ENORI

ESSEX NATIVE OYSTER RESTORATION INITIATIVE

Blackwater, Crouch, Roach & Colne

Marine Conservation Zone:

Native Oyster bed restoration plan

& conservation Strategy

ZSL LET'S WORK FOR WILDLIFE

Blackwater Oystermans Association

THE wildlife TRUSTS ESSEX Wildlife Trust

BLUE MARINE FOUNDATION

NATURAL ENGLAND

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The Nature Conservancy

Kent & Essex IFCA Kent & Essex Inshore Fisheries and Conservation Authority

Environment Agency

Colchester Oyster Fishery SUPPLIERS OF THE FINEST SEAFOOD

Contents

Introduction

The Blackwater, Crouch, Roach and Colne Marine Conservation Zone (hereafter referred to as "the MCZ") is located as part of the wider Outer Thames estuary. The designation covers an area of 284 km^2 protecting one of the largest estuaries in England. The Blackwater Estuary extends to a length of 21.2km, from its tidal limit at Maldon to its mouth. (Figure 1) The upper estuary is narrow and bounded on each side with sea wall defences to protect the town of Maldon, from here it begins to widen and splits into two distinct tidal channels that flow either side of Northey and Osea Island. On the North shore the Blackwater is joined by the Colne Estuary and on the South shore is contiguous with the Dengie peninsula. The landmass of the Dengie forms the north shore of the River Crouch, a narrow estuary impounded by seawalls on either side. The River Roach enters the Crouch from the South East around Wallasea Island. Intertidal habitat is predominantly mudflat & saltmarsh. Sub tidally benthic substratum is mainly sedimentary and ranges from mud, muddy sand, sand and sub tidal mixed.

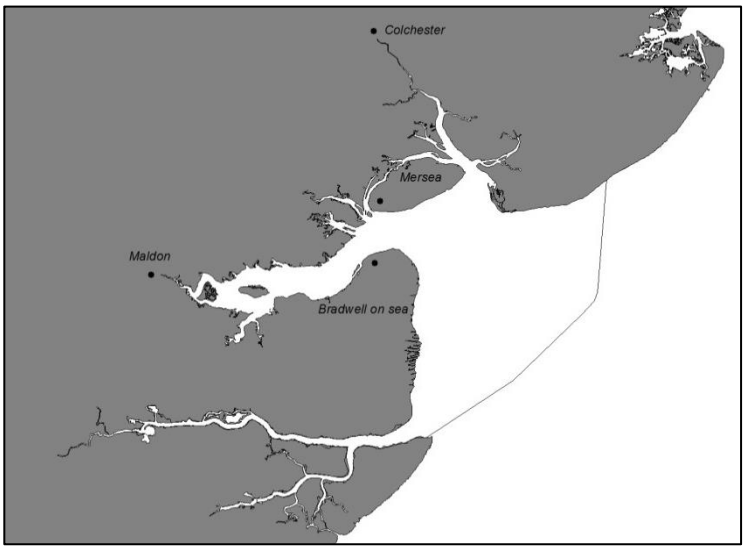


Figure 1 Location of Blackwater, Colne, Crouch & Roach Marine Conservation Zone ('the MCZ')

Table 1- The MCZ was established to offer protection to four different features:

Native Oysters *Ostrea edulis*
Native Oyster *Ostrea edulis* beds
Intertidal mixed sediments
Clacton Cliffs and foreshore

The following restoration plan relates only to Native Oyster *Ostrea edulis* beds within the public grounds which are based on the conservation advice for the MCZ[1]. The remaining areas of public ground are being managed for the sustainability of the Native oyster species by the Kent and Essex Inshore Fishery and Conservation Authority (K&EIFCA). There are also areas of the estuary that are under private ownership and fall outside of the current conservation advice.

Figure 2 Map showing extent of private grounds within the BCCR MCZ

The site is considered to be the most important area for both wild native oysters and their beds within the southeast region, with significant beds occurring in the Crouch and Roach estuaries and throughout the Blackwater Estuary, though the existing data is thought to underestimate their distribution.

[1] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UKMCZ0003

The site overlaps with several other designations including;

Name	Designation	Legislation	Date of designation
Blackwater **Colne** **Crouch** **Roach** **Foulness**	Site of Special Scientific Interest	Wildlife & Countryside Act	1990
Ramsar	Ramsar Site	EU Natura 2000	1995
Mid Essex Coast Phase 1-5	Special Protection Area	Directive 79/409/EEC later amended in 2009 to Directive 2009/147/EC	Phase 1 – Dengie 1994 Phase 2 – Colne 1994 Phase 3 – Crouch & Roach 1998 Phase 4 – Blackwater 1995 Phase 5 – Foulness 1996
Essex Estuaries	Special Area Conservation	Council Directive 92/43/EEC	1996

Table 2 Designations and supporting legislation protecting the Colne, Blackwater, Crouch and Roach Estuaries and the surrounding coastal waters.

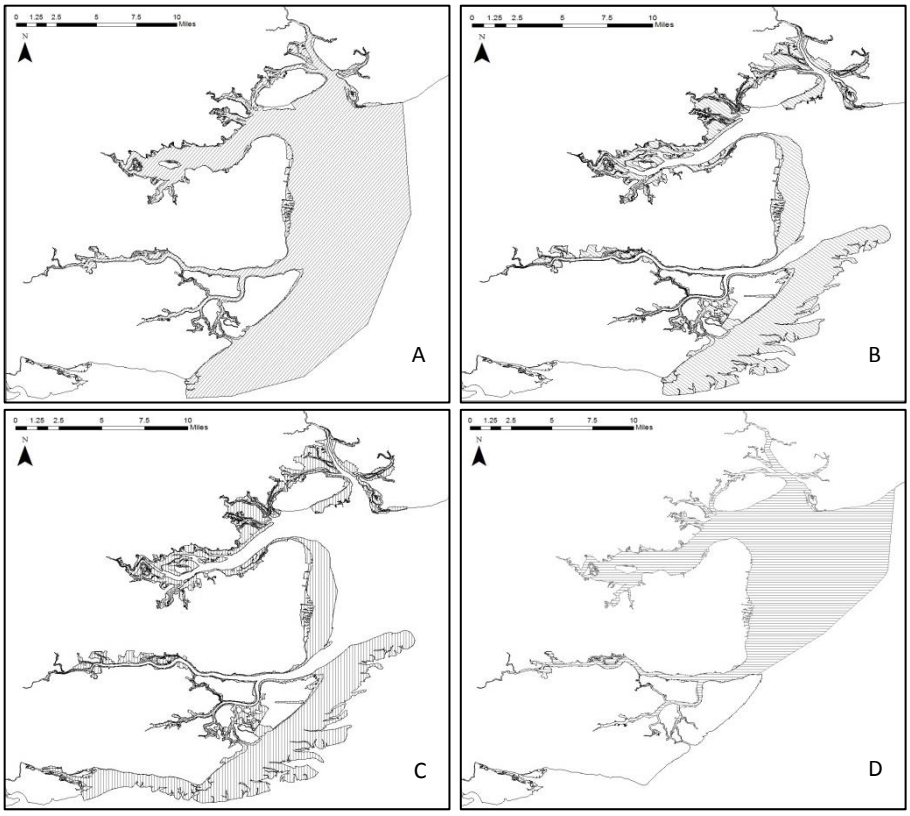


Figure 3 Nature conservation designations (A) Essex Estuaries Special Area Conservation (SAC). (B) Essex Estuaries Mid Coast Phase 1-5 Special Protection Area (SPA). (C) Essex Ramsar sites (D) Blackwater, Colne, Crouch & Roach Marine Conservation Zone (MCZ)

Due to the co-located nature conservation designations the approach towards restoration of *O.edulis* and *O.edulis* beds must take into account the wider extent of the coast and its designations which allows the area to function for nature conservation as a whole.

Essex Native Oyster Restoration Initiative (ENORI)

Essex Native Oyster Restoration Initiative (ENORI) was formed in 2013, with the aim of progressing the conservation objectives and management practices of the MCZ and to support restoration of the native oyster in the region. ENORI comprises of industry (BOA), conservation groups (EWT, The Nature Conservancy, Blue Marine and ZSL), and as well as statutory bodies such as Natural England and Kent and Essex Inshore Fisheries and Conservation Authority (KEIFCA), the regulatory authority responsible for furthering the requirements of the MCZ.

The ENORI aims to develop best practice in Marine conservation and fisheries management, develop recovery projects and measures with the purpose of furthering the statuary aims of recovering stocks within the MCZ site.

ENORI promote wider understanding of issues pertaining to the restoration of the site, seek guidance further the aims of the group and the conservation objectives.

The group will be responsible for overseeing the implementation of measures to enhance the restoration and condition of the native oyster and to ensure that the Plan is sustained and further developed.

The role of the E NORI

- Recovery of Native Oyster Beds and associated communities.
- create defined areas where Native Oyster Bed, associated community and habitat can be set aside for restoration activity and conservation purposes.
- To promote and further the aims of the conservation objectives of the site
- To support and develop detailed proposals and work with the wider stakeholder group
- To review the data gathered for the site and where necessary identify how the data gaps can be filled.
- To help coordinate and evaluate different oyster recovery techniques
- To discuss and develop management options for sustainable exploitation of oysters within the site and highlight stakeholder priorities.
- To be advised by, make recommendations to and work closely with the statutory bodies and regulators.

Description Native oyster beds

Ostrea edulis belongs in the phylum Mollusca and is described as a filter feeding bivalve. Once commonly found throughout UK coastal waters numbers and extent of populations dwindled as a result of overfishing, deteriorating water quality, sedimentation and disease. [5] The extent and distribution of the Native oyster observed today is significantly smaller than that of the 1800's [6] and is now reduced to only a few small populations nationally. [7] the vulnerability of the species is reflected in the UK Biodiversity Action Plan status for Native Oyster and Native Oyster beds [8]

The ecology of the Native Oyster means that the free swimming larvae will preferentially settle on the shell (or cultch) of another Native Oyster, because of this consecutive generations of oysters build a complex bed habitat, this process is known as ecosystem engineering. [9, 10] The complex three dimensional structure that is formed as a result provides emergent hard substratum on otherwise flat soft-sediment bottoms (Wells 1961). This biologically engineered bed provides nooks

and crannies in which the juvenile fish and crustaceans can avoid predation (Grabowski 2004). In the Blackwater these include Sea bass (*Dicentrarchus labrax*) Smelt (*Osmerus eperlanus*) Flounder (*Platichthys flesus*) Herring (*Clupea harengus*) eel (*Anguilla anguilla*) and Thick lipped mullet (*Chelon labrosus*) [11]. The shell itself also acts as a habitat serving as centre for a large and varied fauna that utilizes the hard substrate (Wells 1961), increasing community structure (Mills 1969) and ecological value.

OSPAR convention defined oyster beds as follows:

Beds of the oyster Ostrea edulis occurring at densities of 5 or more per m^2 on shallow mostly sheltered sediments (typically 0-10m depth, but occasionally down to 30m). There may be considerable quantities of dead oyster shell making up a substantial portion of the substratum.

Oysters in the Essex Estuaries

Kent and Essex have historically (pre 1800's) had significant oyster populations and beds would have covered the majority of the Essex Estuaries SAC area.

A survey conducted by Essex Wildlife Trust & Blackwater Oystermens Association in 2012 found *O.edulis* beds are present in four remaining locations within the MCZ area. St Lawrence Bay, The Nass and Ray Sand channel, the mouth of the Colne.

The largest populations are found in the Ray Sand, this covers an area of approximately 3.5km^2 although densities within that area can vary significantly over this area.

The Nass and the St. Lawrence bay are observed to have similar size populations. Covering approximately 1.5km^2 and 1.68km^2 respectively.

The survey also found areas where oyster have historically been but are no longer present, The Bench head, the Knoll and the Priory spit all have large amounts of oyster shell still in situ, suggesting that these areas have historically supported large populations.

The Nass and the South bank both lie within the boundary of a Several Order, and are protected under a bylaw issued under the Sea Fisheries (Shellfish) Act 1967. Populations within the Ray Sand channel are protected by a fisheries bylaw issued by the Kent & Essex Inshore Fisheries & Conservation Authority prohibiting the removal of *O.edulis.*

The ENORI partners have identified the area of subtidal mixed sediment off the Mersea shore for potential future Native Oyster Beds, as it is subtidal mixed sediment in an area of historical Native

Oyster Beds. It has been agreed by the ENORI partners that all restorative work will initially take place within the confines of this box

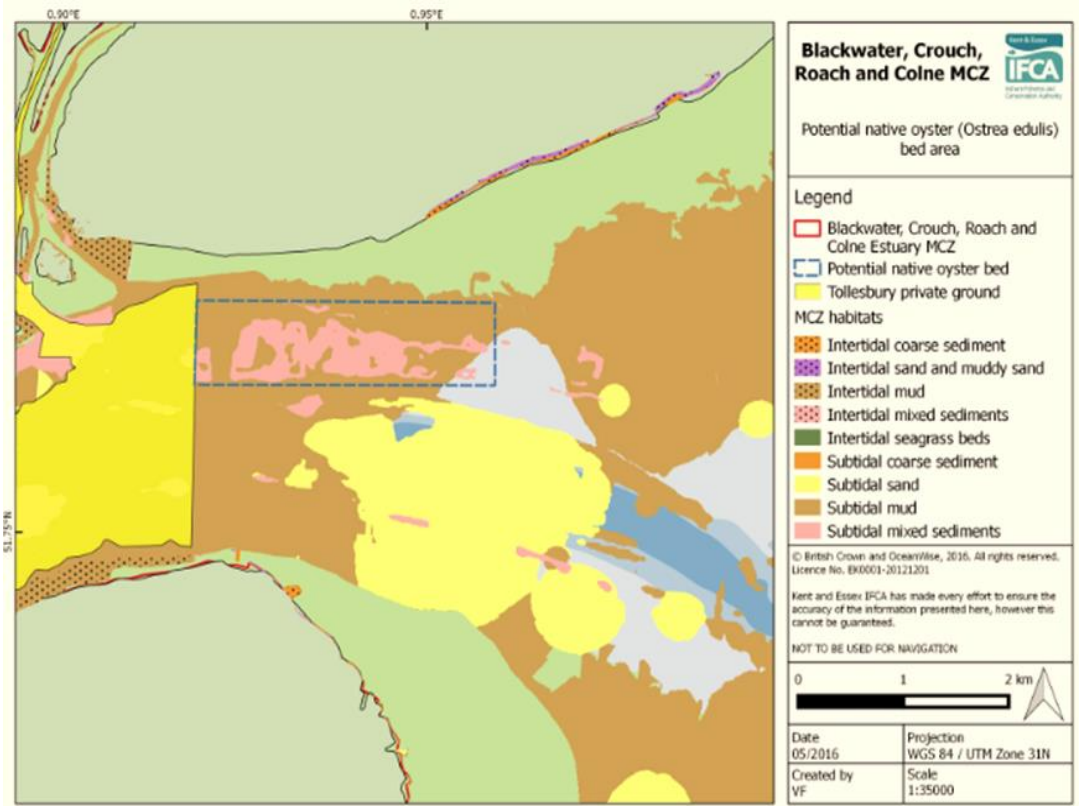
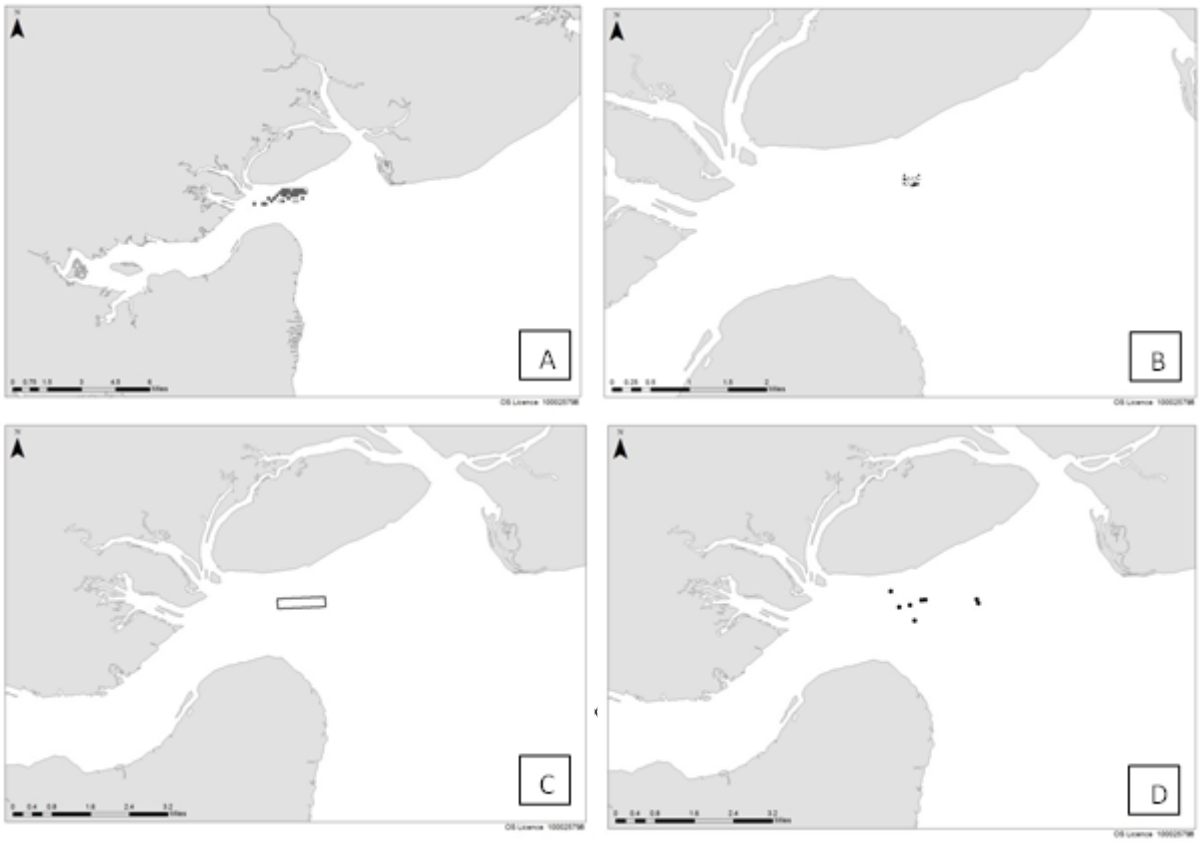


Figure 4 Location of restoration area known as 'the box'

Activities undertaken



What we know…

Management objectives to be achieved through this plan

Based on the available survey data the native oyster beds in Blackwater, Crouch, Roach and Colne MCZ are deemed to be both cultch limited and brood stock limited. As such, the proposed restoration activities aim to address both of these issues. Currently the restoration activities will be limited to actions undertaken within the restoration box off the Mersea shore. Figure 4

Recruitment limitation

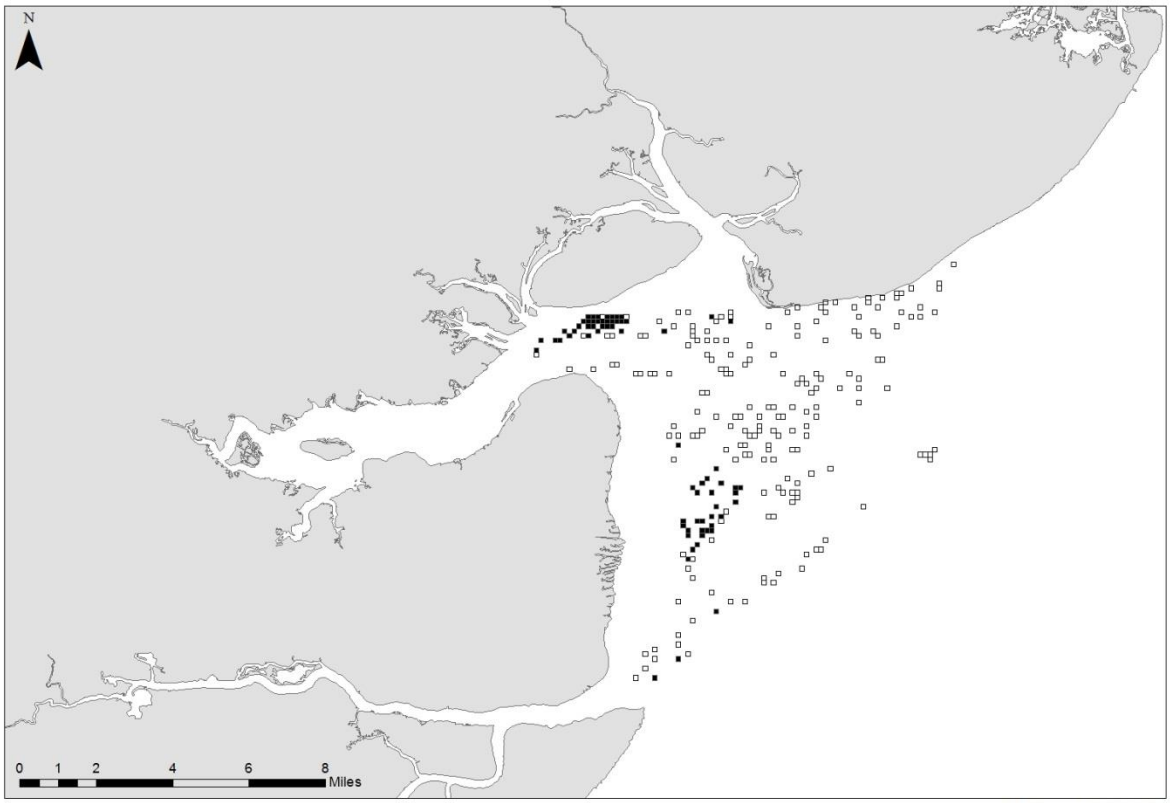


Figure 6 Presence and absence of *O.edulis* throughout the public grounds[2]

2107 individuals were sampled and measured over 284 sites (Figure 6). The age class distribution is skewed towards the larger size classes, or older individuals, (greatest number: 506 individuals sampled within the 70-79mm category).

[2] source: EWT & BOA 2012 survey of abundance and distribution of *O.edulis* throughout the proposed MCZ BCCR

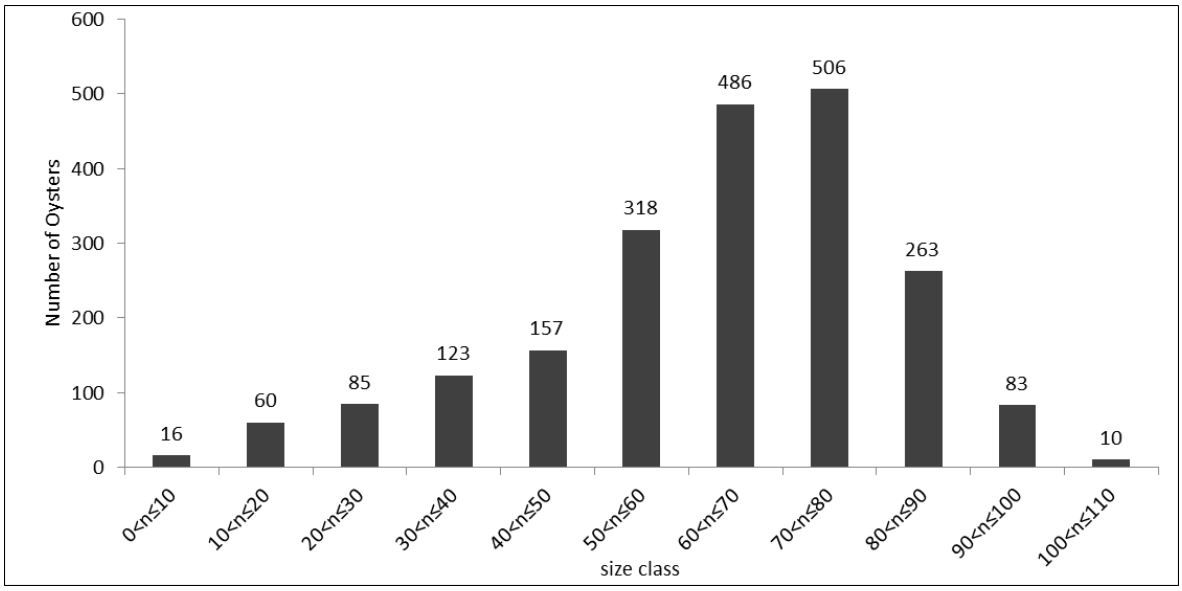


Figure 7: Total number of *Ostrea edulis* sampled during dredge survey of the BCCR Marine Conservation Zone n = Total number of oysters (n = 2107) D = total number of sites (D = 284)

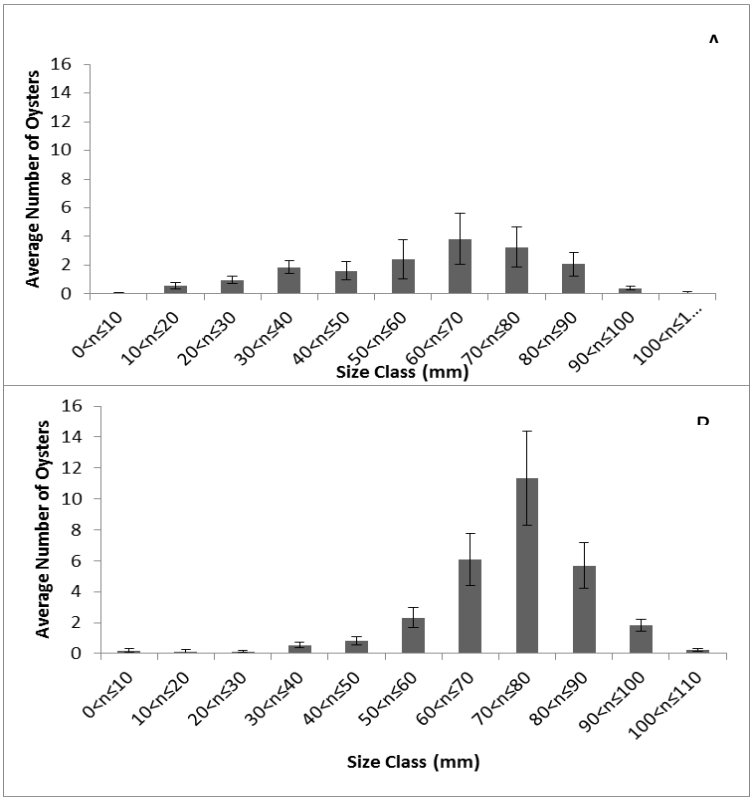


Figure 8 Number of *Ostrea edulis* and their size class distribution found in A: The Nass B: Ray Sands, showing the standard error.

Survey shows greatest number of individuals are present with the Ray sand survey area, a smaller number of individuals are found within the Nass survey Zone, inside the restoration box.

Suitable substratum type

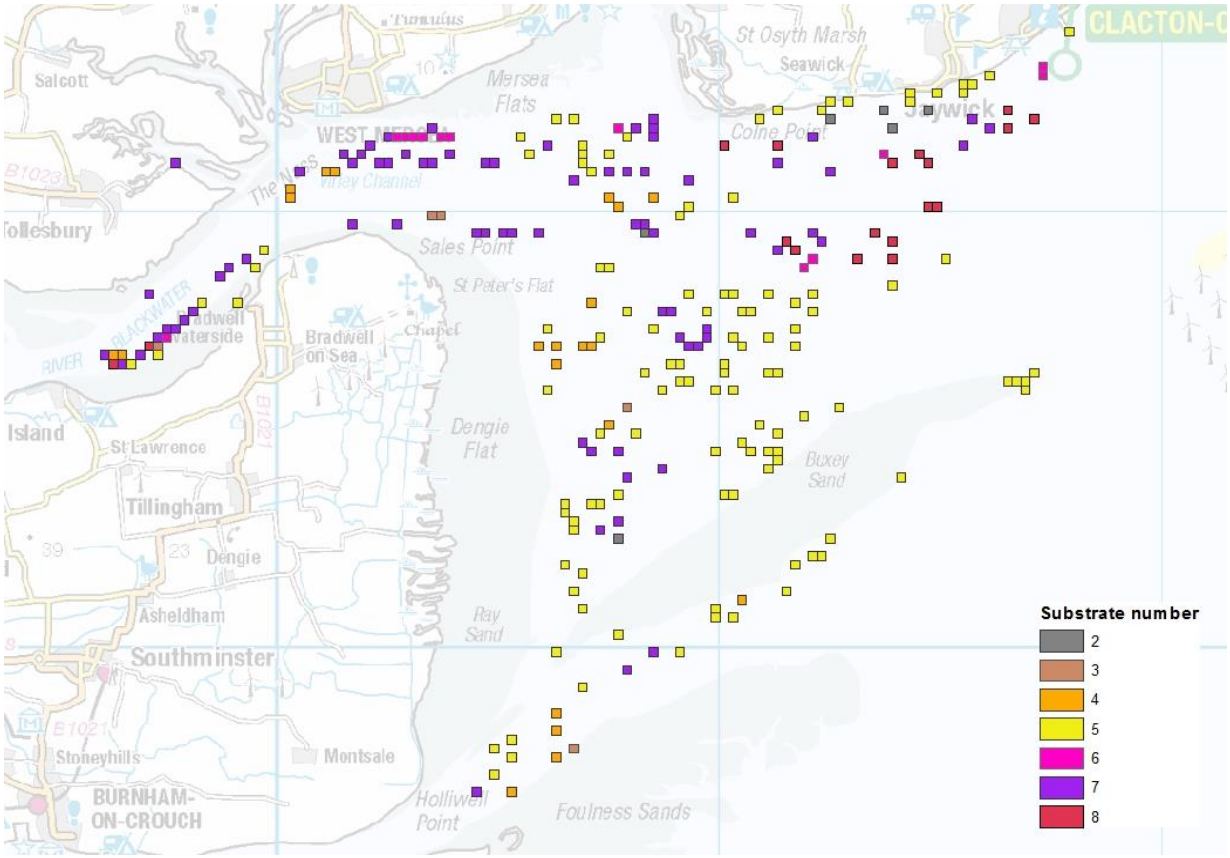


Figure 9 Benthic Substratum categorisation: Numbers refer to a type of substrate and can be explained using Table 3 Substratum categorisation

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Silt	Clay	Fine mud	Coarse mud	Sand	Gravel	Shell	Cobbles

Table 3 Substratum categorisation

Benthic substratum categorised during the EWT/BOA abundance and distribution survey 2012 (

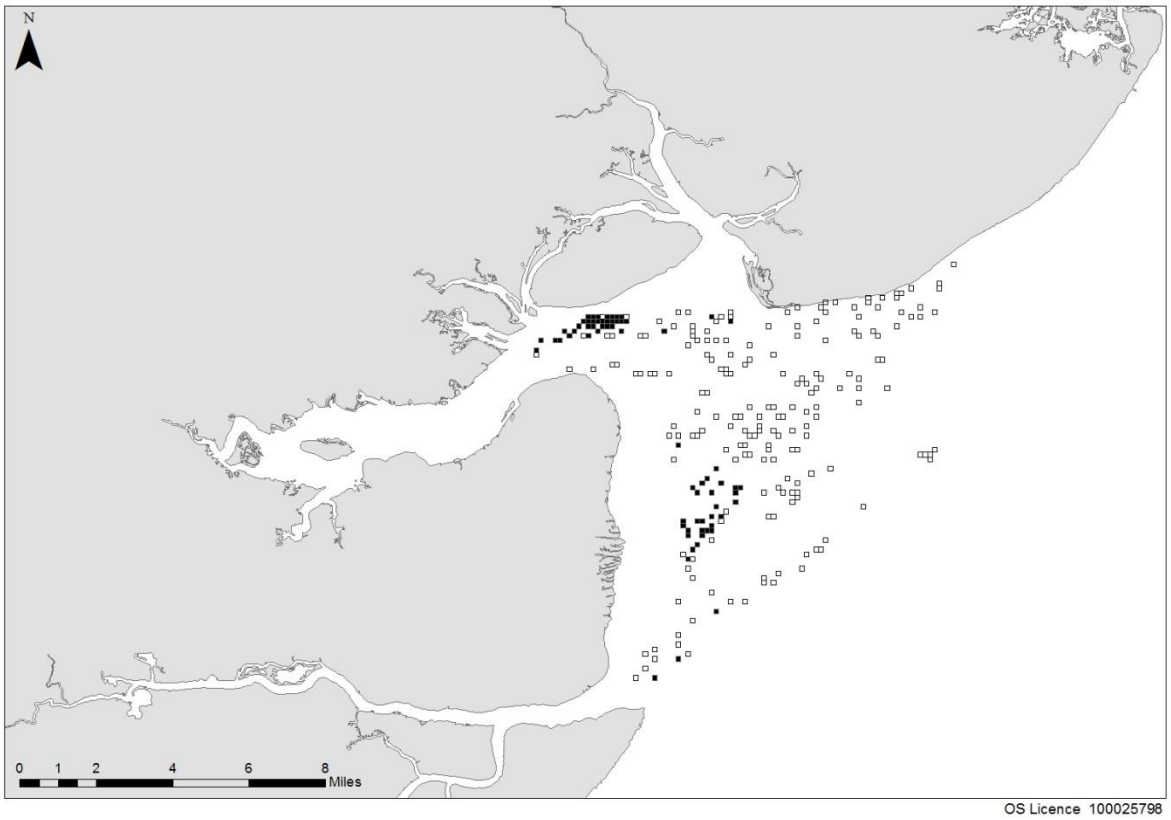


Figure 6) results show the BCCR MCZ is dominated by subtidal mud, subtidal sandy mud and subtidal sand with 138 of the 244 making up these features. The study has also identified substratum features including shell dominated subtidal mixed sediment, subtidal gravel and subtidal cobbles.

Suitable substratum availability

Figure 10 Location of grab samples

Areas identified during the EWT/BOA 2012 substratum survey were further sampled to determine substratum suitability and availability.

Table 4 Weight (g) and particle size composition (mm) of three sites Blackwater, Bench Head and Ray sand

	Blackwater
Particle size	Weight (g)

2- 10mm	11	100	61	37	21	575	396	13	37
10- 20mm	14	86	24	23	10	250	82	24	112
Over 20mm	56	45	89	162	59	340	288	59	64
Total weight (over 2mm)	81	231	174	222	81	1165	766	96	113
	Bench Head								
2- 10mm	126	424	101	155	396	575	227	452	157
10- 20mm	107	255	263	260	82	250	173	170	51
Over 20mm	498	332	787	708	288	340	457	375	807
Total weight (over 2mm)	731	1011	1151	1123	766	1165	857	997	1015
	Ray Sand								
2- 10mm	191	3	6	7	21	70	61	10	11
10- 20mm	24	11	9	6	10	60	24	86	14
Over 20mm	97	45	26	51	59	51	89	45	56
Total weight (over 2mm)	312	59	41	64	90	181	174	141	81

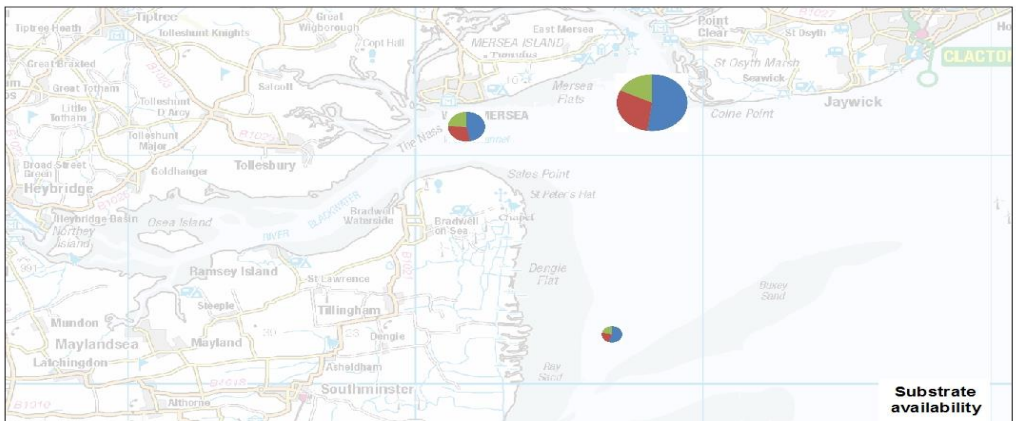


Figure 12: Substratum availability - Amount of substratum per $1m^2$ over 2mm within each of the three survey zones Colne, Nass, Ray Sand

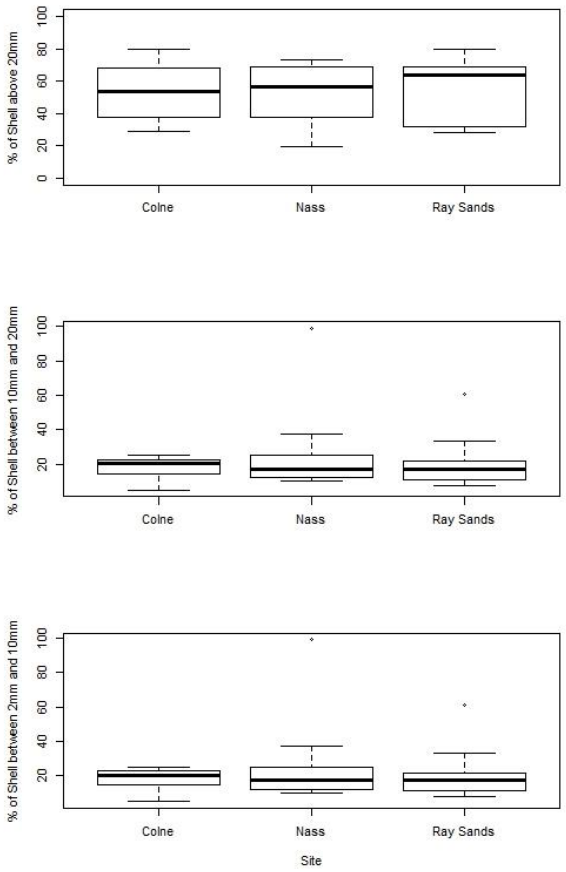
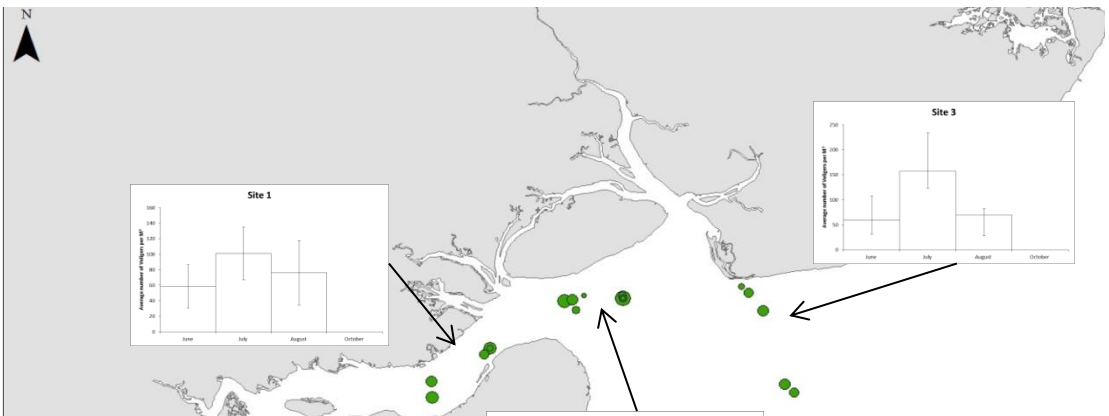


Figure 11 Composition of substratum displayed as a percentage across three survey zones Colne, Nass and Ray Sands

Average veliger density

Table 5 Average number of *O.edulis* veliger's (m^3) across three sites, Blackwater, Bench head & Outer Estuary from July – October 2016

	June			
	Site 1	site 2	site 3	Average
Blackwater	51.44107	88.94837	34.52306	58.30416
Bench Head	27.55711	35.80344	23.64644	29.00233
Outer Estuary	14.68386	110.4093	51.97566	59.02292
	July			
	site 1	site 2	site 3	Average
Blackwater	105.3927	133.0897	64.65963	101.0473
Bench Head	87.52445	175.4813	103.7778	122.2612
Outer Estuary	69.79944	212.2066	189.1348	157.0469
	August			
	site 1	site 2	site 3	Average
Blackwater	76.91532	116.839	33.62266	75.79232
Bench Head	75.90906	71.55198	61.58949	69.68351
Outer Estuary	54.9333	79.59501	73.67139	69.3999
	October			
Blackwater	Site 1	Site 2	Site 3	Average
Bench Head	0	0	0	0
Outer Estuary	0	0	0	0
	0	0	0	0



Number of *O.edulis* veligers across three survey zones Blackwater, Bench Head and Outer estuary were calculated for June, July, August & October (**Error! Reference source not found.**). Spatially there was no significant difference observed for number of veligers across the three zones (F=0.872, P = 0.358, df=1). A significant temporal difference was observed between number of veligers recorded across months June, July, August & October (F= 22.888, P = 1.08E-07, df = 3), but no significant difference was observed between survey zones (spatial) and month (temporal) sampled (F= 1.168, P = 0.339, df = 3)

Overview: Potential restoration activities

Planned restoration activities for the site include:

- Cultch laying
- Cultch management
- Brood stock enhancement
- Protection (Limitation of dredging and trawling)
- Monitoring

Proposed project	Statutory body	Notes
Cultch laying	NE	Critical friend role

Brood stock enhancement	NE	Critical friend role
Settlement cages	NE/IFCA?	

All active restoration activities require a habitat regulation assessment (HRA) to be undertaken and approved by NE.

Cultch laying

Additional shell material can be added to the estuary floor in order to mitigate the lack of available suitable settlement substrate for young oysters. This is termed cultch laying. Oyster larvae show a preference for living adult oysters when settling out of the water column, but will also settle on many hard substrates, in particular other shell material. The choice of shell material in oyster restoration efforts is often dictated by the cost and availability of materials. Materials trialled successfully in oyster restoration efforts include: oyster shell, other bivalve shell, concrete and limestone marl. Given the SAC status if the site, only mollusc shells will be trialled. In order not to impact negatively on the listed SAC features, it has been advised by NE that cultch improvements may only take place initially within the restoration box on areas of subtidal mixed sediments.

A number of potential shell sources for cultch have been considered by ENORI, these include locally sourced cockle shell, mussel shell, oyster shell and zebra mussel shell. The zebra mussel, *Dreissena polymorpha*, is an invasive non-native freshwater species, originally from the Ponto-Caspian region. It is highly abundant in water treatment works and reservoirs in the local area and therefore has the potential to be a highly abundant shell source. There are, however, known risks in utilizing this shell resource. The zebra mussel has a tolerance of brackish conditions and is known to co-occur with the invasive killer shrimp, *Dikerogammarus villosus* (Devin et al., 2003). The killer shrimp is a diverse omnivore, which has been known to prey not only on the rest of the macroinvertebrate community where it co-occurs, but also to consume fish eggs (Platvoet et al., 2009). Extreme care must therefore be taken when using this shell as a source of cultch. Acceptable treatments have been discussed with Cefas and strict adherence to treatment of all shell by either heat treatment, chemical treatment, or extended drying will be undertaken before any shell material can be moved into the estuary.

Cultch laying can take a number of forms. In order to achieve habitat restoration, the usual practice in the United States is to lay shell on the bottom, either loose, or in mesh bags which keep the shell together initially, but decay over time. Given the difficulties in sampling the waters of the Blackwater, ENORI will be undertaking initial cultch trials in with cultch housed in gabions (Box 2).

These will be used to test the adequacy of each of the available cultch materials in capturing spat (juvenile oysters). The following shell materials will be tested:

- Zebra mussel shell,
- *Crassostrea gigas* shell
- cockle shell

In this initial trial the zebra mussel shell will be treated by being immersed in hypersaline water (35%) for 7 days to ensure that there are no living epifauna or associated fauna on the shell material. The gabions will be placed within the restoration box in X and removed in Y. even if up to ten were used they would cover an area of under $60m^2$ within the $2km^2$ restoration box. At the end of the experiment the cultch will be examined and the number of spat settled per unit volume of each shell type will be enumerated.

In the longer term, as funds are secured, it is in the intention of ENORI to use the data gathered from the gabion experiments to inform larger scale cultch placement. This would be on bottom, and shell will be placed at varying abundances on appropriate sediments in an effort to create beds with different elevations. The existing oyster densities at the selected sites within the restoration box will be assessed prior to cultch placement to avoid any unnecessary impact on existing oysters. The creation of areas of cultch with different elevations will allow ENORI to assess the impact of the shell adding relief to the seafloor shown that reefs or beds with greater relief tend to have higher success in recruiting oysters (Lenihan et al., 2001). Furthermore, experimental work in Europe suggests that being situated at a higher elevation on the seafloor may also benefit the Native Oyster (Sawusdee et al., 2015). Under the advice of NE all restoration activity can only take place on subtidal mixed sediments (Further costings for large scale cultch recovery project see Appendix II)

Cultch management/Cleaning

Traditional management of oyster areas by the oyster industry includes the undertaking of cultch cleaning prior to the oyster larvae settling. This traditional activity in the Blackwater is termed locally as harrowing, and involves the dragging of a series of chains along the oyster beds in order to agitate

the overlying sediments and remove them from the existing cultch. Harrowing has been shown to have an impact on the associated community and no positive benefit to oyster recruitment in Lough Foyle, at the boarder of Ireland and Northern Ireland (Bromley et al., 2015). It is not, however, known whether the impact in the Blackwater is similar. The impact of this activity on the oyster settlement and the associated community in the Blackwater is therefore currently being assessed by KEIFCA in the restoration box.

Following assessment by KEIFCA of the impact of harrowing, ENORI will revisit whether harrowing should be included as a management practice to support the recovery of the native oyster to the Blackwater, Crouch, Roach and Colne MCZ.

Brood stock enhancement - relaying

Surveys of the Blackwater identified not only a lack of available cultch for the settlement of oysters, but also a lack of recruitment. Surveys undertake by Essex University, BOA and EWT in 2015 found low concentrations of larvae in the water column during the breeding season (see average veliger density section). It is likely that this lack of recruitment is at least in part the result of low adult oyster densities. As the males broadcast spawn, low densities of adults can result in reduced fertilization of eggs within the females. This recruitment limitation can potentially be overcome by placing adult oysters at higher densities in brood stock sanctuaries.

In 2015 a restoration project was proposed, this was a pilot project from which to develop a larger restoration plan proposals. The project proposal, to translocate 25,000 breeding adult *O.edulis* to a site in the Blackwater Estuary. Translocation is the intentional movement of a species in an area where it is common to where it has become depleted (Bromley et al., 2016) and it has been used successfully in terrestrial conservation for many years as a method to increase the distribution, resilience and breeding potential of the target species (Seddon et al., 2014). Translocation of marine species for the purpose of marine conservation is less common and although generally accepted is not studied in the same depth as its terrestrial equivalents (Bromley et al., 2016). Oysters were translocated from an area of private grounds within the MCZ that support high numbers of *O.edulis* and placed in an area of public ground that has historically supported *O.edulis*. The project aimed to create a meta-population from an indigenous population, reducing the risk of mortality or importation of pests or disease and ensuring that local genetic variability is maintained.

In October 2016 the translocation project and the 6.5ha of new oyster bed that was created was formally ‘adopted’ by Natural England and included in a much larger conservation area (the box) for the progression of native oyster conservation. This ‘no take zone’ mimics that of the originally proposed reference areas that were dropped from the MCZ in 2012. The translocated oysters are to

act as a breeding stock for the continued production of veligers into the MCZ area. While also monitored to increase knowledge of the development of oyster beds, their associated communities. As funding is secured, ENORI will seek to scale up the brood stock enhancement efforts, and to monitor the impact of bonamia within the restoration site.

Protection

In order to ensure the recovery of the native oyster habitat as it arises, ENORI are seeking the protection of the restoration box from bottom towed gears. This proposal is currently under consultation by KEIFCA.

Monitoring:

Restoration Box Monitoring

In June 2016 25,000 live native Oysters of approximately 50mm and over were translocated to the restoration box. The overarching objective being to restore an active oyster bed to promote high reproduction and future recruitment of existing or actively restored habitats in the public MCZ.

This also presents an opportunity to explore the ecology of a high density oyster bed relative to surrounding habitats where oysters are now absent or at very low density. Much of the information we have on the benefits of oyster beds to biodiversity or ecosystem services are either from different habitat types or locations (e.g.), different species (e.g.) or over 50 years old.

As part of ongoing research projects based at the University of Essex and following a year for the relayed oysters to settle into their new habitat in the restoration box, a baseline survey has been proposed to meet the following objectives:

1. To provide baseline data on oyster density in the box post relay
2. To attempt a mark-recapture analysis or survival estimate from the marked oysters
3. To measure spat settlement and recruitment of new oysters to the site
4. To provide data on biodiversity association with oysters at different densities
5. To provide information on nitrification potential of the sea floor with and without oysters

Methods of the Oyster restoration Box baseline survey

The Oyster restoration box is being considered as having two non-independent areas where brood enhancement has begun. One where known numbers of marked oysters were relayed and a larger area where unmarked oysters were relayed.

The objective is to carry out 3 replicate sample dredges using a standard 1.4m oyster dredge (ladder type) towed for a distance of 100m in each of the two areas. The dredge isThis represents 6 dredges

in total. All surface macrofauna and substratum composition including shell budget (weight in g) will be counted, measured and photographed on board the boat and returned as best as possible to its original position. Any Pacific Oysters dredged will not be returned.

10 1m^2 grab samples will be taken from each sampling area – associated with each trio of 100m dredges. This will represent 20 grab samples from the oyster box in total. From each grab sample, all surface macrofauna will be counted and measured/photographed. In these smaller biomass samples, used to truth the density of species and the selectivity of the dredge, abundance and size of settled shellfish spat will also be recorded. All macrofauna will be returned, except any Pacific Oysters.

A one litre subsample of the top 20cm of the grab material from each grab will be taken for washing through a 2mm sieve to capture subsurface macrofauna. Two 5ml samples from the top 5cm of each grab sample will be taken and stored in 25ml sterile tubes – one to be frozen and the other fresh to measure the Nitrification potential of the sea bed.

Oyster restoration box ongoing surveys

Future surveys at the relay site will ideally occur twice annually in 2017-2019 – to ascertain the relative importance of oyster reproduction and survival to recruitment. Biannual surveys are particularly relevant as early results have indicated the role of high mobile benthic predators in responding to localised spatfall of native oysters.

The baseline survey is funded through in kind contributions from the Blackwater and Colchester Oyster Fisheries and the University of Essex. Ongoing surveys are likely to be funded in kind through ENORI partners or through other collaborations with the University of Essex. Methods will be identical to the baseline survey.

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