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03/08/2016	S Pengelly	1.10	Draft	Revision of management measures	
11/08/2016	V Gravestock	1.11	Final Draft	Small amendments to text	
09/09/2016	V Gravestock	1.11	Final Draft	Inclusion of a more detailed recovery rationale and monitoring strategy. Addition of Annex 9 to 11.	
28/09/2016	V Gravestock	1.12	FINAL		

This document has been distributed for information and comment to:

Title	Name	Date sent	Comments received
HRA – Solent Maritime SAC – Clam Dredging v1.3	Natural England	27/10/2015	02/12/2016
HRA – Solent Maritime SAC – Clam Dredging v1.6	Solent EMS consultation	06/01/2016	31/01/2016
HRA – Solent Maritime SAC – Clam Dredging v1.8	Natural England	08/02/2016	01/03/2016
HRA – Solent Maritime SAC – Clam Dredging v1.10	Natural England	03/08/2016	26/08/2016

HRA – Solent Maritime SAC – Clam Dredging v1.12	Natural England	09/09/2016	20/09/2016

Southern Inshore Fisheries and Conservation Authority (IFCA)

Fisheries in EMS Habitats Regulations Assessment for amber and green risk categories

European Marine Site: Solent Maritime SAC (UK0030059)

Feature(s): Estuaries; Mudflats and sandflats not covered by seawater at low tide

Generic Feature(s): -

Site Specific Sub-feature(s): Intertidal mudflat & sandflat communities, Intertidal mixed sediment communities, Subtidal sediment communities; Intertidal mud communities, Intertidal muddy sand communities, Intertidal sand communities, Intertidal mixed sediment communities; Subtidal gravelly sand and mud, Subtidal muddy sand

Generic Sub-feature(s): Intertidal mud, Intertidal mud and sand, Intertidal mixed sediments, Subtidal gravel and sand, Subtidal muddy sand, Subtidal mud, (Subtidal mixed sediments, Subtidal sand, Subtidal mud, Subtidal coarse sediment)

Gear type(s) Assessed: Clam Dredging

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1. Introduction

1.1 Need for an HRA assessment

Southern IFCA has duties under Regulation 9(3) of the Conservation of Habitats and Species Regulations 2010 as a competent authority, with functions relevant to marine conservation to exercise those functions so as to secure compliance with the Habitats Directive. Article 6.2 of the Habitats Directive requires appropriate steps to be taken to avoid, in Natura 2000 sites, the deterioration of natural habitats and habitats of species as well as significant disturbance of the species for which the area has been classified.

Management of European Marine Sites is the responsibility of all competent authorities which have powers or functions which have, or could have, an impact on the marine area within or adjacent to a European Marine Site (EMS). Under section 36 of the Species and Habitats Regulations (2010):

“The relevant authorities, or any of them, may establish for a European marine site a management scheme under which their functions (including any power to make byelaws) are to be exercised so as to secure in relation to that site compliance with the requirements of the Habitats Directive.”

Within the Solent EMS such a management scheme has been developed in the form of the SEMS management scheme which was established in 2004. This resulted in the establishment of a framework for the effective management of the Solent EMS so that the conservation objectives are met. The key principles of the management scheme are included in Annex 2.

In the SEMs Management Group 2015 Monitoring Report, fishing activities have been flagged to be a high risk or (Tier 1) activity. High risk activities are considered as potentially representing a high risk and/or not having sufficient “systems in place to ensure they are managed in line with the Habitats Regulations” and, therefore, requiring further management consideration. During the 2015 consultation a request was made to reduce the risk of fishing activity from high to medium risk. The response from the group was that in order to do this a clear audit and evidence trail would be required to reduce the risk. This assessment, in line with Article 6.2 of the Habitats Directives, will form part of that audit trail, as will other assessments regarding the fishing activities within the Solent EMS. It is considered that some level of management will be required for high risk activities within the EMS.

This audit trail will be achieved through Southern IFCA's responsibilities under the revised approach to the management of commercial fisheries in European Marine sites announced by the Department for Environment, Food and Rural Affairs (DEFRA).

The objective of this revised approach is to ensure that all existing and potential commercial fishing activities in European Marine Sites are managed in accordance with Article 6 of the Habitats Directive. Articles 4.1 and 4.2 of the Birds Directive also require that the Member States ensure the species mentioned in Annex I and regularly occurring migratory bird species are subject to special conservation measures concerning their habitat in order to ensure survival and reproduction in their area of distribution. This affords Special Protection Areas (SPAs) a similar protection regime to that of Special Areas of Conservation (SACs).

This approach is being implemented using an evidence-based, risk-prioritised, and phased approach. Risk prioritisation is informed by using a matrix of the generic sensitivities of the sub-features of the EMS to a suite of fishing activities as a decision making tool. These sub-feature-

activity combinations have been categorised according to specific definitions, as red[1], amber[2], green[3] or blue[4].

Activity/feature interactions identified within the matrix as red risk have the highest priority for implementation of management measures by the end of 2013 in order to avoid the deterioration of Annex I features in line with obligations under Article 6(2) of the Habitats Directive.

Activity/feature interactions identified within the matrix as amber risk require a site-level assessment to determine whether management of an activity is required to conserve site features. Activity/feature interactions identified within the matrix as green also require a site level assessment if there are "in-combination effects" with other plans or projects.

Site level assessments are being carried out in a manner that is consistent with the provisions of Article 6(3) of the Habitats Directive, but are required to meet the 6(2) responsibilities of Southern IFCA as a competent authority. The aim of the assessment will be to consider if the activity could significantly disturb the species or deteriorate natural habitats or the habitats of the protected species and from this, a judgement can be made as to whether or not the conservation measures in place are appropriate to maintain and restore the habitats and species for which the site has been designated to a favourable conservation status (Article 6(2)).If measures are required, the revised approach requires these to be implemented by 2016.

The purpose of this site specific assessment document is to assess whether or not in the view of Southern IFCA the fishing activity 'Clam Dredging' has a likely significant effect on the Estuaries, Mudflats and sandflats not covered by seawater at low tide and Sandbanks slightly covered by seawater all the time of the Solent Maritime SAC; and as part of this assessment to test whether the proposed management measures will be sufficient to ensure that the Southern IFCA meets its responsibilities as a Competent Authority and ensure that the conservation objectives will be met in relation to Clam Dredging over the features/sub-features of the Solent Maritime SAC. Please note that clam dredging is not a permitted fishing activity within the Sussex IFCA district, which extends to cover Chichester Harbour, as part of the previous Sussex Sea Fisheries Committee (SFC) district. Therefore the assessment will not cover Chichester Harbour.

1.2 Documents reviewed to inform this assessment

- SEMs Annual Monitoring Report 2015
- SEMs Delivery Plan 2014
- Natural England's risk assessment Matrix of fishing activities and European habitat features and protected species[5]

[1] Where it is clear that the conservation objectives for a feature (or sub-feature) will not be achieved because of its sensitivity to a type of fishing, - irrespective of feature condition, level of pressure, or background environmental conditions in all EMSs where that feature occurs – suitable management measures will be identified and introduced as a priority to protect those features from that fishing activity or activities.
[2] Where there is doubt as to whether the conservation objectives for a feature (or sub-feature) will be achieved because of its sensitivity to a type of fishing, in all EMSs where that feature occurs, the effect of that activity or activities on such features will need to be assessed in detail at a site specific level. Appropriate management action should then be taken based on that assessment.
[3] Where it is clear that the achievement of conservation objectives for a feature is highly unlikely to be affected by a type of fishing activity or activities, in all EMSs where that feature occurs, further action is not likely to be required, unless there is the potential for in combination effects.
[4] For gear types where there can be no feasible interaction between the gear types and habitat features, a fourth categorisation of blue is used, and no management action should be necessary.
[5] See Fisheries in EMS matrix: http://www.marinemanagement.org.uk/protecting/conservation/documents/ems_fisheries/populated_matrix3.xls

- Reference list[6] (Annex 1)
- Natural England's Regulation 33 advice[7]/Natural England's interim conservative advice
- Site map(s) – sub-feature/feature location and extent (Annex 3)
- Fishing activity data (map(s), etc) (Annex 4)
- Fisheries Impact Evidence Database (FIED)
- Natural England's scoping advice on the potential impacts of clam dredging within the Solent (Annex 5)

2. Information about the EMS

- Solent Maritime SAC (UK0030059)

2.1 Overview and qualifying features

- H1110. Sandbanks which are slightly covered by sea water all the time[8]
    - Subtidal gravelly sand and sand
    - Subtidal muddy sand
    - Subtidal eelgrass *Zostera marina* beds
- **H1130. Estuaries**
    - Saltmarsh communities
    - Intertidal mudflat & sandflats communities
    - Intertidal mixed sediment communities
    - Subtidal sediment communities
- **H1140. Mudflats and sandflats not covered by seawater at low tide; Intertidal mudflats and sandflats**
    - Intertidal mud communities
    - Intertidal muddy sand communities
    - Intertidal sand communities
    - Intertidal mixed sediment communities
- H1150. Coastal lagoons*
- H1210. Annual vegetation of drift lines
- H1220. Perennial vegetation of stony banks; Coastal shingle vegetation outside the reach of waves
- H1310. *Salicornia* and other annuals colonising mud and sand; Glasswort and other annuals colonising mud and sand
- H1320. *Spartina* swards (*Spartinion maritimae*); Cord-grass swards
- H1330. Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)
- H2120. Shifting dunes along the shoreline with *Ammophila arenaria* ("white dunes"); Shifting dunes with marram
- S1016*. Vertigo moulinsiana*; Desmoulin`s whorl snail

Please refer to Annex 3 for a site feature map.

[6] Reference list will include literature cited in the assessment (peer, grey and site specific evidence e.g. research, data on natural disturbance/energy levels etc)
[7] Solent EMS Regulation 33 Conservation Advice: http://publications.naturalengland.org.uk/publication/3194402
[8] Feature mapping has revealed that clam dredging does not occur over the 'Sandbanks which are slightly covered by seawater all the time' feature, as previously thought. 'Sandbanks which are slightly covered by seawater all the time' do not exist within Langstone Harbour or Southampton Water. Where clam dredging takes place over subtidal sediment, all subtidal sediment sub-features will be assessed under the 'Estuaries' sub- feature 'Subtidal sediment communities'.

The Solent Maritime SAC is located in one of only a few major sheltered channels in Europe, lying between a substantial island (the Isle of Wight) and the mainland. The Solent and its inlets are unique in Britain and Europe for their complex tidal regime, with long periods of tidal stand at high and low tide, and for the complexity and particularly dynamic nature of the marine and estuarine habitats present within the area. There is a wide variety of marine sediment habitats influenced by a range of salinities, wave shelter and intensity of tidal streams, resulting in a uniquely complex site. Sediment habitats within the estuaries include extensive areas of estuarine flats, with intertidal areas often supporting eelgrass *Zostera sp.* and green algae, saltmarshes and natural shoreline transitions, such as drift line vegetation.

2.2 Conservation Objectives

The Conservation Objectives for the Solent Maritime SAC features:

- H1130. Estuaries
- H1140. Mudflats and sandflats not covered by seawater at low tide

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

- The extent and distribution of qualifying natural habitats and habitats of qualifying species
- The structure and function (including typical species) of qualifying natural habitats
- The structure and function of the habitats of qualifying species
- The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely
- The populations of qualifying species, and,
- The distribution of qualifying species within the site."

The high level conservation objectives for the Solent Maritime SAC are available online at: http://publications.naturalengland.org.uk/publication/5762436174970880

3. Interest feature(s) of the EMS categorised as 'Red' risk and overview of management measure(s)

- Subtidal eelgrass *Zostera marina* beds

A red risk interaction between bottom towed gears and eelgrass/seagrass beds was identified and subsequently addressed through the creation of the 'Bottom Towed Fishing Gear' byelaw[9] and 'Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds' byelaw[10]. The 'Bottom Towed Fishing Gear' prohibits the use any bottom towed fishing gear within sensitive areas (characterised by reef features or eelgrass/seagrass beds) in European Marine Sites throughout the district. The byelaw also states that if transiting through a prohibited area carrying bottom towed fishing gear, all parts of the gear are inboard and above the sea. Within the Solent EMS, which includes waters to the north of the Isle of Wight, all eastern harbours and Southampton Water, there are 20 prohibited areas. The 'Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds' byelaw prevents digging, fishing for or taking any sea fisheries resource in or from prohibited areas containing eelgrass/seagrass beds in European Marine Sites throughout the District. Exceptions to the prohibition include if a net, rod and line or hook and line are used, in addition to the use of a vessel as long as the vessel's hull is not in contact with the seabed. It is

[9] Bottom Towed Fishing Gear Byelaw: https://secure.toolkitfiles.co.uk/clients/25364/sitedata/files/PDFbyelaw_bottomtowedfishi.pdf
[10] Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds Byelaw: https://secure.toolkitfiles.co.uk/clients/25364/sitedata/files/PDFbyelaw_prohibitionofgat.pdf

also prohibited to carry a rake, spade, fork or any similar tool within specified areas. Within the Solent EMS, which includes north of the Isle of Wight, all eastern harbours and Southampton Water, there are 25 prohibited areas.

4. Information about the fishing activities within the site

4.1 Activities under Consideration/Summary of Fishery

Clam dredging takes place all year round within the Solent Maritime SAC and predominantly targets the non-indigenous Manila clam (*Ruditapes philippinarum*), although the activity also targets American hard-shell clam (*Mercenaria mercenaria*). Occasional catches of the indigenous Grooved Carpet Shell clam (*Ruditapes decussatus)* also occur.

Manila clam is thought to have been introduced into the Solent and Southampton Water in 2005 (Tumnoi, 2012) and a fishery for the species developed a number of years later in 2007/08.

4.2 Technical Gear Specifications

A type of mechanical dredge, known as a box dredge, is used to fish for clams in the Solent Maritime SAC. A mechanical dredge consists of a metal frame with a row of metal teeth which are towed through the sediment using a boat (Figure 1) (Wheeler *et al*., 2014). The dredge is characterised by skis which sit on the base of the dredge and allow it to sit on the seabed whilst being towed. Current management measures do not specify the required configuration of box dredge and as a result the size of a box dredge can widely vary. Box dredges vary from 82 to 122 cm in width, 111 to 130 cm in length and 20 to 36 cm in depth. Some box dredges have a diving plate which helps to stabilise the dredge during deployment. The metal teeth range from 9 to 14 cm (16 cm diagonally) and are situated on the base of the dredge mouth opening. Teeth can be orientated vertically or angled diagonally forward to help cut through the sediment. These teeth penetrate into the sediment disturbing the buried clams which are subsequently caught and retained in the dredge. The posterior metal box is made up of bars, whose spacing also varies from 1.4 to 3.4 cm. This allows the dredge to pass through the sediment and unwanted debris can escape through the bars. Spacing may vary depending on the target species, with a larger bar spacing used for the hard-shell American clam, which has a greater minimum legal size than the Manila clam.

Typically, one or two dredges, although up to three has been observed, are deployed side by side, depending on the size of the boat, from the stern. The dredge is typically deployed using a mechanized winch to lower the gear to the sea bed and lift it back onto the vessel. The dredge is attached to the vessel using a rope which is typically tied to the tow riddle (Figure 2). The angle at which the dredge is towed depends on the tow riddle configuration; the further forward the rope is attached to the dredge, the steeper the angle it will penetrate into the sediment. The dredge is towed along the seabed in straight lines in the direction of the boat. Tows can vary in length and a vessel will go back and forth over the same fishing ground. Once back on deck, the dredge is emptied onto a griddle where the catch is, washed, sorted and sized. The griddle spacing is often optimised to allow for undersized clams to return straight back to the seabed.

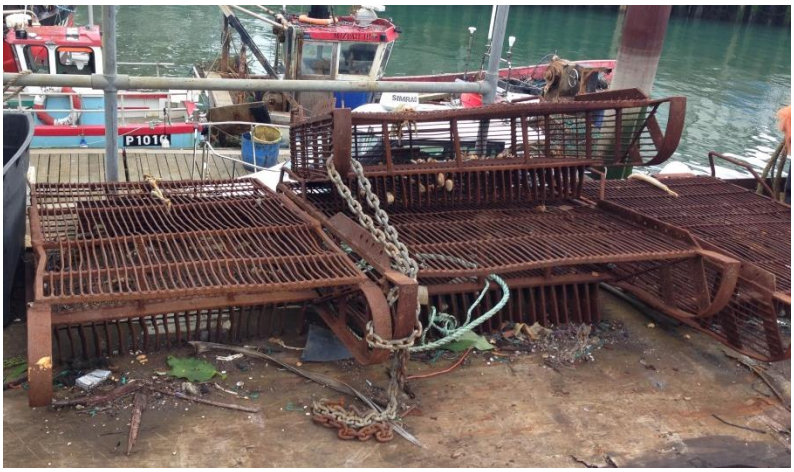

Figure 1. Box dredge used in the Solent clam fishery.

Figure 2. Box dredge tow riddle (highlighted in the red box). Two tow riddles are present on the front of the top of the riddle, one of each side. A rope attaches to the dredge through the holes in the tow riddle.

4.3 Location, Effort and Scale of Fishing Activities

Clam dredging takes place in distinct, small spatial areas, where shellfish beds exist. These largely include the eastern harbours and several discrete areas in Southampton Water and Lee on Solent (Annex 4). These sites occur both intertidally (at high tide) and subtidally, with vessels often operating in very shallow waters.

Sightings data in Annex 4 (split between 2005 to 2011 and 2012 to 2015) illustrates how clam dredge areas have changed over this time period. Between 2005 and 2011, clam dredging is shown to largely occur along the entire length of Southampton Water within the intertidal zone. Particular hotspots that can be identified include the western upper reaches of Southampton Water, where there is a very high density of sightings. These sightings cover areas adjacent to Hythe, extending down to Birds Pile and Lains Lake. Other key areas include Ashlett Creek and the western side of the River Hamble entrance. Between 2012 and 2015, the level of sightings in the western upper reaches of Southampton Water show a clear decline, with no sightings in this area in 2015. The reason for which is explained by changes in shellfish classifications in this area which prohibits fishing for clams from taking place (see section 6.5). Sightings within Ashlett Creek and the western side of the River Hamble remain as key areas of activity, with a greater number of sightings in the lower eastern reaches of Southampton Water near to Lee on Solent. In Langstone Harbour, sightings from 2005 to 2011 show clam dredging was concentrated in the north eastern quarter of the harbour within the intertidal zone, particularly close to North Lake and South Lake, with a number of sightings extending up into Broad Lake. From 2012 to 2015, sightings data show that clam dredging activity is concentrated in an area at the end of the Langstone Channel and to a lesser extent on the intertidal, with a number of sightings located within the channels. Please note that Southern IFCA's sightings data may reflect home ports of patrol vessels, high risk areas and typical patrol routes and therefore are only indicative of fishing activity. Over the ten year period covered by sightings data (2005-2015), it is likely that the geographical extent of the fishery is well reflected, however intensity may be skewed by aforementioned factors.

At its peak in 2007/2008, the clam fishery supported approximately 15 vessels. Since 2012, the number of vessels operating within the fishery has decreased to approximately 7, with an average

of 0 to 1 operating on any one day. This is largely supported by sightings data, provided by Langstone Harbour Board, for vessels fishing from November 2012 until 2014 in Langstone Harbour. During this time period, there were only three months (November 2012, June & July 2014) when the cumulative number of days spent fishing for all vessels exceeded the number of days within that month. Using the cumulative number of days spent fishing for all vessels, an average of 2.0 vessels operated daily in November 2012, 1.4 in June 2014 and 1.1 in July 2014.

The number of vessels sighted in Langstone Harbour by Langstone Harbour Board and in the whole Solent by Southern IFCA are summarised in Tables 1 and 2 respectively. Vessels sighted fishing once a month was discounted from Table 1 as these vessels can be considered to be prospecting. Prospecting involves investigating the potential to catch clams within that area and therefore is considered not to result in sustained fishing activity if a vessel is only sighted once. It is important to note that the data provided by Langstone Harbour Board does not differentiate between gear types or provide location of activities. Vessels which are known not to engage in clam dredging were excluded from Table 1.

Table 1. Vessel sightings in Langstone Harbour from 2012 to 2014, from data provided by Langstone Harbour Board. Sightings of vessels that are known not to oyster dredge were excluded.

Year	No. of fishing vessels sighted twice or more in any one month	No. of fishing vessels sighted 5 times or more in any one month	No. of fishing vessels sighted 10 times or more in any one month
2012	7	6	1
2013	5	1	0
2014	7	4	2

Table 2, shows a decline in the average number of fishing vessels sighted 5 times or more in a month between 2012 and 2015, and in all years no vessels were sighted 10 or more times in a month. The average number of vessels sighted per month and average number of vessels sighted 2 or more times in a month was lower in 2013 to 2015, when compared with 2012. In 2012 and 2014, the winter months appear to be characterised by higher levels of fishing activity, whilst in 2013, the highest levels of fishing activity occurred between June and August.

Table 2. Clam dredging vessel sightings in the Solent from 2012 to 2015, from data collected during sea and land patrols.

Year	Month	No. of fishing vessels sighted	No. of fishing vessels sighted twice or more	No. of fishing vessels sighted 5 times or more	No. of fishing vessels sighted 10 times or more
2012	Jan	11	8	2	0
	Feb	11	9	2	0
	Mar	9	5	0	0
	Apr	3	0	0	0
	May	7	3	0	0
	Jun	4	3	0	0
	Jul	6	0	0	0
	Aug	5	0	0	0
	Sep	11	6	0	0
	Oct	11	1	0	0
	Nov	5	0	0	0
	Dec	7	1	0	0
	Average	**7.5**	**3**	**0.3**	**0**
2013	Jan	6	0	0	0

	Feb	4	0	0	0
	Mar	5	2	0	0
	Apr	3	0	0	0
	May	0	0	0	0
	Jun	9	3	0	0
	Jul	7	3	1	0
	Aug	9	6	0	0
	Sep	4	0	0	0
	Oct	0	0	0	0
	Nov	0	0	0	0
	Dec	0	0	0	0
	Total	**3.9**	**1.2**	**0.1**	**0**
2014	Jan	8	6	0	0
	Feb	11	5	0	0
	Mar	2	0	0	0
	Apr	3	1	0	0
	May	4	1	0	0
	Jun	1	0	0	0
	Jul	5	0	0	0
	Aug	3	0	0	0
	Sep	2	1	0	0
	Oct	4	2	0	0
	Nov	5	0	0	0
	Dec	11	1	0	0
	Average	**4.9**	**1.4**	**0**	**0**
2015	Jan	3	1	0	0
	Feb	1	0	0	0
	Mar	5	3	0	0
	Apr	4	1	0	0
	May	3	1	0	0
	Jun	2	1	0	0
	Jul	1	0	0	0
	Aug	1	0	0	0
	Sep				
	Oct				
	Nov				
	Dec				
	Average	**2.5**	**0.9**	**0**	**0**

Vessels that take part in the fishery largely operate out of Portsmouth Harbour, with other vessels operating out of Warsash and Langstone Harbour. Landings data provided by the Marine Management Organisation (MMO) show the greatest quantities of all clam species between 2005 and 2014 were landed into Portsmouth, with Southampton landing the next greatest quantities of clams (Table 3). There are clear changes in the overall landings of each clam species within the Solent EMS (Figure 3). The development of the Manila clam fishery in 2007/2008 is well demonstrated by the jump in landings of 12.3 tonnes in 2007 to 185.1 tonnes in 2008. Landings of this fishery continued to rise until its peak in 2010, however since then landings have declined, explaining the reduction in vessels participating in the fishery since 2012. The magnitude of

American Hard-Shell clam and Grooved Carpet Shell clam is much less than that of Manila clam. The low level of Grooved Carpet Shell clam landings appears to show a general decline since 2008 which may be explained by simultaneous expansion of the non-indigenous Manila clam population. Landings of American Hard-Shell clam appear to remain relatively stable between 2007 and 2013, despite dipping in 2009 and 2013, although catches showed a large increase in 2014 to 43.7 tonnes. Please note that landings data should be viewed with caution, although reflective of the overall trends of the fishery. Exact figures are not always accurate; however this data represents the best available information to date.

Table 3. Landings (in tonnes) of key clam species (Manila clam - *Ruditapes philippinarum*, American Hard-Shell clam - *Mercenaria mercenaria,* Grooved Carpet Shell clam - *Ruditapes decussatus*) into ports located within the Solent European Marine Site (EMS). Data was provided by the Marine Management Organisation (MMO).

		Landings (Tonnes)									
	Port of Landing	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Manila Clam	Emsworth							0.1	0.2		
	Hamble	0.1			0.5	17.8	4.4	21.7	7.5		
	Isle Of Wight			0.2				0.0			
	Lymington and Keyhaven		4.9	2.1	4.8	2.5	1.8	0.6	6.2	3.4	0.4
	Portsmouth		0.5	5.5	169.8	130.9	263.6	101.8	172.6	69.5	68.6
	Southampton		3.5	4.6	10.1	41.8	79.9	52.3	22.1	10.6	4.1
	Total	**0.1**	**8.9**	**12.3**	**185.1**	**193.0**	**349.6**	**176.5**	**208.6**	**83.5**	**73.1**
American Hard-Shell Clam	Hamble				0.1		0.2	0.3	0.1		
	Lymington and Keyhaven		1.7	5.0	1.2	0.0	0.0	0.0	0.1		
	Portsmouth		0.0	1.6	9.6	0.4	7.2	6.1	7.7	1.6	43.7
	Southampton		3.6	1.7	0.2	0.6	1.8	4.5	4.7	0.0	
	Total	**0.0**	**5.3**	**8.3**	**11.1**	**1.0**	**9.1**	**10.9**	**12.6**	**1.8**	**43.7**
Grooved Carpet Shell Clam	Hamble				6.8	0.2		1.0	0.5		
	Isle of Wight			0.5					0.0		
	Lymington and Keyhaven			0.9	1.5	2.8					
	Portsmouth			0.1	10.9	5.0	11.4	1.3	2.0		
	Southampton				3.2	0.8	0.6	1.0			
	Total			**1.5**	**22.4**	**8.8**	**12.0**	**3.3**	**2.5**		

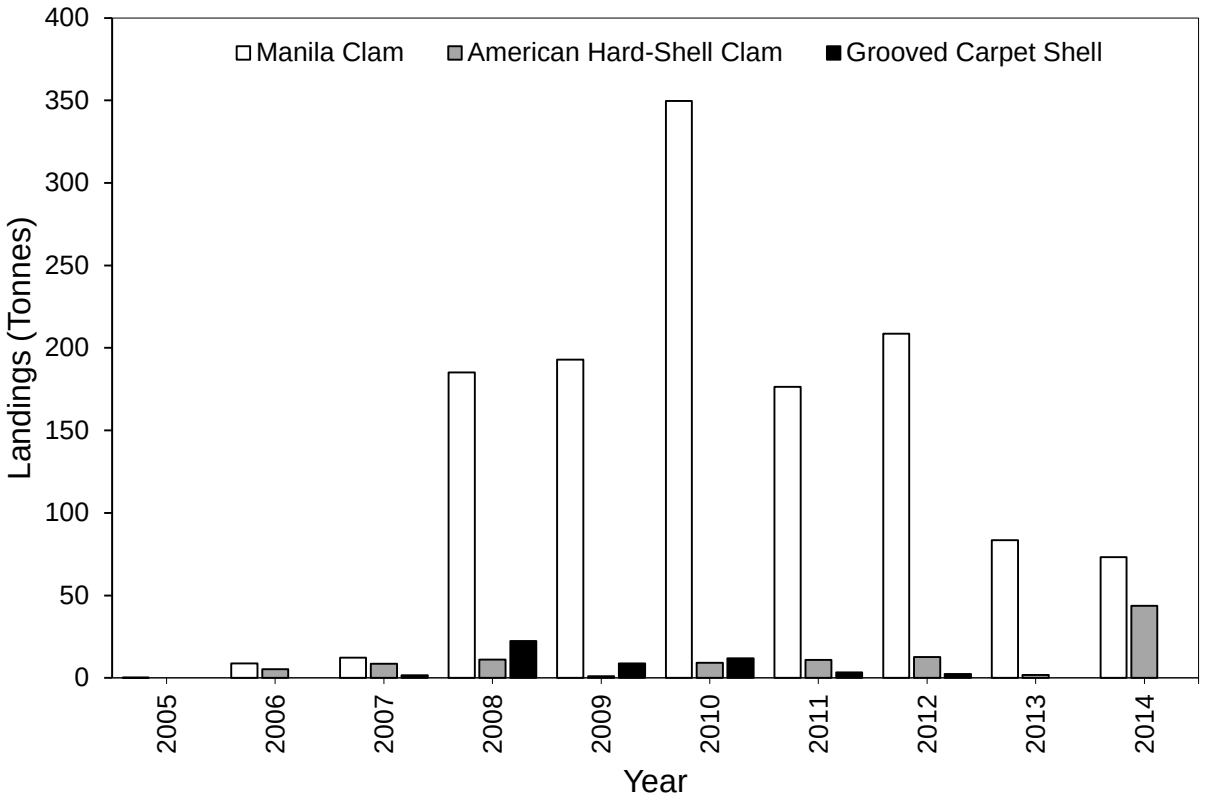

Figure 3. Total landings (in tonnes) of key clam species (Manila clam - *Ruditapes philippinarum*, American Hard-Shell clam - *Mercenaria mercenaria,* Grooved Carpet Shell clam - *Ruditapes decussatus*) into ports located within the Solent European Marine Site (EMS). Data was provided by the Marine Management Organisation (MMO).

5. Test of Likely Significant Effect (TLSE)

The Habitats Regulations assessment (HRA) is a step-wise process and is first subject to a coarse test of whether a plan or project will cause a likely significant effect on an EMS[11]. Each feature/sub-feature was subject to a separate TLSE, so the results are summarised in Table 4.

5.1 Table 4: Summary of LSE Assessment(s)

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

[11] Managing Natura 2000 sites: http://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm

<table>
<tr><td>2. What potential pressures, exerted by the gear type(s), are likely to affect the feature(s)/sub-feature(s)?</td><td colspan="2">Regulation 33 CA/Interim CA:
1. Physical loss – removal
2. Physical loss – smothering
3. Physical damage – siltation/Physical change (to another seabed type)/ Siltation rate changes (high and low)
4. Physical damage – abrasion/ Abrasion/disturbance of the substrate on the surface of the seabed/Penetration and/or disturbance of the substrate below the surface of the seabed
5. Toxic contamination – introduction of synthetic and non-synthetic compounds
6. Non-toxic contamination – changes in nutrient loading and organic loading/Organic enrichment
7. Non-toxic contamination – changes in turbidity/ Changes in suspended solids (water clarity)
8. Introduction of non-native species and translocation/ Introduction or spread of non-indigenous species
9. Selective extraction of species/Removal of non-target species</td></tr>
<tr><td rowspan="4">3. Is the feature(s)/sub-features(s) likely to be exposed to the pressure(s) identified?</td><td>Pressure</td><td>Screening - Justification</td></tr>
<tr><td>3.</td><td>IN – This gear type is known to cause the resuspension of finer sediments. Although the chances of siltation in areas of coarser sediment are lower, communities which inhabit areas of sand and gravel are sensitive to excessive inputs of fine material. Siltation and smothering may arise as an indirect effect of dredging taking place in an adjacent habitat. Further investigation is needed on the magnitude of the pressure, including the effect of the gear and the spatial scale/intensity of the activity.</td></tr>
<tr><td>4.</td><td>IN – This gear type is known to cause abrasion and disturbance to the seabed surface, including changes in topography. Further investigation is needed on the magnitude of the pressure, including the effect of the gear and the spatial scale/intensity of the activity.</td></tr>
<tr><td>9.</td><td>IN – Extraction of species is limited by minimum landing sizes and restrictions on gear, however the unsustainable removal of certain species may affect the ecological balance of the marine communities and predator species. Further investigation is needed on the magnitude of commercial shellfish collection and the role which commercial species may play.</td></tr>
</table>

4. What key attributes of the site are likely to be affected by the identified pressure(s)?	Regulation 33/Interim CA: - Topography - Sediment character/Sediment composition and distribution - Distribution and extent of characteristic range of biotopes/Presence and spatial distribution of subtidal coarse sediment/subtidal sandbank communities/Presence and abundance of typical species/Species composition of component communities	
5. Potential scale of pressures and mechanisms of effect/impact (if known)	Refer to full LSEs.	
6. Is the potential scale or magnitude of any effect likely to be significant?	**Alone** Yes	**OR In-combination**[12] N/A
6. Have NE been consulted on this LSE test? If yes, what was NE's advice?	Please refer to letters from Natural England dated 19/11/2015 & 08/01/16.	

[12] If conclusion of LSE alone an in-combination assessment is not required.

6. Appropriate Assessment

6.1 Co-location of Fishing Activity and Site Features/Sub-feature(s)

Maps of clam dredge sightings data and site features/sub-features can be found in Annex 6. These maps reveal where fishing activity occurs in relation to the designated features/sub-features of the site. Within Southampton Water, clam dredging only occurs on intertidal mud and although a number of sightings appear to be located in areas of saltmarsh, the nature of the fishing activity would eliminate this from occurring within these areas. Therefore these sightings are most likely explained by inaccurate reporting. In Langstone Harbour, clam dredging is shown to occur on intertidal mud, subtidal mixed sediments and on the fringes of intertidal sand and muddy sand. These sub-features are concurrent with the habitat preferences exhibited by the target species. The Manila clam is found intertidally, on the mid to upper shore in mixed sediments including gravel, sand or mud (DFO, 1999; Carter, 2005a). The American hard-shell clam is found in muddy sediments on the lower shore and sublittoral, as well as in bays and estuaries and the species exhibits a preference for sandy environments to depths of 15 m (Carter, 2005b).

6.2 Potential Impacts

6.2.1 Physical disturbance-

There are a number of ways in which mechanical shellfish dredges can cause physical disturbance and these include an increase in sediment suspension above background levels, an increase in turbidity as a result of resuspension, the creation of sediment plumes and a change in sediment composition (Mercaldo-Allen & Goldberg, 2011; Wheeler *et al*., 2014). The most obvious form of physical disturbance are changes in topography (Natural England, 2014). Typically impacts include the creation of depressions and trenches and the smoothing of ripples or creation of ridges within sand environments (Wheeler *et al*., 2014). Intertidal shellfish dredging can result in furrows up to tens of centimetres deep (Kaiser *et al*., 2006). The depth and width of a trench is largely determined by the mode of fishing, gear type and target species (Wheeler *et al*., 2014). An investigation into the effects of clam dredging in Langstone Harbour, where a modified oyster dredge was used, reported a clear disturbance of sediment (muddy gravel) down to a depth of 15 to 20 cm (EMU, 1992) (see Figure 4 and Annex 7 for example of potential bottom towed gear scars in Langstone Harbour). In southern Portugal, passage of a clam dredge produced a depression 30 cm wide and 10 cm deep (Constantino *et al*., 2009). The presence of dredge tracks may exist for days (Gaspar *et al*., 2003), weeks (Manning and Dunnington, 1995; Mercaldo-Allen & Goldberg, 2011) or months (Wheeler *et al*., 2014). The persistence of dredge tracks may depend on the depth at which they occur. In the Portugal-based study, dredge tracks caused by clam dredging were no longer distinguishable after 24 hours at 6 m depth but remained visible for 13 days at a depth of 18 m (Constantino *et al*., 2009). The magnitude of disturbance is based on the method of harvest, depth of gear penetration (i.e. length of teeth), fishing frequency, towing speed and method of deployment (Mercaldo-Allen & Goldberg, 2011).

Figure 4. Seabed scars (shown as numerous lines) potentially caused by bottom towed fishing gear. South Binness Island (tern nesting site) is located in the left hand side of the photo. Photo was taken in March 2012 by the RSPB. Source: Langstone Harbour Board.

Sediment character

Bottom towed fishing gears have been shown to alter the sedimentary characteristics of varying substrate types including subtidal muddy sand and mud habitats (Roberts *et al*., 2010). Experimental clam dredging activity in Langstone Harbour, using a modified oyster dredge, led to the removal of the coarse fraction of the sediment and larger sand and fine sediment fraction, with minor differences in the silt component (EMU, 1992). The sediment type for this area was muddy gravel (EMU, 1992). In contrast, a study assessing the impacts of suction dredging for common cockle in the Dutch Wadden Sea, revealed a loss of fine silts and subsequent increase in median grain size from 166.2 μm in 1988 to 179.1 μm in 1994 (Piersma *et al*., 2001). The sediment type in the study was sand. In addition, it was speculated that the loss of adult shellfish stocks as a result of suction dredging, may have also resulted in a reduction in the production of faeces and pseudofaeces which contribute to the silt component of the sediment (Piersma *et al*., 2001). The resuspension and dispersal of fine particles can lead to long term effects on particular sieve fraction (Pranovi & Giovanardi, 1994); potentially decreasing the clay portion of the sediment (Maier *et al*., 1998). Other changes in sediment character may also include a lack of consolidation of sediments (Aspden *et al*., 2004), the removal of stones and the removal of taxa that produce structure (i.e. tube-dwelling and burrowing organisms) (Johnson, 2002; Mercaldo-Allen & Goldberg, 2011). Such physical alterations can cause a reduction in sediment heterogeneity and structure available to biota as habitat (Johnson, 2002). In soft sediments, impacts on benthic fauna are likely to change sediment characteristics and vice versa (Piersma *et al*., 2001).

An ongoing study conducted by Leo Clarke at the University of Bournemouth investigated the impacts of clam dredging in Poole Harbour using a BACI (Before-After-Control-Impact) methodology. Core samples were taken from separate areas representing different levels of dredging intensity: an area that has historically been intensively dredged and remains open for a seven month season ('chronic' fishing site); an area that has historically been closed to dredging but will be opened for a five month season ('acute' fishing site); and an area that remains permanently closed to dredging (control site). Interim results indicate a significant effect of site (regardless of time) and of time (regardless of site). Organic content and the volume of fine sediments were found to be highest in the control site and lowest in the chronic fishing site during the study period. Additionally, both organic content and fine sediment volume were observed to decrease in all sites during the study. However, the interaction term between time and site, which would indicate an overall impact of dredging activity in terms of relative change, appears non-significant. While incomplete at the time of writing, the analysis of biological assemblage data indicates that a significant shift in community structure occurred within the acute fishing site during the study period. This shift is characterised by an increase in the abundance of polychaete worm species, but does not constitute a change to the overall biotope composition observed during the study.

Resuspension of sediment

The resuspension of fine sediments takes place as fishing gear is towed along the seafloor (Johnson *et al*., 2002). Larger sand particles are redeposited near the dredge whilst measurable amounts of fine silt and clay particles remain in suspension and are potentially transported away by currents (Godcharles, 1971; Tuck *et al*., 2000). The effects of sediment resuspension include increased turbidity and thus a reduction in light, burial of benthic biota, smothering of adjacent areas including potential spawning areas, and negative effects on the feeding and metabolic rates of organisms (Johnson *et al*., 2002). These effects are site-specific and depend on grain size, sediment type, water depth, hydrological conditions, sensitivity of fauna, currents, tides and water mass properties (Coen, 1995).

Resultant sediment plumes and areas of elevated turbidity can extend up to 30 metres beyond the dredge zone (Manning, 1957; Haven, 1979; Manzi *et al*., 1985; Maier *et al*., 1998), potentially transporting and redistributing sediment into adjacent areas (Vining, 1978). In most cases however, the amount of suspended sediment rapidly returns to low levels with distance from the dredge activity (Kyte *et al*., 1976; Maier *et al*., 1998) with 98% resettling within 15 m (Mercaldo-Allen & Goldberg, 2011). Effects of sediment plumes and enhanced turbidity levels appear to be temporary, with the majority of sediment plumes disappearing within hours of dredging (Maier *et al*., 1998). Dispersed sediments may take 30 minutes to 24 hours to resettle (Lambert & Goudreau 1996; Northeast Region EFHSC 200). Shallow water environments with high silt and clay content are likely to experience larger plumes and greater turbidity (Ruffin 1995; Tarnowski 2006).

In the context of natural disturbance, the resuspension of sediment caused by clam dredging in comparison to long-term wind-induced suspension of sediments, may be relatively minor (Auster & Langton 1999). Natural levels of turbidity, generated as a result of winds and tides, can produce particle loads equal to or exceeding that of dredging disturbance (Tarnowski, 2006). Organisms inhabiting inshore environments are therefore adapted to tolerate the resuspension of sediment at a certain level (Tarnowski, 2006). In addition, shellfish dredging only occurs in discrete areas, so the effects caused by resuspension will occur on a much smaller scale than those caused by natural disturbance (Wilber & Clarke, 2001).

6.2.2 Biological disturbance

General ecological issues related to the effects of mechanical shellfish harvesting include resuspension and associated turbidity affects, direct burial and smothering, release of contaminants, release of nutrients, decreased water quality, direct disturbance and removal of infauna and effects on economically important fisheries resources (Coen, 1995). Alterations in particle size and texture may lead to alterations in the type of organisms present in benthic communities (Pranovi and Giovanardi 1994; Skilleter *et al*. 2006). Furthermore, removal of bioturbator species can have indirect ecological effects on the stability and maintenance of biodiversity due to a reduction in habitat complexity (Nilsson & Rosenberg, 2003; Widdicombe *et al*., 2004).

Bottom towed fishing gear has been shown to reduce biomass, production and species richness and diversity (Veale *et al*., 2000; Hiddink *et al*., 2003). Alterations in the size structure of populations and community are also known to occur (Roberts *et al*., 2010). When dredges are towed along the seafloor, surface dwelling organisms can be removed; crushed, buried or exposed and sessile organisms will be removed from the substrate surface (Mercaldo-Allen & Goldberg, 2011). Direct burial or smothering of infaunal and epifaunal organisms is possible due to enhanced sedimentation rates (Mercaldo-Allen & Goldberg, 2011). In a meta-analysis of 39 studies investigating the effects of bottom towed gear, there was an overall reduction of 46% in the abundance of individuals within disturbed (fished) plots (Collie *et al*., 2000). In studies investigating the effect of intertidal dredging, it was common to observe 100% removal of biogenic fauna (Collie *et al*., 2000). This was observed in an experimental study conducted in Langstone Harbour, where the fauna were seen to either be completed removed or considerably reduced by the dredging activity using a modified oyster dredge (EMU, 1992). In the same study, species richness was also found to decrease with a mean number of 6.5 species in the control site compared with 4.4 in the dredge site (EMU, 1992). Another study based in the River Exe in Devon, found that harvesting of manila clams (*Tapes philippinarum*) by hand raking and suction dredging caused an initial reduction of 50% and 90% respectively, in species diversity and abundance (Spencer, 1997). The meta-analysis found that the magnitude of the response of fauna to bottom towed fishing gear varied with gear type, habitat (including sediment type) and among taxa (Collie *et al*., 2000).

In areas that are intensively fished (more than three times per year), the faunal community is likely to be maintained in a permanently altered state and inhabited by fauna adapted to frequent physical disturbance (Collie *et al*., 2000). There is likely to be a shift from communities dominated by relatively high biomass species towards the dominance of high abundances of small-sized organisms (Collie *et al*., 2000). Kaiser *et al*., 2000 reported that regular fishing activity, in the vicinity of the Isle of Man, excluded large-bodied individuals and the resulting benthic community was dominated by smaller bodied organisms more adapted to physical disturbance (Johnson, 2002). The mortality of target and non-target species can also cause an increase in opportunistic species (Wheeler *et al*., 2014). For example, in the initial period after dredging activities, scavenging organisms have been recorded feeding on damaged prey (Gaspar *et al*., 2003).

Whilst dredging causes direct mortality to small and large infaunal and epifaunal organisms, many small benthic organisms such as crustaceans, polychaetes and molluscs, have short generation times and high fecundities, both of which enhance their capacity for rapid recolonization (Coen, 1995). In such instances, the effect of dredging may only be short term. It is thought that short-term and localized depressions in infaunal populations is not a primary concern within subtidal habitats (Coen, 1995).

Vulnerable groups and species

The relative impact of shellfish dredging on benthic organisms is species-specific and largely related to their biological characteristics and physical habitat (Mercaldo-Allen & Goldberg, 2011). The vulnerability of an organism is ultimately related to whether or not it is infaunal or epifaunal, modile or sessile and soft-bodied or hard-shelled (Mercaldo-Allen & Goldberg, 2011). Epifaunal organisms inhabiting the seabed surface are subject to crushing or at risk of being buried, in addition to effects of smothering; whilst infaunal organisms living within sediment may be excavated and exposed (Mercaldo-Allen & Goldberg, 2011). A number of studies have found soft-bodied, deposit feeding crustaceans, polychaetes and ophiuroids to be most affected by dredging activities (Constantino *et al*., 2009). This is supported by a meta-analysis conducted by Collie *et al*. (2000) who predicted a reduction of 93% for anthozoa, malacostraca, ophiuroidea and polychaete after chronic exposure to dredging. Furthermore, a study looking at the effects of mechanical cockle harvesting in intertidal plots of muddy sand and clean sand, found that annelids declined by 74% in intertidal muddy sand and 32% in clean sand; and molluscs declined by 55% in intertidal muddy sand and 45% in clean sand (Ferns *et al*., 2000). Similar results were reported by EMU (1992), who found a distinct reduction in polychaetes, but less distinct difference in bivalves, after dredging had taken place and between dredged and control samples. This corresponds with analysis completed by Collie *et al*. (2000) who reported that bivalves appeared to less sensitive to fishing disturbance than anthozoa, malacostraca, ophiuroidea, holothuroidea, maxillopoda, polychaeta, gastropoda and echinoidea,

A number of studies have highlighted species that are particularly vulnerable to dredging as well as those which appear to be more tolerant. For example, the polychaete *Lanice conchilega* is highly incapable of movement in response to disturbance and therefore takes a significant period of time to recolonise disturbed habitats (Goss-Custard, 1977). Deep burrowing molluscs, such as *Macoma balthica*, also have limited capability to escape. Following suction dredging for the common cockle on intertidal sand, the abundance of *Macoma* declined for 8 years from 1989 to 1996 (Piersma *et al*., 2001). Ferns *et al*. (2000) reported reductions of 30% in the abundance of *Lanica conchilega* in intertidal muddy sand after mechanical cockle harvesting (using a tractor) took place, although abundances of *Macoma balthica* increased. The same study also revealed large reductions of 83% and 52% in the abundance of the polychaete *Pygospio elegans* and *Nephtys hombergii*, respectively (Ferns *et al*., 2000). The former species remained significantly depleted in the area of muddy sand for more than 100 days after harvesting and the latter for more than 50 days (Ferns *et al*., 2000). Other polychaete species also thought to be particularly affected are *Arenicola*, *Scoloplos*, *Heteromastus* and *Glycera* (Collie *et al*., 2000).

The aforementioned 8 year decline in *Macoma* following suction dredging for the common cockle on intertidal sand between 1989 and 1996, was also accompanied by a loss of *Cerastoderma edule* (Piersma *et al*., 2001). Declines of bivalve stocks were caused by a particularly low rate of settlement in fished areas (Piersma *et al*., 2001). It is speculated the reason for a lack of settlement was caused by sediment re-working from suction dredging, in particular the loss of fine-grained sediments which are conducive to bivalve settlement (Piersma *et al*., 2001).

Smothering effects

The resuspension of sediment can impact upon benthic communities through smothering, burial and increased turbidity. These effects may extend to organisms living a distance away from the fished area (Kyte & Chew, 1975). If high levels of sediment are resuspended and exposure to such events is regular, impacts may be severe (Mercaldo-Allen & Goldberg, 2011). Increased turbidity can inhibit respiratory and feeding functions of benthic organisms, in addition to causing hypoxia or anoxia (Morgan & Chuenpagdee, 2003). Sediment resuspension can jeopardise the survival of bivalves and fish as a result of clogged gills and inhibition of burrowing activity (Dorsey & Pederson, 1998). Small organisms and immobile species are particularly vulnerable to smothering (Manning, 1957). A redistribution of finer sediment can also hinder the settlement of organisms if shell or cultch material is buried (Tarnowski, 2006). The severity of such impacts are largely determined by sediment type, the level of sediment burden and the tolerance of organisms which is largely related to their biology (i.e. size, relationship to substrate, life history, mobility) (Coen, 1995).

Studies conducted in England and Florida found that the redistribution of sediments caused through dredging activity did not result in the smothering of benthic organisms within the nearby area and impacts were found to be limited to the directly disturbed area of the dredge (Schroeder, 1924; Spencer *et al*., 1998). Estuarine ecosystems, where dredging typically takes place, are high variable environments with elevated and variable suspended sediment loads and the organisms living there are often well adapted to such conditions (Coen, 1995). Such organisms are therefore generally considered tolerant to short-term perturbations in sediment loads (Lutz, 1938; Kyte *et al*., 1975). Laboratory experiments have shown that the majority of estuarine infaunal species are able to survive burial depths of up to 20 cm or more (Coen, 1995). In contrast, epifaunal and non-motile species can suffer high mortality rates after burial (Coen, 1995).

6.2.3 Chemical disturbance

The majority of experimental studies investigate the physical and biological effects of dredging (Mercaldo-Allen & Goldberg, 2011). Information of chemical effects of dredging is therefore limited (Mercaldo-Allen & Goldberg, 2011). The chemistry of bottom sediments may be altered when benthos are disturbed (Mercaldo-Allen & Goldberg, 2011). A number of studies have reported that sediments become more anoxic after dredging (EMU, 1992; Ferns *et al*., 2000). This may be caused by exposure of deep anaerobic sediment (Johnson, 2002). In one study, a dark anoxic layer was brought to the surface by the action of the harvester on muddy sand, although no such layer presented itself in clean sand (Ferns *et al*., 2000). Disruption of this anoxic layer may result in the release of sulphides into the upper layers of the sediment (Ferns *et al*., 2000). On the other hand, sediments that are overturned by dredging can enhance oxygen penetration into upper sediment layers (Falcão *et al*. 2003).

The removal or disruption to benthic organisms that are involved in biogeochemical processes within the sediment, may alter the biogeochemistry of the sediment (Mercaldo-Allen & Goldberg, 2011). For example, the removal of large benthic bioturbators may affect sediment nutrient and oxygen fluxes ad influence whether the seafloor acts as a source or sink for certain nutrients (Olsgard *et al*., 2008).

6.2.4 Sensitivity

Habitat type

In a meta-analysis of 39 studies, which were conducted on varying sediment types, the most negative impacts occurred in muddy sand and gravel habitats (Collie *et al*., 2000). Surprisingly, the meta-analysis revealed the least impact was observed on mud habitats and not sand, which was not consistent with the results obtained for abundance and species richness (Collie *et al*., 2000). It was however noted that this may have been explained by the fact most studies conducted on mud habitats were looking at the impacts of otter trawls and that if data were available for the effect of dredgers a more negative response for this habitat may have been observed (Collie *et al*., 2000). In a separate meta-analysis of 101 different fishing impact manipulations, the initial and long term impacts of different fishing types were shown to be strongly habitat-specific (Kaiser *et al*., 2006). Gravel habitats were negatively affected in both the short and long term by scallop dredging whilst soft-sediments (especially muddy sand) were particularly vulnerable to fishing impacts, with intertidal dredging shown to have the most severe initial impact (Kaiser *et al*., 2006; Roberts *et al*., 2010).This is supported by a number of studies. Moschino *et al*. (2003) reported enhanced damage to the clam *Chamelea gallina* in fine grain sand compared to those on coarser sand as a result of experimental hydraulic dredging. Another study by Ferns *et al*. (2000) observed a quicker recovery of species in an area of intertidal sand compared with an area of intertidal muddy sand. Recovery of individual species population densities in intertidal sand were reported to take up to 39 days, compared with over 174 days for some species in intertidal muddy sand (Ferns *et al*., 2000). A number of species (*Nephtys hombergii*, *Scoloplos armiger* and *Bathyporeia pilosa*) did take 51 days to recover in intertidal muddy sand (Ferns *et al*., 2000). Ferns *et al*. (2000) suggested that post dredging conditions of intertidal muddy sand may have been unsuitable for recolonization due to the disturbance of anoxic sediments.

The reason for the sensitivity of different sediment types to the impacts of dredging is related to the physical stability of the seabed (Collie *et al*., 2000). Fauna living within unconsolidated sediments such as those in shallow and sandy environments, are more adapted to dynamic environments, periodic resuspension and smothering and therefore able to recover more quickly (Tuck *et al*., 2000; Collie *et al*., 2000). Experimental studies investigating disturbance in shallow sandy environments indicate changes in community response are generally short-term (Kaiser *et al*., 1998). Impacts of bottom towed gear are therefore greatest in areas with low levels of natural disturbance (Hiddink *et al*., 2003).

Sensitivity analyses

A number of recent studies have endeavoured to map the sensitivity of habitats to different pressures (Tillin *et al*., 2010) and fishing activities (Hall *et al*., 2008).

Tilin *et al*. (2010) developed a pressure-feature sensitivity matrix, which in effect is a risk assessment of the compatibility of specific pressure levels and different features of marine protected areas. The approach used considered the resistance (tolerance) and resilience (recovery) of a feature in order to assess its sensitivity to relevant pressures (Tilin *et al*., 2010). Where features have been identified as moderately or highly sensitive to benchmark pressure levels, management measures may be needed to support the achievement of conservation objectives in

situations where activities are likely to exert comparable levels of pressure (Tilin *et al*., 2010). In the context of this assessment, the relevant pressures likely to be exerted are siltation rate changes, penetration and abrasion of the seabed and removal of non-target species. Sensitivity of intertidal and subtidal sediment types to these pressures vary from not sensitive to medium, generally with low confidence in these assessments (Table 5). Intertidal and subtidal mixed sediments appear to be most sensitive to all pressures, whilst intertidal and subtidal coarse sediment has relatively low sensitivity. Intertidal and subtidal mud appear to be particularly sensitive to the removal of species but not to changes in siltation rate, whilst the sensitivity to other pressures varies, with subtidal mud being more sensitive overall. Intertidal muddy sand and sand and subtidal mud appear to have an intermediate level of sensitivity.

Hall *et al*. 2008 aimed to assess the sensitivity of benthic habitats to fishing activities. A matrix approach was used, composed of fishing activities and marine habitat types, and for each fishing activity sensitivity was scored for four levels of activity (Hall *et al*., 2008). The matrix was completed using a mixture of scientific literature and expert judgement (Hall *et al*., 2008). The type of fishing activity chosen was 'oyster/mussel dredging and prospecting' as this was the most similar type of activity to the mechanical clam dredging that takes place within the Solent. All habitat types exhibited medium sensitivity to this activity at high and medium gear intensities and low sensitivity at low and single pass gear intensities (Table 6).

Table 5. Sensitivity of SAC features to pressures identified by Tilin *et al*. (2010). Confidence of sensitivity assessment is included in brackets.

	Pressure				
Feature	Siltation rate changes (low) – 5 cm of final material added to the seabed in a single event	Penetration and/or disturbance of the substrate below the surface of the seabed – structural damage to seabed >25mm	Shallow abrasion/penetration – damage to seabed surface and penetration <25mm	Surface abrasion – damage to seabed surface features	Removal of non-target species
Intertidal course sediment	Low (Low)	Not Sensitive (Low)	Not Sensitive (Low)	Not Sensitive (Low)	Not exposed (High)
Intertidal sand and muddy sand	Medium (Low)	Medium (Low)	Low (High)	Low (High)	Not Sensitive – Medium (Low)
Intertidal mud	Not Sensitive (High)	Low (High)	Low (High)	Not Sensitive (High)	Medium (Medium)
Intertidal mixed sediments	Medium (Low)	Medium – High (Low)	Medium – High (Low)	Medium (Low)	Medium (Low)
Subtidal coarse sediment	Not Sensitive – Medium (Low)	Low – Medium (Low)	Low – Medium (Low)	Not Sensitive – High (Low)	Not Sensitive – Medium (Low)
Subtidal sand	Medium (Low)	Low – Medium (Low to Medium)	Not Sensitive - Medium (Low)	Not Sensitive – Medium (Low)	Not Sensitive – Medium (High)
Subtidal mud	Not Sensitive – Low (Low)	Medium (Low)	Medium (Low)	Low – Medium (Low)	Medium (Low – High)
Subtidal mixed sediments	Not Sensitive (Low)	High (Low)	High (Low)	Medium (Low)	Medium (Medium)

Table 6. Sensitivity of SAC features to different intensities (high, medium, low, single pass) of oyster/mussel dredging as identified by Hall *et al*. (2008).

Habitat Type	Gear Intensity			
	Heavy	Moderate	Light	Single pass
Subtidal stable muddy sands, sandy muds and muds	Medium	Medium	Low	Low
Subtidal stable fine sands	Medium	Medium	Low	Low
Intertidal muds	Medium	Medium	Low	Low
Intertidal Muddy Sands – excl. gaper clams	Medium	Medium	Low	Low
Muds and sands – incl. gaper clams	High	High	Medium	Medium

Oyster/Mussel dredging and Prospecting covers oysters dredging within a wild fishery, prospecting for mussel seed (without remote sampling gear) and mussel dredging within a wild fishery.
Gear activity levels are defined as follows;
Heavy – Daily in 2.5 nm x 2.5 nm
Moderate – 1 to 2 times a week in 2.5 nm x 2.5 nm
Light – 1 to 2 times a month during a season in 2.5 nm x 2.5 nm
Single pass – Single pass of fishing activity in a year overall

6.2.5 Recovery

Recovery ultimately depends on the level of impact which is related to the weight of gear on the seabed, towing speed, the nature of bottom sediments and strength of tides and currents (Jones, 1992).

Habitat type and biological recovery

The timescale for recovery largely depends on sediment type, associated fauna and rate of natural disturbance (Roberts *et al*., 2010). In locations where natural disturbance levels are high, the associated fauna are characterised by species adapted to withstand and recover from disturbance (Collie *et al*., 2000; Roberts *et al*., 2010). More stable habitats, which are often distinguished by high diversity and epifauna, are likely to take a greater time to recover (Roberts *et al*., 2010). The recovery for gravel habitats has been predicted to be in the order of ten years (Collie *et al*., 2005). This was reported by recovery rates observed during a 10 year monitoring program of a gravel habitat located close to the Isle of Man following closure of the area to scallop dredging (Bradshaw *et al*., 2000). Similar recovery periods were estimated for muddy sands, which Kaiser *et al*. (2006) estimated to take years after finding the sediment type was particularly vulnerable to impacts of fishing activities. The recovery periods for sandy habitats is estimated to take days to months (Kaiser *et al*., 2006). In the meta-analysis conducted by Kaiser *et al*. (2006), a significant linear regression with time for the response of annelids to the impacts of intertidal dredging in sand and muddy sand habitats

was reported. Annelids were predicted to have recovered after 98 days post fishing in sand habitats and 1210 days in muddy sand habitats (Kaiser *et al*., 2006). Authors stated recovery for the latter however should be treated with caution (Kaiser *et al*., 2006).

The longer recovery periods for soft sediments are related to the fact these habitats are mediated by physical, chemical and biological processes, as opposed to the dominance of physical processes that occur within sandy habitats (Roberts *et al*., 2010). Furthermore, the recolonization of soft sediment habitats requires the recruitment of larvae, compared with migration of adult organisms in sandy habitats (Kaiser *et al*., 2006).

Population recovery rates are known to be species specific (Roberts *et al*., 2010). Long-lived bivalves will undoubtedly take longer to recovery from disturbance than other species (Roberts *et al*., 2010). Megafaunal species such as molluscs and shrimp over 10 mm in size, especially sessile species, are more vulnerable to impacts of fishing gear than macrofaunal species as a result of their slower growth and therefore are likely to have long recovery periods (Roberts *et al*., 2010). Short-lived and small benthic organisms on the other hand have rapid generation times, high fecundities and therefore excellent recolonization capacities (Coen, 1995). For example, slow-growing large biomass biota such as sponges and soft corals are estimated to take up to 8 years, whilst biota with short life-spans such as polychaetes are estimated to take less than a year (Kaiser *et al*., 2006).

Habitat type and physical recovery

Like the biological recovery of faunal communities, the physical recovery of sediments is largely related to sediment types and can be very site-specific (Mercaldo-Allen & Goldberg, 2011). In high energy environments physical recovery can take days, whereas recovery in low energy areas can take months (Northeast Region EFHSC, 2002; Wallace & Hoff, 2005). Dredge tracks persist for longer periods of time when there is less energy to erode dredge tracks (Mercaldo-Allen & Goldberg, 2011). The dredge associated trenches have found to be deeper and persistent for longer periods on sandy-mud habitats when compared with sand (Gaspar *et al*., 2003). Dredge tracks sandy and coarse sediment habitats are relatively short-lived and can disappear within 24 hours (Gaspar *et al*., 1998; 2003), although can last a few days to no more than a year (De Groot & Lindeboom, 1994; Lindeboom & de Groot, 1998). This is a relatively short period of time and dredge tracks have been known to persist on timescales from days to weeks to months (Gaspar *et al*., 2003; Manning & Dunnington, 1955; Mercaldo-Allen & Goldberg, 2011). Using side scan sonar and underwater video technology, Smith *et al*. (2007) showed trawl impacts on silty clay sediment were evident through the year within the study area, which also included a closed season. Marks left by a hydraulic dredge at a site in England were no longer obvious after 11 weeks (Tuck *et al*., 2000), although it took seven months to restore sediment structure after suction dredging at a separate site in England (Kaiser *et al*., 1996).

Marks left by dredging may no longer be visible after a certain period of time but differences in sediment composition may still be detectable (Mercaldo-Allen & Goldberg, 2011). Using acoustic reflective sonar, long-term changes in sediment structure has been detected between dredge furrows and the surrounding seabed (Mercaldo-Allen & Goldberg, 2011). One year after the use of an escalator harvester in Maryland, the

substrate exhibited less compaction, increased porosity and softer substrates (Pfitzenmeyer, 1972a; 1972b). In Florida, differences in sediment composition between dredged and undredged areas after hydraulic escalator harvesting were no longer present after 1 year (Godcharles, 1971).

The persistence of dredge scars does not necessarily indicate a lack of biological recovery. Dredge scars are likely to persist in areas characterised by low energy, during which time biological recovery may have taken place. It is therefore important to consider the type of environment in which the scars are present as biological recovery may take place over shorter timescales.

Depth

There is an inverse relationship between wave action and depth and so the natural mobility of bottom sediments tends to decrease with depth (Wheeler *et al*., 2014). The impact of shellfish dredging might therefore be more substantial in deeper subtidal habitats (Wheeler *et al*., 2014). Benthic communities in dynamic shallow water are likely to be more capable of overcoming disturbance than those in inhabiting deeper and less dynamic environments and as such are likely to have longer recovery times (Jones, 1992).

Studies on recovery rate

There are a limited number of studies which examine the recovery rate from biological and physical disturbance caused by shellfish dredging. Five studies were found on the impacts of shellfish harvesting on intertidal habitats, four of which are based in the UK (details are provided in Annex 9). The recovery rates reported range from no effect (thus no recovery is required) up to 12 months, with intermediate recovery rates reported at 56 days and 7 months (Kaiser *et al*., 1996; Hall & Harding, 1997). Spencer *et al*. (1998) reported a recovery rate of up to 12 months, although inferred it was not possible to be certain recovery had not occurred before this as not all treatment replicates were taken 4 and 8 months after sampling. The authors compared their findings with similar studies and speculated the greater length of recovery in comparison was related to the protected nature of the site (Spencer *et al*. 1998). This study highlights the importance of exposure in determining recovery rates of different habitats and also how recovery rates are site-specific.

Ferns *et al*. (2000) examined the recovery rates of individual species and found the rate of recovery varied between sediment types (muddy sand versus clean sand). Recovery rates reported for relevant species (i.e. those likely to occur within the Solent EMS) are presented in Annex 9.

6.3 Site Condition

Natural England provides information on the condition of designated sites and describes the status of interest features. This is derived from the application of ‘Common Standards Monitoring Guidance’ which is applied to a subset of ‘attributes’ of site features as set out in the sites’ Regulation 33/35 Conservation Advice document. Feature condition influences the Conservation Objectives in that it is used to determine

whether a ‘maintain’ or ‘recover’ objective is needed to achieve the target level for each attribute. Natural England’s current process for conducting condition assessments for marine features was developed due to requirements to report on condition of Annex 1 features at the national level in 2012/13 under Article 17 of the Habitats Directive. Since then, the methods have been reviewed and Natural England are actively working to revise this process further so that it better fulfils obligations to inform management actions within MPAs and allows them to report on condition. In light of this revision to the assessment methods, the condition assessments for the features of European Marine Sites have not been made available in the timeframe required under the revised approach.

An indication of the condition of site interest features can be inferred, if available, from assessments of SSSIs[13] that underpin the SAC. There are a number of SSSIs which exist within the area covered by Solent Maritime SAC and these, along with relevant feature condition assessments are summarised in Table 7. Note that only SSSI sites where clam dredging is known to occur have been chosen.

[13] SSSI Condition assessments: http://designatedsites.naturalengland.org.uk/.

Table 7. Condition assessments of SSSI units within the Solent Maritime SAC

SSSI Site Name	Habitat	Unit Name	Condition	Condition Threat Risk	Comments
Lee-on-the Solent to Itchen Estuary	Littoral sediment	Hamble Spit	Favourable[14]	High	The mixed sediment biotope has the most diverse biotope. Notable taxa at this site include *Mercenaria mercenaria*, where it is considered one of the largest remaining populations in the Solent – it is occasional but low in abundance. The presence of algal mats in the Hamble estuary and elsewhere in the SSSI suggest eutrophication.
Lee-on-the Solent to Itchen Estuary	Littoral sediment	Hook Foreshore	Unfavourable - recovering[15]	High	Having previously been in favourable condition up until 2000, the condition of this site was found to be unfavourable in 2008, with an unfavourable-recovering condition since 2009. The presence of algal mats in the Hamble estuary and elsewhere in the SSSI suggest eutrophication.
Hythe to Calshot Marshes	Littoral Sediment	Ashlett/Fawley Saltmarshes; Calshot Marshes Lnr	Unfavourable – recovering	Medium	Habitats are affected significantly by sea level rise and 'coastal squeeze. The extent of the habitat exposed at low tide is declining. Changes in water level are also likely to have adverse impacts on the distribution and extent of intertidal sediment biotopes.
Langstone Harbour	Littoral Sediment	Langstone Hbr East; Langstone Oyster Beds;	Unfavourable – recovering	High	Habitats are affected significantly by sea level rise and 'coastal squeeze. The extent of the habitat exposed at low tide is declining. Changes in water level are also likely to have adverse impacts on the distribution and extent of intertidal sediment biotopes. There is also concern about high nutrient levels.
Langstone Harbour	Littoral Sediment	North Binness Island; South Binness Island	Unfavourable – recovering	Medium	Habitats are affected significantly by sea level rise and 'coastal squeeze'. The extent of the habitat exposed at low tide is declining. Changes in water level are also likely to have adverse

[14] Favourable definition - The designated feature(s) within a unit are being adequately conserved and the results from monitoring demonstrate that the feature(s) in the unit are meeting all the mandatory site specific monitoring targets set out in the FCT. The FCT sets the minimum standard for favourable condition for the designated features and there may be scope for the further (voluntary) enhancement of the features / unit. A unit can only be considered favourable when all the component designated features are favourable.

[15] Unfavourable recovering definition - Units/features are not yet fully conserved but all the necessary management mechanisms are in place. At least one of the designated feature(s) mandatory attributes are not meeting their targets (as set out in the site specific FCT). Provided that the recovery work is sustained, the unit/feature will reach favourable condition in time.

					impacts on the distribution and extent of intertidal sediment biotopes. There is also concern about high nutrient levels.

Overall, the SSSI condition assessments appear to suggest that littoral sediments within selected SSSI sites are unfavourable, but recovering. When examining reasons for this, it appears from the condition assessment comments that the reasons for this are largely down to sea level rise and subsequent 'coastal squeeze' which are affecting the extent of the habitat and the biotopes that exist there. In addition to this, a number of the sites also appear to suffer from high nutrient levels. This would suggest that whilst the condition of many of the sites is unfavourable, the reasons for this are unrelated to fishing activities.

6.4 Existing Management Measures

- **Bottom Towed Fishing Gear** byelaw – prohibits bottom towed fishing gear over sensitive features including reef features and seagrass within the Solent Maritime SAC, closing most of the site to these activities.
- **Vessels Used in Fishing** byelaw – prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear and restricted to carry less static gear.
- **The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004** prohibits any fishing boat from deploying or carrying a dredge (unless inboard, secured and stowed) in any part of the Solent European Marine Site. Within the order 'dredge' refers to any form of shellfish dredge used in conjunction with any means of injecting water into the dredge or into the vicinity of the dredge. The reason the order was originally created was to protect seagrass but also restricts this type of shellfish dredging over other protected habitats within the EMS, including intertidal areas.
- **Bass Nursery Areas** – fishing for bass or fishing for any fish using sand-eels as bait by any fishing boat within designated areas is prohibited between 30 April and 1 November. Designated areas include Southampton Water (Cadland foreshore to the Warsash foreshore, but excluding those waters above the Redbridge Causeway on the River Test) and Langstone Harbour (Gunnery Range Light at Eastney Point to Langstone Fairway Buoy, then to the foreshore east of Gunner Point) and all year round in a 556 m radius around the Fawley Power Station outfall.
- **Fixed Engines** byelaw states that the placing and use of fixed engines, other than Fyke Nets, for the taking of seafish is prohibited during the period from 1 April to 30 September in any year in all parts of the Rivers Test and Itchen upstream of the line due East and West from the Southern end of the Port of Southampton Dockhead.
- **Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds** byelaw. This prohibits any person from digging for, fishing for or taking any sea fisheries resource in or from the prohibited areas and does not apply to fishing/taking fisheries resources by means of net, rod and line and hook and line. It also does not apply to fishing for/taking sea fisheries resources using a vessel, provided that no part of the vessels hull in contact with the seabed. No person shall carry a rake, spade, fork or any similar tool in prohibited areas

- **Fishing for Oysters, Mussels and Clam** byelaw states that when fishing for these species only the following methods are used; a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed.
- **Oysters, Clams, Mussels – Prohibition on Night Fishing** byelaw – No person shall dredge or fish or take any before 8.00 am or after 4.00 pm, although this byelaw does not apply to the taking of clams and mussels during any close season for oysters. This byelaw does also not apply to the dredging or fishing or taking of clams in Southampton Water North of the line joining the Northern ends of the Hamble and Fawley Oil Terminal Jetties.
- **Oyster Dredge** byelaw – in dredging or fishing for oysters is any fishery no dredge shall be used which has a front edge or blade exceeding 1.5 metres in length and if two or more dredges are in dredging or fishing for oysters used at the same time or in from the same boat or vessel the total length of the front edges or blades of such dredges when added together shall not exceed 3.0 metres.
- **Oysters** byelaw – no person shall remove from a public or regulated fishery any oyster (other than Portuguese or Pacific oysters) which will pass through a circular ring of 70 mm in internal diameter.
- **Regulation of the Use of Stake or Stop Nets in Langstone Harbour** – north of a line across the harbour entrance (Gunnar point to Eastney Lake Pumping Outfall Light), no person shall place or maintain or partly across a channel or creek at any place which becomes dry at low water, any stake, stop or dosh net during the period between the commencement of the last hour before the tide leaves that place and the expiration of the first hour after the tide has begun to reflow.
- **Oyster Close Season** prohibits any person from dredging or fishing for in or taking any fishery oysters during the period from the 1st day of March to the 31st of October in any year.
- **Temporary Closure of Shellfish Beds** byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established. In the context of this byelaw, 'shellfish' refers to mussels, oysters and clams. Currently this byelaw has been used to close the Solent Oyster fishery for the 2015 season based on results of the survey of Solent Oyster Beds, except for a two week season (1st November to 15th November) in Langstone and Portsmouth Harbours.
- The **Scallop Fishing (England) Order 2012** states that no more than 8 dredges per side to be towed at any one time and provides details for dredge configuration (i.e. the frame cannot exceed 85 cm in width). The **Scallop Fishing** Southern Sea Fisheries District Committee legacy byelaw states the maximum number of dredges which can be towed at any time is twelve, provides details of dredge configuration and that no person shall fish for or take any scallop from any fishery on any day before 0700 and after 1900 local time
- The **Cockles** byelaw states that no person shall fish for or take from a fishery any cockle between 1st day of February and 30th of April and when the cockle bed is covered by water only a dredge less than 460 mm in width can be used. In addition, no person shall remove a cockle that is able to pass through a gauge with a square opening measuring 23.8 mm along each side.
- **American Hard Shelled Clams – Minimum Size** byelaw – no person shall remove from a fishery any clams of the species *Mercenaria mercenaria* which measures less than 63 mm across the longest part of the shell.

- European minimum size, listed under Council Regulation (EEC) 850/98, Statutory Instruments specify the minimum size for Manila clams (*Ruditapes philippinarum*) is 3.5 cm and for Grooved Carpet Shell clams (*Ruditapes decussatus*) is 4.0 cm.

6.5 Classification of Shellfish

EC Regulations 853/2004 and 854/2004 set out criteria relating to the commercial production and sale of live bivalve molluscs (clams, cockles, oysters, mussels etc.) from classified production areas. These regulations form part of UK law and are implemented by means of the Food Safety and Hygiene (England) Regulations 2013. CEFAS coordinate the classification of shellfish beds on behalf of the FSA. Local Authorities are responsible for implementing sampling plans and are empowered to enforce the regulations.

Shellfish production areas are classified according to the extent to which shellfish sampled from the area are contaminated with potentially harmful bacteria. The classification of a production area determines the treatment required before the molluscs may be marketed and the classes are as follows:
A class - bivalve molluscs can be harvested for direct human consumption.
B class - bivalve molluscs can be marketed for human consumption after purification in an approved plant or after relaying in an approved class A relaying area or after being subjected to an EC approved heat treatment process.
C class - bivalve molluscs can be marketed for human consumption only after relaying for at least two months in an approved relaying area followed, where necessary, by treatment in a purification centre, or after an EC approved heat treatment process.
Prohibited areas - molluscs must not be subject to production or be collected.

Currently within the Solent EMS there are a number of areas where clam species are classified for harvesting. Within these areas there are a number where the harvesting of shellfish has been prohibited due to high E. Coli Levels. Included in Annex 8 are the classification maps produced by CEFAS for clam species that interact with Southampton Water and Langstone Harbour. In Southampton Water, areas highlighted in red have been prohibited since 2013 (Annex 8). The classification of these, and all areas included in the maps are subject to regular sampling and the maps included are correct as of August 2015.

6.6 Table 8: Summary of Impacts

The potential pressures, associated impacts, level of exposure and mitigation measures are summarised in table 8. Only relevant attributes identified through the TLSE process have been considered here.

Feature	Sub feature(s)	Attribute	Target	Potential Pressure(s) and Associated Impacts	Likelihood of Impacts Occurring/Level of Exposure to Pressure	Mitigation measures
Estuaries	Subtidal sediment communities (Reg 33); Subtidal mud; Subtidal mixed sediment; Subtidal sand; Subtidal coarse sediment (feature data); Subtidal gravel and sand; Subtidal muddy sand; Subtidal mud; Subtidal mixed sediments (Generic)	Topography	Depth should not deviate significantly from an established baseline, subject to natural change.	Abrasion, penetration and disturbance to the surface of the seabed and below the surface of the seabed were identified as potential pressures. Clam dredging has been reported to disturb the top 15 to 20 cm of sediment (EMU, 1992). Dredging is known to cause changes in topography (Natural England, 2014). Typically impacts include the creation of depressions and trenches and the smoothing of ripples or creation of ridges within sand environments (Wheeler *et al*., 2014). The physical recovery of sediments to such impacts largely depends on sediment type (Mercaldo-Allen & Goldberg, 2011). In high energy environments physical recovery can take days, whereas recovery in low energy areas can take months (Northeast Region EFHSC, 2002; Wallace & Hoff, 2005). Dredge tracks sandy and coarse sediment habitats are relatively short-lived and can disappear within 24 hours (Gaspar *et al*., 1998; 2003), although can last a few days to no more than a year (De Groot & Lindeboom, 1994; Lindeboom & de Groot, 1998). Trawl marks in silty clay sediment have been shown to	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. The distribution of fishing effort, as identified through IFCO knowledge, suggest clam dredging takes place in limited locations. In Southampton Water these include areas just outside of the entrance of the Hamble, Fawley down to Calshot and Lee on Solent, some of which fall outside the boundary of the Solent Maritime SAC. Shellfish classification prohibits fishing for clams in Southampton Water from the Fawley fuel jetty north. In Langstone Harbour, fishing activity is concentrated within the north eastern quarter of the harbour. It is known that clam dredging takes place both subtidally and intertidally so will affect both habitat types. Areas of sand and coarse	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the

				persist throughout the year within the study area (Smith *et al*., 2007).	sediment are unlikely to suffer long-term changes in topography as a result of clam dredging. Maps showing the co-location of fishing activity and site features/sub-feature reveal that no or very little clam dredging takes place in areas of subtidal coarse sediment or subtidal sand. The vast majority of mud habitat within the SAC is intertidal and feature data provided by Natural England show very limited, if no areas of subtidal mud environment. The subtidal channels within Langstone Harbour are largely dominated by subtidal mixed sediments. Within areas of subtidal mixed sediment no or very little clam dredging is known to occur and therefore the activity is highly unlikely to cause any adverse effect on the topography of subtidal sediment types. There is an inverse relationship between wave action and depth and so the natural mobility of bottom sediments tends to decrease with depth (Wheeler *et al*., 2014). The impact of shellfish dredging might therefore be more substantial and long term in deeper subtidal habitats (Wheeler *et al*., 2014).	fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of

						intertidal and subtidal habitats, as well as supporting breeding shellfish populations.
Estuaries	Subtidal sediment communities (Reg 33); Subtidal mud; Subtidal mixed sediment; Subtidal sand; Subtidal coarse sediment (feature data)	Sediment character (Reg 33); Sediment composition and distribution (Interim CA)	Average grain size parameter should not deviate significantly from an established baseline subject to natural change (Reg 33); The distribution of sediment composition types across the feature (and each of its sub-features)(presence/absence of areas mapped in GIS), compared to an established baseline, to ensure continued structural habitat integrity and connectivity (Interim CA)	Abrasion, penetration and disturbance to the surface of the seabed and below the surface of the seabed, as well as changes in siltation rates were identified as potential pressures. Clam dredging has been shown to alter the sedimentary characteristics of the affected substrate. The use of a modified oyster dredge to fish from clams has led to the removal of coarse fraction of sediment (EMU, 1992) and suction dredging has been shown to increase median grains through the loss of fine silts (Piersma *et al*., 2001). The resuspension and dispersal can also lead to long term effects on particular sieve fractions (Pranovi & Giovanardi, 1994); potentially decreasing the clay portion of the sediment (Maier *et al*., 1998). Other changes in sediment character may also include a lack of consolidation of sediments (Aspden *et al*., 2004), the removal of stones and the removal of taxa that produce structure (i.e. tube-dwelling and burrowing organisms) (Johnson, 2002; Mercaldo-Allen & Goldberg, 2011). Alterations to sediment composition may persist after dredge marks are no longer visible (Mercaldo-Allen & Goldberg,	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. The distribution of fishing effort, as identified through IFCO knowledge, suggest clam dredging takes place in limited locations. In Southampton Water these include areas just outside of the entrance of the Hamble, Fawley down to Calshot and Lee on Solent, some of which fall outside the boundary of the Solent Maritime SAC. Shellfish classification prohibits fishing for clams in Southampton Water from the Fawley fuel jetty north. In Langstone Harbour, fishing activity is concentrated within the north eastern quarter of the harbour. It is known that clam dredging takes place both subtidally and intertidally so will affect both habitat types. Maps showing the co-location of fishing activity and site features/sub-feature reveal that	Vessel Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be

				2011). Using acoustic reflective sonar, long-term changes in sediment structure has been detected between dredge furrows and the surrounding seabed (Mercaldo-Allen & Goldberg, 2011). Differences in sediment composition between dredged and undredged areas after hydraulic escalator harvesting were no longer detectable after 1 year (Godcharles, 1971)	no or very little clam dredging takes place in areas of subtidal coarse sediment or subtidal sand. The vast majority of mud habitat within the SAC is intertidal and feature data provided by Natural England show very limited, if no areas of subtidal mud environment. The subtidal channels within Langstone Harbour are largely dominated by subtidal mixed sediments. Within areas of subtidal mixed sediment no or very little clam dredging is known to occur and therefore the activity is highly unlikely to cause any adverse effect on the sediment character of subtidal sediment types. Physical recovery of high energy environments, such as areas of sand and coarse sediment, can take days, whilst low energy areas can take months (Northeast Region EFHSC, 2002; Wallace & Hoff, 2005). Higher energy environments are therefore unlikely to suffer long-term changes in sediment composition as a result of clam dredging.	fished until it becomes established.7 The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.

Estuaries	Subtidal gravel and sand (Generic); Subtidal gravelly sand and sand (Reg 33); Subtidal coarse sediment (Interim CA); Subtidal sand (Interim CA)	Range and distribution of characteristic subtidal sediment biotopes (Reg 33); Presence and spatial distribution of subtidal coarse sediment/subtidal sand sediment communities (Interim CA); Presence and abundance of typical species (Interim CA); Species composition of component communities (Interim CA)	Distribution and extent of characteristic biotopes should not deviate from an established baseline subject to natural change (Reg 33); The presence and spatial distribution of subtidal coarse sediment / subtidal sand communities according to the map (Interim CA); The abundance of listed typical species, to enable each of them to be a viable component of the habitat (Interim CA); The species composition of component communities (Interim CA)	The selection extraction of species and removal of non-target species, as well as changes in siltation rates were identified as potential pressures. Clam dredging is known to cause a number of potential impacts on the faunal community. Dredging results in the direct removal/mortality of benthic and epifaunal organisms – both target and non-target species. There are also indirect affects through the alteration of topography and sediment character and the resuspension of sediments. Bottom towed gear has been shown to reduce biomass, production and species richness and diversity (Veale *et al*., 2000; Hiddink *et al*., 2003). Alterations in the size structure of populations and community are also known to occur (Roberts *et al*., 2010). In areas of gravel and sand, siltation and smothering of faunal communities is a key concern. Areas of sand and gravel are highly sensitive to siltation as the marine communities which are sensitive to inputs of fine material (English Nature, 2001). For example silt can block feeding and respiratory apparatus (English Nature, 2001). Studies conducted in England and Florida found that the redistribution of sediments caused through dredging activity	Resultant sediment plumes and areas of elevated turbidity can extend up to 30 metres beyond the dredge zone (Manning, 1957; Haven, 1979; Manzi *et al*., 1985; Maier *et al*., 1998). The amount of suspended sediment rapidly returns to low levels with distance from the dredge activity (Kyte *et al*., 1976; Mairer *et al*., 1998), with 98% resettling within 15 m (Mercaldo-Allen & Goldberg, 2011). Feature data provided by Natural England show very limited areas of subtidal gravelly sand and sand environments (Annex 3). Within these areas no clam dredging is known to occur and the location of common clam dredging sites means the activity is highly unlikely to cause any adverse effect through resulting sediment plumes and elevated siltation rates. Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. This roughly corresponds to 'moderate' fishing intensity under the sensitivity analysis completed by Hall *et al*. (2008). At this fishing	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established.

				did not result in the smothering of benthic organisms within the nearby area and impacts were found to be limited to the directly disturbed area of the dredge (Schroeder, 1924; Spencer *et al*., 1998).	intensity, the sensitivity of subtidal stable find sands were classed as 'medium'. Different sediment types have varying sensitivities to the impacts of dredging and it is related to the physical stability of the seabed (Collie *et al*., 2000). Fauna living within unconsolidated sediments such as shallow and sandy environments, are more adapted to dynamic environments, periodic resuspension and smothering and therefore able to recover more quickly (Tuck *et al*., 2000; Collie *et al*., 2000). Within the Solent Maritime SAC, they key biotopes associated with littoral gravels and sands, include burrowing amphipods and polychaetes (*Arenicola marina*) in clean sand shores, burrowing amphipods *Pontocrates* spp and *Bathyporeia* spp in lower shore clean sand and dense *Lanice conchilega* in tide swept lower shore sand. Whilst amphipods are highly mobile and able to move away from disturbed areas, the polychaete *Lanice conchilega* are highly incapable of movement in response to disturbance (Goss-Custard, 1977). Ferns *et al*. (2000) reported reductions of 30 and 60% in the abundance of *Lanica conchilega* in intertidal muddy sand and intertidal clean sand respectively after mechanical cockle harvesting	The Cockles byelaw states that no person shall fish for or take from a fishery any cockle between 1st day of February and 30th of April and when the cockle bed is covered by water only a dredge less than 460 mm in width can be used. This largely the use of a clam dredge for harvesting cockles. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35

					(using a tractor) took place. This species remained at below pre-disturbance abundances for more than 86 days after dredging took place (Ferns *et al*., 2000). Other polychaete species also thought to be particularly affected are *Arenicola*, (Collie *et al*., 2000).	weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.
Estuaries	Subtidal muddy sand (Generic); Subtidal muddy sand communities (Reg 33); Subtidal sand (Interim CA)	Range and distribution of characteristic subtidal sediment biotopes (Reg 33); Presence and spatial distribution of subtidal sand communities (Interim CA); Presence and abundance of typical species (Interim CA); Species composition of component communities (Interim CA)	Range and distribution should not deviate significantly from an established baseline subject to natural change (Reg 33); The presence and spatial distribution of subtidal sand communities according to the map (Interim CA); The abundance of listed typical species, to enable each of them to be a viable component of the habitat (Interim CA); The species composition of component communities (Interim CA)	The selection extraction of species and removal of non-target species, were identified as potential pressures. Clam dredging is known to cause a number of potential impacts on the faunal community. Dredging results in the direct removal/mortality of benthic and epifaunal organisms – both target and non-target species. There are also indirect affects through the alteration of topography and sediment character and the resuspension of sediments. Bottom towed gear has been shown to reduce biomass, production and species richness and diversity (Veale *et al*., 2000; Hiddink *et al*., 2003). Alterations in the size structure of populations and community are also known to occur (Roberts *et al*., 2010). In a meta-analysis of 39 studies, those investigating the effect of intertidal dredging commonly reported 100% removal of biogenic fauna (Collie *et al*., 2000). This was also observed in an experimental study conducted in Langstone	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. This roughly corresponds to 'moderate' fishing intensity under the sensitivity analysis completed by Hall *et al*. (2008). At this fishing intensity, the sensitivity of subtidal stable muddy sands, sandy muds and muds were classed as 'medium'. In addition, areas that area intensively fished (more than three times per year), the faunal community is likely to be maintained in a permanently altered state and inhabited by fauna adapted to frequent physical disturbance (Collie *et al*., 2000). Feature data provided by Natural England show relatively limited areas of subtidal sand environments, with most occurring outside the SAC (Annex 3). The subtidal channels within	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing

				Harbour fauna in muddy gravel were seen to either be completed removed or considerably reduced by the dredging activity using a modified oyster dredge (EMU, 1992). In the same study, species richness was also found to decrease with a mean number of 6.5 species in the control site compared with 4.4 in the dredge site (EMU, 1992). The recovery of faunal communities which experience high levels are natural disturbance are generally characterised by species able to withstand and recover from disturbance (Collie *et al*., 2000; Roberts *et al*., 2010). Muddy sands are particularly vulnerable to impacts of fishing activities and recovery periods are estimated to take years (Kaiser *et al*., 2006). For example, in a meta-analysis conducted by Kaiser *et al*. (2006), the post fishing recovery annelids were predicted to have taken 98 days in sand habitats and 1210 days in muddy sand habitats (Kaiser *et al*., 2006). The longer recovery periods for soft sediments are related to the fact these habitats are mediated by physical, chemical and biological processes, as opposed to the dominance of physical processes that occur within sandy habitats (Roberts *et al*., 2010).	Langstone Harbour however are largely dominated by subtidal mixed sediments. Within areas of subtidal sands, sightings data reveals that no clam dredging takes place and the activity therefore will not cause any adverse effect. The likelihood of impacts occurring within subtidal muddy sands are likely to be greater than in coarse sand or intertidal habitats due to a lower natural disturbance rate. Habitats under the stress of frequent disturbance from dredging activity are likely to undergo be a shift from communities dominated by relatively high biomass species towards the dominance of high abundances of small-sized organisms (Collie *et al*., 2000). Many small benthic organisms such as crustaceans, polychaetes and molluscs, have short generation times and high fecundities, both of which enhance their capacity for rapid recolonization (Coen, 1995). In such instances, the effect of dredging may only be short term. Within the Solent Maritime SAC, they key biotopes associated with subtidal mud habitats include estuarine sublittoral muds containing *Aphelochaeta marioni* and *Tubificoides* spp invariable salinity infralittoral mud and *Nephtys hombergii* and	mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established. The Cockles byelaw states that no person shall fish for or take from a fishery any cockle between 1st day of February and 30th of April and when the cockle bed is covered by water only a dredge less than 460 mm in width can be used. This largely the use of a clam dredge for harvesting cockles. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions

					Tubificoides spp in variable salinity infralittoral soft mud. Some areas of subtidal muddy sand support a high number of species including cockles. Ferns *et al*. (2000) reported reductions of 34.6% and 52.2% in the abundance of *Nephtys hombergii* and *Cerastoderma edule* respectively, in intertidal muddy sand after mechanical cockle harvesting (using a tractor), with recovery periods of 51 and >174 days respectively. EMU (1992) reported that most annelids were badly affected by clam dredging (using a modified oyster dredge), except for the opportunist species *Tubificoides benedeni*. Prior to dredging, abundances of 70 individuals per m^2 were observed, one day and eight day post dredging samples revealed 0 and 53 individuals per m^2, illustrating rapid recovery times.	on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.
Estuaries	Subtidal mud (Generic); Subtidal mixed sediments (Generic); Subtidal sediment communities (Reg 33)	Range and distribution of characteristic subtidal sediment biotopes (Reg 33); Presence and spatial distribution of subtidal mixed communities (Interim CA); Presence and	Range and distribution should not deviate significantly from an established baseline subject to natural change (Reg 33); The presence and spatial distribution of subtidal mixed communities according to the map (Interim CA); The abundance of listed typical	The selection extraction of species and removal of non-target species, were identified as potential pressures. Clam dredging is known to cause a number of potential impacts on the faunal community. Dredging results in the direct removal/mortality of benthic and epifaunal organisms – both target and non-target species. There are also indirect affects through the alteration of topography and sediment character and the resuspension of sediments.	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. This roughly corresponds to 'moderate' fishing intensity under the sensitivity analysis completed by Hall *et al*. (2008). At this fishing intensity, the sensitivity of subtidal stable muddy sands, sandy muds	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and

		abundance of typical species (Interim CA); Species composition of component communities (Interim CA)	species, to enable each of them to be a viable component of the habitat (Interim CA); The species composition of component communities (Interim CA)	Bottom towed gear has been shown to reduce biomass, production and species richness and diversity (Veale *et al*., 2000; Hiddink *et al*., 2003). Alterations in the size structure of populations and community are also known to occur (Roberts *et al*., 2010). In a meta-analysis of 39 studies, those investigating the effect of intertidal dredging commonly reported 100% removal of biogenic fauna (Collie *et al*., 2000). This was also observed in an experimental study conducted in Langstone Harbour fauna in muddy gravel were seen to either be completed removed or considerably reduced by the dredging activity using a modified oyster dredge (EMU, 1992). In the same study, species richness was also found to decrease with a mean number of 6.5 species in the control site compared with 4.4 in the dredge site (EMU, 1992). The recovery of faunal communities which experience high levels are natural disturbance are generally characterised by species able to withstand and recover from disturbance (Collie *et al*., 2000; Roberts *et al*., 2010). The longer recovery periods for soft sediments are related to the fact these habitats are mediated by physical, chemical and biological processes, as opposed to the	and muds were classed as 'medium'. In addition, areas that area intensively fished (more than three times per year), the faunal community is likely to be maintained in a permanently altered state and inhabited by fauna adapted to frequent physical disturbance (Collie *et al*., 2000). Most of the mud habitats with the SAC are intertidal and feature data provided by Natural England show very limited, if no ,areas of subtidal mud environments (Annex 3). The subtidal channels within Langstone Harbour are largely dominated by subtidal mixed sediments. Within areas of subtidal mud and subtidal mixed sediment no or very little clam dredging is known to occur and therefore the activity is highly unlikely to cause any adverse effect. The likelihood of impacts occurring within subtidal muds are likely to be greater than in coarse sand or intertidal habitats due to a lower natural disturbance rate. Habitats under the stress of frequent disturbance from dredging activity are likely to undergo be a shift from communities dominated by relatively high biomass species towards the dominance of high abundances of small-sized organisms (Collie *et al*., 2000).	Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established. The Cockles byelaw states that no person shall fish for or take from a fishery any cockle between 1st day of February and 30th of April and when the cockle bed is covered by water only a dredge less than 460 mm in width can be used. This largely the use of a clam dredge for harvesting cockles. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing

				dominance of physical processes that occur within sandy habitats (Roberts *et al*., 2010).	Many small benthic organisms such as crustaceans, polychaetes and molluscs, have short generation times and high fecundities, both of which enhance their capacity for rapid recolonization (Coen, 1995). In such instances, the effect of dredging may only be short term. Within the Solent Maritime SAC, they key biotopes associated with subtidal mud habitats include estuarine sublittoral muds containing *Aphelochaeta marioni* and *Tubificoides* spp invariable salinity infralittoral mud and *Nephtys hombergii* and *Tubificoides* spp in variable salinity infralittoral soft mud. Some areas of subtidal muddy sand support a high number of species including cockles. Ferns *et al*. (2000) reported reductions of 34.6% and 52.2% in the abundance of *Nephtys hombergii* and *Cerastoderma edule* respectively, in intertidal muddy sand after mechanical cockle harvesting (using a tractor), with recovery periods of 51 and >174 days respectively. EMU (1992) reported that most annelids were badly affected by clam dredging (using a modified oyster dredge), except for the opportunist species *Tubificoides benedeni*. Prior to dredging, abundances of 70 individuals per m^2 were observed, one day and eight day post dredging samples revealed 0 and	areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.

					53 individuals per m^2, illustrating rapid recovery times.	
Intertidal mudflats and sandflats	Intertidal mud (Generic & Interim CA); Intertidal mud communities (Reg 33)	Topography	Shore profile should not deviate significantly from an established baseline subject to natural change (Reg 33); The presence of topographic features, while allowing for natural responses to hydrodynamic regime, by preventing erosion or deposition through human-induced activity (Interim CA)	Abrasion, penetration and disturbance to the surface of the seabed and below the surface of the seabed were identified as potential pressures. Clam dredging has been reported to disturb the top 15 to 20 cm of sediment (EMU, 1992). Dredging is known to cause changes in topography (Natural England, 2014). Typically impacts include the creation of depressions and trenches and the smoothing of ripples or creation of ridges within sand environments (Wheeler *et al*., 2014). The physical recovery of sediments to such impacts largely depends on sediment type (Mercaldo-Allen & Goldberg, 2011). In high energy environments physical recovery can take days, whereas recovery in low energy areas can take months (Northeast Region EFHSC, 2002; Wallace & Hoff, 2005). Trawl marks in silty clay sediment have been shown to persist throughout the year within the study area (Smith *et al*., 2007).	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. The distribution of fishing effort, as identified through IFCO knowledge, suggest clam dredging takes place in limited locations. In Southampton Water these include areas just outside of the entrance of the Hamble, Fawley down to Calshot and Lee on Solent, some of which fall outside the boundary of the Solent Maritime SAC. Shellfish classification prohibits fishing for clams in Southampton Water from the Fawley fuel jetty north. In Langstone Harbour, fishing activity is concentrated within the north eastern quarter of the harbour. It is known that clam dredging takes place both subtidally and intertidally so will affect both habitat types. Feature data provided by Natural England shows large areas of intertidal mud within the SAC (Annex 3). Within these areas	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes

					clam dredging is known to occur and this means the activity is likely to cause a potential adverse effect. There is an inverse relationship between wave action and depth and so the natural mobility of bottom sediments tends to decrease with depth (Wheeler *et al*., 2014). The impact of shellfish dredging in intertidal habitats might therefore be less significant and shorter term than in subtidal habitats.	established. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.
Intertidal	Intertidal	Sediment	Average particle	Abrasion, penetration and	Reports of clam dredging in the	Vessels Used in Fishing byelaw

mudflats and sandflats	mud (Generic & Interim CA); Intertidal mud communities (Reg 33)	character (Reg 33); Sediment composition and distribution (Interim CA)	size analysis parameters should not deviate significantly from an established baseline subject to natural change (Reg 33); The distribution of sediment composition types across the feature (and each of its sub-features)(presence/absence of areas mapped in GIS), compared to an established baseline, to ensure continued structural habitat integrity and connectivity (Interim CA)	disturbance to the surface of the seabed and below the surface of the seabed, as well as changes in siltation rates were identified as potential pressures. Clam dredging has been shown to alter the sedimentary characteristics of the affected substrate. The use of a modified oyster dredge to fish from clams has led to the removal of coarse fraction of sediment (EMU, 1992) and suction dredging has been shown to increase median grains through the loss of fine silts (Piersma *et al*., 2001). The resuspension and dispersal can also lead to long term effects on particular sieve fractions (Pranovi & Giovanardi, 1994); potentially decreasing the clay portion of the sediment (Maier *et al*., 1998). Other changes in sediment character may also include a lack of consolidation of sediments (Aspden *et al*., 2004), the removal of stones and the removal of taxa that produce structure (i.e. tube-dwelling and burrowing organisms) (Johnson, 2002; Mercaldo-Allen & Goldberg, 2011). Alterations to sediment composition may persist after dredge marks are no longer visible (Mercaldo-Allen & Goldberg, 2011). Using acoustic reflective sonar, long-term changes in sediment structure has been detected between dredge furrows	Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. The distribution of fishing effort, as identified through IFCO knowledge, suggest clam dredging takes place in limited locations. In Southampton Water these include areas just outside of the entrance of the Hamble, Fawley down to Calshot and Lee on Solent, some of which fall outside the boundary of the Solent Maritime SAC. Shellfish classification prohibits fishing for clams in Southampton Water from the Fawley fuel jetty north. In Langstone Harbour, fishing activity is concentrated within the north eastern quarter of the harbour. Feature data provided by Natural England shows large areas of intertidal mud within the SAC (Annex 3). Within these areas clam dredging is known to occur and this means the activity is likely to cause a potential adverse effect. Physical recovery of high energy environments can take days, whilst low energy areas can take	prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established. The Bottom Towed Fishing Gear

				and the surrounding seabed (Mercaldo-Allen & Goldberg, 2011). Differences in sediment composition between dredged and undredged areas after hydraulic escalator harvesting were no longer detectable after 1 year (Godcharles, 1971)	months (Northeast Region EFHSC, 2002; Wallace & Hoff, 2005). Higher energy environments, such as those in the wider Solent, are therefore unlikely to suffer long-term changes in sediment composition as a result of clam dredging. Intertidal habitats within the eastern harbours on the other hand are likely to be lower energy environments.	byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.
Intertidal mudflats and sandflats	Intertidal mud (Generic & Interim CA);	Range and distribution of characteristic mud biotopes	Range and distribution should not deviate significantly from	The selection extraction of species and removal of non-target species, were identified as potential pressures.	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The

	Intertidal mud communities (Reg 33)	(Reg 33); Presence and spatial distribution of intertidal mud communities (Interim CA); Presence and abundance of typical species (Interim CA); Species composition of component communities (Interim CA)	an established baseline subject to natural change (Reg 33); The presence and spatial distribution of intertidal mud communities according to the map (Interim CA); The abundance of listed typical species, to enable each of them to be a viable component of the habitat (Interim CA); The species composition of component communities (Interim CA)	Clam dredging is known to cause a number of potential impacts on the faunal community. Dredging results in the direct removal/mortality of benthic and epifaunal organisms – both target and non-target species. There are also indirect affects through the alteration of topography and sediment character and the resuspension of sediments. Bottom towed gear has been shown to reduce biomass, production and species richness and diversity (Veale *et al*., 2000; Hiddink *et al*., 2003). Alterations in the size structure of populations and community are also known to occur (Roberts *et al*., 2010). In a meta-analysis of 39 studies, those investigating the effect of intertidal dredging commonly reported 100% removal of biogenic fauna and were reported to have the most severe initial impact (Collie *et al*., 2000). Intertidal dredging may refer to other types of dredge including suction dredging. This was also observed in an experimental study conducted in Langstone Harbour where fauna in muddy gravel were seen to either be completed removed or considerably reduced by the dredging activity using a modified oyster dredge (EMU, 1992). In the same study, species richness was also found to	approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. This roughly corresponds to 'moderate' fishing intensity under the sensitivity analysis completed by Hall *et al*. (2008). At this fishing intensity, the sensitivity of intertidal mud was classed as 'medium'. In addition, areas that area intensively fished (more than three times per year), the faunal community is likely to be maintained in a permanently altered state and inhabited by fauna adapted to frequent physical disturbance (Collie *et al*., 2000). Feature data provided by Natural England shows large areas of intertidal mud within the SAC (Annex 3). Within these areas clam dredging is known to occur and this means the activity is likely to cause a potential adverse effect. Intertidal habitats are likely to experience a high rate of natural disturbance than subtidal habitats and therefore the severity of clam dredging impacts may be less. Habitats under the stress of frequent disturbance from dredging activity are likely to undergo be a shift from communities dominated by	reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established. The Cockles byelaw states that no person shall fish for or take from a fishery any cockle between 1st day of February and 30th of

				decrease with a mean number of 6.5 species in the control site compared with 4.4 in the dredge site (EMU, 1992). The recovery of faunal communities which experience high levels are natural disturbance are generally characterised by species able to withstand and recover from disturbance (Collie *et al*., 2000; Roberts *et al*., 2010). The longer recovery periods for soft sediments are related to the fact these habitats are mediated by physical, chemical and biological processes, as opposed to the dominance of physical processes that occur within sandy habitats (Roberts *et al*., 2010).	relatively high biomass species towards the dominance of high abundances of small-sized organisms (Collie *et al*., 2000). Many small benthic organisms such as crustaceans, polychaetes and mollusc (characteristic of mud communities), have short generation times and high fecundities, both of which enhance their capacity for rapid recolonization (Coen, 1995). In such instances, the effect of dredging may only be short term. Within the Solent Maritime SAC, they key biotopes associated with intertidal mud habitats include *Hediste diversicolor*, *Macoma balthica* in sand mud shores, *Hediste diversicolor* and *Scrobicularia plana* in reduced salinity mud shores and *Hediste diversicolor* and *Streblospio shrubnsolii* in sandy mud or soft mud shores. Deep burrowing molluscs, such as *Macoma balthica*, also have limited capability to escape. Following suction dredging for the common cockle on intertidal sand, the abundance of *Macoma* declined for 8 years from 1989 to 1996 (Piersma *et al*., 2001). Ferns *et al*. (2000) however reported increases of 35% in the abundances of *Macoma balthica* in muddy sand immediately following mechanical cockle dredging with a tractor. The same study also reported no change in	April and when the cockle bed is covered by water only a dredge less than 460 mm in width can be used. This largely eliminates the use of a clam dredge for harvesting cockles. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities

					the abundance of *Scrobicular plana*, although abundances were very low (2 individuals per m^2), before and immediately after dredging. Annelids in general are known to be vulnerable to impacts of bottom towed gear. In the meta-analysis conducted by Kaiser *et al*. (2006), a significant linear regression with time for the response of annelids to the impacts of intertidal dredging in sand and muddy sand habitats was reported. Annelids were predicted to have recovery times of 1210 days in muddy sand habitats (Kaiser *et al*., 2006). In support of this, EMU (1992) also reported that annelids were seen to be most badly affected by the action of a mechanical modified oyster dredge.	and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.
Intertidal mudflats and sandflats	Intertidal mud and sand (Generic); Intertidal muddy sand communities (Reg 33); Intertidal sand and muddy sand (Interim CA)	Topography	Shore profile should not deviate significantly from an established baseline subject to natural change (Reg 33); The presence of topographic features, while allowing for natural responses to hydrodynamic regime, by preventing erosion or deposition through human-induced activity	Abrasion, penetration and disturbance to the surface of the seabed and below the surface of the seabed were identified as potential pressures. Clam dredging has been reported to disturb the top 15 to 20 cm of sediment (EMU, 1992). Dredging is known to cause changes in topography (Natural England, 2014). Typically impacts include the creation of depressions and trenches and the smoothing of ripples or creation of ridges within sand environments (Wheeler *et al*., 2014). The physical recovery of sediments	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. The distribution of fishing effort, as identified through IFCO knowledge, suggest clam dredging takes place in limited locations. In Southampton Water these include areas just outside of the entrance of the Hamble, Fawley down to Calshot and Lee	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand

			(Interim CA)	to such impacts largely depends on sediment type (Mercaldo-Allen & Goldberg, 2011). In high energy environments physical recovery can take days, whereas recovery in low energy areas can take months (Northeast Region EFHSC, 2002; Wallace & Hoff, 2005). Trawl marks in silty clay sediment have been shown to persist throughout the year within the study area (Smith *et al*., 2007).	on Solent, some of which fall outside the boundary of the Solent Maritime SAC. Shellfish classification prohibits fishing for clams in Southampton Water from the Fawley fuel jetty north. In Langstone Harbour, fishing activity is concentrated within the north eastern quarter of the harbour. It is known that clam dredging takes place both subtidally and intertidally so will affect both habitat types. Feature data provided by Natural England show intermittent areas of intertidal mud and sand throughout the SAC. Sightings data reveal that clam dredging may occur on the fringes of this sub-feature. When combined with the known sensitivity of this habitat, clam dredging may have the potential to cause an adverse effect. There is an inverse relationship between wave action and depth and so the natural mobility of bottom sediments tends to decrease with depth (Wheeler *et al*., 2014). The impact of shellfish dredging in intertidal habitats might therefore be less significant and shorter term than in subtidal habitats.	picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures

						also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.
Intertidal mudflats and sandflats	Intertidal mud and sand (Generic); Intertidal muddy sand communities (Reg 33); Intertidal sand and muddy sand (Interim CA)	Sediment character (Reg 33); Sediment composition and distribution (Interim CA)	Average particle size analysis parameters should not deviate significantly from an established baseline subject to natural change (Reg 33); The distribution of sediment composition types across the feature (and each of its sub-features)(presence/absence of areas mapped in GIS), compared to an established baseline, to ensure continued	Abrasion, penetration and disturbance to the surface of the seabed and below the surface of the seabed, as well as changes in siltation rates were identified as potential pressures. Clam dredging has been shown to alter the sedimentary characteristics of the affected substrate. The use of a modified oyster dredge to fish from clams has led to the removal of coarse fraction of sediment (EMU, 1992) and suction dredging has been shown to increase median grains through the loss of fine silts (Piersma *et al*., 2001). The resuspension and dispersal can also lead to long term effects on particular sieve fractions (Pranovi & Giovanardi, 1994); potentially	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. The distribution of fishing effort, as identified through IFCO knowledge, suggest clam dredging takes place in limited locations. In Southampton Water these include areas just outside of the entrance of the Hamble, Fawley down to Calshot and Lee on Solent, some of which fall outside the boundary of the Solent Maritime SAC. Shellfish	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only

			structural habitat integrity and connectivity (Interim CA)	decreasing the clay portion of the sediment (Maier *et al*., 1998). Other changes in sediment character may also include a lack of consolidation of sediments (Aspden *et al*., 2004), the removal of stones and the removal of taxa that produce structure (i.e. tube-dwelling and burrowing organisms) (Johnson, 2002; Mercaldo-Allen & Goldberg, 2011). Alterations to sediment composition may persist after dredge marks are no longer visible (Mercaldo-Allen & Goldberg, 2011). Using acoustic reflective sonar, long-term changes in sediment structure has been detected between dredge furrows and the surrounding seabed (Mercaldo-Allen & Goldberg, 2011). Differences in sediment composition between dredged and undredged areas after hydraulic escalator harvesting were no longer detectable after 1 year (Godcharles, 1971)	classification prohibits fishing for clams in Southampton Water from the Fawley fuel jetty north. In Langstone Harbour, fishing activity is concentrated within the north eastern quarter of the harbour. Feature data provided by Natural England show intermittent areas of intertidal mud and sand throughout the SAC. Sightings data reveal that clam dredging may occur on the fringes of this sub-feature. When combined with the known sensitivity of this habitat, clam dredging may have the potential to cause an adverse effect. Physical recovery of high energy environments can take days, whilst low energy areas can take months (Northeast Region EFHSC, 2002; Wallace & Hoff, 2005). Higher energy environments, such as those in the wider Solent, are therefore unlikely to suffer long-term changes in sediment composition as a result of clam dredging. Intertidal habitats within the eastern harbours on the other hand are likely to be lower energy environments.	when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions

						on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.
Intertidal mudflats and sandflats; Estuaries	Intertidal mud and sand (Generic); Intertidal muddy sand communities (Reg 33); Intertidal mudflat and sandflat communities (Reg 33); Intertidal sand communities (Reg 33); Intertidal sand and muddy sand (Interim CA)	Range and distribution of characteristic sand and gravel biotopes (Reg 33); Presence and spatial distribution of intertidal sand and muddy sand communities (Interim CA); Presence and abundance of typical species (Interim CA); Species composition of component	Range and distribution should not deviate significantly from an established baseline subject to natural change (Reg 33); The presence and spatial distribution of intertidal mud communities according to the map (Interim CA); The abundance of listed typical species, to enable each of them to be a viable component of the habitat (Interim CA); The species composition of component communities	The selection extraction of species and removal of non-target species, were identified as potential pressures. Clam dredging is known to cause a number of potential impacts on the faunal community. Dredging results in the direct removal/mortality of benthic and epifaunal organisms – both target and non-target species. There are also indirect affects through the alteration of topography and sediment character and the resuspension of sediments. Bottom towed gear has been shown to reduce biomass, production and species richness and diversity (Veale *et al*., 2000; Hiddink *et al*., 2003). Alterations in the size structure of populations and community are also known to occur (Roberts *et al*., 2010).	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. This roughly corresponds to 'moderate' fishing intensity under the sensitivity analysis completed by Hall *et al*. (2008). At this fishing intensity, the sensitivity of intertidal muddy sand s were classed as 'medium'. In addition, areas that area intensively fished (more than three times per year), the faunal community is likely to be maintained in a permanently altered state and inhabited by fauna adapted to frequent physical disturbance (Collie *et al*., 2000).	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish

		communities (Interim CA)	(Interim CA)	In a meta-analysis of 39 studies, those investigating the effect of intertidal dredging commonly reported 100% removal of biogenic fauna and were reported to have the most severe initial impact (Collie *et al*., 2000). This was also observed in an experimental study conducted in Langstone Harbour where fauna in muddy gravel were seen to either be completed removed or considerably reduced by the dredging activity using a modified oyster dredge (EMU, 1992). In the same study, species richness was also found to decrease with a mean number of 6.5 species in the control site compared with 4.4 in the dredge site (EMU, 1992). The recovery of faunal communities which experience high levels are natural disturbance are generally characterised by species able to withstand and recover from disturbance (Collie *et al*., 2000; Roberts *et al*., 2010). The longer recovery periods for soft sediments are related to the fact these habitats are mediated by physical, chemical and biological processes, as opposed to the dominance of physical processes that occur within sandy habitats (Roberts *et al*., 2010).	Feature data provided by Natural England show intermittent areas of intertidal mud and sand throughout the SAC. Sightings data reveal that clam dredging may occur on the fringes of this sub-feature. When combined with the known sensitivity of this habitat, clam dredging may have the potential to cause an adverse effect. Intertidal habitats are likely to experience a high rate of natural disturbance than subtidal habitats and therefore the severity of clam dredging impacts may be less. Habitats under the stress of frequent disturbance from dredging activity are likely to undergo be a shift from communities dominated by relatively high biomass species towards the dominance of high abundances of small-sized organisms (Collie *et al*., 2000). Many small benthic organisms such as crustaceans, polychaetes and mollusc (characteristic of mud communities), have short generation times and high fecundities, both of which enhance their capacity for rapid recolonization (Coen, 1995). In such instances, the effect of dredging may only be short term. Within the Solent Maritime SAC, they key biotopes associated with intertidal muddy sand include	Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established. The Cockles byelaw states that no person shall fish for or take from a fishery any cockle between 1st day of February and 30th of April and when the cockle bed is covered by water only a dredge less than 460 mm in width can be used. This largely the use of a clam dredge for harvesting cockles. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity

					Polychaetes and *Cerastoderma edule* in fine sand and muddy sand shores and *Macoma balthica* and *Arenicola marina* in muddy sand shores. Deep burrowing molluscs, such as *Macoma balthica*, also have limited capability to escape. Following suction dredging for the common cockle on intertidal sand, the abundance of *Macoma* declined for 8 years from 1989 to 1996 (Piersma *et al*., 2001). Ferns *et al*. (2000) however reported increases of 35% in the abundances of *Macoma balthica* in intertidal muddy sand immediately following mechanical cockle dredging with a tractor. In the same study, Ferns *et al*. (2000) reported reductions of 52.2% in the abundance *Cerastoderma edule* with a recovery periods of >174 days. In a meta-analysis on the impacts caused by bottom towed gear, polychaete species were found to be particularly affected, including *Arenicola* spp (Collie *et al*., 2000).	of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.
Intertidal mudflats and sandflats	Intertidal mixed sediments (Generic & Interim CA); Intertidal mixed sediment communities (Reg 33)	Topography	Shore profile should not deviate significantly from an established baseline subject to natural change (Reg 33); The presence of topographic features, while allowing for natural responses	Abrasion, penetration and disturbance to the surface of the seabed and below the surface of the seabed were identified as potential pressures. Clam dredging has been reported to disturb the top 15 to 20 cm of sediment (EMU, 1992). Dredging is known to cause changes in topography (Natural England, 2014). Typically impacts include	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. The distribution of fishing effort,	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents

			to hydrodynamic regime, by preventing erosion or deposition through human-induced activity (Interim CA)	the creation of depressions and trenches and the smoothing of ripples or creation of ridges within sand environments (Wheeler *et al*., 2014). The physical recovery of sediments to such impacts largely depends on sediment type (Mercaldo-Allen & Goldberg, 2011). In high energy environments physical recovery can take days, whereas recovery in low energy areas can take months (Northeast Region EFHSC, 2002; Wallace & Hoff, 2005). Dredge tracks sandy and coarse sediment habitats are relatively short-lived and can disappear within 24 hours (Gaspar *et al*., 1998; 2003), although can last a few days to no more than a year (De Groot & Lindeboom, 1994; Lindeboom & de Groot, 1998). Trawl marks in silty clay sediment have been shown to persist throughout the year within the study area (Smith *et al*., 2007).	as identified through IFCO knowledge, suggest clam dredging takes place in limited locations. In Southampton Water these include areas just outside of the entrance of the Hamble, Fawley down to Calshot and Lee on Solent, some of which fall outside the boundary of the Solent Maritime SAC. Shellfish classification prohibits fishing for clams in Southampton Water from the Fawley fuel jetty north. In Langstone Harbour, fishing activity is concentrated within the north eastern quarter of the harbour. It is known that clam dredging takes place both subtidally and intertidally so will affect both habitat types. Feature data provided by Natural England show intermittent areas of intertidal mixed sediments throughout the SAC. Sightings data reveal that no clam dredging occurs within these habitats, but clam dredging in some areas, including the entrance to the Hamble and north eastern quarter of Langstone Harbour, do take place in relatively close proximity to areas of intertidal mixed sediment. Changes in topography are a direct impact of clam dredging and therefore it is high unlikely, that despite being in close proximity, the activity will have a significant adverse effect.	pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good

					There is an inverse relationship between wave action and depth and so the natural mobility of bottom sediments tends to decrease with depth (Wheeler *et al*., 2014). The impact of shellfish dredging in intertidal habitats might therefore be less significant and shorter term than in subtidal habitats. Sensitivity analyses conducted by Tilin *et al*. (2010) found that intertidal mixed sediments appear to have 'medium to high' sensitivity to damage to the seabed surface and penetration of the substrate (>25 mm and < 25 mm), although the confidence of these assessments were low.	examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.
Intertidal mudflats and sandflats	Intertidal mixed sediments (Generic & Interim CA); Intertidal mixed sediment communities (Reg 33)	Sediment character (Reg 33); Sediment composition and distribution (Interim CA)	Average particle size analysis parameters should not deviate significantly from an established baseline subject to natural change (Reg 33); The distribution of sediment composition types across the feature (and each of its sub-	Abrasion, penetration and disturbance to the surface of the seabed and below the surface of the seabed, as well as changes in siltation rates were identified as potential pressures. Clam dredging has been shown to alter the sedimentary characteristics of the affected substrate. The use of a modified oyster dredge to fish from clams has led to the removal of coarse fraction of sediment (EMU, 1992) and suction dredging has been	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. The distribution of fishing effort, as identified through IFCO knowledge, suggest clam dredging takes place in limited	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish.

			features)(presence/absence of areas mapped in GIS), compared to an established baseline, to ensure continued structural habitat integrity and connectivity (Interim CA)	shown to increase median grains through the loss of fine silts (Piersma *et al*., 2001). The resuspension and dispersal can also lead to long term effects on particular sieve fractions (Pranovi & Giovanardi, 1994); potentially decreasing the clay portion of the sediment (Maier *et al*., 1998). Other changes in sediment character may also include a lack of consolidation of sediments (Aspden *et al*., 2004), the removal of stones and the removal of taxa that produce structure (i.e. tube-dwelling and burrowing organisms) (Johnson, 2002; Mercaldo-Allen & Goldberg, 2011). Alterations to sediment composition may persist after dredge marks are no longer visible (Mercaldo-Allen & Goldberg, 2011). Using acoustic reflective sonar, long-term changes in sediment structure has been detected between dredge furrows and the surrounding seabed (Mercaldo-Allen & Goldberg, 2011). Differences in sediment composition between dredged and undredged areas after hydraulic escalator harvesting were no longer detectable after 1 year (Godcharles, 1971)	locations. In Southampton Water these include areas just outside of the entrance of the Hamble, Fawley down to Calshot and Lee on Solent, some of which fall outside the boundary of the Solent Maritime SAC. Shellfish classification prohibits fishing for clams in Southampton Water from the Fawley fuel jetty north. In Langstone Harbour, fishing activity is concentrated within the north eastern quarter of the harbour. Feature data provided by Natural England show intermittent areas of intertidal mixed sediments throughout the SAC. Sightings data reveal that no clam dredging occurs within these habitats, but clam dredging in some areas, including the entrance to the Hamble and north eastern quarter of Langstone Harbour, do take place in relatively close proximity to areas of intertidal mixed sediment. Enhanced siltation rates from nearby activity has the potential to impact upon these adjacent habitat types however suspended sediments have been shown to rapidly return to low levels with distance from the dredge activity (Kyte *et al*., 1976; Mairer *et al*., 1998), with 98% resettling within 15 m (Mercaldo-Allen & Goldberg, 2011). Therefore it is unlikely to have a significant adverse effect.	Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering

					Physical recovery of high energy environments can take days, whilst low energy areas can take months (Northeast Region EFHSC, 2002; Wallace & Hoff, 2005). Higher energy environments, such as those in the wider Solent, are therefore unlikely to suffer long-term changes in sediment composition as a result of clam dredging. Intertidal habitats within the eastern harbours on the other hand are likely to be lower energy environments. Sensitivity analyses conducted by Tilin *et al*. (2010) found that intertidal mixed sediments appear to have 'medium to high' sensitivity to damage to the seabed surface and penetration of the substrate (>25 mm and < 25 mm), although the confidence of these assessments were low.	long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.

Intertidal mudflats and sandflats; Estuaries	Intertidal mixed sediments (Generic & Interim CA); Intertidal mixed sediment communities (Reg 33)	Range and distribution of characteristic intertidal mixed sediment biotopes (Reg 33); Presence and spatial distribution of intertidal mud communities (Interim CA); Presence and abundance of typical species (Interim CA); Species composition of component communities (Interim CA)	Range and distribution should not deviate significantly from an established baseline subject to natural change (Reg 33); The presence and spatial distribution of intertidal mixed sediment communities according to the map (Interim CA); The abundance of listed typical species, to enable each of them to be a viable component of the habitat (Interim CA); The species composition of component communities (Interim CA)	The selection extraction of species and removal of non-target species, were identified as potential pressures. Clam dredging is known to cause a number of potential impacts on the faunal community. Dredging results in the direct removal/mortality of benthic and epifaunal organisms – both target and non-target species. There are also indirect affects through the alteration of topography and sediment character and the resuspension of sediments. Bottom towed gear has been shown to reduce biomass, production and species richness and diversity (Veale *et al*., 2000; Hiddink *et al*., 2003). Alterations in the size structure of populations and community are also known to occur (Roberts *et al*., 2010). In a meta-analysis of 39 studies, those investigating the effect of intertidal dredging commonly reported 100% removal of biogenic fauna and were reported to have the most severe initial impact (Collie *et al*., 2000). This was also observed in an experimental study conducted in Langstone Harbour where fauna in muddy gravel were seen to either be completed removed or considerably reduced by the dredging activity using a modified oyster dredge (EMU, 1992). In the same study, species	Reports of clam dredging in the Solent Maritime SAC from local IFCOs indicate a decline in fishing effort since 2012, with only approximately 7 fishing vessels regularly partaking in the fishery. This is supported by a decline in the landings of manila clam. At present, an average of 0 to 1 vessels operate on any one day. This roughly corresponds to 'moderate' fishing intensity under the sensitivity analysis completed by Hall *et al*. (2008). At this fishing intensity, the sensitivity of muds and sands which include gaper clams (*Mya arenaria*) is 'high'. Areas that area intensively fished (more than three times per year), the faunal community is likely to be maintained in a permanently altered state and inhabited by fauna adapted to frequent physical disturbance (Collie *et al*., 2000). Feature data provided by Natural England show intermittent areas of intertidal mixed sediments throughout the SAC. Sightings data reveal that no clam dredging occurs within these habitats, but clam dredging in some areas, including the entrance to the Hamble and north eastern quarter of Langstone Harbour, do take place in relatively close proximity to areas of intertidal mixed sediment. Enhanced siltation rates from nearby activity has the potential to impact upon	Vessels Used in Fishing byelaw prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear. The Solent European Marine Site (Prohibition of Method of Dredging) Order 2004 prevents pump scooping as a means of taking shellfish. Fishing for Oysters, Mussels and Clam byelaw regulates methods can be used to fish for these species. These are a) hand picking and b) dredging using a dredge with a rigid framed mouth so designed to take shellfish only when towed along the sea bed. Temporary Closure of Shellfish Beds byelaw allows the authority to temporarily close any bed or part of a bed of shellfish where it is the opinion of the Committee that it is severely depleted and as such required temporary closure in order to ensure recovery, or any bed or part of bed containing mainly immature or undersized shellfish which is in the interest of protection and development of the fishery, or any bed of transplanted shellfish that ought to not be fished until it becomes established.

				richness was also found to decrease with a mean number of 6.5 species in the control site compared with 4.4 in the dredge site (EMU, 1992). The recovery of faunal communities which experience high levels are natural disturbance are generally characterised by species able to withstand and recover from disturbance (Collie *et al*., 2000; Roberts *et al*., 2010). The longer recovery periods for soft sediments are related to the fact these habitats are mediated by physical, chemical and biological processes, as opposed to the dominance of physical processes that occur within sandy habitats (Roberts *et al*., 2010).	these adjacent habitat types however suspended sediments have been shown to rapidly return to low levels with distance from the dredge activity (Kyte *et al*., 1976; Mairer *et al*., 1998), with 98% resettling within 15 m (Mercaldo-Allen & Goldberg, 2011). Therefore it is unlikely to have a significant adverse effect. Notable species known to exist within this sediment type, in the vicinity of the Hamble Spit, are *Mercenaria mercenaria* (as stated in SSSI condition assessments). This sediment type is therefore likely to be the target of clam dredging, Sensitivity analyses conducted by Tilin *et al*. (2010) found that intertidal mixed sediments appear to have 'medium' sensitivity to the removal of non-target species, although the confidence of assessment was low. Intertidal habitats are likely to experience a high rate of natural disturbance than subtidal habitats and therefore the severity of clam dredging impacts may be less. Habitats under the stress of frequent disturbance from dredging activity are likely to undergo be a shift from communities dominated by relatively high biomass species towards the dominance of high abundances of small-sized	The Cockles byelaw states that no person shall fish for or take from a fishery any cockle between 1st day of February and 30th of April and when the cockle bed is covered by water only a dredge less than 460 mm in width can be used. This largely the use of a clam dredge for harvesting cockles. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including seagrass within the Solent Maritime SAC, closing areas of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement which may result from other additional measures also being introduced. These additional measures include spatial and temporal restrictions on shellfish dredging within the site, via a network of dredge fishing management areas and daily closures from 17:00 to 07:00 (further details in section 7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35

					organisms (Collie *et al*., 2000). Many small benthic organisms such as crustaceans, polychaetes and mollusc (characteristic of mud communities), have short generation times and high fecundities, both of which enhance their capacity for rapid recolonization (Coen, 1995). In such instances, the effect of dredging may only be short term. Within the Solent Maritime SAC, they key biotopes associated with intertidal mixed sediments include *Mya arenaria* and polychaetes in muddy gravel shores. *Mya arenaria*, also known as the gaper clam, is a long-lived and takes several years to mature, so recovery times are much longer than smaller species (Wheeler *et al*., 2014). After experimental clam dredging in Langstone Harbour, the abundance of *Mya arenaria* decreased from 70 individual per m^2, to 35 per m^2 immediately after and then to 0 per m^2 7 days after dredging activity took place, thus showing no signs of recovery within this period (EMU, 1992). The presence of gaper clams increased habitats sensitivity to dredging in a sensitivity analyses conducted by Hall *et al*. (2008). In a meta-analysis conducted by Kaiser *et al*. (2006), a significant linear regression with time for the response of annelids to the impacts of intertidal dredging	weeks of the year during the spring, summer and autumn months in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations.

					revealed estimated recovery periods 1210 days in muddy sand habitats (Kaiser *et al*., 2006). In support of this, the same study in Langstone Harbour also reported that annelids were seen to be most badly affected by the action of a mechanical modified oyster dredge (EMU, 1992).	

7. Management Options

In recognition of the potential pressures of clam dredging upon designated features, sub-features and supporting habitats, Southern IFCA is currently in the process of introducing new bottom towed fishing gear measures to manage shellfish dredging in the Solent European Marine Sites (SEMS). In the Solent Maritime SAC, these measures consist of a network of permanent bottom towed fishing gear closure areas; combined with spatial and seasonal restrictions on shellfish dredging via the introduction of dredge fishing management areas.

The network of permanent bottom towed fishing gear closure areas is designed to protect good examples of SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement. The network of closure areas covers approximately 95.4 km^2 (including those in the original Bottom Towed Fishing Gear byelaw) and equates to approximately 33.9% of the Solent Maritime SAC. The adoption of such an approach ensures pre-emptive and precautionary measures are introduced and that these measures are proportionate to the risk to the site's objectives. Factors considered in the identification of permanent closure areas include existing levels of human disturbance, energy levels, habitat type and recoverability. A number of low-energy areas have been identified as being most suitable for the permanent closures, where levels of abrasion will not prevent the feature reaching favourable condition. Good examples of estuarine habitat including intertidal mud, subtidal mud and saltmarsh have been proposed as permanent closure areas to all types of bottom towed fishing gear. This network of areas, shown in figures 5-7, includes the River Hamble, Sinah Lake, Broom Channel, Russell's Lake, the River Medina, King's Quay, Newtown Creek, the Yar (Yarmouth), and parts of Langstone Harbour, Ashlett Creek, Hythe foreshore, the Test, Lymington and Keyhaven

Three dredge fishing management areas will be introduced by Southern IFCA; of which two (Langstone Harbour and Southampton Water) cover designated features/sub-features of the Solent Maritime SAC (figures 5-7). Within each dredge fishing management area, shellfish dredging will be prohibited for 35 weeks of the year during the spring, summer and autumn months (1st March to 31st October inclusive) in order to enable the recovery of infaunal communities and to maintain the structure of intertidal and subtidal habitats, as well as supporting breeding shellfish populations. The timescale for recovery of disturbed habitats from shellfish dredging is based on a number of different factors, including sediment type, associated fauna, rate of natural disturbance and the level/scale of impact (Robert *et al*., 2010; Jones, 1992). As such, determining a suitable period for recovery is particularly difficult and is further compounded by a lack of data on the condition and species that occur within the site. To help overcome these difficulties it is important to examine existing literature (which represents best available evidence) on recovery rates from similar activities to infer potential timescales for recovery, in conjunction with site specific knowledge. A total of five studies were examined, all of which cover the impacts of shellfish dredging on intertidal habitats and four of which are based in the UK (details given in Annex 9). Recovery rates range from no effect (thus no recovery needed) up to 12 months. Spencer *et al*. (1998) reported a recovery rate of up to 12 months, although inferred it was not possible to be certain that recovery had not occurred before as not all treatment replicates were taken 4 and 8 months after sampling. The authors speculated that the greater length of recovery when compared with similar studies that reported recovery rates of 56 days and 7 months after harvesting was related to the protected nature of the site (Spencer *et al*. 1998). This study highlights the importance of exposure (i.e. rate of natural disturbance) as a factor in determining recovery rates. The Solent harbour areas accessible to shellfish dredging, as illustrated in Figure 5 to 7, are subject to relatively large tidal fluctuations, in addition to currents and wind exposure and are therefore considered to be areas of moderate energy. Based on the level of disturbance and periods of recovery reported from other studies, it is anticipated that 35 weeks will provide a

sufficient period to allow recovery of impacted habitats. It is however important to note there the difficulty in determining a period of recovery due to a number of data gaps, which will be made easier with condition data and any results from arising monitoring studies.

The summer months represent the period of highest biological activity for invertebrate infauna of mudflats and the closure to shellfish during this time will support the recovery of communities from the effects of human and/or natural disturbance. As such, the timing of the recovery period has been designed to allow for the quickest recovery possible, this is because the restoration of a community in temperate zones is likely to be more rapid if the cessation of sediment disturbance occurs prior to the spring-summer influx of recruits (Borja *et al*., 2010). This supports the timing of the reproductive season for key species within the site which generally occurs between spring and autumn (see Annex 10 for reproductive season of key species). Restricting shellfish dredging during winter is likely to aid restoration of infaunal communities if the main recolonisation mechanism is by those who undergo recolonization via by larval settlement. This supports the recolonization strategies used by a number of individual species, with a number of species employing both larval settlement and active or passive migration (i.e. *Macoma balthica*, *Hediste diversicolor*) (see Annex 10 for recolonization strategies of key species).

Shellfish dredging in the Langstone Harbour and Southampton Water dredge fishing management areas will be permitted for 120 days annually: from 1st November to 28th February inclusive. During this period, dredging will only be permitted between 07.00 and 17.00 each day in order to further manage fishing effort and to aid compliance.

While it is acknowledged that clam dredging will continue to take place within the Solent Maritime SAC, the short duration of the fishing season combined with the prohibition on fishing during the biologically productive summer months is considered sufficient to enable the physical and biological recovery of designated features/sub-features. On this basis, the restriction of clam fishing in the SAC to a 120 day period will not hinder the site from achieving its conservation objectives.

7.1 Monitoring

To ensure shellfish dredging within the Solent Maritime SAC continues to be managed in a manner consistent with the conservation objectives of the site Southern IFCA aims to monitor the impact of fishing activity upon designated features and sub-features. Monitoring will be undertaken in partnership with other organisations including Natural England, whose statutory duties include monitoring the condition of European Marine Sites, as well as other agencies where appropriate. The initial monitoring strategy will look to compare fished areas to non-fished (control) areas before and after the fishing season in relation to key attributes including sediment character and faunal composition. A formal monitoring plan incorporating the above strategy will be finalised with Natural England prior to the implementation of management measures. It is important to note that any monitoring strategy is subject to resources and funding and any additional monitoring requirements, such as the monitoring of newly closed permanent areas, will be subject to such restrictions. Monitoring may help to fill a number of data gaps including an indication of site condition (in the absence of condition data) and site specific recovery rates. Additionally, following the introduction of management measures, Southern IFCA, as part of their statutory duties, will continue to monitor the level of fishing activity (i.e. number of vessels) engaged in shellfish dredging within management areas, including maintaining sightings data.

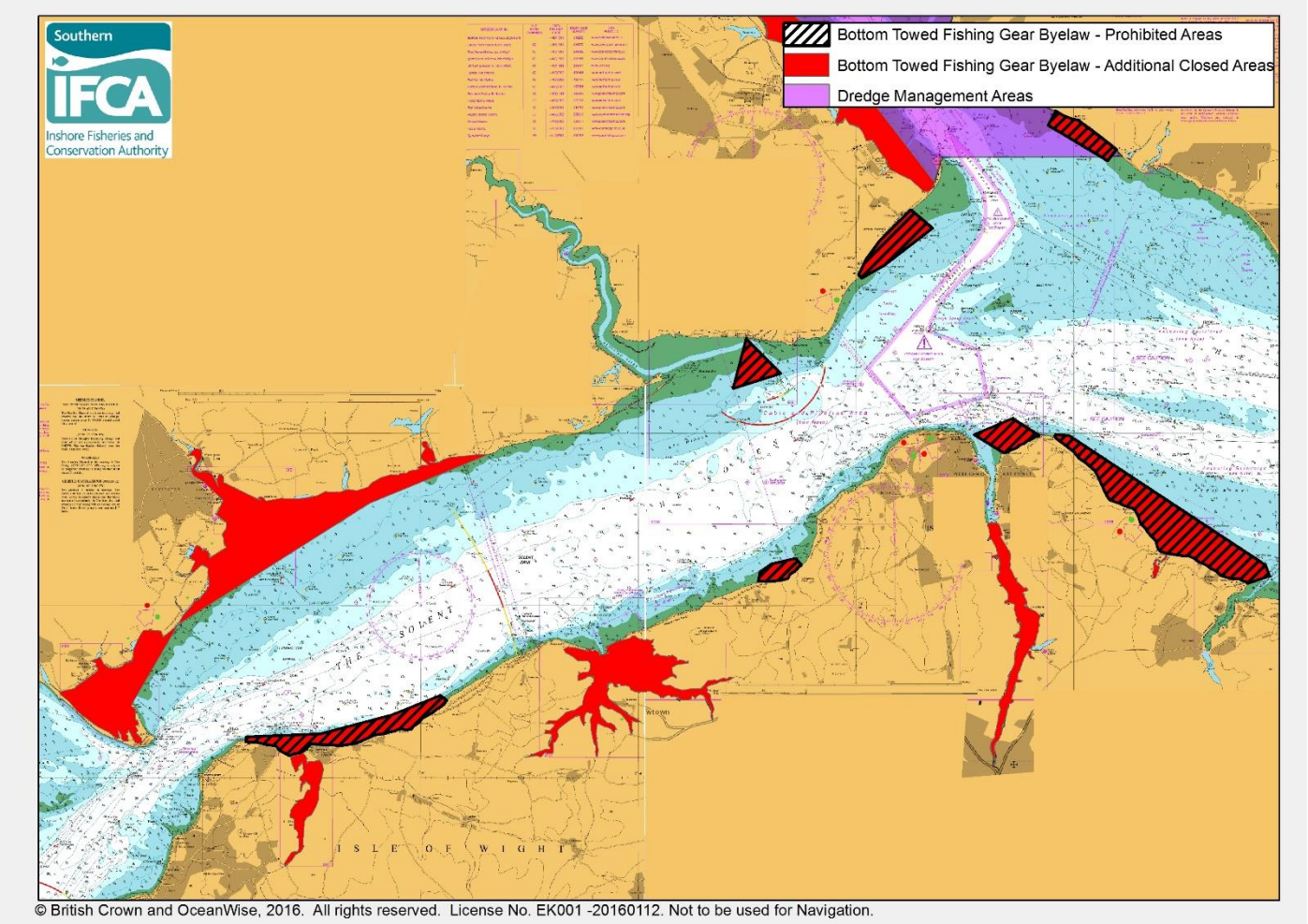

Figure 5. Proposed wider Solent permanent bottom towed fishing gear closure areas

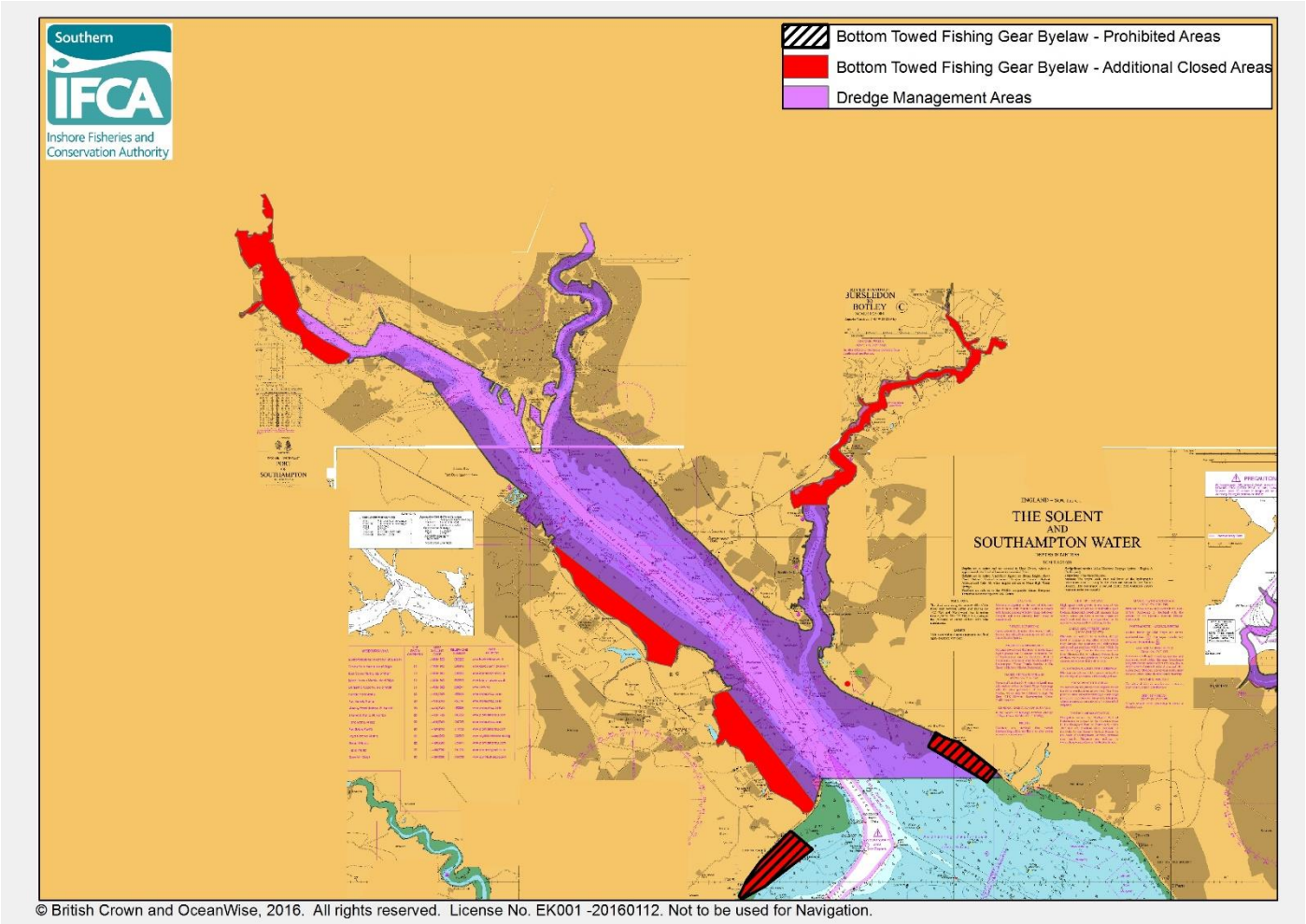

Figure 6. Proposed Southampton Water permanent bottom towed fishing gear closure areas and dredge fishing management area

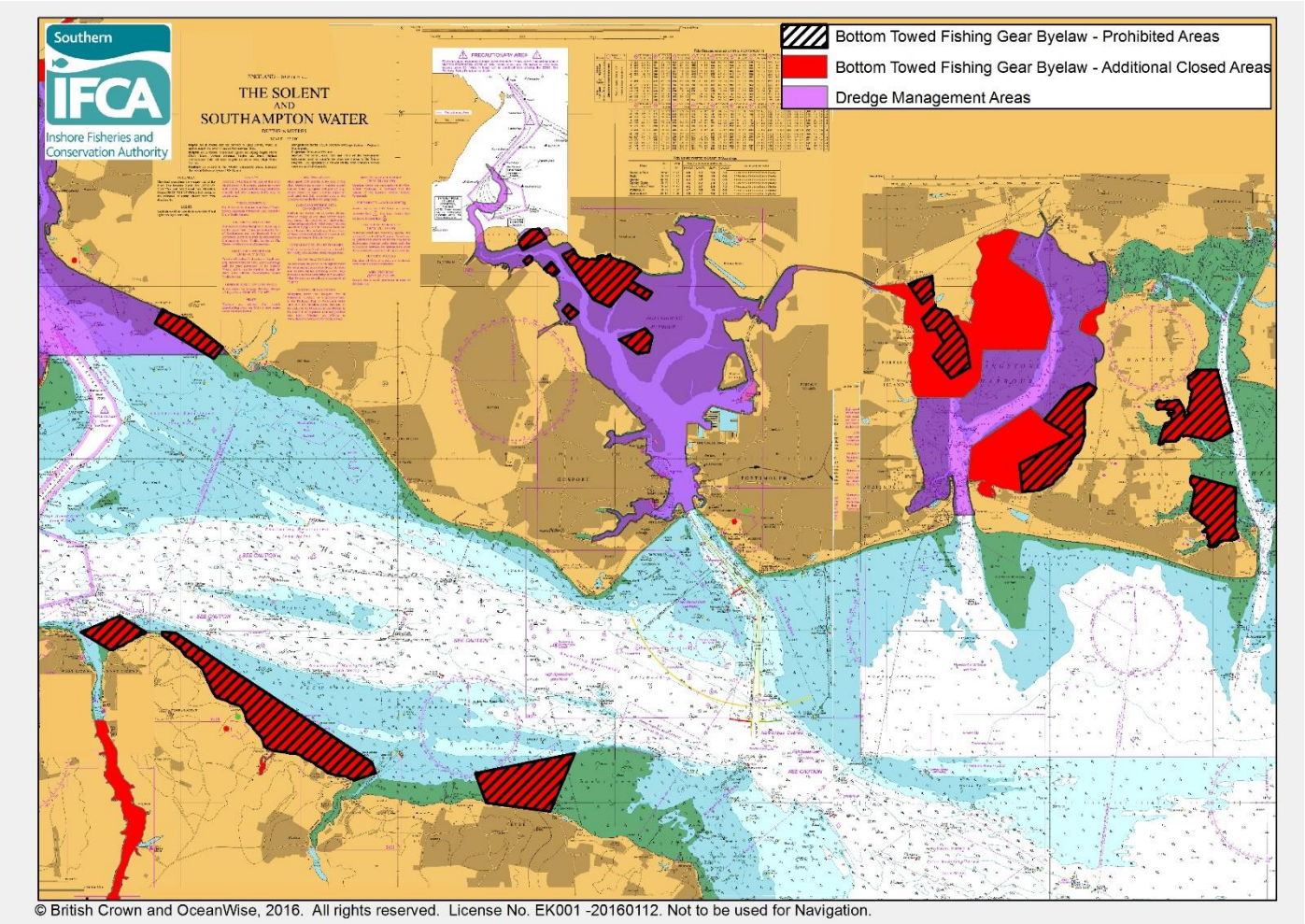

Figure 7. Proposed Langstone Harbour permanent bottom towed fishing gear closure areas and dredge fishing management area

8. Conclusion[16]

In order to conclude whether clam dredging has an adverse effect on the integrity of the Solent Maritime SAC, it is necessary to assess whether the impacts of this activity will hinder the site's conservation objectives, namely:
"ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring:

- The extent and distribution of qualifying natural habitats and habitats of qualifying species;
- The structure and function (including typical species) of qualifying natural habitats;
- The structure and function of the habitats of qualifying species;
- The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- The populations of qualifying species; and
- The distribution of qualifying species within the site."

The review of research into the impacts of shellfish dredging (detailed in section 6.2) identifiess that this activity has the capability to cause both physical and biological disturbance. Physical disturbance can occur through changes in topography and sediment character. Biological disturbances can occur through direct burial and smothering, direct disturbance and removal of

[16] If conclusion of adverse effect alone an in-combination assessment is not required.

infauna. It is therefore recognised that this activity has the potential to lead to an adverse effect upon the following SAC feature attributes:

- Topography
- Sediment character
- Range and distribution of characteristic biotopes

The likelihood and magnitude of adverse effects upon these attributes will be determined by the following variables:

i) Number of vessels participating
ii) Location of dredging activity
iii) Timing and duration of dredging activity
iv) Sensitivity of site features/sub-features to dredging
v) Ability of site features/sub-features to recover from dredging

Additionally, the location, timing, duration and intensity of clam dredging activity within the site will be influenced by existing management measures (see section 6.4) and/or those being developed to mitigate adverse effects (see section 7).

Having reviewed a wide range of evidence, including scientific literature, sightings data and feature mapping, it has been concluded that at current levels and location of clam dredging, the activity has the potential to have a significant adverse effect on the qualifying features and sub-features of the Solent Maritime SAC. The risks to site integrity are addressed through the introduction of proposed management measures for bottom towed gear outlined in section 7 and therefore based on the introduction of these management measures it is concluded that clam dredging will not have an adverse effect on site integrity. The rationale for this conclusion is summarised below:

- Fisheries data held by the Southern IFCA indicates that the number of vessels clam dredging within the SAC is relatively low. A decline in fishing effort has been observed since 2012, with approximately 7 fishing vessels regularly partaking in the fishery and an average of 0 to 1 vessels operating on any one day (section 4.3).

- While sightings data confirms that clam dredging does take place over qualifying features and sub-features of the SAC, it only occurs in distinct spatial areas where shellfish beds exist (Annex 6). Consequently, there are large areas of the site which are not impacted by dredging. A network of permanent bottom towed fishing gear closure areas will be introduced to protect good examples of SAC habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement.

- In those areas of the SAC where clam dredging occurs, potential impacts upon features/sub-features will be mitigated through the introduction of dredge fishing management areas. Dredging will only be permitted for a total of 120 days annually within these three areas. During this period, dredging will only be permitted between 07.00 and 17.00 each day in order to further manage fishing effort and to aid compliance.

- It is acknowledged that the restriction of clam dredging to 120 days within each dredge management area could lead to an increase in the intensity of fishing effort. However, this is not anticipated to result in an adverse effect on the SAC, due to the shortened duration of the season and the low number of vessels participating in the fishery. Additionally, through opening each of the three areas (Southampton Water, Langstone Harbour and Portsmouth

Harbour) simultaneously it is considered that fishing pressure will be diluted, avoiding a 'honey-pot' situation (section 7).

- A review of scientific literature indicates that the sensitivity of different sediment types to dredging is related to the physical stability of the seabed, with impacts deemed to be greater upon softer sediment habitats and those with low levels of natural disturbance (section 6.2.4). Sightings data reveals that clam dredging in the Solent Maritime SAC occurs predominantly over intertidal mud and subtidal mixed sediments (Annex 6). Potentially adverse effects upon sensitive habitats will be mitigated through the introduction of a network of permanently closed areas which includes areas of low-energy sediment habitat; together with seasonal and spatial restrictions on clam dredging within the SAC.

- It is acknowledged that physical and biological recovery times are difficult to predict, being determined by a range of site-specific factors such as sediment type, associated fauna and rates of natural disturbance. Previous research indicates that recovery times will be greater in areas of lower energy (section 7); and those comprised of softer sediment habitats (section 6.2.5). In order to mitigate potentially adverse effects upon such habitats in the Solent Maritime SAC, a network of permanently closed areas will be introduced which includes areas of low energy sediment habitat. Where clam dredging may continue, the restriction of fishing to 120 days within each dredge management area will result in a corresponding recovery period of 35 weeks. Additionally, as the summer months represent the period of highest biological activity for invertebrate infauna, the closure of the clam fishery during this time will support these communities to recover from the effects of human and/or natural disturbance.

In summary, it is concluded that clam dredging alone will not have an adverse effect on the Solent Maritime SAC and will not hinder the site from achieving its conservation objectives with the introduction of proposed bottom towed fishing gear management measures. It is Southern IFCA's duty as the competent and relevant authority to manage damaging activities that may affect site integrity and lead to deterioration of the site.

In order to ensure that the management of clam dredging remains consistent with the conservation objectives of the site, Southern IFCA aim to implement a monitoring programme, in partnership with Natural England, to assess the impacts of fishing activity upon supporting habitats (details provided in section 7). In addition to this, Southern IFCA will continue to monitor fishing effort through sightings data and information from IFCOs. In the short term a change in the status of the fishery is unforeseen, however it is recognised that the status of a fishery may change. On this basis, the management of clam dredging will be reviewed as appropriate should new evidence on activity levels and/or gear-habitat interaction become available.

9. In-combination assessment

Based on the introduction of proposed bottom towed fishing gear management measures, no adverse effect on designated features or sub-features was concluded for the effects of clam dredging alone within the Solent Maritime SAC Clam dredging occurs in the Solent Maritime SAC alongside other fishing activities and commercial plans and projects and therefore requires an in-combination assessment.

Commercial plans and projects that occur within or may affect the Solent Maritime SAC are considered in section 9.1. The impacts of these plans or projects require a Habitats Regulations Assessment in their own right, accounting for any in-combination effects, alongside existing fisheries activities.

There is the potential for clam dredging to have a likely significant effect when considered in-combination with other fishing activities that occur within the site. These are outlined in section 9.2. Any fishing activities that were screened out as part of the revised approach assessment process will not be considered (see Solent Maritime SAC screening summary for details of these activities). In the Solent Maritime SAC, commercially licensed fishing vessels are known to utilise a number of different gear types and can be engaged in multiple fishing activities and this, whilst dividing effort between gear types, may lead to cumulative impacts different to those of a single fishing activity.

9.1 Other plans and projects

Project details	Status	Potential for in-combination effect
Kendalls Wharf extension	In planning	Relevant impact pathways identified in relation to this project include loss of intertidal habitat and increase in suspended sediment concentrations. Loss of intertidal habitat – As part of this project, the total area subject to capital dredging is expected to be 0.33 ha. Following dredging, 0.073 ha of intertidal mudflat would be removed. The total intertidal area lost or altered is 0.148 ha which equates to 0.01% of the total intertidal habitat in Langstone Harbour. The impact significance of intertidal habitat loss was concluded to be minor[17]. Increase in suspended sediment concentrations – It is estimated that during capital dredge operations suspended sediment concentrations could reach a maximum of 196 mg/l. Naturally occurring suspended sediment concentrations reach up to 200 mg/l within Langstone Harbour. The impact significance of increases in suspended sediment concentration was concluded to be not significant[18]. In addition, a back-hoe dredger will be used to minimise sediments suspended. At a tLSE level for clam dredging, physical damage from siltation and abrasion were screened in and it was recognised that dredging causes disturbance to the seabed but does result not in the physical loss of the extent of the feature. Common impact pathways with the project therefore include an increase in suspended sediment concentrations. The level of increase in suspended sediment concentrations associated with the project have been shown to be at the same magnitude as those which occur naturally and are likely to far exceed those caused by

[17] When an effect will be experienced but the effect magnitude is sufficiently small and well within accepted standards and/or receptor is of low sensitivity.
[18] An impact that, after assessment, was found not to be significant in the context of the environmental statement objectives.

		dredging. The project and its relevant impact pathways were considered from not significant to negligible and are likely to be of small scale and localised in their nature. Knowledge of clam dredging activity reveals that the area of the project and surrounding areas is not subject to the activity, further limiting the potential for in-combination effects due to a lack of spatial overlap. Based on the limited significance and small scale of the project impact pathways and locality of the activity in relation to the project, it is unlikely the project and activity will lead to in-combination effects.
Queen Elizabeth aircraft carrier capital dredge	Consented and underway	Relevant impact pathways identified in relation to the project include an increase in suspended sediment concentrations and increase in sedimentation rates (as identified by the appropriate assessment). The capital dredging operation in Portsmouth Harbour and approach channel will result in resuspension of sediment into the water column and potentially result in smothering of sensitive habitats. A likely significant effect on the Solent Maritime SAC was concluded for the estuaries, mudflats and sandflats, Salicornia and sandbanks features for project element and associated impact pathways. Modelling of suspended sediment concentrations found changes would be temporary and largely confined to the area of the approach channel and Harbour, with levels reducing significantly to the west of the channel due to mixing and dispersal and any redeposition of sediment would be concentrated within the immediate vicinity. Generally coastal waters would be unaffected by significant increases in suspended sediment concentrations above natural background levels and the concentration of suspended sediments was shown to cease after 7 days post dredging. Modelling also concluded that predicted sediment accumulations will be confined to a number of small areas away from the intertidal area within Portsmouth Harbour. A more detailed appropriate assessment concluded the approach channel dredge would not result in an adverse effect on the integrity of the site, with no direct implications anticipated for designated features. At a tLSE level for clam dredging physical damage from siltation was screened in. Increases in suspended sediment concentrations from dredging are localised and temporary in nature. Studies on shellfish dredging have reported suspended sediment rapidly returns to low levels with distance

		from the dredge activity (Kyte *et al*., 1976; Mairer *et al*., 1998), with 98% resettling within 15 m (Mercaldo-Allen & Goldberg, 2011). When this is combined with the very low levels of suspended sediments and lack of impact thought to occur as a result of the project, it is unlikely that there will be in-combination effects.
Royal Pier phase 2 reclamation and capital dredge	In planning	Relevant impact pathways identified in relation to the project include an increase suspended sediment concentrations and increase in sedimentation rates. Increases in suspended sediment concentrations and subsequent increases in sedimentation rates may arise from a number of different pathways including dredging, reclamation works and piling works. The area of proposed dredging will extend to 18,700 metres and will remove around 37,000 cubic metres of material. The area to be dredged is one of low flow speeds and sediments disturbed during dredging will return to the bed in the vicinity of the dredging site. Any sediment release within the dredging site is most likely to occur in the bottom metre of the water column, increasing to suspended sediment concentrations to around 10,000 mg/l, reducing to a few hundred mg/l through the water column before resettling to the seabed. The predicted sediment plume will be largely confined to the dredge area due to very flows. Modelling estimates the suspended sediment concentrations of 10-20 mg/l could occur in the water column up to 50 to 100 m from the source. Increases of more than 10 mg/l are not expected beyond 250 m up and down estuary in the direction of the main channel and within 100 m of the outer extent of the dredge. Accumulation will be in the order of 0.1-0.2 m over the dredge area. The proposed dredging works are predicted to lead to a negligible increase in suspended sediment concentrations in and around the site and are predicted to not be significant. Dewatering activities associated with the proposed land reclamation will have the potential to create a sediment plume, resulting in sediment dispersion and deposition in the vicinity of the site. This will be minimised by the use of silt busters and/or sediment filters. Dewatering activities will last between 3 and 5 days. Proposed piling works have the potential to release sediments from the seabed a result of minor disturbance to sediments surrounding the piles. Suspended sediment concentrations are predicted to increase by 10-30 mg/l around each pile being

		driven. As a result of the low tidal flows, the maximum extent of dispersion will be no greater than 100 m up and down estuary from the site and no further than the north eastern edge of the navigation channel. The relatively small areas of piling and demolition mean the effects will be negligible and not significant. It was concluded that the small scale of the works and distance from designated nature conservation sites, like the Solent Maritime SAC, mean the proposed land reclamation and dredging will not significantly affected features of the site. Similarly, the impacts resulting from piling work were considered negligible and not significant. At a tLSE level for clam dredging, physical damage from siltation was screened in. Increases in suspended sediment concentration from dredging are localised and temporary in nature. Studies on shellfish dredging have reported suspended sediment rapidly returns to low levels with distance from the dredge activity (Kyte *et al*., 1976; Mairer *et al*., 1998), with 98% resettling within 15 m (Mercaldo-Allen & Goldberg, 2011). When this is combined with the small scale of the work, localised impacts and distance from the SAC, it is unlikely that there will be in-combination effects.
Portchester to Emsworth Coastal Defence Strategy	In planning	Relevant impact pathways identified in relation to the project include the loss of intertidal habitat. The Portsea Island Coastal Strategy Study [PICSS] was approved in 2011 and covers the whole of Portsea Island. The strategy confirms the North Solent Shoreline Management Plan [SMP] policy (2010) for Portsea Island of 'Hold the Line' and splits Portsea Island into 7 discrete flood cells. Under the North Portsea Island scheme, covering 8.4 km of coastline from Tipner through to Milton, works have been identified including raising of seawalls and improving seawalls structural integrity. These proposed works are planned over the first ten years and these follow a phased approach, including Phase 1, Ports Creek Railways Bridge to Kendall's Wharf Northern Boundary, and Phase 2, Milton Common and Great Salterns Quay. Coastal squeeze loss of 11.69 ha of intertidal will be caused by sea level rise and the delivery of the delivery of the strategic policy option of 'Hold the Line'. An appropriate assessment concluded that because of the calculated coastal squeeze losses, that implementation of the strategy would have an

		adverse effect on designated sites. The AA however also concluded there is justification for these adverse effects as there is no alterative policy and there is an over-riding public need to protect life and property and so an Imperative Reasons of Overriding Public Interest statement was made. Environmental compensation will be achieved through the Regional Habitat Creation Programme which promotes the realignment of defences elsewhere in the Solent to create new intertidal habitats. This was signed off by Defra in April 2011. The phases that are currently underway or in planning have a small working footprint during their construction which is strictly controlled by a Construction and Environment Management Plan. Direct disturbance to the sediment is minimal and in discrete locations at any one time. For phase 1 there was an access footprint of 15m and in phase 2 a maximum access footprint of 10 m along the Milton Common Frontage and 20 m around Great Salterns Quay. No LSE is expected as any disturbance to discrete working areas is minimal, temporary and must follow good working practices as outlined in the Construction and Environment Management Plan. Phase 2 works will lead to the gain of 2,460m^2 mudflat habitat within Langstone Harbour from the removal of Great Salterns Quay. At a tLSE level for clam dredging, physical damage from siltation and abrasion were screened in and it was recognised that dredging causes disturbance to the seabed but does not result in the physical loss of the extent of the feature. The combined impacts of phased small scale coastal defence works and clam dredging will not lead to in-combination effects due to the small scale and localised nature of the impacts, a lack of overlapping impact pathways and spatial interaction. The general loss of intertidal from the overall strategy has been signed off by Defra under an Imperative Reasons of Overriding Public Interest statement.
Wightlink – Fishbourne to Portsmouth	In planning	Relevant impact pathways identified in relation to the project include the loss of intertidal habitat. The project involves the installation of three piles below MHWST, each with a diameter of 1.2 m and installation depth of 25 m below the seabed, is estimated to displace approximately 25.5m^3 of sediment. Drill operations will lead to the release of sediment and an increase in scour around the

		installed piles. The total volume of material eroded is estimated to be 60m^3. The area directly affected by piling works is approximately 13.6m^2 with a further 77m^2 affected by scour. Scour has the potential to locally alter the nature of the seabed in the vicinity of each pile structure, especially in terms of its composition. Although in relatively close proximity, the planned works are actually outside of the SAC boundary, so designated habitats are not directly affected by pile placement or associated scour. At a tLSE level for clam dredging, physical damage from siltation and abrasion were screened in and it was recognised that dredging causes disturbance to the seabed but does not result in the physical loss of the extent of the feature. Impacts surrounding the installation of three piles are small scale and localised, affecting a very limited area which occurs outside of the SAC and therefore cannot lead to in-combination affects with clam dredging. It is also important to point out that impact pathways of the project and activity do not overlap.
Cowes breakwater (Shrape extension), marine and capital dredge	In planning	The environmental statement or habitats regulation assessment is currently not available (as of 06/04/2016) and so there is a lack of information regarding the impact pathways which may arise from this project, thus making it hard to assess. Potential and relevant impact pathways are likely to include increases in suspended sediment concentrations and increase in sedimentation rates. These impact pathways are likely to arise from dredging of the new Eastern Channel. The dredging is likely to be small scale and as such increases in suspended sediment and sedimentation rates are likely to be limited, localised and temporary in nature. At a tLSE level for clam dredging physical damage from siltation was screened in. Studies on shellfish dredging have reported suspended sediment rapidly returns to low levels with distance from the dredge activity (Kyte *et al*., 1976; Mairer *et al*., 1998), with 98% resettling within 15 m (Mercaldo-Allen & Goldberg, 2011). It is therefore not anticipated that the project and activity will lead to any in-combination effects.
IFA2 Cable	In planning	The environmental statement or habitats regulation assessment is currently not available (as of 05/04/2016) and so there is a lack of information

		regarding the impact pathways which may arise from this project, thus making it hard to assess. The interconnector is made up of undersea cables which will enter a converter station based at Daedalus airfield in Stubbington and a substation near Chilling in Warsash. There will be a need for undersea cables to run from Daedalus to Chilling to connect the two sites. Where the cable comes ashore there are two options available in order to bury the cable; trenching and drilling. Trenching involves digging a trench to bury the cable and drilling involves using horizontal directional drilling, the latter of which involves drilling underneath the beach. Potential and relevant impact pathways are likely to include increase in suspended sediment concentrations, increase in sedimentation rate and loss of intertidal. If drilling is used then there is unlikely to be a loss of intertidal. If trenching is used there is likely to be a loss of some intertidal habitat, although this is likely to be limited in extent when compared with the rest of the SAC. Increases in suspended sediment concentrations and sedimentation rates are likely to be small scale, temporary (one off events) and localised to each area. At a tLSE level for clam dredging, physical damage from siltation was screened in. Studies on shellfish dredging have reported suspended sediment rapidly returns to low levels with distance from the dredge activity (Kyte *et al*., 1976; Mairer *et al*., 1998), with 98% resettling within 15 m (Mercaldo-Allen & Goldberg, 2011). Although in relatively close proximity, both sites are outside of the SAC boundary and therefore will not be affected by a loss of intertidal. Based on the small scale, temporary and localised nature of the impacts of the project and activity with respect to suspended sediments and sedimentation rates, it is anticipated that the combination of both will not lead to in-combination effects.

9.2 Other fishing activities

Fishing activity	Potential for in-combination effect
Oyster dredging	Common impact pathways were identified at a tLSE level and these include physical damage – siltation, physical damage – abrasion and selective extraction of species. The two activities target different species, and based

	on this and mitigation measures such as minimum sizes which are present for each target species, it is unlikely there will be significant in-combination effects with respect to selective extraction. Oyster dredging is concentrated takes place in distinct, small spatial areas where shellfish beds exist. In recent years these areas include the channels running up into the north eastern quarter of Langstone Harbour and an area known as Sword Sands, located fairly centrally within the harbour. Within the Solent Maritime SAC, the activity overlaps within the north eastern quarter of Langstone Harbour, although the number of oyster dredge sightings are very low. Historic sightings data is presented in Annex 12 and this shows a clear overlap of the two activities in several discrete areas including the north eastern quarter of Langstone Harbour, outside the entrance to the Hamble, Ashlett Creek and western upper reaches of Southampton Water. It is important to note that oyster dredging has not taken place in the Southampton Water or the wider Solent since the 2013/14 season. Despite being open for the full season in 2012, no oyster dredging sightings occurred. Based on the nature of both gear types, which are forms of shellfish dredges known to penetrate into the seabed, and the known impact pathways of both activities, oyster dredging and clam dredging have the potential to cause in-combination effects. The areas of concern are those where the activities are known to overlap which is mainly in subtidal areas or on the fringes of the intertidal. The upper reaches of the intertidal are much less at risk of in-combination effects due to the lack of oyster dredging taking place over these features. These in-combination effects, which include physical damage through abrasion (and penetration) and potentially siltation, can only take place when both activities are allowed i.e. within the oyster season. It is also worth noting the differences in the design of both dredges. The design of the oyster dredge, is likely to cause less damage than those used for clam dredging which can have teeth of up to 14 cm. The ladder on an oyster dredge can be up to 8.5 cm long. An oyster dredge is designed to be towed on top of the seabed, thus limiting penetration into the sediment, the clam dredge is designed to penetrate into the sediment. This is linked to the ecology of the target species. The oyster fishery has been restricted spatially and temporally through the 'Temporary Closure of Shellfish Beds' byelaw since the 2013/14 oyster season. The most recent season (2015/16) was restricted to two weeks in length and fishing was only allowed to take place in Langstone and Portsmouth Harbour, with the wider Solent and Southampton Water prohibited to oyster fishing. These restrictions are and have been applied on an annual basis in order to aid recovery of depleted oyster stocks in the Solent. In the absence of such restrictions, the proposed bottom towed fishing gear management measures, outlined in section 7 (permanent and seasonal closures), which will apply to both oyster dredging and clam dredging, address any risks posed to site integrity through any in-combination effects of the two activities. In addition, the proposed management measures also addresses the potential for future expansion into areas not previously subject to fishing effort, which is likely to occur in the event of stock recovery.
Trawling (beam	Common impact pathways identified at a tLSE level include physical damage

trawl & light otter trawl)	– siltation, physical damage – abrasion and selective extraction of species. The two activities target different species and therefore there will be no in-combination effects with respect to selective extraction of species. Trawling is generally focused subtidally in the central and eastern Solent, occurring at lower levels in the western Solent. The level of trawling occurring within the SAC is limited and sightings data shows it occurs on an infrequent basis. Sightings data presented in Annex 12 demonstrates a very limited spatial overlap between recent clam dredging sightings (indicative of current levels) and trawl sightings (split between 2005-2011 and 2012-2015) within the SAC, with limited spatial overlap occurring in Southampton Water and the north eastern quarter of Langstone Harbour where the number of recent (2012-2015) trawl sightings are low in both areas. Based on this lack of spatial overlap, and low level of trawling within the SAC, it is unlikely the two activities will lead to any significant in-combination effects through physical damage (siltation and abrasion).
Light otter trawling (for sandeels)	Common impact pathways were identified at a tLSE level and these include; physical damage – siltation, physical damage – abrasion and selective extraction of species. The two activities target different species and therefore there will be no in-combination effects with respect to selective extraction of species. Light otter trawling for sandeels occurs in one area of Langstone Harbour known as Sword Sands located in the main channels in the southern and central parts of the harbour. Clam dredging is often focused in areas on softer sediment in distinct, small spatial areas where shellfish beds exist. These largely include the north eastern quarter of Langstone Harbour. These sites occur intertidally (fished at high tide) and subtidally, with vessels often operating in very shallow waters. Sightings data presented in Annex 12 (indicative of recent fishing activity) reveal there is no spatial overlap between the two activities and therefore there are likely to be no in-combination effects for any of the impact pathways identified.
Demersal netting	No impact pathways were identified at a tLSE level for demersal netting. The activity is low impact and unlikely to lead to any in-combination effects. In addition, static gear types such as netting and mobile gear types such as clam dredging are not compatible and often occur in different areas, thus largely eliminating any spatial overlap between the two activities.
Demersal longlining	No impact pathways were identified at a tLSE level for demersal longlining. The activity is low impact and unlikely to lead to any in-combination effects. In addition, static gear types such as longlining and mobile gear types such as clam dredging are not compatible and often occur in different areas, thus largely eliminating any spatial overlap between the two activities.
Potting	No impact pathways were identified at a tLSE level for potting within the Solent Maritime SAC. The activity is low impact and unlikely to lead to any in-combination effects. In addition, static gear types such as potting and mobile gear types such as clam dredging are not compatible and often occur in different areas, thus largely eliminating any spatial overlap between the two activities.

10. Summary of consultation with Natural England

Consultation	Date submitted	Response from NE	Date received
First draft – excluding management measures (v1.6)	27/10/2015	Recommended amendments	02/12/2015
Revised draft in response to NE recommendations (v1.8)	08/02/2016	Accepted amendments	01/03/2016
Revised draft – including management measures (v1.9)	03/08/2016	Recommended amendments	26/08/2016
Revised final draft – including changes to conclusion and management options (v1.12)	09/09/2016	Formal advice	20/09/2016

11. Integrity test

Based on the bottom towed fishing gear management measures proposed by Southern IFCA, (see section 7), it has been concluded that clam dredging alone will not have an adverse effect on the integrity of the Solent Maritime SAC and will not hinder the site from achieving its conservation objectives. The in-combination assessment concluded the potential for adverse effect between clam dredging and oyster dredging in areas of spatial overlap due to similar impact pathways. However the proposed bottom towed fishing gear management measures, which will apply to both activities, address any risks posed to site integrity through in-combination effects, regardless of restrictions imposed on the oyster fishery through the 'Temporary Closure of Shellfish Beds' byelaw and therefore also addresses any risk to the achievement of the sites conservation objectives should the oyster fishery develop.

A change in the current status of the clam and oyster fishery, upon which the Habitats Regulation Assessment is based, is unforeseen, however it is recognised that future changes may occur. For example, efforts are currently being made to restore the Solent oyster population. Southern IFCA will continue to monitor fishing activity within the Solent Maritime SAC, in addition to collating data on the potential impacts of shellfish dredging upon site features/sub-features. New evidence on activity levels, and impacts (such as that collected through monitoring), will be periodically reviewed to ensure management of the fishery continues to be compatible with the conservation objectives of the site. In the event new evidence has the potential to hinder the sites conservation objectives, such as an increase in fishing activity, a Habitat Regulations Assessment will be undertaken.

Annex 1: Reference list

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Annex 2: The Key Principles of the SEMS Management Scheme (http://www.solentems.org.uk/sems/management_scheme/)

Principle 1 - Favourable Condition

The SEMS has qualified for designation against the background of current use and there is a working assumption that the features for which the site is designated are in favourable condition from the time of designation. The Management Scheme and the monitoring to be carried out by 2006 will test this assumption.

Principle 2 - Sustainable Development

The aim of the Management Scheme is not to exclude human activities from SEMS, but rather to ensure that they are undertaken in ways which do not threaten the nature conservation interest, and wherever possible, in ways that support it. The Management Scheme should ensure a balance of social, economic and environmental objectives when considering the management of activities within the Solent.

Principle 3 - Regulatory Use of Bye-laws

New bye-laws may be used as a regulatory mechanism for the SEMS. These should only be introduced into the Management Scheme when all other options have been considered and it is the only effective solution.

Principle 4 - Links to Existing Management and Other Plans/Initiative

Where appropriate the SEMS Management Scheme will directly utilise management actions from other existing management plans. The actions identified in the Management Scheme will therefore serve to inform and support existing management effects rather than duplicate them. The management measures identified in other plans will remain the mechanism through which these are to be implemented.

Principle 5 - Onus of Proof

The wording for principle 5 is based on the following three-stage process:

- Stage 1 - Evidence must be established that a site feature is in deterioration. This evidence must be scientific, credible and unambiguous but it need not originate from English Nature itself. It is acknowledged that other Relevant Authorities will be undertaking monitoring regimes and if their programmes flag up something of interest, it would be expected that they would present it to English Nature for further comment and verification.

- Stage 2 - English Nature, as the Government's body with responsibility for nature conservation, must believe that a site feature is in deterioration. If the evidence to support this view has come from their own monitoring - or if it has come from an external, authoritative source - EN should act as a conduit to demonstrate this fact to the Relevant Authority with responsibility for the management of the activity suspected of having detrimental effect.
- Stage 3 - English Nature and the Relevant Authority (ies) involved should work together to establish any cause and effect relationship. From this, changes to management actions may be made.

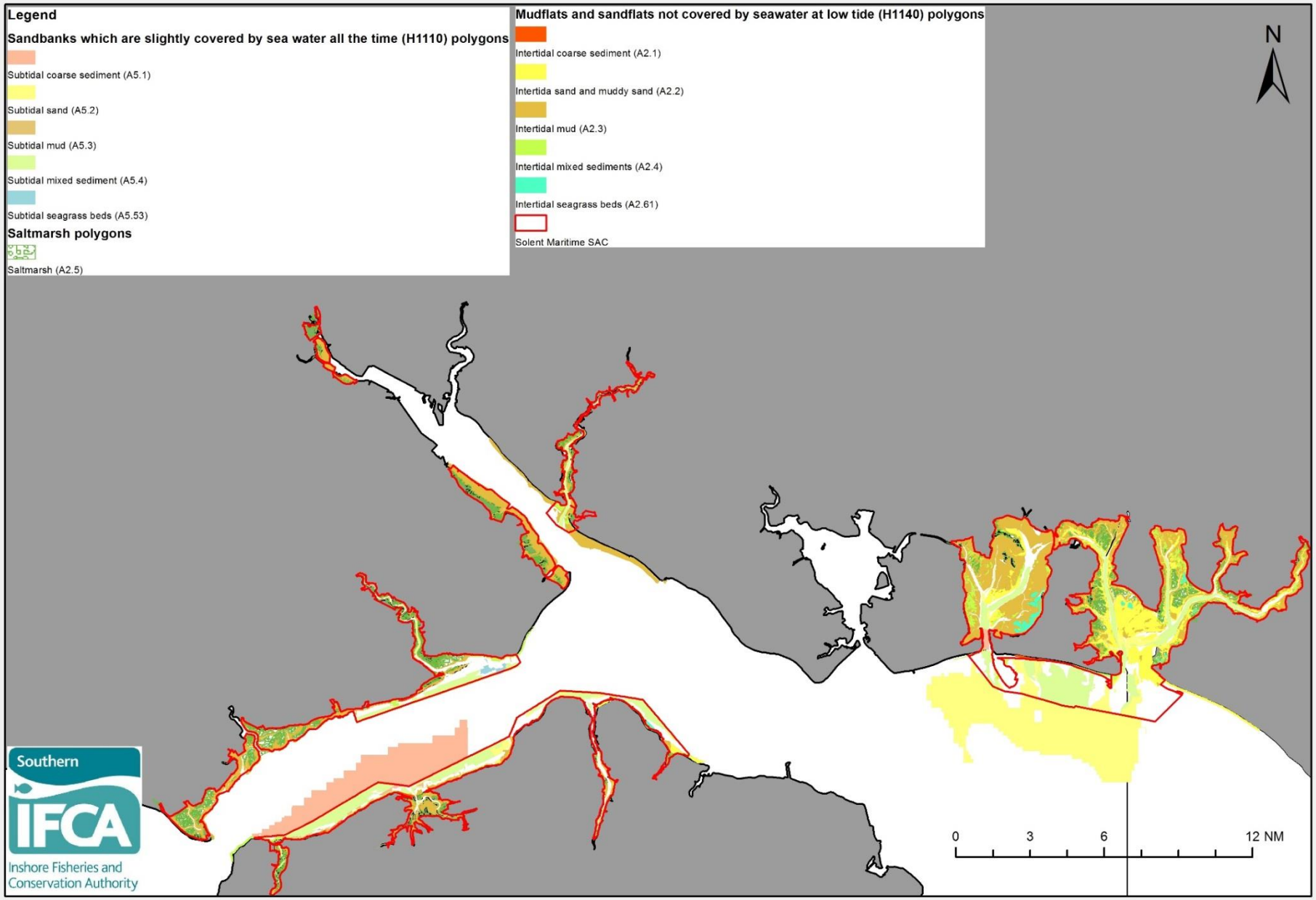
Consideration of this process had led to the following definition of onus of proof: If through their own site condition monitoring programme or that of another Relevant Authority, English Nature can demonstrate that they have reasonable evidence to indicate that a deterioration in the condition of a SEMS feature or species exists, then English Nature and the Relevant Authorities concerned will work together to identify any cause and effect relationship.

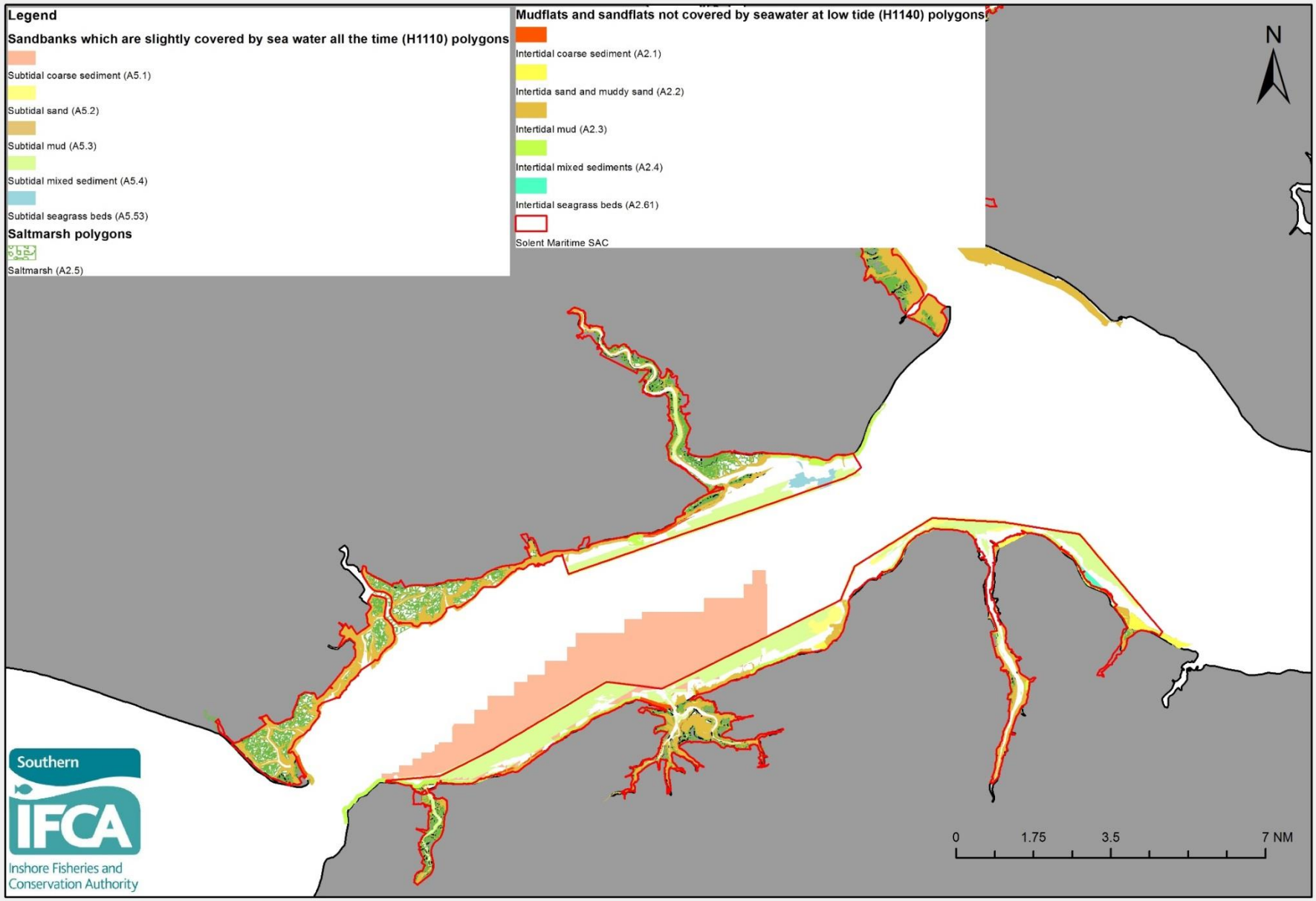
Principle 6 - Management Actions

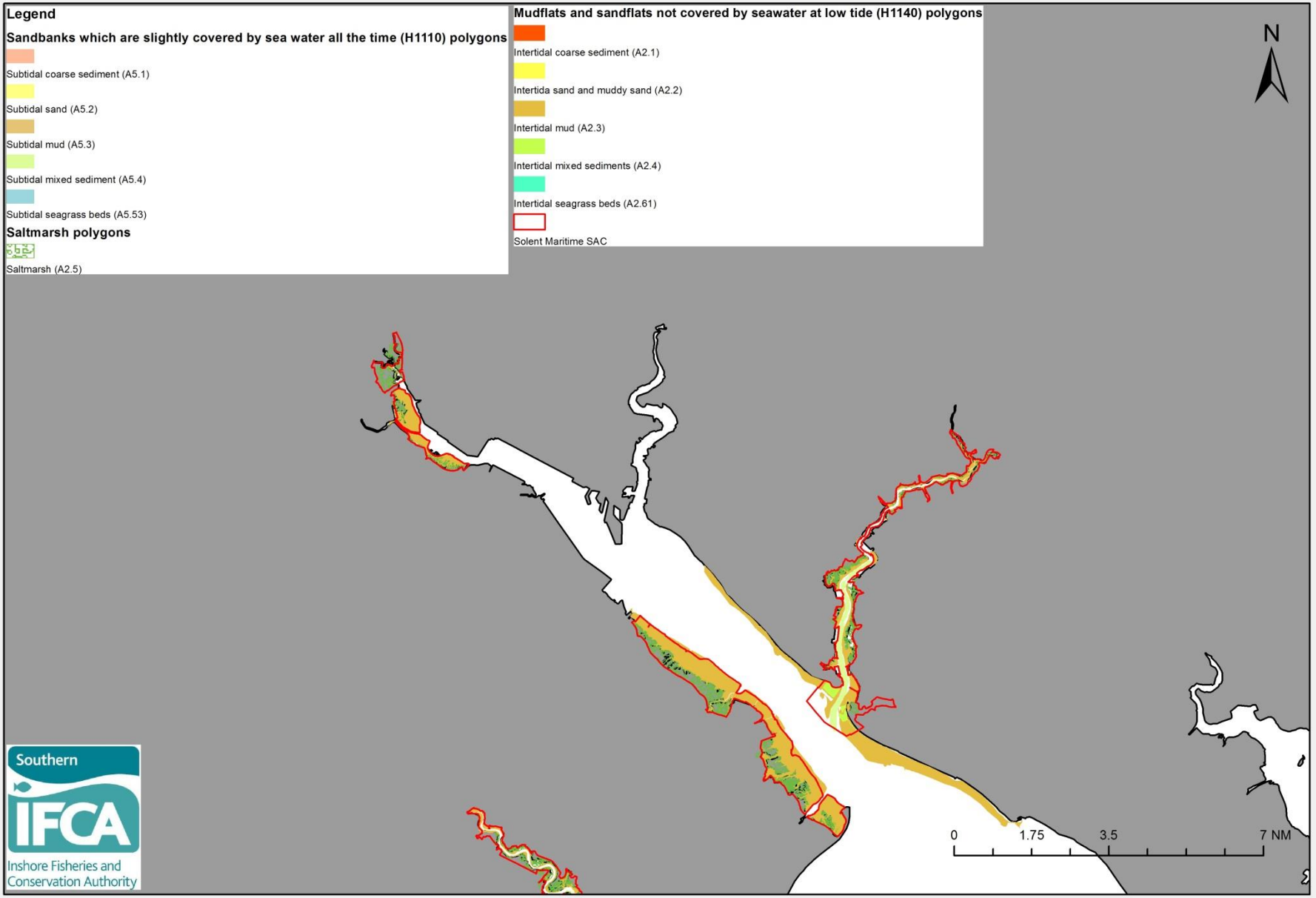
Where reasonable evidence is found to clearly demonstrate the cause and effect relationship the Relevant Authorities involved will instigate changes to the management of the activity, which will be within a RAs statutory obligations and will provide a solution that is in accordance with the Regulations and be fair, balanced, proportionate and appropriate to the site and the activity. Where the cause and effect relationship is uncertain but deterioration in the condition is still significant the Relevant Authorities should consider any potential changes in management practices in light of the precautionary principle* and the cost effectiveness of proposed measures in preventing damage. However, the precautionary principle should not be used to prevent existing management actions continuing where there is no evidence of real risk of deterioration or significant disturbance to site features.

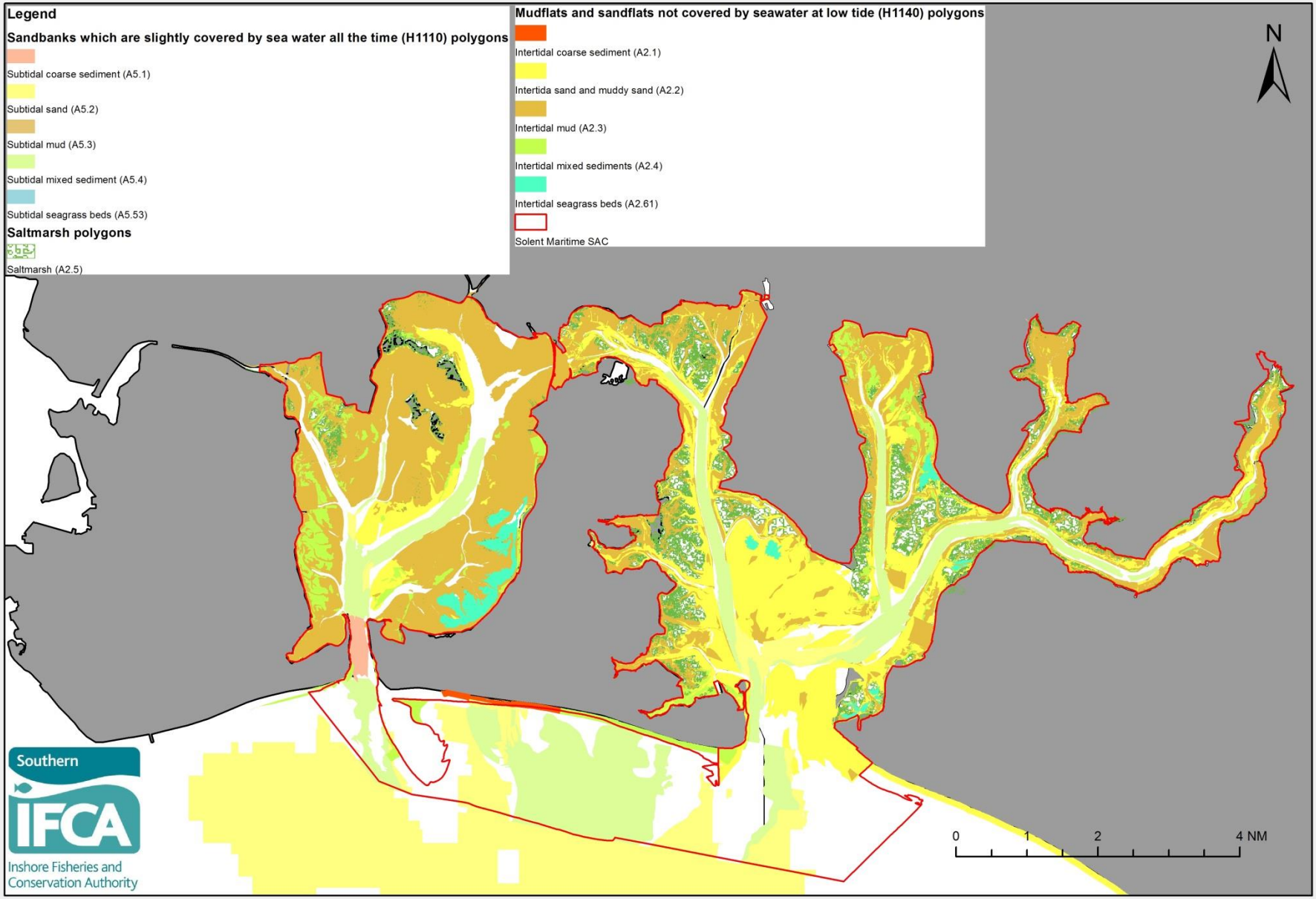
All forms of environmental risk should be tested against the precautionary principle which means that where there are real risks to the site, lack of full scientific certainty should not be used as a reason for postponing measures that are likely to be cost effective in preventing such damage. It does not however imply that the suggested cause of such damage must be eradicated unless proved to be harmless and it cannot be used as a licence to invent hypothetical consequences. Moreover, it is important, when considering whether information available is sufficient, to take account of the associated balance of likely costs, including environmental costs, and benefits." (DETR & the Welsh Office, 1998).

Annex 3: Site Feature/Sub-feature Map(s) for Solent Maritime SAC (Whole Solent Maritime SAC, Western Solent, Southampton Water and Langstone and Chichester Harbour)

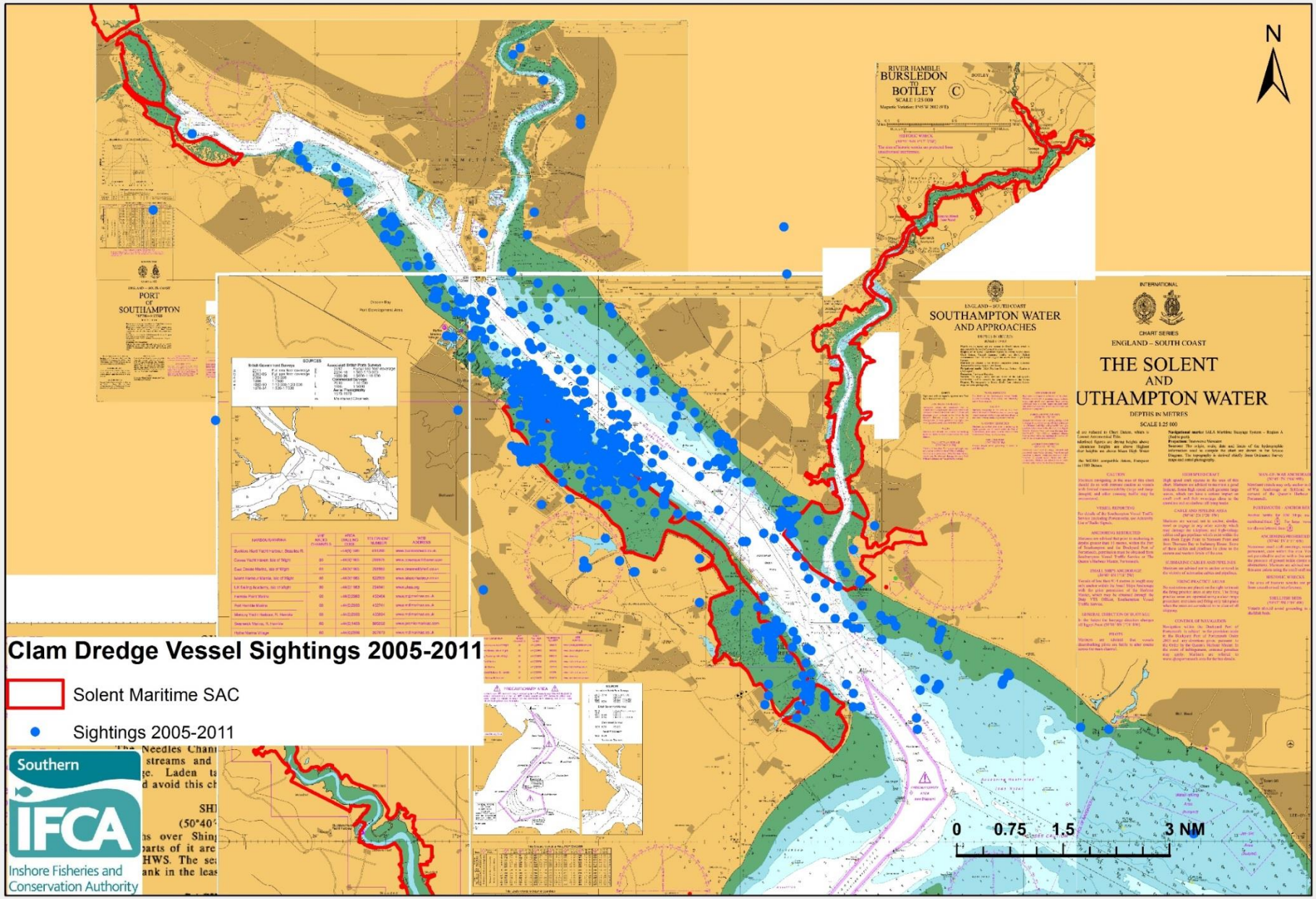


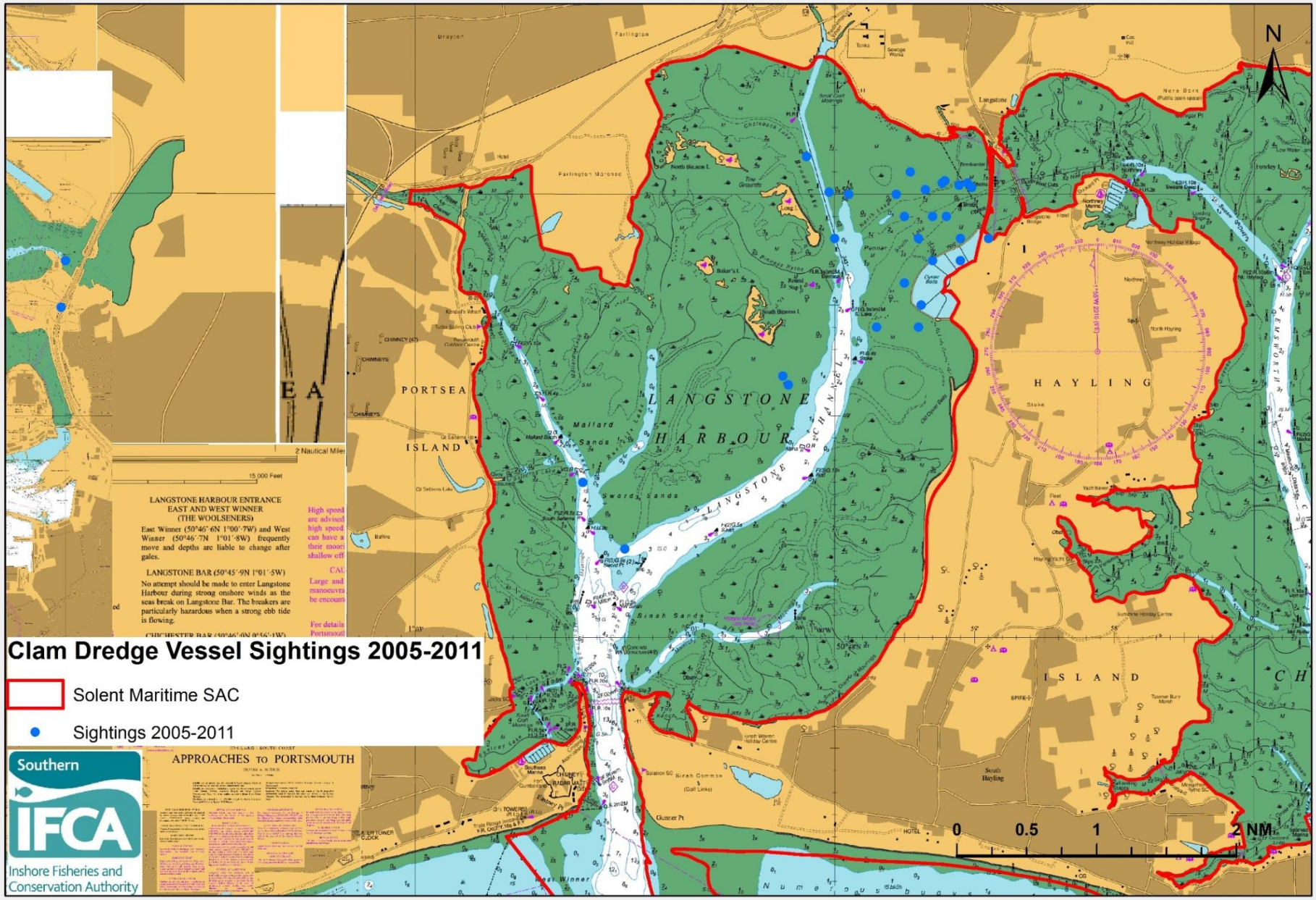


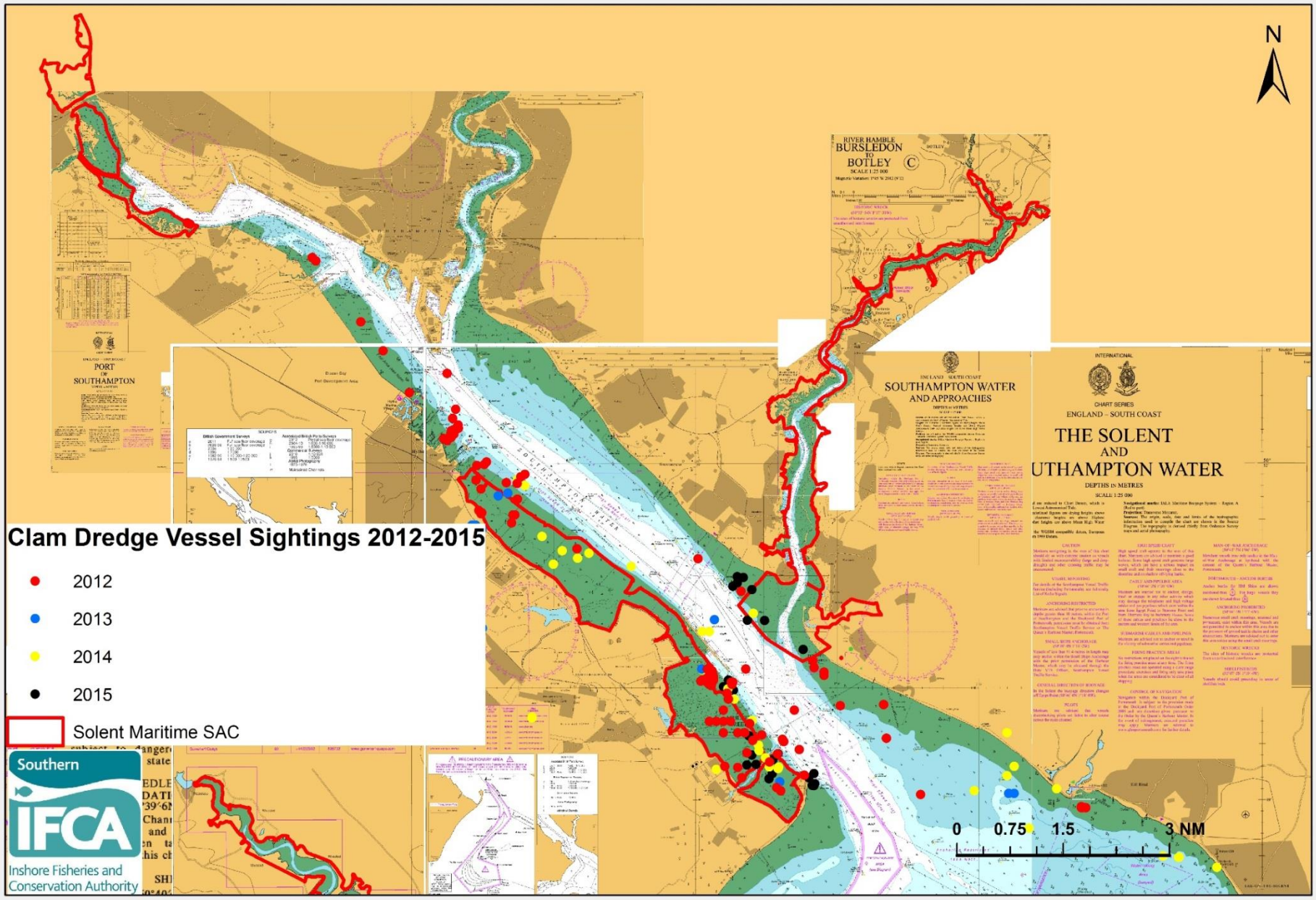


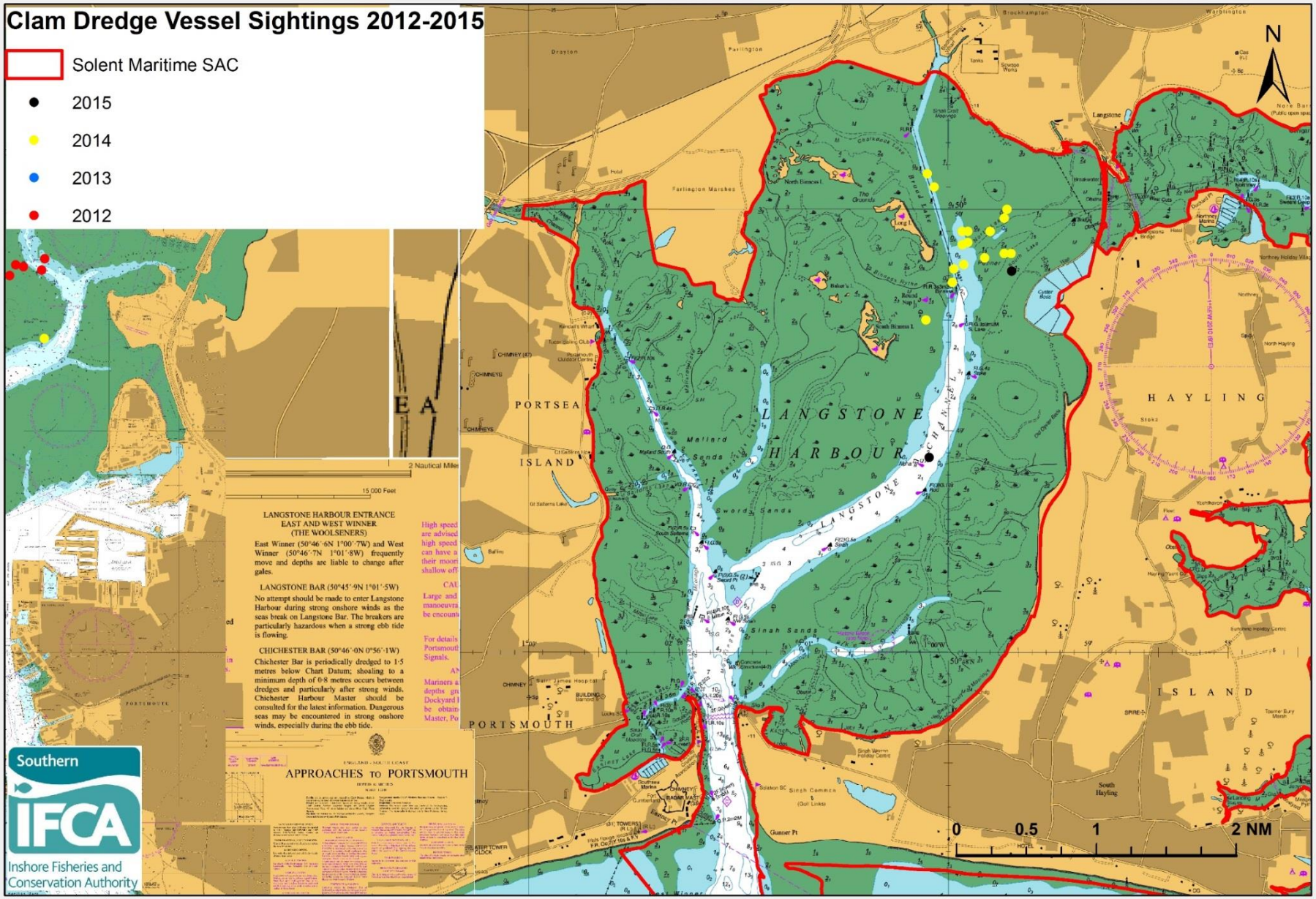


Annex 4: Fishing Activity Map(s) using Clam Dredging Sightings Data from 2005-2015 (2005-11 & 2012-2015 (broken down by year) in Southampton Water and Langstone Harbour)









Annex 5: Natural England's Scoping Advice

Date: 19 December 2014
Our ref: 132777

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BY EMAIL ONLY

Dear Rob

Natural England's advice on the potential impacts of clam dredging within the Solent

The following constitutes Natural England's formal advice regarding the potential impacts of dredging for clams on the nature conservation features of the following designated sites:

- Solent Maritime Special Area of Conservation (SAC)
- Solent and Southampton Water Special Protection Area (SPA)
- Solent and Southampton Water Wetland of International Importance under the Ramsar Convention (Ramsar site)

Clam dredging is an established fishing activity that is practised within the Solent on a year-round basis. The principal species targeted are the Manila clam (*Tapes philippinarium*) and the American Hard Shell clam (*Mercenaria mercenaria*), but catches may also include the Carpet Shell clam (*Ruditapes decussatus*). Clam dredging effort within the Solent is focused upon intertidal habitats, with potential impacts on the designated sites listed above. These sites are afforded protection under the Habitats and Species Regulations 2010 (as amended), and underpinned by Sites of Special Scientific Interest (SSSI) which are afforded protection under the Wildlife and Countryside Act (1981) (as amended under the Countryside and Rights of Way Act 2000). The Solent clam fishery is subject to a number of Southern Inshore Fisheries and Conservation Authority (SIFCA) byelaws that regulate the type of dredge that may be used; the hours during which vessels may fish; the spatial extent of the fishery (to avoid damage to seagrass beds); and a minimum landing size for American Hard Shell clams (*Mercenaria mercenaria*). Additionally, the Manila clam (*Tapes philippinarium)* is subject to a minimum landing size determined by the European Commission. There are currently no byelaw restrictions on the number of licensed vessels that dredge for clams in the Solent, or the months of the year during which they operate. Clam dredging also takes place in Portsmouth Harbour SPA and Chichester and Langstone SPA, and Natural England will provide advice with respect to these designated sites in due course.

1. Legal Requirements

Natural England and the Southern IFCA have duties under Regulation 9(3) of the Conservation of the Habitats & Species Regulations 2010 as competent authorities with functions relevant to marine conservation to exercise those functions so as to secure compliance with the Habitats Directive. Article 6.2 of the Habitats Directive requires appropriate steps to be taken to avoid, in Natura 2000 sites, the deterioration of natural habitats and habitats of species as well as significant disturbance of the species for which the area has been classified. SIFCA also need to ensure that the measures proposed are compatible with the conservation and enhancement of the special interest of relevant SSSIs in line with their status as a Section 28G authority under the Wildlife and Countryside Act 1981 (as amended).

This advice is to inform the scope of an assessment required by SIFCA through Defra's revised approach to the management of commercial fisheries within European Marine Sites, to avoid damage or deterioration to the conservation features of the Solent Maritime SAC and Solent and Southampton Water SPA and Ramsar site.

2. Protected Sites

2.1 Solent Maritime SAC

2.1.1 Site overview

The Solent Maritime SAC is located in one of only a few major sheltered channels in Europe, lying between a substantial island (the Isle of Wight) and the mainland. The Solent and its inlets are unique in Britain and Europe for their complex tidal regime, with long periods of tidal stand at high and low tide, and for the complexity and particularly dynamic nature of the marine and estuarine habitats present within the area. There is a wide variety of marine sediment habitats influenced by a range of salinities, wave shelter and intensity of tidal streams, resulting in a uniquely complex site. Sediment habitats within the estuaries include extensive areas of estuarine flats, with intertidal areas often supporting eelgrass *Zostera sp.* and green algae, saltmarshes and natural shoreline transitions, such as drift line vegetation.

2.1.2 Features/sub-features at risk of impact

Natural England has reviewed the SAC features/sub-features at risk of impact from clam dredging and agrees with the prioritisation exercise conducted by SIFCA. In addition to these 'at risk' features, we recommend that SIFCA also consider the risk of impact of clam dredging upon sub-tidal SAC features. While the focus of clam dredging effort occurs within intertidal habitats, the potential remains for dredging to take place within the sub-tidal zone also. To this end, Natural England has identified the features and sub-features which are at risk of impact from clam dredging, and should therefore be included in an assessment of this activity within the Solent Maritime SAC (Table 1). As you are aware, Natural England is in the process of revising the Regulation 35 Conservation Advice document for the Solent Maritime SAC which is scheduled for draft publication in Spring 2015. We have sought to prioritise the drafting of Regulation 35 documents of relevance to this scoping advice, and have used the revised feature and sub-feature descriptions for the Solent Maritime SAC within this advice letter.

Table 1: Summary of Solent Maritime SAC features/sub-features at risk of impact from clam dredging

Feature	Sub-feature
Estuaries	Intertidal coarse sediment
	Intertidal mixed sediments
	Intertidal mud
	Intertidal sand and muddy sand
	Intertidal seagrass beds
	Subtidal coarse sediment
	Subtidal sand
	Subtidal seagrass beds
Mudflats and sandflats not covered by seawater at low tide	Intertidal coarse sediment
	Intertidal mixed sediments
	Intertidal mud
	Intertidal sand and muddy sand
	Intertidal seagrass beds
Sandbanks which are slightly covered by seawater all the time	Subtidal coarse sediment
	Subtidal sand
	Subtidal seagrass beds

Data on the presence and extent of these features/sub-features has been provided to SIFCA through Natural England's ongoing Evidence Mapping Project. We recommend that SIFCA utilise this GIS data as best available evidence on presence and extent, and where possible, seek to incorporate this data with evidence of clam dredging activity to identify and assess impacts. While the sub-features in table 1 have been identified as at risk of impact from clam dredging, it may be possible that clams do not occur within all of these habitats in the Solent Maritime SAC.

The conservation objectives of these features/sub-features together with their specific attributes and targets are outlined below in section 2.1.3

2.1.3 Conservation Objectives

The European Site Conservation Objectives for the Solent Maritime SAC[1] are as follows:

> With regard to the SAC and the natural habitats and/or species for which the site has been designated (the 'Qualifying Features' listed below), and subject to natural change;
>
> Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring;
> - The extent and distribution of qualifying natural habitats and habitats of qualifying species;
> - The structure and function (including typical species) of qualifying natural habitats;
> - The structure and function of the habitats of qualifying species;
> - The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
> - The populations of qualifying species; and
> - The distribution of qualifying species within the site.

[1] Source: http://publications.naturalengland.org.uk/publication/5762436174970880

The above objectives should be considered in conjunction with accompanying Supplementary Advice Tables (SATs) which are scheduled for draft publication within the Regulation 35 Conservation Advice document in Spring 2015. As the Regulation 35 attribute and target descriptions were not finalised at the time of writing, we have used the existing Regulation 33 descriptions within this letter. Please note that the wording of these attributes and targets may therefore be subject to revision, however, it is not envisaged that the general principles upon which they are based will change substantively. Natural England will provide SIFCA with a copy of the SATs for the Solent Maritime SAC once finalised.

2.1.4 Condition Assessment

Natural England provides information on the condition of designated sites and describes the status of interest features. This is derived from the application of 'Common Standards Monitoring Guidance' which is applied to a subset of 'attributes' of site features as set out in the sites' Regulation 33/35 Conservation Advice document. Feature condition influences the Conservation Objectives in that it is used to determine whether a 'maintain' or 'recover' objective is needed to achieve the target level for each attribute.

Natural England's current process for conducting condition assessments for marine features was developed due to requirements to report on condition of Annex 1 features at the national level in 2012/13 under Article 17 of the Habitats Directive. Since then, the methods have been reviewed and we are actively working now to revise this process further so that it better fulfils obligations to inform management actions within MPAs and allows us to report on condition. In light of this revision to the assessment methods, Natural England will not be publishing condition information until this process is complete. We therefore advise that IFCAs assess the potential impact of amber-green or new fishing activities on a site, using a broad range of available information in addition to the Conservation Objectives. This information should include (but not be limited to) the following:

- Feature sensitivity information or advice on operations (to be drafted Spring 2015);
- The Natural England SPA toolkit and Fisheries Impacts Evidence Database;
- Activity information including distribution, type and intensity;
- Existing management practices and measures;
- Risk information including potential impact pathways between activities and features.

Additionally, an indication of condition for site interest features may, in some instances, be obtained from assessments of the SSSIs that underpin the SAC, which are available online at: http://designatedsites.naturalengland.org.uk/. Natural England is happy to liaise further with SIFCA in interpreting and utilising this data.

Natural England also recommends that SIFCA consider other threats to the condition of the site as highlighted in the Solent European Marine Sites (SEMS) Delivery Plan (http://www.solentems.org.uk/publications/) when assessing the impact of clam dredging upon Solent Maritime SAC qualifying features.

2.2 Solent and Southampton Water SPA and Ramsar site

2.2.1 Site overview

The Solent and Southampton Water Special Protection Area (SPA) and Ramsar site extends from Hurst Spit to Hill Head along the south coast of Hampshire, and from Yarmouth to Whitecliff Bay along the north coast of the Isle of Wight. The site comprises a series of estuaries and harbours with extensive mudflats and saltmarshes together with adjacent coastal habitats including saline lagoons, shingle beaches, reedbeds, damp woodland and

grazing marsh. The mudflats support beds of *Enteromorpha sp.* and *Zostera sp.* and have a rich invertebrate fauna that forms the food resource for estuarine birds. In summer, the site is of importance for breeding seabirds, including Mediterranean gulls and four species of terns. In winter, the site supports a large and diverse assemblage of waterbirds, including geese, ducks and waders.

2.2.2 Features and supporting habitats at risk of impact

Natural England has identified the following features and supporting habitats of the Solent and Southampton Water SPA and Ramsar site that are at risk of impact from clam dredging. These impacts include disturbance and displacement, competition for prey, changes in food availability and physical damage or loss of non-breeding habitat.

- Internationally important populations of regularly occurring Annex 1 species (breeding):
  - Mediterranean gull
  - Sandwich tern
  - Common tern
  - Little tern
  - Roseate tern

- Internationally important populations of regularly occurring migratory species (non-breeding):
  - Dark-bellied brent goose
  - Teal
  - Ringed plover
  - Black-tailed godwit

- Internationally important assemblage of waterfowl:
  - Wintering waterfowl assemblage

The supporting habitats at risk of impact from clam dredging are principally those that occur within the intertidal zone and are utilised by regularly occurring migratory species and the wintering waterfowl assemblage, namely:

- Intertidal coarse sediment
- Intertidal mixed sediments
- Intertidal mud
- Intertidal sand and muddy sand
- Intertidal seagrass beds

While the use of towed fishing gear has the potential to impact upon saltmarsh and *Spartina* swards in certain locations, informal discussions with SIFCA indicate that clam dredging is unlikely to have a significant effect upon these features in the Solent due to the proximity at which vessels may feasibly operate. However, Natural England recommends that SIFCA seek to confirm this using vessel sightings and habitat mapping data, and also consider the likelihood of this current situation changing in the future (e.g. through the realistic evolution of the fishery).

2.2.3 Conservation Objectives

The European Site Conservation Objectives for the Solent and Southampton Water SPA and Ramsar site[2] are as follows:

> With regard to the SPA and the individual species and/or assemblage of species for which the site has been classified (the 'Qualifying Features' listed below), and subject to natural change;
>
> Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;
> - The extent and distribution of the habitats of the qualifying features;
> - The structure and function of the habitats of the qualifying features;
> - The supporting processes on which the habitats of the qualifying features rely;
> - The population of each of the qualifying features;
> - The distribution of the qualifying features within the site.

As with the Solent Maritime SAC, the above objectives should be considered in conjunction with accompanying Supplementary Advice Tables (SATs) which will be published within the Regulation 35 Conservation Advice document. While this document is not scheduled for publication until Spring 2016 we have included the draft SPA attributes and targets in section 3.2. Please note that the wording of these attributes and targets may be subject to further revision, however, the general principles upon which they are based are unlikely to vary substantively. Natural England will provide SIFCA with a copy of the SATs for the Solent and Southampton Water SPA and Ramsar site once finalised.

2.2.4 Condition Assessment

While a formal condition assessment of the Solent and Southampton Water SPA and Ramsar site is not currently available, an indication of condition for bird species and their supporting habitats may be obtained from a number of sources – which are detailed below.

The British Trust for Ornithology (BTO) Wetland Bird Survey (WeBS) aims to identify population sizes, determine trends in numbers and distribution, and identify important sites for non-breeding waterbirds in the UK. Data can be used to highlight SPA bird features where population numbers have exhibited trends that are inconsistent with regional and/or national population trends, and thereby may be subject to site-specific pressures. Species that have undergone major changes in numbers are triggered by the issuing of a WeBS Alert, which can be viewed online at: http://blx1.bto.org/webs-reporting/.

The most recent WeBS report, based upon Alerts status as of 2009/10, does not trigger alerts for three of the four internationally important populations of regularly occurring migratory species within the SPA site: Dark-bellied brent goose; Teal; and Black-tailed godwit. While numbers of Ringed plover within the site have been stable in the short-term (5 years), their previous decline has triggered an alert for the long-term (25 years) reporting period. The WeBS report notes that this trend appears to be tracking that of wider regional and British trends, which suggests that the declining numbers underpinning these Alerts result from broad-scale population trends. Furthermore, the report states that the increasing proportion of regional numbers supported by the Solent and Southampton Water SPA suggests that environmental conditions remain relatively favourable and also indicates that

[2] Source: http://publications.naturalengland.org.uk/publication/6567218288525312

this site is becoming increasingly important on a regional scale for this species. It should be noted, however, that this data may not have captured the effects of fishing activities that have commenced or increased in intensity during the ensuing period. Similarly, these effects may not necessarily be captured in the next WeBS Alerts report (due in 2015) due to the time lag between cause and effect. Natural England recommends that these observations are given due consideration when assessing the impact of clam dredging upon SPA/Ramsar qualifying features.

Information on breeding seabird species is available through JNCC's Seabird Monitoring Programme (SMP), which collates sample data on breeding numbers and breeding success of seabirds in Britain and Ireland. The most recent population trends are presented in the Seabird Population Trends and Causes of Change: 1986-2012 report, which can be viewed online at: http://jncc.defra.gov.uk/page-3201. Alternatively, this data has been analysed by ABPmer on behalf of Natural England and provided to IFCAs within Natural England's SPA Toolkit. Unfortunately, data is not currently available for the qualifying bird species of the Solent and Southampton Water SPA (i.e. Mediterranean gull, Sandwich tern, Common tern, Little tern and Roseate tern) due to insufficient records. Natural England therefore recommends that SIFCA utilise data collated through alternative sources, including site leads and nature reserve wardens where applicable. Natural England is currently collating this data for tern species which we will make available to Southern IFCA early next year.

In addition to the qualifying bird species and assemblage it is necessary to consider the status of supporting habitats when assessing condition of the SPA and Ramsar site. As noted in section 2.2.2, Natural England has identified habitats within the intertidal zone to be at particular risk of impact from clam dredging. An indication of condition for these supporting habitats may be obtained from assessments of the SSSIs that underpin the SPA/Ramsar site, which are available online at: http://designatedsites.naturalengland.org.uk/. Natural England is happy to liaise further with SIFCA in interpreting and utilising this data.

As with the Solent Maritime SAC, SIFCA should also consider other threats to the condition of the site as highlighted in the SEMS Delivery Plan (http://www.solentems.org.uk/publications/) when assessing the impact of clam dredging upon SPA/Ramsar qualifying features.

3. Potential impacts on attribute targets that could prevent the achievement of conservation objectives

Having identified the SAC and SPA features, sub-features and supporting habitats at risk of impact from clam dredging in sections 2.1.2 and 2.2.2 respectively, the following section outlines the relevant site attributes, targets and impact pathways that should be considered by SIFCA when assessing this activity. As previously noted, Natural England is currently revising the Conservation Advice documents for these sites so the wording of these attributes and targets may be subject to change.

The magnitude of clam dredging impacts on benthic habitats will be determined by a combination of factors which include the location, scale and intensity of harvesting activities, together with local environment conditions such as sediment characteristics, water depth, wave exposure, strength of tidal currents, the presence of algae and seagrass, and intertidal/sub-tidal location (Kaiser et al. 2001; Wheeler et al. 2014). Similarly, the magnitude of impacts upon bird populations will be determined by environmental conditions such as the type and size of target and non-target prey species, climate/weather, alternate foraging sites, competition from other species and the relevant extent of alternate food supplies. Natural England recommends that these attributes are given full consideration when assessing the

significance of potential impacts upon the SAC and SPA/Ramsar site. In the first instance, we recommend that SIFCA collate spatial/temporal effort data on clam dredging within the designated sites and analyse this with respect to the location of sensitive features. Natural England is in the process of providing SIFCA with GIS feature mapping for the Solent Maritime SAC which collates confidence assessed datasets and represents our best available evidence base. In addition to SAC features, this feature mapping data will include the presence and extent of Solent and Southampton Water SPA supporting habitats where available.

For data pertaining to the distribution of SPA bird features, Natural England recommends that SIFCA utilise BTO WeBS Core Counts data on numbers and trends, together with that collected through the WeBS Low Tide Count (LTC) scheme. The LTC scheme collects data on feeding waterbirds within major UK estuaries, although sites are counted approximately every six years rather than annually. The estuaries within the Solent and Southampton Water SPA for which LTC data is available include Southampton Water (2000/2001), Beaulieu (2010/11), North-west Solent (2010/11) and Newtown Harbour (2008/9). Data can be viewed online at: http://blx1.bto.org/webs-reporting/?tab=lowtide or downloaded in GIS format through Natural England's SPA Toolkit. As with WeBS Alerts, we would advise caution when using this data for assessments of fishing activity.

Additional data on bird roosting sites is provided in the Solent Waders and Brent Goose Strategy (King, 2010), the outputs of which are available online at: http://www.solentforum.org/forum/sub_groups/Natural_Environment_Group/Waders%20and%20Brent%20Goose%20Strategy/.

3.1 Solent Maritime SAC

3.1.1 Feature: Estuaries; Mudflats and sandflats not covered by seawater at low tide; Sandbanks which are slightly covered by seawater all the time

1. Relevant attribute (Reg.33):
Topography

Target:
Shore profile should not deviate significantly from an established baseline, subject to natural change.

Potential Impacts:
Clam dredging can have a direct impact upon mudflats, sandflats and sandbanks by physically altering their topography. Typical effects include the creation of depressions and trenches, and the smoothing of ripples or creation of ridges within sand environments (Wheeler et al. 2014). Topography reflects the energy conditions and stability of soft sediment habitats, which in turn influences the distribution of benthic communities. For this reason, Natural England recommends that potential impacts upon the topography of mudflats, sandflats and sandbanks are also assessed with respect to sediment character and the range and distribution of characteristic biotopes.

2. Relevant attribute (Reg.33):
Sediment Character

Target:
i) Particle Size Analysis (PSA): Average PSA parameters should not deviate significantly from the baseline, subject to natural change.

ii) Sediment penetrability: Average measure should not deviate significantly from an established baseline, subject to natural change.

Potential Impacts:
Clam dredging has the potential to alter the sediment character of benthic habitats with resultant impacts upon community structure. Disruption caused by dredging can alter the physical structure of soft sediments, resulting in a loss of stability and vertical stratification (Tarnowski, 2006). Additionally, the disruption of sediments can release anoxic materials and contaminants which have a potentially detrimental effect upon re-colonisation and recruitment of target and non-target species (Piersma et al., 2001).

3.1.2 Sub-features: Intertidal coarse sediment; Intertidal mixed sediments; Intertidal mud; Intertidal sand and muddy sand; Intertidal seagrass beds; Subtidal coarse sediment; Subtidal sand; Subtidal seagrass beds

1. Relevant attribute (Reg.33):
Range and distribution of characteristic biotopes

Target:
Range and distribution should not deviate significantly from an established baseline, subject to natural change.

Potential Impacts:
Clam dredging has a number of potential impacts upon the range and distribution of characteristic biotopes. In addition to indirect effects of altering topography and sediment character, dredging results in the direct removal/mortality of benthic and epifaunal organisms – including both target and non-target species. Research suggests that impacts will be influenced by the type of organisms affected and the substrate over which dredging takes place. For example, Ferns et al. (2000) found that the decline of annelids, molluscs and crustaceans from dredging was greater in intertidal muddy sand habitats compared with intertidal sand. Population densities also took longer to recover within intertidal muddy sand, which the authors attributed to the release of anoxic chemicals.

2. Relevant attribute (Reg.33):
Extent of *Zostera* beds

Target:
No decrease in extent from an established baseline subject to natural change.

Potential Impacts:
Clam dredging can impact upon seagrass beds through two principal pathways: the direct removal/damage of shoots and rhizomes; and the indirect effect of sediment plumes smothering seagrass and reducing light absorption. As shellfish dredging within the vicinity of seagrass beds is prohibited by SIFCA's Bottom Towed Fishing Gear Byelaw, this activity is not considered to represent a significant risk to this sub-feature of the SAC. However, given that the potential currently exists for clam dredging activity to interact with this sub-feature, Natural England recommends its inclusion in the assessment process – together with consideration of byelaw compliance.

3.2 Solent and Southampton Water SPA and Ramsar site

Natural England has reviewed the potential impacts of clam dredging within the Solent and Southampton Water SPA and Ramsar site and identified the following impact pathways through which this activity may affect designated features and supporting habitats:

i) Disturbance and displacement caused by human activity
ii) Competition for prey
iii) Changes in food availability
iv) Physical damage or loss of non-breeding habitat

These impact pathways are explored in greater detail within the following sub-sections. In addition to the above, there are a number of direct and indirect impacts that are not likely to have a significant effect upon features or supporting habitats of the Solent and Southampton Water SPA and Ramsar site. These impacts are discussed briefly below:

- Mortality: Bird mortality can occur from entrapment within active fishing gear, or from entrapment/ingestion of lost or discarded fishing gear. The main risk is presented to diving seabirds interacting with nets, lines and traps. Due to the bird species present in the site and the type of gear used for clam dredging, Natural England do not consider this impact to have a significant effect upon the features of the SPA.

- Increased turbidity: Sediment mobilisation from dredging may result in increased turbidity, which can affect the success of birds feeding in the water column due to reduced visibility. The impact of increased turbidity will be determined by foraging strategies, with birds such as cormorants, mergansers and diving ducks being particularly at risk. Natural England has reviewed the potential impacts of increased turbidity upon the bird features listed in section 2.2.2 and do not consider this to have a significant effect due to the nature of their foraging strategies.

3.2.1 Disturbance and displacement caused by human activity

1. Relevant attribute/Sub-attribute:
Supporting habitat: minimising disturbance caused by human activity

Target:
The frequency, duration and/or intensity of disturbance affecting foraging and/or roosting birds should not reach levels that substantially affects the feature.

Potential Impacts:
Disturbance represents the stimulus that alters normal bird behaviour within a given area, and can result in displacement when birds are unable to use an area due to the magnitude of disturbance present. The response of birds to disturbance is influenced by a range of factors, including distance from the source of disturbance and the scale of disturbance (Stillman et al., 2009). Disturbance that results in birds taking flight can simultaneously increase energy demands and reduce food intake with potential consequences for survival and reproduction.

Fishing activity has the potential to cause bird disturbance through a number of direct impact pathways, including: visual and/or noise disturbance resulting from the presence/movement of fishing vessels; the presence/movement of people; and the operation of fishing gear. The magnitude of disturbance and displacement caused by clam dredging within the Solent and Southampton Water SPA and Ramsar site will be influenced by the intensity of fishing

activity (including the number of vessels, frequency and duration) relative to the proximity of sensitive bird species.

3.2.2 Competition for prey

1. Relevant attribute/sub-attribute:
Supporting habitat: food availability within supporting habitat

Target:
(I) Maintain overall prey availability at preferred prey sizes.
(II) Maintain a high cover/abundance of preferred food plants (e.g. *Zostera, Ulva sp.*).

Potential Impacts:
Fishing activity can have a direct impact upon birds through the targeted removal of organisms that are prey species of the bird feature. The food requirements of shorebirds within a cold climate are considerably greater due to thermoregulatory needs (Wheeler et al. 2014). Therefore, the principal bird features at risk from clam dredging impacts upon prey availability are benthic-feeding bird species that utilise the SPA/Ramsar site during the overwintering period (01 October – 31 March). Species such as Mediterranean gulls and terns are not likely to be at risk of significant impacts upon prey availability due to their surface-feeding behaviour and lack of prey interaction with clam dredging gear.

3.2.3 Changes in prey availability

1. Relevant attribute/sub-attribute:
Supporting habitat: food availability within supporting habitat

Target:
(I) Maintain overall prey availability at preferred prey sizes.
(II) Maintain a high cover/abundance of preferred food plants (e.g. *Zostera, Ulva sp.*).

Potential Impacts:
Fishing activity can have an indirect impact upon birds by affecting the availability of prey/food, through pathways that do not include targeted removal. These pathways include: physical disturbance to habitats resulting in changes to community structure; removal/mortality of non-target organisms through bycatch or interaction with fishing gear; smothering of prey species from increased sedimentation; and physical damage to supporting habitats such as *Zostera sp.* which is a key food source for Dark-bellied brent geese.

While shorebirds will typically eat a range of species including molluscs and annelids, the type of preferred prey will vary between bird species – which should be acknowledged when assessing impacts. Consistent with impacts resulting from competition for prey (see 3.2.2), the principal bird features at risk from changes in prey availability are non-breeding overwintering species rather than Mediterranean gulls and terns.

3.2.4 Physical damage or loss of non-breeding habitat

1. Relevant attribute/sub-attribute:
Supporting habitat: extent and distribution of supporting non-breeding habitat.

Target:
Maintain the extent and distribution of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding).

Potential Impacts:
Fishing activity can have an indirect impact upon birds by physically damaging or removing supporting habitat, including that used for roosting, nesting and feeding. An assessment of impacts from clam dredging upon the above attribute and target should consider effects that are not captured through other pathways (e.g. damage or loss of feeding habitat). Natural England therefore recommends that SIFCA examine the potential impacts of clam dredging with respect to damage or loss of roosting and nesting habitats.

Informal discussions with SIFCA indicate that clam dredging is unlikely to interact with the roosting or nesting habitats of designated bird species within the Solent and Southampton Water SPA and Ramsar site. However, we recommend that further assessment is undertaken using vessel sightings, habitat mapping and species distribution data in order to ascertain that no significant impacts occur.

4. Additional considerations

While it is acknowledged within research literature that shellfish dredging can have an adverse impact upon benthic habitats, evidence of the magnitude of this impact and its resultant effects upon shorebird populations remains relatively underdeveloped – particularly with respect to longer-term impacts (Wheeler et al. 2014). Natural England therefore welcomes the opportunity to collaborate with SIFCA and Bournemouth University in supervising a PhD project to explore the impacts of harvesting activities upon birds in the Solent. It is envisaged that this research will provide a key source of evidence in assessing the impacts of clam dredging upon features, sub-features and supporting habitats of the Solent Maritime SAC and Solent and Southampton Water SPA and Ramsar site.

In addition to the collation of primary data on the site-specific impacts of clam dredging, Natural England recommends that SIFCA consider existing management of fishing activities (including compliance) when assessing impacts upon designated features. Through this process it may be possible to scope out potential impacts upon features where clam dredging is prohibited, for example, within/adjacent to seagrass beds. Similarly, we recommend that SIFCA also consider the future realistic evolution of the clam fishery, including the introduction of methods such as pump scoop dredging which may affect the type and/or magnitude of impacts.

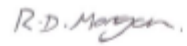
5. Summary

Natural England agrees with the Southern IFCA's prioritisation of clam dredging within the Solent as a high risk amber activity for Defra's revised approach to the management of commercial fisheries within European Marine Sites. The advice provided in this letter identifies the principal features, sub-features and supporting habitats of the Solent Maritime SAC and Solent and Southampton Water SPA and Ramsar site that may be adversely impacted by clam dredging activity. In addition to considering the impacts upon bird features and intertidal habitats previously identified by SIFCA, Natural England recommends that impacts upon subtidal habitats are also included in the assessment of clam dredging in the Solent.

Natural England welcomes the opportunity to work collaboratively with SIFCA in assessing the magnitude of these impacts and their resultant effects upon site integrity. As noted previously, this assessment will require the collation and analysis of clam dredging effort data, together with primary and secondary evidence on the impacts of this activity. Natural England would also be happy to work with SIFCA in developing management measures that may result from this assessment – including site-specific monitoring of fishing activity and impacts.

For any queries relating to the content of this letter please contact me using the details provided below.

Yours sincerely



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Annex 6: Co-Location of Fishing Activity using Clam Dredging Sightings (2012 to 2015) and Site Feature(s)/Sub-feature(s) (Southampton Water and Langstone Harbour)

Co-location of Clam Dredging and Features/Sub-features

- Clam Dredge Sightings 2012-2015
- Solent Maritime SAC

Mudflats and sandflats not covered by seawater at low tide (H1140) polygons

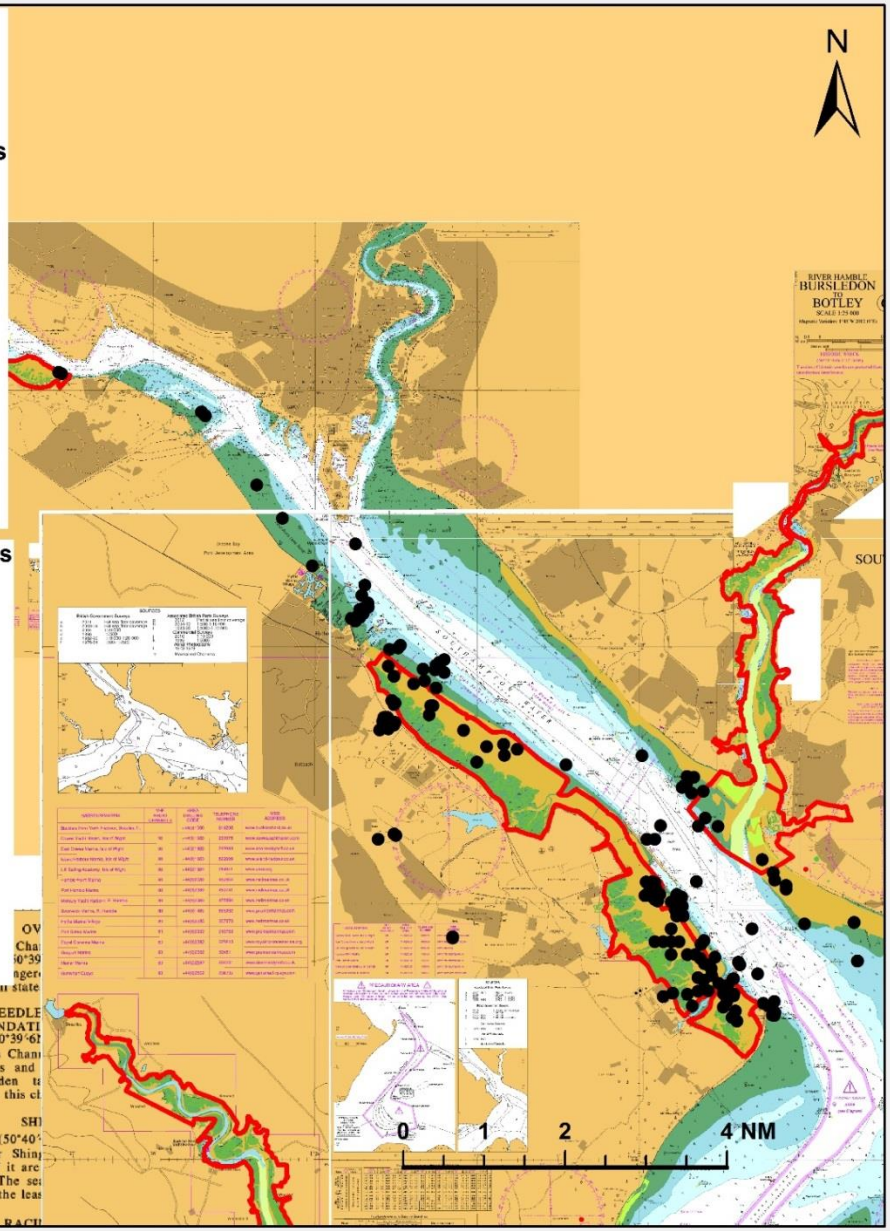
- Intertidal coarse sediment (A2.1)
- Intertida sand and muddy sand (A2.2)
- Intertidal mud (A2.3)
- Intertidal mixed sediments (A2.4)
- Intertidal seagrass beds (A2.61)

Sandbanks which are slightly covered by sea water all the time (H1110) polygons

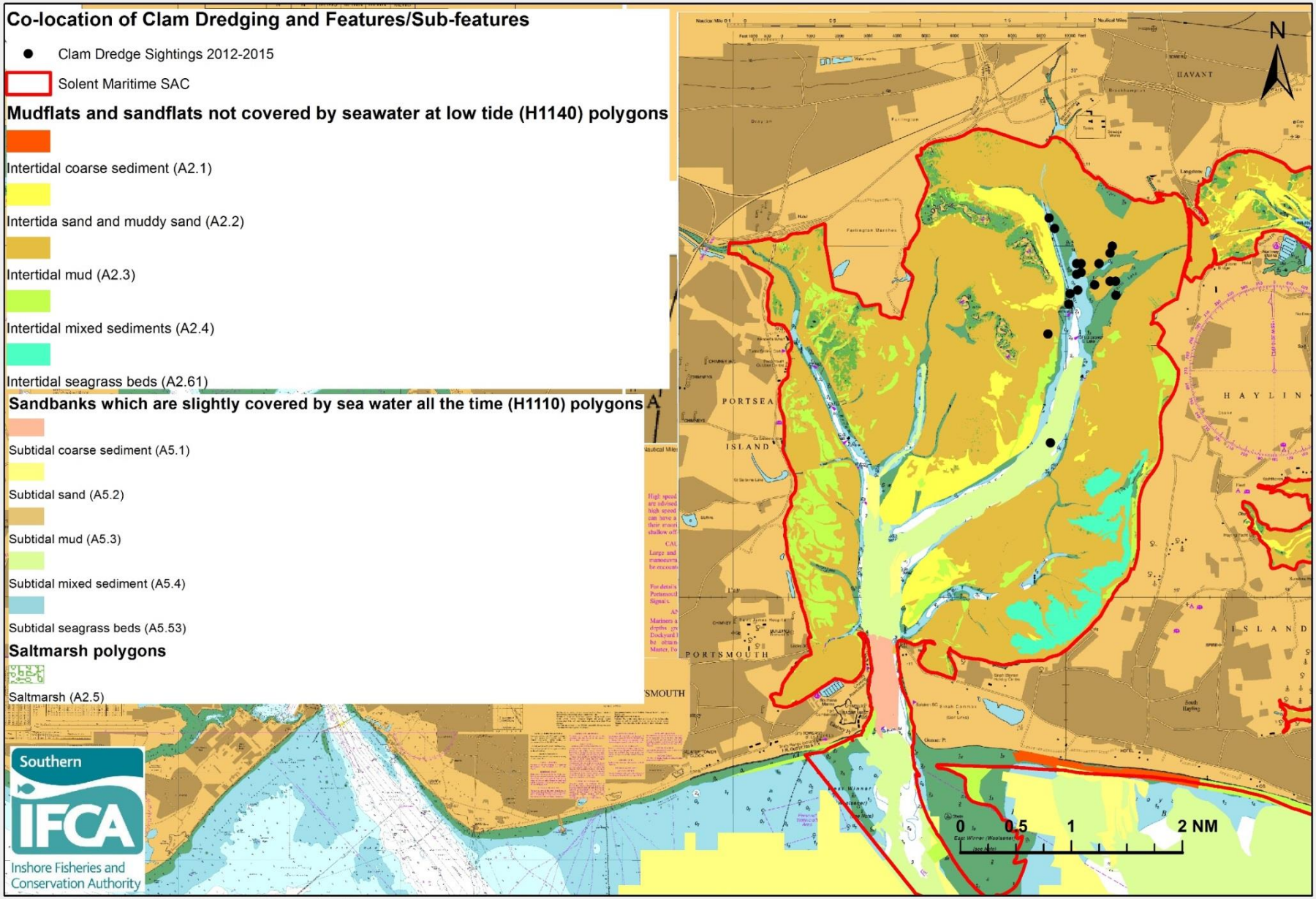
- Subtidal coarse sediment (A5.1)
- Subtidal sand (A5.2)
- Subtidal mud (A5.3)
- Subtidal mixed sediment (A5.4)
- Subtidal seagrass beds (A5.53)

Saltmarsh polygons

- Saltmarsh (A2.5)

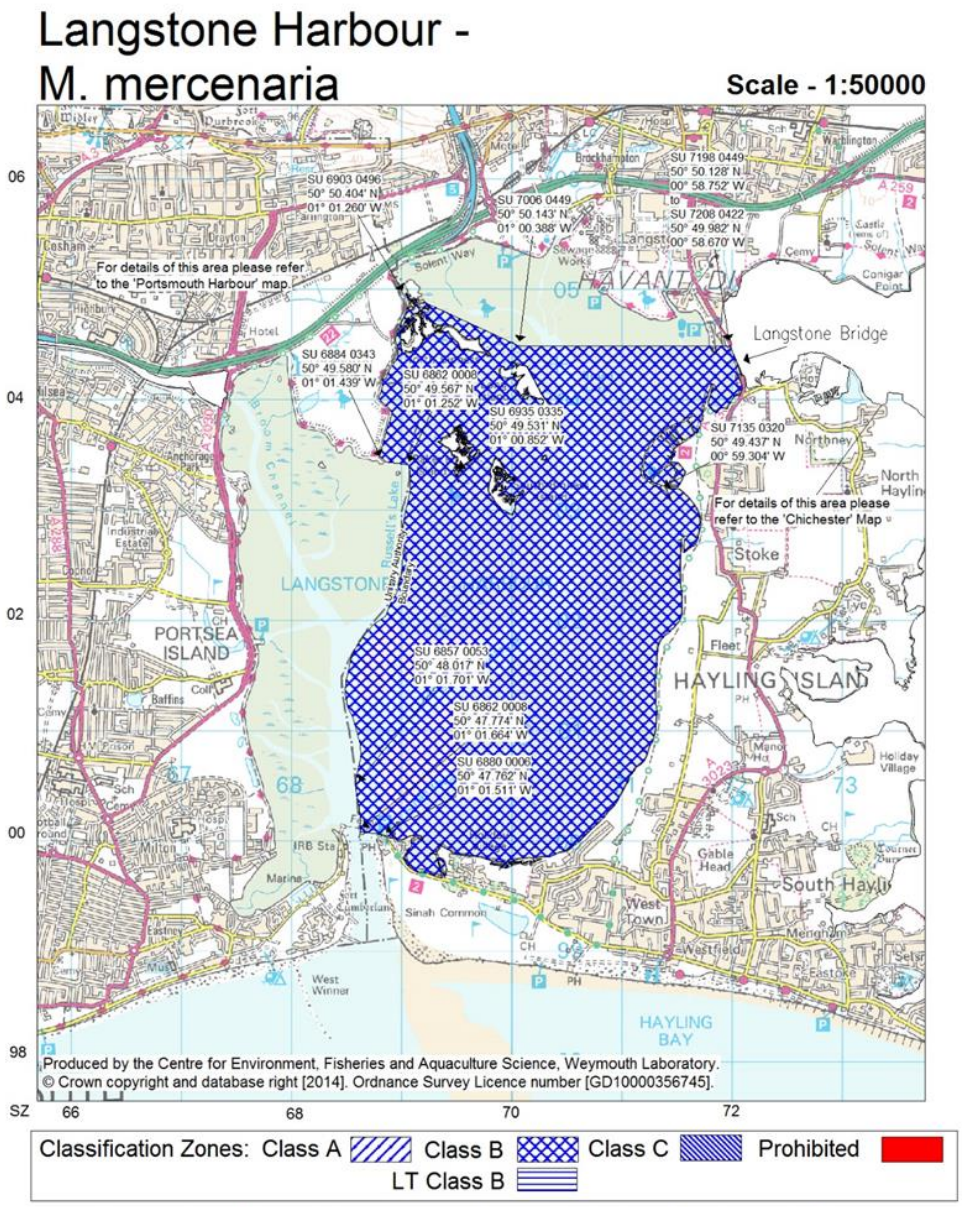


Southern IFCA
Inshore Fisheries and Conservation Authority



Annex 7: Seabed scars (shown as numerous lines), visible from Google Earth, potentially caused by clam dredging within Langstone Harbour. These images were taken on 22/04/2015. Source: Google Earth.

Annex 8: Classification of Bivalve Mollusc Production Areas interacting with the Solent European Marine Site



Classification of Bivalve Mollusc Production Areas: Effective from 1 September 2014

The areas delineated above are those classified as bivalve mollusc production areas under EU Regulation 854/2004.

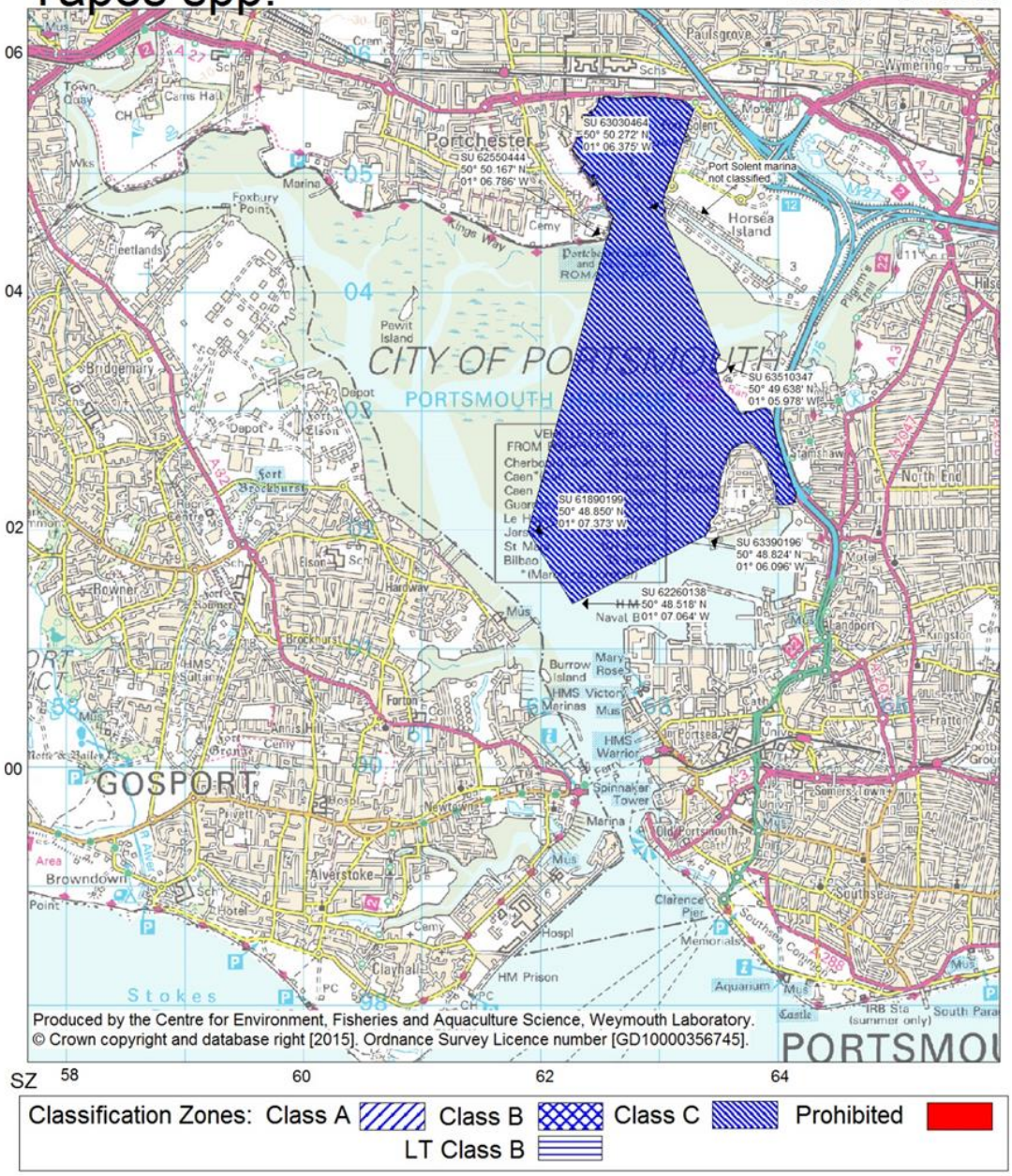
Further details on the classified species and the areas may be obtained from the responsible Food Authority. Enquiries regarding the maps should be directed to: Shellfish Microbiology, CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB. (Tel: 01305 206600 Fax: 01305 206601)

N.B. Lat/Longs quoted are WGS84
Seprate map for O. edulis at Langstone Harbour

Food Authority: Portsmouth Port Health Authority

Portsmouth Harbour - Tapes spp.

Scale - 1:50000



Classification Zones: Class A | Class B | Class C | Prohibited | LT Class B

Classification of Bivalve Mollusc Production Areas: Effective from 30 April 2015

The areas delineated above are those classified as bivalve mollusc production areas under EU Regulation 854/2004.

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(Tel: 01305 206600 Fax: 01305 206601)

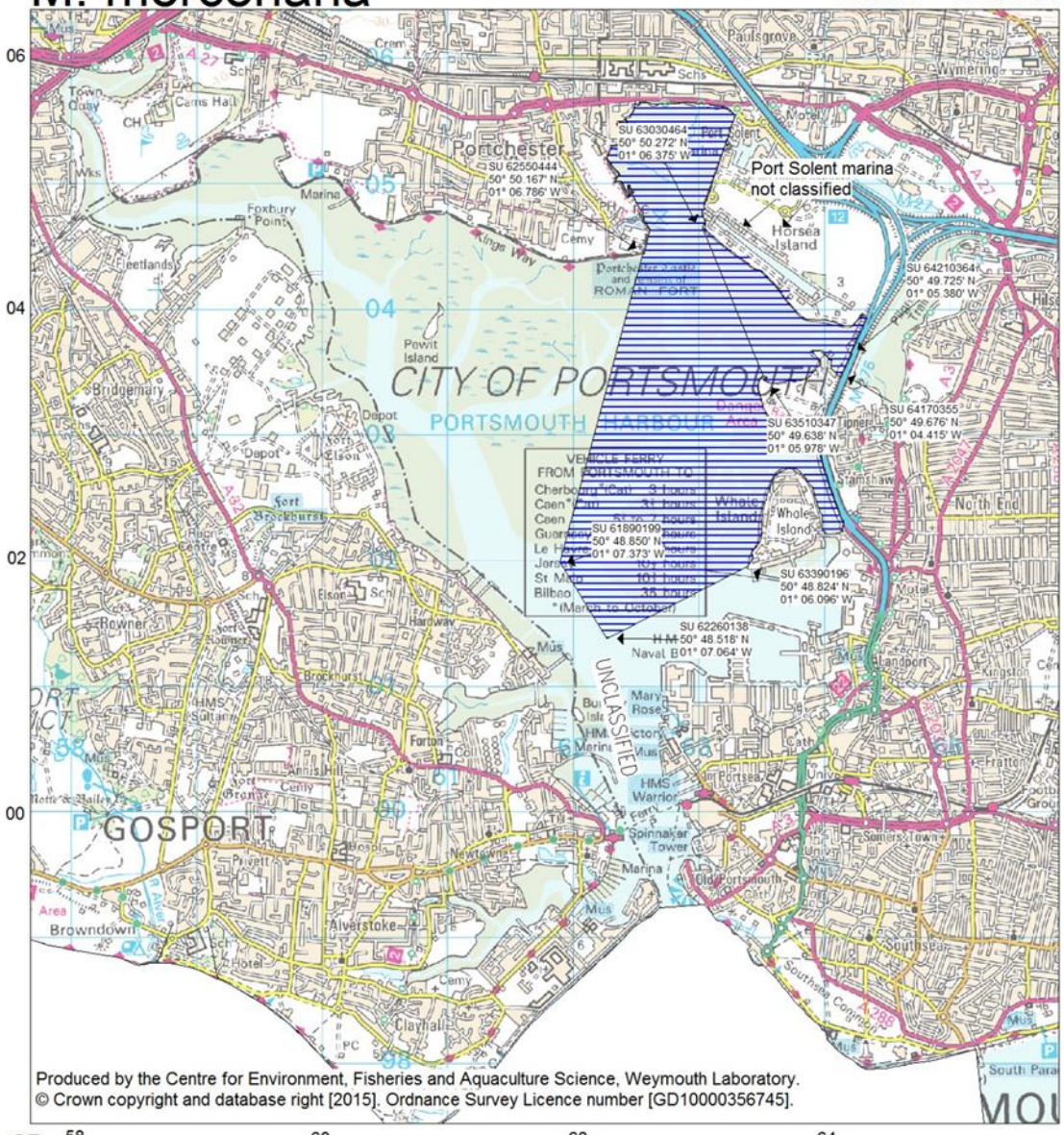
N.B. Lat/Longs quoted are WGS84
Seperate maps available for C. edule, and M. mercenaria at Portsmouth Harbour

Food Authority: Portsmouth Port Health Authority

 SIFCA Reference: SIFCA/HRA/06/001

Portsmouth Harbour - M. mercenaria

Scale - 1:50000



Classification Zones: Class A | Class B | Class C | Prohibited | LT Class B

Classification of Bivalve Mollusc Production Areas: Effective from 4 June 2015

The areas delineated above are those classified as bivalve mollusc production areas under EU Regulation 854/2004.

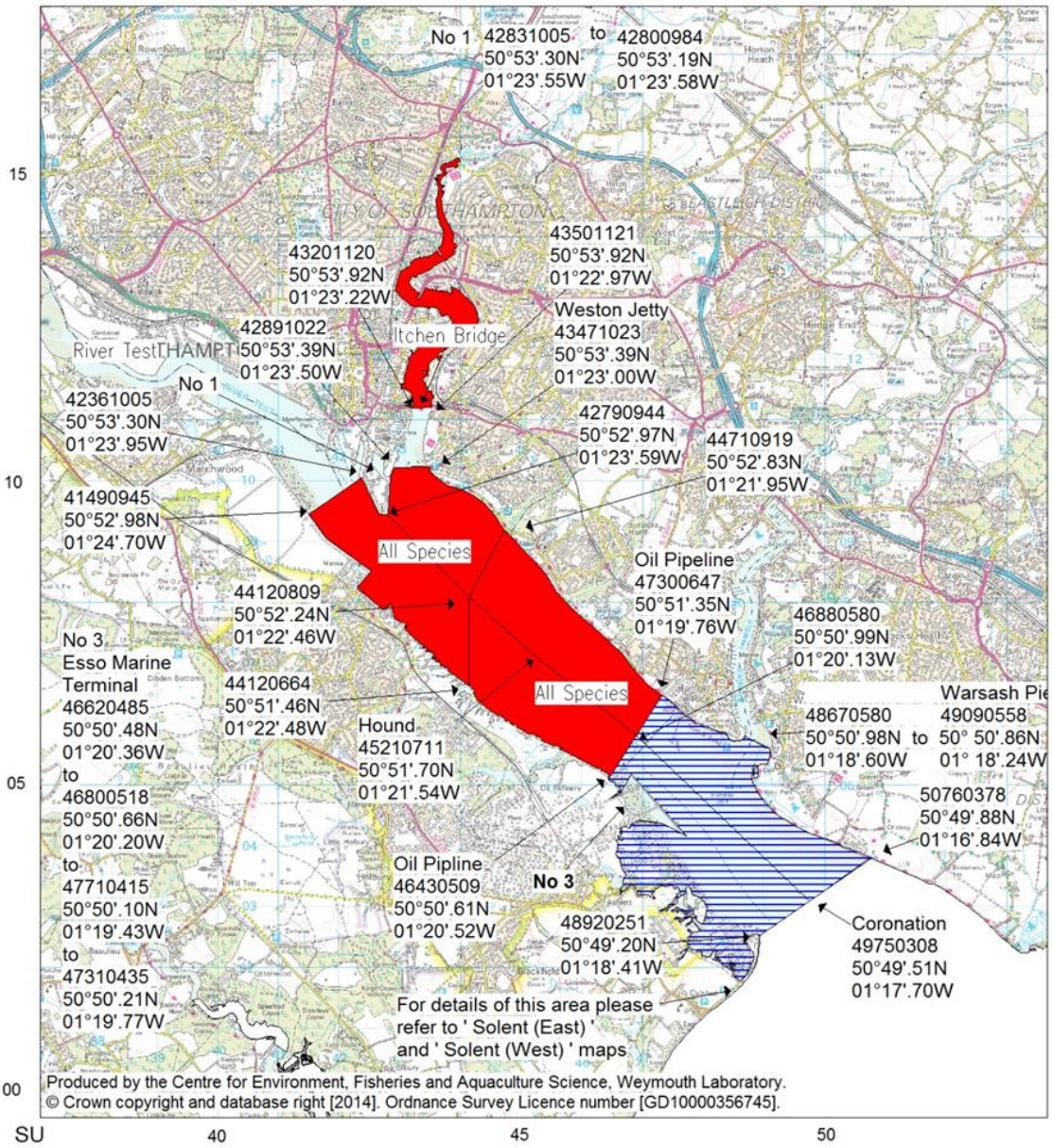
Further details on the classified species and the areas may be obtained from the responsible Food Authority. Enquiries regarding the maps should be directed to: Shellfish Microbiology, CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB.
(Tel: 01305 206600 Fax: 01305 206601)

N.B. Lat/Longs quoted are WGS84
Seperate maps available for C. edule and Tapes spp. at Portsmouth Harbour

Food Authority: Portsmouth Port Health Authority

 SIFCA Reference: SIFCA/HRA/06/001

Southampton Water - M. mercenaria Scale 1:100000



Classification Zones: Class A | Class B | Class C | Prohibited | LT Class B

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(Tel: 01305 206600 Fax: 01305 206601)

N.B. No harvesting is permitted from Prohibited or unclassified areas
i.e. areas that are not shaded to denote class A, B, LT B or C

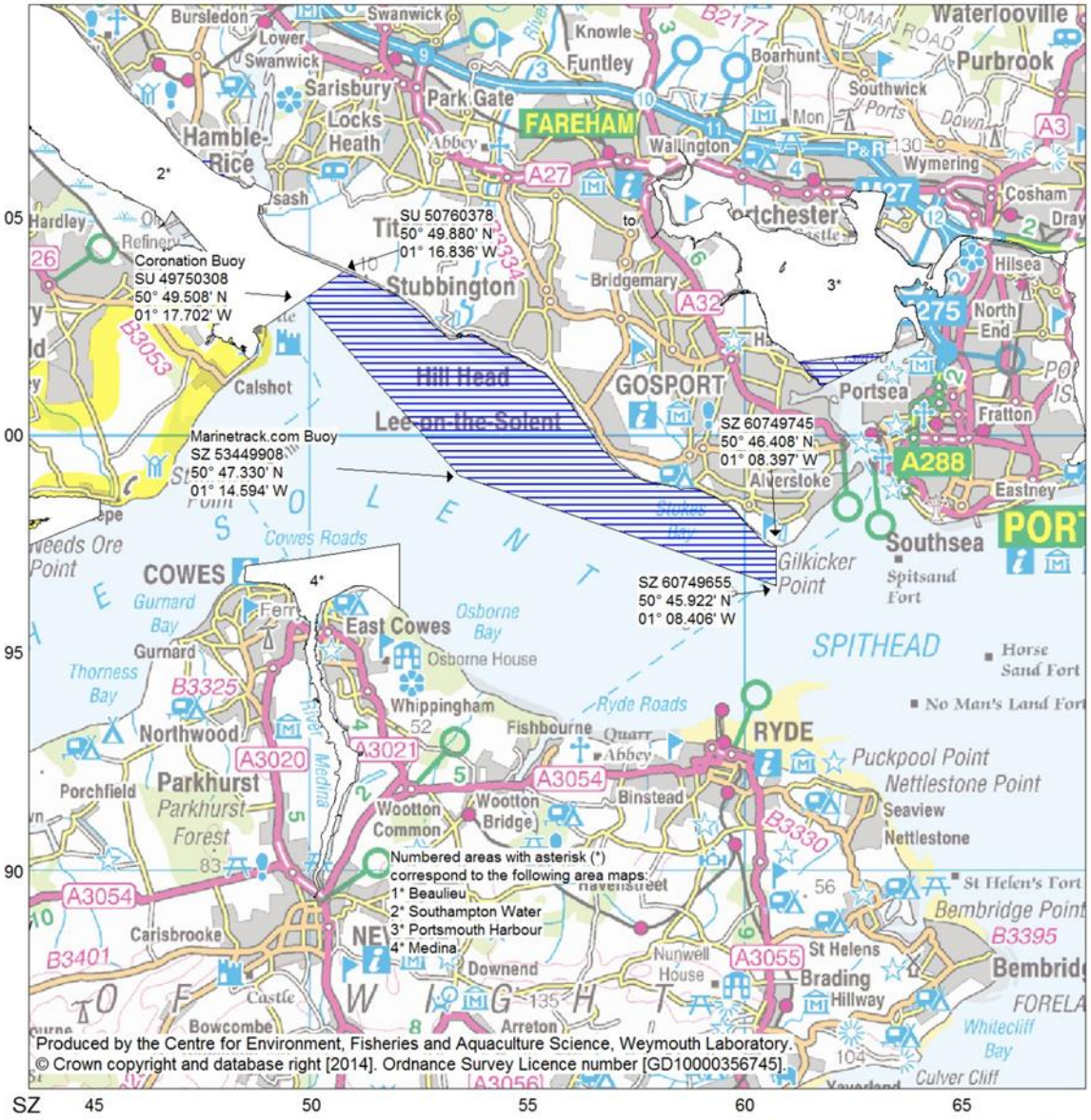
Lat/Longs quoted are WGS84
Separate maps available for O. edulis at Southampton Water

Food Authority: Southampton Port Health Authority

 SIFCA Reference: SIFCA/HRA/06/001

Solent (East) - M. mercenaria

Scale - 1:140000



Produced by the Centre for Environment, Fisheries and Aquaculture Science, Weymouth Laboratory.

Classification Zones: Class A | Class B | Class C | Prohibited | LT Class B

Classification of Bivalve Mollusc Production Areas: Effective from 1 September 2014

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(Tel: 01305 206600 Fax: 01305 206601)

N.B. Lat/Longs quoted are WGS84
Separate map available for O. edulis at Solent (East)

Food Authorities: Fareham Borough Council
Gosport Borough Council
Isle of Wight Council
Portsmouth Port Health Authority
Southampton Port Health Authority

 SIFCA Reference: SIFCA/HRA/06/001

Annex 9. Table of studies investigating the impacts of shellfish dredging and recovery rates.

Study	Location and Exposure	Gear Type and Target Species	Sediment Type	Recovery Period	Species-Specific Recovery
Ferns, P.N., Rostron, D.M. & Sima, H.Y. 2000. Effects of mechanical cockle harvesting on intertidal communities. *Journal of Applied Ecology*, 37, 464-474.	Burry Inlet, South Wales	Tractor-towed cockle harvester Common cockle -*Cerastoderma edule*	Intertidal clean sand and muddy sand	Recovery was considered with invertebrate sampling conducted 15 and 86 days after harvesting in both sediment types and 174 days in muddy sand only. Unfortunately sampling was not continued long enough to determine how long invertebrate communities took to recover. Movement of adults or passive transport as a result of sediment movements, was sufficient to allow recovery of modest invertebrate populations in clean sand, but inadequate to allow recovery of large populations in muddy sand. See species-specific recovery.	Muddy sand: *Pygospio elegans* - >174 days *Hydrobia ulvae* - >174 days *Nephtys hombergii* – 51 days *Bathyporeia pilosa* – 51 days *Lanice conchilega* – 0 days *Corophium arenarium* – 0 days *Macoma balthica* - >86 days Cerastoderma edule - >174 days *Pygospio elegans* - >86 days *Crangon creangon* - >86 days *Retusa obtusa* - >86 days Clean sand: *Bathyporeia pilosa* – 39 days *Macoma balthica* - <86 days Cerastoderma edule – 0 days *Pygospio elegans* - >86

					days *Nephtys homergii* - <86 days *Carcinus maenas* - <86 days
Kaiser, M.J., Edwards, B. & Spencer, B.E. 1996. Infaunal community changes as a result of commercial clam cultivation and harvesting. *Aquatic Living Resources*, 9, 57-63.	Whitestable, Kent, south-east England	Suction dredge Manila clam – *Tapes philippinarum*	Clay interspersed with patches of shell debris and lignin deposits (from local paper mill) overlaid with fine sand and silt. Exposed to prevailing north easterly winds.	Seven months after harvesting, no significant differences in infaunal communities were found between the harvested clam lay and either of the control sites (near and far). After seven months, sediment fractions in the harvested plot did not significantly differ from the sediment in control areas, as sedimentation had nearly restored sediment structure.	*Nephtys hombergii* contributed to the most similarity between samples taken from the clam lay 7 months after harvesting and was also dominant in control areas.
Hall, S.J. & Harding, M.J.C. 1997. Physical disturbance and marine benthic communities: the effects of mechanical harvesting of cockles on non-target benthic infauna. *Journal*	Auchencairn Bay, Solway Firth, Dumfries, Scotland	Suction dredge & tractor dredge Common cockle – *Cerastoderma edule*	Sediments generally become coarser in the centre of the bay and low water mark (median diameter = 3.5ø, 88μm) (near to the study area). Silt/clay fraction (<62.5 μm)	Suction dredge – statistically significant effects were present, but overall faunal structure in distributed plots recovered after 56 days. This occurred against a background of seasonal response. Tractor dredge – no statistically significant	Suction dredge - significant treatment (disturbed versus undisturbed) effects were reported for *Pygospio elegans* and *Cerastoderma edule*. There were also a significant time effect and significant time-treatment interaction for *Pygospio elegans*. Tractor dredge – mean

of Applied Ecology, 34, 497-517.			ranges from 25 to 60% in the centre.	effects on total abundance and number of species and overall faunal structure in distributed plots recovered after 56 days. This occurred against a background of general seasonal decline.	abundance of *P. elegans* remained higher in the undisturbed treatment until day 56. No significant treatment effect occurred for any species but a significant time treatment occurred for *P. elegans*, *Nepthys* sp. and *C. edule*, with a significant time treatment interaction for *P. elegans*.
Spencer, B.E., Kaiser, M.J. & Edwards, D.B. 1998. Intertidal clam harvesting: benthic community change and recovery. *Aquaculture Research*, 29, 429-437.	River Exe, England (see Spencer *et al*., 1996; 1997)	Suction dredge Manila clam – *Tapes philippinarum*	Unknown – study refers to stable sediment and protection from onshore winds by a sand dune bar.	Recovery of sediment structure and invertebrate infaunal communities occurred 12 months after harvesting. Four months after harvesting, significant differences between the harvested plot, previously net-covered plot and control plot were detectable (67% similarity between treatments), although there were indication of recruitment or migration. Eight months after harvesting, similarity between treatments increased to 85%, however significant differences were still	*Pygospio elegans* abundance was greater in the harvested plot than any other four months after harvesting, whilst *Nephtys hombergii* abundance remained lower.

				apparent between treatment and control plots (excluding previously net-covered plot and the harvested plot). Trenches (10 cm deep) left by suction dredging were infilled within 2 to 3 months.	
Peterson, C.H., Summerson, H.C. & Fegley, S.R. 1987. Ecological consequences of mechanical harvesting of clams. *Fishery Bulletin*, 85, 2, 281-298.	Back Sound, North Carolina, USA	'Clam kicking' – mechanical form of clam harvest involving the modification of boat engines to direct propeller wash downwards to suspend bottom sediments and clams into a plume and collected in a trawl net towed behind the boat. American hard shell clam - *Mercencaria mercenaria*	Seagrass bed and sandflat	Monitored the impact of different intensities of clam kicking, as well as clam raking, for up to four years. Clam harvesting had no impact on the density or species composition of small benthic macroinvertebrates, largely made up of polychaetes. The study concluded that polychaetes recover rapidly from disturbance and as such the communities are unlikely to be adversely affected by clam harvesting.	-

Annex 10. Table of recolonization strategies and reproductive seasons of potential key species in the Solent European Marine Site. These species were selected from the potential species list in Annex 11.

Species	Recolonization Strategy	Reproductive Season	References
Arenicola marina	Above-surface migration	Autumn to winter	McLusky *et al*. (1983) http://www.marlin.ac.uk/biotic/browse.php?sp=4238
Macoma balthica	Active migration of adults and larval settlement/recolonization	Spring and autumn	http://www.marlin.ac.uk/species/detail/1465 http://www.marlin.ac.uk/biotic/browse.php?sp=4272
Hydrobia ulvae	Active migration	March to October	http://www.marlin.ac.uk/habitats/detail/206/cerastoderma_edule_and_polychaetes_in_littoral_muddy_sand http://www.marlin.ac.uk/biotic/browse.php?sp=4186
Pygospio elegans	Larval recolonization	December to May or January to August	http://www.marlin.ac.uk/habitats/detail/206/cerastoderma_edule_and_polychaetes_in_littoral_muddy_sand http://www.marlin.ac.uk/biotic/browse.php?sp=6530
Hediste diversicolor	Adult migration and juvenile recruitment	Spring to summer	Lewis *et al*. (2002) http://www.marlin.ac.uk/biotic/browse.php?sp=4253
Scrobicularia plana	Larval recolonization	May to September	Lewis *et al*. (2002) Santos *et al*. (2011)
Nephtys hombergii	Passive and active migration	Variable; May and September (Tyne Estuary), throughout the year peaking in July and November (Southampton Water), August and September (Århus Bay, Denmark)	Hall and Harding (1997) http://www.marlin.ac.uk/biotic/browse.php?sp=4414

Annex 11. Potential Species List for the Solent European Marine Site (derived from SAC biotopes outlined in the Regulation 33 Conservation Advice Package and prey species of vulnerable (to shellfish dredging) SPA bird species).

SAC Species (Summary of key biotopes for SAC sub-features – Appendix XI):
Pontocrates spp.
Bathyporeia spp.
Lanice conchilega
*Corophium**
*Macoma balthica**
*Arenicola marina**
*Cerastoderma edule**
*Hediste diversicolor** (previously *Nereis diversicolor*)
Mya arenaria
Pygospio elegans
*Scrobicularia plana**
Streblospio shrubnsolii
Aphelochaeta marioni
Tubificoides
Nephtys hombergii

Prey species of potentially vulnerable (to shellfish dredging) SPA bird species*:
Cardium spp
Nereis spp
Crangon spp.
Carcinus spp.
Retusa obtusa
Corophium volutator
Gammarus spp.
Tubiflex spp.
Nerine spp.
Hydrobia ulvae

Annex 12: Co-location of Historic Trawl Sightings (2005-2011, 2012-2015), Clam Dredging (2012-2015) Oyster Dredging (2012, 2014-2015) Sightings in the entire Solent Maritime SAC and Southampton Water and the Langstone and Chichester portions of the Solent Maritime SAC