a likely significant effect on the biotope immediately affected by the activity and the communities that occupy this niche. However the remaining 616Ha or 71% of biotope types SS.SMu.SMuVS and SS.SMu.ISaMu will remain unaffected by any cultivation. The Essex Estuaries SAC contains 7758Ha of biotope types SS.SMu.SMuVS and SS.SMu.ISaMu. Therefore the 244ha impacted area makes up only 3% of the total area of SS.SMu.SMuVS and SS.SMu.ISaMu within the SAC.	An area of 563Ha (45%) of the total area of the several order has been identified as mixed sediment biotopes SS.SMx.Imx and SS.SMx.SMxVS. Of this 563ha, 110ha are actively cleaned, maintained and harvested from by the oyster industry. This is 19% of the biotope types SS.SMx.Imx and SS.SMx.SMxVS within the several order affected by cleaning, maintenance and harvesting. It is concluded that the remaining 453Ha or 36% of biotope types SS.SMx.Imx and SS.SMx.SMxVS within the several order will remain unaffected by any cultivation. The Essex Estuaries SAC contains 5763Ha of biotope types SS.SMx.Imx (1782Ha) and SS.SMx.SMxVS (3981Ha) Therefore the 110ha impacted area makes up only 2% of the total area of SS.SMx.Imx and SS.SMx.SMxVS.within the SAC. Due to the findings in Allison *et al* 2017 (unpub) it is proposed that the act of cleaning and harrowing has a positive effect on increasing numbers of *O.edulis*. As *O.edulis* is a species associated with biotope types SS.SMx.Imx and SS.SMx.SMxVS it is therefore concluded that the act of encouraging the colonisation of a species associated with these biotopes is having a positive impact on the biotope rather than a negative and therefore the conclusion of no likely significant detrimental effect can be assumed.
Mitigation measures	Adaptive management and monitoring	No mitigation measures proposed

Is the potential scale or magnitude of any effect likely to be significant?

	Likely significant effect	**Notes**
Alone	**Yes**	Due to the activity being directly linked to the management and conservation of the designation any likely significant effect can be ruled out at this stage.
In combination	**No**	As above

Have NE been consulted on LSE? If yes, what was NE's advice

1. Yes, NE's primary concerns relate specifically to abrasion/disturbance of the substrate on the surface of the seabed. Communication with NE staff regarding a pragmatic approach has focused on the use of skegs to reduce surface area of the dredge interacting with the seabed. Implementation of the proposed adaptive management plan and the associated monitoring plan (see section 14) undertaken in collaboration with the University of Essex to progress understanding of potential impacts and recovery time to benthic substratum is being undertaken.

Activities undertaken by the T&MOCo that may cause an impact on the protected features are cleaning and harvesting of oyster beds. These are currently being researched as a ground recovery project with the University of Essex. The impact on bird life of these activities is likely to be very minimal as this is undertaken in the subtidal area, though there may be slight disturbance from the oyster boat.

Other users of the estuary would include sailing and powerboats and rod fishing from boats. These activities are unlikely to cause any major disturbance to the birds or impact on any protected features.

The combined activities of the T&MOCo and other users in the Blackwater is overall unlikely to make any impact on the features or bird populations.

10. TLSE Blackwater Estuary (Mid-Essex Coast Phase 4) SPA

10.1 - introduction

The T&MOCo is the umbrella company that controls the rights to fishing within the existing SO. If an individual wishes to harvest *O.edulis* from within the boundary of the SO they must first become a member of the BOA. In 2017 the BOA comprised 7 oyster boats employing around 30 full time workers directly involved in the maintenance and harvesting of *O.edulis* from within the SO. In order to harvest *O.edulis* throughout the winter months, individuals are required to undertake cleaning in the summer months immediately prior to spawning, this ensures the oyster grounds or subtidal mixed sediment is in optimal condition to receive the veligers, or free swimming motile larvae. A clean surface is required for the veliger to cement on to and grow.

Due to the area being designated under the Birds Directive, a TLSE is required to rule out any disturbance to breeding or over wintering birds. In order to quantify potential disturbance the number of hours of cleaning and harvesting within the SO has been calculated for the previous 3 years (Table 9).

Table 9. Number of hours of cleaning and harvesting *O.edulis* within the Several order area

Number of hours				
Activity /Year	**2014**	**2015**	**2016**	**2017**
Dredging	No dredging	123	124	66
Cleaning	109	No cleaning	68	70

1. **Is the activity/activities directly connected with or necessary to the management of the site for nature conservation?** No

10.2 – TLSE Blckwater Estuary SPA

Table 10 Mid Essex Coast Blackwater Estuary TLSE for SPA features

Feature	Does the feature occur within the footprint of the proposed works	Is the feature likely to be impacted by the proposed works	Is the integrity of the site compromised due to the proposed works
Black-tailed godwit, (Non-breeding)	N	N	N
Bar tailed Godwit (Non-Breeding)	N	N	N
Dark-bellied Brent goose, (Non-breeding)	Y	Y	N
Dunlin, (Non-breeding)	N	N	N
Grey plover, (Non-breeding)	N	N	N
Hen harrier, (Non-breeding)	N	N	N
Redshank (Non-Breeding)	N	N	N
Sanderling (Non-Breeding)	N	N	N
Curlew (Non-Breeding)	N	N	N
Goldeneye (Non Breeding)	Y	Y	N
Shelduck (Non-Breeding)	Y	Y	N
Teal (Non-Breeding)	Y	Y	N
Mute Swan (Non Breeding)	N	N	N
Little tern, (Breeding)	N	N	N
Pochard, (Breeding)	N	N	N
Avocet, (Breeding)	N	N	N
Common tern (Breeding)	N	N	N
Ringed plover, (Breeding)	N	N	N
Cormorant (Breeding)	N	N	N
Knot (Non Breeding)	N	N	N
Oystercatcher (Breeding)	N	N	N

2. What potential pressures such as abrasion/physical loss by gear type(s) are likely to affect the interest features? (reference to conservation objectives)

Table 11. Potential pressures exerted on the designated features from the assessed activity

Pressure	Exposure
1. Abrasion/disturbance of the substrate on the surface of the seabed	Y
2. Changes in suspended solids (water clarity)	Y
3. Genetic modification & translocation of indigenous species	N
4. Introduction of microbial pathogens	N
5. Introduction or spread of invasive non-indigenous species (INIS)	N
6. Penetration and/or disturbance of the substratum below the surface of the seabed,	Y
7. including abrasion	Y
8. Removal of non-target species	Y
9. Removal of target species	Y
10. Smothering and siltation rate changes (Light)	Y
11. Visual disturbance	N
12. Deoxygenation	N
13. Hydrocarbon & PAH contamination	N
14. Introduction of light	N
15. Litter	N
16. Nutrient enrichment	N
17. Organic enrichment	N
18. Physical change (to another seabed type)	Y
19. Physical change (to another sediment	Y

11. Appropriate Assessment (SPA)

11.1 Potential risks to features

The following Appropriate assessment table only includes those features and sub features which have been identified as having a potential impact through the Test of Likely significant effect on the SPA in section 9.

Feature	Sub-feature	Conservation Objective	Potential pressure (Such as abrasion, disturbance) exerted by gear type	Potential ecological impact of pressure exerted by the activity	Level of exposure of the feature to pressure	Mitigation measures
Breeding	Little tern, (Breeding) Knot (Non Breeding) Pochard, (Breeding) Avocet, (Breeding) Oystercatcher (Breeding) Little tern (Breeding) Common tern (Breeding) Ringed plover, (Breeding	Ensure that the integrity of the site is maintained, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining; The extent and distribution of the habitats of the qualifying features The structure and function of the habitats of the qualifying features The supporting processes on which the habitats of the qualifying features rely The population of each of the qualifying features, and, The distribution of the qualifying features within the site.	Noise/visual disturbance Changes in turbidity/ water clarity	Non physical disturbance affecting feeding, foraging of breeding species	Cleaning of subtidal mixed sediment occurs immediately prior to spawning in order to liberate sediment covering oyster cultch (mainly shell) This creates a clean hard surface on which oyster veligers can settle. Temperatures over 15^{o}C will trigger *O.edulis* to begin spawning, therefore cleaning occurs in the summer months, this is predominantly in early June, but can vary year on year depending on climatic conditions. Once spawning has begun cleaning ceases in order to preserve young veligers which have recently settled, therefore number of hours cleaning per year	

					is minimal. (Table 9\) Due to significant recreational activities occurring within and around the several order area, including recreation angling, sailing, jet skis, tourism and holiday makers an additional 68-70 hours vessel time within the several order is not considered to significantly affect breeding birds through disturbance.	
Non Breeding **(overwintering)**	Black-tailed godwit, (Non-breeding) Bar tailed Godwit (Non-Breeding) Dark-bellied Brent goose, (Non-breeding) Dunlin, (Non-breeding) Grey plover, (Non-breeding) Hen harrier, (Non-breeding) Redshank (Non-Breeding)	Ensure that the integrity of the site is maintained, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining; The extent and distribution of the habitats of the qualifying features The structure and function of the habitats of the qualifying features The supporting processes on			The size of the BOA fleet is 7 boats. The total hours spent harvesting is 2015 = 123 2016 = 124 2017 = 66 The extent of the several order is within an area of considerable human disturbance, high levels of recreational activities, sailing, fishing, jet-ski-ing and bird watching. It is proposed that the additional dredging and cleaning activities will not have a likely	

	Sanderling (Non-Breeding) Curlew (Non-Breeding) Goldeneye (Non Breeding) Shelduck (Non-Breeding) Teal (Non-Breeding)	which the habitats of the qualifying features rely The population of each of the qualifying features, and, The distribution of the qualifying features within the site.			significant effect on the over wintering bird species due to the low level of time spent undertaking the tasks. For example, in 2015 a total of 112 hours of cleaning was undertaken. Seven boats working a 8 hour day cleaning and harvesting each vessel would only spend 2 days working within the SO. In 2016 this number remained at 2 days working time and in 2017 this reduced to 1 working day per vessel over the winter period. It is due to these low levels of activity that there will be no likely significant effect of disturbance to over wintering birds	

3. **Is the potential scale or magnitude of any effect likely to be significant?**
   Alone : No

	Likely significant effect?	
Alone	No	Due to the low intensity of vessels accessing the SO for cleaning during the summer months and harvesting in the winter months i.e. 1-2 days per boat based on 7 registered boats working an 8 hour day, a likely significant effect due to scale or magnitude is unlikely.
In Combination	No	There are no other potential plans or projects in the area.

4. **Have NE been consulted on LSE? If yes, what was NE's advice?**

Yes. No further comments from NE regarding disturbance to over wintering birds

12. TLSE Blackwater, Crouch, Roach and Colne Estuaries MCZ

12.1 Introduction

In 2013 the Blackwater, Colne, Crouch & Roach MCZ was designated under the Marine and Coastal Access Act. The Features of Conservation Importance (FOCI) designated under the Act includes intertidal mixed sediments, native oyster and native oyster beds. Due to age structure anomalies in the meta populations the conservation objectives for the feature is to recover to a favourable condition. Subsequently the ENORI was established to address concerns and design management plans to recover the species and the habitats it creates. The group is made up of scientists, Non-governmental Organisations (NGOs), statutory regulators and the oyster industry. The Blackwater Oystermen have been an instrumental part of the process from designation through to design and collection of data for the management plan to recover the species. Communication through the ENORI group with NE has concluded that active intervention is necessary for the recovery of the species, therefore cleaning and cultivation within the SO can be regarded as being directly connected with or necessary to the management of the site for conservation.

Current analysis indicates that oysters are sensitive to the impacts of commercial fisheries, therefore the following are required for boats working the ground of the SO.

12.2 Enforcement

- All harvesting boats working within the SO must be registered, licensed and insured in order to be allowed to tender for work whether cleaning or harvesting.
- All subcontractors are experienced oystermen who are members of the BOA and shareholders of the T&MOCo.
- Boats and crew have to abide by the Health and Safety risk assessment of the T&MOCo.
- The number of boats available to apply for the work under these terms remains less than 10.
- Boats must supply evidence of ‘tracks’ (areas worked, cleaned or harvested) to the T&MOCo. These are created by using a Memory Map tracking system.

12.3 Monitoring

Annual surveys of the oyster grounds are undertaken by the T&MOCo to assess:

1. The need for cleaning, where, when and how much.
2. Stock assessment in conjunction with University of Essex to inform if harvesting can take place.
3. Cefas disease testing.

1. **Is the activity/activities directly connected with or necessary to the management of the site for nature conservation?** Yes

Table 12 BCRC MCZ TLSE

Feature/sub feature	Does the feature occur within the footprint of the proposed works	Is the feature likely to be impacted by the proposed works	Is the integrity of the site compromised due to the proposed works
Intertidal mixed sediments	N	N	N
Native oyster beds	Y	N	N
Native oyster	Y	N	N

2. What potential pressures such as abrasion/physical loss by gear type(s) are likely to affect the interest features? *(reference to conservation objectives)*

Pressure	Exposure
1. Abrasion/disturbance of the substrate on the surface of the seabed	Y
2. Changes in suspended solids (water clarity)	Y
3. Genetic modification & translocation of indigenous species	N
4. Introduction of microbial pathogens	N
5. Introduction or spread of invasive non-indigenous species (INIS)	N
6. Penetration and/or disturbance of the substratum below the surface of the seabed,	N
7. including abrasion	N
8. Removal of non-target species	Y
9. Removal of target species	Y
10. Smothering and siltation rate changes (Light)	N
11. Visual disturbance	N
12. Deoxygenation	N
13. Hydrocarbon & PAH contamination	N
14. Introduction of light	N
15. Litter	N
16. Nutrient enrichment	N
17. Organic enrichment	N
18. Physical change (to another seabed type)	Y
19. Physical change (to another sediment)	Y

3. Is the potential scale or magnitude of any effect likely to be significant?

	Test of likely significance	
Alone	No	Due to the activity being directly linked to the management and conservation of the designation any likely significant effect can be ruled out at this stage.
In combination	No	

Activities undertaken by the T&MOCo that may cause an impact on the protected features are cleaning and dredging of oyster beds. This may cause disturbance of the bed which may not recover. Ground recovery investigations are being undertaken with the University of Essex to assess any damage caused and how long before the ground recovers. The bird populations are not affected by the T&MOCo cleaning/dredging as this is only carried out on subtidal areas. There maybe minor disturbance by the presence of the oyster boat.

Other activities that occur within the area of the SO are sailing, powerboating and rod fishing from boats. There may be some disturbance to the birdlife from sailing and powerboats, dependent upon the state of tide but very little if any from rod fishing.

In combination it is not felt that any impact is made on the birds and any impact on protected features is in areas where native oysters are currently found.

4. Have NE been consulted on LSE? If yes, what was NE's advice?

Yes. No further comments regarding the TLSE for the BCRC MCZ were received from NE.

NE are a statutory body present on the ENORI and as such have worked with the T&MOCo since 2012 on the designation of the MCZ and how it can be managed for the benefit of nature conservation. All comments from communication with NE have been incorporated in the design of the management and monitoring plan at every stage.

13. Conclusion

13.1 Alone

Proposal to renew the existing Tollesbury and Mersea (Blackwater) Fishery Order, on a like for like basis is sought, the extent (area) has reduced slightly due to the exclusion of Thornfleet Creek. However, there is an application for an increase in catch species to include non-native species *C. Gigas*, *M. mercinaria* and native species *M. edulis* & *C. edule.* The request for all shellfish and bivalve species to be included in the SO is to allow for the removal/management of non-native species which may encroach on *O. edulis* beds and to prevent unregulated boats from fishing the area. This approach protects the shellfish, whilst also protecting the benthic substratum habitat subtidal mud and subtidal mixed sediment both of which are regarded as sensitive habitats under the TLSE.

13.2 Conclusion (SPA)

The number of boats within the BOA fleet is 7 in total. The number of hours spent harvesting has been consistently low; 2015 = 123 hours, 2016 = 124 hours, 2017 = 66 hours. Due to the low level of activity being undertaken it is concluded that there is no likely significant effect on Annex 1 species and over wintering bird assemblage covered under the Birds Directive (Blackwater Estuary SPA).

13.3 Conclusion (SAC)

Likely significant effect on the SAC features subtidal mud; this habitat type has been deemed sensitive to bottom towed gear under the revised approach to fishing activities and is contained within the footprint of the SO area.

The impact on this habitats type in terms of scale has been assessed as negligible due to the low intensity of the activities impacting on the area, and the total amount of area itself being representative of only 2% of total biotope area within the SAC. However, the impact on that section of subtidal mud is unrefuted. It is therefore proposed that a combination of avoidance measures, adaptive management and monitoring are put in place to monitor impacts to mud habitat, and ensure that the feature remains in good condition.

There is in total 680ha of subtidal mud within the SO, of this 244ha are impacted from cleaning and harvesting of *O.edulis*. 436ha remain undisturbed, this represents 35% of the area of the SO which is impacted on from harvesting and 65% of the SO which is unimpacted. In total there is 7758ha of subtidal mud contained within the Essex Estuaries SAC. The 244ha of impacted mud represents 3% of the total area of the SAC feature within the Essex Estuaries. This is an inevitable consequence of native oyster reef restoration – the sub-tidal mud flat feature will transform into a mixed habitat.

It is proposed that due to only 35% of the mud communities within the SO being impacted there is an additional 65% of unimpacted subtidal mud within the SO. It is therefore an ideal opportunity to implement adaptive management protocol and to put in place a series of monitoring requirements to assess the impact dredging has on subtidal mud communities. These studies are currently being undertaken and once the results are concluded it will be possible to determine how much mitigation is necessary if any. It may even be found that the restoration/conservation of the oyster reef is mitigation enough.

13.4 Conclusion (MCZ)

As the aim of the SO is to maintain a native oyster reef, which is directly linked to the management goal of the MCZ for the conservation of native oysters, then it is concluded that there will be no adverse effect as a result of the activity. The SO provides a positive contribution to the MCZ designation. Populations of *O. edulis* within the SO have been shown to act as brood stock for the MCZ, the production and export of veligers from the SO area provides a positive contribution for the FOCI and HOCI. In addition, works carried out by the BOA have provided boat time and expertise to the ENORI project for the progression of the MCZ, its management, monitoring and ongoing conservation projects.

14. Adaptive management procedure for implementation

14.1 Introduction

Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. It's most effective form, 'active' adaptive management employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed." (Nyberg, 1998)

In 2007 the Shellfish Association of Great Britain (SAGB) and NE agreed aims in which to manage shellfisheries and aquaculture within European Marine Sites (SAC & SPA) through an ecosystem management based approach:

'*the ecosystem based approach to management which integrates conservation and shellfisheries or farm management objectives is central to achieving sustainable development of the shell fish industry within European Marine Sites, A key component of the ecosystem approach is adaptive management'.*

This pragmatic approach to multiuse MPA's allows for the progression of an activity, in this case the renewal of the T&MOCo SO, in light of 'uncertainties' surrounding the impact of the activity on the designated feature/s. Allowing the industry and the statutory regulators to work together to develop best practice guidance, strict management measures and robust scientific monitoring plans in which to assess the potential impact and if necessary modify management and behaviour accordingly.

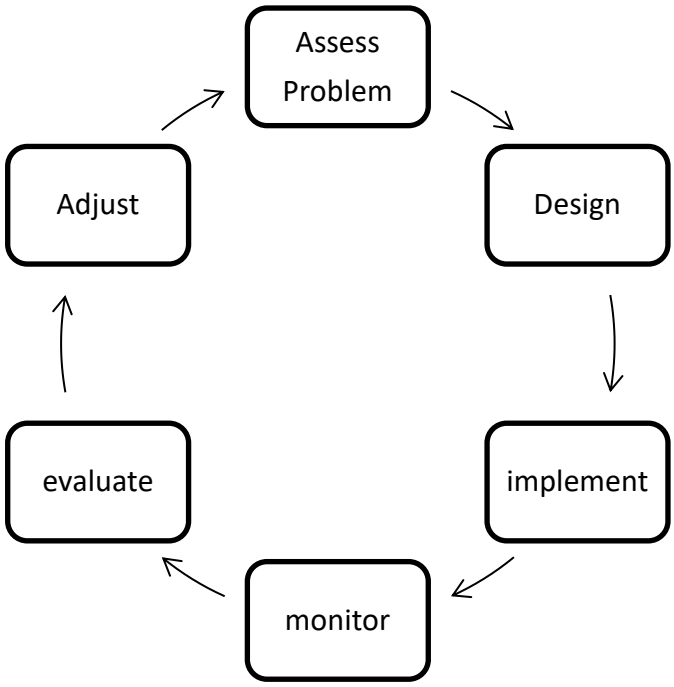

Figure 8 Conceptual framework for adaptive management (Nyberg, 1998, Woolmer, 2009)

14. 2 Adaptive Management Plan - Design and Implementation

To ensure compliance under the adaptive management framework the following management and monitoring plan is proposed by the T&MOCo.

The monitoring plan has been developed and will be implemented in conjunction with the University of Essex using existing techniques developed by the Kent and Essex IFCA.

All data collected during monitoring of the SO will be analysed in partnership with independent scientists based at the University of Essex, findings will be submitted to NE, ENORI and used to inform future management practices.

Conservation boxes

These are a new concept for the T&MOCo, The idea is to establish an untouched spawning stock of the native European oyster *O. edulis* while managing the non native *C. gigas* . Profits made from the removal and sale of *C.gigas* will be used for the conservation and restoration of *O.edulis* beds within each of the Conservation Boxes (Figure 1). Due to the presence of bonamia within the SO regular testing for the disease is undertaken. Should it be necessary to reduce the density of native oysters within a conservation box due to the concern of overpopulation and possible disease, this will be carried out.

Conservation Box 1

Has a stock on its north east boundary which will remain unharvested. The stock will be assessed periodically for invasive species and any encroachment of *C. gigas* will be removed and destroyed.

Conservation Box 2

There is a stock of oysters on the south west boundary which will remain unharvested. The stock will be assessed periodically and any encroachment of *C. gigas* or other non native invasive species will be removed and destroyed.

Conservation Box 3

There are stocks of oysters on both the north and south boundary which will remain unharvested. The stock will be assessed periodically and any encroachment of *C. gigas* or other non native invasive species will be removed and destroyed.

Fisheries Boxes

Fisheries Box 1

Historically this area has produced consistently high numbers of *O.edulis.* Between 2012 and 2016 there was a continuous spatfall during the breeding season (May – September). In 2016 during high winds and northerly winds the oyster grounds experienced high sediment loading and loss of mixed sediment (cultch). A cultch relaying project may be planned for the future in this area.

Fisheries Box 2

This area contain large numbers of Slipper limpets (*Crepidula fornicata).* The T&MOCo have repeatedly used harrows and bagless dredges to clean the area and create cultch and subtidal mixed sediment from *C.fornicata* shell.

Fisheries Box 3

This area also contains large numbers of *C.fornicata*, harrows and bagless dredges are also used in this area to break up *C.fornicata* chains and create a source of cultch.

Fisheries Box 4

This area has the potential to be very good for the cultivation of *O.edulis* and the T&MOCo propose to push the restoration of the historic oyster grounds along the western boundary of this box using management and cultivation techniques appropriate to a *Bonamia* area and in line with Cefas guidance. Maintenance of the subtidal mixed sediment is proposed using traditional techniques of harrowing and the use of bagless dredges.

Fisheries Box 5

Historically (30years) this area contained high numbers of *O.edulis* along the north east boundary of the box. Adverse environmental conditions, pollution (TBT) and *Bonamia* have reduced stocks significantly in this area. Abundant seasonal macro algae grows prolifically along the southern boundary of Box 5. The benthic substratum is predominantly subtidal mixed sediment and therefore lends itself to restoration for *O.edulis*.

Fisheries Box 6

This area has potential to support high numbers of *O.edulis*. A number of >70mm *O.edulis* were recorded in this area in 2017 and the area supports a range of age cohorts, suggesting good annual spatfall and successful maturation of veligers. Benthic substratum is predominantly subtidal mixed sediment. The area also supports high numbers of *C.fornicata* and it is proposed that these non native invasive species area managed by the T&MOCo to support *O.edulis* restoration.

Fisheries Box 7

This restoration area contains the Bradwell nuclear power station's discharge pipe and has experienced several pollution incidents during both the operational life of the power station and during the decommissioning of the power station. Benthic substratum is predominantly subtidal mixed sediment. Due to the proximity of the area and the dominant benthic substratum type this area is predicted to recover with management, but recovery is likely to be slow.

Fisheries box 8

Due to its close proximity to the Bradwell Nuclear power station discharge pipe, this area has also seen reduced levels of *O.edulis*, however, the dominant benthic substratum is subtidal mixed sediment, and *O.edulis* are present within this area. It is proposed that a cultch relaying project will be implemented in this area to encourage additional spatfall.

Thirslet Creek

This area has historically been used to grow *O.edulis* for the culinary market. Currently the intertidal area is inundated with *C. gigas*. The intention is to remove *C.gigas* from the intertidal, restoring mudflats, enabling access for over wintering and wading wildfowl. Any profits accrued in the removal of and sale of *C. gigas* will be used to aid the restoration efforts in conservation boxes 1,2 & 3.

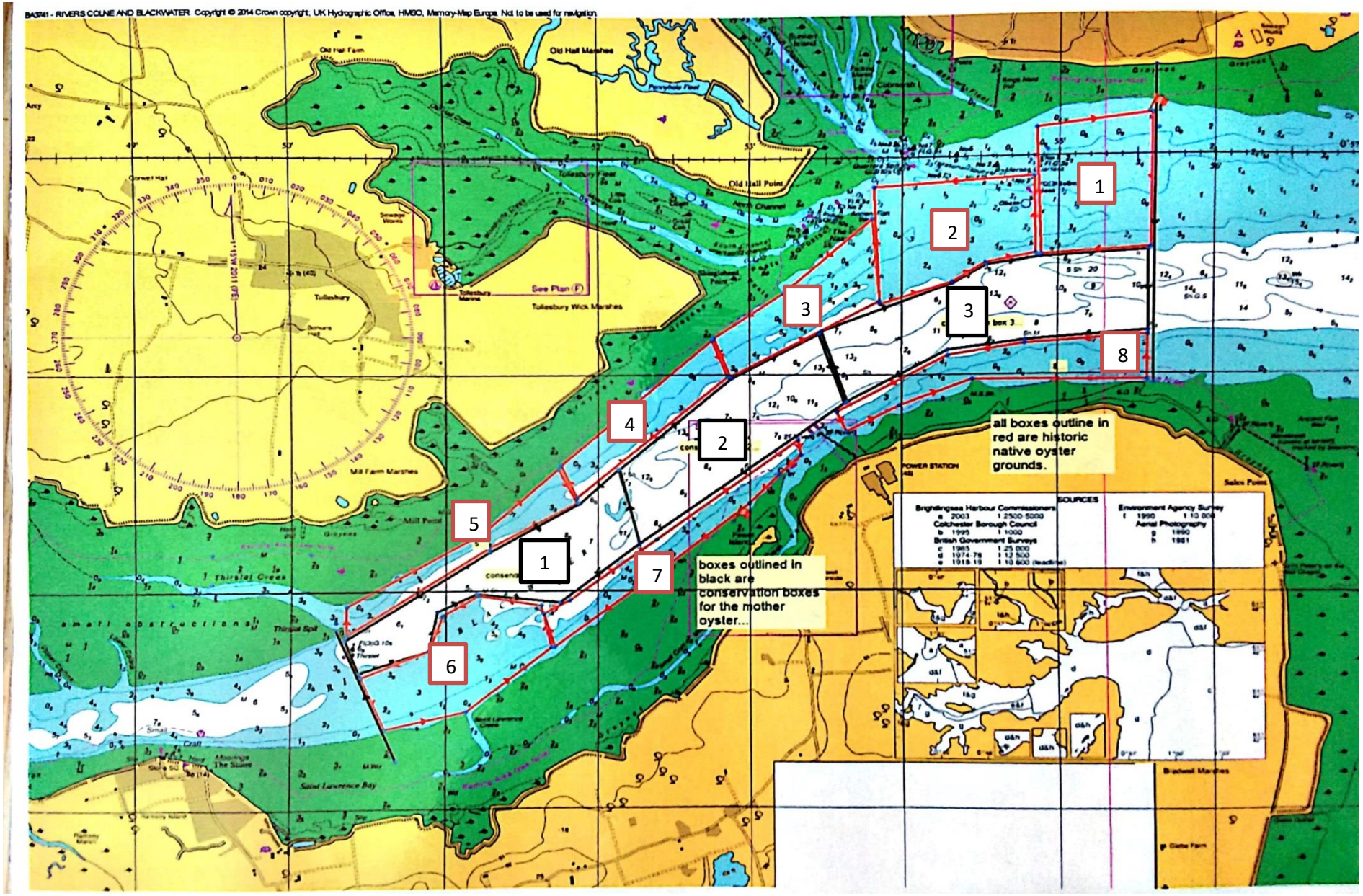

Figure 9 Map shows the location and extent of the conservation box area (Black Lines) and the historically fished O.edulis grounds (Red lines) within the Blackwater Estuary existing SO area.

14.3 Management Principles

A. Work with the University of Essex to assess stock levels
B. Maintain breeding populations and spawning stock above minimum levels
C. Establish brood stock areas
D. Maintain brood stock density in line with CEFAS recommendations
E. Sell stock to ENORI project to establish brood stock areas in line with conservation objectives and management plan within the Blackwater, Colne, Crouch & Roach Marine Conservation Zone area.
F. Combine extraction of *O.edulis* with cleaning of subtidal mixed sediment, reducing the impact of both activities. Timings will be inked to temperature to ensure cleaning of cultch occurs immediately prior to settlement of veliger larvae.
G. Work with the University of Essex to monitor temperature and veliger density within the water column to ensure ground is ready to receive spat.
H. Monthly surveys for starfish (*Asterias rubens)* and American tingle incursions, assess sediment loading on subtidal mixed sediment.
I. Survey and removal of invasive species to ensure no encroachment onto newly established *O.edulis* areas.
J. Clean and separate *O.edulis* shell, break up any slipper limpet chains.
K. Work with the University of Essex to determine tingle spawning areas in order to effectively control their spread.
L. Establish in partnership with the University of Essex a monitoring plan to determine ground recovery time post dredging and/or harrowing.
M. Deposition of shell (which has been previously stored to aid sterilisation as necessary) to maintain shell budget in areas where cultch is being lost.
N. Leave area for 12 months after successful spatfall in order to protect newly settled juveniles.
O. Working with the University of Essex to establish if *O.edulis* growth is affected by the presence of *B. ostreae*.
P. Work with CEFAS to continue annual *Bonamia* sampling throughout the Blackwater Estuary.
Q. Use standard ladder dredges maximum width of 2.43m, fitted with skegs to minimise interaction with the sea bed.
R. Work in partnership with ENORI and Anglian Water to encourage high water quality in the Blackwater.
S. When moving to new grounds, ensure 'healthy' gear hygiene by sterilising, by an approved method, dredges and dredging tackle to stop the spread of *B. ostreae.*
T. Engage with plans for new nuclear at Bradwell

14.4 5 year management plan

To be read in conjunction with the Management principles above												
	Fisheries Box								Conservation Box			Thirslet creek
	Box 1	Box 2	Box 3	Box 4	Box 5	Box 6	Box 7	Box 8	Box 1	Box 2	Box 3	
2018	A B D G H I J N O Q	A B D E F G H I J L N O Q	A B D E F H I J N O P Q	A H I J N Q	A H I N O	A B D E H I J N O P Q	A B D F H I J N Q	A B D F H I J N Q	A B C I	A B C I	A B C I	A H I K N Q
2019	B D E F H I J N O Q	B D E F S H I J L N O Q	B D E F H I J N O P Q	Q H I J N	H I N O	B D E H I J N O P Q	B D F H I N Q	A D F H I M N P Q	B C I	B C I	B C I	H I K N Q
2020	B D E F H I J M N O P Q	B D E F H I J N O Q	B D E F H I J N O P Q	B H I J N Q	H I J N O	B D E H I J N O P Q	B D H I J N Q	B D F H I N O Q	B C I	B C I	B C I	H I K N Q
2021	B D E F H I J N O P Q	B D E F H I J M N O P Q	B D E F H I J M N O P Q	B H D I J N Q	H I J N O	B D E H I J N O P Q	B D H I N Q	B D F H I N O P Q	B C I	B C I	B C I	H I K N Q
2022	B D E F H I J M N O P Q	B D E F H I J N O P Q	B D E F H I J N O P Q	B H D I J N Q	H I J N O	B D E H I J N O P Q	B D H I J N Q	B D F H I M N Q	B C I		B C I	F H I J K N Q

14.4 Monitor

In line with adaptive management principles and to ensure compliance with NE's advice the following monitoring plan is proposed.

NE's advice regarding the use of dredges within the SAC and MCZ are primarily regarding *'Abrasion/disturbance of the substrate on the surface of the seabed'*. It is therefore proposed that a monitoring plan be implemented alongside the proposed management plan and its principles to establish brood stock areas and control on invasive non native species. Additional monitoring is to determine if any detrimental impacts are observed on subtidal mud and subtidal mixed sediment caused by the use of oyster dredges. The proposed monitoring methodology is taken directly from the Kent and Essex IFCA (K&E IFCA). The K&EIFCA undertook a three year trial (2014 – 2017) to establish if oyster dredges have a detrimental impact on subtidal mud in the Ray Sand Channel and subtidal mixed sediment in the Blackwater Estuary. Methodologies included the use of side scan sonar and grab samples. The T&MOCo propose to extend the survey beyond three years, to progress our understanding of the potential impacts of oyster dredging on different benthic substratum, whilst using the data to feed into and advise the proposed adaptive management plan.

Sampling Methodology

Suitable sampling locations whereby gear interactions with the benthic substratum have not occurred for a notable period of time have been identified within the SO area to the west of the old Tollesbury Pier. The dominant substratum type is subtidal mixed sediment.

The entire site is approximately 250*600m. Pre-dredging sampling of the site will commence at the beginning of September in line with recommendations from NE) for JNCC habitat type, further Particle Size Analysis (PSA) and biodiversity assessments to take place.

Each of the three dredge transects will be repeated three times (n=9) in line with NE recommendations to establish recovery time.

Data will be collected before and immediately after dredging the site and then at subsequent intervals (1 month, 2 months and 6-8 months).

Three dredge transects running south west to north east diagonally will be taken across the recovery experiment site using a 1.2m ladder dredge (each separated with at least 100m to allow independent control sampling).

Additional data collection methods include sonar/video in line with K&EIFCA methodology developed between 2014-2017 to identify impacts to benthic substratum and the longevity of physical dredging marks on the substrate.

Grab sampling to establish habitat type (PSA analysis) (JNCC definitions) and micro dredging to identify associated species (grab and micro-dredging(5-10m))

The microdredge will be a short dredge over a small area using a standard dredge fitted with a small mesh to capture a sample of what is present in that area for the biodiversity assessment. This will provide replicated assessments of the effects of dredging and any time to recovery – with both local and national implications for dredging on soft sediments.

Sampling will continue until the end of next summer to represent at least 12 months since dredging.

The table below outlines the objective, method, data and replication.

Data/time	Before	1-2days	1month	2 months	6-8months	12months
Sonar/video	Y	Y		Y	Y	Y
Grab/PSA (5)	Y			Y	Y	Y
Grab-Biodiversity	Y		Y		Y	Y
Micro Dredge	Y		Y		Y	Y
Report					Y (Feb 2019)	Y

PSA Analysis methodology

Samples for sediment and PSA analysis

1. From a 0.12m² grab, insert a 250ml core into the grab to its full depth and retain this core.
2. Minimum depth of a successful grab **must** be 5cm depth.
3. Shell debris is considered part of the marine sediment structure and is included in the sample. This includes shell debris, dead slippers, worm tubes etc. Due to their role in contributing to the sediment definitions – live slipper limpet stacks can also be included – but not deliberately targeted. Other large live marine fauna will be removed.
4. Place core into a labelled clean container then seal. As the sediment is muddy a smaller volume is suitable, anything from 100ml to 250ml can be used.
5. Samples can be frozen – if freezing is required then it will occur as soon as possible.

Laboratory sample preparation for sediment type determination and PSA analysis – sieve based analysis

1. Open sample container and remove any conspicuous marine fauna such as amphipods or small annelids that have emerged. Any shell debris, slipper limpet shells or coralline algae must not be removed.
2. Describe the sample visually before the analysis – e.g. shelly or gravelly mud, muddy sand. Any fauna can be recorded.
3. Take three small (about 10-20 grams) subsamples from the bulk sample. For one, push then wash -the sample through a 1mm sieve into a plastic pot. For each sample – pour through a funnel into a labelled falcon tube. Allow to settle and pour off water for freeze storage. Place the other two in labelled storage containers and freeze in case needed.
4. Each of these is a replicate for <1mm PSA analysis. Dispose of any material left on the 1mm sieve.
5. Wet split the remaining sample. Take the same from its original container, weigh and record this weight. Place the sample on a 1mm sieve, push and wash the sample through into retainer. Wash this <1mm sample into a weighing container. Allow this <1mm sample to settle until excess water can be poured off (sometimes up to 24hrs). After weighing this

sample (see point 7 below) – dry the sample in a low oven heat until fully dry and record the weight.

6. Transfer or wash the >1mm sample left on the 1mm sieve into a weighting boat and remove any excess water. Record the weight of the Wet >1mm sample. Dry the sample on a low oven heat and record the weight of the Dry >1mm sample. Once the dry weight is attained store the sample until the end of the project.
7. The Wet weight of the <1mm sample can be calculated by subtracting the Wet weight of the >1mm sample from the weight of the total sample – or from weighting the post settled sample after excess water has been removed.

Further analysis of the >1mm large particle size fraction

1. Once dry the larger particle sample can be further analysed in 0.5-1mm intervals using dry sieving. Retain the sample until the end of the project.

Quality assurance

Samples, or components of them, will be retained so that reanalysis is possible if requested.

15. References

BROMLEY, C., MCGONIGLE, C., ASHTON, E. C. & ROBERTS, D. 2015. Restoring degraded European native oyster, Ostrea edulis, habitat: is there a case for harrowing? *Hydrobiologia*, 1-15.

CHESMAN, B., BURT, G. & LANGSTON, W. J. 2006. Characterisation of European marine sites. Essex Estuaries European Marine Site. *Occasional publication. Marine Biological Association of the United Kingdom,* 17, 198.

NYBERG, J. B. 1998. Statistics and the practice of adaptive management. *Statistical methods for adaptive management studies*, 1.

WOOLMER., A. 2009. Appropriate Assessment & Shellfisheries: Adaptive Management Protocol

Annex 1 – Advice on operations Essex Estuaries SAC

Advice on Operations for Essex Estuaries SAC: Shellfish aquaculture: bottom culture																					
	Estuaries											Mud flats and sand flats					Sand banks				
	Intertidal seagrass beds	Intertidal rock	Intertidal coarse sediment	Intertidal mixed sediments	Intertidal mud	Intertidal sand and muddy sand	Subtidal seagrass beds	Subtidal coarse sediment	Subtidal mixed sediments	Subtidal mud	Subtidal sand	Intertidal seagrass beds	Intertidal coarse sediment	Intertidal mixed sediments	Intertidal mud	Intertidal sand and muddy sand	Subtidal seagrass beds	Subtidal coarse sediment	Subtidal mixed sediments	Subtidal mud	Subtidal sand
Pressure Name																					
Abrasion/disturbance of the substrate on the surface of the seabed	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Changes in suspended solids (water clarity)	S	S	S	S	S	S	S	NS	S	S	S	S	S	S	S	S	S	NS	S	S	S
Genetic modification & translocation of indigenous species	IE	IE		IE			NS		S		IE	IE		IE			NS		S		IE
Introduction of microbial pathogens	S	S	IE	S	S	S	S	S	S	S	S	S	IE	S	S	S	S	S	S	S	S
Introduction or spread of invasive non-indigenous species (INIS)	S	S	NS	S	S	S	S	S	S	S	S	S	NS	S	S	S	S	S	S	S	S
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Removal of non-target species	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Removal of target species									S		S								S		S
Smothering and siltation rate changes (Light)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Visual disturbance		NS	NS			NS			NS	NS	NS		NS			NS			NS	NS	NS
Deoxygenation	NS	S	NS	S	NS	S	NS	S	S	S	S	NS	NS	S	NS	S	NS	S	S	S	S

Hydrocarbon & PAH contamination	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Introduction of light	S	S	IE	IE	NS	S	S	IE	IE	NS	S	S	IE	IE	NS	S	S	IE	IE	NS	S
Litter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nutrient enrichment	S	IE	NS	NS	NS	NS	S	NS	NS	NS	NS	S	NS	NS	NS	NS	S	NS	NS	NS	NS
Organic enrichment	S	S	NS	NS	NS	NS	S	NS	IE	S	S	S	NS	NS	NS	NS	S	NS	IE	S	S
Physical change (to another seabed type)		S																			
Physical change (to another sediment type)	S		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

Annex 2: Blackwater, Crouch, Roach and Colne Estuaries MCZ Advice on operations MCZ

Presure Name	Habitat		Species
	Intertidal mixed sediments	Native oyster beds	Native oyster
Abrasion/disturbance of the substrate on the surface of the seabed	S	S	S
Changes in suspended solids (water clarity)	S	NS	NS
Genetic modification & translocation of indigenous species	IE	S	
Introduction of microbial pathogens	S	S	S
Introduction or spread of invasive non-indigenous species (INIS)	S	S	S
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion	S	S	S
Removal of non-target species	S	S	NS
Removal of target species		S	S
Smothering and siltation rate changes (Light)	S	S	S
Visual disturbance			NA
Collision BELOW water with static or moving objects not naturally found in the marine environment			NS
Deoxygenation	S	NS	NS
Hydrocarbon & PAH contamination	NS	NS	NS
Introduction of light	IE	NS	NA
Litter	NA	NA	NA
Nutrient enrichment	NS	NS	NS
Organic enrichment	NS	NS	NS
Physical change (to another seabed type)		S	S
Physical change (to another sediment type)	S		S
Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)	NS	NS	NS
Transition elements & organo-metal (e.g. TBT) contamination	NS	NS	NA
Underwater noise changes			NS

Annex 3: Blackwater Estuary SPA Advice on Operations

Advice on Operations for Blackwater Estuary: Shellfish aquaculture: bottom culture																			
	Bird								Supporting habitat										
Pressure Name	Black-tailed godwit, Non-breeding	Dark-bellied Brent goose, Non-breeding	Dunlin, Non-breeding	Grey plover, Non-breeding	Hen harrier, Non-breeding	Little tern, Breeding	Pochard, Breeding	Ringed plover, Breeding	Coastal reedbeds	Freshwater and coastal grazing marsh	Atlantic salt meadows	Intertidal seagrass beds	Intertidal rock	Intertidal biogenic reef: mussel beds	Intertidal coarse sediment	Intertidal mixed sediments	Intertidal mud	Intertidal sand and muddy sand	Water column
Abrasion/disturbance of the substrate on the surface of the seabed												S	S	S	S	S	S	S	
Changes in suspended solids (water clarity)						S	S					S	S	NS	S	S	S	S	S
Genetic modification & translocation of indigenous species												IE	IE	IE		IE			S
Introduction of microbial pathogens	S	S	S	S	IE	S	S	S				S	S	S	IE	S	S	S	NS
Introduction or spread of invasive non-indigenous species (INIS)	S	IE	S	S		S	S	S				S	S	S	NS	S	S	S	S
Penetration and/or disturbance of the substratum below the surface of the seabed, including												S	S	S	S	S	S	S	

abrasion																		
Removal of non-target species	S	S	S	S	S	S	S	S				S	S	S	S	S	S	S	
Removal of target species														S					
Smothering and siltation rate changes (Light)												S	S	S	S	S	S	S	
Visual disturbance	S	S	S	S	IE	S	S	S					NS		NS			NS	S
Above water noise	S	S	S	S	IE	S	S	S											
Collision ABOVE water with static or moving objects not naturally found in the marine environment (e.g., boats, machinery, and structures)	S	S	S	S	S	S	S	S											
Collision BELOW water with static or moving objects not naturally found in the marine environment						S	S												
Deoxygenation												NS	S	NS	NS	S	NS	S	S

Hydrocarbon & PAH contamination	IE	IE	IE	IE		IE	IE	IE				NS	NS	NS	NS	NS	NS	NS	S
Introduction of light	S	S	S	S	IE	IE	S	S				S	S	IE	IE	IE	NS	S	S
Litter	IE	IE	IE	IE		S	S	IE				NA	NA	NA	NA	NA	NA	NA	S
Nutrient enrichment												S	IE	NS	NS	NS	NS	NS	S
Organic enrichment												S	S	NS	NS	NS	NS	NS	S
Physical change (to another seabed type)													S						
Physical change (to another sediment type)												S		NS	S	S	S	S	
Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)	IE	IE	IE	IE	IE	IE	IE	IE				NS	NS	NS	NS	NS	NS	NS	S
Transition elements & organo-metal (e.g. TBT) contamination	S	S	S	S	IE	IE	IE	S				NS	NS	NS	NS	NS	NS	NS	S
Underwater noise changes		IE				IE	S												S