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Southern Inshore Fisheries and Conservation Authority (IFCA)

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

European Marine Site: Solent and Southampton Water SPA (UK9011061)

Feature(s): Internationally important populations of regularly occurring migratory species (Dark-bellied brent goose; Teal; Ringed plover; Black-tailed godwit); Internationally important assemblage of waterfowl (Wintering waterfowl assemblage)

Generic Feature(s): Estuarine birds

Site Specific Sub-feature(s)/Supporting Habitat(s): Intertidal mudflats and sandflats; Mixed sediment shores

Generic Sub-feature(s)/Supporting Habitat(s): Intertidal mud and sand; Intertidal mixed sediments

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 (SEMS) 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 are managed in accordance with Article 6 of the Habitats Directive.

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].

[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

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 internationally important populations of the regularly occurring migratory species and internationally important assemblage of waterfowl and their supporting habitats of the Solent and Southampton Water SPA; 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 and supporting habitats of the Solent and Southampton Water SPA.

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]
- 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)

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

[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

- 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 and Southampton Water SPA (UK9011061)

2.1 Overview and qualifying features

- Internationally important populations of the regularly occurring Annex 1 species (A176 *Larus melanocephalus*; Mediterranean gull (Breeding); A191 *Sterna sandvicensis*; Sandwich tern (Breeding); A192 *Sterna dougallii*; Roseate tern (Breeding); A193 *Sterna hirundo*; Common tern (Breeding); A195 *Sterna albifrons*; Little tern (Breeding))
- **Internationally important populations of the regularly occurring migratory species** (A046a *Branta bernicla bernicla*; Dark-bellied brent goose (Non-breeding); A052 *Anas crecca*; Eurasian teal (Non-breeding); A137 *Charadrius hiaticula*; Ringed plover (Non-breeding); A156 *Limosa limosa islandica*; Black-tailed godwit (Non-breeding))
    - Saltmarsh
    - Intertidal mudflats and sandflats
    - Boulder and cobble shores
    - Mixed sediment shores
- **Internationally important assemblage of waterfowl (Waterbird assemblage)**
    - Saltmarsh
    - Intertidal mudflats and sandflats
    - Boulder and cobble shores
    - Mixed sediment shores

Please refer to Annex 3 for a map of supporting habitats.

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 Conservation Objectives

The conservation objective for the Solent and Southampton Water SPA features:

- Internationally important populations of the regularly occurring migratory species
- Internationally important assemblage of waterfowl

Are to "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, and,
- The distribution of the qualifying features within the site.**"**

The high level conservation objectives for the Solent and Southampton Water SPA are available online at: http://publications.naturalengland.org.uk/publication/6567218288525312

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

- Subtidal eelgrass *Zostera marina* beds (supporting habitat of the bird interest features)

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[8] and 'Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds' byelaw[9]. 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 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 and Southampton Water 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 and Southampton Water SPA. 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

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

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 upper western 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 upper western 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. 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. The number of vessels sighted in the whole Solent by Southern IFCA are summarised in Table 1. Table 1 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 1. 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. 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 2. 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**		

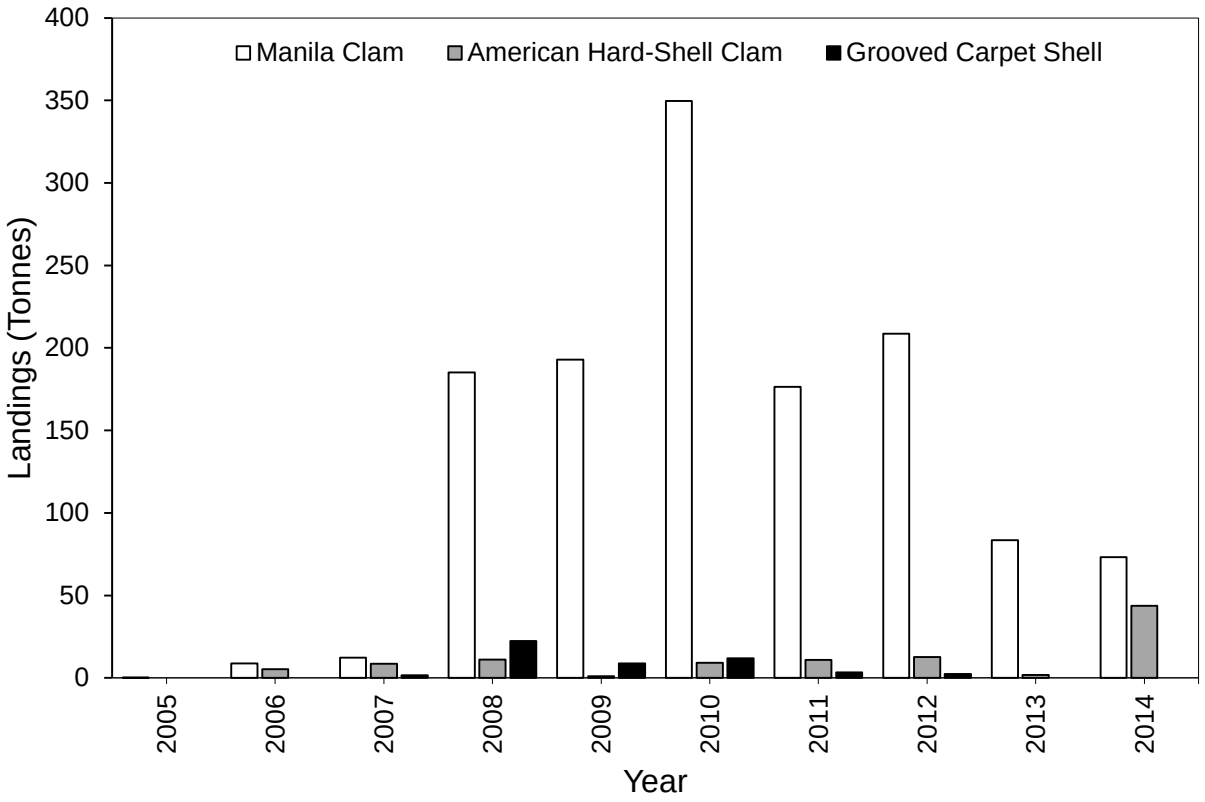

Figure 3. Total landings (in tonnes) of key clam species (Manila clam - *Ruditapes philippinarum*, American Hard-Shell clam - *Mercenaria mercenaria*, Grooved Carpet Shell clam - *Ruditapes decussatus*) into ports located within the Solent European Marine Site (EMS). Data was provided by the Marine Management 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[10]. Each feature/supporting habitat was subject to a TLSE, the results of which are summarised in table 3 and 4.

5.1 Table 3: Summary of LSE Assessment(s) – Estuarine birds

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

[10] 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)/supporting habitat(s)?</td><td colspan="2">Regulation 33 Advice/SPA Toolkit:
1. Physical loss (of non-breeding habitat) – removal
2. Physical loss (of non-breeding habitat) – smothering
3. Physical damage (of non-breeding habitat) – abrasion
4. Non-physical disturbance (and displacement) – noise
5. Non-physical disturbance (and displacement) – visual presence
6. Toxic contamination – introduction of synthetic and non-synthetic compounds
7. Non-toxic contamination – changes in nutrient loading and organic loading
8. Non-toxic contamination – changes in turbidity/Increased turbidity
9. Selective extraction of species/Competition for prey
10. SPA Toolkit Only: Changes in food availability

Additional pressures identified from Portsmouth Harbour SPA Draft Regulation 35 Advice:
11. Collision above water with static or moving objects
12. Introduction of light
13. Introduction of microbial pathogens
14. Introduction or spread of non-indigenous species</td></tr>
<tr><td rowspan="3">3. Is the feature(s)/supporting habitat(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 – Clam dredging is known to cause abrasion and disturbance to the seabed surface. Supporting habitats including intertidal mudflats and sandflats and sand and shingle are all considered vulnerable to physical damage by abrasion. The exposure to activities and one-off developments that may cause abrasion is higher for intertidal mudflats, sandflats and mixed sediment communities. Repeated or permanent damage can adversely affect the ability of the habitats to recover and may ultimately lead to loss. Further assessment on the local of vessel sightings, supporting habitats and species distribution is necessary to confirm this.</td></tr>
<tr><td>4.</td><td>IN – Vessels can operate close inshore and noise disturbance can result from the presence/movement of fishing vessels and operation of fishing gear. The magnitude of disturbance and displacement is influenced by the intensity of fishing (no. of vessels, frequency and duration) and the activities relative proximity to sensitive bird species (wildfowl & waders). Further investigation is therefore necessary into the scale activity and location of sensitive bird species.</td></tr>
</table>

	5.	IN – Vessels can operate close inshore and visual disturbance is possible from the presence/movement of fishing vessels and operation of fishing gear. The magnitude of disturbance and displacement is influenced by the intensity of fishing (no. of vessels, frequency and duration) and the activities relative proximity to sensitive bird species (wildfowl & waders). Further investigation is therefore necessary into the scale activity and location of sensitive bird species.
	10.	IN – Clam dredging can have an indirect impact on bird species by affecting the availability of prey through community structure changes as a result of physical disturbance, removal/mortality of non-target organisms, smothering of prey species and physical damage to supporting habitats. Further assessment of clam dredging impacts on non-target species is needed, with consideration given to the sensitivity of different prey types and the key prey groups of different bird features.
4. What key attributes of the site are likely to be effected by the identified pressure(s)?	Regulation 33 Advice: - Disturbance - Supporting habitat(s): Extent and distribution - Supporting habitat(s): Food availability Clam Dredging (Solent and Southampton Water SPA) NE Scoping Advice: - Supporting habitat: minimising disturbance caused by human activity - Supporting habitat: food availability within supporting habitat - Supporting habitat: extent and distribution of supporting non-breeding habitat	
5. Potential scale of pressures and mechanisms of effect/impact (if known)	Refer to full LSE	
6. Is the potential scale or magnitude of any effect likely to be significant?	**Alone** Yes	**OR In-combination**[11] 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.	

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

5.2 Table 4: Summary of LSE Assessment(s) – Intertidal mud and sand; Intertidal mixed sediments

<table>
<tr><td>1. Is the activity/activities directly connected with or necessary to the management of the site for nature conservation?</td><td colspan="2">No</td></tr>
<tr><td>2. What potential pressures, exerted by the gear type(s), are likely to affect the feature(s)/supporting habitat(s)?</td><td colspan="2">Regulation 33 Advice/ Additional pressures identified from Portsmouth Harbour SPA Draft Regulation 35 Advice:
1. Physical loss (of non-breeding habitat) – removal
2. Physical loss (of non-breeding habitat) – smothering/Siltation rate changes (high and low), including smothering
3. Physical damage (of non-breeding habitat) – abrasion/Abrasion/disturbance of the substrate on the seabed surface/ Penetration and/or disturbance of the substrate below the seabed surface including abrasion
4. Toxic contamination – introduction of synthetic and non-synthetic compounds
5. Non-toxic contamination – changes in nutrient loading and organic loading/Organic enrichment
6. Non-toxic contamination – changes in turbidity/Changes in suspended solids (water clarity)
7. Portsmouth Harbour SPA Draft Regulation Advice: Introduction of microbial pathogens
8. Portsmouth Harbour SPA Draft Regulation Advice: Introduction or spread of non-indigenous species
Portsmouth Harbour SPA Draft Regulation Advice only:
9. Physical change (to another seabed type)</td></tr>
<tr><td rowspan="2">3. Is the feature(s)/supporting habitat(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 – Clam dredging is known to cause abrasion and subsurface disturbance to the seabed surface through the penetration of the dredges ‘teeth’ into the sediment. Supporting habitats including intertidal mudflats and sandflats and sand and shingle are all considered vulnerable to physical damage by abrasion. The exposure to activities and one-off developments that may cause abrasion is higher for intertidal mudflats, sandflats and mixed sediment communities. Repeated or permanent damage can adversely affect the ability of the habitats to recover and may ultimately lead to loss. Further assessment on the local of vessel sightings, supporting habitats and species distribution is necessary to confirm this</td></tr>
</table>

4. What key attributes of the site are likely to be effected by the identified pressure(s)?	Regulation 33 Advice: - Disturbance - Supporting habitat(s): Extent and distribution - Supporting habitat(s): Food availability Clam Dredging (Solent and Southampton Water SPA) NE Scoping Advice: - Supporting habitat: minimising disturbance caused by human activity - Supporting habitat: food availability within supporting habitat - Supporting habitat: extent and distribution of supporting non-breeding habitat	
5. Potential scale of pressures and mechanisms of effect/impact (if known)	Physical loss through removal and smothering has been screened out and there is no relevant attribute which relates to the physical damage of the supporting habitat.	
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/Supporting habitats

Key areas favoured by designated bird species in the Solent and Southampton Water SPA are summarised in table 5.

Table 5. Key areas for designated bird species in the Solent and Southampton Water SPA. Source: Stillman *et al*., (2009) and EA Alerts (2004).

Common Name	Latin Name	Favoured Area(s)
Dark-bellied brent goose	*Branta bernicla bernicla*	**Low tide** data shows the greatest concentrations at Farlington Marshes in Langstone, Thorney and Bosham Channels in Chichester Harbour. Hayling and Portsea Islands. Low tide WeBS data distribution maps (presented in Annex 7 and 8) reveal relatively high densities of this species on the eastern side of the Hamble entrance.
Eurasian teal	*Anas crecca*	Majority are found in Southampton Water and the north-west Solent (Hythe, River Test and Beaulieu). Elsewhere, there are significant numbers on Farlington marshes in Langstone, Thorney Island in Chichester, and in the Yar and Newton on the Isle of Wight. See also low tide WeBS data distribution maps presented in Annex 7 and 8.
Ringed plover	*Charadrius hiaticula*	**At low tide**, notable concentrations occur at Pennington Marshes near Lymington, at the mouth of the Hamble, and on the foreshore at Havant. **At low tide**, ringed plover distribution is localised and is focused upon Hurst. **At high tide**, the largest roosts has known to occur at Calshot, Warsash to Hook foreshore, Beaulieu River and the Hurst-Lymington. Notable flocks occur around the north coast of the Isle of Wight, especially at Ryde and Bembridge Harbour. See also low tide WeBS data distribution maps presented in Annex 7 and 8.
Black-tailed godwit	*Limosa limosa islandica*	**Low tide** WeBS data distribution maps (presented in Annex 7 and 8) reveal very low densities throughout Southampton Water.

Bird roosting sites from the Solent Waders and Brent Goose Strategy are presented in Annex 10.

A map of clam dredge sightings and supporting habitats can be found in Annex 6. This map reveals where fishing activity occurs in relation to the designated supporting habitats 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 and

are most likely explained by inaccurate reporting. Using knowledge presented in table 5, low tide WeBS data distribution maps (presented in Annex 7 and 8) and data provided in the Solent Overwintering Birds Workshop in Annex 9, clam dredging may have some effect on sites used by the Eurasian teal including Ashlett Creek and the upper western reaches of the Southampton Water near Hythe, Dark-bellied brent goose including Ashlett Creek and Ringed plover including the western side of the Hamble entrance. It is important to note that low tide WeBS data, illustrated in Annex 7 and 8, will be indicative on when birds are feeding are low tide and clam dredging occurs at high tide, so it is likely that clam dredging will have very little direct impact on the disturbance of designated bird species feeding on the intertidal mudflats.

Please note that the low tide count WeBS data distribution map displayed in Annex 8 represents counts made in 2000/01. This map represents dot density and not the location of individual counts. It is important to note that the low tide count WeBS data collection is undertaken in the Solent during the winter period on neap tides, two hours either side of low water. This means that a number of areas will be missed as they will be covered by water, particularly in Portsmouth Harbour. On a spring tide a larger area of the intertidal is exposed and this can lead to a greater number of birds. The maps therefore only represent a snapshot in time.

6.2 Potential Impacts on Birds and Supporting Habitats

The potential impacts of shellfish dredging on Solent and Southampton Water SPA designated bird species, identified by Natural England (2014), include direct impacts through disturbance and displacement caused by human activity and competition for prey and indirect impacts through changes in prey availability. Wheeler *et al*. (2014) identified a knowledge gap on the effects of shellfish dredging due to a lack of research.

The scale of impact caused by shellfish dredging depends on a number of factors which include the scale and intensity of harvest, the size of targeted shellfish, species taken, season, weather, availability of alternative foraging sites, competition and extent of alternate food resources (Stillman *et al*., 2001; Goss-Custard *et al*., 2004; Verhulst *et al*., 2004; West *et al*., 2005).

6.2.1 Changes in prey availability

Prey availability can be modified directly through the targeted removal of shellfish species that also form a prey item of designated bird species; and indirectly through physical disturbance or damage to supporting habitats which can result in changes to community structure, the removal and mortality of non-target organisms through interaction with fishing gear and smothering of prey species through increased sedimentation (Natural England, 2014).

Direct competition

Commercial shellfisheries can provide a potential source of conflict by competing with the same food resources as certain bird species (Schmechel, 2001; Atkinson *et al*., 2003). The removal of food resources by shellfishing therefore has the potential to have detrimental effects on

the amount of food available per bird and subsequently increases the chance of a threshold being reached where mortality from starvation begins to increase (West *et al*., 2005; Navedo *et al*., 2008). The removal of shellfish from productive beds, along with associated disturbance, can drive birds from preferred feeding grounds to areas of poorer quality. This can lead to an increase in bird densities and a subsequent intensification of interference and exploitation competition for food which can reduce intake rate and probability of starvation, particularly in winter (Goss-Custard & Verboven, 1993; Clark, 1993; Goss-Custard *et al*., 1996). It is important to understand to what degree bird species are able to switch to other food resources, if their target species (that may also be the target species of the fishery) is reduced (Schmechel, 2001). It was reported by Zwarts *et al*. (1996a) that along the north west European coast there are limited possibilities of alternative prey items for certain bird species, especially in winter due to changes in availability (Schmechel, 2001). Using individual behaviour-based models it has been shown that shellfish stocks should not fall below 2.5 to 8 times the biomass that shorebird populations require to survive (Stillman *et al*. 2003; Goss-Custard *et al*. 2004; Stillman *et al*. 2010).

A link has been shown between the state of shellfish stocks and oystercatcher survival in the Wash (Schmechel, 2001). The Wash, constitutes an important estuary for supporting large numbers of wintering waterfowl (310 000), including internationally important numbers of knot and oystercatcher (Schmechel, 2001; Atkinson *et al*., 2003). The area also supports one of the three major cockle fisheries in Britain (Atkinson *et al*., 2003). The majority of cockle harvesting involves the use of continuous delivery hydraulic suction dredges (Bannister, 1998; 1999). Between 1990 and 1999, stocks of cockles and mussels collapsed following a period of poor recruitment and high levels of fishing effort in the 1980s (Bannister, 1998; 1999). During this period, oystercatcher populations fell from 110,000 to 40,000 (Atkinson *et al*., 2000). Population modelling has confirmed that declines in the availability of these prey items were associated with changes in oystercatcher survival between 1970 and 1998, which included three periods of mass mortality (Atkinson *et al*., 2003). Oystercatchers are particularly sensitive to low cockle stocks in years where stocks of mussels are also low and in the Wash, it is thought that mussels act as a buffer during periods when cockle numbers are low (Atkinson *et al*., 2003; Velhurst *et al*., 2004). In the Wash, oystercatcher mortality occurred during winters when stocks of both species were low (Atkinson *et al*., 2003).

Atkinson *et al*. (2010) investigated overall changes in the waterbird assemblage in the Wash between 1980-1982 and 2002-2003. During this study period, the waterbird assemblage underwent a gradual change from one being dominated by species with a high proportion of bivalves or 'other' prey i.e. crustaceans and fish in their diet to those with a higher proportion of worms (Atkinson *et al*., 2010). Three winters in this period were characterised by elevated levels of oystercatcher mortality, 5 to 13 times greater than normal winter levels (Atkinson *et al*., 2010). The great declines were observed in oystercatcher, knot and shelduck (Atkinson *et al*., 2010). Bar-tailed godwit and grey plover showed large increases over the study period. As expected, these changes were found to be significantly related to mussel and cockle stock levels and nutrient levels to a lesser extent (Atkinson *et al*., 2010). Six out of 11 bird species investigated, showed significantly lower rates of annual change in the 10 years before and after the crash of mussel stocks (which occurred during 1992) (Atkinson *et al*., 2010).

There have also been changes in the bird populations in other areas were cockle fisheries are known exist. Like the Wash, the Burrey Inlet cockle fishery saw a decrease in the number of oystercatchers feeding in the inlet for a number of years, in response to removal of less than 25% of available cockle stocks (Norris *et al*., 1998). Oystercatcher numbers remained stable or slightly increased from 1970 to 1986, before declining

through to 1993 and then recovering slightly (Schmechel, 2001). In the Thames, there has been a consistent increase in the number of birds from 5000 in the 1970s to 16000 in 1997/98, despite a simultaneous increase in cockle dredging (Schmechel, 2001).

Stillman *et al*. (2001) used a behaviour-based model to investigate the effects of present-day management regimes of the Exe estuary mussel fishery and Burry Inlet cockle fishery on the survival and numbers of overwintering oystercatchers. Results of the study concluded that at present intensities (2 fishing units in the Exe estuary and 50 fishing units in Burry Inlet) in both fisheries does not cause oystercatcher mortality to be higher than it would be in absence of the activity (Stillman *et al*., 2001). Theoretical changes in management, such as fishing effort, a reduction in the minimum size of target species and increase in the daily catch quota were shown to have an impact on oystercatcher mortality and population size (Stillman *et al*., 2001). Different fishing methods were investigated as part of the study. The model predicted the use of dredges on either estuary increased the time birds would spent feeding and the use of supplementary feeding areas (Stillman *et al*., 2001). As would be expected, the removal rates of mussels and cockles using mussel dredges and suction dredges were much greater that hand-raking or hand-picking (Stillman *et al*., 2001). Sixty suction dredges could kill all the Burry Inlet oystercatchers (Stillman *et al*., 2001). Hand-raking for mussels however was found to reduce the area of beds, permanently increase interference and disturb birds, temporarily increasing interference, whilst dredging for mussels only decreased bed area (Stillman *et al*., 2001). The varying impacts of different fishing methods reflect differences in the way they deplete shellfish stocks (Stillman *et al*., 2001).

Size of prey species

The exact role of the fishery and its effect on bird population, as a result of direct competition, will largely depend on the different size fractions of the stock that may be exploited by fishers and birds (Schmechel, 2001). Whilst there may be an overlap in the size of cockles taken by both fishers and birds, most bird predation is of a smaller size class than fishers take (Norris *et al*., 1998). If sizes overlap there can be a genuine conflict of interest between the birds and the fishery, therefore larger minimum sizes are therefore more favourable to birds (Lambeck *et al*., 1996). Oystercatchers have shown a preference for older cockles, 20 to 40 mm, and will not take cockles less than 10 mm when these larger size classes are available (Hulscher, 1982; Zwarts *et al*., 1996a). On the other hand, oystercatchers do not necessarily chose the largest cockles as they are difficult to handle, with studies reporting that larger cockles were refused more often than small ones (Zwarts *et al*. 1996a). Oystercatchers are known to refuse small prey due to low profitability and the size of cockles left after fishing may therefore have an impact on feeding rate of the oystercatcher (Zwarts *et al*. 1996b; Wheeler *et al*., 2014).

Indirect effects

Fishing activity can have indirect impact upon birds by affecting the availability of prey through pathways that do not include targeted removal (Natural England, 2014). In general, bottom towed fishing gear has been shown to reduce biomass, production and species richness and diversity of benthic communities where fishing activities take place (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). 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 a study by Ferns *et al*. (2000), bird feed activity increased shortly after the mechanical harvesting of cockles using a tractor, particularly in areas of muddy sand rather than in areas of clean sand. Gulls and waders took advantage of the invertebrates made available by harvesting. For example, 80 dunlins and seven curlews were observed feeding on harvested areas 6 days after harvesting. Following this increase, the level of bird activity declined in areas of muddy sand when compared with control areas and become particularly apparent 21 and 45 days after harvest (Figure 4). Levels of bird activity remained significantly lower in curlews and gulls for more than 80 days after harvesting and in oystercatchers for more than 50 days. Any initial net benefit of harvesting was matched by decreased feeding opportunities in the winter. Harvesting large areas however would not result in a neutral effects, firstly as the bird population would not be large enough to fully exploit the enhanced feeding opportunities and secondly the subsequent reduction in feeding opportunities would extend over a longer period of time (Ferns *et al*., 2000). Other effects would include the migration of birds into unharvested areas which would then lead to increased bird densities in these areas (Sutherland & Goss-Custard 1991; Goss-Custard 1993).

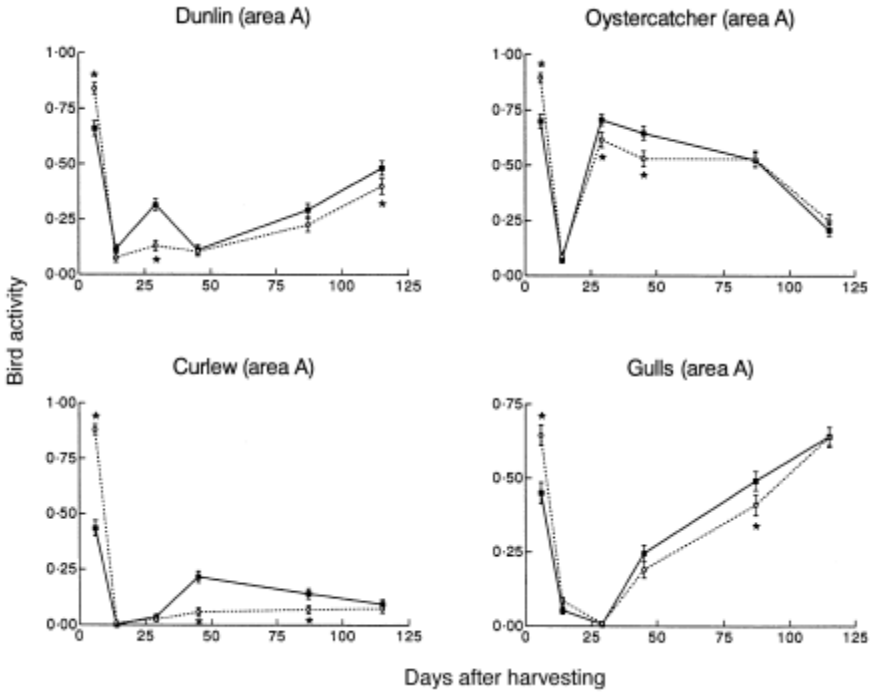

Figure 4. Mean proportion (±SD) of samples in control (black squares) and harvested (white circles) sectors containing footprints of different bird species. Significant differences between sectors are indicated by an asterisk and estimated by bootstrapping. Source: Ferns *et al*., 2000

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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). 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). These shifts in the faunal communities can be reflected in the associated waterbird assemblage (Atkinson *et al*., 2010). In the Wash, a lack of recruitment and heavy fishing pressure led to low stock levels of cockles and mussels (Bannister, 1998; 1999). During this period of stock collapse, the waterbird assemblage underwent a shift from one dominated by species with a high proportion of bivalves and 'other' prey such as crustaceans and fish in their diet, to those with a higher proportion of worms, with the oystercatcher, knot and shelduck showing the highest levels of decline (Atkinson *et al*., 2010). Under intense dredging pressure, research suggests that benthic invertebrates such as worms, which are characterised by rapid growth and short generation times, should predominate over species such as bivalves with slower growth and longer generation times (Atkinson *et al*., 2010).

The relative impact of shellfish dredging on benthic organisms, which form potential prey items, 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,

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.

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* are highly incapable of movement in response to disturbance and therefore take 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).

Recovery

The timescale of recovery for benthic communities and potential prey species largely depends on sediment type, associated fauna and the 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).

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).

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 13). 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 form prey species) are presented in Annex 12.

Species-specific diets

While shorebirds will typically eat a range of different prey species such as molluscs and annelids, the type of preferred prey species will vary between bird species (Natural England, 2014). It is important to acknowledge these variations in prey preference as the impacts of dredging on bird species are likely to vary depending on the vulnerability of prey species to impacts of dredging. The plasticity of a bird's diet will also vary depending on the species and it is important to consider alternate prey species as bird will not be restricted to one source of food. Table 6 provides details of prey items taken by designated bird species within the Solent and Southampton Water SPA. For example, oystercatchers will prey upon small cockles, Baltic tellins, soft-shell clams, lug-worms and ragworms (Wheeler *et al*., 2014). Some prey items may be of low value to the birds and not a major component of their diet (Zwarts *et al*. 1996ab; Atkinson *et al*. 2003 in Wheeler *et al*., 2015). Alternative prey sources may also be less available as organisms may bury deeper into the sediment and thus require the birds to expend a greater amount of energy (Zwarts *et al*. 1996ab). Birds may directly compete with the fishery if both target the same species. The key bird species at risk from changes in prey availability are non-breeding overwintering species as food requirements are considerably greater during winter due to thermoregulatory needs and metabolic costs (Wheeler *et al*., 2014).

Table 6. Typical prey items known to be taken by designated bird species in the Solent and Southampton Water SPA. Information on general prey preference was obtained from the SPA Tool Kit. Specific information on prey species was taken from the Solent EMS Regulation 33 Advice and from Portsmouth Harbour SPA Draft Regulation 35 Advice.

Common Name	Latin Name	General Prey Preference	Prey Species
Dark-bellied brent goose	*Branta bernicla bernicla*	Plants/grasses/seeds	*Zostera* spp., *Enteromorpha*, *Ulva lactuca*
Teal	*Anas crecca*	Plants/grasses/seeds	*Enteromorpha* spp., *Ulvae* spp.
Ringed plover	*Charadrius hiaticula*	Molluscs, crustaceans, insects, worms	*Gammarus* spp. *Tubifex*
Black-tailed godwit	*Limosa limosa*	Insects, worms, plants/grasses/seeds	*Hediste diversicolor*, *Cerastoderma edule*, *Macoma baltica*, *Cardium*, *Neresis*

6.2.2 Disturbance and displacement

Generic impacts

Human disturbance to shorebirds can be defined as 'any situation in which human activities cause bird to behave differently from the behaviour it would exhibit without presence of that activity' (Wheeler *et al*., 2014). The response of birds to disturbance is influenced by a number of factors, including distance from the disturbance source, scale of disturbance and time of year (Stillman *et al*., 2009). Disturbance from many small-scale sources is thought to be more detrimental than fewer, large-scale sources (West *et al*., 2002).

Disturbance can result in displacement when birds are unable to use an area due to the magnitude of the disturbance present (Natural England, 2014). Under certain circumstances the impacts of disturbance may be equivalent to habitat loss, although such effects are reversible (Madsen, 1995; Hill *et al*., 1997; Stillman *et al*., 2007; Natural England *et al*., 2012). The effects of habitat loss through disturbance can include a reduction in the survival of displaced individuals and effects on the population size (Goss-Custard *et al*., 1995; Burton *et al*., 2006). Sites with high levels of human activity are often characterised by lower densities of birds when compared with sites that have low levels (Burger, 1981; Klein *et al*., 1995). The movement of birds to alternate feeding areas as a result of disturbance, which may be less suitable, can lead to increased shorebird density and thus interspecific competition; with alternate sites becoming depleted in food resources if used for prolonged periods of time (Goss-Custard, 2006; Wheeler *et al*., 2014). Disturbance can affect wintering bird populations in a number of ways including reduced intake a result of enhanced vigilance (Riddington 1996; Goss-Custard *et al*. 2006; Klaassen *et al*. 2006) and physiological impacts such as stress (Thiel *et al*., 2011). Such impacts can affect the fitness of individuals and have knock-on effects at a population scale (Natural England, 2011). Furthermore, disturbance can cause birds to take flight which increase energy demands and reduce food intake with potential consequences for survival and reproduction.

Birds can modify their behaviour in order to compensate for disturbance (Stillman *et al*., 2009). Some bird species may become habituated to particular disturbance events or types of disturbance (Walker *et al*., 2006, Nisbet, 2000, Baudains & Lloyd, 2007; Blumstein *et al*., 2003) and can do so over short periods of time (Rees *et al*., 2005; Stillman *et al*., 2009). The frequency of the disturbance will help to determine the extent to which birds can become habituated and thus the distance at which they respond (Stillman *et al*., 2009). The behavioural response of a bird to disturbance is also dependent on the time of year (Stillman *et al*., 2009). Towards the end of winter, when migratory birds need to increase feeding rates to provide energy for migration, behavioural response to disturbance is less (Stillman *et al*., 2009). Birds will approach a disturbance source more closely and return more quickly after a disturbance has taken place (Stillman *et al*., 2009).

In the context of shellfish harvesting from a vessel, limited research has taken place to investigate its potential effects on bird populations through disturbance. It is thought that shellfish dredging has very little direct impact on disturbance of waders since it occurs at high tide (Sewell *et al*., 2007). Sewell *et al*. (2007, p. 51) stated that 'We know of no evidence that dredging will have a direct impact in terms of disturbance on seabirds since most dredging occurs subtidally or at high-tide'. Wheeler *et al*. (2014) however stated, like other forms of disturbance, it could cause relocation and increased energy expenditure of birds.

Examples of disturbance impacts

In the mid-1980s, localised and sustained disturbance from bait diggers at Lindisfarne National Nature Reserve was considered responsible for significant declines in the numbers of Wigeon, Bar-tailed godwit and Redshank at the site (Townshend & O'Connor, 1993).

In 1996/97, Gill *et al*. (2001) investigated the effect of human-induced disturbance on Black-tailed godwits across 20 sites on the east coast of England. The study revealed no significant relationship between numbers of godwits and human activity at a range of spatial scales (Gill *et al*., 2001). There was also no effect of the presence of marinas or footpaths on the number of godwits supported on the adjacent mudflats (Gill *et al*., 2001).

Using a behaviour-based model, Durell *et al*. (2005) explored the effect if an extension to the port at Le Havre and proposed mitigation measures on the mortality and body condition of three overwintering bird species; Curlew, Dunlin and Oystercatcher. Body condition was expressed as the percentage of birds failing to achieve at least 75% of their target weight for the time of year. Disturbance to feeding birds, day and night, had a significant effect on the mortality and body condition of all three species. The same was found for roosting birds. Roost disturbance was simulated by increased energy costs due to extra flying time of 10 minutes or more each day. Disturbance limited to the daytime only removed the effect of disturbance in curlew and oyster catcher, and although reduced the disturbance effect it still had a significant effect on the body condition and mortality of feeding dunlin. The introduction of a buffer zone, which would prevent disturbance within 150 m of the seawall, reduced the effects of disturbance on mortality and body condition to pre-disturbance levels.

Studies in the Solent which have focused on disturbance to birds, have reported disturbance levels of 30% during the winter of 1993/94 using disturbance events observed during low tide counts. Sources of disturbance from human activity on the shore included dog walkers, walkers, bait diggers and kite flyers (Thompson, 1994). A more recent study conducted from December 2009 to February 2010, which formed phase II of the Solent Disturbance & Mitigation Project, found for water-based recreational activities that 25% of observations resulted in disturbance and on the intertidal 41% of observation result in disturbance (Liley *et al*., 2010). Surfing, rowing and horse riding were activities found to most likely result in disturbance to birds. Over half of incidences where major flight was observed involved activities on the intertidal, with dog walking accounting for 47% of major flight events (Liley *et al*., 2010). The most responsive bird species to different activities were Oystercatcher and Wigeon (Liley *et al*., 2010). These two species had the highest proportion of observations involving a disturbance response. Primary data collected by Liley *et al*. (2010) was used to predict if disturbance could reduce the survival of birds using computer models (Stillman *et al*., 2012). Dunlin, Ringed plover, Oystercatcher and Curlew were predicted to be the species most vulnerable to disturbance due to a combination of disturbance distances (see species-specific response), night-time feeding efficiency and vulnerability to food competition at high competitor densities (Stillman *et al*., 2012). Redshank, Grey plover and Black-tailed godwit typically had the shortest disturbance distances and were able to feed relatively effectively at night, meaning that these species were less effected by visitors (Stillman *et al*., 2012). Disturbance was predicted to result in increases in the level of time spent feeding intertidally by Dunlin, Ringed plover, Redshank and Grey plover, with no effect on Black-tailed godwit and reductions in Oystercatcher and Curlew (Stillman *et al*., 2012). This was related to the ability of modelled birds to feed in terrestrial habitats, as those unable to do so spent longer feeding in intertidal habitats (Stillman *et al*., 2012).

Species-specific response

Responsiveness to disturbance is thought to be a species-specific trait (Yasué, 2005). Gathe and Hüppop (2004) developed a wind farm sensitivity index (WSI) for seabirds. The index was based on nine factors, derived from species' attributes, and include; flight manoeuvrability, flight altitude, percentage of time flying, nocturnal flight activity, sensitivity towards disturbance by ship and helicopter traffic, flexibility in habitat use, biogeographical population size, adult survival rate and European threat and conservation status (Gathe & Hüppop, 2004). Each factor was scored on a 5-point scale from 1 (low vulnerability of seabirds) to 5 (high vulnerability of seabirds). The WSI was used by King *et al*. (2009) to develop sensitivity scores for species likely to be susceptible to cumulative impacts of offshore wind farms development. Table 7 provides available sensitivity scores of species within Solent and Southampton Water SPA, with details of scores given for the species vulnerability to disturbance by ship and helicopter traffic.

Table 7. Sensitivity scores for designated bird species in the Solent and Southampton SPA to offshore wind farm developments. Higher scores are indicative of a greater sensitivity. Information on species vulnerability to disturbance by ship or helicopter traffic is also provided. Scores were taken from King *et al*. 2009 who calculated scores using methods by Garthe & Hüppop (2004).

Species	Total sensitivity score	Disturbance by ship and helicopter traffic (1 – very flexible in habitat use, 5 – reliant on specific habitat characteristics)

Dark-bellied brent goose	21.7	2
Black-tailed godwit	9.9	1
Ringed plover	5.3	1
Teal	3.8	1

There is great variation in the escape flight distances between species (Kirby *et al*., 2000) and the distance at which birds fly away from a disturbance can be viewed as a specie-specific trait (Blumstein *et al*., 2003). Response distances can depend on a number of different factors, including the time of year, tide, frequency, regularity and severity of disturbance, flock size and age of bird (WWT Consulting, 2012). Body mass has also been shown to be positively related to response distance (Liley *et al*., 2010). Table 8 and 9 provides details of response distances of species within Solent and Southampton Water SPA, with Table 9 providing details of response distances in relation to different types of activities.

Table 8. Distances from disturbance stimuli (in metres) at which study waterbird species took flight. Taken from Kirby *et al*., 2004 in WWT Consulting 2012.

	Study						
	Tydeman 1978	Cooke 1980	Tensen and van Zoest	Watmough 1983a,b	Smit and Visser 1993	Smit and Visser 1993	Smit and Visser 1993
Activity	Boats	Researcher	People	Researcher	People	Kayaks	Surfers
Distance measure	Min	Mean	Mean	Mean	Mean	Mean	Mean
Brent goose					105		
Teal	400	86					
Ringed plover					121		

Table 9. Comparison, by species, of distances (in metres) at which no response or disturbance events (i.e. alert, short walk/swim, short flight or major flight) occurred. Significance column indicates results from Mann-Whitney statistical tests.

Species	**No response**		**Disturbance occurred**		**Significance**
	Median	Range	Median	Range	
Brent goose	97	17-215	51.5	5-178	P<0.01
Teal	137	20-175	60	35-200	P<0.05

In a study by Liley *et al*. (2010), which formed phase II of the Solent Disturbance & Mitigation Project, there was no clear set-back distance that would result in no response. There were instances where no response occurred within a few metres and there were instances were major flight occurred when birds when over 200 m from the disturbance source (Liley *et al*., 2010). Having said this, the proportion of events resulting in the displacement of birds declined beyond 100 m (Liley *et al*., 2010).

Mitigation

The effects of disturbance on the quality of an area for birds are reversible (Natural England *et al*., 2012). Studies have shown that bird numbers increase when either the source of disturbance is removed or mitigated (Natural England *et al*., 2012). Modelling of wintering oystercatchers on the Exe estuary revealed that preventing disturbance during late winter, when feeding conditions are harder and a migratory bird's energetic demands are higher, has been shown to largely eliminate any predicted population consequences (West *et al*., 2002). Following this modelling, it was recommended that to eliminate predicted population consequences of disturbances, competent authorities responsible for management should prevent disturbance to birds during late winter (West *et al*., 2002).

Establishing flight-initiation distances may be considered a starting point for competent authorities responsible for management in order to minimise adverse effects of disturbance (Wheeler *et al*., 2014). The establishment of such buffer areas are dependent on a number of factors including population densities, food availability, time of year and behaviour of individuals (Wheeler *et al*., 2014). As aforementioned, a buffer zone of 150 m from the seawall was found to reduce the effects of disturbance from an extension to the port at Le Havre on the mortality and body condition to pre-disturbance levels for three bird species (dunlin, curlew and oystercatcher) (Durell *et al*. 2005). Investigation into disturbance caused by recreational activities in the Solent however suggested that there was no clear set-back distance, for all species on all sites due to the large variability observed in response distances, which would result in no disturbance (Liley *et al*., 2010). The largely variability in flight-initiation distances suggests that competent authorities should be conservative when developing buffer zones, although previously published flight-initiation distances for a given species may be used as a guideline for setting buffer zones (Blumstein *et al*., 2003).

Whilst many authors may try and define a distance beyond which disturbance is assumed to have no effect, which is then used in turn to determine set-back distances, it may be inappropriate to set such distances (Stillman *et al*., 2009). The reason for this is because of the variation between species (Blumstein *et al*., 2005), as well as variation between individuals of the same species (Beale & Monaghan, 2004). This is further compounded by particular circumstances such as habitat, flock size, cold weather, variations in food availability, all of which will influence a bird's ability to response to disturbance and hence the scale of the impact (Rees *et al*., 2005; Stillman *et al*., 2001). In addition, there is no guarantee that the behavioural response i.e. response distance, will be related to population consequence (Gill *et al*., 1996; 2001b).

6.3 Site-Specific Seasonality Table

Table 10 below indicates (highlighted in grey) when significant numbers of each mobile designated feature are most likely to be present at the site during a typical calendar year. Periods highlighted in grey are likely to require consideration of mitigation to minimise impacts to qualifying bird features during these principal periods of site usage by those features. The months which are not highlighted in grey do not necessarily indicate when features are absent, rather that features may be present in less significant numbers than in typical years.

Table 10. Presence by month of mobile designated features at the Solent and Southampton Water SPA. Grey indicates periods of

presence in significant numbers whereas blank (white) indicates either periods of absence or of presence but only in numbers of less significance.

Common Name	Latin Name	Designated Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Reference
Black-tailed godwit	*Limosa limosa islandica*	Non-breeding													BTO data (analysed 13th August 2015)
Dark-bellied brent goose	*Branta bernicla bernicla*	Non-breeding													BTO data (analysed 13th August 2015)
Ringed plover	*Charadrius hiaticula*	Non-breeding													BTO data (analysed 13th August 2015)
Teal	*Anas crecca*	Non-breeding													BTO data (analysed 13th August 2015)

6.4 Site Condition

6.4.1 Condition Assessments

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 SPA. There are a number of SSSIs which exist within the area covered by Solent and Southampton Water SPA and these, along with relevant feature condition assessments are summarised in Table 10. Note that only SSSI sites where clam dredging is known to occur have been chosen.

Table 11. Condition assessments of SSSI units within the Solent and Southampton Water SPA (2010)

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	Littoral sediment	Hook Foreshore	Unfavourable -	High	Having previously been in favourable condition up until 2000, the condition of this site was found to be unfavourable in 2008,

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

[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.

Estuary			recovering[15]		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.

Overall, the SSSI condition assessments appear to suggest that littoral sediments within selected SSSI sites are favourable and 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.

6.4.2 Population Trends

Population trend data, where available, can be used to identify site-specific pressures. Information on population trends comes from Wetland Bird Survey (WeBS) Alerts and JNCC's Seabird Monitoring Programme (SMP) population data. WeBS Alert data is available for the four regularly occurring migratory species (Dark-bellied brent goose, Teal; Black-tailed godwit and Ringed plover) and provides information on population sizes, from which trends in numbers and distribution can be detected. The most recent WeBS report is based upon Alerts status as of 2009/10 and identifies a long-term (up to 25 years) high alert for Ringed plover, despite being stable in the short-term (5 years). The WeBS report states the decline appears to reflect that of the region and British trends and therefore declining numbers result from broad-scale population trends. It also states that there is an increasing proportion of regional numbers supported by this site, which suggest that the environmental conditions remain relatively favourable and the Southampton Water and Solent SPA is becoming increasingly important on a regional scale for these species.

It is important to note that the data used to inform WeBS Alerts was collected in 2009/10 and therefore this data may not have captured the effects of fishing activities that have since commenced or increased since publication. The effects of fishing activities may not necessarily be captured in the next WeBS Alerts report (due in 2015) due to the time lag between cause and effect. With respect to clam dredging, the level of fishing effort has been seen to decrease in recent years and therefore any effects of fishing activity are likely to be reduced when compared to 2009/10.

[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.

6.5 Existing Management Measures

- **Bottom Towed Fishing Gear** byelaw – prohibits bottom towed fishing gear over sensitive features including reef features and seagrass within the Solent and Southampton Water SPA, 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.

6.6 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 11 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 11). 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.

6.7 Table 12: Summary of Impacts

The potential pressures, associated impacts, level of exposure and mitigation measures are summarised in table 12. Only relevant attributes identified through the TLSE process have been considered here.

Feature	Supporting habitat(s)	Attribute	Target	Potential Pressure(s) and Associated Impacts	Nature and Likelihood of Impacts	Mitigation measures[16]
Internationally important waterfowl assemblage including the internationally	Intertidal mudflats and sandflats	Food availability	Presence and abundance of suitable prey species should not deviate significantly	Selective extraction of species and competition for prey were identified as potential pressures through direct impacts of clam dredging. Changes in prey availability and competition for prey were identified as potential pressures through indirect impacts of clam dredging.	Reports of clam dredging within Solent and Southampton Water SPA from local IFCOs indicate a decline in fishing effort since 2012, with an average of 2.5 vessels sighted per month in the Solent in 2015. At present, 0 to 1 vessels operate on any one day.	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.

[16] Detail how this reduces/removes the potential pressure/impact(s) on the feature e.g. spatial/temporal/effort restrictions that would be introduced.

important regularly occurring migratory species			from an established baseline, subject to natural change	The selective extraction of species and competition for prey were screened out at TLSE level as Manila clam and American hard-shell clam do not represent the prey species of designated bird species. The indirect change in prey availability is caused through physical disturbance or damage to supporting habitats which can result in changes to community structure, the removal and mortality of non-target organisms through interaction with fishing gear and smothering of prey species through increased sedimentation. Bottom towed gear has been shown to reduce biomass, production and species richness and diversity (Veale *et al*., 2000; Hiddink *et al*., 2003). 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. The relative impact of shellfish dredging on benthic organisms, which form potential prey items,	Feature data provided by Natural England, combined with sightings data, reveals that clam dredging occurs over this supporting habitat. This means the activity is likely to cause a potential adverse effect on the benthic communities on which designated bird species rely. Using available information on the diet of designated bird species and WeBS low tide count data distribution maps (Annex 7 and 8), designated bird species sensitive to changes in food availability within intertidal mudflats and sandflats subject to clam dredging include the Dark-bellied brent goose, teal and ringed plover. The main areas of concern include the western side of Southampton Water, particularly Ashlett Creek and the western side of the Hamble entrance. Prey preferences exhibited by the Dark-bellied brent goose and Teal include plants, grasses and seeds and this makes them less sensitive to changes in food availability, as clam dredging is known to cause changes to infaunal invertebrates. The Dark-bellied brent goose foods upon feed upon eel grass (*Zostera* spp.) which is protected under the Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds byelaw and Bottom Towed Fishing Gear byelaw. The main species of concern is therefore the Ringed plover which expresses a preference for molluscs, crustaceans, insects and worms. Higher density	In addition to amending the Bottom Towed Fishing Gear Byelaw, Southern IFCA is implementing a network of permanent bottom towed fishing gear closure areas. The network is designed to protect good examples of low-energy habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement. 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

				is species-specific and largely related to their biological characteristics and physical habitat (Mercaldo-Allen & Goldberg, 2011). Population recovery rates are species specific (Roberts *et al*., 2010).). Long-lived bivalves will undoubtedly take longer to recovery from disturbance than other species such as short-lived and small benthic organisms on the other hand have rapid generation times, high fecundities and therefore excellent recolonization capacities (Coen, 1995; Roberts *et al*., 2010).	feeding areas, identified from low tide WeBS data distribution maps in Annex 7, where clam dredging takes place include the western side of the Hamble entrance. SSSI condition assessments regard this area as in favourable condition. Significant numbers of Ringed plover occur between August and May. Despite a long-term high alert from Ringed plover within the Solent and Southampton Water SPA, the population has remained stable in the short-term (past five years). 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. 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 on food availability may only be short term. Annelids in general however 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	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 eliminates the use of a clam dredge for harvesting cockles. The Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds byelaw prohibits any person from digging for, fishing for or taking any sea fisheries resource in or from the prohibited areas. No person shall carry a rake, spade, fork or any similar tool in prohibited areas. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including reef features and seagrass within the Solent and Southampton Water SPA, closing most 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

					have recovery times of 1210 days in muddy sand habitats (Kaiser *et al*., 2006). Kaiser *et al*. (2006) stated this date of recovery should however be reviewed with caution, as it well beyond the last observation time period. EMU (1992) also reported that annelids were seen to be most badly affected by the action of a mechanical modified oyster dredge.	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.
Internationally important waterfowl assemblage including the internationally important regularly occurring migratory species	Mixed sediment shores	Food availability	Presence and abundance of prey species and algae should not deviate significantly from an established baseline, subject to natural change.	Selective extraction of species and competition for prey were identified as potential pressures through direct impacts of clam dredging. Changes in prey availability and competition for prey were identified as potential pressures through indirect impacts of clam dredging. The selective extraction of species and competition for prey were screened out at TLSE level as Manila clam and American hard-shell clam do not represent the prey species of designated bird species.	Reports of clam dredging within Solent and Southampton Water SPA from local IFCOs indicate a decline in fishing effort since 2012, with an average of 2.5 vessels sighted per month in the Solent in 2015. At present, 0 to 1 vessels operate on any one day. Mixed sediment shores provide an important feeding habitat for Ringed plover who feed on small invertebrates and the Dark-bellied brent goose who feed on algae (*Enteromorpha* spp.), a food item also preferred by teal.	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

				The indirect change in prey availability is caused through physical disturbance or damage to supporting habitats which can result in changes to community structure, the removal and mortality of non-target organisms through interaction with fishing gear and smothering of prey species through increased sedimentation. Bottom towed gear has been shown to reduce biomass, production and species richness and diversity (Veale *et al*., 2000; Hiddink *et al*., 2003). 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. The relative impact of shellfish dredging on benthic organisms, which form potential prey items, is species-specific and largely related to their biological characteristics and physical habitat (Mercaldo-Allen & Goldberg, 2011). Population recovery rates are species specific (Roberts *et al*., 2010).). Long-lived bivalves will	Feature data provided by Natural England, combined with sightings data, reveals that clam dredging does not occur over this supporting habitat. This means the activity is highly unlikely to cause a potential adverse effect on the benthic communities on which designated bird species rely.	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 eliminates the use of a clam dredge for harvesting cockles. The Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds byelaw prohibits any person from digging for, fishing for or taking any sea fisheries resource in or from the prohibited areas. No

				undoubtedly take longer to recovery from disturbance than other species such as short-lived and small benthic organisms on the other hand have rapid generation times, high fecundities and therefore excellent recolonization capacities (Coen, 1995; Roberts *et al*., 2010).		person shall carry a rake, spade, fork or any similar tool in prohibited areas. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including reef features and seagrass within the Solent and Southampton Water SPA, closing most 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.
Internationally important waterfowl assemblage	-	Disturbance	No significant reduction in numbers or displacement of wintering birds from an established baseline, subject to natural change.	Disturbance and displacement through visual presence and noise were identified as potential pressures of clam dredging. Disturbance can result in displacement when birds are unable to use an area due to the magnitude of the disturbance. The effects of disturbance can include a reduction in the survival of displaced individuals and effects on the population size. The movement of birds to less suitable feeding areas can lead to increased densities and interspecific competition. Disturbance can cause birds to take flight which increase energy demands and reduce food intake with potential consequences for survival and reproduction. The significance of disturbance is likely to depend on the availability of alternative undisturbed areas for birds and the frequency, seasonality and intensity at which shellfish dredging takes place. Responsiveness to disturbance is largely thought to be a species-specific trait.	Reports of clam dredging within Solent and Southampton Water SPA from local IFCOs indicate a decline in fishing effort since 2012, with an average of 2.5 vessels sighted per month in the Solent in 2015. At present, 0 to 1 vessels operate on any one day. It is thought that shellfish dredging has very little direct impact on disturbance of waders since it occurs at high tide and feeding takes place at low tide, thus eliminating the possibly of any adverse significant effect. The Solent and Southampton Water is an area subject to high levels of vessel traffic and some bird species can become habituated to particular disturbance events or types of disturbance. In the context of the high vessel levels that occur within the Solent and Southampton Water, it is therefore highly unlikely that clam dredging will lead to a significant adverse effect on the feature. In addition, Southampton Water is subject to regular maintenance dredging that is likely to lead to greater disturbance than that caused by shellfish dredging.	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. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including reef features and seagrass within the Solent and Southampton Water SPA, closing most 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.
Dark-bellied brent goose	-	Disturbance	No significant reduction in numbers or displacement of wintering birds from an established baseline, subject to natural change.	Disturbance and displacement through visual presence and noise were identified as potential pressures of clam dredging. Disturbance can result in displacement when birds are unable to use an area due to the magnitude of the disturbance. The effects of disturbance can include a reduction in the survival of displaced individuals and effects on the population size. The movement of birds to less suitable feeding areas can lead to increased densities and interspecific competition. Disturbance can cause birds to take flight which increase energy demands and reduce food intake with potential consequences for survival and reproduction. The significance of disturbance is likely to depend on the	Reports of clam dredging within Solent and Southampton Water SPA from local IFCOs indicate a decline in fishing effort since 2012, with an average of 2.5 vessels sighted per month in the Solent in 2015. At present, 0 to 1 vessels operate on any one day. Dark-bellied brent geese are known to feed on intertidal mudflats and sandflats and in on mixed sediment shores during low tide. It is however thought that shellfish dredging has very little direct impact on disturbance of waders since it occurs at high tide and feeding takes place at low tide, thus eliminating the possibly of any adverse significant effect. The wind-farm sensitivity index indicates the Dark-bellied brent goose has moderate sensitivity to wind farm developments. The escape flight distance exhibited by the	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. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including reef features and seagrass within the Solent and Southampton Water SPA, closing most of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of permanent bottom towed fishing

				availability of alternative undisturbed areas for birds and the frequency, seasonality and intensity at which shellfish dredging takes place. Responsiveness to disturbance is largely thought to be a species-specific trait.	species ranges. The median distance at which a response occurred was reported at 51.5 metres in the Solent. The Solent and Southampton Water is an area subject to high levels of vessel traffic and some bird species can become habituated to particular disturbance events or types of disturbance. In the context of the high vessel levels that occur within the Solent and Southampton Water, it is therefore highly unlikely that clam dredging will lead to a significant adverse effect on the feature. In addition, Southampton Water is subject to regular maintenance dredging that is likely to lead to greater disturbance than that caused by shellfish dredging.	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.
Teal	-	Disturbance	No significant reduction in numbers or displacement of wintering birds from an established baseline, subject to natural	Disturbance and displacement through visual presence and noise were identified as potential pressures of clam dredging. Disturbance can result in displacement when birds are unable to use an area due to the magnitude of the disturbance. The effects of disturbance can include a reduction in the survival of displaced individuals and effects on the population	Reports of clam dredging within Solent and Southampton Water SPA from local IFCOs indicate a decline in fishing effort since 2012, with an average of 2.5 vessels sighted per month in the Solent in 2015. At present, 0 to 1 vessels operate on any one day. Teal are known to feed at low tide in areas where clam dredging activity also occurs. It is however thought that shellfish dredging has very little	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

			change.	size. The movement of birds to less suitable feeding areas can lead to increased densities and interspecific competition. Disturbance can cause birds to take flight which increase energy demands and reduce food intake with potential consequences for survival and reproduction. The significance of disturbance is likely to depend on the availability of alternative undisturbed areas for birds and the frequency, seasonality and intensity at which shellfish dredging takes place. Responsiveness to disturbance is largely thought to be a species-specific trait.	direct impact on disturbance of waders since it occurs at high tide and feeding takes place at low tide, thus eliminating the possibly of any adverse significant effect. The wind-farm sensitivity index indicates the teal has a very low sensitivity to wind farm developments. The escape flight distance exhibited by the species widely ranges. In response to boats, the distance from the disturbance stimuli was 400 m, however in response to researchers was 86 m. In another study, the median distance at which a response occurred was reported at 60 metres in the Solent. The Solent and Southampton Water is an area subject to high levels of vessel traffic and some bird species can become habituated to particular disturbance events or types of disturbance. In the context of the high vessel levels that occur within the Solent and Southampton Water, it is therefore highly unlikely that clam dredging will lead to a significant adverse effect on the feature. In addition, Southampton Water is subject to regular maintenance dredging that is likely to lead to greater disturbance than that caused by shellfish dredging.	taking shellfish. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including reef features and seagrass within the Solent and Southampton Water SPA, closing most 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.

Ringed plover	-	Disturbance	No significant reduction in numbers or displacement of wintering birds from an established baseline, subject to natural change.	Disturbance and displacement through visual presence and noise were identified as potential pressures of clam dredging. Disturbance can result in displacement when birds are unable to use an area due to the magnitude of the disturbance. The effects of disturbance can include a reduction in the survival of displaced individuals and effects on the population size. The movement of birds to less suitable feeding areas can lead to increased densities and interspecific competition. Disturbance can cause birds to take flight which increase energy demands and reduce food intake with potential consequences for survival and reproduction. The significance of disturbance is likely to depend on the availability of alternative undisturbed areas for birds and the frequency, seasonality and intensity at which shellfish dredging takes place. Responsiveness to disturbance is largely thought to be a species-specific trait.	Reports of clam dredging within Solent and Southampton Water SPA from local IFCOs indicate a decline in fishing effort since 2012, with an average of 2.5 vessels sighted per month in the Solent in 2015. At present, 0 to 1 vessels operate on any one day. Ringed plover is known to feed at low tide in at least one site where clam dredging also takes place. It is however thought that shellfish dredging has very little direct impact on disturbance of waders since it occurs at high tide and feeding takes place at low tide, thus eliminating the possibly of any adverse significant effect. The wind-farm sensitivity index indicates the Ringed plover has very low sensitivity to wind farm developments. The escape flight distance exhibited by the species has been reported at 121 m in response to disturbance of people. Studies of bird disturbance in the Solent revealed that Ringed plover was one of the most vulnerable to disturbance and it was reported that disturbance increased the level of time spent feeding (Stillman *et al*., 2012). It is worth noting however that the study looked at disturbance in response to land-based and water-based recreational activities, with half of all incidences where major flight was observed involving activities on the intertidal.	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. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including reef features and seagrass within the Solent and Southampton Water SPA, closing most 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

					The Solent and Southampton Water is an area subject to high levels of vessel traffic and some bird species can become habituated to particular disturbance events or types of disturbance. In the context of the high vessel levels that occur within the Solent and Southampton Water, it is therefore highly unlikely that clam dredging will lead to a significant adverse effect on the feature. In addition, Southampton Water is subject to regular maintenance dredging that is likely to lead to greater disturbance than that caused by shellfish dredging.	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.
Black-tailed godwit	-	Disturbance	No significant reduction in numbers or displacement of wintering birds from an established baseline, subject to natural change.	Disturbance and displacement through visual presence and noise were identified as potential pressures of clam dredging. Disturbance can result in displacement when birds are unable to use an area due to the magnitude of the disturbance. The effects of disturbance can include a reduction in the survival of displaced individuals and effects on the population size. The movement of birds to less suitable feeding areas can lead to increased densities and interspecific competition. Disturbance can cause birds to take flight which increase energy demands and reduce food intake with potential consequences for survival and reproduction. The significance of disturbance	Reports of clam dredging within Solent and Southampton Water SPA from local IFCOs indicate a decline in fishing effort since 2012, with an average of 2.5 vessels sighted per month in the Solent in 2015. At present, 0 to 1 vessels operate on any one day. WeBS low tide data distribution maps, presented in Annex 7 and 8, reveal low densities of Black-tailed godwit at low tide however the areas in which the species occurs do not coincide with areas of clam dredging activity, thus largely eliminating the likelihood of any significant adverse effect. In addition, it is thought that shellfish dredging has very little direct impact on disturbance of waders since it occurs at high tide and feeding takes place at low tide. The wind-farm sensitivity index indicates the Black-tailed godwit has	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. The Bottom Towed Fishing Gear byelaw prohibits bottom towed fishing gear over sensitive features including reef features and seagrass within the Solent and Southampton Water SPA, closing most of the site to these activities. Southern IFCA is currently amending this byelaw to introduce additional network of

				is likely to depend on the availability of alternative undisturbed areas for birds and the frequency, seasonality and intensity at which shellfish dredging takes place. Responsiveness to disturbance is largely thought to be a species-specific trait.	low sensitivity to wind farm developments. Furthermore, Gill *et al*. (2001) reported no significant relationship between numbers of black-tailed godwits and human activity at a range of spatial scales (Gill *et al*., 2001). There was also no effect of the presence of marinas or footpaths on the number of godwits supported on the adjacent mudflats (Gill *et al*., 2001). Another study looking at the disturbance of bird species in the Solent reported low vulnerability to disturbance as a result of short disturbance distances and ability to feed effectively at night, when disturbance levels are much lower (Stillman *et al*., 2012). The Solent and Southampton Water is an area subject to high levels of vessel traffic and some bird species can become habituated to particular disturbance events or types of disturbance. In the context of the high vessel levels that occur within the Solent and Southampton Water, it is therefore highly unlikely that clam dredging will lead to a significant adverse effect on the feature. In addition, Southampton Water is subject to regular maintenance dredging that is likely to lead to greater disturbance than that caused by shellfish dredging.	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.

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 and Southampton Water SPA, 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 principally to protect good examples of SAC features and by virtue SPA supporting habitats, maintaining the integrity of these sites, whilst also offering long-term stability to guard against the effects of fishing effort displacement. The network of closure areas (including those in the original Bottom Towed Fishing Gear byelaw) covers approximately 95.4 km^2 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 sites' 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/supporting habitat from 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. In the Solent and Southampton SPA, this network of areas includes the River Hamble, the River Medina, King's Quay, Newtown Creek, the Yar (Yarmouth), Ashlett Creek, Hythe foreshore, the Test, Lymington and Keyhaven (figures 5-6).

Three dredge fishing management areas will be introduced by Southern IFCA; of which one (Southampton Water) will cover the designated features/supporting habitats of the Solent and Southampton Water SPA (figure 6). Within this 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 13). 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 6, 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, the closure to shellfish dredging during this time will support these communities to recover 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 14 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 14 for recolonization strategies of key species).

The main concern surrounding shellfish dredging relates to food availability for designated bird species. The length of the closure is designed to allow for sufficient recovery of potential prey species and the timing of the closure coincides with the arrival of overwintering birds (July to October), thus ensuring sufficient food availability during this crucial period. In addition, there appears to be a lack of evidence to suggest a site-specific link between shellfish dredging and adverse effects on designated bird species as a result of reductions in food availability. Available scientific literature is largely focused on the decline of bird populations when the fishery and bird species target the same species, which is not the case in Portsmouth Harbour. The monitoring strategy, proposed to take place in conjunction with the introduction of new bottom towed fishing gear management (see paragraph below), will help to address any concerns surrounding food availability during the open season.

Shellfish dredging in the Southampton Water dredge fishing management area 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 and Southampton Water SPA, 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 supporting habitats. On this basis, the restriction of clam fishing in the SPA 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 and Southampton Water SPA, 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. Available data on bird populations (i.e. WeBs) will also be incorporated to allow monitoring of any potential impacts of new management on designated bird species 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.

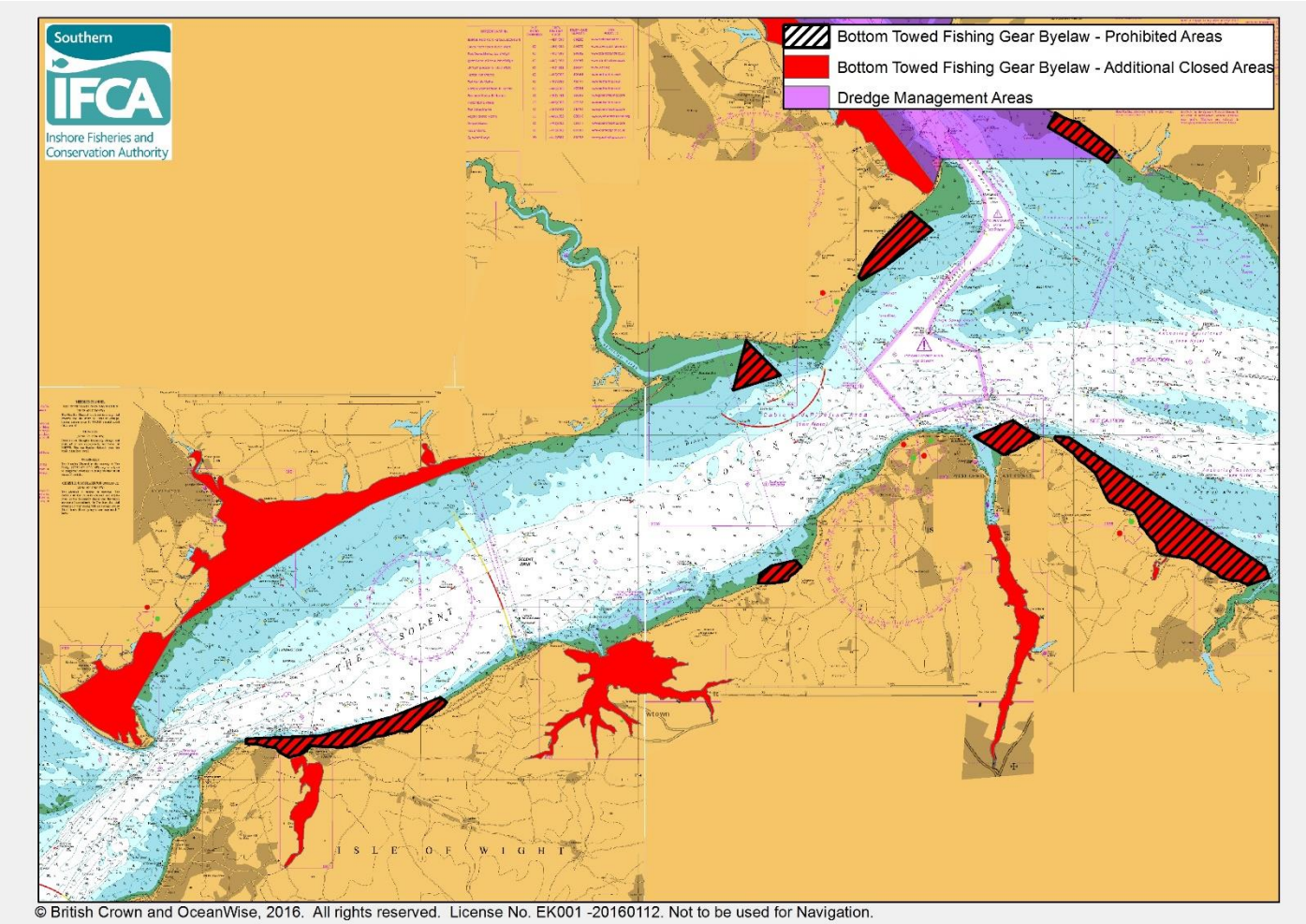


Figure 5. Proposed wider Solent permanent bottom towed fishing gear closure areas

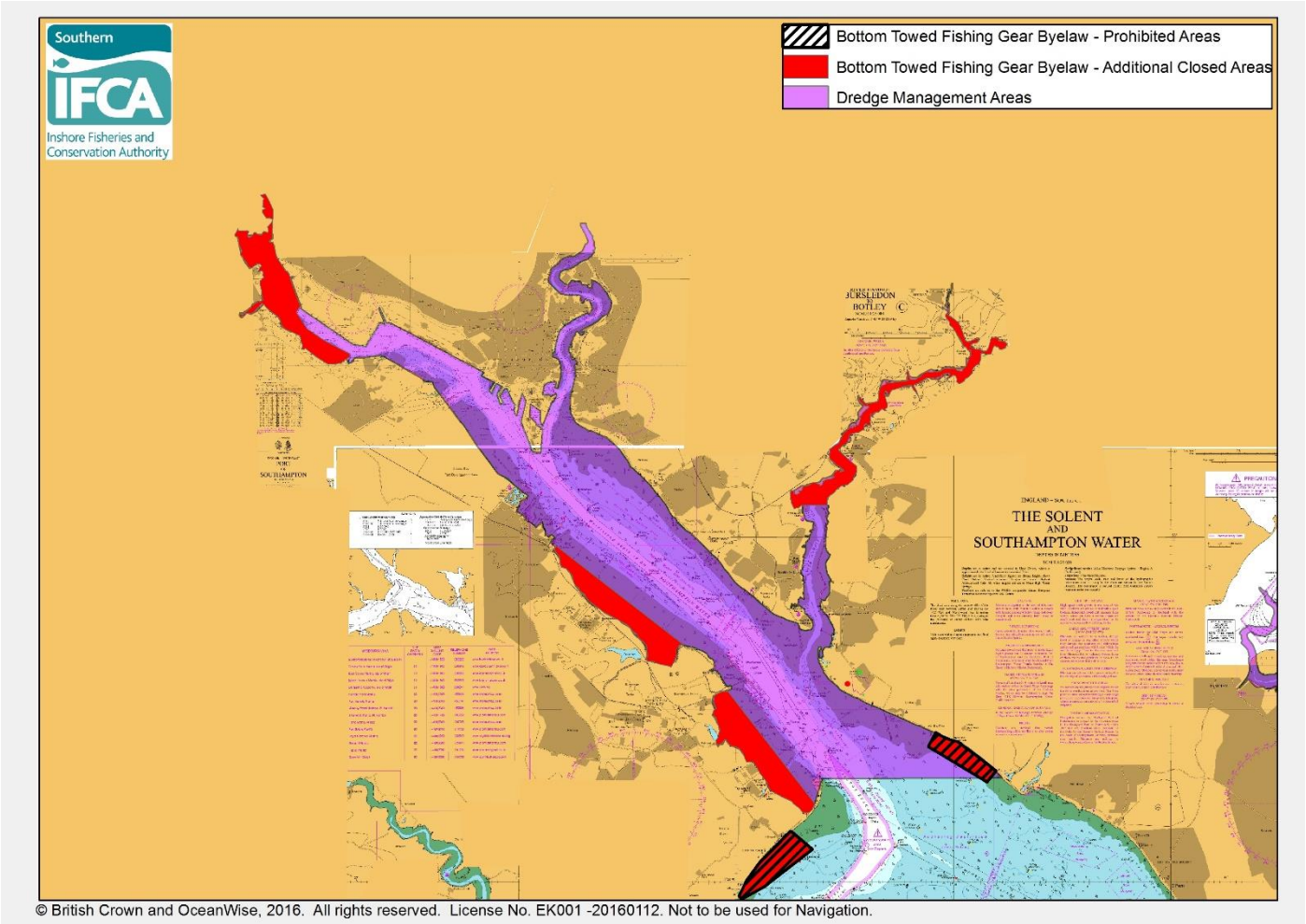


Figure 6. Proposed Southampton Water permanent bottom towed fishing gear closure areas and dredge fishing management area

8. Conclusion[17]

In order to conclude whether clam dredging has an adverse effect on the integrity of the Solent and Southampton Water SPA, 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 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, and,
- The distribution of the qualifying features within the site**."**

The review of research into the impacts of shellfish dredging (detailed in section 6.2) identifies that this activity has the capability to disturb regularly occurring migratory birds and waterfowl species and lead to changes in prey availability. Disturbance can occur visually or through noise. Changes in prey availability relate to the indirect effects of clam dredging which include interactions with fishing gear through crushing, burial or exposure; and smothering of prey species through enhanced sedimentation. It is therefore recognised that this activity has the potential to lead an adverse effect upon the following SPA attributes:

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

- Disturbance
- Food availability

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/supporting habitats to dredging
v) Ability of supporting habitats to recover from the effects of dredging

Additionally, the location, timing, duration and intensity of clam dredging activity within the site will be influenced by existing management measures (see section 6.5) 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 and Southampton Water SPA. 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 SPA 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 supporting habitats of the SPA, 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. The introduction of a network of permanent bottom towed fishing gear closure areas will protect good examples of SPA supporting habitats, maintaining the integrity of the site, whilst also offering long-term stability to guard against the effects of fishing effort displacement.

- Potential impacts upon SPA supporting habitats will be further mitigated through the introduction of a dredge fishing management area within Southampton Water. Dredging will only be permitted for a total of 120 days within this area. 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 Southampton Water could lead to an increase in the intensity of fishing effort, however the simultaneous opening of all three dredge fishing management areas (Southampton Water, Portsmouth Harbour and Langstone Harbour) is designed to dilute fishing effort and avoid the 'honey-pot' effect caused by short openings of small areas (section 7). This is not anticipated to result in an adverse effect on the SPA, due to the shortened duration of the season and the low number of vessels participating in the fishery.

- Clam dredging is unlikely to lead to the disturbance of designated bird species for a number of reasons. Birds which feed on the intertidal do so at low tide and clam dredging is

undertaken at high tide, thus effectively eliminating the possibility of disturbance during feeding periods. Bird species within Southampton Water and the wider Solent are also subject to high levels of vessel traffic and so are likely to be habituated to such types of disturbance. Furthermore, the prohibition of clam dredging within Southampton Water for 35 weeks of the year will eliminate potential disturbance from fishing vessels during this period.

- A review of scientific literature indicates that the impacts of shellfish dredging on benthic organisms, which form potential prey items, is species-specific and largely related to their biological characteristics and physical habitat (section 6.2.1). Sightings data reveals that clam dredging in the Solent and Southampton Water SPA occurs over intertidal mud, which provides feeding habitat for the Dark-bellied brent goose, Teal and Ringed plover (Annexes 7-9). Potentially adverse effects upon this supporting habitat will be mitigated through the introduction of a network of permanently closed areas; together with seasonal and spatial restrictions on clam dredging within the SPA. Furthermore, the prey preferences exhibited by Dark-bellied brent geese and Teal include plants, grasses and seeds, which makes these species less sensitive to changes in benthic food availability.

- It is acknowledged that habitat 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; and those comprised of softer sediment habitats (section 6.2.1). In order to mitigate potentially adverse effects upon such habitats in the Solent and Southampton Water SPA, a network of permanently closed areas will be introduced which includes areas of low energy sediment habitat. Additionally, the restriction of fishing within Southampton Water to 120 days will result in a corresponding recovery period of 35 weeks. 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 and Southampton Water SPA 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. 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 bird features and their supporting habitats was concluded for the effects of clam dredging alone within the Solent and Southampton Water SPA. Clam dredging occurs in the Solent and Southampton Water SPA 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 and Southampton Water SPA are considered in section 9.1. The impacts of these plans or projects require a Habitat 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 and Southampton Water SPA screening summary for details of these activities). In the Solent and Southampton Water SPA, 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
Queen Elizabeth aircraft carrier capital dredge	Consented and underway	Relevant impact pathways identified in relation to the project include loss of intertidal (as identified by the appropriate assessment). A likely significant effect on the interest features of the Solent and Southampton Water SPA was concluded for the loss of intertidal as a result of the approach channel dredge. The approach channel dredge is expected to lead to an average increase of 2 to 4 mm in water levels at low water within the harbour. This permanent rise in water level translates to a loss of approximately 1 hectare of low intertidal mudflat distributed throughout the harbour, representing a loss of 0.12% of intertidal resources. This corresponds to a reduction in mudflat exposure around low water for approximately three hours per month (0.001 percent of mudflat hectare exposure per month). Designated interest features from Solent and Southampton SPA move freely between adjacent SPAs (including Portsmouth Harbour) and so may be affected by the loss of intertidal as a result of the proposed dredging activity, potentially leading to increased pressure on available food sources in other SPAs. When considering the available range of intertidal resource across the Solent, in-combination with the short reduction in exposure, it was deemed in the appropriate assessment that the loss of 1 hectare of intertidal mudflat will not have an adverse effect on integrity of the site. At a tLSE level for clam dredging, physical damage and abrasion were screened in. It was recognised that clam dredging causes disturbance to the seabed but did not result in the physical loss of the extent of the feature.

		It has been concluded that impacts surrounding the approach capital dredge will not have an effect on the integrity of the site. The lack of overlapping impact pathways and lack of spatial interaction means there will be no in-combination effect between the project and activity.
Royal Pier phase 2 reclamation and capital dredge	In planning	Relevant impact pathways identified in relation to the project include bird disturbance (construction), increase in suspended sediment concentrations and increase in sedimentation rates. Bird disturbance – during construction there will be two periods of offshore piling (lasting up to five months and four months respectively). Noise levels on the closest parts of the SPA during piling would peak at 58 dB, potentially at a level where behavioural responses could occur. This level is below those recorded in studies where significant displacement was recorded as a result of noise. The site is located approximately 520 m from the closest area of intertidal mudflats within the SPA, separated by the main approach channel to Southampton Docks. Given that the piling will take place within an environment already experiencing high levels of noise, and the distance separating piling activity from the SPA, no significant effects are predicted to occur as a result of noise or visual disturbance. Potential to affect the Solent and Southampton Water SPA by occur as a result of new residents making use of the coastal sites for recreations. To compensate for this, a financial contribution (£172 per dwelling) will be made towards the Interim Solent Recreation Mitigation Strategy, which sets out measures to address the effects of increased recreation on the protected sites of the Solent. Increase in 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. With respect to suspended sediment and sedimentation rates, it was concluded that the small scale of the works and distance from designated nature conservation sites, like the Solent and Southampton Water SPA, 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, visual disturbance and noise disturbance were screened in. On further investigation (contained within this HRA), both impact pathways have been screened out. The reason for this is largely down to the limited potential for direct

		impact since the activity occurs at high tide and feeding/foraging takes place at low tide, thus largely eliminating the possibility of disturbance. In further support of this, Southampton Water is subject to high levels of vessel traffic and it is likely that some bird species become habituated to these types of disturbance. Physical damage from siltation was not identified by the Regulation 33 Conservation Advice for the Solent and Southampton Water SPA Distance from the Solent and Southampton Water SPA mean there are likely to be negligible if any impacts on the site from the project. Any impacts from clam dredging within the site and therefore highly unlikely to overlap spatially with those resulting from the project. This combined with the limited potential for disturbance from clam dredging and relatively small scale, temporary and localised impacts from the project are unlikely to lead to in-combination effects.
Wightlink – Fishbourne to Portsmouth	In planning	Relevant impact pathways identified in relation to the project include bird disturbance (construction) and loss of intertidal. Bird disturbance – the proposed project include a range of activities, such as piling, which have the potential to result in a temporary source of noise and visual disturbance to roosting and feeding waterbirds during construction. The works are proposed to take place between September 2016 and March 2017 and seven pile groups are to be constructed in total, three of which will be below high water. Continuous Flight Auger bored concrete piles will be used and these produce a much lower level of noise and vibration. Ornithological monitoring has generally only recorded low numbers of waders and waterfowl in the Wootton Creek area and the adjacent foreshore around the ferry berth is reported to be of limited value as a supporting habitat. Recent studies have reported infrequent and mild behavioural responses in response to piling and regular construction activities. Sensitivity to piling and other construction disturbance was assessed as low to moderate and the vulnerability is consequently assessed as low. The importance is scored as high in particular because of the protection afforded to SPA interest features under the Habitats Regulations. Therefore, the temporary disturbance impact during construction has been assessed as minor adverse. Loss of intertidal - 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. The scour footprint for piles located within the Solent and Southampton Water SPA could potentially be 40m^2, which makes up 0.00007% of the total designated site area. The area would effectively be lowered and subject to accelerated flows. The area directly affected by piling works is not located within the SPA. The adjacent habitat that could be affected is of high importance as an SPA supporting habitat but in view of the scale of the effects predicted the indirect habitat modification impacts on mudflat habitats are assessed as insignificant. At a tLSE level for clam dredging, visual disturbance and noise disturbance were screened in. On further investigation (contained within this HRA), both impact pathways have been screened out. The reason for this is largely down to the limited potential for direct impact since the activity occurs at high tide and feeding/foraging takes place at low tide, thus largely eliminating the possibility of disturbance. In further support of this, Southampton Water is subject to high levels of vessel traffic and it is likely that some bird species become habituated to these types of disturbance. At a tLSE level for clam dredging, physical damage and abrasion were also screened in. It was recognised that clam dredging causes disturbance to the seabed but did not result in the physical loss of the extent of the feature. There are unlikely to be significant in-combination effects in relation to noise and visual disturbance due to the limited potential for this impact pathway as a result of clam dredging and due to the limited the temporary, localised and small scale disturbance from construction works associated with the project. Furthermore the environmental statement confirmed the area is not of high importance to waterbirds. Clam dredging will not lead to the loss of the intertidal and those impacts from the project only cover a very small proportion of the SPA. Based on this there is unlikely to be any in-combination effects.

Cowes breakwater (Shrape extension), marine and capital dredge	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. 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. Physical damage from siltation was not identified by the Regulation 33 Conservation Advice for the Solent and Southampton Water SPA and so was not included as a potential impact pathway at a tLSE level. 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, loss of intertidal and bird disturbance (construction). 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 SPA. Increases in suspended sediment concentrations and sedimentation rates are likely to

		be small scale, temporary (one off events) and localised to each area. Trenching and drilling are likely to lead to small scale, temporary and local bird disturbance as construction work falls within the site. At a tLSE level for clam dredging, visual disturbance and noise disturbance were screened in. On further investigation (contained within this HRA), both impact pathways have been screened out. The reason for this is largely down to the limited potential for direct impact since the activity occurs at high tide and feeding/foraging takes place at low tide, thus largely eliminating the possibility of disturbance. In further support of this, Southampton Water is subject to high levels of vessel traffic and it is likely that some bird species become habituated to these types of disturbance. At a tLSE level for clam dredging, physical damage and abrasion were also screened in. It was recognised that clam dredging causes disturbance to the seabed but did not result in the physical loss of the extent of the feature. Physical damage from siltation was not identified by the Regulation 33 Conservation Advice for the Solent and Southampton Water SPA and so was not included as a potential impact pathway at a tLSE level. It is therefore not anticipated that the project and activity will lead to any in-combination effects.

9.2 Other fishing activities

Fishing activity	Potential for in-combination effect
Oyster dredging	Common impact pathways identified at a tLSE level include physical damage – abrasion, disturbance (noise and visual) and changes in food availability. Noise and visual disturbance were both screened out at an appropriate assessment level as they occur at high tide or in subtidal areas. Birds feed at low tide and subtidal sediment communities do not form supporting habitats for the SPA. It is unlikely the two activities will lead to significant in-combination effects with respect to disturbance (noise and visual). Oyster dredging takes place in distinct, small spatial areas, where shellfish beds exist. While fishing effort is typically focused upon subtidal habitats, historic sightings data (presented in Annex 16) shows a clear overlap with clam dredging in several discrete areas including Ashlett Creek and the 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 on the fringes of the intertidal when considering SPA supporting habitat within the Solent and Southampton Water SPA. 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 (light otter trawl)	No impact pathways were identified at a tLSE level for light otter trawling. The reason for this is the low incidence of trawling within the Solent and Southampton Water SPA as the activity is concentrated subtidally. The two activities target different species and therefore there will be no in-combination effects with respect to selective extraction of species. The level of trawling occurring within SPA is limited and sightings data show it occurs on an infrequent basis. Sightings data presented in Annex 17 demonstrate no overlap between clam sightings data and trawl sightings. Based on the low incidence of trawling within the Solent and Southampton Water SPA due to the subtidal nature of the activity, it highly unlikely there would be any spatial overlap between the two activities and as such in-combination effects are unlikely to occur.
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	No impact pathways were identified at a tLSE level for demersal longlining.

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.
Handlines & Jigging/Trolling	No impact pathways were identified at a tLSE level for handlines and jigging/trolling. The activity is very low impact and unlikely to lead to any in-combination effects.

10. Summary of consultation with Natural England

Consultation	Date submitted	Response from NE	Date received
First draft – excluding management measures (v1.1)	27/10/15	Recommended amendments	02/12/15
Revised draft in response to NE recommendations (v1.5)	08/02/16	Accepted amendments	01/03/16
Revised draft – including management measures (v1.6)	03/08/2016	Recommended amendments	26/08/2016
Revised final draft – including changes to conclusion and management options (v1.9)	09/09/2016	Formal advice	28/09/2016

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 and Southampton Water SPA 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 and Southampton Water SPA, in addition to collating data on the potential impacts of shellfish dredging upon site features/supporting habitats. 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

Atkinson, P.W., Austin, G.E., Burton, N.H.K., Musgrove, A.J., Pollitt, M., Rehfisch, M.M., 2000. WeBS Alerts 1998/99: Changes in Numbers of Wintering Waterbirds in the United Kingdom at National, Country and Special Protection Area (SPA) Scales (BTO Research Report No. 239). BTO, Norfolk. 127 pp.

Atkinson, P.W., Clark, N.A., Bell, M.C., Dare, P.J., Clark, J.A. & Ireland, P.L. 2003. Changes in commercially fished shellfish stocks and shorebird populations in the Wash, England. *Biol. Cons*., **114**, 127-141.

Atkinson, P.W., Maclean, I.M.D. & Clark, N.A. 2010. Impacts of shellfisheries and nutrient inputs on waterbird communities in the Wash, England. *J. Appl. Ecol*., **47**, 191-199.

Austin, G. E., Read, W. J., Calbrade, N. A., Mellan, H. J., Musgrove, A. J., Skellorn, W., Hearn, R. D., Stroud, D. A., Wotton, S. R. & Holt, C. A. 2014. *Waterbirds in the UK 2011/12: The Wetland Bird Survey*. BTO, RSPB and JNCC, in association with WWT. British Trust for Ornithology, Thetford.

Bannister, R.C.A., 1998. Analysing cockle and mussel stocks. Part 1—The Wash. *Shellfish News*, **6**, 25–29.

Bannister, R.C.A., 1999. The Dr Walne memorial lecture. A review of shellfish resources and their management. In: Proceedings of the Thirtieth Annual Shellfish Conference of the Shellfish Association of Great Britain. SAGB, London.

Baudains, T. P. & Lloyd, P. 2007. Habituation and habitat changes can moderate the impacts of human disturbance on shorebird breeding performance. *Anim. Conserv*., **10,** 400-407.

Beale, C. M. & Monaghan, P. 2004. Behavioural responses to human disturbance: a matter of choice? *Anim. Behav.*, **68,** 1065-1069.

Blumstein, D.T., Anthony, D.T., Harcourt, R.G. & Ross, G. 2003. Testing a key assumption of wildlife buffer zones: is flight initiation distance a species specific trait? *Biol. Cons*., **110**, 97-100.

Blumstein, D. T., Fernandez-Juricic, E., Zollner, P. A. & Garity, S. C. 2005. Inter-specific variation in avian responses to human disturbance. *J. Appl. Ecol.*, **42**, 5, 943-953.

Bradshaw, C., Veale, L.O., Hill, A.S., & Brand, A.R. 2000. The effects of scallop dredging on gravelly seabed communities. In Kaiser, M.J. & de Groots, S.J. (Eds). *The Effects of Fishing on Non-Target Species and Habitats: Biological Conservation and Socio-Economic Issues*. Oxford, Blackwell Science, pp. 83-104.

Brearey, D.M. 1982. The feeding ecology and foraging behaviour of Sanderling *Calidris alba* and Turnstone *Arenaria interpres* at Teesmouth N. E. England. Theses. Durham University. UK. 412 pp.

Burger, J. 1981. The effect of human activity on birds at a coastal bay. *Biol. Cons*., **21**, 231-241.
Burton, N.H.K., Rehfisch, M.M., Clark, N.A. & Dodd, S.G. 2006. Impacts of sudden winter habitat loss on the body condition and survival of redshank *Tringa totanus*. *J. Appl. Ecol*., **43**, 464-473.

Clark, N.A. 1993. Wash oystercatchers starving. *BTO News*, **185**, 1, 24.

Coen, L.D. 1995. A review of the potential impacts of mechanical harvesting on subtidal and intertidal shellfish resources. SCDNR-MRRI, 46 pp.

Collie, J.S., Hall, S.J., Kaiser, M.J. & Poiner, I.R. 2000 A quantitative analysis of fishing impacts on shelf-sea benthos. *J. Anim. Ecol*., **69**, 785-798.

Collie, J.S., Hermsen, J.M., Valentine, P.C. & Almeida, F.P. 2005. Effects of fishing on gravel habitats: assessment and recovery of benthic megafauna on Georges Bank. American Fisheries Society Symposium. American Fisheries Society. 325 pp.

Constantino, R., Gaspar, M.B., Tata-Regala, J., Carvalho, S., Curdia. J., Drago, T. Taborda, R. 2009. Clam dredging effects and subsequent recovery of benthic communities at different depth ranges. *Mar. Environ. Res*., **67**, 89-99.

Cox, R., Lancaster, J. & Rutherford, V. 2014. Review of Potential Impacts on the Diet of Sanderlings and Ringed Plovers and their Foraging Distribution. Tidal Lagoon Swansea Bay. 1063030. Natural Power. 15 pp.

Durell, S.E.A. Le V. Dit. & Kelly, C.P. 1990. Diets of Dunlin *Calidris alpine* and Grey Plover *Pluvialis squatarola* on the Wash as determined by dropping analysis. *Bird Study*, **37**, 1, 44-47.

Durell, S.E.A. Le V. dit., Stillman, R.A., Triplet, P., Aulert, C., Biot, D.O. dit., Bouchet, A., Duhamel, S., Mayot & Goss-Custard, J.D. 2005. Modelling the efficacy of proposed mitigation areas for shorebirds: a case study on the Seine estuary, France. *Biol. Cons*., **123**, 67-77.

EA Alerts. 2004. 4.5.1 Solent & Southampton Water SPA (UK9011061). BTO Research Report No. 347. 14 pp.

EMU. 1992. An experimental study on the impact of clam dredging on soft-sediment macroinvertebrates. Report to English Nature No. 92/2/291. 92 pp.

European Commission. 2009. European Union Management Plan 2009-2011. Redshank *Tringa totanus*. Technical Report – 2009 – 031. 44 pp.

Ferns, P.N., Rostron, D.M. & Sima, H.Y. 2000. Effects of mechanical cockle harvesting on intertidal communities. *J. Appl. Ecol*., 37. 464-474.

Garthe, S. & Hüppop, O. 2004. Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. *J. Appl. Ecol*., **41**, 724-734.

Gill, J.A., Sutherland, W.J. & Watkinson, A.R. 1996. A method to quantify the effects of human disturbance on animal populations. *J. Appl. Ecol.,* **33**, 786-792.

Gill, J.A., Norris, K. & Sutherland, W.J. 2001a. The effects of disturbance on habitat use by black-tailed godwits *Limosa limosa*. *J. Appl. Ecol*., **38**, 846-856.

Gill, J.A., Norris, K. & Sutherland, W.J. 2001b. Why behavioural responses may not reflect the population consequences of human disturbance. *Biol*. *Conserv*. **97,** 265–268

Goss-Custard, J.D. 1977. The ecology of the Wash. III. Density-related behaviour and the possible effects of a loss of feeding grounds on wading birds (Charadrii). *J. Anim. Ecol*., **14**, 721-739.

Goss-Custard, J.D. 1993. The effect of migration and scale on the study of bird populations: 1991. Witherby Lecture. *Bird Study*, **40**, 81-96.

Goss-Custard, J.D. & Verboven, N. 1993. Disturbance and feeding shorebirds on the Exe estuary. *Wader Study Group Bulletin, Special Issue*, **68**, 59–66.

Goss-Custard, J.D., Clarke, R.T., Durell, S.E.A. le V. dit, Caldow, R.W.G. & Ens, B.J. 1995. Population consequences of winter habitat loss in a migratory shorebird. II. Model predictions. *J. Appl. Ecol*., **32**, 337-351.

Goss-Custard, J.D., Durell, S.E.A. le V. dit, Goater, C.P., Hulscher, J.B., Lambeck, R.H.D., Meininger, P.L. & Urfi, J. 1996. How oystercatchers survive the winter. In Goss-Custard, J.D. (Ed). *The Oystercatcher: From Individuals to Populations*. Oxford, UK, Oxford University Press. pp. 133–154.

Goss-Custard, J.D., Stillman, R., West, A.D., Caldow, R.W.G., Triplet, P., Durell, S.E.A. Le V.dit. & McGrorty, S. 2004. When enough is not enough: Shorebirds and shellfishing. *Proc. R. Soc. Lond. B*., **271**, 233-237.

Goss-Custard, J.D., Triplet, P., Sueur, F. & West, A.D. 2006. Critical Thresholds of Disturbance by People and Raptors in Foraging Wading Birds. *Biol. Cons.*, **127**, 88–97.

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. *J. App. Ecol.*, 34, 497-517.

Hiddink, J.G. 2003. Effects of suction-dredging for cockles on non-target fauna in the Wadden Sea, *J. Sea. Res*., **50**, 315-323

Hill, D., Hockin, D., Price, D., Tucker, G., Morriss, R. & Treweek, J. 1997. Bird disturbance: improving the quality and utility of disturbance research. *J. Appl. Ecol*., **34**, 275-288.

Hulscher, J.B. 1982. The oystercatcher *Haematopus ostralegus* as a predator of the bivalve *Macoma balthica* in the Dutch Wadden Sea. *Ardea*, **70**, 89–152.

Johnson, K.A. 2002. A review of national and international literature on the effects of fishing on benthic habitats. NOAA Tech. Memo. NMFS-F/SPO-57. 72 pp.

Kaiser, M.J., Edwards, B. & Spencer, B.E. 1996. Infaunal community changes as a result of commercial clam cultivation and harvesting. *Aquat. Living Resour.,* 9, 57-63.

Kaiser, M.J., Ramsay, K., Richardson, C.A., Spence, F.E. & Brand, A.R. 2000. Chronic fishing disturbance has changed shelf sea benthic community structure. *J. Anim. Ecol.*, **69**, 494-503.

Kaiser, M.J., Clarke, K.R., Hinz, H., Austen, M.C.V., Somerfield, P.J. & Karakassis, I. 2006. Global analysis of response and recovery of benthic biota to fishing. *Mar. Ecol. Prog. Ser*., **311**, 1-14

King, S., Maclean, I.M.D., Norman, T. & Prior, A. 2009. Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers. COWRIE. 129 pp.

Kirby, J., Davidson, N., Giles, N., Owen, M. & Spray, C. 2004. Waterbirds & Wetland recreation handbook. A review of issues and management practice. WWT. 128 pp.

Klaassen, M., Bauer, S., Madsen, J. & Tombre, I. 2006. Modelling Behavioural and Fitness Consequences of Disturbance for Geese Along Their Spring Flyway. *J. Appl. Ecol.*, **43**, 92–100.

Klein, M.L., Humphrey, S.R. & Percival, H.F. 1995. Effects of ecotourism on the distribution of waterbirds in a wildlife refuge. *Conserv. Biol*., **9**, 1454-1465.

Lewis, L.J., Davenport, J. & Kelly, T.C. 2002. A Study on the Impact of Pipeline Construction on Estuarine Benthic Invertebrate Communities. *Estuar. Coast. Shelf. S*., 55, 213-221.

Lambeck, R., Goss-Custard, J.D. & Triplet, P. 1996. Oystercatchers and man in the coastal zone. In Goss-Custard, J.D. (Ed). The Oystercatcher: From Individuals to Populations. Oxford, Oxford University Press. pp. 289-326

Liley, D., Stillman, R. A. & Fearnley, H. 2010. The Solent Disturbance and Mitigation Project: results of disturbance fieldwork 2009/10. Report to the Solent Forum. 71 pp.

Madsen, J. 1995. Impacts of disturbance on migratory waterfowl. *Ibis*, **137** (Supplement), S67-S74.

McLusky, D.S., Anderson, F.E. & Wolfe-Murphy, S. 1983. Distribution and population of *Arenicola marina* and other benthic fauna after bait digging. *Mar. Ecol. Prog. Ser*., 11, 173-179.

Mercaldo-Allen, R. & Goldberg, R. 2011. Review of the Ecological Effects of Dredging in the Cultivation and Harvest of Molluscan Shellfish. NOAA Technical Memorandum NMFS-NE-220. 84 pp.

Natural England. 2011. Bait collection in Poole Harbour European Marine Site. 19 pp.

Natural England, Wildside Ecology & Suffolk Coast and Heaths AONB. 2012. A simple method for assessment the risk of disturbance to birds and coastal sites. 32 pp.

Natural England. 2014. Natural England's advice on the potential impacts of clam dredging within the Solent. Advice to Southern Inshore Fisheries and Conservation Authority 19/12/14. 14 pp.

Navedo, J.G. & Masero, J.A. 2008. Effects of traditional clam harvesting on the foraging ecology of migrating curlews (*Numenius arquata*). *J. Exp. Mar. Biol. Ecol*., **355**, 1, 59-65.

Nisbet, I. C. T. 2000. Disturbance, habituation, and management of waterbird colonies – Commentary. *Waterbirds: The International Journal of Waterbird Biology,* **23,** 312-332.

Norris, K., Bannister, R.C.A. & Walker, P.W. 1998: Changes In the number of oystercatchers, *Haematopus ostralegus* wintering in the Burry Inlet in relation to the biomass of cockles *Cerastoderma edule* and its commercial exploitation. *J. Appl. Ecol.*, **35**, 75–85.

Peterson, C.H., Summerson, H.C. & Fegley, S.R. 1987. Ecological consequences of mechanical harvesting of clams. *Fish. Bull.*, 85, 2, 281-298.

Piersma, T., Koolhaas, A., Dekinga, A., Beukema, J.J., Dekker, R. & Essink, K. 2001. Long-term indirect effects of mechanical cockle-dredging on intertidal bivalve stocks in the Wadden Sea. *J. Appl. Ecol*. **38**, 976-990.

Potts, P. 2014. 06/11/2014. RE: Roost sites in Portsmouth Harbour. In Portsmouth Harbour Draft Regulation 35 Conservation Advice.

Rees, E. C., Bruce, J. H. & White, G. T. 2005. Factors affecting the behavioural responses of whooper swans (*Cygnus c. cygnus*) to various human activities. *Biol. Cons.,* **121,** 369-382

Riddington, R., Hassall, M., Lane, S.J., Rurner, P.A. & Walters, R. 1996. The impacts of disturbance on the behaviour and energy budgets of Brent Geese *Branta b. bernicla*. *Bird Study*, **43**, 269-279.

Roberts, C., Smith, C., Tillin, H. & Tyler-Walters, H. 2010. Review of existing approaches to evaluate marine habitat vulnerability to commercial fishing activities. Report: SC080016/R3.Environment Agency, Bristol. 150 pp.

Santos, S., Cardoso, J.F.M.F., Carvalho, C., Luttihuizen, P.C. & van der Veer, H.W. 2011. Seasonal variability in somatic and reproductive investment of the bivalve *Scrobicularia plana* (da Costa, 1778) along a latitudinal gradient. *Estuar. Coast. Shelf. S*., 92, 19-26.

Schmechel, F. 2001. Potential impacts of mechanical cockle harvesting on shorebirds in Golden and Tasman Bays, New Zealand. DOC Science Internal Series 19. New Zealand Department of Conservation. 51 pp.

Sewell, J., Harris, R., Hinz, H., Votier, S. & Hiscock, K. 2007. An Assessment of the Impact of Selected Fishing Activities on European Marine Sites and a Review of Mitigation Measures. SR591. Seafish Technology. 219 pp.

Spencer, B.E., Kaiser, M.J. & Edwards, D.B. 1998. Intertidal clam harvesting: benthic community change and recovery. *Aquac. Res.*, 29, 429-437.

Stillman, R. A., Goss-Custard, J. D., West, A. D., Durell, S., McGrorty, S., Caldow, R. W. G., Norris, K. J., Johnstone, I. G., Ens, B. J., Van der Meer, J. & Triplet, P. 2001. Predicting shorebird mortality and population size under different regimes of shellfishery management. *J. Appl. Ecol.,* **38,** 857-868.

Stillman, R., West, A.D., Goss-Custard, J.D., Caldow, R.W.G., McGrorty, S., Durrel, S.E.A. Le V.dit., Yates, M.C., Atkinson, P.W., Clark, N.A., Bell, M.C., Drare, P.J. & Mander, M. 2003. An individual behaviour-based model can predict shorebird mortality using routinely collected shellfishery data, *J. Appl. Ecol.*, **6**, 1090-1101.

Stillman, R.A., West, A.D., Caldow, R.W.G. & Durell, S.E.A. le V. dit. 2007. Predicting the effect of disturbance on coastal birds. *Ibis*, **149** (Suppl. 1), 9-14.

Stillman, R., Cox, J., Liley, D., Ravenscroft, N., Sharp, J. & Wells, M. 2009. Solent disturbance and mitigation project: Phase I report. Report to the Solent Forum. 103 pp.

Stillman, R.A., Moore, J.J., Woolmer, A.P., Murphy, M.D., Walker, P., Vanstaene, K.R., Palmer, D. & Sandersond, W.G. 2010. Assessing waterbird conservation objectives: An example for the Burry Inlet, UK. *Biol. Cons*., **143**, 2617-2630.

Stillman, R. A., West, A. D., Clarke, R. T. & Liley, D. 2012. Solent Disturbance and Mitigation Project Phase II: Predicting the impact of human disturbance on overwintering birds in the Solent. Report to the Solent Forum. 121 pp.

Sutherland, W.J. & Goss-Custard, J.D. 1991. Predicting the consequences of habitat loss on shorebird populations. *Acta Congressus Internationalis Ornithologica*, **20**, 2199-2207.

Thiel, D., Jenni-Eiermann, S., Palme, R. & Jenni, L. 2011 Winter Tourism Increases Stress Hormone Levels in the Capercaillie *Tetrao urogallus*. *Ibis*, **153**, 122–133.

Thompson, J. R. 1994. Report on pilot project to investigate recreational disturbance to overwintering birds in the Solent 1993-94. Hampshire County Council.

Townshend, D. J., & O'Connor, D. A. 1993. Some effects of disturbance to waterfowl from bait-digging and wildfowling at Lindisfarne National Nature Reserve, north-east England. In Davidson, N. & Rothwell, P. (Eds). *Disturbance to Waterfowl on Estuaries*. Wader Study Group Bulletin, 68 (Special Issue). pp. 47–52.

Tumnoi, W. 2012. The Autoecology of *Tapes philippinarum* (Adams and Reeve, 1850) in Southampton Water, UK. PhD Thesis. University of Southampton. UK. 182 pp.

Veale, L.O., Hill, A.S., Hawkins, S.J. & Brand, A.R. 2000. Effects of long term physical disturbance by commercial scallop fishing on subtidal epifaunal assemblages and habitats. *Mar.Biol.,* **137**, 2, 325-337.

Verhulst, S., Oosterbeek, K., Rutten, A.L. & Ens, B.J. 2004. Shellfish fishery severely reduces condition and survival of oystercatchers despite creation of large marine protected areas. *Ecol. Soc*., **9**, 1, 17.

Walker, B. G., Dee Boersma, P. & Wingfield, J. C. 2006. Habituation of Adult Magellanic Penguins to Human Visitation as Expressed through Behavior and Corticosterone Secretion. *Cons. Biol.,* **20,** 146-154.

West, A. D., Goss-Custard, J. D., Stillman, R. A., Caldow, R. W. G., Durell, S. & McGrorty, S. 2002. Predicting the impacts of disturbance on shorebird mortality using a behaviour-based model. *Biol. Cons.,* **106,** 319-328.

West, A.D., Goss-Custard, J.D., Stillman, R.A., Caldow, R.W.G., Durell, S.E.A. le V. dit & McGrorty, S**.** 2002.Predicting the impacts of disturbance on shorebird mortality using a behaviour-based model. *Biol*. *Conserv*., **106,** 319–328.

West, A.D., Goss-Custard, J.D., Durell, S.E.A. Le V.dit. & Stillman, R.A. 2005. Maintaining estuary quality for shorebirds: towards simple guidelines. *Biol. Cons*., **123**, 211-224.

Wheeler, R., Stillman, R.A.S. & Herbert, R.J.H. 2014. Ecological impacts of clam and cockle harvesting on benthic habitats and waterfowl. Report to Natural England. Bournemouth University. 42pp.

WWT Consulting. 2012. Review of the impacts of fisheries on marine birds with particular reference to Wales. Marine Spatial Planning in Wales Project. CCW Policy Research Report No 11/6. 57 pp

Yasué, M. 2005. The effects of human presence, flock size and prey density on shorebird foraging rates. *J. Ethol.*, **23,** 199-204.

Zwarts, L., Cayford, J.T., Hulscher, J.B., Kersten, M. & Meire, P.M. 1996a. Prey size selection and intake rate. In Goss-Custard, J.D. (Ed). *The Oystercatcher: From Individuals to Populations*. Oxford, Oxford University Press.

Zwarts, L., Ens, B.J., Goss-Custard, J.D., Hulscher, J.B., Durell. S.E.A. le V.dit. 1996b. Causes of variation in prey profitability and its consequences for the intake rate of the oystercatcher *Haematopus ostralegus*. *Ardea*, **84a**, 229-268.

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.

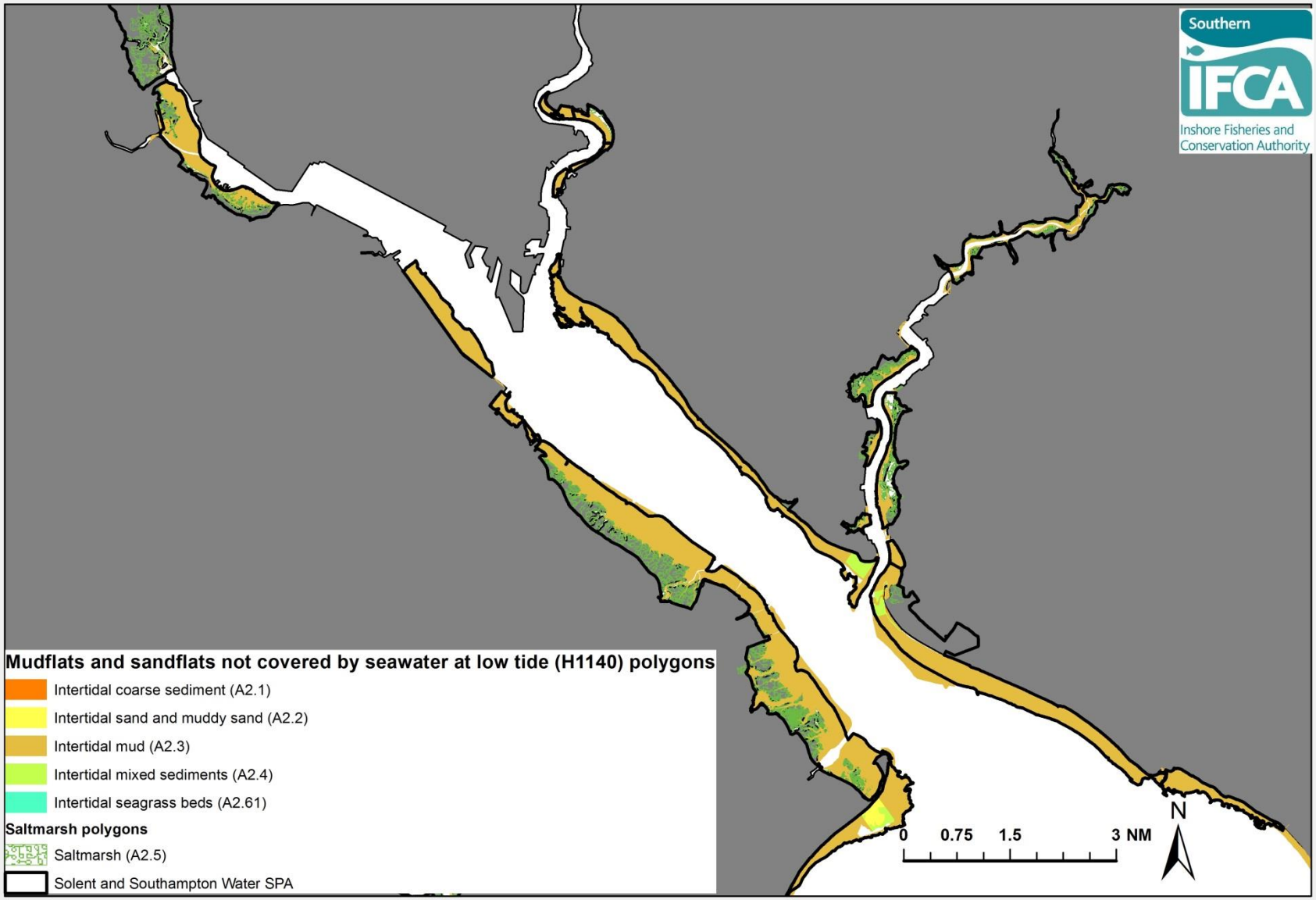
Consideration of this process had led to the following definition of onus of proof: If through their own site condition monitoring programme or that of another Relevant Authority, English Nature can demonstrate that they have reasonable evidence to indicate that a deterioration in the condition of a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

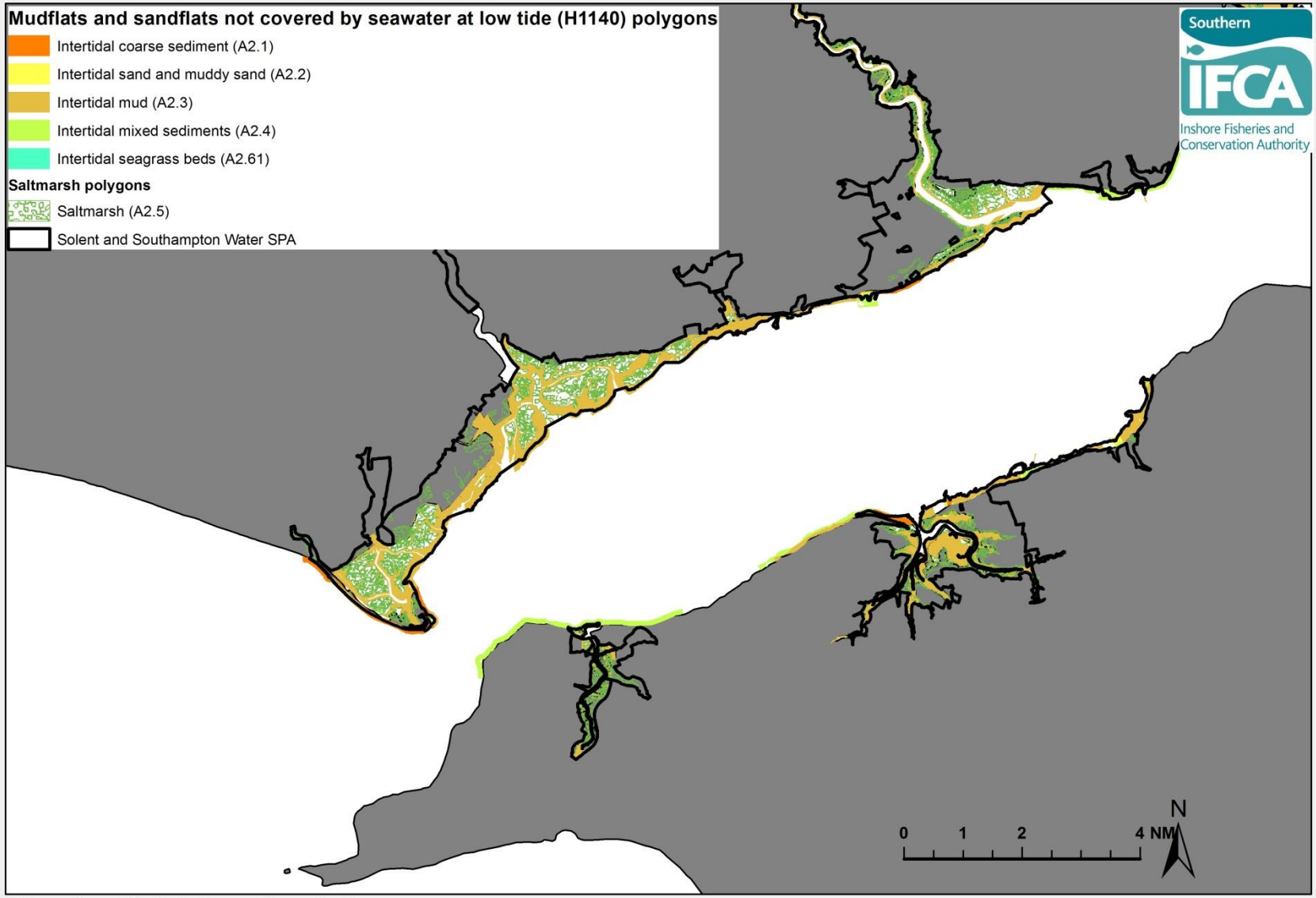
Principle 6 - Management Actions

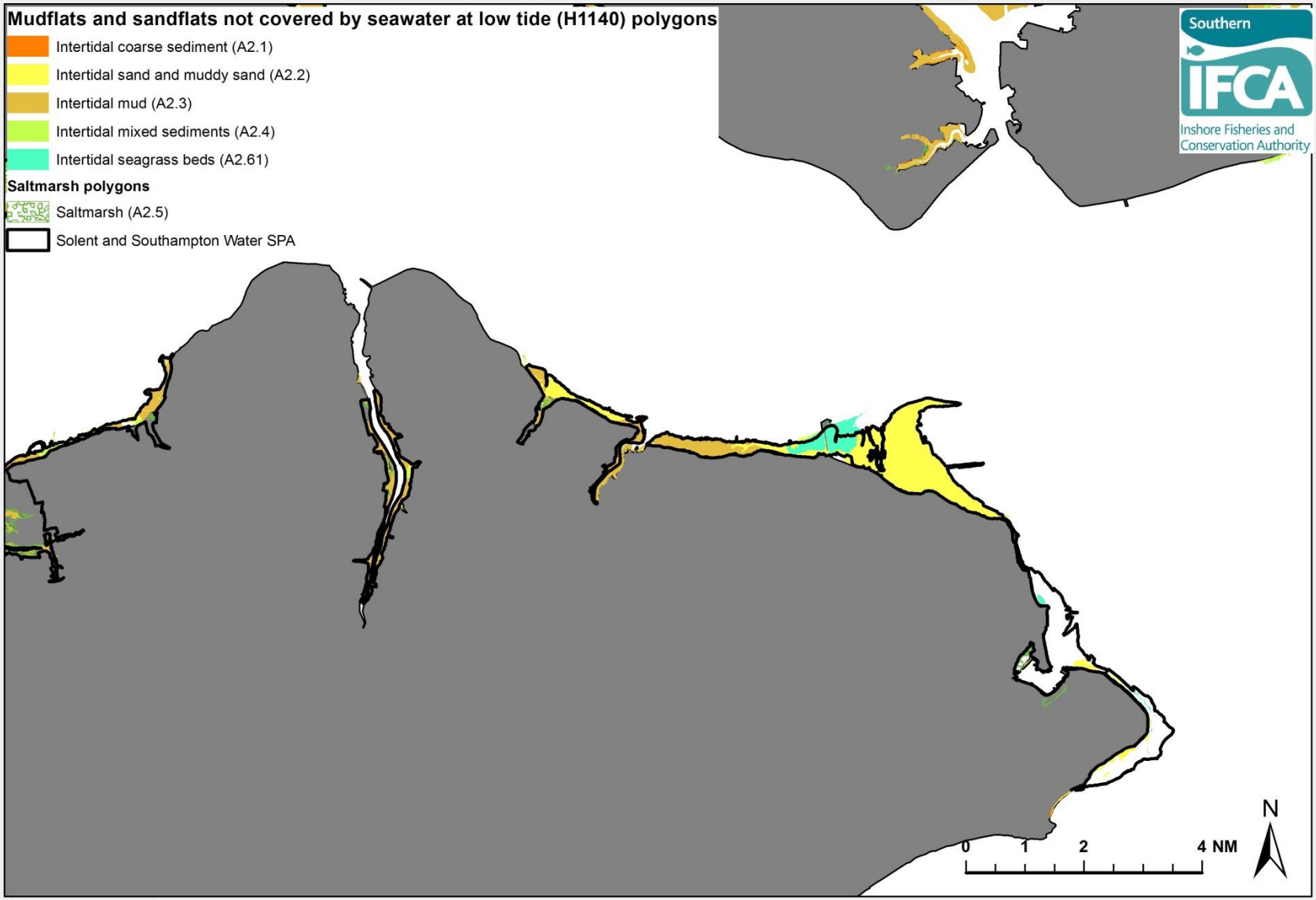
Where reasonable evidence is found to clearly demonstrate the cause and effect relationship the Relevant Authorities involved will instigate changes to the management of the activity, which will be within a RAs statutory obligations and will provide a solution that is in accordance with the Regulations 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).

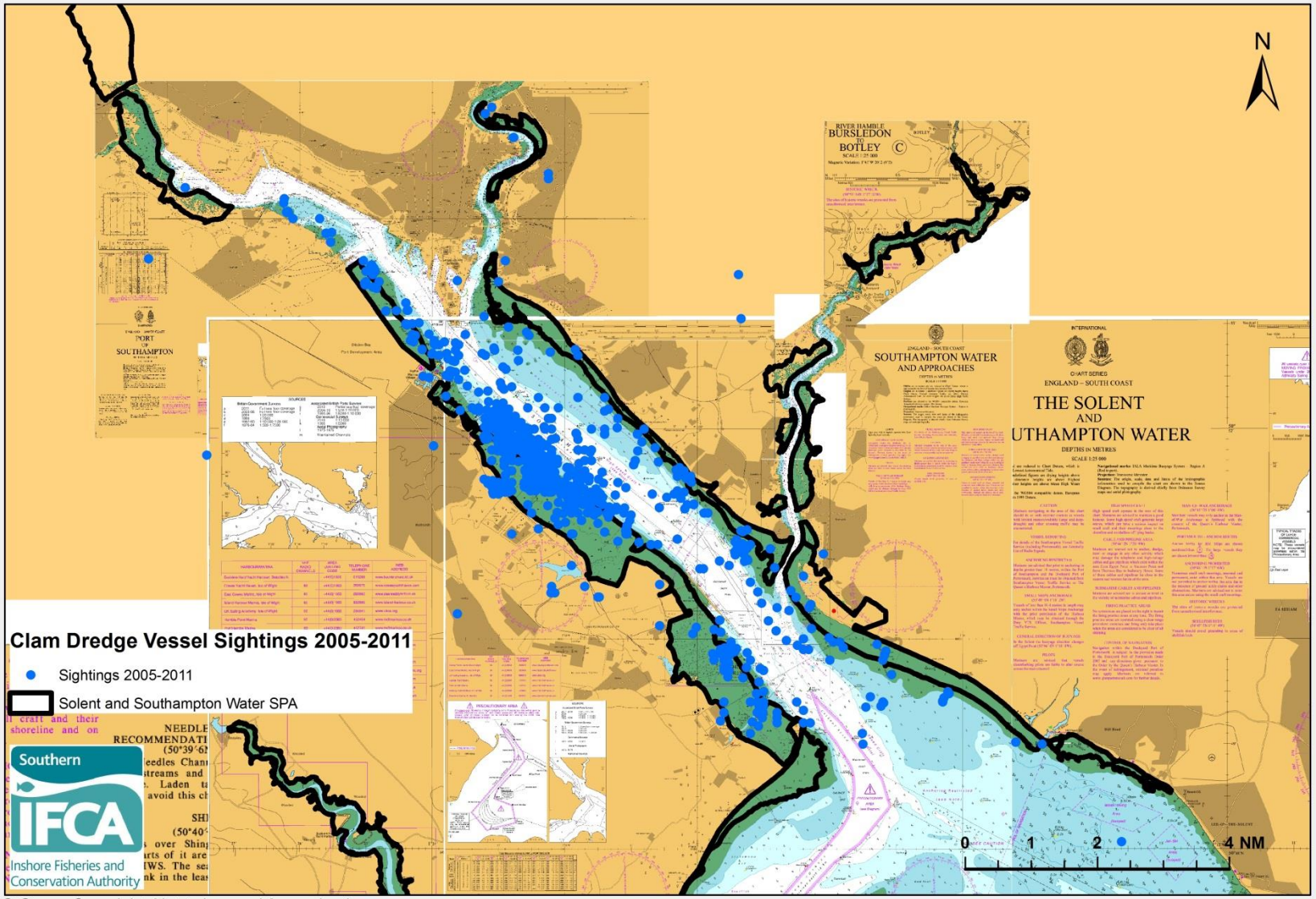
Annex 3: Site Supporting Habitat(s) map for Solent and Southampton Water SPA (Southampton Water, Western Solent and Eastern Solent)



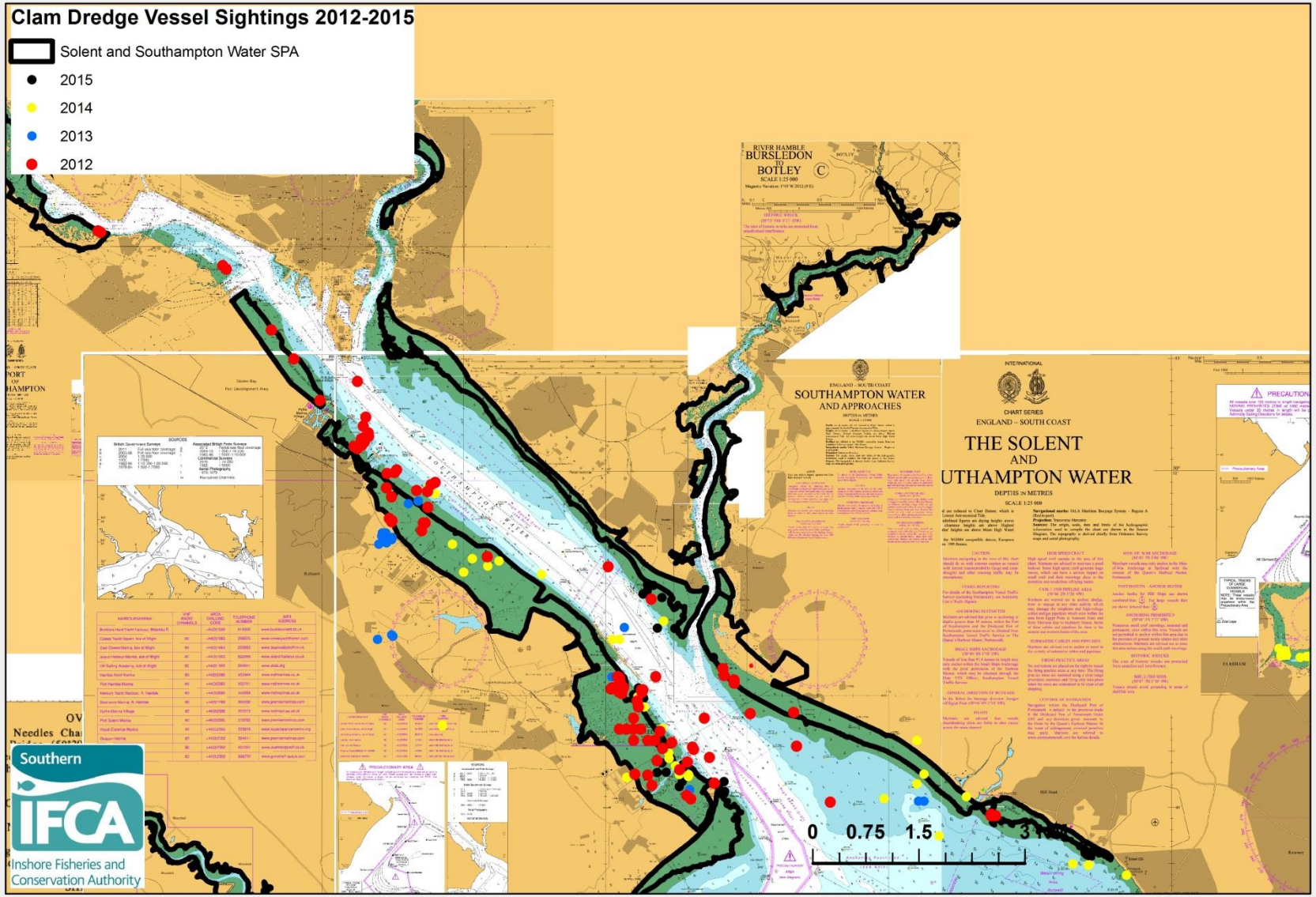




Annex 4: Fishing Activity Map(s) using Clam Dredging Sightings Data from 2005-2015 (2005-11 & 2012-2015 (broken down by year) in Solent and Southampton Water SPA



SIFCA Reference: SIFCA/HRA/08/001



SIFCA Reference: SIFCA/HRA/08/001

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.

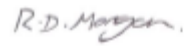
5. Summary

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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Telephone: 0300 060 0240

References

Badino, G., Bona, F., Maffiotti, A., Giovanardi, O., & Pranovi, F. (2004). Impact of mechanical clam harvesting on a benthic habitat: evaluation by means of sediment profile imaging. *Aquatic Conservation: Marine and Freshwater Ecosystems, 14, 59-67.*

Ferns, P. N., Rostron, D. M., & Siman, H. Y. (2000). Effects of mechanical cockle harvesting on intertidal communities. *Journal of Applied Ecology, 37, 464-474.*

Kaiser, M. J., Broad, G., & Hall, S. J. (2001). Disturbance of intertidal soft-sediment benthic communities by cockle hand raking. *Journal of Sea Research, 45, 119-130.*

King, D. (2010). *Solent Waders and Brent Goose Strategy 2010.* Hampshire and Isle of Wight Wildlife Trust.

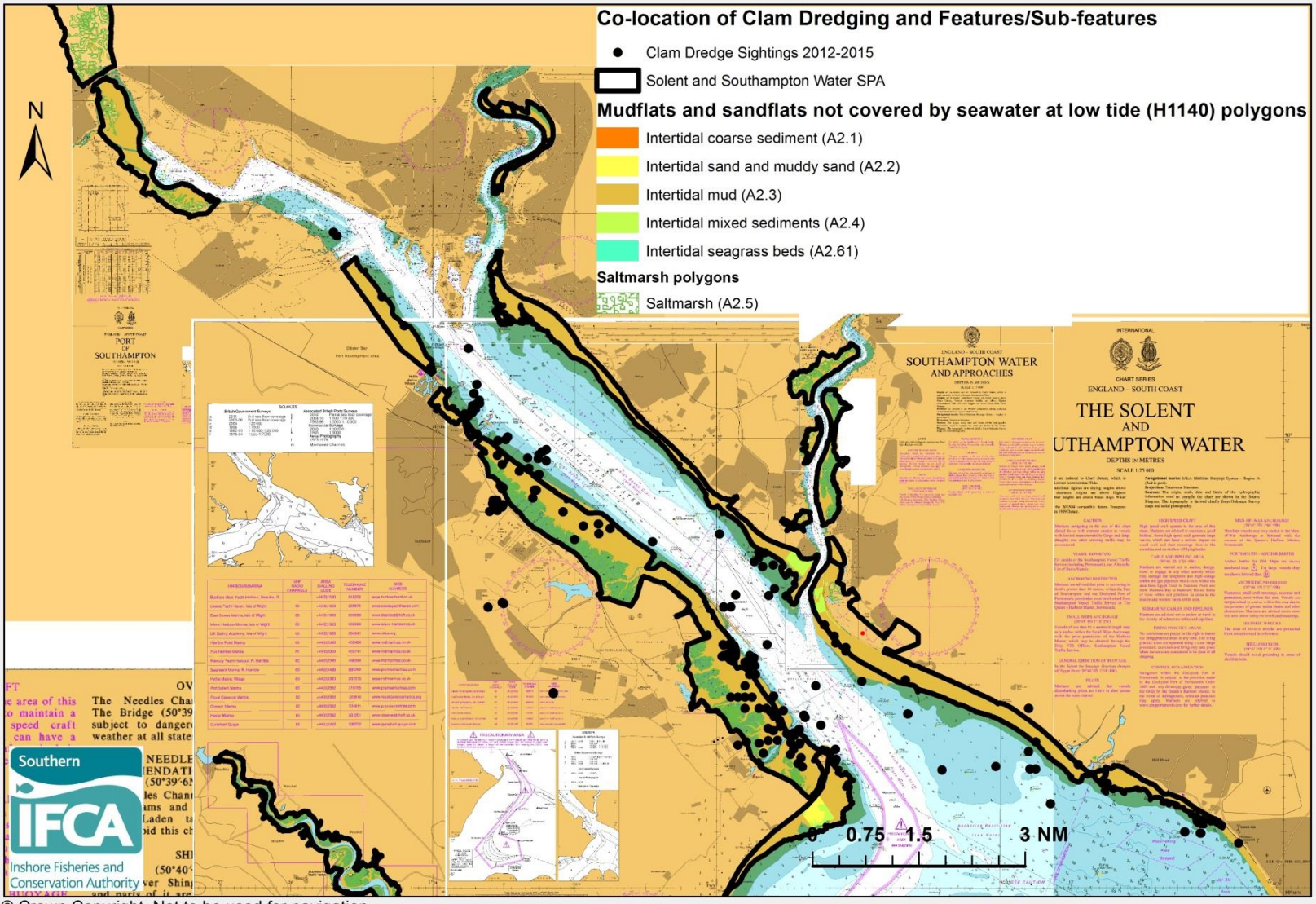
Piersma, T., Koolhaas, A., Dekinga, A., Beukema, J.J., Dekker, R., & Essink, K. (2001). Long-Term Indirect Effects of Mechanical Cockle-Dredging on Intertidal Bivalve Stocks in the Wadden Sea. *Journal of Applied Ecology, 38(5), 976-990.*

Stillman, R. A., Cox, J., Liley, D., Ravenscroft, N., Sharp, J., & Wells, M. (2009). *Solent disturbance and mitigation project: Phase I report.* Report to the Solent Forum.

Tarnowski M. (2006). A literature review of the ecological effects of hydraulic escalator dredging. *Fish. Tech. Rep. Ser. 48:30.*

Wheeler, R., Stillman, R. A. S., & Herbert, R. J. H. (2014). *Ecological impacts of clam and cockle harvesting on benthic habitats and waterfowl.* Report to Natural England. Bournemouth University.

Annex 6: Co-Location of Fishing Activity and Site Supporting habitat(s)



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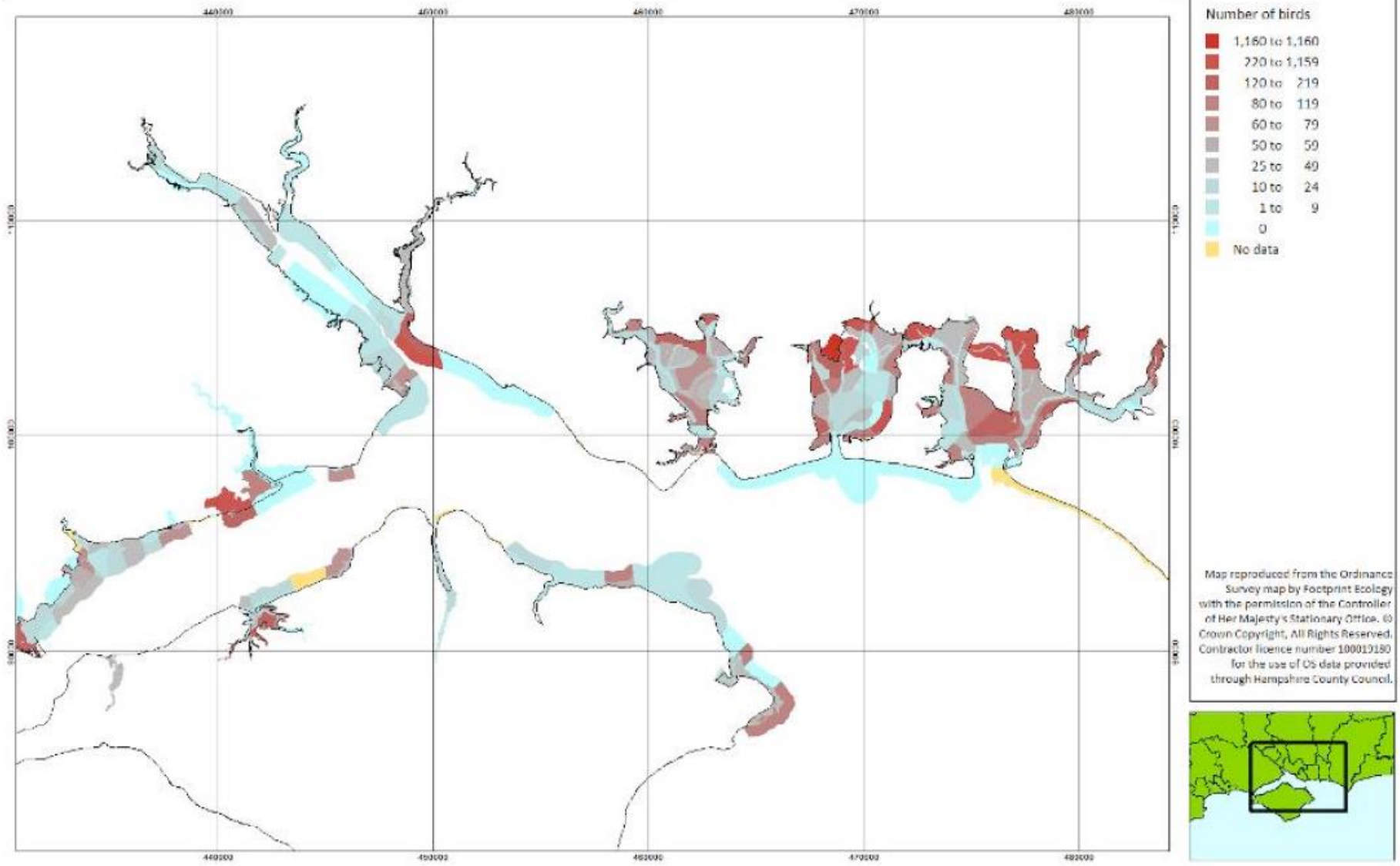
SIFCA Reference: SIFCA/HRA/08/001

Annex 7: Low tide WeBS data distribution maps for Dark-bellied brent goose, Teal, Ringed plover and Black-tailed godwit in the Solent taken from Stillman *et al*., (2009).

Map 13: Low tide WeBS data for dark-bellied brent goose

Solent disturbance and mitigation project: Phase I



25 November 2008

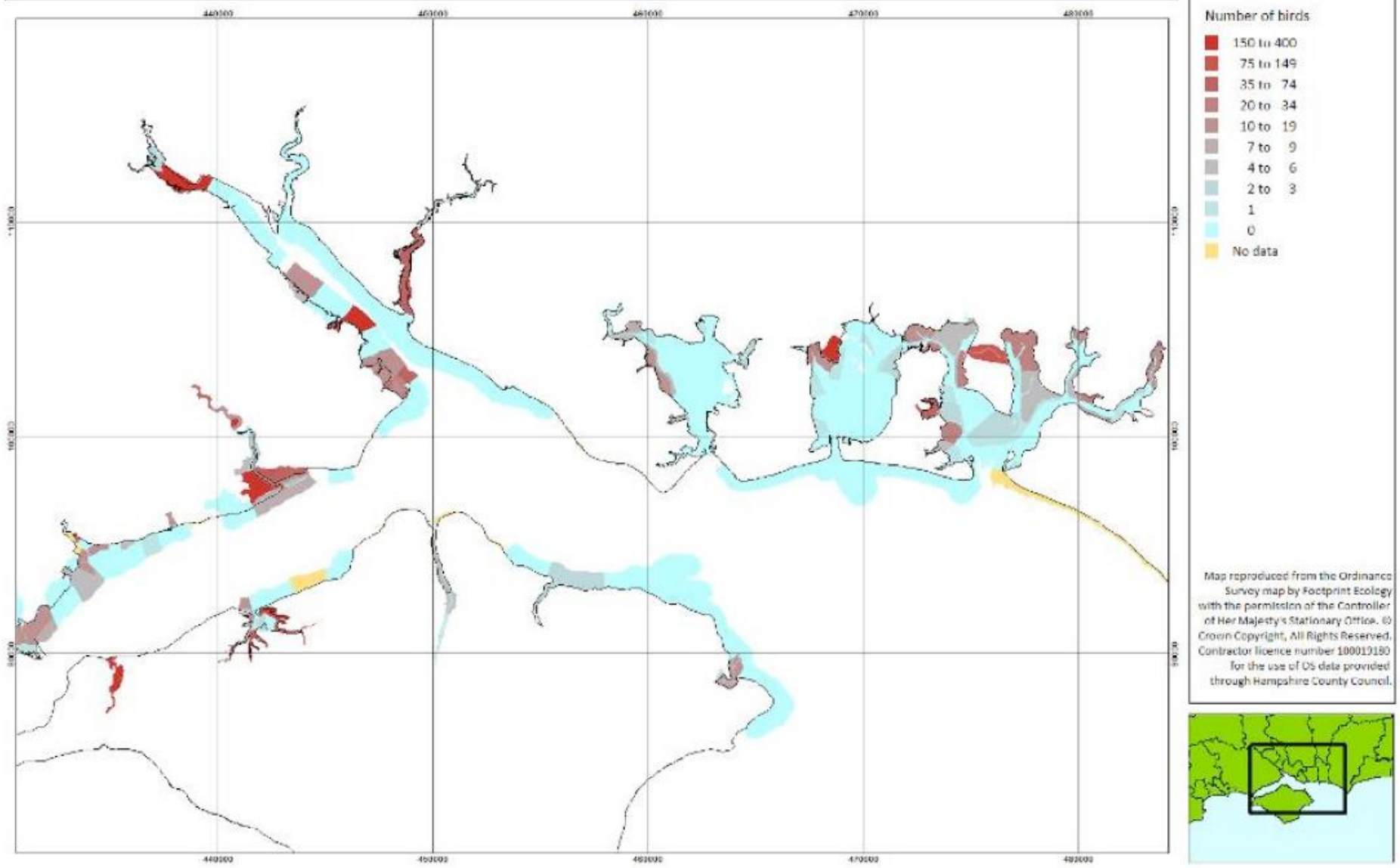
Scale 1:228500

Number of birds

- 1,160 to 1,160
- 220 to 1,159
- 120 to 219
- 80 to 119
- 60 to 79
- 50 to 59
- 25 to 49
- 10 to 24
- 1 to 9
- 0
- No data

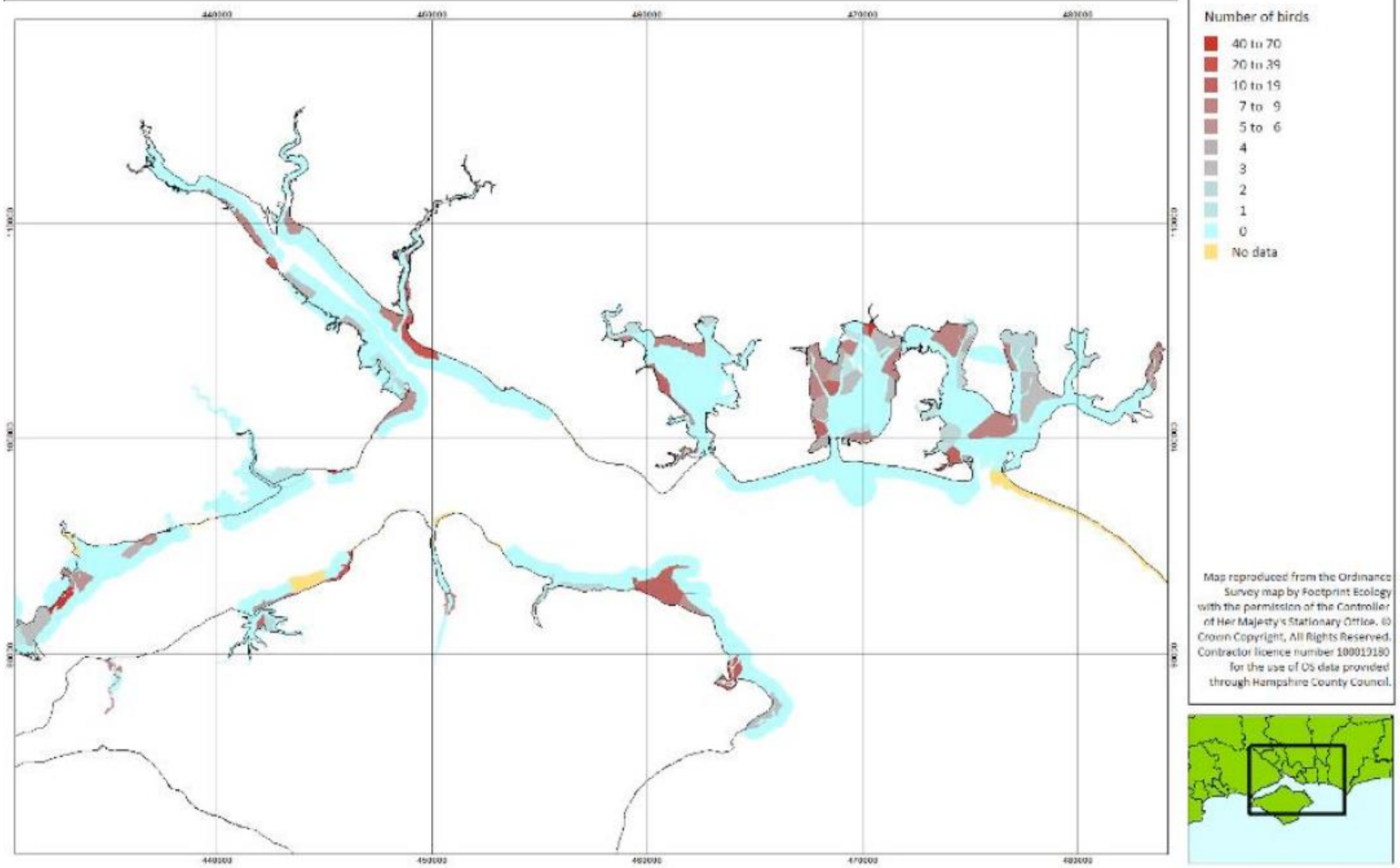
Map 16: Low tide WeBS data for teal

Solent disturbance and mitigation project: Phase I



Map 19: Low tide WeBS data for ringed plover

Solent disturbance and mitigation project: Phase I



25 November 2008

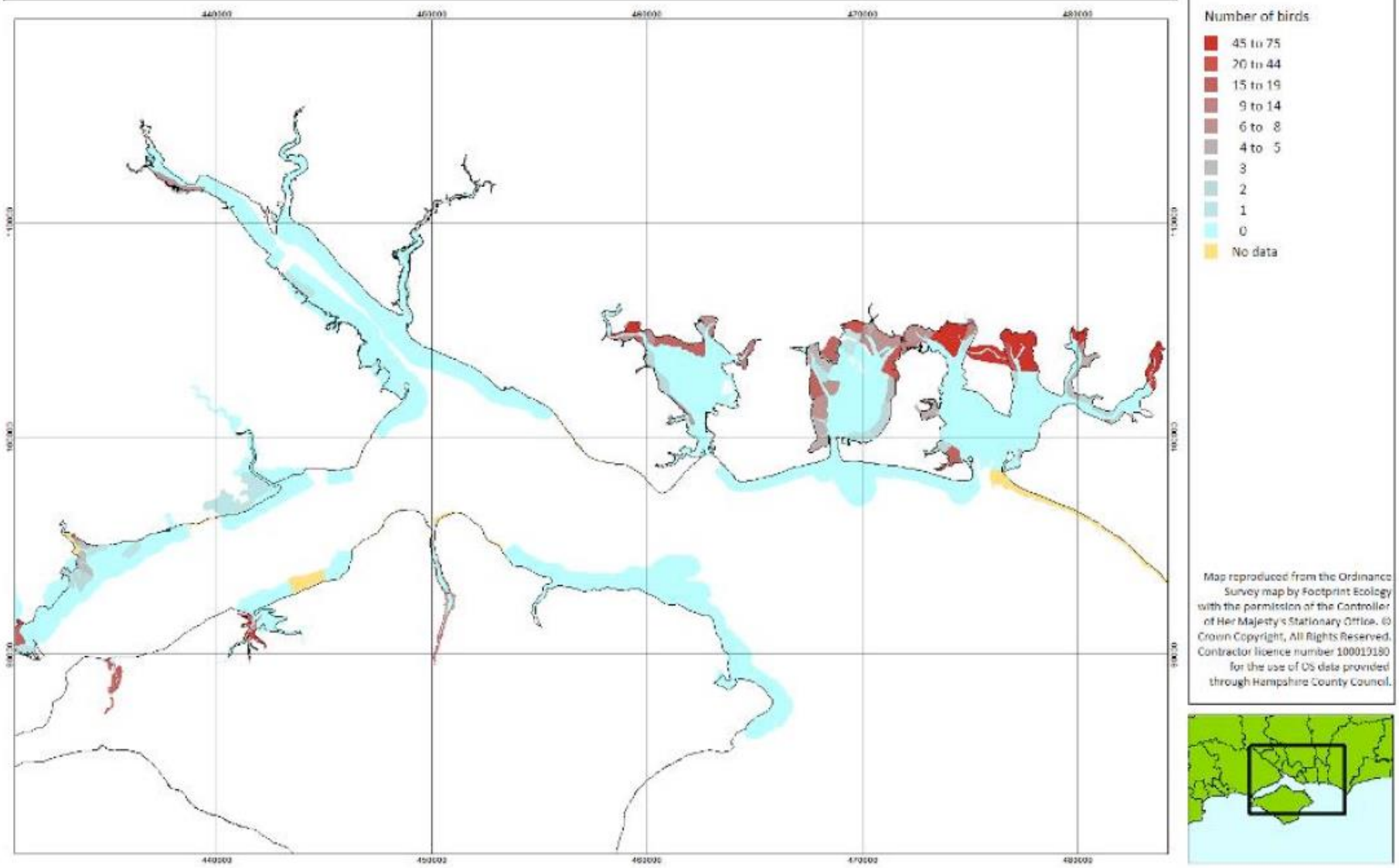
Scale 1:228500

Number of birds

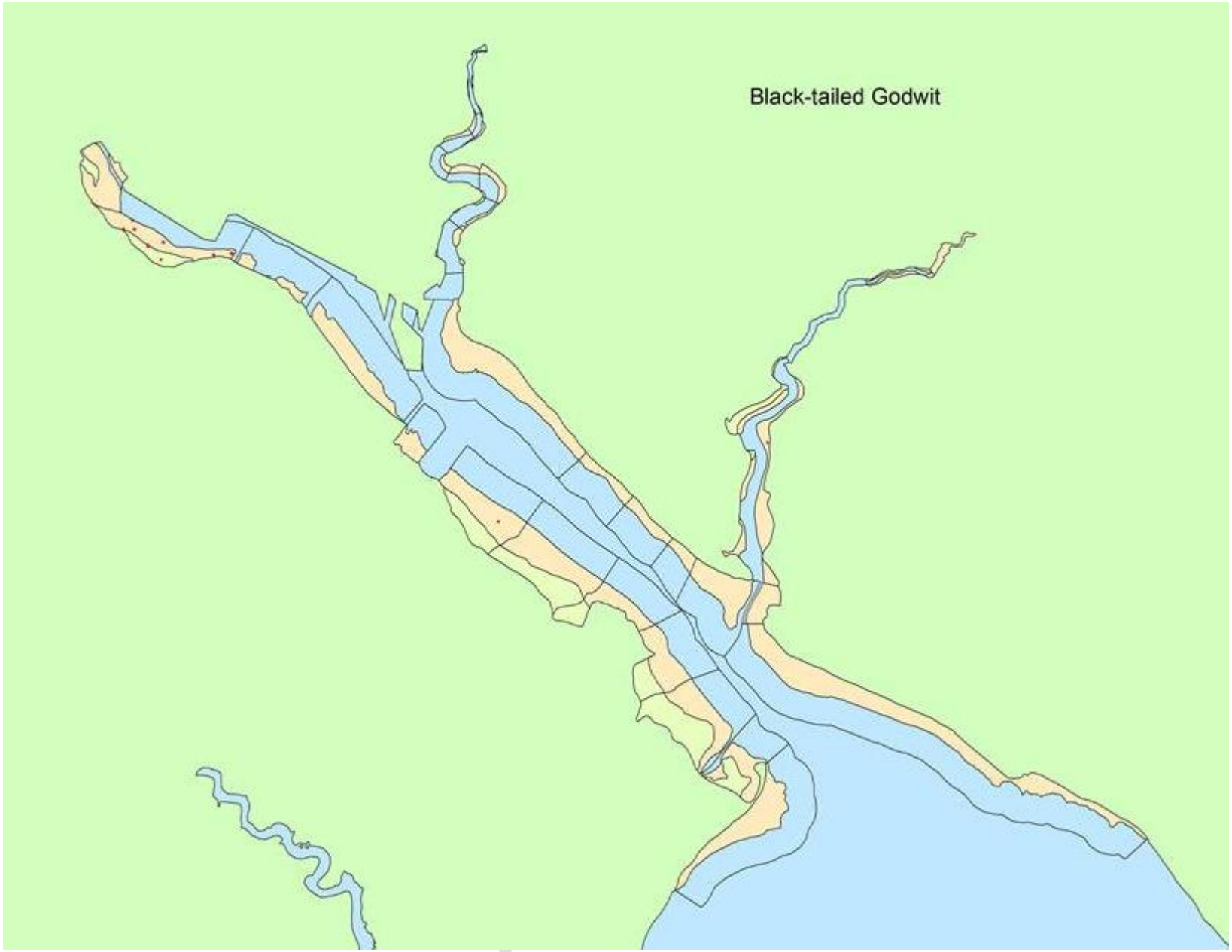
- 40 to 70
- 20 to 39
- 10 to 19
- 7 to 9
- 5 to 6
- 4
- 3
- 2
- 1
- 0
- No data

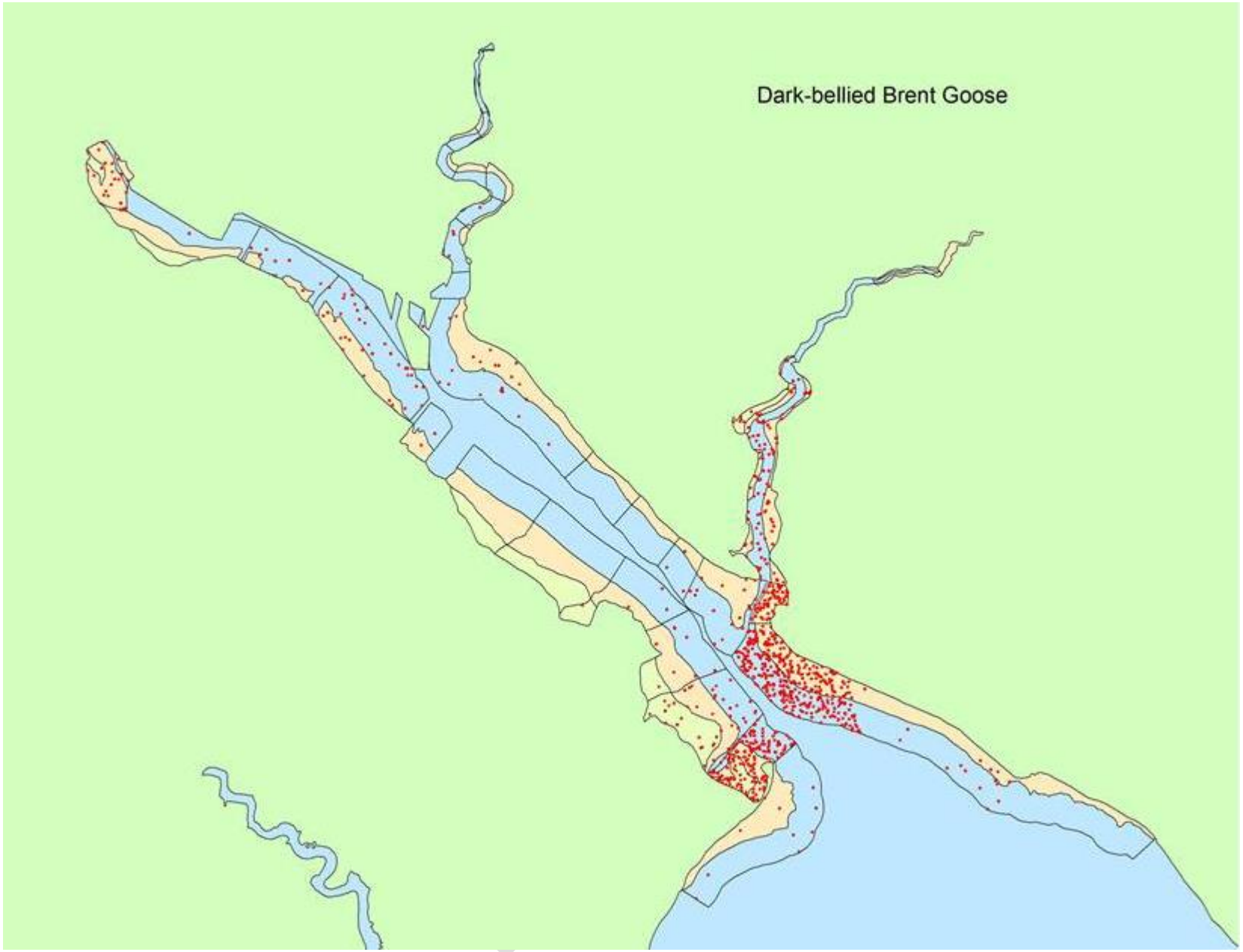
Map 23: Low tide WeBS data for black-tailed godwit

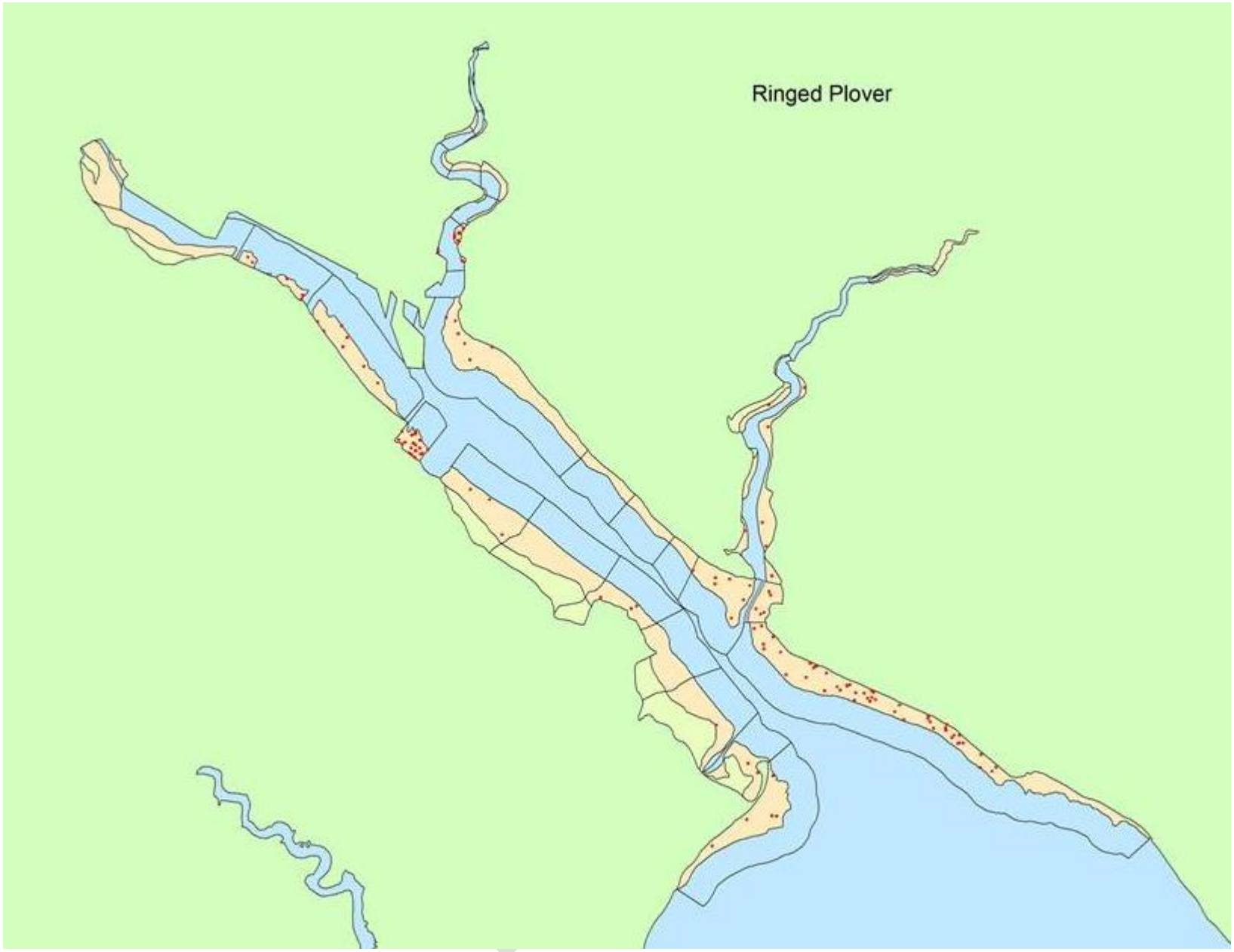
Solent disturbance and mitigation project: Phase I

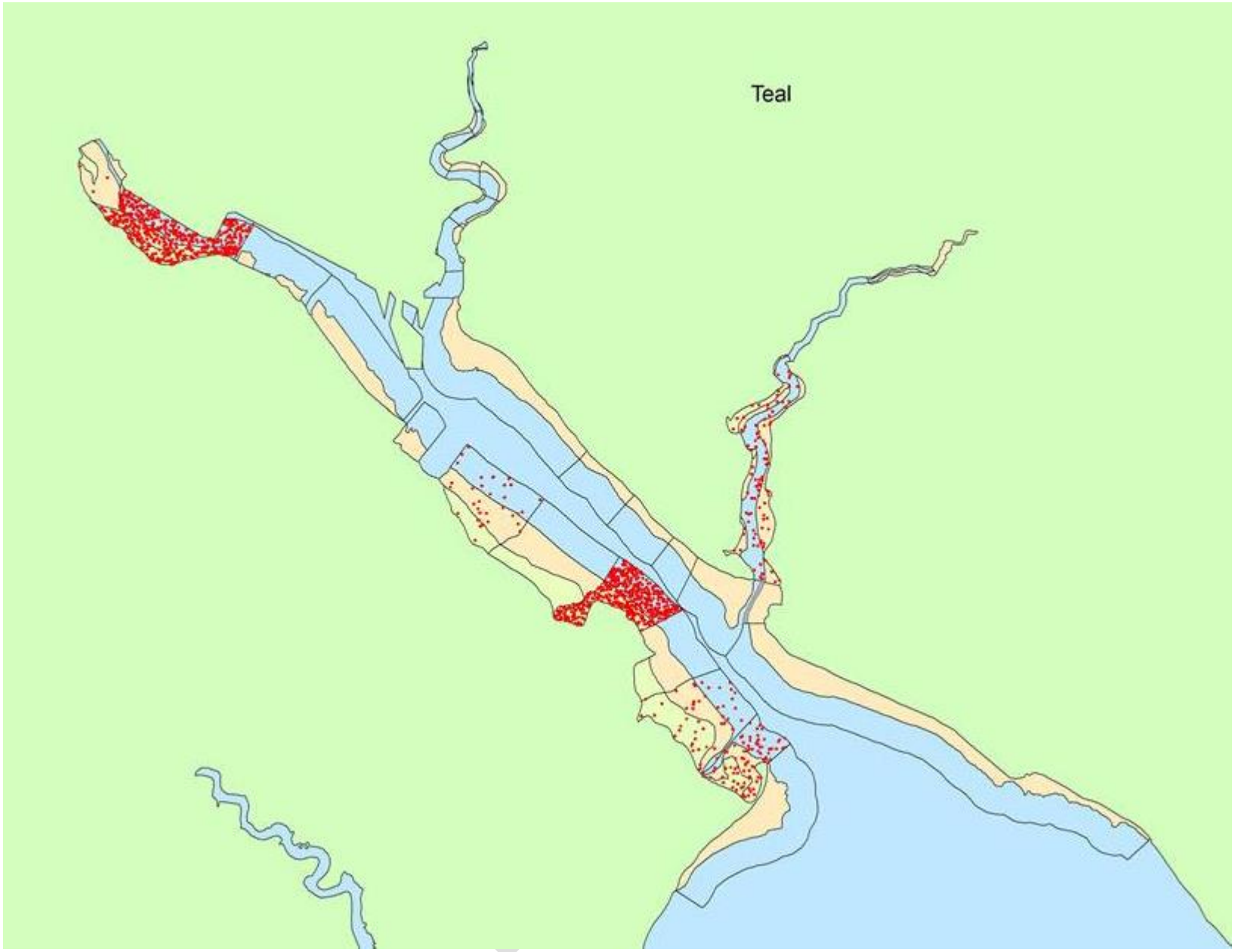


Annex 8: WeBS Low Tide Count (LTC) scheme point data density distribution maps from 2000/01 for Black-tailed godwit, Dark-bellied Brent goose, Ringed plover and Teal in Southampton Water. Taken from http://blx1.bto.org/webs-reporting/?tab=lowtide.


Black-tailed Godwit


Dark-bellied Brent Goose


Ringed Plover


Teal

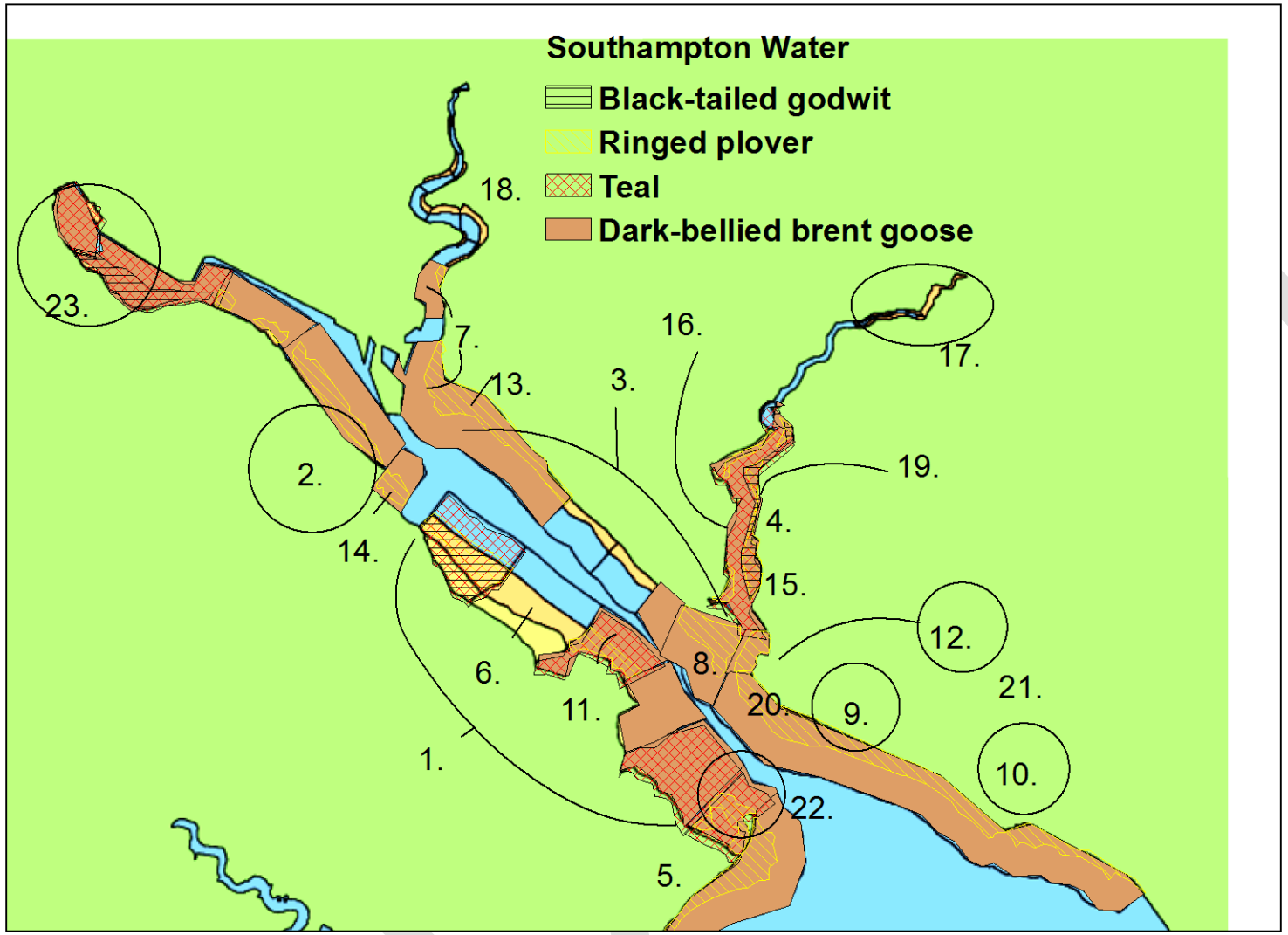
Annex 9: Important Feeding Sites for Overwintering Bird Species within Southampton Water. Taken from the Solent Overwintering Birds Workshop Report (Draft) (Natural England, In Press)

Southampton Water notes (map provided on page 6)

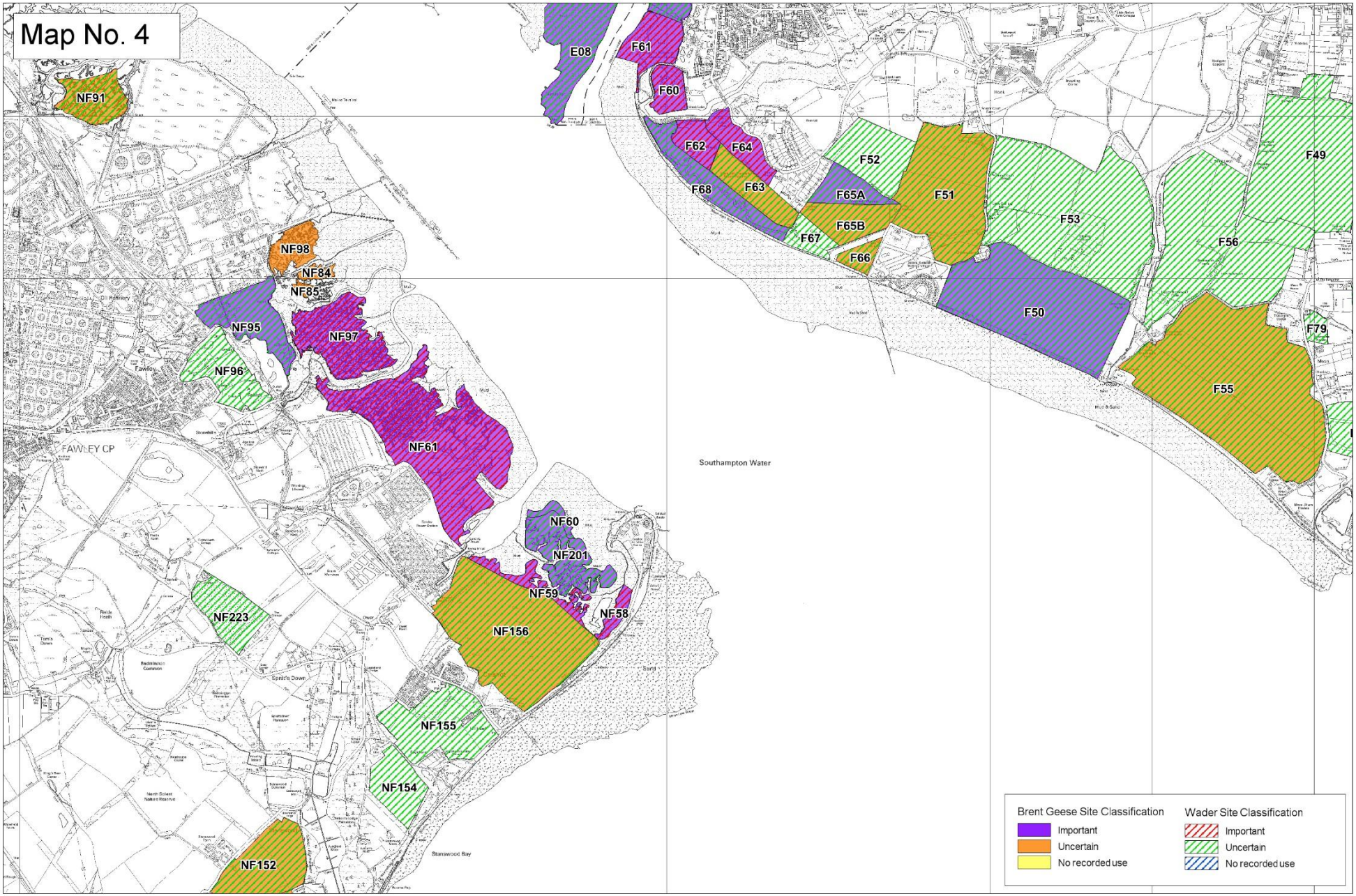
1. Teal more widespread in saltmarsh.
2. Dibden reclaim can be very important for WN & L.
3. Data poor area due to poor access & lots of creeks.
4. Hamble – BW regular.
5. BW regular (50-100).
6. Difficult to view area – saltmarsh.
7. Especially important in February/March and early winter (200+ dark-bellied brent geese).
8. Brent geese use Hamble point mudflat at low tide – cross to east side Hamble at rising tide.
9. Chilling wheatfield (c. 2000 brent geese).
10. Hill Head – very important for brent geese.
11. Ashlett Creek – hot water outlet from petrochemical works.
12. Hook with Warsash Reserve and Titchfield Haven important for teal feeding and roosting.
13. Ringed plover increasing at Weston Shore in recent winters.
14. Ringed plover – some group birds roost at Hythe.

15. Ringed plover - Lower Hamble important in autumn.
16. Black-tailed godwit feeding area – lower Hamble.
17. Black-tailed godwit – use in small numbers during spring.
18. Black-tailed godwit – increasing numbers – new trend in last 5 years, especially in Northam during spring.
19. Black-tailed godwit – roost especially in autumn/winter.
20. Black-tailed godwit – Hook main roost.
21. Black-tailed godwit – Titchfield Haven floods mid-winter and river autumn/winter.
22. Black-tailed godwit – Combe important.
23. Black-tailed godwit – Eling Cut Mash/Bry.

Nb. Passage birds, i.e. ringed plover and curlews not picked up with low tide winter counts, but 500+ ringed plover using the area in August/September. Species such as brent geese, wigeon, black-tailed godwit not recorded but occur in important numbers on adjacent SSSI. Brent geese using Southampton Water/Hamble/Chilling are all one population – proved by colour-ringing by Farlington Ringing Group.

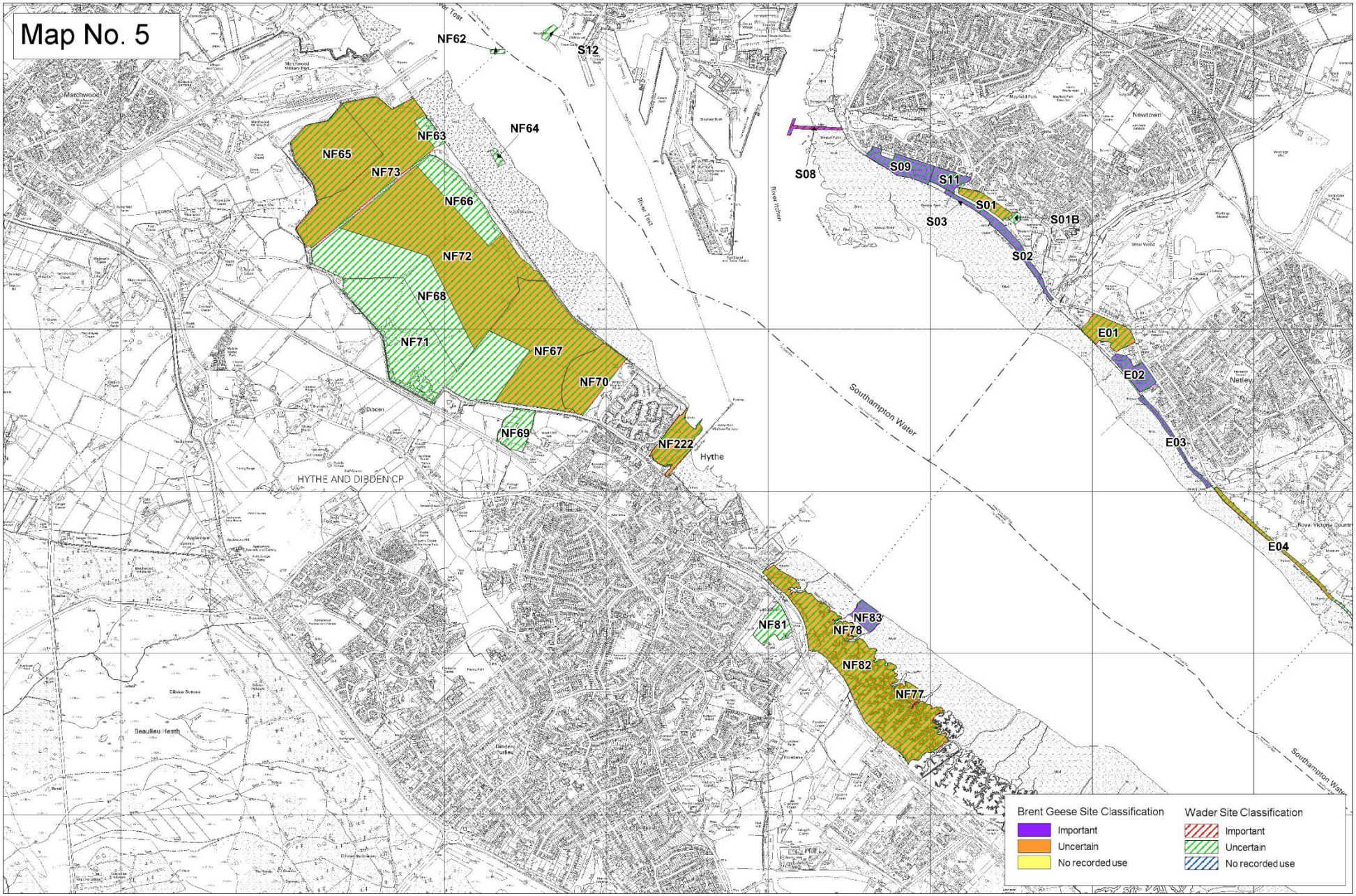

Southampton Water
Black-tailed godwit
Ringed plover
Teal
Dark-bellied brent goose
18.
23.
7.
16.
17.
13.
3.
2.
19.
4.
14.
15.
12.
8.
6.
21.
11.
20.
9.
1.
10.
22.
5.

Annex 10: Bird roosting sites from the Solent Waders and Brent Goose Strategy. Taken from http://www.solentforum.org/forum/sub_groups/Natural_Environment_Group/Waders%20and%20Brent%20Goose%20Strategy/.



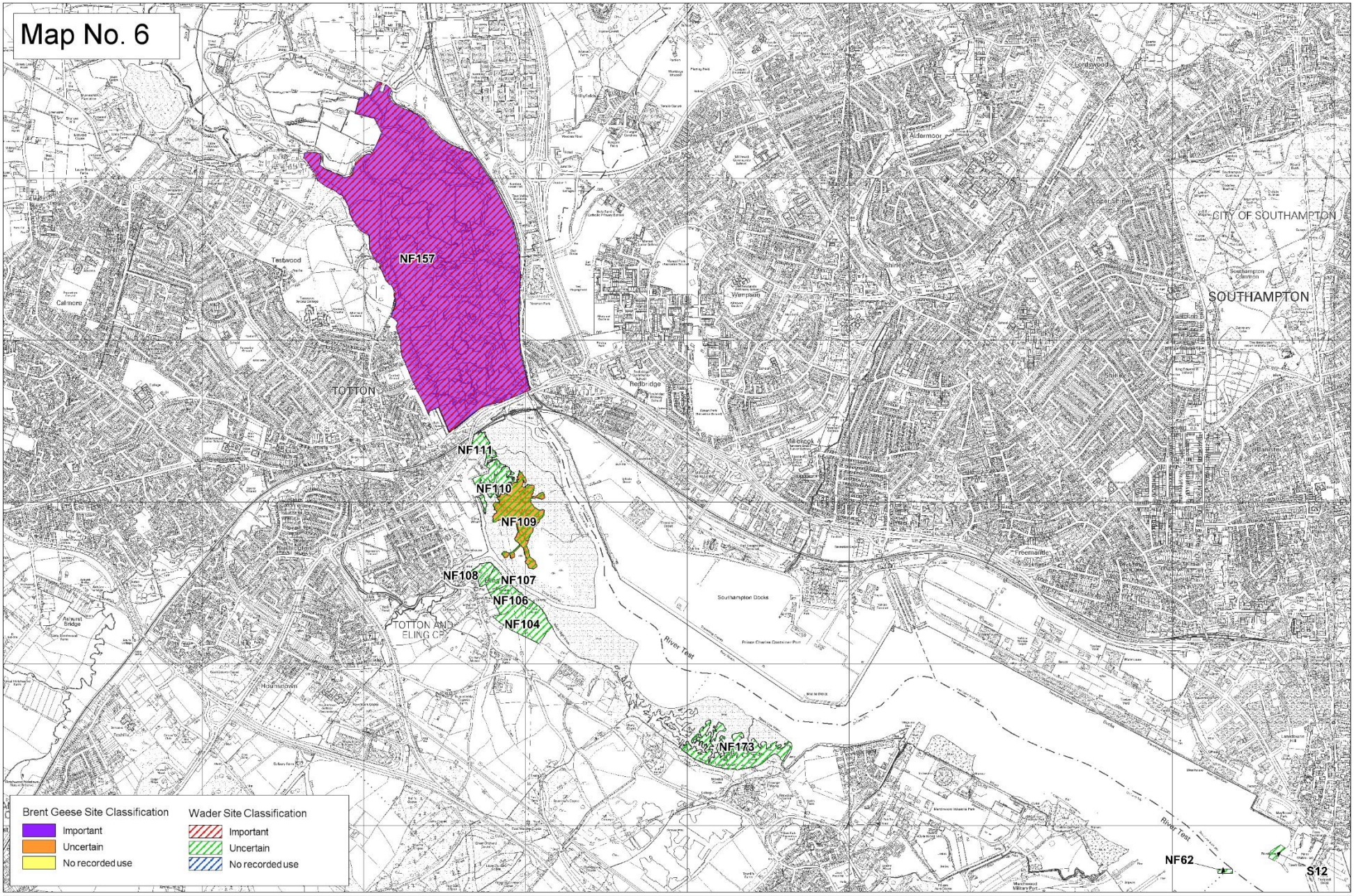
Current Use Analysis: Important Sites for Waders and Brent Geese

N



Current Use Analysis: Important Sites for Waders and Brent Geese

N



Current Use Analysis: Important Sites for Waders and Brent Geese

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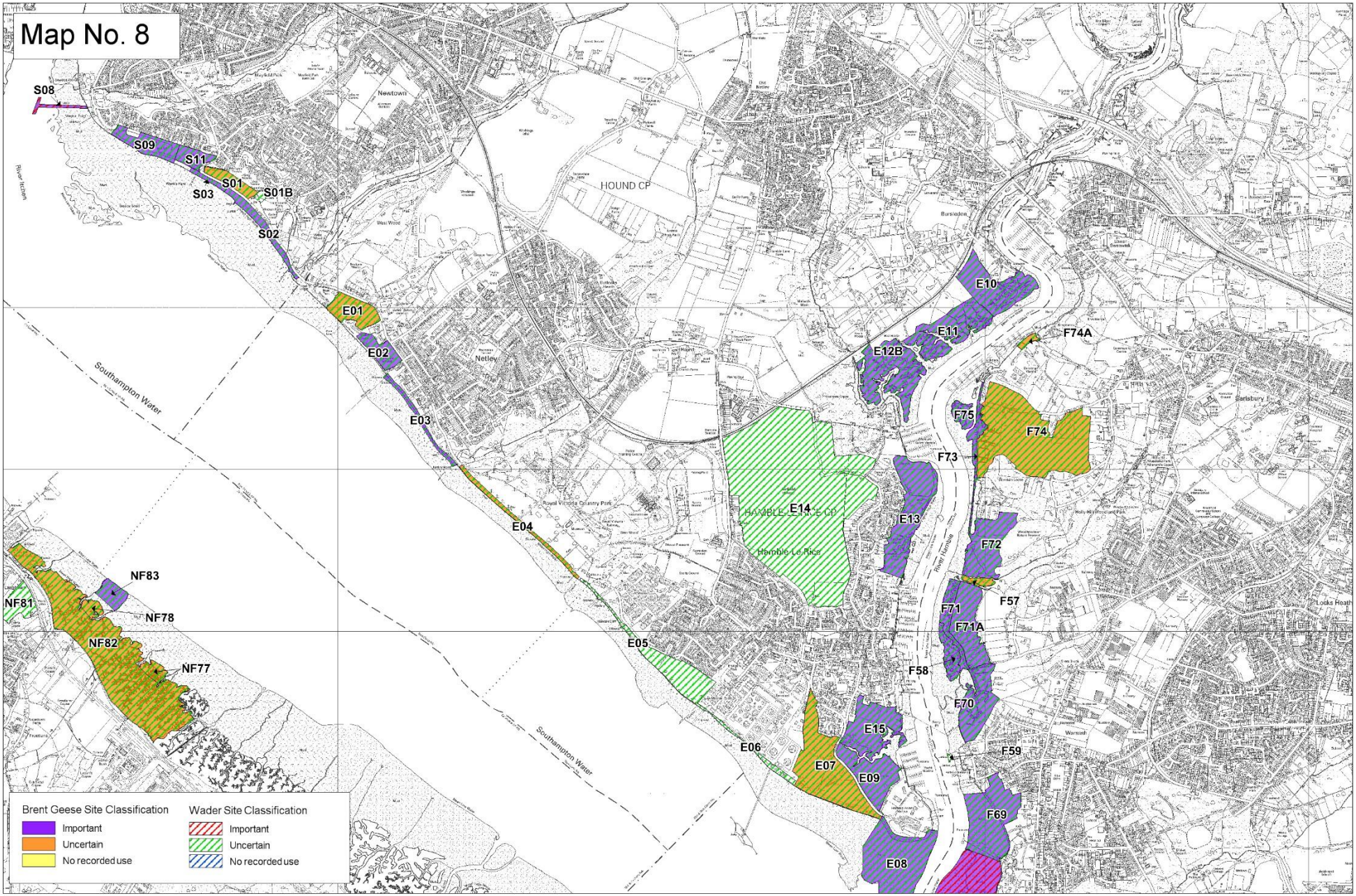

Current Use Analysis: Important Sites for Waders and Brent Geese

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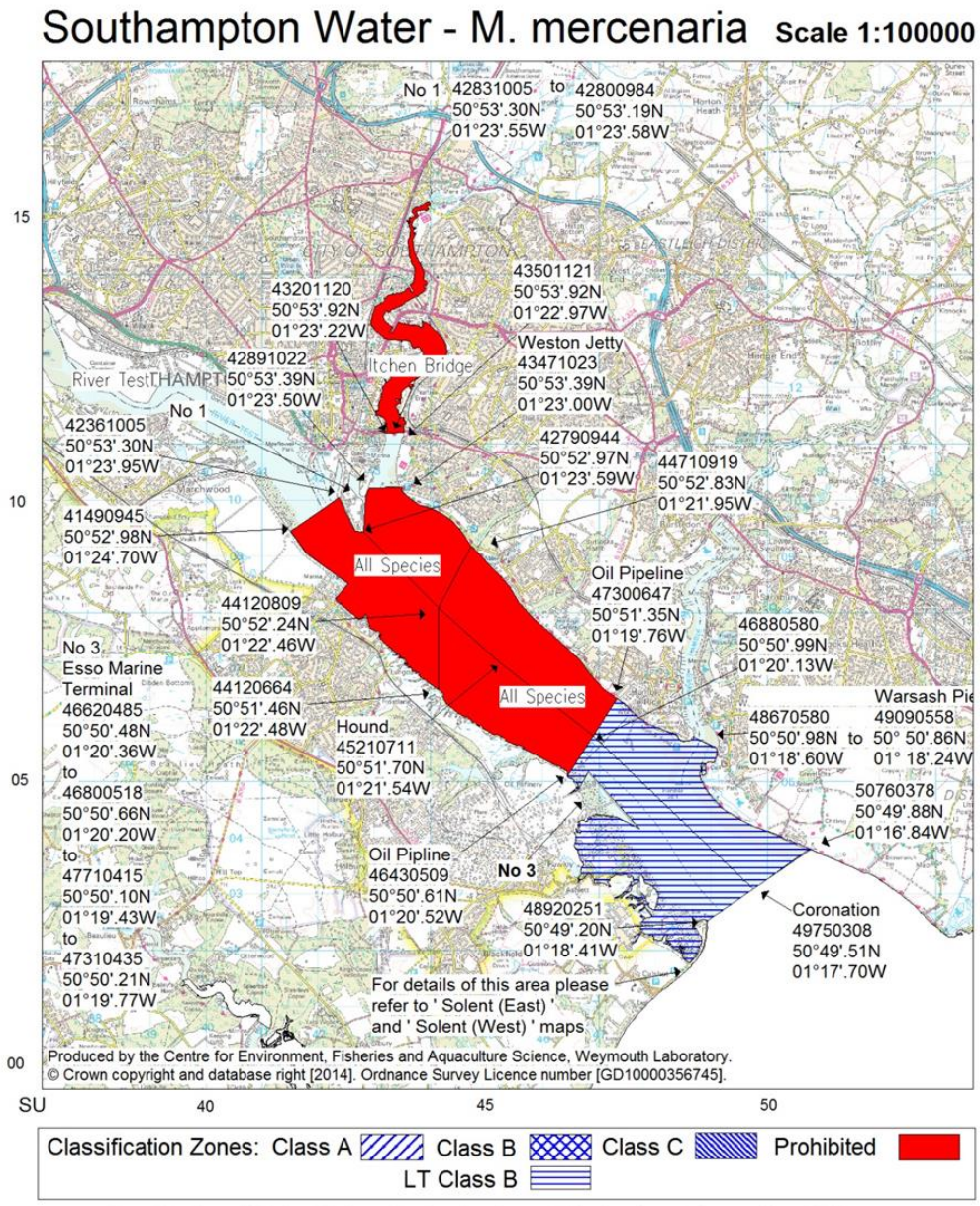
Annex 11: Classification of Bivalve Mollusc Production Areas interacting with the Solent and Southampton Water SPA



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)

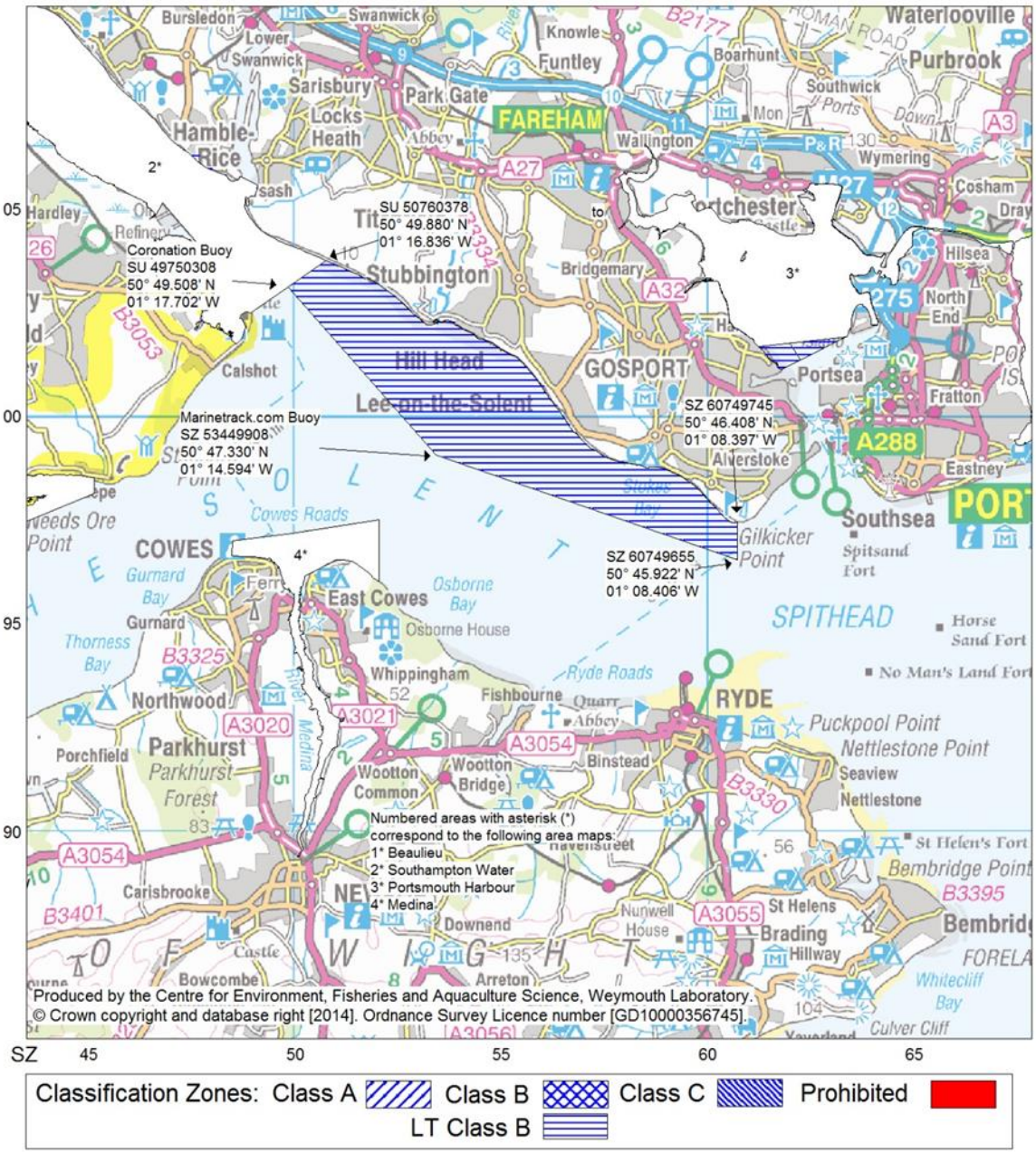
N.B. No harvesting is permitted from Prohibited or unclassified areas i.e. areas that are not shaded to denote class A, B, LT B or C

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

Food Authority: Southampton Port Health Authority

Solent (East) - M. mercenaria

Scale - 1:140000



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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

Annex 12. Table of recovery rates of prey species taken by bird species which may be impacted by changes in prey availability as a result of shellfish dredging in Solent and Southampton Water SPA. Taken from Ferns *et al*., (2000).

Species	% Change After Harvesting – Muddy Sand	% Change After Harvesting – Clean Sand	Recovery Period
Macoma balthica	55%	-6%	0 days (muddy sand) >86 days (clean sand)
Cerastoderma edule	-35%	-15%	>86 days (muddy sand) 0 days (clean sand)
Hediste diversicolor	-	-33%*	-

*Low abundances were found

Annex 13. 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, 88*µ*m) (near to the study area). Silt/clay fraction (<62.5 *µ*m)	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 14. 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 15.

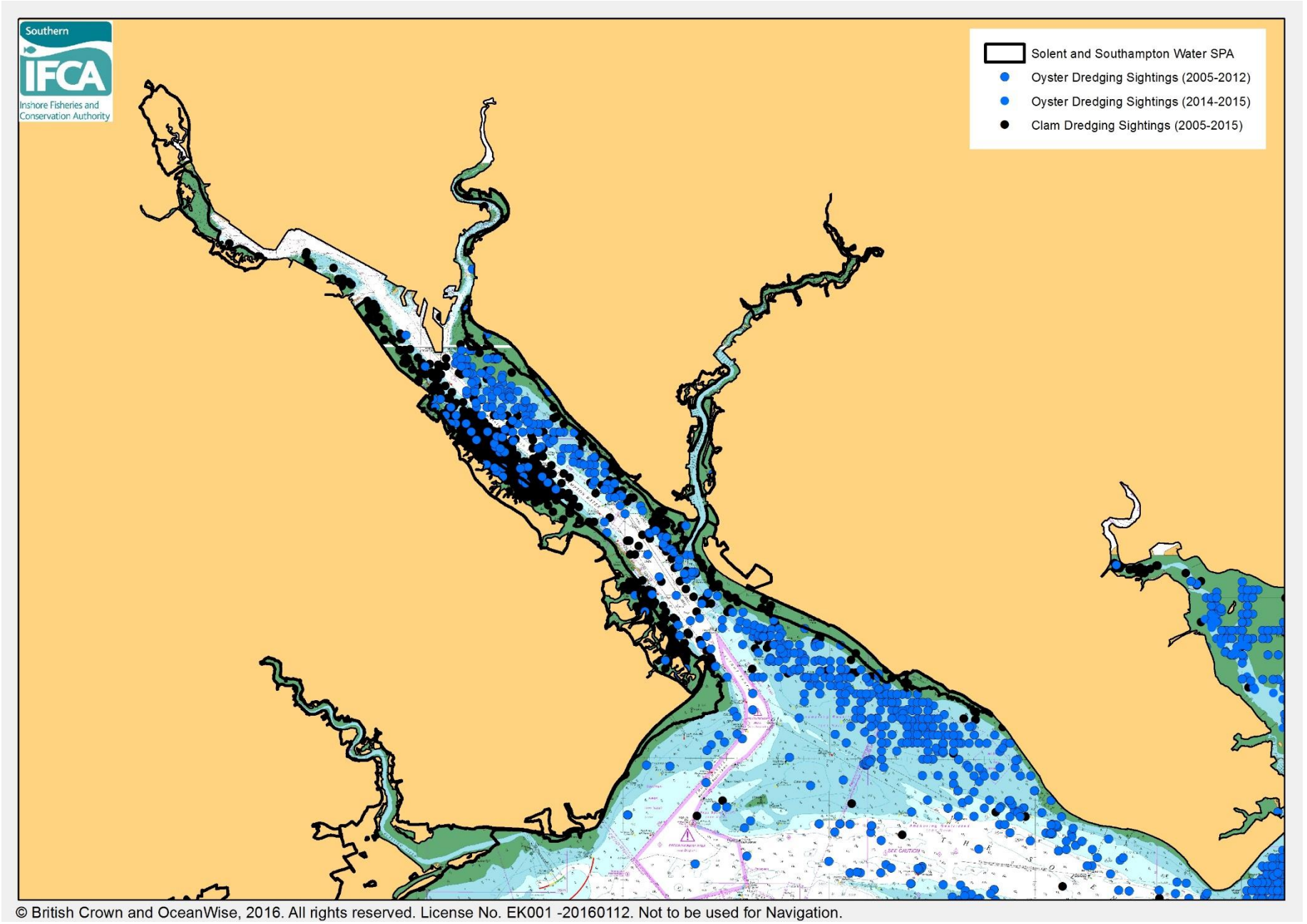
Species	Recolonization Strategy	Reproductive Season	References
Arenicola marina	Above-surface migration	Autumn to winter	McLusky et al. (1983) http://www.marlin.ac.uk/biotic/browse.php?sp=4238
Macoma balthica	Active migration of adults and larval settlement/recolonization	Spring and autumn	http://www.marlin.ac.uk/species/detail/1465 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 15. 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).

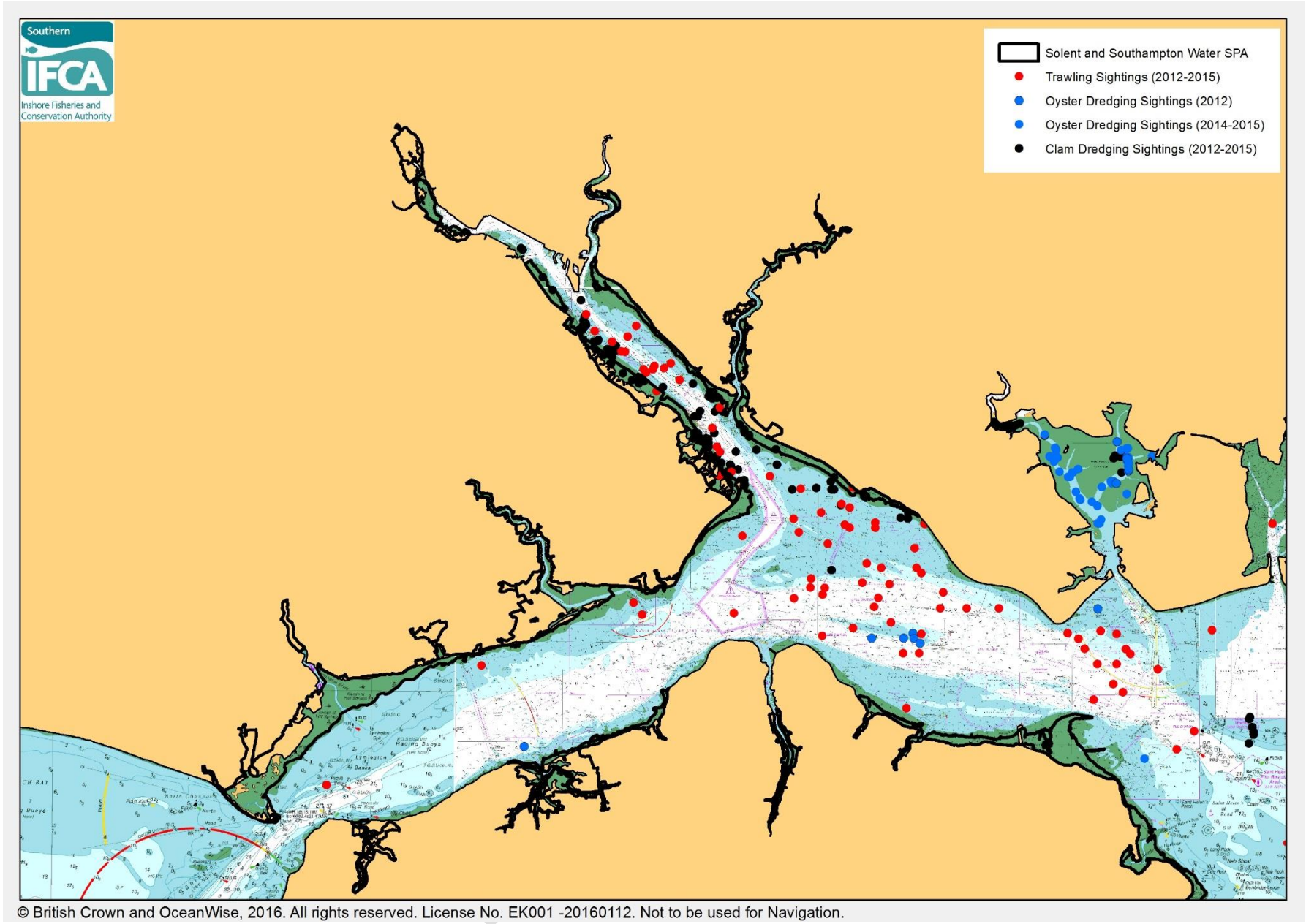
SAC Species from Solent Maritime SAC (Summary of key biotopes for SAC sub-features – Appendix XI):
Pontocrates spp.
Bathyporeia spp.
Lanice conchilega
*Corophium**
*Macoma balthica**
*Arenicola marina**
*Cerastoderma edule**
*Hediste diversicolor** (previously *Nereis diversicolor*)
Mya arenaria
Pygospio 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 16: Co-location of Historic Clam Dredging (2005-2015) and Oyster Dredging (2005-2012, 2014-2015) Sightings in the Southampton Water portion of the Solent and Southampton Water SPA



Annex 17: Co-location of Recent Trawl Sightings (2012-2015), Clam Dredging (2012-2015) Oyster Dredging (2012, 2014-2015) Sightings in the entire Solent and Southampton Water SPA


Southern
IFCA
Inshore Fisheries and Conservation Authority
Solent and Southampton Water SPA
Trawling Sightings (2012-2015)
Oyster Dredging Sightings (2012)
Oyster Dredging Sightings (2014-2015)
Clam Dredging Sightings (2012-2015)
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