Habitats Regulations Assessment:
Commercial beam trawling for brown shrimp (*Crangon* spp.) and pink shrimp (*Pandalus montagui*) in The Wash and North Norfolk Coast Special Area of Conservation

Revision History			
Version	**Date**	**Revision**	**Editor**
v.2.0*	02/02/2018	Created document and updated.	All
v.2.1	27/2/2018	Final edits	JCS
v2.2	25/06/2018	Added mitigation section	JCS
v2.2	25/06/2018	Added in-combination assessment section	JCS
v2.2	25/06/2018	Updated conclusion	JCS
v2.2	25/06/2018	Added integrity test	JCS
v2.2	25/06/2018	Updated references	JCS
v2.2	25/06/2018	Updated Table of Figures	JCS
v2.2	25/06/2018	Updated Table of Tables	JCS
v2.2	26/06/2018	Formatting; Table of Contents	SH
v2.3	19/07/2018	Correction on p.37 relating to NE advice	JCS
v2.3	27/7/2018	Inserted Figure 14 at p.73	JCS

*This document replaces the assessment completed in 2016 (v.1).

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1 Introduction

1.1 Need for a Habitats Regulations Assessment

In 2012, the Department for the Environment, Food and Rural Affairs (Defra) announced a revised approach to the management of commercial fisheries in European Marine Sites (EMS). This approach ensures that all commercial fishing activities are managed in accordance with Article 6 of the Habitats Directive (European Council, 1992).

Risk prioritisation is informed by a matrix of the generic sensitivity of sub-features of EMS to a suite of fishing activities (MMO, 2014). These activity/sub-feature interactions have been categorised according to specific definitions, as red (high priority interactions with management already in place), amber, green or blue risks. Defined amber risks require a site-level assessment to determine whether management of the activity is required to conserve site features. Green risks also require a site-level assessment if they have “in combination effects” with other plans or projects.

Site-level assessments are carried out in a manner consistent with the requirements of Article 6(3) of the Habitats Directive (European Council, 1992). These assessments determine whether management measures are required to ensure that the integrity of the defined site is not adversely affected by fishing activity.

1.2 Documents reviewed to inform this assessment

- Natural England’s risk assessment matrix of fishing activities and European habitat features and protected species (MMO, 2014)
- Natural England’s Conservation Advice from the Designated Sites View (Natural England, 2017a; 2017b)
- Fishing activity data (Eastern IFCA: sightings data, shrimp return forms; MMO landings data)
- Reference list: Including literature cited in this assessment (peer-reviewed literature and site-specific evidence including data on sensitivity and condition)

2 Information about The Wash and North Norfolk Coast SAC

2.1 Site information

Situated on the East coast of England, The Wash and North Norfolk Coast SAC is a European Marine Site comprised of a marine embayment and an adjacent barrier coast. It covers 1,077 km^2 and is designated for eight Annex I habitat features and two Annex II species features (European Council, 1992) (Table 1).

Table 1. Qualifying habitat and species features in The Wash and North Norfolk Coast SAC, and their generic sub-features (Natural England, 2017a).

Code	Qualifying feature	Sub-feature(s)
H1110	Sandbanks which are slightly covered by sea water all the time	Subtidal mixed sediments
		Subtidal coarse sediments
		Subtidal sand
		Subtidal mud
H1140	Mudflats and sandflats not covered by seawater at low tide	Intertidal coarse sediments
		Intertidal mixed sediments
		Intertidal mud
		Intertidal sand and muddy sand
		Intertidal seagrass beds
H1150	Coastal lagoons	
H1160	Large shallow inlets and bays	Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)
		Circalittoral rock
		Intertidal biogenic reef: mussel beds
		Intertidal biogenic reef: *Sabellaria* spp.
		Intertidal coarse sediment
		Intertidal mud
		Intertidal rock
		Intertidal sand and muddy sand
		Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)
		Subtidal biogenic reefs: mussel beds
		Subtidal biogenic reefs: *Sabellaria* spp.
		Subtidal coarse sediment
		Subtidal mixed sediments
		Subtidal mud
		Subtidal sand
		Subtidal stony reef
H1170	Reefs	Circalittoral rock
		Intertidal biogenic reef: mussel beds
		Intertidal biogenic reef: *Sabellaria* spp.
		Intertidal rock
		Subtidal biogenic reef: mussel beds
		Subtidal biogenic reef: *Sabellaria* spp.
		Subtidal stony reef
H1310	Salicornia and other annuals colonising mud and sand	
H1330	Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	
H1420	Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)	
S1355	Otter (*Lutra lutra*)	

S1365	Harbour (common) seal (*Phoca vitulina*)

These features and sub-features are distributed throughout marine and intertidal areas of the SAC (Table 2; Figures 1 & 2).

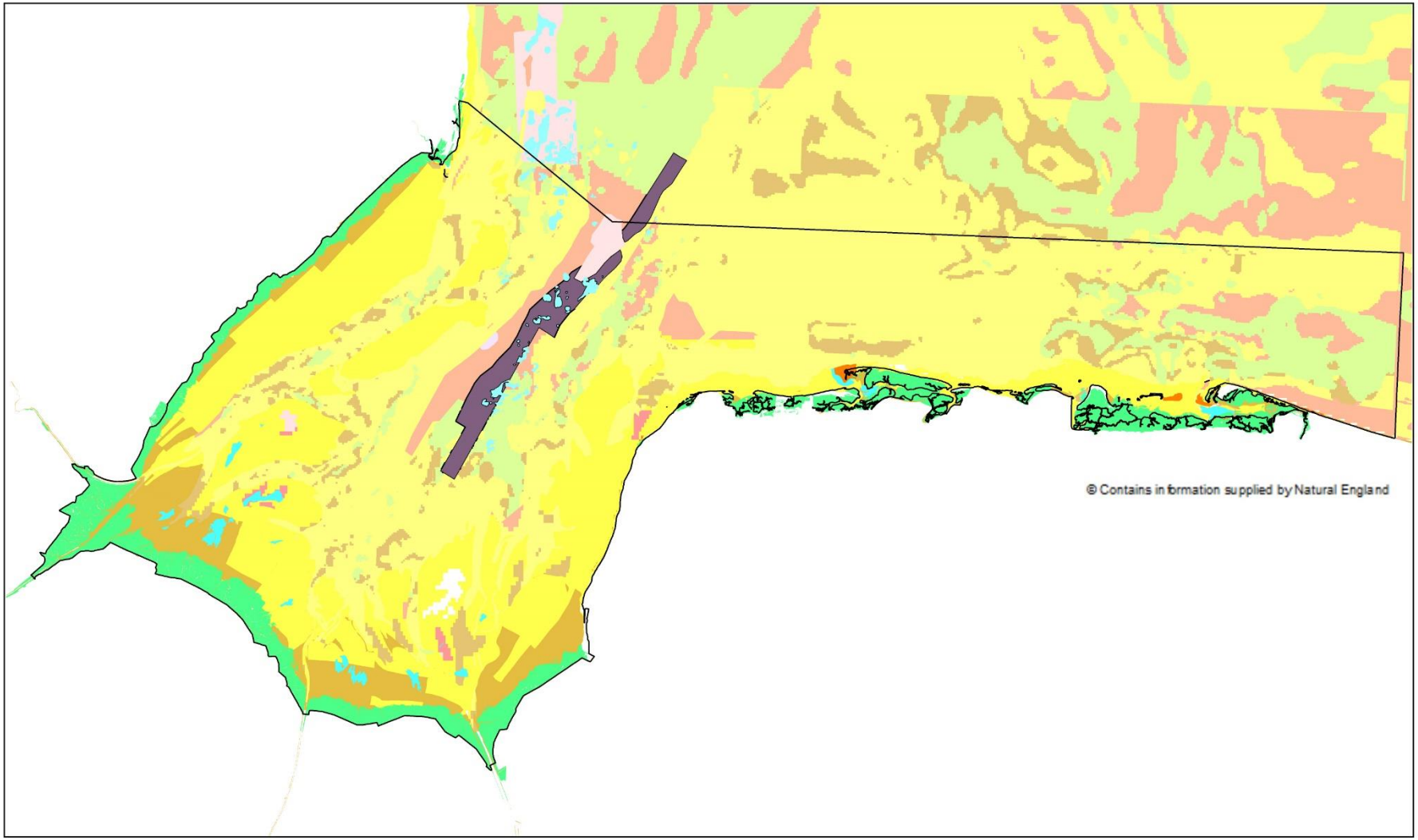


Figure 1a Distribution of habitats in The Wash & North Norfolk Coast SAC (legend on next page)

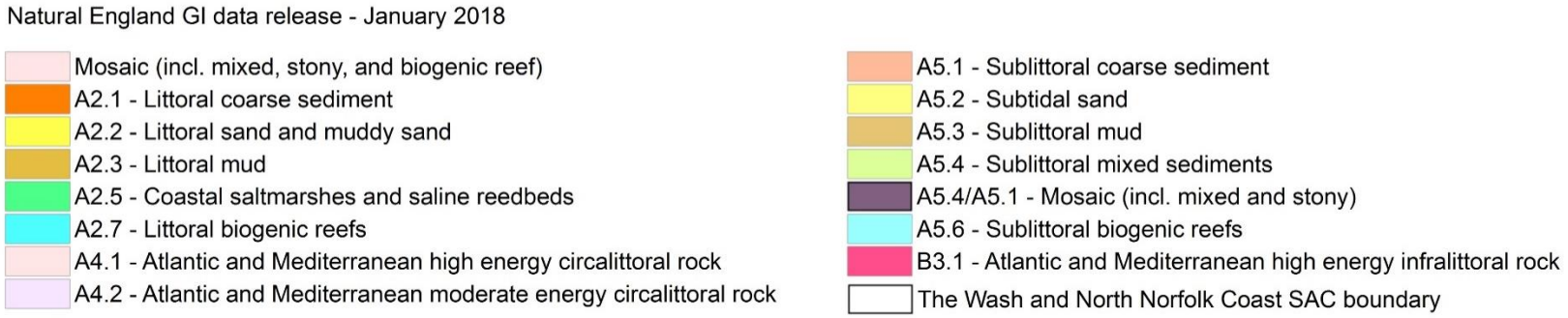


***Figure 1b*.** Legend for Figure 1a. Distribution of habitats in The Wash & North Norfolk Coast SAC

Table 2. Proportion of The Wash and North Norfolk Coast SAC within marine, intertidal and saltmarsh habitats.

Habitat type	**Marine**	**Intertidal**	**Saltmarsh**
Features supported	H1160 Inlets	H1140 Mudflats	H1310 *Salicomia*
	H1170 Reef	H1150 Lagoons	H1330 Salt meadow
	H1110 Sandbank		H1420 Halophilous scrub
Proportion of site covered	51%	46%	3%

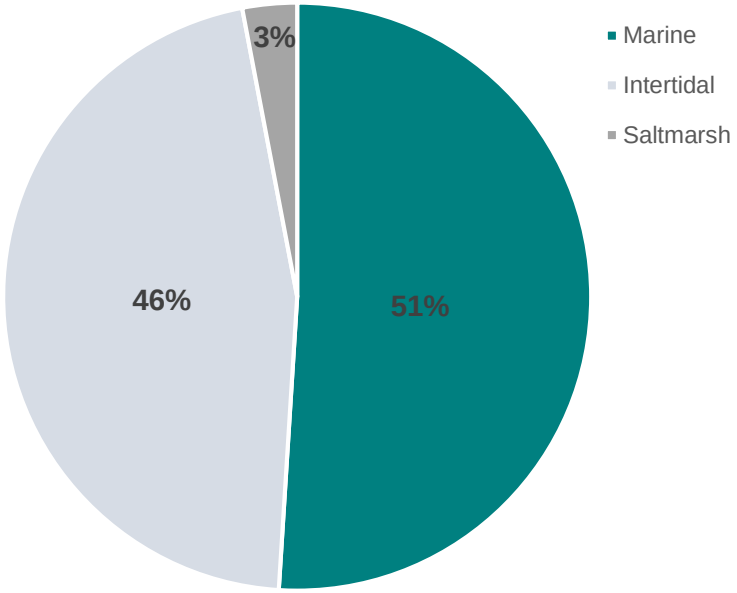


Figure 2. Proportion of The Wash and North Norfolk Coast SAC within marine, intertidal and saltmarsh habitats. Please note a small proportion of the H1170 Reef in the SAC is also intertidal mussel bed. This number is too low to be reflected in this figure. In 2017, 521 ha of intertidal mussel bed were recorded during annual mussel stock assessments (Jessop, 2017). There is also a private fishery within The Wash and North Norfolk Coast SAC. This does not form a part of Eastern IFCA's annual stock assessment.

The marine (subtidal) and much of the intertidal and saltmarsh areas of The Wash and North Norfolk Coast SAC are relatively inaccessible and in general have not been subject to major development pressures, outside of historic land reclamation. However, the site supports a range of longstanding commercial and recreational activities adapted to or reflecting the area's character (The Wash and North Norfolk Marine Partnership, 2017). Commercial activities include shellfish fishing, aquaculture, commercial shipping and port activity (at Boston, Fosdyke, Sutton Bridge, Wisbech, King's Lynn and Wells-next-the-Sea); key recreational activities in the area (where access permits) are tourism, bird watching, wildfowling, walking, dog-walking, angling, sailing and water sports. The area also supports RAF Holbeach air weapons range, an area composed of 3,100 ha of intertidal mudflats and 775 ha of saltmarsh. This has been used for bombing since 1926 (Defence Training Estates East, n.d.). In the past 15 years, the offshore renewable energy industry has expanded significantly in the area, with several offshore wind farm arrays being situated offshore of the SAC and their electricity export cables installed within the site for connection at onshore substations (Figure 3a; Figure 3b).

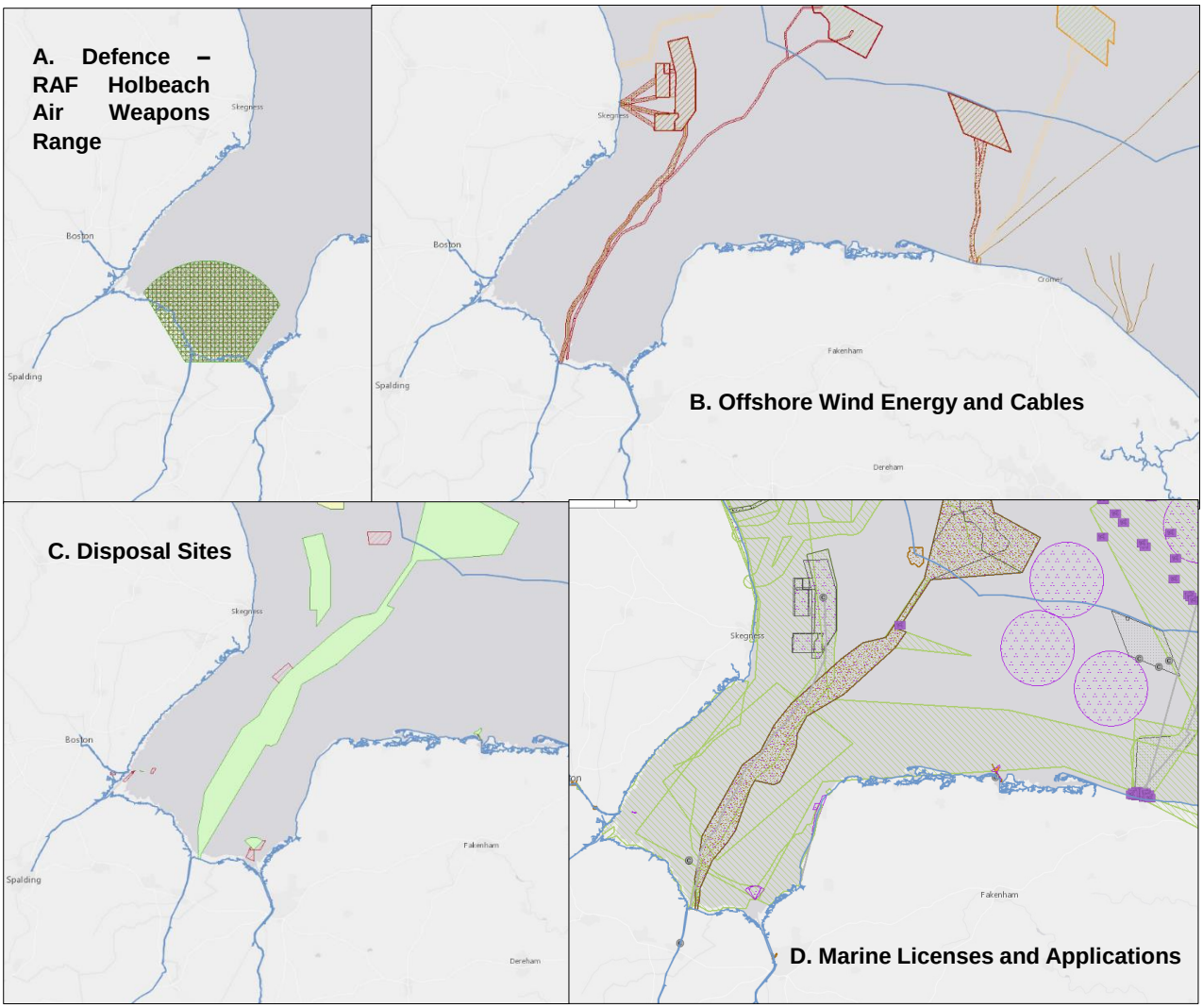


Figure 3a. Usage of The Wash and North Norfolk Coast as of 19 December 2017, including **A.** Defence, **B.** Offshore wind energy and cables, **C.** Disposal sites and **D.** Marine licences and applications. Data and chart reproduced from MMO (2017).

Figure 3b. Map legend (Figure 3a). Reproduced from MMO (2017).

2.2 Conservation objectives

Conservation objectives, attributes and targets assigned to designated features and sub-features (Table 1) of the site are detailed in Appendix 1. These are assigned to ensure site integrity is maintained or restored as appropriate, and that the site contributes to achieving Favourable Conservation Status of its Qualifying Features, subject to natural change (Natural England, 2017a).

The majority of features and sub-features in The Wash and North Norfolk Coast SAC have been allocated a “maintain” objective (Appendix 1), due to a lack of evidence that the feature is being impacted by any anthropogenic activities (Natural England, 2017a). A small number of attributes of certain sub-features have been allocated “recover” objectives – based on knowledge of the sensitivity of the feature to activities that are occurring/have occurred on the site (in some cases, specifically because an attribute “may be affected by trawling”) (Natural England, 2017a). Eastern IFCA will be required to implement management measures if meeting these targets is assessed as being prevented by fishing activity. The conservation objectives for site features (and sub-features) and their attributes are considered within the pressures section (Section 5) of this assessment.

2.3 Feature condition

The condition of all the designated site features and sub-features is currently reported as “not assessed” for The Wash and North Norfolk Coast SAC (Natural England, 2017a; Appendix 2). However, baseline condition and current feature condition are important considerations for assessments of impacts of activities. This can provide an indication of the impacts of historical and ongoing activities on the SAC. Therefore, Eastern IFCA has undertaken to obtain as much relevant evidence as possible to inform on feature condition. This is presented and clearly referenced throughout this document.

Eastern IFCA has sought Natural England’s advice on target condition for the features and sub-features in the site whose target condition is not quantified in the formal conservation advice. Natural England has advised that activity impact assessments do not necessarily require quantified condition targets, but should focus on the impact the activity has on the site features (and sub-features), based on the features’ sensitivity to pressures. For the purposes of this assessment, Eastern IFCA has evaluated all available evidence on the impact of shrimp beam trawling on site features, including a detailed examination of feature sensitivity to pressures, in order to determine whether the activity is hindering or enabling the furthering of site’s conservation objectives. Current feature condition has been considered (using benthic survey data) to determine whether the identified pressures arising from the ongoing shrimp fishery have caused declines in condition. The overall conclusion of the assessment – whether the activity is having an adverse effect on site integrity – is arrived at by assessing the extent to which the activity affects features in relation to their conservation objective targets.

Where feature condition (according to attributes such as extent, abundance, and composition of component communities, set out in the supplementary advice on conservation objectives) is being maintained, it is judged that the activity is not hindering the "maintain" conservation objectives from being furthered. Where feature condition is improving, it is judged that the activity is not hindering the "recover" conservation objectives from being furthered.

Where it is not clear that feature condition is being maintained or improved (as required by "maintain" or "recover" objectives, respectively), it is judged that the activity could be preventing the conservation objective from being furthered. The likelihood of the shrimp fishing activity (as opposed to another activity or natural change) preventing the conservation objective(s) being furthered is then considered. Where a feature or sub-feature is sensitive to the pressures arising from shrimp fishing, this assessment has considered in more detail whether the level of pressure is likely to result in adverse effect on site integrity.

If there is evidence that shrimp fishing activity is hindering conservation objectives being furthered, or if it cannot be shown that shrimp fishing activity is not hindering conservation objectives being furthered[1], it is judged that the activity is or could be having an adverse effect on site integrity.

A definition of "full recovery" is given by MarLIN (the Marine Life Information Network) (highlighted below):

> Full recovery: return to the state of the habitat that existed prior to impact. This does not necessarily mean that every component species has returned to its prior condition, abundance or extent, but that the relevant functional components are present and the habitat is structurally and functionally recognisable as the initial habitat of interest.
>
> MarLIN – The Marine Life Information Network
>
> https://www.marlin.ac.uk/habitats/detail/36/mytilus_edulis_beds_on_sublittoral_sediment

N.B. This is an ecological definition, not focused on European Marine Site management targets. The distinction is important because European Marine Sites are designed to be "sustainable use" sites as opposed to pristine reference areas: "*European marine sites have been selected with many activities already taking place and it is recognised that these are normally compatible with the conservation interest at their current levels… It is not the aim to exclude human activities from European marine sites, but rather to ensure that they are undertaken in ways that do not threaten the nature conservation interest"* (UK Marine SACs project).

For the current assessment, there is a lack of information on the "prior condition" of the Wash & North Norfolk Coast SAC because the fishery under assessment has been

[1] As required by the Habitats Regulations

ongoing for several decades, i.e. since long before the site was designated. Baseline (target) condition for “maintain” objective features is considered to be their condition at time of designation. Target condition for “recover” objective features has not been specified, but using the definition above, it is considered that the target should be the presence of relevant functional components, in a habitat that is structurally and functionally recognisable as the listed feature/sub feature. EUNIS biotope descriptions (i.e. physical characteristics and characterising biota) have been utilised to consider the structure and function of the features/sub features as part of this assessment.

3 Shrimp fishing within The Wash and North Norfolk Coast SAC

3.1 Fishing activity

3.1.1 Fishing fleet and gear characteristics

The Wash and North Norfolk brown shrimp fishery is the most important in the UK, accounting for approximately 90% of UK landings (ICES, 2010). This is a year-round fishery but effort and landings typically peak from September to November (Innes *et al*., 2007; ICES, 2015). In the past, the fishery has been a significant employer in the ports of Boston and King's Lynn (Innes *et al*., 2007). Beam trawling for shrimp is one of the main fishing activities occurring within The Wash and North Norfolk Coast SAC.

Aviat *et al.* (2011) reported that approximately 500 vessels and 1,000 fishers are involved in the North Sea brown shrimp fishery (i.e. across the whole of the North Sea brown shrimp fishing area, of which The Wash is a small part). Currently, approximately 37,000 tonnes of shrimp are fished per annum by Dutch (53%), German (33%), Danish (8%), UK (2%), Belgian (2%) and French (1%), including the Eastern English Channel) vessels (Seafish, 2017). Reflecting on these percentages, The Wash and North Norfolk Coast brown shrimp fishery is of huge importance on a local level, however, it is not nearly as extensive or intensive as the continental fishery.

Traditionally, two species were targeted in The Wash and North Norfolk Coast area by this activity; brown shrimp (*Crangon spp.*) and pink shrimp (*Pandalus montagui*), with the pink shrimp fishery being the more important fishery for more than 150 years (MES, 2012). Currently there is no fishing for pink shrimp due to market conditions, competing potting activity and restrictions on towed demersal gear in the available grounds. The pink shrimp fishery used to operate in deeper waters of The Wash and its approaches, and is often associated with biogenic reef created by *Sabellaria spinulosa* colonies. The sightings data (Figure 11) does not differentiate between brown and pink shrimp trawling activity but very few vessels (<5% fleet) were targeting pink shrimps during 2005-2014 (Eastern IFCA, Senior IFCO, *pers. comm.*).

Vessels participating in the brown shrimp fishery range in size and operate relatively short trips, lasting 12 to 48 hours (ABPmer and Ichthys Marine, 2015b). Eastern IFCA records (2016) show the smallest vessel operating in the fishery is 7.85m, with the average length being 11.99 m (**Figure 4.** *Size frequency of vessels fishing for brown shrimp in The Wash and North Norfolk Coast SAC.*Figure 4). Under Eastern IFCA's byelaw 15, vessels operating in the 0 to 3 nm part of the SAC must not exceed 15.24m in length. There are four vessels over 15.24m exempted from the byelaw because they have 'grandfather rights' (Eastern IFCA, 2017).

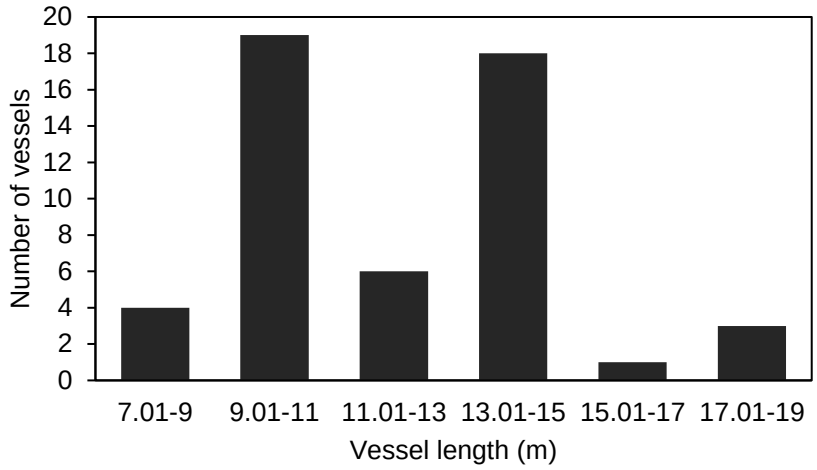


Figure 4. Size frequency of vessels fishing for brown shrimp in The Wash and North Norfolk Coast SAC.

The most common gear used in the shrimp fishery is a pair of beam trawls (Figure 5) (Tiews, 1970). Weight of the gear determines the degree of impact trawls have on substrate (Royal Commission on Environmental Pollution, 2004). Unlike trawling gear typically used to target flatfish, the shrimp gear utilised in The Wash and North Norfolk Coast SAC is relatively light (see Table 3 below). It comprises a steel beam, steel beam "shoes", a footrope (with or without rollers – see Figure 6) and the net. The shrimp gear configuration does not include chain mats or tickler chains (which are typically employed in flatfish trawl gear, and are associated with surface abrasion and sub-surface penetration). Until the late 1980s, all the Wash shrimping vessels employed single beam trawls; however, in the current shrimp fishery all vessels participating in the fishery use twin beams (Catchpole *et al*., 2008).

Larger finfish beam trawl vessels are approximately 25 to 40m long, up to 1000 horsepower (hp) and can tow two trawls 12 m wide. These trawls can weigh up to nine tonnes per side and operate at speeds of up to 7 knots (Seafish, 2005). In The Wash, beam lengths are up to eight metres each side depending on vessel size (Table 3) (Eastern IFCA, Senior IFCO, *pers. comm.*), and vessel engine power is limited to 221kW (296hp) (European Council, 1998). Vessels in The Wash tow significantly lighter weights, generally up to a maximum of two tonnes. Weight is not restricted but naturally limited based on the beam length (Poseidon 2017), The shrimp vessels operate on a much slower pace of between one and three knots (Eastern IFCA, Senior IFCO *pers. comm.*). This distinction is important because most published research into the impacts of beam trawls examines the larger fish beam trawls, whilst there is very little published research into the effects of the types of shrimp beam trawls that operate within The Wash and North Norfolk Coast SAC.

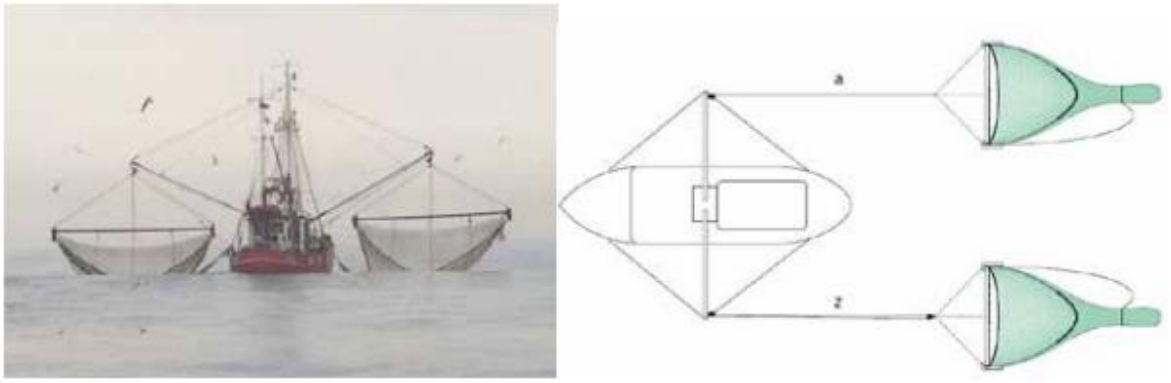


Figure 5*.* Twin shrimp beam trawl gear similar to that used in The Wash (ABPmer and Ichthys Marine, 2015b).

Table 3. Minimum, maximum and mean beam length and gear weight values across a fleet of 51 shrimp beam trawl vessels. Table produced from Eastern IFCA vessel data for 2017.

	Minimum	Maximum	Mean
Beam Length (m)	3.23	8	6.02
Gear Weight (kg)	50	2000	560

Two European fisheries technical conservation measures apply to the shrimp fishery. These relate to the use of riddles on board and the requirement to fish using veil nets (to reduce bycatch) (EC 850/98) (Figure 6). Legally the nets require cod end mesh sizes between 16 and 31 mm, however in The Wash the range employed is usually between 22 and 24 mm. According to Catchpole (2008), a study specific to The Wash, using veil nets the average catch per tow for marketable shrimp was 22.3kg (43%), for unmarketable small shrimp it was 23.7kg (45%) and for finfish it was 6.2kg (12%).

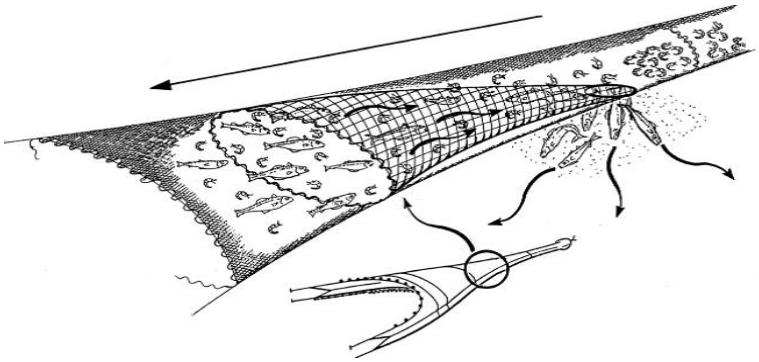


Figure 6*.* Veil net, used to reduce bycatch in brown shrimp trawls (from Seafish, 2017).

A veil net, which must have a mesh size of ≤70 mm, is used to reduce bycatch of larger fish and catches are riddled to discard smaller species (Poseidon, 2017; Figure 6).

The width of trawl shoes varies across the fleet from 15 to 25cm, and there is also variation in the presence and number of rollers which operate on each foot rope (Figure 7). Where used, rubber rollers are each approximately 20cm wide by 10cm long.

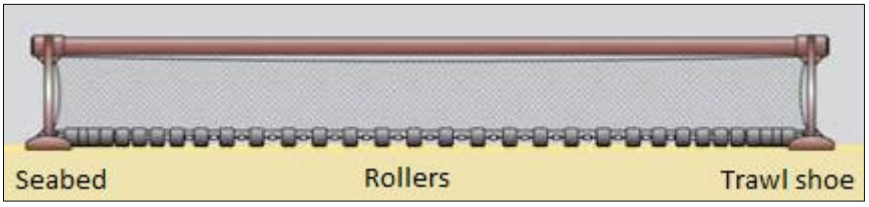


Figure 7*.* A typical beam trawl used within The Wash and North Norfolk Coast SAC, with rollers operating along a foot rope. Diagram adapted from Verschueren and Polet (2009).

3.1.2 Temporal variations in effort

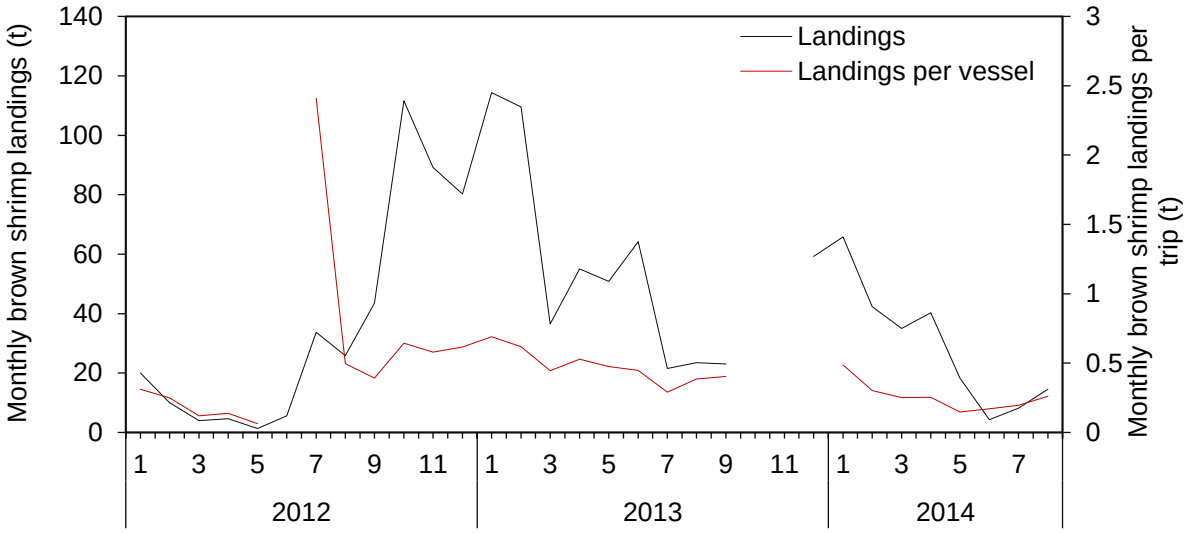


Figure 8. Monthly brown shrimp landings and landings per vessel trip into ports within The Wash and North Norfolk Coast SAC (2012-2014).

Fishing effort in the shrimp beam trawl fishery can vary considerably within and between years. MMO landings data indicates annual variability (Figure 8). This reflects the ecology of brown shrimp, which occupy a low trophic level (MES, 2012) and are thought to be subject to large, natural fluctuations in population size (Viegas *et al.,* 2007). Stock monitoring is not carried out as the high reproductive rate and mobility of the species means surveys can only indicate local abundance at a given time, rather than enabling estimates of stock biomass (Eastern IFCA, Senior IFCO, *pers. comm.*).

The number of vessels operating in the SAC varies monthly and annually. On average, 39 vessels engaged in this fishery each year between 2010 and 2015 (inclusive); (range: 27-48) (Figure 9; Table 4). Seasonal and annual variation in fishing effort reflects environmental and socio-economic influences.

Effort in the fishery typically peaks in autumn (September to November) and is low over summer (May to July) (Figure 9). Inter-annual variation in the number of vessels operating per month is a consequence of variation in stock biomass, market drivers and the productivity of other fisheries. The Wash Fishery Order annual cockle fishery

influences seasonal patterns in shrimp fishing, as many fishers who target shrimps also target cockles using the same vessel but at different times of year.

In late 2015, Eastern IFCA introduced a requirement for all participants in the beam trawl shrimp fishery to provide weekly logs of activity (including area fished, duration of fishing activity, and amount of catch landed). This data will be used to understand temporal and spatial trends in the fishery in more detail. The first twelve months of data have been used to inform this assessment of impacts on sensitive seabed habitats in The Wash and North Norfolk Coast SAC. Eastern IFCA will continue to monitor trends in activity, as set out in the monitoring and control plan for this fishery (Section 6).

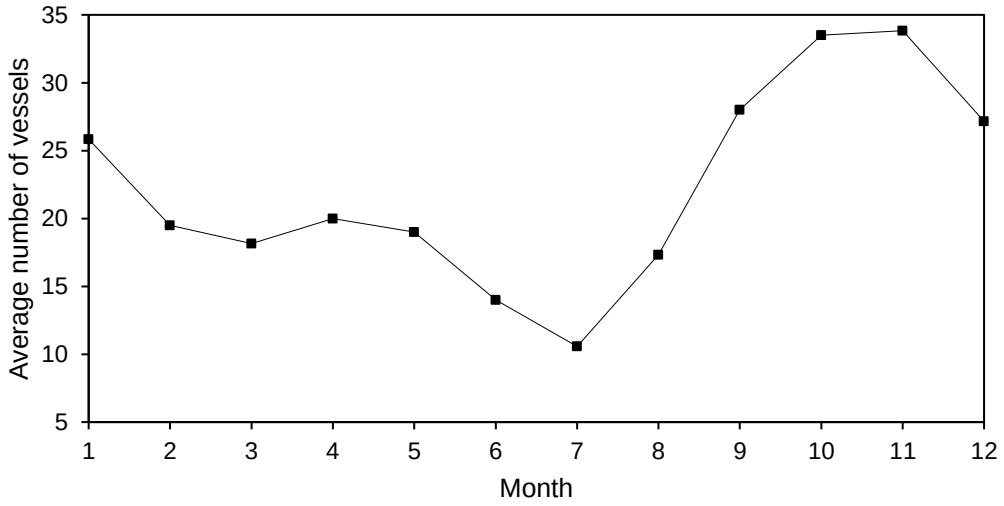


Figure 9. The number of vessels landing brown shrimp into the ports of Boston, Brancaster Staithe, Cromer, Fosdyke, King's Lynn and Wells-next-the-Sea by month between 2010 and 2015 (inclusive). Figure produced from MMO landings data.

Table 4. The maximum, minimum and average number of vessels active in a month from 2010 to 2015. Derived from counts of vessels in MMO landings data for the ports of Boston, Brancaster Staithe, Cromer, Fosdyke, King's Lynn and Wells-next-the-Sea.

Year	Number of vessels		
	Minimum	Maximum	Mean
2010	19	44	29.4
2011	4	28	11.8
2012	9	53	26.2
2013	18	43	31.1
2014	12	41	27.9
2015	1	33	13.9

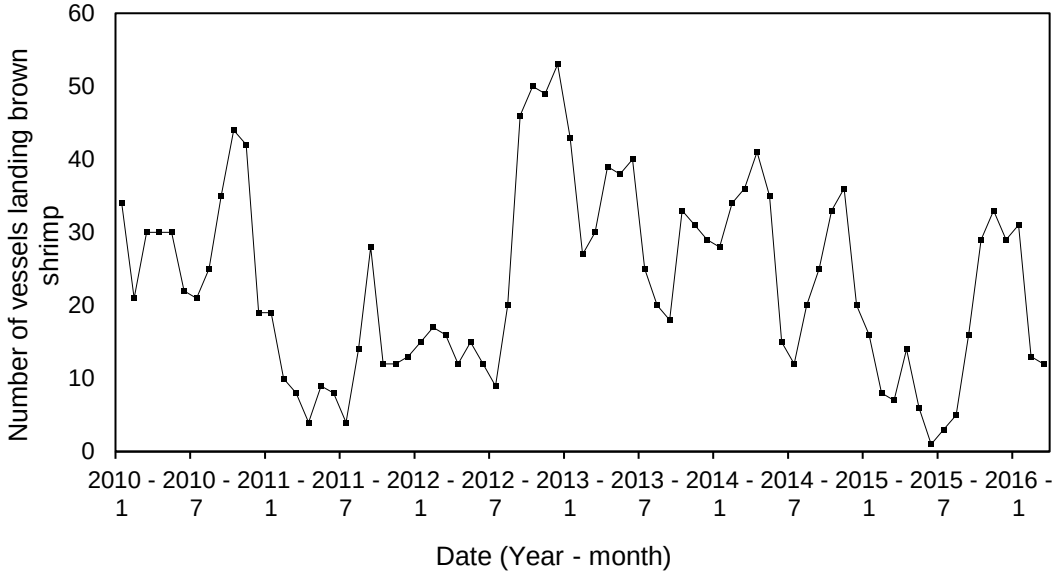


Figure 10. Number of shrimp trawl vessels landing brown shrimp each month between January 2010 and March 2016 into the ports of Boston, Brancaster Staithe, Cromer, Fosdyke, King's Lynn and Wells-next-the-Sea. Figure produced using landings data provided by the MMO (2016).

3.1.3 Spatial distribution of fishing activity within the site

Shrimp beam trawling activity predominantly occurs in The Wash embayment, and to a lesser extent along the North Norfolk coast. A small proportion of the shrimp fishing fleet targets grounds beyond the limits of the SAC but the majority of shrimp fishing activity occurs within the site.

Shrimp trawling can be carried out in water depths up to 50m below chart datum (CD) (Eastern IFCA, Senior IFCO, *pers. comm*.). However, brown shrimp trawling is primarily carried out in waters 0 to 10m below CD, often following the submerged edges of sandbanks, and channels between sandbanks. Some effort occurs in waters deeper than 10m below CD, where areas of subtidal sediment with the preferred particle size for brown shrimp burial occur (Pinn and Ansell, 1993) as well as subtidal habitat suitable for pink shrimp. Environmental factors such as temperature and tidal forcing can result in the migration of brown shrimp into waters deeper than 10m. A small amount of shrimp fishing is carried out over intertidal areas, but this is generally limited to the outer edges of sandbanks.

Until late 2015, there was no requirement for fishers to record where they had fished within the site. Fishers were required to record catch volumes (landings) by ICES rectangles and report these figures monthly to the MMO. This provides a record of spatial activity on a broad scale, but are not suitable for assessing the intensity of activity over sub-features within designated sites.

3.1.3.1 Eastern IFCA sightings data

Sightings of shrimp fishing in the SAC have been recorded opportunistically by Eastern IFCA (Figure 11). Whilst these records are not standardised by recording effort, they can indicate spatial patterns of shrimping activity. Given the highly variable level of recording year on year, the sightings data do not provide absolute intensity of fishing effort across the site, but do illustrate broader spatial patterns. This assessment has used the Eastern IFCA sightings data as a general indication of patterns of shrimp fishing; it has been examined in conjunction with the more detailed Eastern IFCA shrimp returns data (Figure 12), to ascertain the relative proportion of fishing activity in different parts of the site.

The highest fishing intensity occurs in channels between the intertidal mudflats of The Wash, with relatively little activity in the deeper waters of the central Wash, and very little activity along the North Norfolk Coast (Figure 11). However, as each vessel sighting depends on the Eastern IFCA patrol vessels being in the vicinity, the results are influenced by the location and activities of these vessels based in Sutton Bridge (close to the southern central Wash), that spend a considerable proportion of time in The Wash around the intertidal beds managing the Wash Fishery Order shellfish fisheries. Much less time is spent off the North Norfolk Coast – consequently, sightings records for that area of the site are likely to be disproportionately low[2].

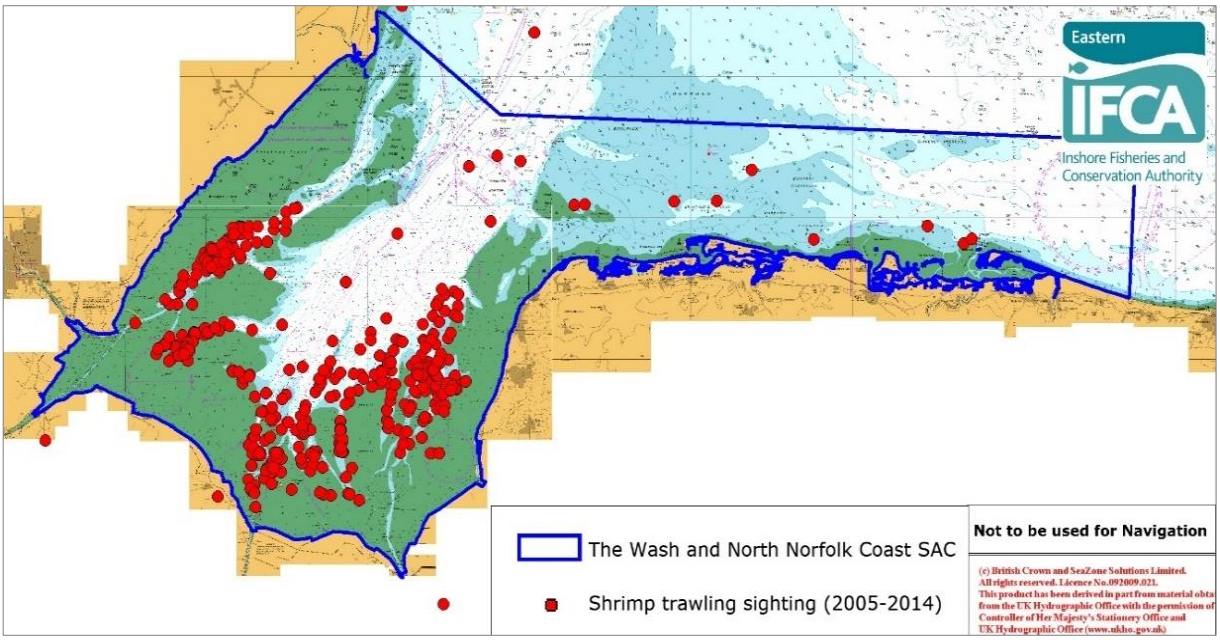


Figure 11. Spatial distribution of shrimp trawling vessel sightings in The Wash and North Norfolk Coast SAC 2005-2014.

[2] Subsequent analysis of EIFCA shrimp returns data for 2016 show approximately 75% shrimp fishing activity occurs within The Wash embayment, and 25% in the north Norfolk coast area of the SAC

Although sightings data are subject to limitations, they do provide a reasonable indication of the distribution of shrimp fishing activity within the site. This understanding of the spatial extent of activity is supplemented by expert advice from experienced fishery officers and fishers familiar with this fishery, Eastern IFCA shrimp returns data for 2016 (Figure 12) and VMS data (tracked vessel movements from fishing vessels >15m (2009-2013); Figure 13).

3.1.3.2 Eastern IFCA shrimp returns data

From late 2015, Eastern IFCA introduced a new system of reporting, which required shrimp fishers to report their shrimp fishing activity on a weekly basis. The required information includes details of shrimp landings (weight of shrimp landed) and the location of trawling activity, using a grid of small rectangles (3.34 km x 2.78 km) (Figure 12). This provides a mechanism to monitor intensity of trawling effort over any part of the site, and applies to all shrimp fishing vessels (compared with VMS which only applies to larger vessels). It includes detail of the start and end location of shrimp tows (i.e. where the gear was deployed), whereas VMS only tracks a vessel's location and fishing activity is assumed based on vessel speed.

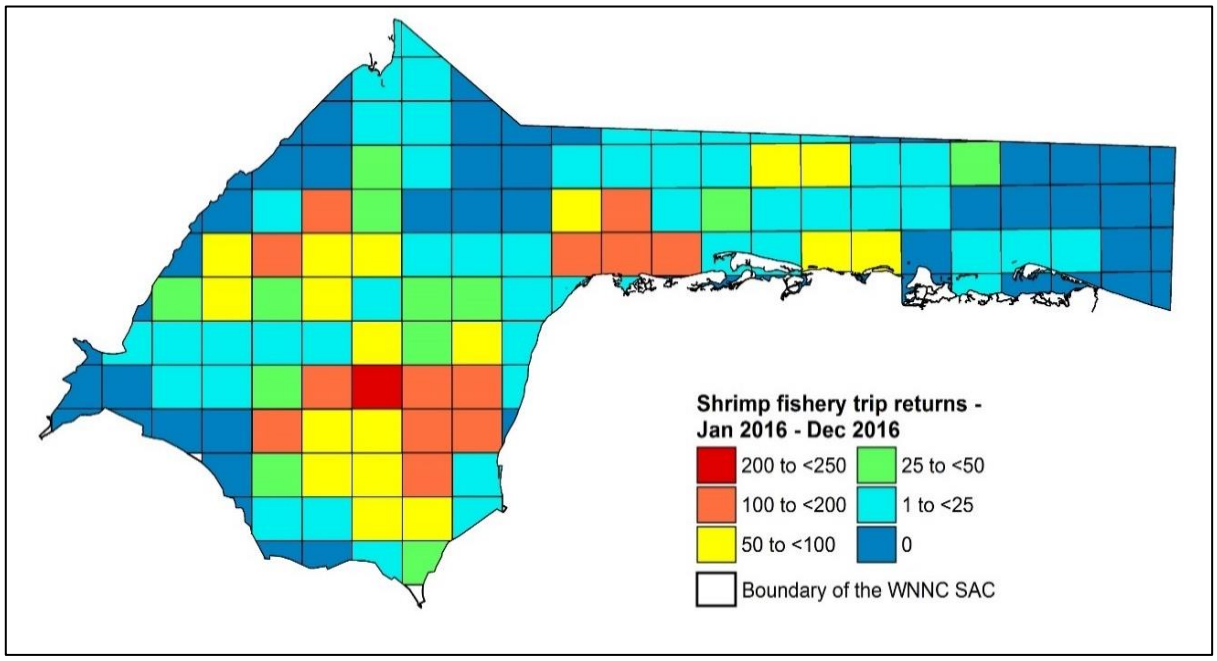


Figure 12. Shrimp fishing intensity (number of tows) in The Wash and North Norfolk Coast, 2016 (Eastern IFCA shrimp returns data).

The shrimp returns data provide a further indication of spatial patterns of fishing within the site, albeit for a single year at time of writing this assessment. Eastern IFCA is aware that despite the byelaw requirement, not all shrimp fishing activity is reported in this way so the returns data do not provide a complete record of effort. However, the location of reported activity corresponds well with sightings data, VMS (tracking of

larger fishing vessels) and fishery officer knowledge, so although the dataset is incomplete, the spatial information is of high confidence. Confidence in the fishing intensity figures for each rectangle has been increased by verifying returns levels against MMO landings data, in order to apply a correction to account for the missing returns data.

3.1.3.3 Vessel monitoring system (VMS) data

Vessel monitoring system (VMS) data were also examined. The smaller fishing vessels that typically operate in coastal waters are not currently represented in VMS data, as until 2012 VMS was only required in vessels over 15m, and currently is only required in vessels over 12m. In the current shrimp fishing fleet of 50 vessels (i.e. vessels able to target the fishery but not necessarily active), 22 vessels (44%) are over 12m and already required to have VMS, and 4 vessels (8%) are over 15m and have used VMS since 2009. In 2015, ABPmer conducted an independent assessment of the impacts of the shrimp fishery in The Wash and North Norfolk Coast SAC. That work used VMS tracks from 2009 to 2013 to plot the frequency of exposure to fishing activities[3] and produce a heat map of fishing intensity for vessels >15m (Figure 13) (ABPmer and Ichthys Marine, 2015a).

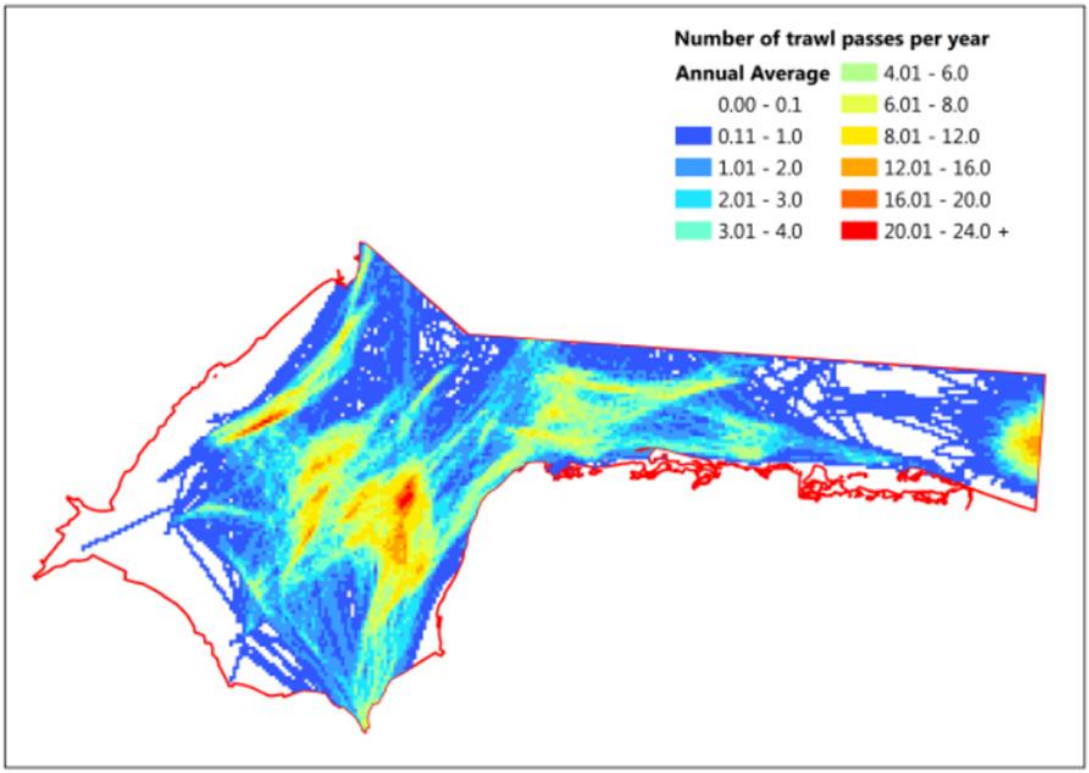


Figure 13. Average number of trawl passes per 250 m grid cell as recorded by VMS tracks (2009-2013). Image taken from ABPmer and Ichthys Marine (2015a).

[3]It is important to note that these VMS tracks are representative of gear types: Beam trawls, Miscellaneous or Unknown (null) and may not be indicative of just shrimping activity.

The VMS data should be viewed with caution: they include trawling activity and "unknown" activity. The intensely fished area at the eastern end of the north Norfolk coast was reported as "unknown" activity, but is known to be an important potting ground. Similarly, activity type in parts of the deeper, central Wash area were reported as "unknown" but are potting grounds, which automatically precludes trawling activity. Despite these caveats, the VMS data are considered to be of some value – they do highlight similar important trawling grounds in The Wash and North Norfolk Coast to those highlighted in sightings data and EIFCA returns data. The more heavily fished areas include the grounds known as "the Common" in the eastern half of the embayment, the Boston Deeps channel on the western side, and edges of the deeper, central Wash area. Activity can also be clearly seen on the shallow Burnham Flats off the western part of the north Norfolk coast.

In 2018, Eastern IFCA will be participating in an inshore VMS trial, to be applied to small inshore vessels based in The Wash and North Norfolk Coast SAC. All vessels will have the opportunity to have inshore VMS fitted as part of this project, prior to Defra making this a legal requirement in the near future (Eastern IFCA, Senior IFCO, *pers. comm.*).

3.2 Regulations applied to beam trawling for shrimp in the Eastern IFCA district

Fishers exploiting the shrimp fishery require a fishing vessel licence issued by the Marine Management Organisation. Legislation regulating beam trawling for shrimp within The Wash and North Norfolk Coast SAC includes EC 850/98 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms, The Shrimp Fishing Nets Order 2002 and three Eastern IFCA byelaws (Table 5).

Table 5. Byelaws within the Eastern IFCA district that regulate beam trawling for shrimp. More information on all Eastern IFCA byelaws can be found at: *http://www.eastern-ifca.gov.uk/byelaws* .

Byelaw	Description
Byelaw 11: Development of Shellfish Fisheries	This byelaw enables Eastern IFCA to require fisheries information (e.g. landed weights, area fished, fishing effort etc.) from fishers operating in a shellfish fishery within the district.
Byelaw 12: Inshore Trawling Restriction	This byelaw prohibits vessels >15.24 m in length from fishing using towed nets within 3 nautical miles of the coast. It also prohibits all vessels from fishing with towed nets between Blakeney Church and Mundesley Church on the North Norfolk Coast.
Marine Protected Areas Byelaw 2016	Prohibits towed demersal fishing activities in ten discrete areas of The Wash, five areas of the North Norfolk Coast, and one area of The Humber. Hand-working activity is also prohibited in the Humber closure area. The byelaw serves to protect the most sensitive marine habitats (biogenic *Sabellaria spinulosa* reef, stony reef and intertidal eelgrass (seagrass) beds) from fishing impacts.

3.3 Additional management measures

A “Wash Shrimp Fishery Advisory Working Group” was set up to focus on obtaining a Marine Stewardship Council (MSC) status (accreditation) for a sustainable shrimp fishery. The group developed a management plan in 2017 describing the overall management structure and responsibilities for The Wash brown shrimp fishery, and detailing specific fishery management measures determined to meet the objectives required to obtain accreditation. The measures relate to three areas: stock sustainability, environmental management, and governance of the fishery. Habitat and ecosystem interactions are included within the environmental management considerations. Accreditation is considered unlikely to be achieved unless MPA requirements are being fulfilled (i.e. conservation objectives furthered); therefore, the accreditation process is a timely development in the shrimp fishery to complement MPA-based management measures.

The accreditation management plan aims to encompass all vessels active in the shrimp fishery and is self-regulated by the industry[4]; it requires shrimp vessels participating in the accreditation scheme to abide by all relevant EU, UK and Eastern IFCA regulations (including measures applied by Eastern IFCA for the purposes of nature conservation). Eastern IFCA has committed to work with the accreditation process. The Eastern IFCA Monitoring and Control Plan for the fishery, (designed to ensure it is operated within appropriate environmental limits and to be developed building on the findings of this assessment and measures that it generates) will also be informed by the accreditation management plan.

[4]Shrimp are landed to two processors in King’s Lynn who are able to ensure compliance with the accreditation management plan by only purchasing shrimps from participating vessels

4 Test for likely significant effect

It is not possible to rule out the possibility that the brown shrimp fishery will have a significant effect on site features, therefore all potential impacts have been taken to full assessment (Section 5).

5 Appropriate assessment

5.1 Screening process

Certain designated features and sub-features of the site have been scoped out at this stage and not taken to full assessment (Table 6; Appendix 3).

Table 6. Features and sub-features scoped out and not taken to further assessment

Feature/sub-feature	Justification	References
Coastal lagoons	Blue (Non-occurring interactions - EMS matrix)	MMO (2014)
Intertidal seagrass beds	Red (High-risk interactions - EMS matrix) – Appropriate management already in place	Eastern IFCA (2014); MMO (2014)
Circalittoral rock		
Subtidal stony reef		
Intertidal biogenic reef: *Sabellaria* spp.		
Subtidal biogenic reef: *Sabellaria* spp.		
Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	NOIR (non-occurring interactions report); Natural England correspondence	Eastern IFCA (2015); Appendix 4
Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)		
Salicornia and other annuals colonising mud and sand		
Otter (*Lutra lutra*)	Advice on operations – interaction not relevant	Natural England, 2017b
Intertidal rock	Shrimp beam trawling activity highly unlikely	Eastern IFCA, Senior IFCO (*Pers. comm.*)
Intertidal mixed sediment	Feature misclassified – should be subtidal mixed sediments	Natural England Data Release, August 2017
Intertidal biogenic reef: mussel beds	Shrimp beam trawling activity does not occur on this feature	Addendum to Appendix 3

Following this screening process, the following features (bold) and sub-features will be taken forward for further consideration[5]:

- **Large shallow inlets and bays**
- **Mudflats and sandflats not covered by seawater at low tide**
- **Sandbanks which are slightly covered by sea water all the time**
- Harbour (common) seal
- Intertidal coarse sediment
- Intertidal mud
- Intertidal sand and muddy sand
- Subtidal biogenic reefs: mussel beds
- Subtidal coarse sediment
- Subtidal mixed sediments
- Subtidal mud
- Subtidal sand
- Water column[6]

5.2 Low risk pressures

For those features and sub-features taken to further assessment, fifteen low risk interactions were identified from the online conservation advice (Advice on Operations) (Natural England, 2017b) and have been considered further in Appendix 5. This part of the assessment considered the nature and scale of the shrimp fishing activity and its effects on the features/sub-features listed in section 5.1, via pressure pathways set out in the conservation advice.

The assessment of all fifteen low-risk pressures concluded that shrimp beam trawling will not have an adverse effect on site integrity.

5.3 Medium and high-risk pressures

For those features and sub-features taken to further assessment, six medium and high-risk pressures were identified from the online conservation advice (Advice on Operations) (Natural England, 2017b) and are summarised in Table 7.

The assessment of the shrimp beam trawl fishery in relation to these pressures is set out in in Appendices 6-12, and is summarised in Table 8.

The assessment of medium and high-risk pressures concluded that four pressures (listed below) would not have an adverse effect on site integrity:

- **Changes in suspended solids**

[5]*N.B.* Intertidal biogenic reef: mussel beds were scoped out of this assessment after Appendix 3 was agreed. This feature had not been considered in the Non-Occurring Interactions Report, had it been so considered it would have been scoped out at an earlier stage. For more details see Appendix 3a.
[6]'Water column' is not listed as a designated feature or sub-feature of the site however it is included in Natural England Advice on Operations (Natural England, 2017b). It is therefore considered as a sub-feature from this point on in the assessment process.

- **Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion**
- **Removal of target species (water column only)**
- **Smothering and siltation rate changes (light)**

The assessment identified that further assessment was required for two remaining medium- to high-risk pressures:

- **Abrasion/disturbance of the substrate on the surface of the seabed**
- **Removal of non-target species**

The further assessment is presented in Section 5.3.1, and is supported by Appendices 7 to 12.

Table 7. Sensitivity of features to medium/high-risk pressures (Key: S = Sensitive; NS = Not Sensitive; NR = not Relevant; IE = Insufficient Evidence) (Natural England, 2017b)

Feature	Medium/high-risk pressures					
	Abrasion/disturbance of the substrate on the surface of the seabed	Changes in suspended solids (water clarity)	Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion	Removal of non-target species	Removal of target species	Smothering and siltation rate changes (Light)
Harbour seal	NR	NR	NR	S	NR	NR
Water column	NR	S	NR	S	S	NR
Subtidal biogenic reefs: mussel beds	S	NS	S	S	NR	S
Subtidal mixed sediments	S	NS	S	S	NR	S
Intertidal coarse sediment	S	S	S	S	NR	S
Intertidal mud	S	S	S	S	NR	S
Intertidal sand and muddy sand	S	S	S	S	NR	S
Subtidal coarse sediment	S	S	S	S	NR	S
Subtidal mud	S	S	S	S	NR	S
Subtidal sand	S	S	S	S	NR	S

Table 8. Summary of the assessment of medium to high-risk interactions identified from the Natural England Advice on Operations detailed in Appendix 6 (Natural England, 2017b).

Pressure	Assessment
Abrasion/disturbance of the substrate on the surface of the seabed	Further assessment required: detailed in Appendices 7-12
Changes in suspended solids (water clarity)	No adverse effect on site integrity
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion	No adverse effect on site integrity (surface penetration considered within assessment of abrasion)
Removal of non-target species	Further assessment required: detailed in Appendices 7-12
Removal of target species 'Water column' only	No adverse effect on site integrity
Smothering and siltation rate changes (light)	No adverse effect on site integrity

5.3.1 Further assessment of surface abrasion/disturbance and removal of non-target species

This section of the assessment evaluates the evidence relating to diversity and species richness against information about shrimp fishing activity within The Wash and North Norfolk Coast SAC. It presents this evaluation in a series of different ways, developed using the best available information which, in most cases, is limited in some way. The data limitations are presented alongside the evaluations. In light of the data limitations, no single part of the evaluation is considered to provide definitive evidence relating to the impacts of the shrimp fishery. Therefore, the conclusions of each section combined are gathered in order to ascertain whether there is sufficient information to judge whether the fishery is having an adverse effect on site integrity, in relation to abrasion and removal of non-target species.

This section of the assessment examines two medium/high risk pressures: abrasion and removal of non-target organisms, which required further examination before a conclusion on adverse effect can be made. It utilises available information on the presence and distribution of species deemed sensitive to abrasion, to enable a judgement to be made on whether the conservation objectives for the benthic habitat sub-features of the SAC are being impacted by the shrimp fishery. Expert judgement using available information is applied in the absence of primary evidence (direct studies) on the impact of shrimp beam trawling on habitat features and their communities in The Wash and North Norfolk Coast SAC, and in the absence of a published condition assessment status for the site's sub-features.

Whilst there is extensive scientific literature relating to the impact of beam trawling on seabed habitats and communities (see references as set out in the conservation advice relating to abrasion in Appendix 6), there is very little literature relating specifically to the impact of *shrimp* beam trawling. One EU study report on the North Sea Brown Shrimp fisheries (Aviat *et al* 2011), (of which the UK fishery forms only 2%, with the main fisheries being Dutch (53%), German (37%) and Danish (8%) – Seafish 2017), reported that the effects of shrimp trawls on the sea bed are minimal and only temporary. This reflects that shrimp beam trawls are designed to target shrimps above the surface of the sea bed, compared with finfish beam trawling that is designed to displace fish from the seabed itself. Aviat *et al.* (2011) was not primarily an assessment of shrimp fishing on marine protected area features, but provides interesting North Sea wide context for the current Wash & North Norfolk Coast focussed assessment.

Shrimp beam trawling does result in some level of abrasion of the seabed, primarily through contact with shrimp trawl shoes (which support the beam), and to a lesser extent through contact between the net and rollers (if used). Coldwell *et al* (2007) describe how the rollers ride over the surface of the seabed rather than penetrating it,

but Aviat *et al* 2011 note that [because of the curvature of the net] the outer rollers do not roll fully in parallel to the trawling direction, resulting in some abrasion of the sediment in the outer parts of the gear track. The extent of the abrasion impact is considered in more detail below.

Appendix 6 sets out numerous references relating to fishing by beam trawling causing reductions in diversity and species richness by reducing the relative abundance or removing completely species that are sensitive to abrasion (Appendix 6, medium/high pressures).

This section includes an examination of the abundance and distribution of sensitive species (Appendices 7,7a, 8c-j), the examination of the diversity and evenness of species across the site (Appendices 8a and 8b), natural disturbance (Appendix 9) and the infaunal quality index assessment (Appendix 10). Species diversity is evaluated against fishing effort, habitat type and water depth (Appendix 11). Finally, Appendix 12 assesses the impact of shrimp beam trawling in relation to the characteristics of the biotopes within the sub-feature habitats of the site (including sensitivity of characterising species).

Natural England (statutory nature conservation advisor) advised it would be helpful to investigate the occurrence, abundance and distribution of sensitive species within the site to help identify areas of the site where shrimp fishing should be excluded. Eastern IFCA considered sensitive species in relation to the site's conservation objectives. The conservation objectives particularly relevant to this part of the assessment are:

> For subtidal sand and subtidal coarse sediment communities, to "*maintain the presence and spatial distribution of communities*", and to "*maintain the species composition of component communities*"; and
>
> For subtidal mixed sediments and subtidal muds, to "*recover the presence and spatial distribution of communities according to the map*" and to "*recover the species composition of component communities*."

However, at time of writing, recovery targets (in terms of presence and spatial distribution of communities, and species composition of component communities) and a "map" have not been specified. It has therefore been judged for the purposes of this assessment that where sensitive species maintain their presence, and their spatial distribution does not reduce over the long term, the maintain target is being furthered, and where their presence and distribution increase, the recover target is being furthered.

The conservation advice notes that:

> "*Efforts to accurately identify and map the biological component of subtidal mixed sediment biotopes [and subtidal mud biotopes] in The Wash have been restricted by survey conditions and the spatial heterogeneity of the biotopes*

present (Meadows and Frojan, 2012), (McIlwaine et al., 2014). (APEM, 2013) found biotope composition of The Wash to show significant variation over time. This trend appears to be largely driven by changes in sediment composition, and (APEM, 2013) suggest that The Wash exists as a dynamic system fluctuating between sediment states."

This natural variation in the distribution of biotopes over space and time means that long-term datasets are particularly valuable for identifying change in condition. It is not possible to ascertain the cause of changes in species distribution and abundance in the short term because of the dynamic nature of The Wash. However, longer-term trends in species abundance – particularly for sensitive species – are likely to indicate a change in site condition, which can be considered in relation to human activities and conservation objectives. This approach has been taken in this part of the assessment.

(i) Sensitive species/taxa[7]

Eastern IFCA has considered available data on the abundance and distribution of certain sensitive species within the SAC[8], over a twenty-year time period. Appendix 7 sets out how the species were selected for this examination. The results are considered in the context of the ongoing beam trawl shrimp fishery.

Species' sensitivity is considered in terms of their intolerance and sensitivity to abrasion and displacement, according to information presented by the Marine Life Information Network (MarLIN). A dataset of species found within the site was derived from benthic survey information provided by Natural England and Environment Agency, and supplemented by on-site records of shrimp trawling bycatch species (Catchpole *et al.,* 2008) (further information in Appendix 7). The survey data listed 90 taxa (mostly species but some genera where species were not identified), and an additional four epibenthic species from the bycatch records. MarLIN sensitivity information was available for 23 species from the 90 taxa listed in the sensitive species dataset.

Eastern IFCA also examined the sensitivity of species using the Biological Traits Information Catalogue (BIOTIC) (MarLIN 2006). The information available from BIOTIC allowed Eastern IFCA to allocate a sensitivity "score" based on the size, fragility, habit, feeding method and mobility of each species. A total of 26 species (from the compiled dataset of sensitive benthic species identified in NE, EA and Catchpole data) were identified as being potentially sensitive to beam trawling, based on these traits (De Juan and Demestre, 2012). Eight taxa, deemed to be sufficiently well represented (i.e. occurred in sufficient numbers to enable some temporal and spatial analysis to be conducted) in the combined species dataset, were taken forward for the in-depth examination of presence/abundance and distribution. These species were selected to provide a representative range of characteristics (position, size, fragility, habit, feeding method and mobility) of benthic fauna present within the site.

The presence/abundance and distribution (according to depth class and EUNIS sediment code) of eight sensitive taxa were examined:

- *Abra alba* White furrow shell
- *Bathyporeia elegans* Burrowing sand shrimp
- *Flustra foliacea* Hornwrack, lemongrass
- *Hydrallmania falcata* A colonial hydroid
- *Lanice conchigela* Sand mason worm

[7] Most of the available data relates to species but some refers to genus or family, so collectively the list refers to taxa (groups) rather than species

[8]These data are not available for the North Norfolk Coast so the consideration of sensitive species is focused on The Wash embayment.

- *Mediomastus fragilis* Bristleworm
- *Mytilidae* Marine mussels
- *Ophiuroidea* Brittlestars

Reasons for selecting these taxa, and further information on each one, are set out in Appendix 7. They include taxa categorised by Natural England as being sensitive (e.g. *Mytillidae*), taxa recorded as shrimp beam trawl bycatch e.g. *Ophiuroidea* (Catchpole *et al.,* 2008) – i.e. vulnerable to the pressure "removal of non-target organisms" – and emergent species that are likely to be vulnerable to abrasion pressure from beam trawling because of their position erect from the seabed (e.g. colonial bryozoans such as *Flustra foliacea* or hydroids such as *Hydrallmania*).

The sensitive species data are presented as a measure of the status of the biological communities within sub-features, in terms of sensitive species being indicators of trawling abrasion/removal of non-target organisms. It is acknowledged that this does not provide a complete nor definitive indicator of physical or biological disturbance from shrimp trawling, but enables an informed judgement to be made using best available evidence.

As well as focusing on eight sensitive taxa in the site, consideration was made of the overall diversity of taxa across the site over time and the relative proportions of taxa within samples of benthic species (abundance ratio).

A more detailed description of methods applied and the full results are presented as appendices to this main document:

> Appendix 7: Consideration of species sensitivity data - methods
> Appendix 8: Abundance (or presence/absence for colonial species), diversity and evenness assessment (number of taxa and abundance ratio)

A summary of the findings of each appendix and their relevance to this assessment is set out below.

<u>Abundance (or presence/absence) of sensitive species</u>

Each of the eight sensitive species was examined in terms of abundance (or presence/absence for the two colonial species) across the study area, and by EUNIS habitat (sediment type and intertidal/subtidal location) and depth, over 20 years (from 1995). No data were available for four of these years (2009, 2012, 2013, 2014). Separating the data into EUNIS habitat and depth classes resulted in very low numbers of data points for many of the categories (numbers are presented at Appendix 8l), so the value of this interpretation is limited, and should be considered with caution. The greater number of data points for each EUNIS habitat across all depths for each species provides more confidence in forming conclusions about the abundance of each species over time for each habitat, although numbers are still low in terms of statistical confidence. Observations have been made about the results in

individual sediment type/depth combinations (Table 9), but it is considered that the data are more sensibly used to assess for any obvious trends in abundance for each species across all habitat and depth categories over the 20-year timescale, which could reflect improvements or declines in site condition as a result of beam trawling activity. The results are presented graphically at Appendices 8c-8j.

Table 9. Summary of sensitive species abundance & distribution analyses, which are presented graphically at Appendices 8c – 8j.

Species	Abundance	Trend	Comment
Abra alba (Appendix 8c)	Low to medium	Upward trend for combined habitats and depths, and for all combined depths; Downward trend for subtidal sand in 0-10m depth; Downward trend in subtidal mixed sediments >10m depth	Low confidence in data for individual habitats/depths because of low abundance figures; Subtidal sand result possibly skewed by a single high result
Bathyporeia elegans (Appendix 8d)	Consistently very low	Possible upward trend for combined habitats and depths	Low confidence in trends for individual habitats/depths because of very low abundance figures
Flustra folicea (Appendix 8e)	Absent to medium	No presence recorded in intertidal habitats; Upward trend for all subtidal habitats and depths, separately and combined	Colonial species: presence/absence recorded rather than abundance
Hydrallmania falcata (Appendix 8f)	Absent to medium	Possible upward trend for separate and combined habitats and depths	Low number of samples in some habitats reduces confidence in “trends”
Lanice conchilega (Appendix 8g)	Generally low, some high outliers	Weak upward trend for combined habitats and depths; Upward trend for 0-10m depth;	Low confidence in data for individual habitats/depths because of generally low abundance figures

Species	Abundance	Trend	Comment
		Weak downward trend for >10m depth	
Mediomastus fragilis (Appendix 8h)	Consistently low	Very slight upward trend for combined habitats and depths; Weak upward trend for intertidal sand and combined habitats at 0-10m depth; Downward trend in combined habitats >10m depth.	Low confidence in data for individual habitats/depths because of low number of data points
Mytilidae (Appendix 8i)	Low to medium	Downward trend for separate and combined habitats and depths	Eastern IFCA has high confidence data for intertidal mussel beds (no interaction with shrimp fishery); taxa not expected to be consistently present over time
Ophiuroidea (Appendix 8j)	Low to medium; one high outlier	No overall trend for combined habitats and depths; Weak upward trend in intertidal sand; Possible downward trend in >10m depth.	High outlier (>500 individuals/0.1m^2) recorded on one occasion in subtidal mixed sediment habitat >10m depth could reflect (ephemeral) brittlestar bed

The shrimp fishery is an ongoing activity that has taken place within the site throughout the period examined in this analysis. It is suggested that should any activity within the site be having an adverse effect on communities within subtidal habitats, this would be evidenced by declines in these sensitive species. The use of a longer-term data set (20 years) is likely to enable genuine trends to be identified, whereas short-term data are more likely to reflect responses to seasonal or annual fluctuations in environmental conditions or one-off events.

Some downward trends in abundance were noted for particular species and habitat/depth combinations. These are considered below. Again, it is emphasised that

the low number of data points for each species/habitat/depth category reduces confidence in apparent trends recorded; it is more meaningful to consider the results for each species across all habitat/depth combinations.

- *Abra alba*

This bivalve mollusc returned a downward trend in shallow subtidal sand, but there is low confidence in this trend because of the low number of data points, which means a single point can significantly skew the result. A similar low number of data points provided a downward trend in deeper (>10m depth) subtidal mixed sediments. However, the overall trends (for each depth category, and for all habitats/depths combined) are increasing.

- *Mytilidae*

This analysis of mussels (*Mytilidae*) showed a general downward trend in abundance over the 20-year timescale[9]. Eastern IFCA maintains detailed records of intertidal mussel (*Mytilus edulis*) abundance and extent in the Wash Fishery Order area of The Wash through annual stock surveys (e.g. Jessop 2016). There has been a decline in biomass of mussels on intertidal beds in the 2010s, although an increase in biomass and extent of beds was recorded in 2017.

The recorded decline in abundance of *Mytlidae* in intertidal areas is not judged to be caused by the shrimp fishery. The occurrence of an atypical mortality in intertidal mussel populations in The Wash has been recorded since 2009 (Jessop 2016) and is thought to be linked to a naturally-occurring the parasite *Mytilicola intestinalis*. Shrimp fishing does not coincide with intertidal mussel beds: the shrimp fishery avoids these features (whose locations are well known), to prevent their gear snagging but also to prevent damage to this fishery and conservation resource.

It is therefore judged that the shrimp fishery is not affecting the abundance and distribution of intertidal mussel beds.

Reflecting their economic and conservation value, Eastern IFCA has conducted comprehensive monitoring of intertidal mussel beds in The Wash for over 20 years. Subtidal habitats are subject to less extensive and less frequent surveys, some undertaken by Eastern IFCA (e.g. habitat mapping focused on the subtidal biogenic reef *Sabellaria spinulosa*) and some by other agencies (e.g. Environment Agency, Natural England, Cefas). Because of their infrequent occurrence and short longevity,

[9]Sublittoral mussel beds are ephemeral features, vulnerable to loss through predation, smothering and natural disturbance because of a lack of hard settlement surfaces in sedimentary environments. Eastern IFCA is not aware of any primary evidence showing the frequency of sublittoral mussel beds occurring. Anecdotal reports (Eastern IFCA officers and fishers) state there is a low frequency of sublittoral mussel beds being found in The Wash and its approaches is low (in the region of once every three years over the past 20 years) (Ron Jessop, Eastern IFCA, *pers. comm*.).

there is no dedicated monitoring of habitats for the presence of sublittoral mussel beds, but when they do occur Eastern IFCA attempts to estimate their extent, population composition and biomass.

This analysis has shown a decline in the abundance of sublittoral mussels over time. Sublittoral beds are ephemeral (i.e. not expected to survive into beds of mature mussels) because of their vulnerability to predation (e.g. by starfish *Asterias rubens*) and detachment from sediment substrata through natural disturbance. Their presence within the site is infrequent and sporadic.

The high value of sublittoral mussels as a fishery resource (used in shellfish aquaculture within the site) and the possibility of snagging gear deters shrimp trawling over mussel beds once located. Furthermore, mussels were not recorded as bycatch by Catchpole *et al.* (2008). However, it is assessed that there is a low possibility that shrimp beam trawling could have some incidental impact on sublittoral mussel beds where their existence has not been recorded.

Mussels require a hard surface to attach to for their secondary (permanent) settlement stage, for example adult mussels or stony reef (MarLIN). Eastern IFCA's Marine Protected Areas byelaw currently protects biogenic and subtidal stony reef features within the site. However, primary settlement of mussels can be associated with hydroids (e.g. *Hydrallmania*); if the shrimp fishery was reducing the abundance of this species it could impair mussel settlement. The assessment of this hydroid did not show declines in its occurrence, but confidence in the data is low because of the low number of data points.

It is therefore judged that it cannot be ruled out that the shrimp beam trawl fishery is contributing to the observed decline in sublittoral mussel abundance in The Wash.

- *Bathyporeia elegans*

There was a possible upward trend for all habitats and depths combined, but the recorded abundance of this free-living, burrowing species on all sampling occasions was very low (highest mean abundance was 6 individuals per $0.1m^2$). Examination of trends over time was therefore not considered to be useful in relation to potential impacts of the shrimp fishery on the abundance and distribution of this sensitive species.

- *Flustra foliacea*

Again, there were low numbers of data points for this colonial species. Stable or upward trends were recorded for all habitat types and all depths, separately and combined. This suggests that no activity occurring within the site is having a negative impact on the abundance or distribution of this species.

- *Hydrallmania falcata*

Again, there were low numbers of data points for this colonial species. Stable or upward trends were recorded for all habitat types and all depths, separately and combined. This suggests that no activity occurring within the site is having a negative impact on the abundance or distribution of this species.

- *Lanice conchilega*

Although there were low numbers of data points for depth/habitat combinations, each of the >10m depth habitats except coarse sediment returned a downward trend for this fragile, tubiculous species. This suggests that the abundance of this species could be declining over time in this depth category, across most habitats in the site. Whilst this downward trend is outweighed by a steeper upward trend for shallower subtidal habitats, the data suggest that the abundance of this species is not being maintained in deeper parts of the site. The combined data for all habitats/depths showed a weak upward trend.

- *Mediomastus fragilis*

A downward trend was noted for this burrowing bristleworm species for subtidal mixed sediment habitat and mosaic habitat, both at >10m depth, compared with an upward trend for other habitats at this depth. Upward trends were visible for intertidal habitats and shallow subtidal habitats. Overall across all habitat/depth combinations, a very slight upward trend was observed. As for the rest of this analysis, the low number of data points for each species/habitat/depth combination means the results should be interpreted with caution, but a precautionary interpretation would be that the abundance of this species is not being maintained in the deeper areas of mixed sediment habitat.

- *Ophiuroidea*

The analysis for this taxon showed declines in abundance over time for all deeper (>10m depth) subtidal habitats except sand. The presence of a very high number of individuals in one subtidal mixed sediment sample in 1998 was responsible for the downward trend in this habitat. Again, the low number of data points means caution is required in interpretation, but the combined weight of evidence suggests the abundance objective is not being furthered in the deeper areas of the site. Declines are also visible in shallower subtidal habitats, but the combined results for these areas shows no upwards or downwards trend.

The low number of data points for many of the habitat/depth categories limited the usefulness of this part of the assessment. There is more confidence in abundance data for the site as a whole (i.e. not separated into EUNIS habitat or depth class) than for the habitat/depth categories that were analysed separately: these show that abundance is increasing for six of the eight sensitive species examined, stable for brittlestars, and declining for mussels.

In the context of the conservation objectives, this provides some low confidence evidence that the presence and extent of communities, and the species composition of component communities, are being maintained across the majority of sediment habitats and depths.

However, the sensitive species abundance data do not indicate that recovery is occurring in subtidal mixed sediment or mud habitats, if recovery would be reflected by an increase in abundance of sensitive species over time. The data suggest declines (albeit without statistical robustness) in abundance over time for the taxa *Abra alba, Lanice conchilega, Mediomastus fragilis, Mytilidae* and *Ophiuroidea*) in habitats deeper than 10m. It is unlikely that deeper water seabed habitats (>10m depth – see Appendix 9 Natural disturbance considerations) undergo significant abrasion from wave action so it can reasonably be argued that deeper water communities are more sensitive to abrasion from anthropogenic sources such as the shrimp beam trawl fishery, than shallow water habitats are.

Although there is no quantitative target for recovery, a precautionary conclusion is presented that the decline and/or lack of increase in abundance of sensitive species in deeper subtidal mixed sediment and mud communities means that adverse effect from the shrimp beam trawl fishery cannot be ruled out.

(ii) Species diversity (number of taxa) (Appendix 8a)

The number of taxa in samples has been considered as an indicator of diversity. The same dataset used in the sensitive species analysis (above) was examined for overall number of taxa in all samples over the 20-year period, and the number of taxa in each EUNIS habitat type and depth class were also plotted. The dataset included epifauna and infauna, taken in grab and core samples.

The results are presented in Appendix 8a. These showed an increase in the total number of taxa found across The Wash between 1995 and 2015 for all habitat/depth categories combined. When separated into depth category, increases in abundance were seen in intertidal and shallow subtidal (0-10m depth) categories. A weak decline was seen in deeper subtidal habitats (>10m depth), although this was influenced by a strong decline based on only two years of data in the "non-designated" habitat category. A weak decline in abundance is seen in the subtidal mixed sediment category at >10m depth.

When examined individually, as in the sensitive species analysis, the low number of samples for each category weakens confidence in the findings. The low r^2 values means the data in general do not show a good fit to any trendline. However, the combined data for particular habitats across all depths, or for particular depths across all habitats, are based on more samples, bringing additional confidence.

It is judged that the data are not definitive but have some value as part of the evidence base for the condition of communities within the site. The absence of visible overall declines in species diversity over time, from this analysis that used the most extensive species dataset available over a twenty-year timeframe, suggests that there is no activity having a significant, deleterious effect on the site.

Thus, it is suggested that the beam trawl shrimp fishery is not preventing the "maintain" conservation objectives[10] from being furthered, for intertidal habitats and for subtidal sand and subtidal coarse sediment communities.

The species diversity (number of taxa) analysis does not indicate that the species composition of component communities is recovering for subtidal mixed sediments. In the absence of a definition or target number of species to "recover" to, this assessment has assumed that an upward trend in the number of species would indicate recovery. Noting the caveats outlined above, upward trends are not evident in these data.

[10]For subtidal sand and subtidal coarse sediment communities, the conservation objective is to "*maintain the presence and spatial distribution of communities*", and to "*maintain the species composition of component communities*".

Therefore, for this section of the assessment, a precautionary conclusion is presented that an adverse effect on these recover objectives[11] cannot be ruled out, for subtidal mixed sediments.

Finally, the abundance data for subtidal mud show a weak upward trend, suggesting the shrimp beam trawl fishery is not preventing the recover objective for this sub-feature from being furthered.

[11]For subtidal mixed sediments and subtidal muds, to "*recover the presence and spatial distribution of communities according to the map*" and to "*recover the species composition of component communities*"

(iii) Species evenness (abundance ratio) (Appendix 8b)

This measure has been examined as a further indicator of the condition of component communities within the site. In the absence of direct activity/impact studies, consideration of community condition despite an ongoing activity (shrimp beam trawling) provides a broad indication of whether that activity is having an impact on the achievement of conservation objectives.

The abundance ratio provides a quantitative measure of the dominance of species: a high figure shows few species dominate the total number of individuals and conversely a low figure shows the number of individuals is relatively evenly spread between species. Dominance of a small number of species is typical in stressed environments where natural communities are disturbed and large numbers of opportunistic species thrive in conditions not suitable for a wider range of species.

The dataset examined for this part of the assessment was the same as that used in the sensitive species analysis and the species diversity assessment (both presented above). It included infaunal and epifaunal species, taken in grab and core samples, between 1995 and 2015. Confidence in these data is medium – there are low numbers of samples for some habitat types and for some depth classes and years, and the location of some sample sites between and within years has varied. However, it is judged that the combined dataset provides a sufficient number of samples per year to enable a reasonable analysis of trends over time.

Noting the caveats outlined above, the results (presented at Appendix 8b) indicate that the abundance ratio in The Wash is declining for the majority of EUNIS habitat types, and depth classes, as well as overall for combined data. The exceptions (i.e. where abundance ratio is seen to be increasing) are intertidal mud habitats (low number of samples; no data after 2000); “intertidal” sublittoral sand (data for three years only); shallow (0-10m depth) subtidal coarse sediment (data for three years only) and shallow (0-10m depth) subtidal mixed sediments. Despite these indications, based on minimal levels of data, the results do not show that any single habitat type (across all depths), any depth class (for all habitats), or the site overall, are showing increases in dominance of any species over the 20-year timescale. This part of the assessment therefore concludes that **the species composition of component communities objective is being maintained within the site at a broad level.** The decline in abundance ratio, i.e. increasing evenness in numbers of individuals of different species, suggests that species composition is being recovered, for all depth classes (with all habitats combined) and all habitats (with all depths combined) except intertidal mud (no data since 2000).

The increase in abundance ratio for subtidal mixed sediments at shallow depths (data available for six years) is countered by a steeper decrease in abundance ratio in this habitat at deeper depths (also six years of data), giving a decreasing abundance ratio

for this habitat overall. The data suggest that species richness is not being recovered for shallow subtidal mixed sediments. Without more robust data or knowing the cause of this trend, a precautionary interpretation would be that the shrimp fishery could be causing a decline in the diversity of species in shallow (0-10m) mixed sediment habitats. However, the limitations of the data for individual habitat/depth combinations must be acknowledged so this interpretation should be viewed with care. **In the context of the ongoing fishery, this suggests that the activity could be limiting the furthering of the community composition conservation objectives for shallow subtidal mixed sediment habitat.**

Appendix 8k presents the results of the analyses of (i) presence and distribution of sensitive species, (ii) species diversity, and (iii) abundance ratio against the “maintain” and “recover” conservation objectives, in a series of summary graphs showing trends over the twenty-year dataset. A simplified summary is given below in Table 10. This should be viewed with consideration of the limitations of the data and caution required in their interpretation, as set out in the preceding paragraphs.

Table 10. Sensitive species analysis, species diversity and abundance ratio results in relation to habitat sub-features allocated “maintain” and “recover” conservation objectives.

	Taxa	Maintain	Recover
Sensitive species	*Abra alba*	✓	✓
	Bathyporeia elegans	✓	✓
	Flustra foliacea	✓	✓
	Hydrallmania falcata	✓	✓
	Lanice conchilega	✓	✗
	Mediomastus fragilis	✓	✗
	Mytilidea	✗	✗
	Ophiuroidea	✗	✓
No. species		✓	✓
Abundance ratio		✓	✓

The weight of evidence shows that both the maintain and recover conservation objectives for the abundance and diversity of species are being met in most cases. The analysis of data relating to particular sensitive species found the dataset to be weak from a statistical perspective (low number of data points) but indicated that one taxa, Mytilidea, was declining across different habitat types, and two taxa (*L. conchilega, M. fragilis*) were not increasing in “recover” (subtidal mixed sediment and subtidal mud) habitats, and one taxon (*Ophiuroidea*) were declining in “maintain” habitats but not in “recover” habitats.

This leads to the precautionary conclusion that it cannot be definitively stated that the shrimp fishery is not preventing the species abundance and composition conservation objectives from being furthered.

Given the limitations of the sensitive species analysis, two further exercises relating to species diversity and community composition were undertaken to strengthen the evidence base of this assessment. They are presented in Appendices 9 and 10, and the results are summarised below.

- Appendix 9 – Natural disturbance considerations (including diversity and faunal cluster data)
- Appendix 10: Infaunal quality index (diversity, species richness, and ecological stressors)

(iv) Natural disturbance and species diversity/faunal cluster distribution (Appendix 9)

This section assessed the likely depth of wave-generated disturbance in The Wash and North Norfolk Coast, based on average wave periods and water depths. It found that intertidal and shallow subtidal areas in The Wash and North Norfolk Coast are subject to high levels of kinetic energy (EMODnet – presented in Appendix 9). It identified that natural disturbance was likely to have similar effects to demersal trawling on shallow (0-10m) parts of the site.

Species diversity and faunal cluster data were investigated (using data presented by Cooper and Barry (2017)) in relation to water depth. This was then overlaid with spatial data on shrimp fishing effort (Eastern IFCA shrimp returns for 2016, presented at section 3.1.3.2 and Figure 12) to enable assessment of the biological data in comparison with fishing effort.

Eastern IFCA did not have access to the data behind the faunal cluster and diversity ranks presented by Cooper and Barry (2017), but utilised the results as presented in the paper. The data sources used by Cooper and Barry (2017) were up to fifty years old, but the actual age of data in the Wash and surrounding areas were not known. Much of the data collated by Cooper and Barry (2017) originated from surveys to inform impact assessments for offshore activities (e.g. aggregate extraction, offshore renewables projects); The Wash and its approaches are a key area for offshore renewable energy development, much of which has taken place in the last twenty years. Although the age of the data is not known, it is considered the analysis is still relevant because the data were very likely to have been gathered contemporaneously with the shrimp fishery.

The analysis showed that shallower waters (<10m) within and outside The Wash and North Norfolk Coast had similar faunal clusters and low diversity levels, irrespective of levels of shrimp fishing activity[12]. Similarly, both within The Wash embayment itself and outside, areas of deeper water coincided with higher diversity and different faunal clusters compared with shallower areas. Some higher diversity results were seen in some of the shallower, more heavily fished areas of The Wash, and lower diversity results were not limited to more heavily fished areas.

This exercise was limited in that it relied on interpretation of graphical data rather than quantitative analysis, but it is presented as the best available evidence relating to

[12]One exception is the shallow area west of the Lynn Knock (just north of The Wash) – this is an area of “mosaic habitat” (e.g. Natural England data release January 2018) – a seabed which attracts a higher diversity of species than finer sediment habitats typically found in shallow areas of The Wash embayment. Eastern IFCA’s shrimp returns data show this area is lightly fished – at similar intensities to western parts of the subtidal sands of the Docking Shoal, where lower diversity is seen.

spatial distribution of fishing intensity and species diversity/faunal clusters. The results support the hypothesis that levels of biological diversity are driven primarily by physical conditions (water depth and sediment type) rather than intensity of shrimp fishing activity.

As for the sensitive species, diversity and species richness assessments presented above, this does not enable a definitive conclusion to be drawn in relation to furthering of the site's conservation objectives and shrimp fishing activity, but it does provide an indication that physical factors and natural processes are strongly influential in the species diversity within the site, whilst shrimp fishing is likely to have less effect, particularly in the shallower (<10m depth) parts of the site.

(v) Infaunal quality index (Appendix 10)

An additional dataset relating to the benthic invertebrate features in the site was considered, to inform the assessment of impacts of shrimp beam trawling on the site. This exercise enabled the further examination of species composition of communities in terms of the overall range of species present within the community (diversity) and their relative abundance (species richness), alongside a third metric based on the response of communities to disturbance. The data were the infaunal quality index (IQI) values for 2005-2015, derived from the identification of biota present in samples taken in surveys in eight years over this period, across The Wash and the North Norfolk Coast areas of the site.

A detailed explanation of the IQI metric and presentation of the IQI values is provided in Appendix 10, and is summarised here. IQI combines measures of diversity (number of taxa), species evenness, and a third measure, the AZTI Marine Biotic Index (AMBI). AMBI was designed to establish ecological quality, by examining the response of soft-bottom benthic communities to natural and anthropogenic disturbances in coastal and estuarine environments (Muxika *et al.,* 2005). AMBI was originally developed as a measure of the ecological quality of benthic communities in relation to organic enrichment and pollution, but has been applied as a measure of other pressures (including sand extraction and dredging). AMBI evaluates ecological condition according to the presence/absence of indicator and stress-sensitive species. Borja *et al.* (2004) noted that the usefulness of AMBI can be reduced when assessing physical impact [abrasion from shrimp beam trawling is an example of a physical impact] and for such cases, a multi-metric approach is recommended, in order to obtain a more comprehensive view of the benthic community. The IQI is a multi-metric approach: it utilises AMBI (38% of the IQI score is derived from AMBI) with two other metrics (diversity and species richness), to arrive at an ecological quality score.

The IQI values for The Wash and North Norfolk Coast were examined for separate habitat (sub-feature) types and overall for all habitat types combined. The data were limited when broken down into habitat types because of the relatively low number of samples for some habitat types per year (presented at Table 5 in Appendix 10). The IQI dataset did not differentiate habitat types until 2007, and not all sediment types were sampled each year. However, the data were sufficient to show IQI scores compared with the conservation objective target of ≥ 0.64, and provide an indication of trend over time.

Prior to 2011, mean annual IQI scores were below the target level. In 2011 and 2015, however, (the latest two years for which data were available), for all subtidal habitats in The Wash, mean annual IQI scores exceeded 0.64. Intertidal IQI data were only available for one year (2012). All intertidal habitats in The Wash recorded an IQI score >0.64.

In the North Norfolk Coast area, there was less temporal coverage (samples were taken in 2010, 2011 and 2015), but for subtidal areas the results showed mean annual IQI scores exceeding the IQI conservation objective target. Intertidal areas of the North Norfolk Coast (only sampled in 2012) recorded mean IQI scores of 0.60, i.e. below the 0.64 target score, because one habitat type (sand and muddy sand) returned an average IQI score of 0.57. It is noted that the position of the IQI samples for sand and muddy sand in North Norfolk were high up in small estuaries, where there is likely to be a strong influence from reduced salinity affecting biological community composition, which could have resulted in the lower score for this sub-feature. Although shrimp beam trawl fishing is carried out close to the shore along parts of the north Norfolk coast, for example Brancaster Bay, the shrimping vessels cannot fish high up in the small estuaries because of hydrographical limitations. It is therefore stipulated that the sub-target IQI score for intertidal sand and muddy sand in North Norfolk could not be a result of shrimp beam trawling activity.

The dataset of IQI values within the Wash and North Norfolk Coast SAC indicates an environment which has been and remains on an upward trajectory of overall environmental quality. A broad-brush assessment indicates that the environment should be considered as being at “good” status, whether considered directly against the WFD standards, or by the broader descriptions associated with certain defined WFD status levels. The single sub-feature showing “moderate” status, below the conservation objective target, is intertidal sand and muddy sand in the north Norfolk part of the site, and this has been ascribed to freshwater influence at the location of the sample.

Were there to be activities having a significant impact on the benthic habitat communities, metrics such as the IQI would indicate that these were present, without necessarily being able to define exactly the specific pressure causing the impacts. As there are no such impacts identified, it is logical that none of the activities currently occurring, alone or in combination, are having these effects. The IQI metric was not designed to detect fishing pressures, having been developed initially to measure infaunal communities in relation to organic pollution, but as set out above, it is reasonable to assert that the parameters measured to provide IQI scores (diversity, evenness and AMBI) will decline if fishing results in long-term damage to infaunal communities.

It is therefore judged that the beam trawl shrimp fishery, which has been ongoing for decades within the site, is not causing in declines in the IQI score, and is not preventing the conservation objective of “maintain” the species composition of component communities” attribute from being achieved (which applies to subtidal coarse sediments, subtidal sand, intertidal coarse sediments and intertidal mud). For reasons set out above, it is also judged that the “restore” target (for the same attribute in intertidal sand and muddy sand) is not being hindered by the shrimp beam trawl fishery.

Two sub-features have a “recover” target for species composition of component communities: subtidal mixed sediments and subtidal mud. Supporting notes in the conservation advice states that community presence/distribution in these sub-features may be affected by trawling. There are limited data (seven samples, all from 2011 for subtidal mud and sandy mud, and 12 and seven samples from 2011 and 2015, respectively) (see **Error! Reference source not found.** in Appendix 10 for full b reakdown of numbers of samples) for subtidal mixed sediments), but the available data show the IQI levels for both sub-features to be within the “good” category (i.e. above the conservation objective target level) and for subtidal mixed sediments, to be increasing over time. These results suggest that even these sub-features, which are more sensitive to abrasion (and therefore removal of non-target species), are not being significantly affected by ongoing activities within the site. As there is only one year of data for subtidal mud, the data do not show whether recovery (increase in IQI level) is occurring for this sub-feature, but the data for subtidal mixed sediment shows an upward trend from 2011 to 2015.

The IQI results give a broad indication that the infaunal species within biological communities in The Wash and North Norfolk Coast are at least being maintained, and probably showing recovery (shown by the upward trajectory of IQI scores over time).

Finally, two additional exercises relating to species diversity, substratum type and shrimp fishing activity were undertaken to strengthen the evidence base of this assessment of the two pressures “Abrasion/disturbance of the substrate on the surface of the seabed” and “Removal of non-target species”. They are presented in Appendices 11 and 12, and the results are summarised below.

- Appendix 11: Species diversity in relation to seabed sediment type, depth and shrimp fishing effort
- Appendix 12: Sensitivities of biotopes to “Abrasion/disturbance of the substrate on the surface of the seabed” and “Removal of non-target species” pressures from shrimp beam trawl fishery

(vi) Consideration of seabed sediment type, depth, species diversity and shrimp fishing effort (Appendix 11)

This section complements the preceding information presented in section 5.3.1 and Appendices 7-10, providing an additional examination of potential effects of the shrimp beam trawl fishery on benthic communities. It builds on Appendix 9, which showed that physical factors (depth and sediment type) and natural processes (sediment mobilisation from wave action) in more shallow areas of the site (<10m depth below chart datum) are likely to have more effect on species diversity than disturbance from shrimp fishing.

The spatial distribution of shrimp fishing effort was identified using shrimp returns data for 2016. These data have been verified in various ways (see Section 3.1.3.2 and Appendix 11), providing a high level of confidence. Effort level (number of tows in 12 months) presented in the rectangular grid supplied with shrimp returns data, was overlaid with diversity rank data points. Diversity rank (from Cooper and Barry, 2017 – see “natural disturbance” section above for limitations) was visually compared in areas of higher intensity fishing and areas of no or lower intensity fishing.

The data were not analysed in a quantitative way because Eastern IFCA did not have access to the diversity dataset. Therefore, observations were made from the graphically-presented data. This part of the evaluation of impacts of the shrimp fishery on community composition should be considered as one part of the wider suite of investigations presented in Section 5.3.1, which together will support the overall conclusion on whether the fishery is having an adverse effect on site integrity.

The examination found no apparent difference between diversity in shallow, sandy habitat areas that supported no or low levels of fishing, and diversity in areas of similar physical characteristics that supported the highest levels of fishing activity. Neither was there an apparent difference between diversity in deeper areas subject to no or low fishing effort compared with diversity in deeper areas subject to higher fishing effort.

The highest diversity scores occurred outside of but close to the site, and correlated with an area of shallow mosaic habitat, part of which was lightly fished and part not fished. This type of habitat is typically avoided by shrimp fishers; its high diversity is ascribed primarily to the heterogeneity of the seabed type.

This analysis shows that fishing intensity does not appear to correlate with species diversity when considered within the stated limitations of this approach. Some more intensively fished areas support relatively high diversity communities, and some non-fished areas support communities of low diversity. Diversity rank appears to be most closely associated with habitat type, being highest in areas of greater heterogeneity and lowest in areas of intertidal and subtidal sands.

This analysis by itself is not sufficient to support conclusions on whether the shrimp fishery is having an adverse effect on site integrity (in terms of abrasion and effects on species composition of component communities). However, it utilises the best available evidence and provides some evidence that shrimp fishing does not result in significantly lower diversity across its range.

(vii) Appendix 12 – Sensitivity of biotopes to abrasion/disturbance of the substrate on the surface of the seabed and removal of non-target species

This final section of the assessment provided an in-depth review of the effects of shrimp beam trawling on the Wash & North Norfolk Coast SAC by examining individual biotopes within sub-features of the site. It considered the sensitivity of named characterising species for each biotope to the two pressures that required further assessment (abrasion/disturbance of the substrate on the surface of the seabed, and removal of non-target species). The results provide further evidence to conclude on the impacts of the fishery on the conservation objectives of the site.

The assessment considered the likelihood of impacts occurring to characterising species, based on the nature, scale and location of the fishery, the extent and distribution of sub-features in the site (where known), the habits of species (e.g. their location within the biotope), their fragility and recovery potential. The two pressures were considered separately for each biotope, although many considerations were applicable to both pressures.

When arriving at a judgement of impact, the assessment accounted for the fact that the shrimp fishery is an ongoing activity, and therefore the pressures it exerts on features occur repeatedly as opposed to being a one-off incident. This consideration is important because the biotope recovery periods quoted by MarLIN (the basis for this section of the assessment) relate to one-off disturbance. The effects of repeated abrasion and/or removal of non-target species mean that recovery to a non-impacted state is not likely, given the frequency of the fishing activity. However, the conservation objectives do not require recovery to a pristine state, but require the sound ecological functioning of the site. This assessment has judged whether, on the basis of the available information, the impacts from the fishery are sufficiently severe and widespread to be having an adverse effect on site integrity.

The findings of the assessment in Appendix 12 are summarised in Table 11. A precautionary approach has been taken in drawing these conclusions. In some cases, the majority of evidence suggests no impact, but some information has indicated there could be an impact from the fishery. The level of confidence in the evidence has been taken into account.

Table 11. Summary of shrimp fishery impact for “abrasion” and “removal of non-target species” pressures assessed by examination of biotopes and characterising species

Pressure	Feature/sub-feature	Shrimp fishery impact	Confidence
Abrasion/ disturbance of the substrate on the surface of the seabed	Harbour seal	No evidence of impact	High
	Intertidal coarse sediment	No evidence of impact	High
	Intertidal mud	Highly unlikely	Medium
	Intertidal sand and muddy sand	Cannot be ruled out	Medium
	Subtidal biogenic reef: mussel beds	Unlikely	Medium
	Subtidal coarse sediment	Unlikely	Medium
	Subtidal mixed sediment	Cannot be ruled out	Medium
	Subtidal mud	Cannot be ruled out	Medium
	Subtidal sand	Cannot be ruled out	Medium
Removal of non-target species	Harbour seal	No evidence of impact	High
	Intertidal coarse sediment	No evidence of impact	High
	Intertidal mud	Highly unlikely	Medium
	Intertidal sand and muddy sand	Cannot be ruled out	Medium
	Subtidal biogenic reef: mussel beds	Unlikely	Medium
	Subtidal coarse sediment	Unlikely	Medium
	Subtidal mixed sediment	Cannot be ruled out	Medium
	Subtidal mud	Cannot be ruled out	Medium
	Subtidal sand	Cannot be ruled out	Medium

Summary of assessment of "abrasion/disturbance of the substrate on the surface of the seabed" and "removal of non-target species"

Table 12: Summary of conclusions of assessment of Abrasion/disturbance of the substrate on the surface of the seabed and Removal of non-target species

Assessment		Appendix	Shrimp fishery impact	Confidence
Species diversity (number of taxa)	Intertidal habitats	8a	No evidence of impact	Low
	Subtidal coarse, sand, and mud		No evidence of impact	Low
	Subtidal mixed sediment		Cannot be ruled out	Low
Abundance ratio (species richness)	Intertidal sand	8b	No evidence of impact	Low
	Intertidal mud		Cannot be ruled out	Low
	Subtidal sand, subtidal mud, deeper subtidal mixed sediment habitats		No evidence of impact	Low
	Shallow subtidal coarse and mixed sediments		Cannot be ruled out	Low
Abundance and distribution of sensitive species	*Abra alba*	8c	Cannot be ruled out (subtidal habitats)	Low
	Bathyporeia elegans	8d	No evidence of impact	Low
	Flustra folicea	8e	No evidence of impact	Low
	Hydrallmania falcata	8f	No evidence of impact	Low

Assessment		Appendix	Shrimp fishery impact	Confidence
	Lanice conchilega	8g	Cannot be ruled out (deeper subtidal habitats)	Low
	Mediomastus fragilis	8h	Cannot be ruled out (deeper subtidal habitats)	Low
	Mytilidea	8i	Cannot be ruled out (subtidal habitats)	Medium
	Ophiuroidea	8j	Cannot be ruled out (subtidal habitats)	Low
Natural disturbance, water depth and fishing intensity	Species diversity and faunal clusters	9	No evidence of impact	Medium
Infaunal quality index		10	No evidence of impact	Medium
Sediment type, depth and fishing intensity	Species diversity	11	No evidence of impact	Medium
Harbour seal sensitivity and Biotope sensitivity	Harbour seal	12	No evidence of impact	High
	A2.1 Intertidal coarse sediment		No evidence of impact	High
	A2.2 Intertidal sand		Cannot be ruled out	Medium
	A2.3 Intertidal mud		Highly unlikely	Medium
	A5.1 Subtidal coarse sediment		Unlikely	Medium

Assessment		Appendix	Shrimp fishery impact	Confidence
	A5.2 Subtidal sand		Cannot be ruled out	Medium
	A5.3 Subtidal mud		Cannot be ruled out	Medium
	A5.4 Subtidal mixed sediment		Cannot be ruled out	Medium
	A5.6 Subtidal biogenic reef		Highly unlikely	Medium

6 Mitigation

This section of the Habitats Regulations Assessment outlines management measures (restrictions on shrimp beam trawling activity) considered to be appropriate to ensure the conservation objectives of the site are furthered.

The assessment identified that impacts from shrimp beam trawling were either *highly unlikely*, *unlikely*, had *no evidence of impact* or *could not be ruled out*, for several sub-features (summarised in Table 12, and shown below in Tables 15, 16 and 17). None of these equated to an adverse effect on the integrity of subfeatures. Overall, however, we judged that an adverse effect on site integrity could not be ruled out. Mitigation is planned to reduce the impacts (or likelihood of impacts) on subfeatures so that risk to the overall integrity of the site is eliminated. This includes mitigation to ensure the level of activity does not increase for subfeatures where potential impact was identified but did not constitute an adverse effect on those subfeatures.

6.1 General mitigation principles

Mitigation is designed to be precautionary, as required by the Habitats Regulations – i.e. where some uncertainty exists about impacts, mitigation will be applied. The level of precaution takes into account the level of confidence in evidence used to support the assessment.

Mitigation is also designed to be proportionate to the risk posed by the effect of the activity. The presence of an impact does not necessarily mean the activity causing the impact must be restricted: if the ecological functioning of the site continues despite a level of impact occurring, the conservation objectives are still being achieved. This fits with the concept of European Marine Sites being “sustainable use” sites. The regulator should demonstrate that it has sufficient control over an activity to ensure it does not increase beyond acceptable levels.

Eastern IFCA created a set of general principles to underpin the development of mitigation measures for the shrimp beam trawl fishery in the Wash & North Norfolk Coast SAC. These are set out in the box below.

General mitigation principles

1. Mitigation should remove the potential for the assessed activity to result in an adverse effect on site integrity.

2. Where the site can withstand the impacts of the activity without site integrity being adversely affected, the activity does not require mitigation.

3. If the habitats regulations assessment could not rule out an adverse effect on site integrity, regulators must take a precautionary approach in management of the activity until it can be shown that adverse effect on site integrity will not occur. This could mean the total exclusion of the activity within the site, or the activity being allowed with restrictions. The regulator must be confident that, if allowing the activity to continue, it will not result in an adverse effect on site integrity.

4. Whilst applying precaution, regulators must also take a pragmatic and enabling approach to activities within protected areas. Mitigation measures should be proportionate to the risks posed by activities, as identified through habitats regulations assessments.

5. Regulators must consider the advice of the statutory nature conservation body (Natural England) when identifying mitigation. When confident that mitigation will satisfy conservation needs, regulators should seek to minimise the socioeconomic effects of mitigation if this is possible without putting conservation objectives at risk.

6. Mitigation should be reviewed periodically, to ensure it remains fit for purpose.

6.2 Mitigation scoring

Where confidence in evidence is low, more precautionary mitigation is required. Conversely, where confidence in evidence is higher, less precautionary measures can be applied. This is illustrated below.

The results of the assessment section of the Habitats Regulations Assessment were described as *level of impact*, with an overall judgement on site integrity. The impact levels have been considered against the *level of confidence in evidence*, to provide a mitigation "score", using the following system:

Table 13: Mitigation scoring system

Impact	Cannot be ruled out	3	3	3
	No evidence of impact	2	2	1
	Unlikely	2	1	1
	Highly unlikely	1	1	1
		Low	Medium	High
		Confidence		

Table 14: Mitigation action related to mitigation score

Mitigation score	Mitigation action
3	Intervention, e.g. prevent interaction occurring, for some or all of feature
2	Management of activity at acceptable level
1	No intervention

Mitigation scores for site subfeatures, for the site as a whole, and for sensitive species, are presented in Tables 15, 16 and 17 respectively. These scores have been considered in determining appropriate mitigation.

Table 15 relates to impacts on subfeatures, from the assessments presented at Appendices 8a, 8b and 12.

Table 16 relates to impacts for the whole site, from the three assessments presented at Appendices 9, 10 and 11.

Table 17 relates to impacts on sensitive species within subfeatures and/or across the whole site, from the assessments presented at Appendices 8c-8j.

Table 15: Mitigation score derived from impact level and confidence **at subfeature level**, from three analyses (species diversity; abundance ratio; biotope sensitivity) used in this assessment. M = mitigation score (see Table 14)

Subfeature	Impact and Confidence (from Table 12) with allocated Mitigation score (M)									Overall (mean) mitigation score (M)
	Species diversity (App 8a)			Abundance ratio (App 8b)			Biotope sensitivity (App 12)			
	Impact	Confidence	M	Impact	Confidence	M	Impact	Confidence	M	
Harbour seal	n/a	n/a	n/a	n/a	n/a	n/a	No evidence of impact	High	1	1
A2.1 Intertidal coarse sediment	No evidence of impact	Low	2	n/a	n/a	n/a	No evidence of impact	High	1	1.5
A2.2 Intertidal sand	No evidence of impact	Low	2	No evidence of impact	Low	2	Cannot be ruled out	Medium	3	2.3
A2.3 Intertidal mud	No evidence of impact	Low	2	Cannot be ruled out	Low	3	Highly unlikely	Medium	1	2
A5.1 Subtidal coarse sediment	No evidence of impact	Low	2	Cannot be ruled out	Low	3	Unlikely	Medium	1	2
A5.2 Subtidal sand	No evidence of impact	Low	2	No evidence of impact	Low	2	Cannot be ruled out	Medium	3	2.3

A5.3 Subtidal mud	No evidence of impact	Low	2	No evidence of impact	Low	2	Cannot be ruled out	Medium	3	2.3
A5.4 Subtidal mixed sediment	Cannot be ruled out	Low	3	No evidence of impact / Cannot be ruled out	Low	3	Cannot be ruled out	Medium	3	3
A5.6 Subtidal biogenic reef	n/a	n/a	n/a	n/a	n/a	n/a	Highly unlikely	Medium	1	1

Table 16. Mitigation score derived from impact level and confidence **at site level**, from three analyses used in this assessment (natural disturbance, water depth & fishing intensity; Infaunal Quality Index and sediment type, depth & fishing intensity) used in this assessment. M = mitigation score (see Table 14).

	Impact and Confidence (from Table 12) with allocated Mitigation score (M)									Overall (mean) mitigation score (M)
	Natural disturbance, water depth & fishing intensity (App 9)			Infaunal quality index (App 10)			Sediment type, depth and fishing intensity (App 11)			
	Impact	Confidence	M	Impact	Confidence	M	Impact	Confidence	M	
W&NNC SAC	No evidence of impact	Medium	2	No evidence of impact	Medium	2	No evidence of impact	Medium	2	2

Table 17: Mitigation score derived from impact level and confidence **at species level**, from assessment of abundance and distribution of sensitive species. M = mitigation score (see Table 14)

Sensitive species (and Appendix)	Impact and Confidence (from Table 12)		Mitigation score (M)
	Assessment of abundance and distribution of sensitive species (App 8c-8j)		
	Impact	Confidence	
Abra alba (App 8c)	No evidence of impact (intertidal habitats)	Low	2
	Cannot be ruled out (subtidal habitats)	Low	3
Bathyporeia elegans (App 8d)	Unlikely	Low	2
Flustra folicea (App 8e)	Unlikely	Low	2
Hydrallmania falcata (App 8f)	Unlikely	Low	2
Lanice conchilega (App 8g)	Unlikely (shallow subtidal habitats)	Low	2
	Cannot be ruled out (deeper subtidal habitats)	Low	3
Mediomastus fragilis (App 8h)	Unlikely (intertidal and shallow subtidal habitats)	Low	2
	Cannot be ruled out (deeper subtidal habitats)	Low	3
Mytilidea (App 8i)	Cannot be ruled out (subtidal habitats)	Medium	3
Ophiuroidea (App 8j)	Unlikely (intertidal and shallow subtidal habitats)	Low	2
	Cannot be ruled out (deeper subtidal habitats)	Low	3

6.3 Mitigation measures

Mitigation will be applied in the form of:

(i) Spatial restrictions on the use of towed demersal fishing gear;
(ii) Technical restrictions on the type of fishing gear; and
(iii) Overall effort limitation in the shrimp beam trawl fishery.

6.3.1 Spatial restrictions

Closed areas prevent the fishery/feature interaction occurring, eliminating all associated pressures including abrasion and removal of non-target species. This level of intervention is judged to be required for some areas of the site in order to protect site integrity.

Areas of The Wash & North Norfolk Coast SAC will be closed to towed demersal fishing gear, to protect significant areas of the most sensitive habitats – primarily subtidal mixed sediments (mitigation score 3), and subtidal mud (mitigation score 2.3). Sensitive species will be also be protected within these areas, e.g. *Abra alba*, *Lanice conchilega*, *Mediomastus fragilis*, *Mytilidea* and *Ophiuroidea*. The closed areas will be applied via amendments to Eastern IFCA's Marine Protected Areas byelaw (http://www.eastern-ifca.gov.uk/marine-protected-areas-byelaw-2016-2/).

Closed areas will not be applied to all areas of the most sensitive subfeatures: unlike "red risk interactions", it is not necessary that the full extent of the subfeature is protected to avoid adverse effect on site integrity. Eastern IFCA has taken a feature-led and pragmatic approach to identifying the areas most suitable for closure. Areas for closure were selected to maximise ecological benefits, through targeted protection of multiple sensitive habitats and incidental protection of less sensitive habitats.

Eastern IFCA has identified that two types of subtidal mixed sediments occur within the site, one being more vulnerable that the other, based on the type of sediment and associated species present[13]. This is evidenced in grab sample and video survey data gathered by Eastern IFCA in 2016 and 2017 (Hormbrey 2018). Closures will be focused on the more vulnerable type of subtidal mixed sediment.

Vulnerable mixed sediment is defined as angular gravel with sand and mud, containing various epifauna and occurring in water deeper than ten metres below chart datum. The other common type of mixed sediment within The Wash is mud or sandy mud with gravel rounded by constant movement, sometimes including a layer of broken shell on the surface and containing very little if any epifauna.

Closures will include a large area of subtidal mixed sediment (with areas of subtidal mud) in deeper water areas (vulnerable habitat) of the central Wash, and an extensive area off the central north Norfolk coast in an area of sea between Wells-next-the-Sea and the eastern boundary of the SAC at Weybourne. The central Wash closure

[13] This information was not available at the time the assessment section (section 5) of this Habitats Regulations Assessment document was written.

includes areas of mosaic habitat (where there is a reasonable amount of vulnerable mixed sediment) and incorporates some “red risk” features including areas of core *Sabellaria spinulosa* reef and subtidal stony reef.

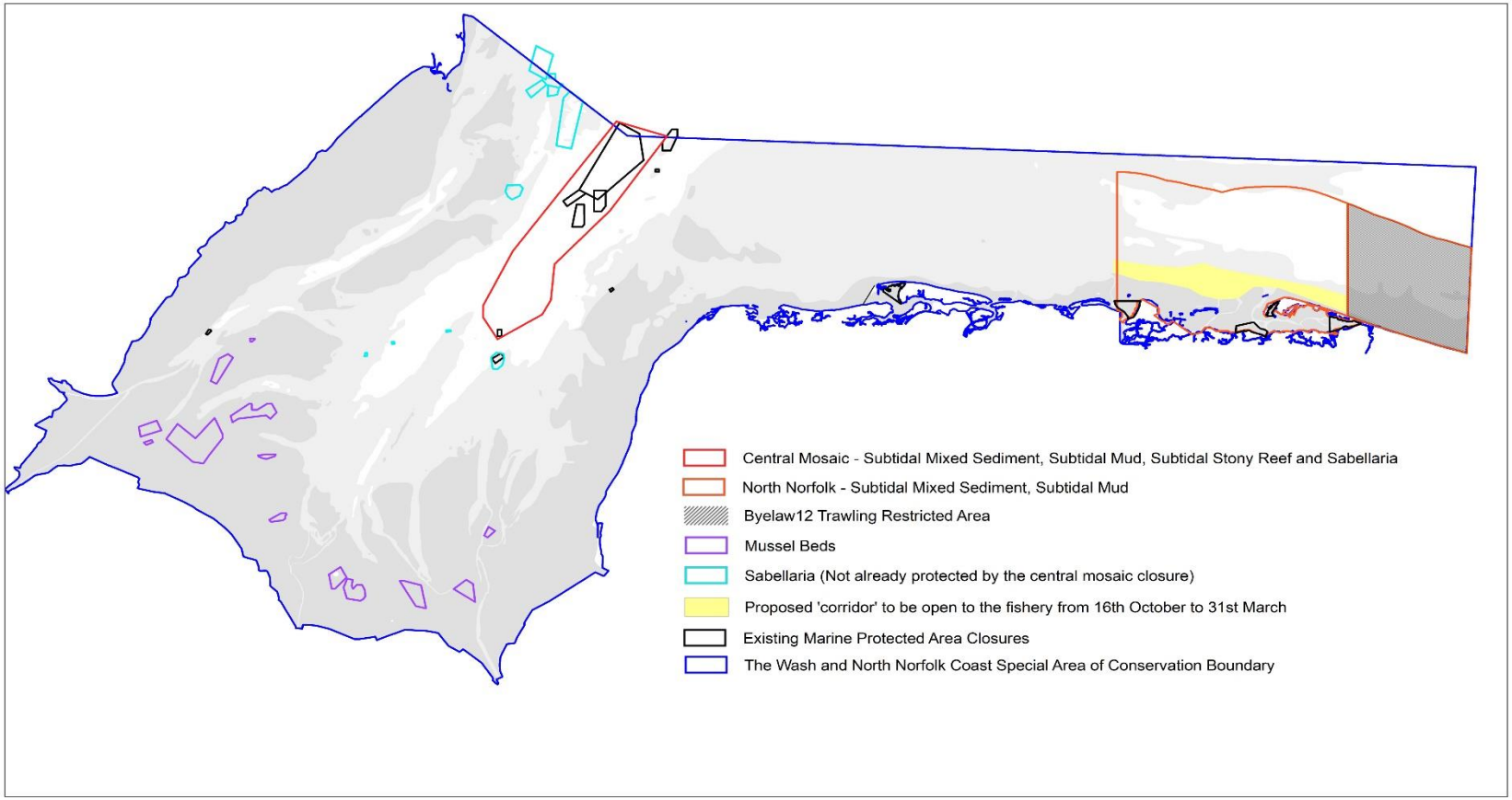
Mitigation will also include areas closed to towed demersal fishing gear over intertidal mussel beds within the site. The assessment did not identify that these features are at risk from shrimp beam trawling, but as biogenic reef they are “red risk” features that require protection. Shrimp beam trawling does not occur in these areas (their locations are well known by fishers and there is no benefit in trawling over mussel beds) but the closures are required under the “Revised Approach” (Defra 2012) and will ensure these important ecological features are protected from trawling damage. It is important to note that this will not preclude future dredge mussel fisheries, which are subject to bespoke Habitats Regulations Assessments and operated within strict conditions of the Wash Fishery Order and existing Eastern IFCA byelaws).

Proposed closed areas are shown in Figure 14. Please note, the actual closed areas will be subject to approval by Defra following full consultation.

It is judged that the spatial closures provide sufficient mitigation to ensure no adverse effect on site integrity from shrimp beam trawl fishery interactions with subtidal mixed sediment and subtidal mud. Furthermore, the closures will provide protection to key sensitive species highlighted in the assessment, including those with a mitigation score of 3[14] (*Abra alba*, *Lanice conchilega*, *Mediomastus fragilis*, *Mytilidea*, and *Ophiuroidea*) where they occur within these two subfeature habitats.

It is judged that spatial closures are not required for the remaining features, nor the remaining parts of the subtidal mixed sediment and subtidal mud subfeatures of the site, but that technical restrictions and overall effort limitations are required to limit impacts in the remainder of the site and ensure adverse effects on site integrity can be ruled out.

[14] Note that this score reflects the low confidence in the sensitive species part of the assessment, rather than a definite impact being identified for these species.



Eastern IFCA
Inshore Fisheries and Conservation Authority

Chart 1: Wash and North Norfolk Coast
Marine Protected Area
Proposed Closures - by related habitat type

Date:06/07/18 Drawn by:SC
Projection: Lat Long WSG84
EMS boundary:JNCC download - UK_SACs_withMarineComponents_2103821

Not to be used for Navigation

2018_06_Overview_Layout_draft Shrimp_closures.WOR

Figure 14 – Proposed closed areas in The Wash & North Norfolk Coast SAC

6.3.2 Technical restrictions

Technical measures are used to restrict the size and type of fishing gear being used in the site, which, coupled with effort control, limits the physical interactions between fishing gear and the environment.

The assessment identified that, aside from the most sensitive subfeatures – which are to be protected by spatial closures as set out in 6.2.1 – the site is able to withstand shrimp beam trawling – i.e. the activity does not prevent the remaining subfeatures' conservation objectives being met. This conclusion was based on the type of fishing gear and level of fishing effort being used in the site, and the various assessments presented in section 5.3. It is important that the fishery remains within these limits so that impacts do not increase beyond the assessed levels (for example if different fishing gear was used or fishing activity displaced from other areas), which could result in adverse effects. The mechanisms for ensuring this are technical restrictions and effort limits. These will be applied by Eastern IFCA as conditions in a new Shrimp Permitting byelaw.

Existing technical restrictions include:

- Maximum vessel length: 15.24m – EIFCA inshore trawling restriction byelaw (http://www.eastern-ifca.gov.uk/byelaw-12-inshore-trawling-restriction/)
- Maximum length of beam: 8m – European Council regulation
- Maximum vessel engine power: 221kW – European Council regulation
- Compulsory use of riddles on board – European Council regulation
- Compulsory use of veil nets (bycatch reduction gear) for vessels using aggregate beam length of 8m or over – European Council regulation
- Cod end mesh: 16-31mm – European Council regulation
- Shrimp fishing activity reporting scheme (Wash & North Norfolk coast area only) – EIFCA development of shellfish fisheries byelaw (http://www.eastern-ifca.gov.uk/byelaw-11-development-shellfish/)

New technical restrictions:

- Prohibition of use of tickler chains (or other gear component intended to penetrate or disturb the seabed)
- Requirement for flat beam shoes (to minimise penetration into seabed)
- Compulsory use of veil nets on all shrimp fishing vessels
- Compulsory use of inshore Vessel Monitoring System (to record vessel position and speed), allowing monitoring of spatial activity.

Potential additional restrictions[15]:

- Maximum weight of shrimp beam trawling gear
- Further restriction on overall size of shrimp beam trawling gear

[15] The potential additional restrictions require additional consideration and are not presented as part of the current mitigation for this Habitats Regulations Assessment.

- Further restriction on maximum vessel engine power
- Restriction on size and number of try-nets[16] permitted to be used.

The restrictions will apply to all shrimp beam trawling areas (i.e. the remainder of the site not affected by spatial closures) within the Wash & North Norfolk Coast SAC.

It is judged that the existing and new technical restrictions – coupled with spatial closures and effort limits – will ensure that the shrimp beam trawl fishery will not result in adverse effects on site integrity.

6.3.3 Effort limits

"Effort" is the level of fishing activity. The assessment of impacts from the shrimp fishery was based on levels of fishing effort as it has occurred in recent years. Effort levels are reported in the assessment using MMO landings data and EIFCA shrimp returns data. There is considerable variation in effort by month and by year, including variation in the number of vessels participating in the fishery and the number of fishing trips undertaken by each vessel. The available data will be carefully considered and used to set an appropriate limit on the activity, for example a maximum number of shrimp fishing trips per year (across the fleet).

Effort limitation will be implemented via a new Eastern IFCA Shrimp Permitting byelaw. It will be applied to whole of The Wash & North Norfolk Coast SAC. The byelaw will enable Eastern IFCA to close the shrimp fishery if the effort limit is reached.

Using rationale set out at Tables 13 and 14, the mitigation scores in Table 15 showed that "Manage activity at an appropriate level" is a proportionate management strategy for several sub-features across the SAC: intertidal coarse sediment (1.5), subtidal mud (2) and subtidal coarse sediment (2). All the sensitive species (Table 17) returned a mitigation score of at least 2 – partially reflecting the low confidence in this part of the assessment because of data limitations, rather than definite impacts from the shrimp fishery. Three different assessments using data across the whole site (Table 16) also returned mitigation scores of 2.

It is judged that, using effort limits to ensure the level of shrimp fishing activity does not exceed that described in the assessment, coupled with spatial closures and technical restrictions (described above), the shrimp beam trawl fishery will not result in an adverse effect on the integrity of the site.

[16] Try-nets are small, usually hand-hauled nets with a short beam (up to 80cm) set in front of shrimp beam trawl gear and used by fishers to check whether the target species is being found, without hauling the beam trawl gear. These were not described in the assessment because their use was not widely recognised. It is judged that their use does not cause additional impact to seabed habitats since any contact area from try-nets is covered by the main shrimp net, and the light weight and small size of try-nets means they do not penetrate into the seabed.

Table 18: Summary of mitigation for Wash & North Norfolk Coast, its sub-features or sensitive species where impacts could not be ruled out. (Mitigation score is explained in Tables 13 and 14). Note existing management measures for this fishery are not included in this table (they are set out in section 6.2.2 above).

Sub-feature	Mitigation score	Mitigation	Mechanism
Harbour seal	1	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
A2.1 Intertidal coarse sediment	1.5	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
A2.2 Intertidal sand	2.3	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
A2.3 Intertidal mud	2	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
A5.1 Subtidal coarse sediment	2	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
A5.2 Subtidal sand	2.3	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
A5.3 Subtidal mud	2.3	Spatial closures (part) Gear restriction; effort limitation	EIFCA Marine Protected Areas byelaw EIFCA Shrimp permitting byelaw
A5.4 Subtidal mixed sediment	3	Spatial closures (part) Gear restriction; effort limitation	EIFCA Marine Protected Areas byelaw EIFCA Shrimp permitting byelaw
A5.6 Subtidal biogenic reef	1	Spatial closures (update of 2014 closures)	EIFCA Marine Protected Areas byelaw EIFCA Shrimp permitting byelaw
W&NNC SAC	2	Spatial closures (part); Gear restriction; effort limitation	EIFCA Marine Protected Areas byelaw EIFCA Shrimp permitting byelaw
Abra alba (App 8c)	2 (intertidal)	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
	3 (subtidal)	Spatial closures (part)	EIFCA Marine Protected Areas byelaw EIFCA Shrimp permitting byelaw

Sub-feature	Mitigation score	Mitigation	Mechanism
Bathyporeia elegans (App 8d)	1	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
Flustra folicea (App 8e)	1	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
Hydrallmania falcata (App 8f)	1	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
Lanice conchilega (App 8g)	1 (shallow subtidal)	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
	3 (deeper subtidal)	Spatial closures (part)	EIFCA Marine Protected Areas byelaw EIFCA Shrimp permitting byelaw
Mediomastus fragilis (App 8h)	1 (intertidal/ shallow subtidal)	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
	3 (deeper subtidal)	Spatial closures (part)	EIFCA Marine Protected Areas byelaw EIFCA Shrimp permitting byelaw
Mytilidea (App 8i)	3	Spatial closures (part)	EIFCA Marine Protected Areas byelaw EIFCA Shrimp permitting byelaw
Ophiuroidea (App 8j)	1 (intertidal / shallow subtidal)	Gear restriction; effort limitation	EIFCA Shrimp permitting byelaw
	3 (deeper subtidal)	Spatial closures (part)	EIFCA Marine Protected Areas byelaw EIFCA Shrimp permitting byelaw

6.4 Monitoring and control

Eastern IFCA will produce a Monitoring and Control Plan for shrimp beam trawling within the Eastern IFCA district, with a particular focus on The Wash & North Norfolk Coast because of the importance of the shrimp fishery in this area and its environmental sensitivities. The plan will clearly define parameters to be monitored, threshold levels and feedback mechanisms, to ensure that any change in fishing effort or feature condition within the site is responded to appropriately and where required, management is adjusted accordingly. Continuous monitoring of fishing activity and data on feature condition within the site will strengthen confidence in the assessment and reduce the need for a more precautionary management approach.

6.5 Mitigation summary

Mitigation is required because the assessment of the shrimp beam trawl fishery in The Wash & North Norfolk Coast SAC concluded that “adverse effect on site integrity” could not be ruled out. This was a precautionary conclusion based on the lack of direct evidence that impacts were not occurring – although many parts of the assessment suggested that impacts were unlikely to occur, particularly on the less sensitive features of the site. The precautionary stance is required by the Habitats Regulations.

Mitigation principles have been set out, to guide the development of mitigation measures. These set out the need to be precautionary where uncertainty exists, as well as reflecting Eastern IFCA’s vision to achieve sustainable fisheries, healthy seas and a viable industry.

A scoring system was applied to help identify what level of mitigation might be appropriate for each subfeature. The score was based on the assessed level of impact and the level of confidence in supporting evidence, in each of the detailed parts of the assessment (presented in Appendices 8a-12 and summarised in section 5.3.1 of this Habitats Regulations Assessment).

Three forms of mitigation will be applied. Spatial closures will protect the most sensitive habitats of the site by excluding towed demersal fisheries from the main areas where they occur. Technical (gear) restrictions and a limit on the amount of shrimp beam trawling (effort) will be applied across the rest of the site, to ensure impacts do not exceed levels identified in the assessment.

The mitigation measures will be applied through Eastern IFCA’s existing Marine Protected Areas byelaw, and a new Eastern IFCA Shrimp Permitting byelaw. Table 18 sets out which measures relate to each subfeature where potential impact was identified.

Eastern IFCA will continue to monitor fishing activity within the site and use fishing activity data alongside subfeature data to inform future reviews of the effectiveness and appropriateness of mitigation.

7 Conclusion

This assessment of the impacts of the shrimp beam trawl fishery on The Wash & North Norfolk Coast SAC has been undertaken by Eastern IFCA as part of the revised approach to fisheries management in European Marine Sites. It has been based on best available evidence but has been hindered by significant limitations in the evidence, as detailed throughout the assessment. A precautionary approach has been taken when the evidence has been insufficient to make a fully informed judgement.

Nonetheless, Eastern IFCA has approached the assessment in a methodical way, utilising the updated conservation advice for the site (provided in March 2017) and previously unavailable information on the spatial distribution of shrimp fishing effort. The assessment has considered evidence for impacts across site features at the broad (site-wide) scale, as well as considering impacts on individual species and biotopes that characterise the site's features. Expert judgement has been applied where local knowledge of the site and the shrimp fishery have informed aspects of the assessment.

The assessment documented the systematic consideration of interactions between the shrimp fishery and site features. It showed the screening of interactions in the initial stage, the consideration of pressures categorised as "low risk" in the conservation advice and then more detailed consideration of medium and high-risk pressures.

The assessment identified that the beam trawl shrimp fishery is likely to be impacting certain sub features of the site through two pressures: *surface abrasion/disturbance* and *removal of non-target species*. These were evaluated using site-specific consideration of sensitive species and indicators of ecological status. The evaluation of these pressures was undertaken in a series of different ways, using the best available information which, in most cases, was limited in some way. The data limitations were presented alongside the evaluations. No single part of the evaluation is considered to provide definitive evidence by itself on the impacts of the shrimp fishery. Therefore, the conclusions of each section were combined to enable judgement to be made in relation to the effect of the fishery on site integrity.

The overall conclusion of the assessment has taken into account whether any reasonable scientific doubt remains as to the possibility of an adverse impact on site integrity occurring as a result of shrimp fishing activity. It has considered this in the context of the mitigation set out to eliminate, reduce or prevent an increase in the level of impacts occurring on the site.

The assessment has identified that, with mitigation in place as set out in this document, the shrimp beam trawl fishery will not result in an adverse effect on site integrity.

8 In-combination assessment

There is potential for in-combination effects with other consented activities affecting features of the site. These are considered below, and summarised in Table 19.

(i) Wash Fishery Order Regulated mussel fishery: Eastern IFCA authorises fisheries from natural mussel beds in the Wash Fishery Order area of The Wash, for direct harvesting or for relaying onto private lays (for growing on before harvesting). These mussel fisheries are predominantly intertidal but very occasionally can take place in subtidal areas. They are subject to strict conditions, including a limited entitlement system, quota, minimum landing size (harvesting fisheries), open and closed areas, open and closed dates and vessel and gear restrictions. The fisheries are subject to an annual, bespoke Habitats Regulations Assessment. The most recent assessment (March 2018) identified that with mitigation (to minimise impacts on intertidal mussel beds, and birds or seals using intertidal areas), the fishery would not have an adverse effect on site integrity. Assessments of future fisheries will consider impacts of the shrimp fishery in their in-combination assessment. Shrimp fishers activity avoid mussel beds so there is no in-combination effect with this feature. With mitigation outlined in this shrimp fishery HRA, it is assessed that adverse effects will not occur as a result of in-combination effects.

(ii) Wash Fishery Order Several mussel fishery: Eastern IFCA authorises private lays in the Wash Fishery Order area of The Wash. This includes 50 lays, covering 276ha. Seed mussel can be hand-picked from Welland Wall and relayed onto lays from a vessel. Lays may be inspected on foot by owners after relaying. Mussel is harvested from lays using up to two 1m wide dredges. No more than 22 vessels take part in this fishery at any one time, however it is important to note that this is an unrealistic level of activity not observed in The Wash, but is provided as a worst-case scenario if all lay holders are active on any one day. During the harvestable fishery season (September – March) fishers may visit lays up to three times per week to harvest stock, however the level of harvesting will depend on stock levels and in some cases lays can remain unvisited for long periods over a year. Mussel seed can be relayed throughout the year, although more commonly between March and April, and the relaying process (depositing mussels on lays) can take up to one hour each day.

Mussel lays, although contributing to available food for mussel-predating species, are private property and are not part of the designated features of the site. Harvesting from mussel lays is not assessed in terms of removal of target species, abrasion, penetration or food availability pressures, however requires consideration of the below pressures:

- There is no potential for relaying activities from Welland Wall to result in the introduction of invasive non-indigenous species (INIS) as all

mussels will be relayed within The Wash. However, if mussels are imported from areas outside of The Wash, consent is required from Eastern IFCA and is sought through a Shellfish Movement Form. Eastern IFCA only permit imports from areas free of shellfish disease. Individual fishers are required under the Wildlife and Countryside Act 1981 to ensure INIS are not present in mussel to be relayed. In addition, formal guidance on preventing the spread of INIS has been distributed to WFO lay holders. With these processes in place the risk of the several fishery introducing INIS is assessed to be minimal.

- Dredging activities could result in localised smothering and changes in siltation rates. However, compared to the high levels of suspended sediments/high turbidity observed within The Wash, activities resulting from this fishery have been assessed as unlikely to result in significant smothering of benthic habitats as a result of entrainment and subsequent resettlement of sediments disturbed during harvesting (ESFJC, 2008).
- There is potential for visual disturbance to SPA species from hand-working activities on Welland Wall or during lay inspections. However, the potential area disturbed per individual compared to the available SPA intertidal feeding habitat in The Wash is negligible (<0.094%, assuming a precautionary disturbance ratio of 300m). Assuming worst case scenario of 22 lay holders simultaneously inspecting lays at low water this would amount to a potential disturbance area of 622.6ha, 2.1% of the overall intertidal mudflats and sandflats. However, this level of activity has never been observed and is therefore considered extremely unlikely.

Upon consideration of these pressures, no significant in-combination effects on site integrity are predicted in-combination with the shrimp beam trawl fishery due to the small scale, limited geographic extent and short duration of the Several fishery activities and the negligible amount of spatial overlap with the shrimp fishery.

(iii) Wash Fishery Order cockle fishery: Eastern IFCA authorises fisheries from natural cockle beds in the Wash Fishery Order area of The Wash, for direct harvesting. These cockle fisheries are intertidal. They are subject to strict conditions, including a limited entitlement system, quota, open and closed areas, open and closed dates and vessel and gear restrictions. The fisheries are subject to an annual, bespoke Habitats Regulations Assessment. The most recent assessment (May 2018) identified that with mitigation (to minimise impacts on intertidal cockle beds, and birds or seals using intertidal areas), the fishery would not have an adverse effect on site integrity. Assessments of future fisheries will consider impacts of the shrimp fishery in their in-combination assessment. It is not anticipated that there will be an in-combination effect between the cockle fishery and the shrimp fishery, due both to the relatively low spatial overlap between the intertidal cockle fishery and the predominantly shallow sub-littoral shrimp fishery (some shrimp fishing occurs on intertidal areas, but it targets edges of mudflats rather than

mid- or upper-shore areas where cockle beds are more typically found), and the fact that many of those participating in the cockle fishery are the same fishers and vessels as participate in the shrimp fishery. As there is a need to remove the shrimp fishing gear before a vessel can go cockle fishing, there is no practical way for the same vessel to participate in both fisheries within a short (day / days) time period. With mitigation outlined in this shrimp fishery HRA, it is assessed that adverse effects will not occur as a result of in-combination effects.

(iv) Eastern IFCA intertidal activities: Eastern IFCA undertakes a range of activities on intertidal areas in the Wash & North Norfolk Coast, including shellfish stock surveys, habitat mapping, shellfish sampling, lay inspections and enforcement activities. The most recent assessment (June 2018) identified that with mitigation (to minimise disturbance to birds or seals using intertidal areas), the activities would not have an adverse effect on site integrity. It is assessed that adverse effects will not occur as a result of in-combination effects with the shrimp fishery, which primarily affects subtidal features, and because of the small scale, limited geographic extent and short duration of the intertidal activities.

(v) Natural England and the Environment Agency conduct their own intertidal surveys throughout the year. These include:

- Opportunistic Macroalgae survey in 2020 and 2023, carried out on foot across the saltmarsh between June and September, involving at least two staff members.
- Saltmarsh surveys are also scheduled for 2018 and 2021, these are foot based surveys between July and August involving at least two staff members.
- Intertidal seagrass survey planned in 2018 along the North Norfolk coast involving at least two staff members.
- Intertidal core survey for Lincs Shore project annually in September/October, involving 1 transect along North Wash intertidal area (at Wrangle Flats) involving at least two staff members.

These surveys are considered in bespoke assessments and no significant in-combination effects are predicted due to the small scale, limited geographic extent and short duration of surveys, and because the shrimp beam trawl fishery primarily affects subtidal features and includes mitigation to limit impacts in intertidal areas.

(vi) Potting fisheries: Within the Wash & North Norfolk Coast, potting fisheries target edible crab, lobster and whelk. MMO authorises potting fisheries for crab and lobster, and Eastern IFCA authorises whelk potting through a permitting byelaw. These fisheries occur mainly off the north Norfolk coast and in the deeper, central areas of The Wash. The fisheries are subtidal and target different seabed types from those targeted in the shrimp fishery. Eastern IFCA assessed the impact of the potting fisheries on biogenic reef features (*Sabellaria spinulosa* reef and subtidal stony reef) and found that no adverse effects occurred on these features at current levels of activity. The assessment did not specifically consider other subtidal habitats, but it is suggested that as no adverse effects were identified on the most sensitive

features (biogenic reefs) which are the primary areas of focus of the potting fishery, the potting fishery would not have an adverse effect on the remaining, less sensitive subtidal features which are subject to lower potting fishing pressures. No significant in-combination effects are predicted with the shrimp beam trawl fishery, because the two fisheries do not overlap spatially and because of mitigation to limit the spatial extent and overall effort in the shrimp fishery.

(vii) Le Strange (private) cockle and mussel fisheries: These fisheries are assented by Natural England. They occur on intertidal beds in the east of The Wash and are subject to management conditions although Eastern IFCA do not have details of these). Natural England liaise with the private estate regarding the management of the fishery to undertake appropriate assessment and ensure activities are in line with conservation objectives for the site. Eastern IFCA liaise with NE to ensure any impacts from the private fishery are duly considered in assessments and have no adverse effects, alone and in-combination, on site integrity. As for the Wash Fishery Order cockle and mussel fisheries, it is assessed that adverse effects will not occur as a result of in-combination effects with the shrimp fishery, which primarily affects subtidal features, and because of the small scale, limited geographic extent and short duration of the intertidal activities.

(viii) Race Bank and Lincs wind farm operations and maintenance activities: These activities are licensed by Marine Management Organisation. They include periodic cable repair/reburial activities, both within the wind farm arrays (outside the Wash & North Norfolk Coast SAC) and along the export cable route (through The Wash), which has localised impacts on seabed habitats. It is likely that the cable works could impact vulnerable subtidal habitats, including those currently protected through Eastern IFCA spatial closures and those proposed for closure as mitigation for the shrimp beam trawl fishery. Eastern IFCA's mitigation proposals for the shrimp fishery will have a protective effect and eliminate adverse effects from the shrimp fishery, but Eastern IFCA is not able to prevent wind farm operators from carrying out works in such areas.

8.1 Summary

The Wash & North Norfolk Coast SAC is an important area for multiple activities. The impacts of the shrimp beam trawl fishery (with mitigation set out in this document) has been considered alongside the impacts of ongoing, licensed activities (with their own mitigation). Although some activities impact the same features impacted by the shrimp fishery, it is judged that, with the outlined mitigation in place, the shrimp fishery will not result in an adverse effect on site integrity alone or in combination with other activities.

Table 19: In-combination assessment summary

Consented activity	Adverse effects on features, alone and in combination with shrimp beam trawl fishery							
	Intertidal habitats		Subtidal habitats		SPA bird species		Harbour seals	
	Alone	I-C	Alone	I-C	Alone	I-C	Alone	I-C
WFO Regulated mussel fishery	No, with mitigation	No, with mitigation	No, with mitigation	No, with mitigation	No, with mitigation	No	No, with mitigation	No
WFO Several mussel fishery	No, with mitigation	No	No	No	No, with mitigation	No	No	No
WFO Regulated cockle fishery	No, with mitigation	No, with mitigation	No	No	No, with mitigation	No	No, with mitigation	No
Eastern IFCA intertidal activties	No, with mitigation	No	No	No	No, with mitigation	No	No, with mitigation	No
Natural England & EA surveys	No	No	No	No	No, with mitigation	No	No, with mitigation	No
Potting fisheries	No	No	No	No, with mitigation	No	No	No	No
Le Strange private cockle and mussel fisheries	No, with mitigation	No, with mitigation	No	No	No, with mitigation	No	No	No
Race Bank and Lincs wind farm operations & maintenance activities	No, with mitigation	No, with mitigation	Possible	No, with mitigation	No, with mitigation	No	No, with mitigation	No

9 Summary of consultation with Natural England

Please see Appendix 4

10 Integrity test

The assessment has identified that, with mitigation in place as set out in this document, the shrimp beam trawl fishery will not result in an adverse effect on site integrity.

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