Appendix 6: Medium/high-risk pressures

Consideration of "pressures" from the Natural England Advice on Operations for "fishing / demersal trawl" – Medium/high-risk

N.B. There has been no attempt to differentiate between features and sub-features within this section, with all being referred to as features for simplicity. In all cases, only features which have not been screened out for other reasons are included in these assessments.

"Medium / high-risk" is defined within the Advice on Operations matrix as a, "pressure [that] is commonly induced by activity at a level that needs to be considered further as part of an assessment". All interactions considered below are identified as "direct" interactions in the Advice on Operations matrix[1].

Summary of findings

Medium/High-risk pressures that do not need to be addressed further:

- Changes in suspended solids (water clarity)
- Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion
- Removal of target species
- Smothering and siltation rate changes (light)

Medium/High-risk pressures that are addressed further in the document:

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

[1]https://designatedsites.naturalengland.org.uk/Marine/FAPMatrix.aspx?SiteCode=UK0017075&SiteName=wash+and+north+norfolk&SiteNameDisplay=The+Wash+and+North+Norfolk+Coast+SAC&countryCode=&responsiblePerson=&SeaArea=&IFCAArea= , accessed 24 July 2017

Format for completion of examinations:

From "Advice on Operations" webpage https://designatedsites.naturalengland.org.uk/Marine/FAPMatrix.aspx?SiteCode=UK0017075&SiteName=wash+and+north+norfolk&SiteNameDisplay=The+Wash+and+North+Norfolk+Coast+SAC&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=	
Pressure	Copied from within the pop-up window generated by clicking on e.g. an "S" in the "Advice on Operations" table
Pressure Description Copied from within the pop-up window generated by clicking on e.g. an "S" in the "Advice on Operations" table	
Pressure Benchmark Copied from within the pop-up window generated by clicking on e.g. an "S" in the "Advice on Operations" table	
Activity Pressure Justification Copied from within the pop-up window generated by clicking on a Pressure name in the "Advice on Operations" table	
Pressure considered "Not Relevant" for features – Extracted from the "Advice on Operations" table	
Insufficient Evidence for the features – Extracted from the "Advice on Operations" table	
Features considered Not Sensitive to the pressure – Extracted from the "Advice on Operations" table	
Features considered Sensitive to the pressure – Extracted from the "Advice on Operations" table	
Discussion (this section generated by Eastern IFCA) Generated by Eastern IFCA, considering the magnitude and form of the pressure generated by shrimp beam trawling and the sensitivities of the feature under consideration, including where appropriate consideration of specific biotopes which make up the feature (obtained by clicking on "S" in the "Advice on Operations" table, and then clicking on the number in the "Relevant Biotopes" section of that pop-up)	

Conclusion

Conclusion on whether adverse effect on site integrity can be ruled out for this pressure, or whether there is a need to consider this pressure further. If so, an assessment as to -

- Which aspects of the pressure
- Which biotopes making up the feature
- Which effects to consider

are of relevance.

“Medium / High” Pressures

From “Advice on Operations” webpage	
Pressure	**Abrasion/disturbance of the substrate on the surface of the seabed**
Pressure Description Physical disturbance or abrasion at the surface of the substratum in sedimentary or rocky habitats. The effects are relevant to epiflora and epifauna living on the surface of the substratum. In intertidal and sublittoral fringe habitats, surface abrasion is likely to result from recreational access and trampling (inc. climbing) by human or livestock, vehicular access, moorings (ropes, chains), activities that increase scour and grounding of vessels (deliberate or accidental). In the sublittoral, surface abrasion is likely to result from pots or creels, cables and chains associated with fixed gears and moorings, anchoring of recreational vessels, objects placed on the seabed such as the legs of jack-up barges, and harvesting of seaweeds (e.g. kelps) or other intertidal species (trampling) or of epifaunal species (e.g. oysters). In sublittoral habitats, passing bottom gear (e.g. rock hopper gear) may also cause surface abrasion to epifaunal and epifloral communities, including epifaunal biogenic reef communities. Activities associated with surface abrasion can cover relatively large spatial areas e.g. bottom trawls or bio-prospecting or be relatively localized activities e.g. seaweed harvesting, recreation, potting, and aquaculture. **(Description as above in Advice on Operations table (Abrasion / Disturbance) for all features under consideration here)**	
Pressure Benchmark Damage to surface features (e.g. species and physical structures within the habitat)	
Activity Pressure Justification The pressure results where the gear makes contact with the seafloor. The area affected is determined by the footprint of the gear and the amount of movement across the seabed. The different gear components will make variable contributions to the total physical disturbance of the seabed and its associated biota, and hence the pressure will vary according to factors such as gear type, design/modifications, size and weight, method of operation (including towing speed) and habitat characteristics (e.g. topography). • Lart, 2012 • Polet and Depestele, 2010 • Suuronen et al., 2012	

Towed bottom fishing gears are used to catch species that live in, on or in association with the seabed and therefore are designed to remain in close contact with the seabed. That interaction with the seabed can lead to disturbance of the upper layers of the seabed (e.g. see pressures 'Siltation rate changes (low'), 'Changes in suspended solids'); direct removal (e.g. see pressures 'Removal of target species', 'Removal of non-target species'), damage, displacement or death of the benthic flora and fauna; short-term attraction of scavengers; and the alteration of habitat structure (e.g. flattening of wave forms, removal of rock, removal of structural organisms).

- Kaiser et al., 2001
- Gubbay and Knapman, 1999
- Sewell and Hiscock, 2005
- Collie et al., 2000
- Kaiser et al., 2002

As a relative comparison of gear types, otter trawls tend to have less physical impact on the seafloor than the notoriously damaging beam trawls *(see Footnote 1)* (and dredges) with their heavy tickler chains, although the doors of an otter trawl do create recognisable scour of the seabed.

- Hinz et al., 2012
- Polet and Depestele, 2010
- Lart, 2012
- Paschen et al., 2000

The magnitude of the immediate response to fishing disturbance, cumulative effects and recovery times varies significantly according to factors such as the type of fishing gear and fishing intensity, the habitat and sediment type, levels of natural disturbance and among different taxa

- Collie et al., 2000
- Boulcott et al., 2014
- Kaiser et al., 2006
- Hinz et al., 2009
- Kaiser et al., 2001

Pressure considered "Not Relevant" for features –

- Harbour seal
- Water column

Insufficient Evidence for the features –

Features considered Not Sensitive to the pressure –

Features considered Sensitive to the pressure –

- Intertidal biogenic reef: mussel beds
- Intertidal coarse sediment

- Intertidal mud
- Intertidal sand and muddy sand
- Subtidal biogenic reefs: mussel beds
- Subtidal coarse sediment
- Subtidal mixed sediments
- Subtidal mud
- Subtidal sand

Footnote 1

The information within the “Activity Pressure Justification” section of the Natural England “Advice on Operations” webpage contains the statement “*the notoriously damaging beam trawls (and dredges) with their heavy tickler chains*”. It should be noted that the beam trawl gear used by the Wash shrimp fishing fleet is appreciably lighter in overall weight than beam trawl gear used in finfish fisheries (see section 3.1.1 of this assessment), and the Wash fleet do not routinely use tickler chains. Both of these facts can be attributed to the fact that the shrimp fishers are attempting to catch a species which is above (whether only slightly when walking, or a little more when swimming) the seabed, rather than dislodging or digging out a buried species, such as occurs in flatfish beam trawling.

Discussion (this section generated by Eastern IFCA)

Whilst there is extensive scientific literature relating to the impact of beam trawling on seabed habitats and communities (as set out in the conservation advice above), there is very little literature relating specifically to the impact of *shrimp* beam trawling. An EU document on the North Sea Brown Shrimp fisheries (Aviat *et al* 2011), of which the UK fishery forms only 2%, reported that the effect of shrimp trawls on the sea bed is negligible. This reflects that shrimp beam trawls are designed to target shrimps above the surface of the sea bed, compared with finfish beam trawling that is designed to displace fish from the seabed itself.

However, Eastern IFCA has assessed that shrimp beam trawling is likely to result in some level of abrasion of the seabed, primarily through contact with shrimp trawl shoes (which support the beam), and to a lesser extent through contact between the net and rollers (if used). The extent of the abrasion impact has therefore been considered in more detail. Due to the complexity of this interaction it is not feasible to present all the information within this format. Please see Section 5.1.3 for full consideration of this pressure.

Conclusion

Cannot rule out adverse effect on site integrity from abrasion pressure at this stage.

From “Advice on Operations” webpage	
Pressure	**Changes in suspended solids (water clarity)**
Pressure Description Changes water clarity (or turbidity) due to changes in sediment & organic particulate matter and chemical concentrations. It is related to activities disturbing sediment and/or organic particulate matter and mobilizing it into the water column. It could be 'natural' land run-off and riverine discharges or from anthropogenic activities such as all forms of dredging, disposal at sea, cable and pipeline burial, secondary effects of construction works, e.g. breakwaters. Particle size, hydrological energy (current speed & direction) and tidal excursion are all influencing factors on the spatial extent and temporal duration. Salinity, turbulence, pH and temperature may result in flocculation of suspended organic matter. Anthropogenic sources are mostly short lived and over relatively small spatial extents. Changes in suspended sediment loads can also alter the scour experienced by species and habitats. Therefore, the effects of scour are also addressed here. **(Description as above in Advice on Operations table (Changes in suspended solids (water clarity)) for all features under consideration here)**	
Pressure Benchmark A change in one Water Framework Directive (WFD) ecological status class for one year within site.	
Activity Pressure Justification This pressure may result from physical disturbance of the sediment, along with hydrodynamic action caused by the passage of towed gear, leading to entrainment and suspension of the substrate behind and around the gear components • Sewell et al., 2007 • Gubbay and Knapman, 1999 • Lart, 2012 • Kaiser et al., 2002 • Riemann and E, 1991 • O'Neill et al., 2008 • Dale et al., 2011 • O’Neill and Summerbell, 2011 . The quantity of suspended material and its spatial and temporal persistence will depend on factors associated with the gear (such as type/design, weight, towing speed), sediment (particle size, composition, compactness), the intensity of the activity and the background hydrographic conditions • Sewell et al., 2007	

- Kaiser et al., 2002
- Dale et al., 2011
- O’Neill and Summerbell, 2011

. Turbid plumes can reduce light levels and smother feeding and respiratory organs. Prolonged exposure to the pressure may result in changes in sediment composition through suspension and transport of finer material. There are also concerns over resuspension of phytoplankton cysts and copepod eggs

- Kaiser et al., 2001
- Sewell et al., 2007
- Gubbay and Knapman, 1999
- Kaiser et al., 2002
- O’Neill and Summerbell, 2011

. Further effects are also considered under the pressures: Deoxygenation, Nutrient enrichment and Organic enrichment.

Pressure considered “Not Relevant” for features –

- Harbour seal

Insufficient Evidence for the features –

Features considered Not Sensitive to the pressure –

- Intertidal biogenic reef: mussel beds
- Subtidal biogenic reefs: mussel beds
- Subtidal mixed sediments

Features considered Sensitive to the pressure –

- Intertidal coarse sediment
- Intertidal mud
- Intertidal sand and muddy sand
- Subtidal coarse sediment
- Subtidal mud
- Subtidal sand
- Water column

Discussion (this section generated by Eastern IFCA)

The WFD ecological status class for “Wash Outer” has been “Moderate” in every year from 2009 to 2016. That for “Wash Inner” was “Moderate” in 2009, becoming “Bad” in 2010 and 2011, and subsequently reverting to “Moderate” for every year up to and including 2016. Therefore, the pressure benchmark of “*A change* (presumably a decline, to indicate a negative impact) *in one Water Framework Directive (WFD) ecological status class for one year within site*.” has not occurred in recent years.

The Wash is highly dynamic, with large amount of sediment being moved into, out of and around The Wash by tidal currents. The National Rivers Authority "Wash Zone Report" (NRA, 1994) identifies that 30,000 to 120,000 tonnes of sediment flux through The Wash on every tidal cycle, depending on the state of the tide. Ke *et al* (1996) suggested that 6.8 million tonnes of suspended sediment are supplied to The Wash every year from offshore sources, with an additional 14,000 tonnes being supplied by bedload transport. The same paper records a maximum suspended solids concentration of 1000 – 1500 mg/L (1-1.5 kg/m^3), the highest concentrations being found in the river channels and inshore areas, and lower concentrations towards the mouth of The Wash. In contrast, Tattersall, Elliott and Lynn (2003) examined the Tamar estuary (an estuary with a relatively low sediment load), identifying depth-averaged concentrations of 0.25-0.40 kg/m^3. The variable nature of sediment loads in UK estuaries and bays, and consequently the ability of the ecosystem to respond to changes in these levels, is reported in the "UK Marine SACs Project" website section "Dredging and disposal: Suspended sediments and turbidity", which states "*Background suspended solid and turbidity levels in marine SACs are highly variable. In many estuaries and bays background turbidity levels are high, such as the Wash, the Severn, the Dee and the Mersey (Parr et al., 1998). Organisms in these environments are able to tolerate continuous exposure to high suspended sediment concentrations, for much longer than would occur in most dredging operations (IADC/CEDA 1998; Peddicord & McFarland 1978; Stern & Stickle 1978).*" (Web Ref 1) Dellapenna *et al*. (2006), examining the re-settlement of sediment resulting from the passage of a shrimp otter trawl on muddy ground in Galveston Bay, Texas, recorded that sediment concentrations returned to background levels approximately 14 minutes after passage of the trawl.
Conclusion Set against the naturally high background levels of suspended sediment in The Wash, there is no reasonable likelihood that the amounts of sediment raised by the shrimp fishing activity could have a significant effect. The Water Framework Directive classification is within the limits set out by the Pressure Benchmark. Elevated levels of sediment caused by the passage of shrimp beam trawl gear are likely to be short term (Dellapenna *et al*., 2006), and of lesser duration and magnitude than the organisms are adapted to (UK SAC website, Web Ref 1). Therefore, it is not considered that the pressure "Changes in suspended solids (water clarity)" needs to be addressed further in this assessment. **There is no adverse effect on site integrity from changes in suspended solids (water clarity)**

From “Advice on Operations” webpage	
Pressure	**Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion**
Pressure Description Physical disturbance of sediments where there is limited or no loss of substratum from the system. This pressure is associated with activities such as anchoring, taking of sediment/geological cores, cone penetration tests, cable burial (ploughing or jetting), propeller wash from vessels, certain fishing activities, e.g. scallop dredging, beam trawling. Agitation dredging, where sediments are deliberately disturbed by and by gravity & hydraulic dredging where sediments are deliberately disturbed and moved by currents could also be associated with this pressure type. Compression of sediments, e.g. from the legs of a jack-up barge could also fit into this pressure type. Abrasion relates to the damage of the sea bed surface layers (typically up to 50cm depth). Activities associated with abrasion can cover relatively large spatial areas and include: fishing with towed demersal trawls (fish & shellfish); bio-prospecting such as harvesting of biogenic features such as maerl beds where, after extraction, conditions for recolonization remain suitable or relatively localized activities including: seaweed harvesting, recreation, potting, aquaculture. Change from gravel to silt substrata would adversely affect herring spawning grounds. Loss, removal or modification of the substratum is not included within this pressure (see the physical loss pressure theme). Penetration and damage to the soft rock substrata are considered, however the penetration into hard bedrock is deemed unlikely. **(Description as above in Advice on Operations table (Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion) for all features under consideration here)**	
Pressure Benchmark Damage to sub-surface features (e.g. species and physical structures within the habitat)	
Activity Pressure Justification The pressure results where the gear makes contact with the seafloor. The area affected is determined by the footprint of the gear and the amount of movement across the seabed. The different gear components will make variable contributions to the total physical disturbance of the seabed and its associated biota, and hence the pressure will vary according to factors such as gear type, design/modifications, size and weight, method of operation (including towing speed) and habitat characteristics (e.g. topography) • Lart, 2012 • Polet and Depestele, 2010	

- Suuronen et al., 2012

Towed bottom fishing gears are used to catch species that live in, on or in association with the seabed and therefore are designed to remain in close contact with the seabed. That interaction with the seabed can lead to disturbance of the upper layers of the seabed (e.g. see pressures ‘Siltation rate changes (low’), ‘Changes in suspended solids’); direct removal (e.g. see pressures ‘Removal of target species’, ‘Removal of non-target species’), damage, displacement or death of the benthic flora and fauna; short-term attraction of scavengers; and the alteration of habitat structure (e.g. flattening of wave forms, removal of rock, removal of structural organisms)

- Kaiser et al., 2001
- Gubbay and Knapman, 1999
- Sewell and Hiscock, 2005
- Collie et al., 2000
- Kaiser et al., 2002

As a relative comparison of gear types, otter trawls tend to have less physical impact on the seafloor than the notoriously damaging beam trawls (and dredges). The heavy tickler chains of beam trawls can penetrate up to 8 cm into the seabed *(see Footnote 1)*, whereas it is the trawl door of an otter trawl that creates the greatest amount of scour of the seabed

- Hinz et al., 2012
- Polet and Depestele, 2010
- Lart, 2012
- Paschen et al., 2000

The magnitude of the immediate response to fishing disturbance, cumulative effects and recovery times varies significantly according to factors such as the type of fishing gear and fishing intensity, the habitat and sediment type, levels of natural disturbance and among different taxa

- Collie et al., 2000
- Boulcott et al., 2014
- Kaiser et al., 2006
- Hinz et al., 2009
- Kaiser et al., 2001

Pressure considered “Not Relevant” for features –

- Harbour seal
- Water column

Insufficient Evidence for the features –

Features considered Not Sensitive to the pressure –

Features considered Sensitive to the pressure –

- Intertidal biogenic reef: mussel beds
- Subtidal biogenic reefs: mussel beds
- Subtidal mixed sediments
- Intertidal coarse sediment
- Intertidal mud
- Intertidal sand and muddy sand
- Subtidal coarse sediment
- Subtidal mud
- Subtidal sand

Footnote 1

The information within the "Activity Pressure Justification" section of the Natural England "Advice on Operations" webpage contains the statement "…*the notoriously damaging beam trawls (and dredges). The heavy tickler chains of beam trawls can penetrate up to 8 cm into the seabed* …". It should be noted that the beam trawl gear used by the local fleet is appreciably lighter in overall weight than beam trawl gear used in finfish fisheries, and the local fleet do not routinely use tickler chains. Both of these facts can be attributed to the fact that the shrimp fishers are attempting to catch a species which is above (whether only slightly when walking, or a little more when swimming) the seabed, rather than dislodging or digging out a buried species such as the flatfish beam trawls use.

Discussion (this section generated by Eastern IFCA)

This pressure relates specifically to disturbance of substratum below the surface, caused by penetration or compression. The Pressure Description identifies a typical penetration depth of 50 cm for this pressure.

The light weight beam trawls used for shrimp fishing in The Wash do not penetrate the seabed to anything like the depth identified within the Pressure Benchmark, with maximum penetrations from the shoes of the order of 2.5 cm (Eastern IFCA, Senior IFCO, *Pers. comm.*). It has been judged appropriate to assess this low level of penetration within the pressure category "abrasion/disturbance of the substrate on the surface of the seabed".

Catchpole *et al*. (2008) examined the bycatch from shrimp beam trawls within The Wash. A species list for the bycatch, and the classification of these species by lifestyle type, is presented below. There are no infaunal species represented within this list, indicating that the fishing gear was not penetrating to any significant extent below the seabed.

Species	Type

Carcinus maenas	Shore crab	Epibenthic
Liocarcinus spp.	Swimming crab	Epibenthic
Asterias rubens	Starfish	Epibenthic
Ophiothrix fragilis	Brittlestar	Epibenthic
Macropodia spp.	Tiny spider crab	Epibenthic
Pomotoschistus minutus	Sand goby	Fish
Pleuronectes platessa	Plaice	Fish
Merlangius merlangus	Whiting	Fish
Clupea harengus	Herring	Fish
Limanda limanda	Dab	Fish
Sprattus sprattus	Sprat	Fish
Agonus cataphractus	Pogge	Fish
Osmerus eperlanus	Smelt	Fish
Gadus morhua	Cod	Fish
Syngnathidae	Pipefish	Fish
Platichthys flesus	Flounder	Fish
Pegusa lascaris	Sand sole	Fish
Liparis liparis	Sea-snail	Fish
Taurulus spp.	Scorpion fish	Fish
Dicentrarchus labrax	Bass	Fish
Echiichthys vipera	Lesser weaver	Fish
Solea solea	Sole	Fish
Ciliata mustela	5 bearded rockling	Fish
Raja clavata	Thornback ray	Fish
Lycodes esmarkii	Eelpout	Fish
Sepiola atlantica	Little cuttlefish	Free swimming

Conclusion

There is very little likelihood of the light weight shrimp beam trawl gear, as used in The WNNC SAC, penetrating the seabed to a level approaching that in the Description for this pressure. This is borne out by the absence of infaunal species in a controlled examination of bycatch from the fishery.

Therefore, it is not considered that the pressure “Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion” needs to be addressed further in this assessment.

No adverse effect on site integrity from Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion.

Note that shallow penetration (as caused by the shrimp fishery) is considered within the assessment of the pressure “abrasion/disturbance of the substrate on the surface of the seabed”.

From “Advice on Operations” webpage	
Pressure	**Removal of non-target species**

Pressure Description

For all features EXCEPT Harbour Seals & Water Column -

By-catch associated with all fishing, harvesting and extraction activities. Ecological consequences include food web dependencies, population dynamics of fish, marine mammals, turtles and sea birds (including survival threats in extreme cases, e.g. Harbour Porpoise in Central and Eastern Baltic). The physical effects of fishing gear on sea bed communities are addressed by the "abrasion" pressure type so the pressure addresses the direct removal of individuals associated with fishing/ harvesting.

- Intertidal biogenic reef: mussel beds
- Intertidal coarse sediment
- Intertidal mud
- Intertidal sand and muddy sand
- Subtidal coarse sediment
- Subtidal mud
- Subtidal sand
- Subtidal mixed sediments

For Harbour Seals –

This pressure addresses the effects caused by fishing, hunting or harvesting of marine resources including direct removal of individuals and physical resources (e.g. aggregates, cooling water, etc.). Ecological consequences include food web dependencies, population dynamics of fish, marine mammals, turtles and sea birds (including survival threats in extreme case). Includes entrapment in static fishing gear and power plants as a form of by-catch on aquatic fauna.

For Water Column –

By-catch associated with all fishing, harvesting and extraction activities. Ecological consequences include food web dependencies, population dynamics of fish, marine mammals, turtles and sea birds (including survival threats in extreme cases, e.g. Harbour Porpoise in Central and Eastern Baltic). The physical effects of fishing gear on sea bed communities are addressed by the "abrasion" pressure type so the pressure addresses the direct removal of individuals associated with fishing/ harvesting.

Pressure Benchmark

For all features EXCEPT Harbour Seals & Water Column -

Removal of species present in the biotope by incidental non-targeted catch (by-catch) through a targeted fishery, shellfishery or harvesting at a commercial or recreational scale.

For Harbour Seals –

The introduction of bycatch risk in areas used by features

For Water Column –

Removal of species present in the biotope by incidental non-targeted catch (by-catch) through a targeted fishery, shellfishery or harvesting at a commercial or recreational scale.

Activity Pressure Justification

For all features EXCEPT Harbour Seals & Water Column -

Bycatch (i.e. discarded catch) is associated with almost all fishing activities and is related to factors such as the gear type and its design (i.e. its selectivity), the targeted species and effort. There are significant concerns over the impacts of discards on marine ecosystems, including changes in population abundance and demographics of affected species and altered species assemblages and food web structures

- Alverson et al., 1994
- Kaiser et al., 2001

. However, discards also provide important food resources for some scavenging species, including seabirds

- Heath et al., 2014
- Jennings and Kaiser, 1998

. Mixed-species and shrimp/prawn demersal trawl fisheries are associated with the highest rates of discarding and pose the most complex problems to resolve

- Alverson et al., 1994
- Feekings et al., 2012
- Catchpole et al., 2005

. Benthic trawls most frequently result in bycatch of fish, crustaceans and other invertebrates and less frequently turtles and birds

- Gubbay and Knapman, 1999
- Sewell and Hiscock, 2005
- ICES (International Council for Exploration of the Sea), 2013
- Pierpoint, 2000
- Bergmann and Moore, 2001
- Catchpole et al., 2005
- Tulp et al., 2005

For Harbour Seals –

Between 1975 and 1998, 630 harbour seal pups were tagged along the Norwegian coast, and 80 (13%) harbour seal tags were returned. Incidental mortality, mainly in bottom-set nets, accounted for the majority of deaths (48% of individuals). Seals were most vulnerable to incidental mortality in fishing gear during the first three months after birth, but high incidental mortality prevailed during the first 8–10 months (Bjørge et al. 2002). Patterns of stranding and causes of death of 286 stranded harbour seals on the Dutch coast were analysed over a 30-year period (1979–2008) (Osinga et al. 2012). Besides phocine distemper, the next most common cause of death for harbour seals was bycatch (19% of mortalities). Research on marine bycatch has largely focused on quantifying mortality and less is known about sublethal effects, including the potential for behavioural alterations, physiological and energetic costs, and associated reductions in feeding, growth, or reproduction (i.e. fitness) (Wilson et al. 2014). It is currently unknown, however, whether sublethal effects can have significant consequences at the population- or ecosystem-level (Wilson et al. 2014).

For Water Column –

JUSTIFICATION ONLY RELEVANT TO BIRDS: Surface-feeding seabirds such as common tern (Sterna hirundo) are dependent on biological and physical processes affecting prey availability close to the surface of the water (Schwemmer et al, 2009). Food availability affects breeding success of seabirds including the number of pairs breeding, laying dates, clutch sizes and fledging success (Bolton, Houston & Monaghan, 1992; Mills et al, 2008; Szostek et al, 2014). A number of fish species that surface-feeding birds such as terns feed on include commercially relevant species such as clupeids and gadids (Bugoni & Vooren, 2004; Robinson & Hamer, 2000) as well as industrially-fished species such as sandeels (Robinson & Hamer, 2000); changes in their populations as a result of removal via commercial fishery practices as either target species or non-target species (i.e. by-catch) could limit the availability of food to terns and similar seabirds (Furness, 2003; Bugoni & Vooren, 2004). The true impact of fishing on seabirds populations in terms of removal of prey species is difficult to measure (Robinson & Hamer, 2000; Furness, 2003). However, a number of seabirds utilise fisheries discards including lesser black-backed gulls, often found in large numbers around vessels (Valeiras, 2003). Terns have also been found to rely on fishery discards to some degree in some areas (Traversi & Vooren, 2010). This seems to be related to the proximity of the fishing vessels to tern colonies (Traversi & Vooren, 2010). The discontinuation of discards in the UK would therefore potentially affect those colonies relying on a more constant source of discards as a food source.

Pressure considered “Not Relevant” for features –

Insufficient Evidence for the features –
Features considered Not Sensitive to the pressure –
Features considered Sensitive to the pressure – • Harbour seal • Water column • Intertidal biogenic reef: mussel beds • Subtidal biogenic reefs: mussel beds • Subtidal mixed sediments • Intertidal coarse sediment • Intertidal mud • Intertidal sand and muddy sand • Subtidal coarse sediment • Subtidal mud • Subtidal sand
Discussion (this section generated by Eastern IFCA) Due to the complexity of this interaction it is not feasible to present all the information within this format, please see section 5.1.3 for full assessment of this pressure.
Conclusion **Cannot rule out adverse effect on site integrity from Removal of non-target species pressure at this stage.**

From “Advice on Operations” webpage	
Pressure	**Removal of target species**
Pressure Description The commercial exploitation of fish & shellfish stocks, including smaller scale harvesting, angling and scientific sampling. The physical effects of fishing gear on sea bed communities are addressed by the "abrasion" pressures above. This pressure addresses the direct removal / harvesting of biota. Ecological consequences include the sustainability of stocks, impacting energy flows through food webs and the size and age composition within fish stocks.	
Pressure Benchmark Removal of species present in the biotope targeted by a fishery, shellfishery or harvesting at a commercial or recreational scale	
Activity Pressure Justification Demersal trawls target a range of demersal fish species and also remove species which may themselves be of conservation importance or may form part of the biotope (e.g. Norway lobster - *Nephrops norvegicus*) or wider community composition associated with designated features/sub-features. As part of targeted fisheries, incidental non target catch may also be retained and landed due to its commercial value (e.g. spiny lobster (*Palinurus elephas*), lobsters (*Homarus gammarus*), crabs, scallops (*Pecten* spp.), etc). These species may be considered part of the wider community composition associated with features or sub-features of designated sites or may themselves be of conservation importance (e.g. crawfish) • Gubbay and Knapman, 1999 • Sewell and Hiscock, 2005 • Joint Nature Conservation Council (JNCC) and Natural England (NE), 2011 **JUSTIFICATION ONLY RELEVANT TO BIRDS:** Surface-feeding seabirds such as common tern (*Sterna hirundo*) are dependent on biological and physical processes affecting prey availability close to the surface of the water (Schwemmer et al, 2009). Food availability affects breeding success of seabirds including the number of pairs breeding, laying dates, clutch sizes and fledging success (Bolton, Houston & Monaghan, 1992; Mills et al, 2008; Szostek et al, 2014). A number of fish species that surface-feeding birds such as terns feed on include commercially relevant species such as clupeids and gadids (Bugoni & Vooren, 2004; Robinson & Hamer, 2000) as well as industrially-fished species such as sandeels (Robinson & Hamer, 2000); changes in their populations as a result of removal via commercial fishery practices as either target species or non-target species (i.e. by-	

catch) or reductions by other means could limit the availability of food to terns and similar seabirds (Bugoni & Vooren, 2004; Mitchell et al., 2004). However, a number of seabirds utilise fisheries discards including lesser black-backed gulls, often found in large numbers around vessels (Valeiras, 2003). Terns have also been found to rely on fishery discards to some degree in some areas (Traversi & Vooren, 2010). This seems to be related to the proximity of the fishing vessels to tern colonies (Traversi & Vooren, 2010). The discontinuation of discards in the UK would therefore potentially affect those colonies relying on a more constant source of discards as a food source.

Pressure considered "Not Relevant" for features –

- Harbour seal
- Intertidal biogenic reef: mussel beds
- Subtidal biogenic reefs: mussel beds
- Subtidal mixed sediments
- Intertidal coarse sediment
- Intertidal mud
- Intertidal sand and muddy sand
- Subtidal coarse sediment
- Subtidal mud
- Subtidal sand

Insufficient Evidence for the features –

Features considered Not Sensitive to the pressure –

Features considered Sensitive to the pressure –

- Water column

Discussion (this section generated by Eastern IFCA)

This examination is based only on the effects of the removal of shrimps (target species) on relevant birds (included in Feature "Water Column"). The effect pathway is the removal of food source for the birds.

The "Matrix of fisheries gear types and European marine site protected features" (Web Ref 2) presents the interaction between "Beam Trawling – Shrimp" and "Surface Feeding Birds" as "blue" (non-occurring) interaction. Eastern IFCA considers this interaction should not be scoped out because there is the potential for an interaction to occur.

The benthic habit of shrimp, coupled with the surface feeding habit of the bird species, indicates that shrimp will not normally form an important food resource. However, the main prey sources for The WNNC SPA species and other bird species found in the area have been considered (Table 1 presented at end of this document).

Within the WNNC SAC, the bird species for which shrimps could potentially be a significant food source are Tern species, in particularly Arctic Tern (*Sterna paradisaea*), Common Tern (*Sterna hirundo*), Little Tern (*Sternula albifrons*) and Sandwich Tern (*Sterna sandvicensis*). The diet of these species have been considered further (below) to identify whether brown shrimp form an important food resource to any of these species and whether the removal of these species from the water column could provide a pathway for a potential impact.

For Tern species, most of the literature on diet focuses on chicks and less so on adults. It appears that Tern species feed predominantly on clupeids (Herring and Sprat) and sand eels, however other species such as crustaceans and invertebrates can form part of their diet (Eglington and Perrow, 2014). In general, smaller fish or invertebrate species tend to be swallowed by adults at sea, with the larger or more nutritionally valuable fish being taken back for the chicks. Prey availability appears to be important in determining diet but it appears there is preference for certain prey, generally based on profitability. In nutritional terms, invertebrates are poor prey for chicks compared to lipid rich fish.

In the diet of Little terns, small fish such as clupeids (Herring and Sprat) and sand eels predominate, but other important prey items include crustaceans, other invertebrates, fish larvae, annelid worms and even insects (Beijersbergen, 2014; Eglington and Perrow, 2014).

Sandwich terns feed on a highly specialised diet dominated by a few fish species of high nutritive value, but squid, crustaceans, insects and worms have occasionally been reported and it appears that cluepids are more important than sandeels for this species (Eglington and Perrow, 2014).

Common tern adults take a wide range of prey including fish, crustaceans, squid and marine worms and feed on aquatic and terrestrial insects more frequently than other tern species (Eglington and Perrow, 2014). The main prey delivered to chicks are herring, sprat, sandeel, saith *Pollachius virens*, whiting and cod, but this is largely dependent on prey availability. Common tern show extreme plasticity in foraging behaviour and exploit a diverse range of prey resources and foraging methods which can result in striking differences between common tern diet in different colonies. Whilst shrimp and prawns have been found to predominate in some areas, such as the Ythan Estuary (Cramp *et al.,* 1985), in Norfolk it appears that small, young clupeids were the dominant item presented to chicks (*Perrow et al*., 2010).

The Arctic tern is capable of taking a wide variety of prey items but appears dependant on a few important prey items (Eglington and Perrow, 2014). In the UK Sandeels are the most important prey species for chicks and adults, with cluepids making up most of the remainder of the diet. Adults may exploit smaller prey, even including insects and for these species diet appears relatively consistent between colonies.

In addition to this, it is well known that seabirds, including terns, feed on the discards of small fish and shrimps from shrimping vessels. It is highly likely that, rather than reducing the overall amount of food available to the relevant bird component of the “Water Column” feature, the overall activity of shrimp fishing vessels increases the food supply to these creatures.

An assessment was made of whether the shrimp fishery is causing significant reductions in shrimp (target species) populations and could therefore affect prey availability for seabirds. The annual natural mortality of brown shrimp, and specific fishing mortalities for certain years, were assessed by Medley (2016), as presented below:

Year	Annual fishing mortality[2]	Natural mortality
2012/13	1.887	3.64
2013/14	1.439	
2014/15	0.891	
2015/16	0.994	

This indicates that in all years, the fishing mortality was well below the natural mortality, with a declining trend in fishing mortality recent years.

Medley (2016) used a simple population dynamics model that accounted for recruitment, growth, natural mortality and the observed catches. It was fitted using Bayesian Markov chain Monte Carlo (MCMC) software, with results reported in terms of probabilities and risk. Medley stated that the stock is currently exploited at a low-risk level. The estimated probability that the stock could be reduced below 20% of its unexploited state in any year is less than 1%. The stock assessment was based on a four-year time series, and made use of the seasonal contrast in each year to fit the model.

The shrimp fishing fleet follows the highest abundance of marketable shrimp, and is thus peripatetic. Fishing tends to be conducted in water deeper than the birds can feed in (given the draft of the fishing vessels), so the direct impact of the fishing fleet on the potential food supply for birds is limited. Shrimp, being an *r* strategist species, reproduce rapidly and quickly recover populations when subject to fishing pressure.

[2] Annual fishing mortality and natural mortality can be >1 (i.e. >100% of the standing stock) because shrimps reproduce quickly so removal of more than the standing stock does not create a net reduction in population.

Conclusion
Whilst shrimp form part of the diet for some species of birds, particularly Tern species, found in the area, the Brown shrimp *Crangon crangon* does not constitute the main source of prey for any of these species. The mortality of the stock due to fishing has, in all years examined, been well below the natural mortality. There is a generally low dependence of the relevant components of the "Water Column" feature on shrimp under natural conditions, and in fact the overall "food balance" for inshore surface feeding birds from the shrimp fishing activity is in all probability positive. It is therefore concluded that the pressure "Removal of target species" does not need to be addressed further in this assessment. **There is no adverse effect on site integrity from the removal of target species**

From "Advice on Operations" webpage	
Pressure	**Smothering and siltation rate changes (Light)**
Pressure Description When the natural rates of siltation are altered (increased or decreased). Siltation (or sedimentation) is the settling out of silt/sediments suspended in the water column. Activities associated with this pressure type include mariculture, land claim, navigation dredging, disposal at sea, marine mineral extraction, cable and pipeline laying and various construction activities. It can result in short lived sediment concentration gradients and the accumulation of sediments on the sea floor. This accumulation of sediments is synonymous with "light" smothering, which relates to the depth of vertical overburden. "Light" smothering relates to the deposition of layers of sediment on the seabed. It is associated with activities such as sea disposal of dredged materials where sediments are deliberately deposited on the sea bed. For "light" smothering most benthic biota may be able to adapt, i.e. vertically migrate through the deposited sediment.	
Pressure Benchmark 'Light' deposition of up to 5 cm of fine material added to the habitat in a single, discrete event	
Activity Pressure Justification This pressure may result from physical disturbance of the sediment, along with hydrodynamic action caused by the passage of towed gear, leading to entrainment	

and suspension of the substrate behind and around the gear components and subsequent siltation

- Sewell et al., 2007
- Gubbay and Knapman, 1999
- Lart, 2012
- Kaiser et al., 2002
- Riemann and E, 1991
- O'Neill et al., 2008
- Dale et al., 2011
- O'Neill and Summerbell, 2011

. The quantity of suspended material, its spatial and temporal persistence and subsequent patterns of deposition will depend on factors associated with the gear (such as type/design, weight, towing speed), sediment (particle size, composition, compactness), the intensity of the activity and the background hydrographic conditions

- Sewell et al., 2007
- Kaiser et al., 2002
- Dale et al., 2011
- O'Neill and Summerbell, 2011

. Sediment remobilisation and deposition can affect the settlement, feeding, and survival of biota through smothering of feeding and respiratory organs. Prolonged exposure of an area to the pressure may result in changes in sediment composition

- Kaiser et al., 2001
- Sewell et al., 2007
- Gubbay and Knapman, 1999
- Kaiser et al., 2002
- O'Neill and Summerbell, 2011

Further effects are also considered under the pressures: Deoxygenation, Nutrient enrichment and Organic enrichment.

Pressure considered "Not Relevant" for features –

- Harbour seal
- Water column

Insufficient Evidence for the features –

Features considered Not Sensitive to the pressure –

Features considered Sensitive to the pressure –

- Intertidal biogenic reef: mussel beds
- Subtidal biogenic reefs: mussel beds

- Subtidal mixed sediments
- Intertidal coarse sediment
- Intertidal mud
- Intertidal sand and muddy sand
- Subtidal coarse sediment
- Subtidal mud
- Subtidal sand

Discussion (this section generated by Eastern IFCA)

Modelling of sediment disturbance by the gear used in the Wash shrimp fishery (ABPmer and Ichthys Marine, 2015) identified a maximum mobilisation of sediment due to passage of the fishing gear of 1.8 mm. Assuming that all of this settles within the “footprint” of that fishing pass (or an equivalent area at some other location) (a precautionary approach, as some of the sediment raised will inevitably be carried further away) there will be the same depth of sediment re-settling. This is well below the Pressure Benchmark level.

The NRA report "Wash Zone Report – A Monitoring Review" (NRA, 1994) suggests a sediment flux of between 30 000 and 120 000 tonnes of sediment with every tide, depending on the tidal state (springs or neaps). Calculating this to an annual flux over the whole area of The Wash indicates an annual flux, or deposition, of some 60 – 120 mm of sediment if spread evenly over the whole area. Ke, Evans and Collins (1996) suggest that 6.8 million tonnes of suspended sediment are supplied to The Wash every year from offshore sources, with an additional 14 000 tonnes being supplied by bedload transport.

Conclusion

The Wash area is one of very dynamic suspended sediment movement, settlement and re-suspension. Benthic communities within the site are well adapted to the challenges this may bring in terms of having to cope with settlement of sediment (WEBREF 1). Set against the background of the naturally occurring sediment movements, those associated with the beam trawl fishery for shrimps are insignificant and do not approach the Pressure Benchmark levels.

Therefore, it is not considered that the pressure “Smothering and siltation rate changes (Light)” needs to be addressed further in this assessment.

There is no adverse effect on integrity from smothering and siltation rate changes (light).

Table 1 Prey preferences of protected (Special Protection Area) bird species within the Wash and North Norfolk Coast European Marine Site and other bird species found in the area.

Bird species	**Breeding/ Non-breeding?**	**Sources of food**	**Shrimps (*Crangon crangon*) form Key part of diet?**
The Wash SPA and North Norfolk Coast SPA species			
Avocet (*Recurvirostra avosetta*)	Breeding	Invertebrates, especially crustaceans and worms, including shrimps (RSPB, 2017) Wading birds, feed on intertidal mud sand and shallow coastal waters[3] (NE, 2017b)	No
Bar-tailed godwit (*Limosa lapponica*)	Non-breeding	Insects, molluscs (*Mytilus edulis*), crustaceans (*Corophium* spp.), salt water clams (*Macoma balthica*), worms and plant material (RSPB, 2017; NE, 2017a) *Lanice, Nereis* and *Macoma* identified as most important prey species (Goss-Custard, Jones and Newbery, 1977)	No
Bewick's swan (*Cygnus columbianus bewickii*)	Non-breeding	Aquatic plants, grass and agricultural fields (RSPB, 2017; NE, 2017b)	No
Bittern (*Botaurus stellaris*)	Breeding	Fish, amphibians and insects, feed in tidal reedbeds and coastal grazing marsh (RSPB, 2017; NE, 2017a)	No
Black-tailed godwit (*Limosa limosa islandica*)	Non-breeding	Insects, worms and snails, bivalves and plant material (RSPB, 2017; NE, 2017a)	No
Common scoter (*Melanitta nigra*)	Non-breeding	Bivalve molluscs (such as *Ensis* spp., *Phauslegumen, Abra* spp., *Nucula* spp.,) crabs, snails and small fish (RSPB, 2017; NE, 2017a)	No
Common tern (*Sterna hirundo*)	Breeding	Fish (RSPB, 2017; NE, 2017a) Main food source is marine fish, but crustaceans (shrimp and prawns) predominate in some areas (Cramp *et al.,* 1985).	Potential
Curlew (*Numenius arquata*)	Non-breeding	Polychaete worms, shellfish (clams, cockles), shrimps[1] and littoral crabs. Wading birds, forage across intertidal mudflats, wet grassland and arable fields (RSPB, 2017; NE, 2017a) *Carcinus*, *Lanice conchilega* and several other polychaetes and bivalve molluscs identified as most important prey species (Goss-Custard, Jones and Newbery, 1977)	No
Dark-bellied brent goose	Non-breeding	Vegetation, especially eel-grass, green algae (RSPB, 2017; NE, 2017a)	No

[3] Foraging grounds of waders (generally intertidal mud, sand and shallow coastal waters) are not considered to overlap with Brown shrimp (*Crangon crangon*) shrimping grounds. Waders are more likely to forage on other species on shrimps that occur in very shallow water (RSPB *pers. comm*).

(*Branta bernicla bernicla*)			
Dunlin (*Calidris alpina alpina*)	Non-breeding	Small worms (polychaete spp.), mud snails (*Peringia ulvae*/*Hydrobia ulvae* spp.), shrimps (*Caridea* spp.), cockles (*Cerastoderma edule)*, mussels (*Mytilus edulis)* and numerous insect species (RSPB, 2017; NE, 2017a) *Peringia ulvae* and *Nereis diversicolor* (polychaete worm) identified as most important food species (Goss-Custard, Jones and Newbery, 1977)	No
Gadwall (*Anas strepera*),	Non-breeding	Stems, leaves and seeds (RSPB, 2017) Submerged macrophytes such as floating sweet-grass (*Glyceria fluitans)*, pondweeds (*Potamogeton* spp.) and other plants (NE, 2017a)	No
Goldeneye (*Bucephala clangula*)	Non-breeding	Mussels, cockles, small mud snails, worms, crabs and small fish, some vegetative material and algae (RSPB, 2017; NE, 2017a)	No
Golden plover (*Pluvialis apricaria*)	Non-breeding	Worms and beetles (RSPB, 2017)	No
Grey plover (*Pluvialis squatarola*)	Non-breeding	Nereid worms (such as *Nereis* spp. and *Arenicola marina)*, mud snails (*Peringia ulvae)* and small bivalves (*Macoma balthica)* (RSPB, 2017; NE, 2017a) *Lanice*, other polychaetes, *Cerastoderma*, *Carcinus* and *Macoma* identified as the most important species (Goss-Custard, Jones and Newbery, 1977)	No
Knot (Calidris canutus)	Non-breeding	Shellfish (cockle spat and mud snails) and worms (RSPB, 2017; NE, 2017a) *Macoma balthica* and *Cerastoderma (cockles)* identified as the most important food source (Goss-Custard, Jones and Newbery, 1977)	No
Lapwing (*Vanellus vanellus*)	Non-breeding	Worms and insects (RSPB, 2017)	No
Little tern (*Sternula albifrons*)	Breeding	Fish (RSPB, 2017; NE, 2017a) Chicks feed on sand eels and crustacea (Lincolnshire Wildlife Trust, *pers. comm*.). At Gibraltar point 90% of chick diet identified as crustacea, with the majority identified as *Nanantia* (obsolete taxon comprising of shrimp and prawn families) (Davies, 1981).	Potential
Marsh harrier (*Circus aeruginosus*)	Breeding	Small birds and mammals (RSPB, 2017)	No
Montagu's harrier	Breeding	Small birds, voles, shrews, rabbits, lizards and insects (RSPB, 2017)	No

(*Circus pygargus*)			
Oystercatcher (*Haematopus ostralegus*)	Non-breeding	Mussels and cockles on the coast (Goss-Custard, Jones and Newbery, 1977; RSPB, 2017; NE, 2017a)	No
Pink-footed goose (*Anser brachyrhynchus*)	Non-breeding	Grain, winter cereals, potatoes, root crops (such as potatoes and carrots), oilseed rape and grassland (RSPB, 2017; NE, 2017a)	No
Pintail (*Anas acuta*)	Non-breeding	Plants and invertebrates, such as the small mud snail (*Peringia ulvae)* and the seeds of saltmarsh plants (RSPB, 2017; NE, 2017a)	No
Redshank (*Tringa totanus*)	Non-breeding	Insects, earthworms, molluscs and crustaceans (RSPB, 2017) Mud snail (*Peringia ulvae)*, large polychaetes (such as *Nereis diversicolor)*, small annelid worms, shrimp (*Corophium* spp.), as well as *Macoma balthica* and small crabs (*Carcinus* spp.) (NE, 2017a) *Carcinus maenas*, *Crangon spp*., *Hydrobia*, *Nereis* and various amphipods identified as most important food source (Goss-Custard, Jones and Newbery, 1977)	No
Sanderling (Calidris alba)	Non-breeding	Small marine worms, crustaceans and molluscs (RSPB, 2017) Small polychaetes (*Nereis* spp.) and amphipods (*Bathyporeia spp*.) and *Eurydice* spp*.* (NE, 2017a)	No
Sandwich tern (*Sterna sandvicensis*)	Breeding	Fish such as sandeels, sprats and whiting (RSPB, 2017; NE, 2017a) Feed mainly on fish, but squid, crustaceans, insects and worms have occasionally been reported (Eglington and Perrow, 2014)	Potential
Shelduck (*Tadorna tadorna*)	Non-breeding	Invertebrates, small shellfish and aquatic snails, such as the small mud snail (*Hydrobia ulvae),* and oligochaete worms (RSPB, 2017; NE, 2017a)	No
Turnstone (*Arenaria interpres*)	Non-breeding	Insects, crustaceans and molluscs, cockle and mussel spat (RSPB, 2017; NE, 2017a)	No
White fronted goose (*Anser albifrons*)	Non-breeding	Grass, clover, grain, winter wheat and potatoes (RSPB, 2017)	No
Whooper swan *(Cygnus cygnus)*	Non-breeding	Aquatic plants, grass, grain, potatoes (RSPB, 2017)	No
Wigeon (*Anas penelope*)	Non-breeding	Aquatic plants, grasses, roots (RSPB, 2017) Terrestrial grasses (*Puccinellia maritima)* and red fescue (*Festuca rubra)*, and algae (*Enteromorpha* spp*)* (NE, 2017a)	No

Non-SPA bird species			
Arctic tern (*Sterna paradisaea*)	Breeding/ Non-breeding	Mainly fish but also crustaceans and insects, including shrimps.	Potential
Black headed gull (*Chroicocephalus ridibundus*)	Breeding	Worms, insects, fish and carrion (RSPB, 2017)	No
Black throated divers (*Gavia arctica*)	Non-breeding	Fish (RSPB, 2017)	No
Common gull (*Larus canus*)	Breeding	Worms, insects, fish, carrion and rubbish (RSPB, 2017)	No
Cormorant (*Phalacrocorax carbo*)	Breeding	Fish (RSPB, 2017)	No
Eider *(Somateria mollissima)*	Non-breeding	Shellfish, especially mussels (RSPB, 2017)	No
Fulmar *(Fulmarus glacialis)*	Breeding	Fish waste and crustaceans (RSPB, 2017)	No
Gannets (*Morus bassanus*)	Breeding	Fish (RSPB, 2017)	No
Guillemot (*Uria aalge*)	Breeding	Fish and crustaceans (RSPB, 2017)	No
Great crested grebe (*Podiceps cristatus*)	Non-breeding	Fish (RSPB, 2017)	No
Great white egret (*Ardea alba*)	Breeding	Fish, insects and frogs, caught by spearing with its long, sharp beak (RSPB, 2017)	No
Grey heron (*Ardea cinereal*)	Breeding	Lots of fish, but also small birds such as ducklings, small mammals like voles, and amphibians (RSPB, 2017)	No
Herring gull (*Larus argentatus*)	Breeding	Ominivorous, scavenger (RSPB, 2017)	No
Kittiwake (*Rissa tridactyla*)	Breeding	Sandeels, small shoaling fish, shrimps[4] and worms (RSPB, 2017)	No
Lesser black-backed gull (*Larus fuscus*)	Breeding	Omnivore - scavenges a wide range of food (RSPB, 2017)	No
Little grebe (*Tachybaptus ruficollis*)	Breeding	Insects, larvae and small fish (RSPB, 2017) Have been seen to eat shrimps (Lincolnshire Wildlife Trust, *pers. comm*.)	No
Little egret *(Egretta garzetta*)	Breeding	Fish (RSPB, 2017)	No
Little gull (*Hydrocoloeus minutus*)	Non-breeding	Flying insects, small fish and aquatic invertebrates (Cornell Lab of Ornithology, 2018). Surface water feeder.	No

[4] Shrimp do not form their primary food source (BTO, 2017)

Mallard (*Anas platyrhynchos*)	Breeding	Seeds, acorns and berries, plants, insects and shellfish (RSPB, 2017)	No
Razorbills (*Alca torda*)	Breeding	Fish, especially sandeels, sprats and herrings (RSPB, 2017)	No
Red throated divers (*Gavia stellata*)	Non-breeding	Fish (LWT, 2017; RSPB, 2017)	No
Ringed plover (*Charadrius hiaticula*)	Non-breeding	Flies, spiders, marine worms, crustaceans, molluscs (RSPB, 2017)	No
Roseate Tern (*Sterna dougallii*)	Non-breeding	Fish	No
Shag (*Phalacrocorax aristotelis*)	Breeding	Fish and occasionally crustacea and molluscs (RSPB, 2017)	No
Spoonbill (*Platalea leucorodia*)	Non-breeding	Mainly aquatic insects and small fish (RSPB, 2017)	No
Teal (*Anas crecca*)	Breeding	Seeds and small invertebrates (RSPB, 2017)	No

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[5] Citations detailed in Natural England advice text (yellow tables) are not detailed in the reference list but can be found through the web link

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