East Anglia TWO Offshore Windfarm

Appendix 10.1

Fish and Shellfish Ecology Technical Appendix

Preliminary Environmental Information
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Glossary of Acronyms

Cefas	Centre for Environment, Fisheries and Aquaculture Science
CUPE	Catch per unit effort
EIA	Environmental Impact Assessment
HAWG	Herring Assessment Working Group
IBTS	International Beam Trawl Survey
ICES	International Council for the Exploration of the Sea
IFCA	Inshore Fisheries and Conservation Authorities
IHLS	International Herring Larvae Survey
IUCN	The International Union for Conservation of Nature
MMO	Marine Management Organisation
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PSA	Particle Size Analysis
TAC	Total Allowable Catch

Glossary of Terminology

East Anglia TWO project	The proposed project consisting of up to 75 wind turbines, up to four offshore electrical platforms, up to one offshore operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
East Anglia TWO windfarm site	The offshore area within which wind turbines and offshore platforms will be located.
Offshore cable corridor	This is the area which will contain the offshore export cable between offshore electrical platforms and landfall jointing bay.
Offshore development area	The East Anglia TWO windfarm site and offshore cable corridor (up to Mean High Water Springs).

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10.1 Technical Appendix

1. The following document describes the fish and shellfish ecology of species that have been considered in the Environment Impact Assessment (EIA). The impact assessment presented in ***Chapter 10 Fish and Shellfish Ecology*** also includes a summary of the baseline presented in this document.

10.1.1 Overview of Fish and Shellfish Species

2. The East Anglia TWO project is encompassed within International Council for the Exploration of the Sea (ICES) Southern North Sea Division (IVc) statistical rectangles[1]. The East Anglia TWO windfarm site and part of the offshore cable corridor are within rectangle 33F2 and the near shore sections of the offshore cable corridor lie within 33F1, as shown in ***Figure 10.1.***

10.1.1.1 International Beam Trawl Survey

3. International Beam Trawl Survey (IBTS) data recorded in the study area (ICES rectangles 33F1, 33F2) have been analysed and used to characterise the fish and shellfish community in the offshore development area.

4. The 65 species present in the study area (***Figure 10.1***) expressed as their average abundance (CPUE) in IBT surveys (first and third quarters) for the years 2008-2018 is given in ***Table 10.1.1***. Greater sandeel CPUE was highest in the East Anglia TWO windfarm site (33F2) (***Figure 10.22***), whereas whiting CPUE was highest in the offshore cable corridor (33F1) (***Figure 10.8***).

Table 10.1.1 Average catch per unit effort CPUE (number/hour) for principal species recorded in the IBTS in ICES rectangles 33F1 and 33F2 (2008-2018) (DATRAS 2018)

Common name	Scientific name	CPUE (number of individuals per hour)	
		33F1 Offshore cable corridor	33F2 East TWO Windfarm site
Greater sandeel	*Hyperoplus lanceolatus*	0.98	273.41
Whiting	*Merlangius merlangus*	26.99	110.01
Herring	*Clupea harengus*	6.59	53.91
Dab	*Limanda limanda*	4.96	17.23
Grey gurnard	*Eutrigla gurnardus*	0.37	14.33
Lesser weever	*Echiichthys vipera*	1.45	13.40

[1] The boundaries of each ICES rectangle aligns to 0.5° latitude by 1.0° longitude, giving whole rectangle dimensions of approximately 30 by 30 nautical miles (nm), at UK latitudes.

Common name	Scientific name	CPUE (number of individuals per hour)	
		33F1 Offshore cable corridor	33F2 East TWO Windfarm site
Anchovy	*Engraulis encrasicolus*	0.24	5.91
European plaice	*Pleuronectes platessa*	2.21	5.09
Cod	*Gadus morhua*	2.70	4.63
Common squid	*Loligo subulata*	0.00	4.47
European common squid	*Alloteuthis subulata*	0.00	4.03
European squid	*Loligo vulgaris*	0.08	4.00
Lemon sole	*Microstomus kitt*	2.62	2.96
Striped red mullet	*Mullus surmuletus*	0.15	2.88
Common dragonet	*Callionymus lyra*	2.08	2.63
Raitt's sandeel	*Ammodytes marinus*	0.00	2.42
Pogge	*Agonus cataphractus*	2.94	2.38
Starry smoothhound	*Mustelus asterias*	3.43	2.26
Smooth sandeel	*Gymnammodytes semisquamatus*	0.00	1.79
Thornback ray	*Raja clavata*	3.12	1.41
Goby	*Gobiidae*	2.95	1.36
Yellow sole	*Buglossidium luteum*	0.56	1.16
European bass	*Dicentrarchus labrax*	1.22	0.98
European flounder	*Platichthys flesus*	1.35	0.94
Red gurnard	*Chelidonichthys cuculus*	0.00	0.90
Broadnose skate	*Bathyraja brachyurops*	0.00	0.86
Lesser sandeel	*Ammodytes tobianus*	2.67	0.84
Smoothhound	*Mustelus mustelus*	0.18	0.81
Twaite shad	*Alosa fallax*	0.62	0.71
Scaldfish	*Arnoglossus laterna*	0.16	0.70
Spotted ray	*Raja montagui*	1.05	0.68

Common name	Scientific name	CPUE (number of individuals per hour)	
		33F1 Offshore cable corridor	33F2 East TWO Windfarm site
Edible crab	*Cancer pagurus*	2.64	0.61
Tub gurnard	*Chelidonichthys lucerna*	0.37	0.58
Blonde ray	*Raja brachyura*	0.55	0.53
Long finned squid	*Loligo forbesi*	0.00	0.49
Lozano's goby	*Pomatoschistus lozanoi*	0.57	0.45
Gobies	*Pomatoschistus*	1.45	0.44
Crystal goby	*Crystallogobius linearis*	0.57	0.43
Fivebeard rockling	*Ciliata mustela*	1.49	0.41
Sandeel	*Ammodytes*	0.49	0.34
Transparent goby	*Aphia minuta*	0.00	0.33
Thickback sole	*Microchirus variegatus*	0.00	0.25
Fourbeard rockling	*Enchelyopus cimbrius*	0.10	0.19
Spotted dragonet	*Callionymus maculatus*	0.00	0.19
Sand goby	*Pomatoschistus minutus*	0.15	0.18
Northern rockling	*Ciliata septentrionalis*	1.04	0.16
Tope	*Galeorhinus galeus*	0.00	0.15
European lobster	*Homarus gammarus*	0.38	0.14
Allis shad	*Alosa alosa*	0.00	0.13
Undulate ray	*Raja undulata*	0.00	0.13
Reticulated dragonet	*Callionymus reticulatus*	0.00	0.11
Lumpfish	*Cyclopterus lumpus*	0.15	0.10
Rock gunnel	*Pholis gunnellus*	0.10	0.10
Short-horn sculpin	*Myoxocephalus scorpius*	1.16	0.10
Cuckoo ray	*Leucoraja naevus*	0.00	0.10
Snake pipefish	*Entelurus aequoreus*	0.00	0.06

Common name	Scientific name	CPUE (number of individuals per hour)	
		33F1 Offshore cable corridor	33F2 East TWO Windfarm site
Black goby	*Gobius niger*	0.20	0.05
Blue whiting	*Micromesistius poutassou*	0.00	0.05
Pollock	*Pollachius virens*	0.00	0.05
Agone	*Alosa agone*	1.75	0.00
Common sea snail	*Liparis liparis*	0.46	0.00
Sea lamprey	*Petromyzon marinus*	0.13	0.00
Starry ray	*Amblyraja radiata*	0.08	0.00
Angler fish	*Lophius piscatorius*	0.08	0.00

10.1.1.2 UK MMO Landings Data

5. As discussed in ***section 10.5.2.3.1*** of ***Chapter 10 Fish and Shellfish Ecology***, UK Marine Management Organisation (MMO) landings data from the period 2012 to 2016 show a difference in key commercial fishing species landed from rectangles 33F1 and 33F2, as shown in ***Table 10.1.2.***

Table 10.1.2 Average weight (tonnes) and percentage contribution of the principal commercial species (MMO landings data 2012-2016) within each ICES rectangle relevant to the East Anglia TWO windfarm site and the offshore cable corridor

Species	33F1 (inshore)		33F2 (offshore)	
	Average landings (tonnes)	Average contribution to total landings in 33F1	Average landings (tonnes)	Average contribution to total landings in 33F2
Bass	0.1985	1.01%	0.0203	0.03%
Blonde ray	0.1243	0.63%	0.2240	0.37%
Brill	0.0148	0.08%	0.5001	0.83%
Catfish	0.0020	0.01%	0.0013	0.00%
Cod	0.7292	3.71%	0.3503	0.58%
Common stingray			0.0175	0.03%
Conger Eels	0.0052	0.03%		

Species	33F1 (inshore)		33F2 (offshore)	
	Average landings (tonnes)	Average contribution to total landings in 33F1	Average landings (tonnes)	Average contribution to total landings in 33F2
Cuckoo ray	0.0033	0.02%		
Dab	0.0294	0.15%	0.0552	0.09%
Dogfish (scyliorhinidae)	0.0165	0.08%		
Eels	0.0004	0.00%		
Flounder or flukes	0.2899	1.48%	0.0136	0.02%
Garfish	0.0007	0.00%		
Greater weever			0.0012	0.00%
Gurnard and latchet	0.0226	0.12%	0.0070	0.01%
Grey gurnards	0.0030	0.02%		
Red gurnards	0.0068	0.03%	0.2700	0.45%
Haddock	0.0220	0.11%	0.0004	0.00%
Hake	0.0072	0.04%	0.0040	0.01%
Halibut	0.0050	0.03%		
Herring	0.6062	3.09%	36.0285	59.67%
Horse mackerel	0.0738	0.38%	0.0011	0.00%
John dory	0.0009	0.00%	0.0006	0.00%
Lemon sole	0.0113	0.06%	0.0633	0.10%
Lesser spotted dogfish	0.4437	2.26%	0.3033	0.50%
Ling	0.0031	0.02%	0.0015	0.00%
Lumpfish	0.0029	0.01%		
Mackerel	0.0305	0.16%	0.2996	0.50%
Monk or angler fish	0.0344	0.18%	0.0152	0.03%
Mullet	0.0232	0.12%	0.0012	0.00%
Pilchard	0.0052	0.03%		
Plaice	0.0188	0.10%	4.1676	6.90%

Species	33F1 (inshore)		33F2 (offshore)	
	Average landings (tonnes)	Average contribution to total landings in 33F1	Average landings (tonnes)	Average contribution to total landings in 33F2
Pollack	0.0007	0.00%	0.0141	0.02%
Pouting/Bib	0.0054	0.03%	0.0237	0.04%
Finfish				
Rabbit fish/ rattail	0.0005	0.00%		
Red mullet	0.0025	0.01%	0.0169	0.03%
Roes	0.0324	0.16%	0.0114	0.02%
Sand smelt	0.0055	0.03%		
Sand sole	0.0105	0.05%		
Sea trout	0.0068	0.03%		
Shad	0.0005	0.00%		
Skates and rays	0.1626	0.83%	0.0110	0.02%
Small-eyed ray	0.0047	0.02%		
Smooth hammerhead	0.0330	0.17%		
Smooth hound	0.1729	0.88%	0.0584	0.10%
Sole	0.7304	3.72%	1.5903	2.63%
Spotted ray	0.0430	0.22%	0.0412	0.07%
Sprats	0.1329	0.68%		
Starry ray	0.0123	0.06%		
Thornback ray	0.6294	3.21%	0.2566	0.42%
Tope	0.0314	0.16%	0.0131	0.02%
Tub gurnards	0.0014	0.01%	0.4643	0.77%
Turbot	0.0090	0.05%	0.3322	0.55%
Whiting	0.0470	0.24%	0.0241	0.04%
Witch	0.0032	0.02%		
Wrasse	0.0002	0.00%		

Species	33F1 (inshore)		33F2 (offshore)	
	Average landings (tonnes)	Average contribution to total landings in 33F1	Average landings (tonnes)	Average contribution to total landings in 33F2
Shellfish (including all molluscs)				
Brown shrimp	1.3509	6.88%		
Crabs	0.1440	0.73%	0.0011	0.00%
Cuttlefish	0.0065	0.03%	0.1198	0.20%
Lobsters	0.1168	0.60%	0.0047	0.01%
Nephrops (Norway lobster)	0.2956	1.51%		
Octopus	0.0009	0.00%	0.0007	0.00%
Scallops	3.3321	16.97%		
Squid	0.0228	0.12%	0.0692	0.11%
Whelks	9.5512	48.65%	14.9814	24.81%

6. ***Plate 10.1.1*** and ***Plate 10.1.2*** show the UK annual landing weights (tonnes) for the offshore development area between 2012 and 2016. Foreign landings are discussed in ***Chapter 13 Commercial Fisheries***. ***Plate 10.1.1*** displays landings from ICES rectangle 33F1 that overlaps with the offshore cable corridor. From this area, species of the greatest weight were whelks along with cod, dover sole and thornback ray. The commercial whelk fisheries were reasonably consistent between 2012 and 2014, with a significant increase in 2015 (409.7 tonnes). 2016 landings show a substantial decrease (151.65 tonnes), this is likely to correlate with the implementation of the emergency Whelk Permit Byelaw in April 2016 by Eastern Inshore Fisheries and Conservation Authorities (IFCA), followed by the Whelk Permit Byelaw in late October that year.

7. Lesser spotted dogfish, smoothhound and lobster landings have remained fairly consistent over the five years shown. Herring landings rose up to 2015, before dropping marginally in 2016. Similarly, bass, blonde ray, cod, dabs, dover sole and thornback ray landings all declined in either 2015 or 2016. Flounder or fluke landings fluctuated across the five years, with 2013 landings at their lowest (2.73 tonnes), peaking in 2014 at 15.75 tonnes and continuing to vary.

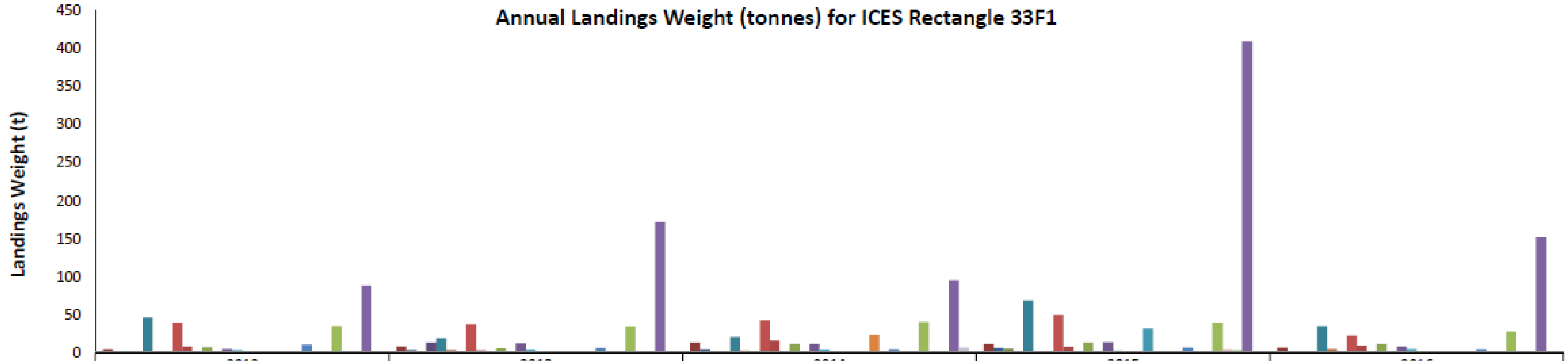
8. Crab landings gradually increased from 2014 onwards, whereas significant landings for brown shrimp, nephrops and scallop were recorded in one year

only; with 12.91 tonnes of brown shrimp landed in 2013 and 1.61 tonnes of nephrops and 23.06 tonnes of scallops landed in 2014.

9. Species such as plaice, tub gurnard, turbot, and whiting were not continually landed in significant quantities over this period. However, plaice landings went from 1.42 tonnes in 2014 to 31.51 tonnes in 2015, while turbot and tub gurnard landings also increased in 2015, increasing from less than 0.6 tonnes in other years to 3.57 and 4.3 tonnes, respectively. Whiting were landed in each of the years, mostly under 0.5 tonnes, although 6.48 tonnes were landed in 2013.

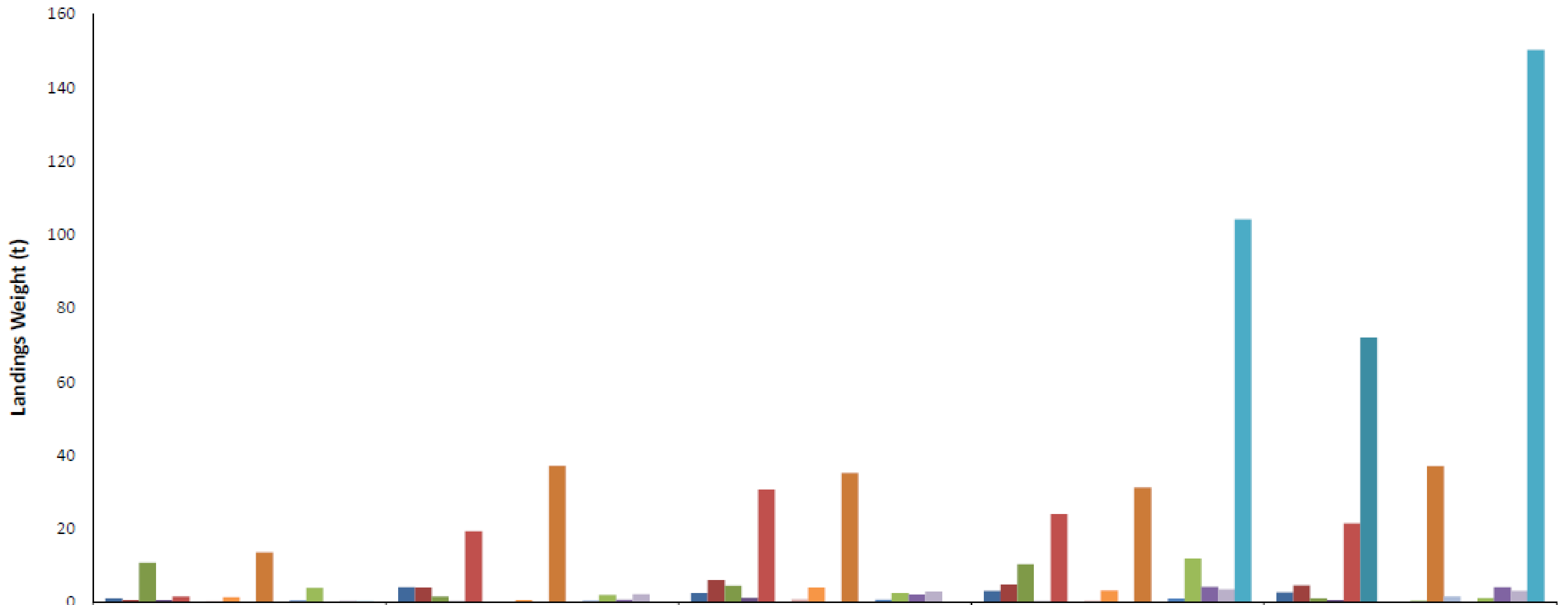
10. ***Plate 10.1.2*** displays landings from ICES rectangle 33F2 that overlaps with the East Anglia TWO windfarm site. From this rectangle, the greatest landings were of whelk along with plaice and dover sole. Whelk landings were low between 2012 and 2013, and dramatically increased in 2015. Whereas dover sole landings decreased in 2015 and 2016.

11. Blonde ray, brill and plaice landings have remained fairly consistent over the five-year period. Herring landings were non-existent until 2016 with 71.99 tonnes then being landed. Cod, lesser spotted dogfish and thornback ray landings were variable over all five years. Cod landings peaked in 2012 at 10.84 tonnes, while lesser spotted dogfish peaked in 2014 at 4.09 tonnes and thornback ray in 2015 at 11.91 tonnes. Tub gurnard and turbot landings both increased from 2013, reaching 4.3 tonnes and 3.5 tonnes, respectively.



	2012	2013	2014	2015	2016
Bass	4	8	13	11	6
Blonde ray	2	3	4	6	1
Brill	0	1	0	5	0
Brown shrimps	0	13	0	0	0
Cod	46	18	20	68	35
Crabs	1	3	2	2	4
Dabs	1	1	1	1	0
Dover sole	39	37	43	49	22
Flounder or Fluke	8	3	16	7	9
Gurnards and Latchets	0	0	2	0	0
Herring	7	5	11	13	11
Lemon sole	0	0	1	0	0
Lesser spotted dogfish	4	12	11	13	8
Lobsters	3	4	4	2	5
Monks and Anglers	0	0	1	0	0
Nephrops	0	0	2	0	0
Plaice	0	0	1	32	0
Roes	1	0	0	0	0
Scallops	0	0	23	0	0
Skates and Rays	0	1	1	0	0
Smoothhound	10	6	4	6	4
Spotted ray	0	0	0	0	1
Sprats	0	0	0	1	0
Thornback ray	34	34	40	40	28
Tub gurnards	0	0	0	4	0
Turbot	0	0	1	4	0
Whelks	88	172	95	410	152
Whiting	1	0	6	0	0

Plate 10.1.1 Annual Lands Weight (tonnes) for ICES Rectangles 33F1



	2012	2013	2014	2015	2016
Blonde ray	1	4	3	3	3
Brill	1	4	6	5	5
Cod	11	2	5	10	1
Dabs	1	0	1	0	1
Dover sole	2	19	31	24	21
Herring	0	0	0	0	72
Lemon sole	0	0	1	0	0
Lesser spotted dogfish	1	1	4	3	0
Mackerel	0	0	0	0	1
Plaice	14	37	35	31	37
Red gurnards	0	0	0	0	2
Smoothhound	0	0	1	1	0
Thornback ray	4	2	3	12	1
Tub gurnards	0	1	2	4	4
Turbot	0	2	3	4	3
Whelks	0	0	0	104	150

Plate 10.1.2 Annual Landings Weight (tonnes) for ICES Rectangle 33F2

10.1.2 Commercial Demersal Species

10.1.2.1 Dover Sole

12. In the North Sea, the main Dover sole populations are found south of latitude 56°N with a wide distribution in the southern and eastern North Sea (ICES 2006; Limpenny et al. 2011) (***Figure 10.2***). Bottom sea temperatures determine the population's northern limit, and need to be above 3-4°C or they are otherwise lethal (Burt and Millner 2008). Sole tend to occupy shallow, sandy and sandy /muddy habitats (ICES 2006), down to depths of 70m (Eastwood et al. 2000; Limpenny et al. 2011). In the winter, sole tend to move further offshore and have been found at depths up to 150m (Kay and Dipper 2009; Reeve 2007).

13. In spring, mature fish return to shallow coastal waters to spawn. Spawning areas include those with relatively higher water temperatures, such as the mouths of estuaries e.g. the Wash and Thames Estuary, and shallow waters such as sand banks, which also act as nursery areas for juveniles (Limpenny et al. 2011). Juveniles reside in shallow inshore waters whereas fish in their first year of life (0-groups) are generally abundant at all depths (Rogers et al. 1998).

14. The offshore development area overlaps high intensity sole spawning grounds as defined by Ellis et al. (2012) and Coull et al. (1998). The western section of the offshore cable corridor falls within low intensity nursery grounds (Ellis et al. 2010) as shown in ***Figure 10.3***. The maximum juvenile catch rate in this area ranges from 11 – 100 n/m^3 to 101 – 1000 n/m^3.

15. Sole spawning is considered to begin in March in the English Channel and southern North Sea, once sea temperatures reach around 7°C (Limpenny et al. 2011). Spawning continues until May with a peak in April and sporadic spawning continuing until June. Van Damme et al. (2011) conducted ichthyoplankton surveys and found the highest concentrations of stage one eggs between April and June (***Plate 10.1.3***).

16. Dover sole is a key species targeted by UK, Dutch and Belgian vessels near the offshore development area. The Dutch beam trawler fleet is allocated larger quotas for sole, and are mostly active in rectangle 33F2, not being permitted to fish within 12nm of the UK coast. The Belgian fleet lands mostly sole from rectangle 33F2, however smaller vessels are also used within rectangle 33F1 (see ***Chapter 13 Commercial Fisheries***). ICES has advised that landings of sole in 2018 should not exceed 21,644 tonnes in the North Sea (subarea IV) (ICES 2018).

17. As shown in ***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***, sole is listed as a species of principal importance.

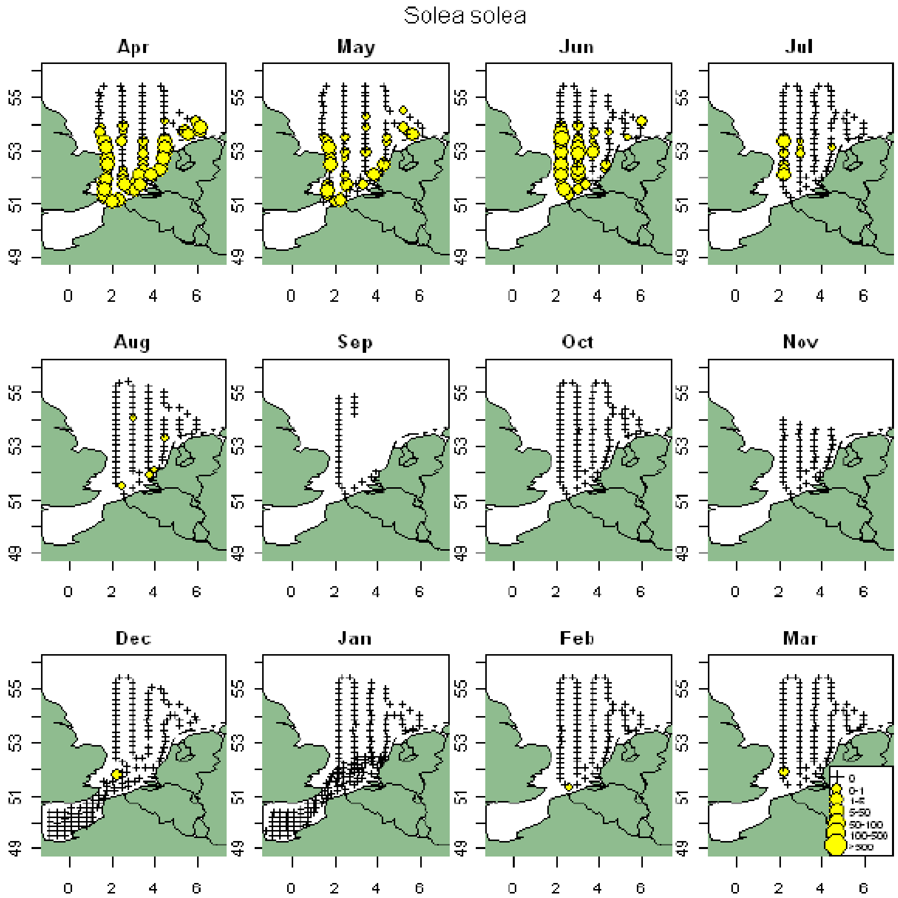


Plate 10.1.3 Spatial and temporal distribution of stage 1 sole eggs (van Damme et al. 2011).

10.1.2.2 Plaice

18. Plaice are widespread throughout the North Sea (***Figure 10.4***), most commonly found between 10-50m but potentially occurring from 0-200m. They exhibit a preference for sand and gravel substrates, but are also found on mud (Ruiz 2007).

19. Plaice tagging studies in the North Sea (Centre for Environment, Fisheries and Aquaculture Science (Cefas) and collaborators) have shown that plaice divide into three sub-populations during summer months for feeding in the Southern and German Bights; along the east coast of the UK; and in the Skagerrak and Kattegat (Hunter et al. 2004). Loots et al. (2010) also described the spawning distribution of North Sea plaice, concluding that high abundances occur in the southern North Sea and along the east coast of the UK, and very low abundances in the central North Sea. The Wadden Sea is also an important nursery area for plaice, especially in the intertidal and shallow subtidal zones (Jörg 2016), although juveniles have also been recorded distributed offshore (ICES 2014).

20. ***Figure 10.5*** shows the western section of the offshore cable corridor lying within low intensity nursery grounds (Coull et al. 1998; Ellis et al. 2010).

21. In the southern North Sea and English Channel where tides are stronger, plaice take advantage of fast tidal currents and migrate by selective tidal stream transport. Mature fish are understood to select the tidal streams flowing towards spawning grounds, whilst spent fish use the reciprocal tidal stream to return to feeding grounds (Cefas 2000).

22. Spawning in the North Sea is widespread, with high intensity grounds across most of the offshore and deeper areas of the southern North Sea and off the UK coast from Flamborough Head. Low intensity spawning grounds are found as far north as the Moray Firth and connected to known nursery areas (Hufnagl et al. 2013).

23. Areas of egg production are extensive, ranging from the English Channel to as far north as approximately latitude 58°N off the coast of Norway, as shown by ***Figure 10.5*** (Ellis et al. 2010; ICES 2018a). ***Figure 10.5*** indicates that the East Anglia TWO windfarm site and the eastern section of the offshore cable corridor overlap with an area defined as a low intensity spawning ground for plaice (Coull et al. 1998; Ellis et al. 2010). The focal centres of egg concentrations are considered to be located in the English Channel, Southern Bight and German Bight (Hufnagl et al. 2013).

24. Ichthyoplankton surveys (***Plate 10.1.4***) have generally found plaice stage one eggs in the southern North Sea between December and March, with the highest concentrations in the east of the southern North Sea occurring in January (van Damme et al. 2011). In 2003, it was concluded by Hunter et al. that individual fish return to the same spawning areas, suggesting strong spawning area fidelity (Hunter et al. 2003).

25. Juvenile nursery grounds are generally located in shallow (<10m deep) sandy areas, with some 0-group fish staying behind in pools on tidal flats in estuaries during the ebb tide (ICES 2006b).

26. Plaice are one of the main species targeted by commercial fishing vessels near the East Anglia TWO windfarm site, notably by Dutch beam trawlers (see ***Chapter 13 Commercial Fisheries***). Targeted fishing for plaice must have a minimum mesh size of 100-120mm, however plaice are also caught as bycatch in mixed fisheries (targeting sole) due to reduced mesh sizes.

27. Plaice were one of the principal species caught during the otter and beam trawl surveys undertaken in 2013, within the East Anglia THREE and former East Anglia FOUR sites (EATL 2015).

28. Plaice is listed as a species of principal importance and its conservation status is defined as of 'Least Concern' in the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***). ICES has advised that the Total Allowable Catch (TAC) for plaice in Area IV (North Sea) and subdivision 20 (Skagerrak) for 2018 should not exceed 13,9052 tonnes (ICES 2018c).

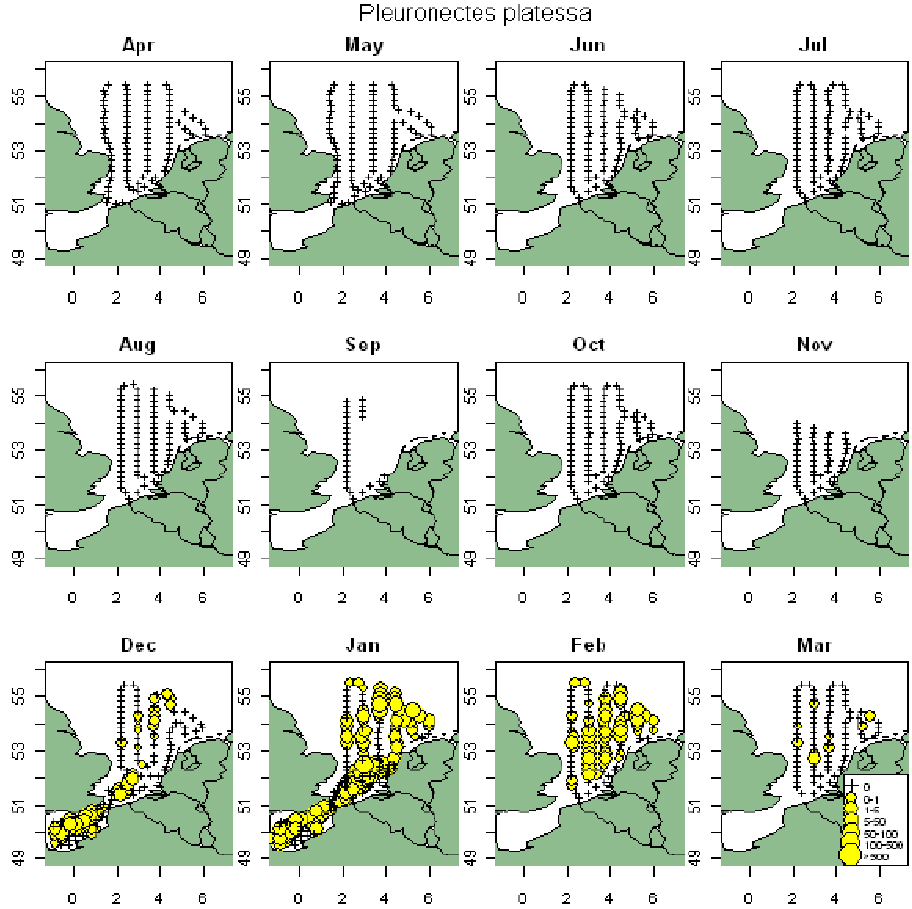


Plate 10.1.4 Spatial and temporal distribution of plaice yolk sac larvae (van Damme et al. 2011)

10.1.2.3 Cod

29. Cod are a demersal species, tolerant of a wide range of environments throughout the North Sea (***Figure 10.6***). Those in the northern North Sea tend to be found in deep (greater than 150m), warmer and more saline conditions, whereas cod in the southern North Sea are generally found in shallow (less than 50m), colder and less saline waters (Hedger et al. 2004). Sub-adults occupy a wide range of habitat types but are often found in shallower waters than adults (ICES 2006c). The results of quarterly IBTS surveys show that adults occur extensively during the colder, winter months but that their range contracts during spring and summer as they retreat northwards in response to increasing water temperatures in the English Channel and Southern Bight. Cod

undergo an extensive spawning migration, returning to the southern North Sea during autumn (NVL 2018).

30. Genetic studies have shown that the North Sea cod stock comprises of numerous sub-populations that inhabit different regions, but are reproductively isolated (Heath et al. 2014). The indirect, limited degree of mixing suggests slow recolonization in areas where sub-populations are depleted (ICES 2018d). There are limited movements of young cod from the eastern English Channel into the southern North Sea, and cod in the German Bight show some limited mixing with those in the Southern Bight (Horwood et al. 2006).

31. Limited information exists regarding the cod spawning areas which are currently active in the North Sea (Fox et al. 2008). Tagging studies have shown that cod tagged and released at spawning locations will roam for hundreds of kilometres but will return to the same area they were initially caught (Heath et al. 2014). Cod are pelagic spawners, hence cod spawning grounds are not substrate specific. However, temperatures around 5-7°C and high salinities have been found to be of preference (González-Irusta 2015).

32. Persistence of cod spawning grounds over a period of study was related to inter-annual stability in temperature, with high variability in the use of Southern Bight spawning grounds (González-Irusta 2015). Previous studies have documented the presence of spawning areas in the Southern Bight, near Flamborough and around the southern and eastern edges of the Dogger Bank (NVL 2018). Van Damme et al. (2011) found yolk sac larvae at a limited number of sampling stations in the east of the southern North Sea in February (***Plate 10.1.5***). Ichthyoplankton surveys shown in ***Figure 10.7*** confirm the results of these spawning studies showing hot spots of egg production around the southern and eastern edges of the Dogger Bank, in the German Bight, the Moray Firth and to the east of the Shetlands (Fox et al. 2008).

33. The offshore development area lies within an extensive low intensity spawning area defined by Ellis et al. (2010) and shown in ***Figure 10.7***. In the Southern Bight, peak spawning occurs in February (Heessen and Rijnsdorp 1989), however in the southern North Sea it varies from the last week of January to mid-February (Fox et al. 2008), with peak spawning occurring in the eastern English Channel in mid-February (Brander 1994).

34. For management purposes, ICES currently defines three separate assessment areas for North Sea cod: Divisions IIIa (Skagerrak), VIId (English Channel) and Sub-Area IV (southern and northern North Sea). ICES has advised, based on the EU-Norway management plan, that landings of cod in the North Sea should not exceed 28,204 tonnes in 2019 (ICES 2018d). ICES reports that since

implementing effort management (days at sea regulation) fishing mortality rates have reduced and the stock size has increased since 2006 (ICES 2018d).

35. Cod is a target species for smaller, multipurpose vessels in East Anglia, particularly inshore (within rectangle 33F1) (***Table 10.1.2***). In otter trawl samples at both control and at windfarm stations conducted in February 2013 for East Anglia THREE and the former East Anglia FOUR windfarms, low numbers of cod were recorded overall. For East Anglia THREE, cod was only present during surveys in February; while for East Anglia FOUR cod was only present in May (NVL 2018).

36. Cod is listed as a species of principal importance, included in the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) list of threatened and / or declining species. The IUCN defines the species' status as 'Vulnerable' (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***).

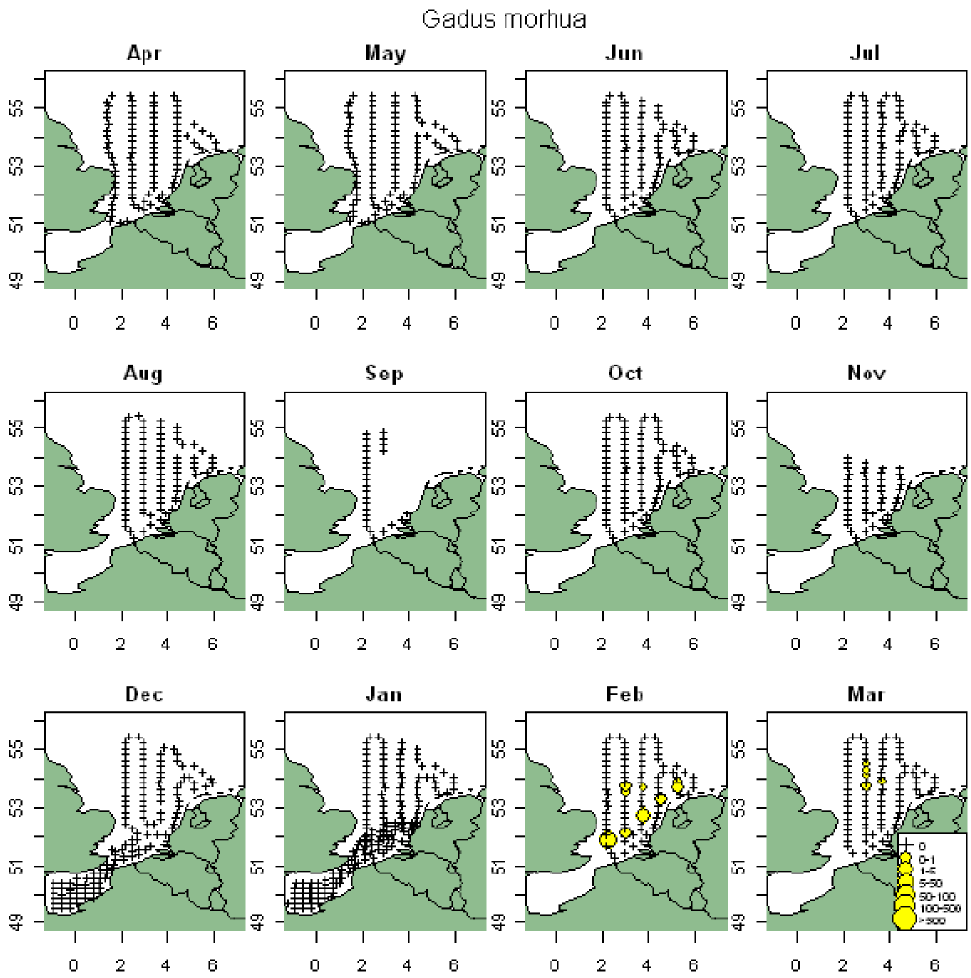


Plate 10.1.5 Spatial and temporal distribution of cod yolk sac larvae (van Damme et al. 2011)

10.1.2.4 Whiting

37. Whiting is found at high densities across the North Sea, with exception of the Dogger Bank, which generally shows lower abundance (Kerby et al. 2013)

38. Whiting is a fast-growing demersal species, reaching maturity at two years (Loots et al. 2011). They are commonly found near the bottom in depths from 10 to 200m (ICES 2006d) inhabiting a variety of substrates such as mud, gravel, sand and rock (Barnes 2008b). As illustrated by ***Figure 10.8***, whiting occurs throughout the North Sea, Skagerrak and Kattegat (ICES 2006d), with pelagic young generally found in offshore waters, while older whiting occur extensively in coastal waters (González-Irusta and Wright 2017). ***Figure 10.9*** illustrates juvenile distribution throughout the North Sea, with great abundances off the German Bight, Dutch coast, the central North Sea and further north.

39. Whiting has one of the longest spawning periods among North Sea species, from February to June, peaking in April (Loot et al. 2011; Coull et al. 1998; van Damme et al. 2011). González-Irusta and Wright (2017) classified spawning areas, with one in the northern North Sea and the other in the south and west of the North Sea. The southern spawning distribution extends up to the southern part of the Firth of Forth and eastwards to the German Bight (González-Irusta and Wright 2017).

40. Past studies of spawning in the southern and central North Sea found peak abundance to be between 20-40m, but still abundant at depths to 125m (González-Irusta and Wright 2017). Along with temperature and salinity, high tidal streams are important environmental factors that influence the geographical extent of spawning sites (Loot et al. 2011; González-Irusta and Wright 2017).

41. As shown in ***Figure 10.9***, the eastern section of the offshore cable corridor and East Anglia TWO windfarm site (74% of the offshore development area) are within low intensity spawning areas for whiting (Ellis et al. 2010). Hoowever this equates to 0.1% of the whole spawning area overlapped by the offshore development area. Additionally, the offshore development area overlaps with nursery grounds defined by Ellis et al. (2010), with the nearest nursery ground defined by Coull et al. (1998) 12km away. Notably, the distributions of juveniles shown in ***Figure 10.9***, reproduced from Ellis et al. (2010) and Cefas 2018 data, does not correlate with the whiting nursery grounds depicted by Coull et al. (1998).

42. Whiting eggs have been recorded in the vicinity of the offshore development area (ICES 2018) (***Figure 10.9***), coinciding with the spawning areas given in Coull et al. (1998) and Ellis et al. (2012). Whiting yolk sac larvae were found

between December to March during previous IMARES surveys (van Damme et al. 2011) (***Plate 10.1.6***).

43. French demersal otter trawlers target whiting in spring for one or two months in the North Sea (***Chapter 13 Commercial Fisheries***), although substantial quantities are also discarded from commercial catches (ICES 2018e). Landings by weight for whiting are low in the offshore cable corridor (33F1), and non-existent in the East Anglia TWO windfarm site. However, during the otter trawl fish sampling undertaken in East Anglia THREE and former East Anglia FOUR sites in 2013, whiting was one of the top three species caught (NVL 2017).

44. As shown in ***Table 10. 17*** of ***Chapter 10 Fish and Shellfish Ecology***, whiting is listed as a species of principal importance and ICES has advised that total catches should be no more than 25,302 tonnes in the North Sea and Eastern Channel for 2019 (ICES 2018e).

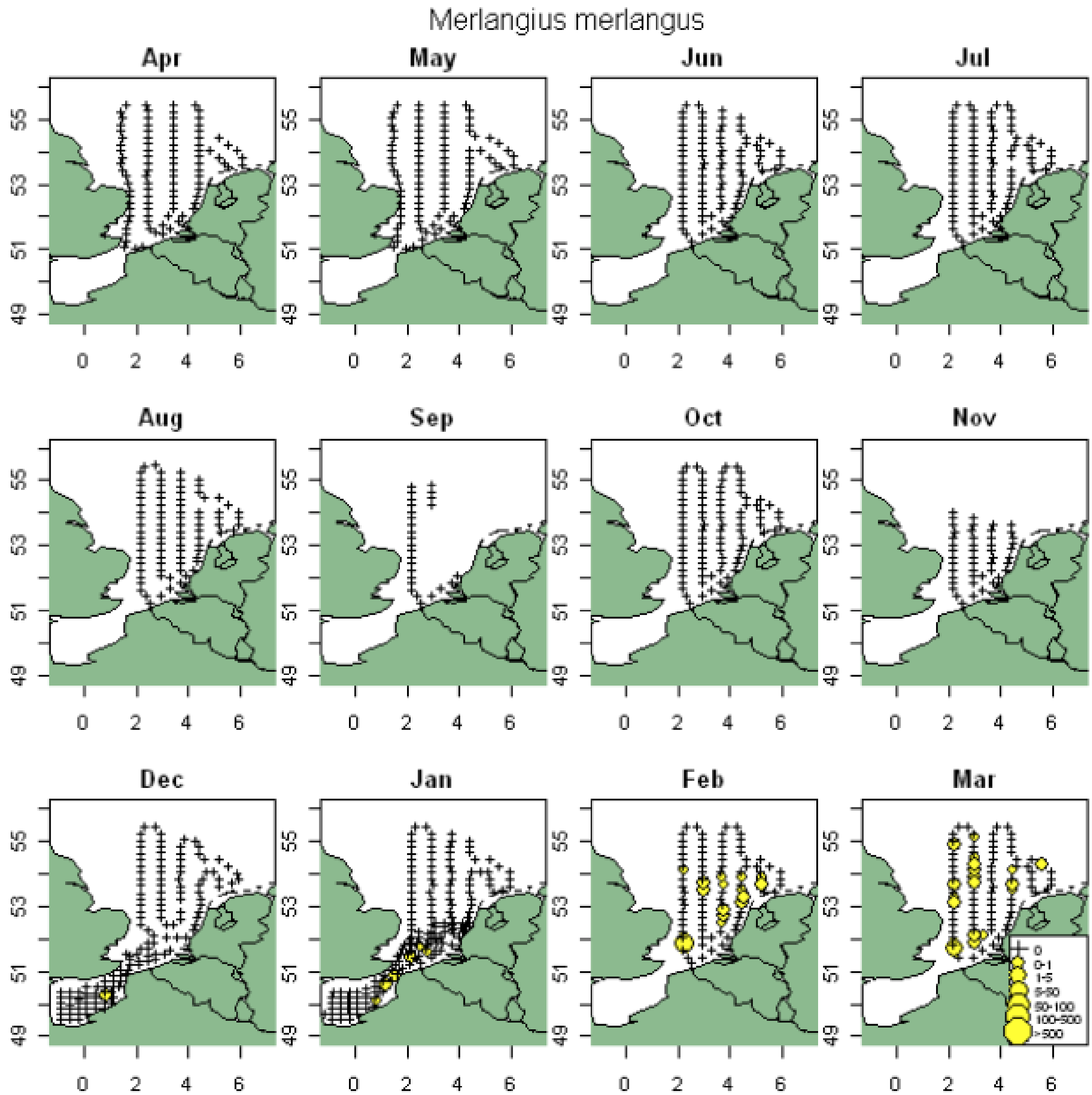


Plate 10.1.6 Spatial and temporal distribution of whiting yolk sac larvae (van Damme et al. 2011)

10.1.2.5 Lemon Sole

45. Lemon sole is a commercially important flatfish found in the shelf waters of the North Atlantic from the White Sea and Iceland southwards to the Bay of Biscay (ICES 2018f). As shown in ***Figure 10.10***, they are of greatest abundance in the central region of the North Sea and off the east coast of Scotland.

46. Lemon sole appears to prefer sandy and gravelly substrates between 20-200m depth (Barnes 2008c), living deeper and at higher salinity and lower temperature than plaice or sole (Hinz et al. 2006).

47. Sexual maturity occurs in males at 2-4 years and at 4-5 years in females (Monroe et al. 2015). Lemon sole may live for about 20+ years and can attain

lengths of over 60cm (Fish Base 2018a). They spawn in spring and summer, starting in April in the north-west of the North Sea and spreading north and east as the seasons progress (Monroe et al. 2015). The offshore development area is within lemon sole spawning and nursery grounds as defined by Coull et al. (1998) (***Figure 10.11***). The lemon sole does not have well-defined spawning grounds, but simply spawns widely throughout its range, as shown by larvae distribution in ***Figure 10.12*** and ***Plate 10.1.7***.

48. Lemon sole is generally a bycatch species in mixed fisheries (ICES 2018f). There is no formal or analytical assessment of lemon sole in EU waters, due to sparsity of data on age and length distributions in landings and discards from countries participating in the fishery (ICES 2018f). Survey information available for the North Sea subarea IV and Divisions IIIa and VIId shows fluctuation of biomass without significant trend since the mid-1980s, although landings data have mostly decreased since the mid-1980s, with a small increase in recent years (ICES 2018f). ICES advice for 2018 and 2019 is that catches of lemon sole should be no more than 5,484 tonnes (ICES 2018g). Provided discard rates do not change (28% of the total catch) this implies landings of no more than 3,924 tonnes (ICES 2018g).

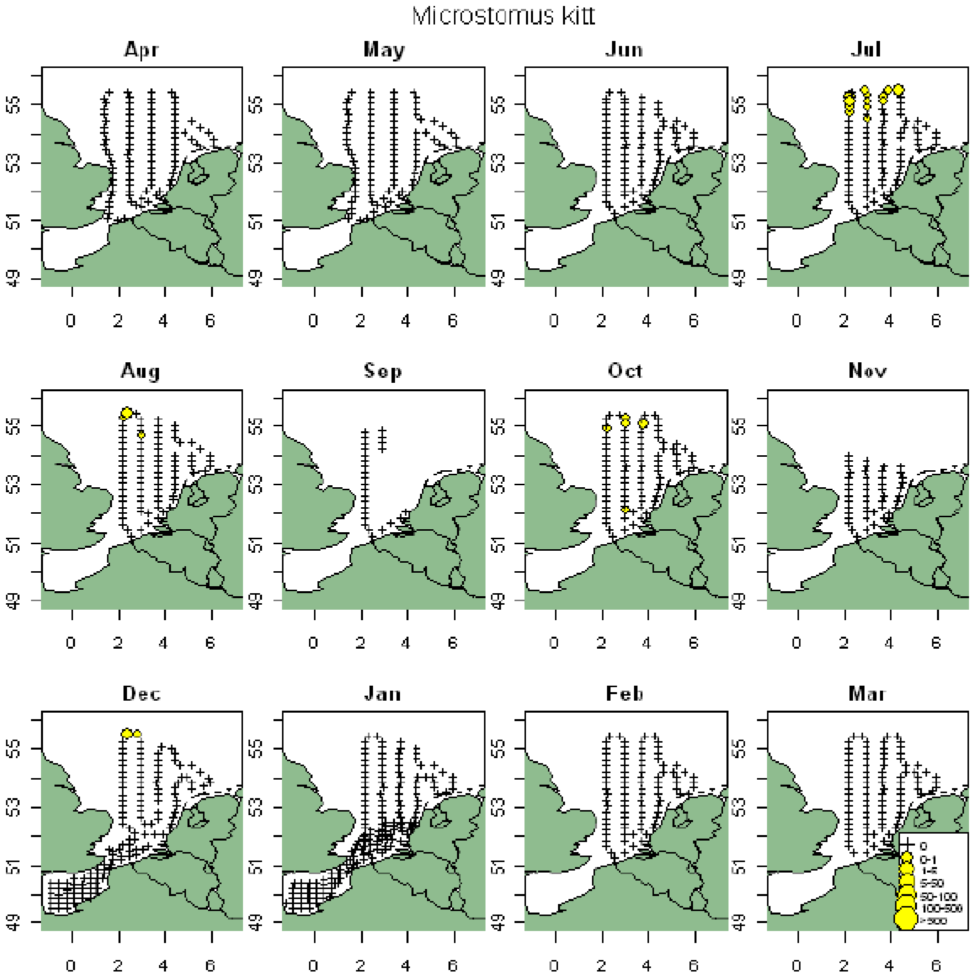


Plate 10.1.7 Spatial and temporal distribution of non-yolk sac lemon sole larvae (van Damme et al. 2011)

10.1.2.6 Seabass

49. The European seabass is found in the coasts, estuaries and lagoons of the Mediterranean Sea and north-eastern Atlantic Ocean. Studies have concluded that the Mediterranean and Atlantic fish are sub species due to differing in morphology, life history and genetics (ICES 2018i).

50. Seabass is slow growing, maturing later, around 4-7 years of age (IFM 2015). They exhibit sexual growth dimorphism where female bass mature at a greater size and age than males (Kennedy and Fitzmaurice 1972). They tend to be more common in shallow waters, but can inhabit coastal waters at depths of 100m (Fish Base 2018b).

51. Seabass undergo seasonal migration from inshore to offshore spawning sites, entering coastal waters and estuaries in summer to feed and then migrating offshore in colder weather to spawn (IFM 2015). Previous studies have suggested that they have fidelity with summer feeding grounds (de Pontual et al. 2018). However, it is yet to be clarified if this is learnt behaviour or natal

homing (de Pontual et al. 2018).

52. Seabass is a group spawner, releasing pelagic eggs into the water column once a year, usually in spring (Fish Base 2018b). ***Plate 10.1.8*** displays where eggs of seabass were found in the central southern North Sea and Doggerbank, with van Damme et al. (2011) stating that the eggs found were in different developmental stages.

53. The juvenile stage occurs approximately two months after spawning (Kelley 1988), with larval bass remaining in the plankton, transported inshore by currents into post-larval habitats in estuaries and shallow coastal waters (Jennings and Pawson 1992) as they grow into juveniles. Bass can tolerate brackish water habitats such as those in estuaries and river mouths where they spend much of their juvenile stage (Kennedy and Fitzmaurice 1972). Juveniles form schools, whereas adults appear to be less social (Fish Base 2018b).

54. Seabass is an important commercial and recreational stock, however its fisheries have been in dramatic stock decline since 2010 (Williams et al. 2018). Many factors have contributed to the stock decline, including a period of poor recruitment due to adverse environmental conditions, along with unchecked expansion of fishing efforts, and unsustainable catch efforts (Williams et al. 2018).

55. As of 1st January 2017, new bass fishing regulations came into play throughout the UK. In the North Sea, commercial fisheries are only permitted to catch and retain bass with fixed gillnets, hooks and lines, demersal trawls and seines. Use of any other gears to catch or retain bass, including drift nets, are prohibited. In addition to these regulations, recreational fishers are permitted one seabass per day, and any additional fish caught must be returned immediately during the period of 1st October to 31st December 2018. Commercial fisheries are not permitted in the South West Approaches, Irish Sea or Celtic Sea throughout 2018. During January 2018 and from 1st April until 31st January 2019, fisheries are restricted in the North Sea, and Channel, and only permitted if authorisation from the MMO has been obtained. Fishing for bass during February and March 2018 was prohibited (MMO 2018). According to ICES advice, no more than 1,789 tonnes should be landed by both commercial and recreational catches (ICES 2018h).

56. ***Figure 10.12*** shows the extent of the historical sea bass fishery near the offshore development area.

57. Seabass is classified as of ‘Least Concern’ in the IUCN Red List of Threatened Species (***Table 10.17*** of ***Chapter 10 Fish and shellfish Ecology***). Chartable data for sea bass is limited.

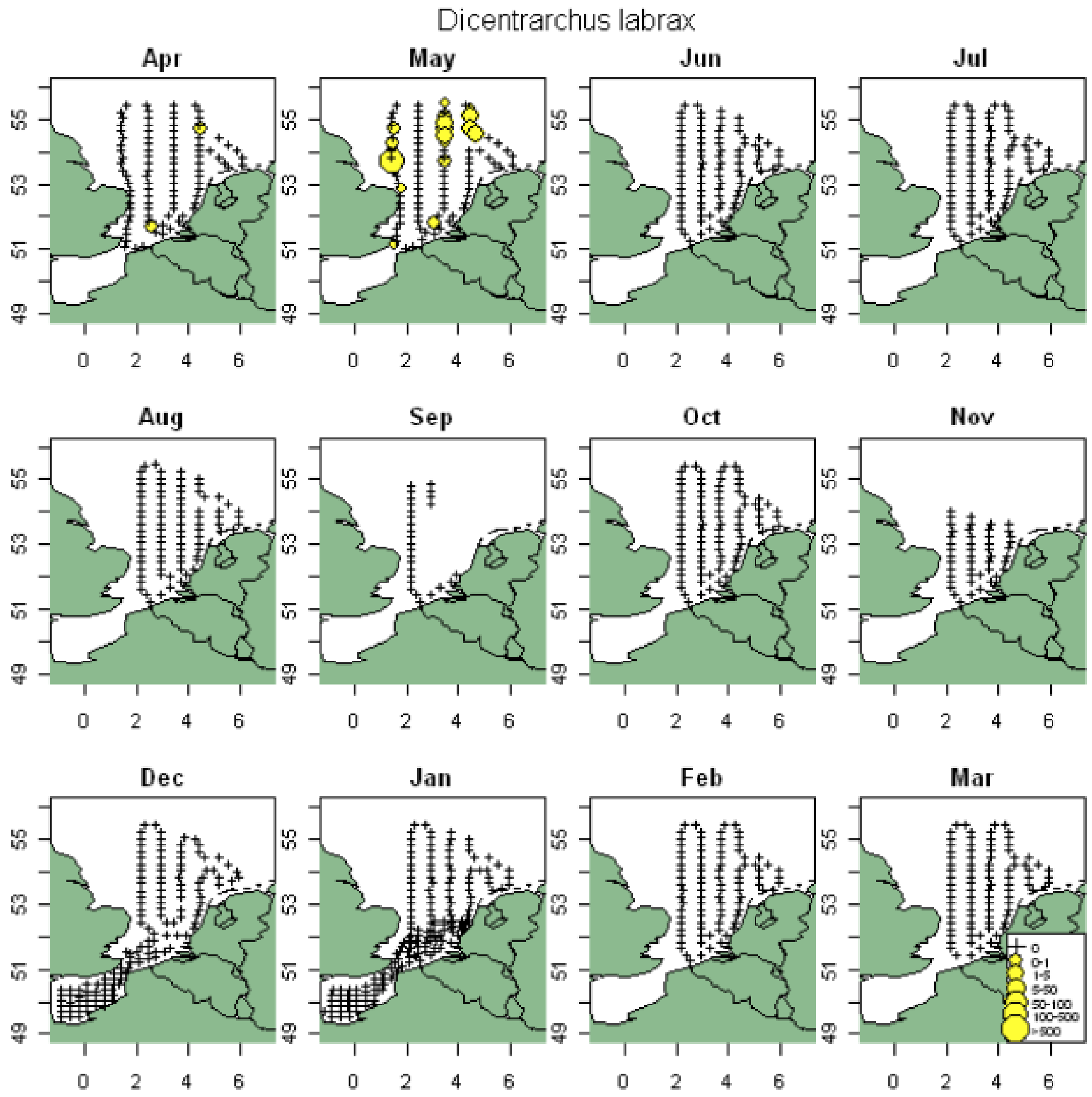


Plate 10.1.8 Spatial and temporal distribution of stage 1 seabass eggs (van Damme et al. 2011)

10.1.3 Commercial Pelagic Species

10.1.3.1 Herring

58. Herring is widely found throughout the North Sea, as shown in ***Figure 10.13***, with greatest abundances found in the English Channel, German Bight, Kattegat and northern North Sea. Their distribution is also determined by favourable feeding conditions (Corten 2000). Adult fish are pelagic and are found mostly in continental shelf seas to depths of 200m (ICES 2006e). Juvenile fish are found generally in shallower waters to depths of 100m, moving to deeper waters once they reach two years. Herring form shoals, generally remaining in deep water or close to the sea bed during the day and migrating vertically towards the sea surface during the night (ICES 2006e).

59. The North Sea consists of spring-spawning and autumn-spawning herring. ***Plate 10.1.9*** displays where both types of spawners are typically found. It is autumn-spawning herring stock, that is relevant to the project and are considered to comprise of four spawning components as shown in ***Plate 10.1.9*** (Payne 2010). The Downs sub-population is of significance to the proposed East Anglia TWO project, being located 1.35km away. This population spawns from late autumn through to February (peak during December and January) in the eastern English Channel and southern Bight of the North Sea (ICES 2018k), and moves towards the central and northern North Sea in spring and summer to feed. The other three sub-populations spawn in the North Sea in August/September (the Orkney–Shetland, the Buchan and the Banks components) (***Plate 10.1.9***).

60. Herring are demersal spawners and spawn on coarse substrates such as sand, gravel, shells and pebbles (ICES 2006e). The Downs herring produce fewer and larger eggs than the other spawning populations in the North Sea; however, their eggs form most of the herring larvae in the North Sea (Schmidt et al. 2009). Once planktonic, the larvae rise to the surface and are transported eastwards to nursery grounds by prevailing currents towards the German Bight and Skagerrak (Dickey-Collas 2005; ICES 2006e).

61. As previously mentioned, the East Anglia TWO windfarm site is 1.35km from the spawning grounds of the Downs component as demonstrated by Coull et al. (1998) (***Figure 10.14***). ***Figure 10.14*** also shows that the offshore development area lies within broadly defined low intensity nursery grounds for herring (Ellis et al. 2010), with 26% of the offshore development area within high intensity nursery grounds as defined by Ellis et al. (2010). The overlap of the offshore development area is less than 1% of all high intensity nursery areas for herring in the North Sea. According to the results of the International Herring Larvae Survey (IHLS) conducted in the area, herring larvae densities in the immediate vicinity of the offshore development area were zero in 2017 (***Figure 10.17)***. Previous years indicate high abundances (up to 10,000 n/m^3) of larvae present in the immediate vicinity of the offshore development ***Figure 10.15***, ***Figure 10.16*** and ***Figure 10.17***).

62. Monthly ichthyoplankton surveys conducted by van Damme et al. (2011), encompassing the offshore development area, did not find yolk sac herring larvae near the offshore development area (***Plate 10.1.10***). IHLS southern North Sea surveys conducted between 2007 and 2017 recorded some small larvae (<11mm) at stations surrounding, and on some years, within the East Anglia TWO windfarm site (***Figure 10.15***, ***Figure 10.16*** and ***Figure 10.17***). It cannot be ruled out therefore, that on occasions, currents may carry some planktonic larvae through the offshore development area, from spawning

grounds in the eastern English Channel and southern Bight of the North Sea to the nursery areas along the Dutch coast and into the German Bight (ICES 2018k).

63. Herring is of limited commercial importance within the study area (***Plate 10.1.1*** and ***Plate 10.1.2***). Landings in the regional area are primarily from the inshore ICES rectangle 33F1; however, 72 tonnes were landed in 2016 from ICES rectangle 33F2, with very few landings between 2012 and 2015. Clupeids (herring and sprat) were present, albeit in relatively low numbers, at sites sampled in the East Anglia THREE and former East Anglia FOUR surveys (EATL 2015).

64. Herring is of conservation interest, being listed as a species of principal importance (***Table 10. 15*** of ***Chapter 10 Fish and Shellfish Ecology***). Fishing over-exploitation during the 1960s followed by a failure in recruitment in the 1970s caused Downs herring to be the first North Sea component to collapse, and it was subsequently the component that took the longest time to recover (NVL 2018). However, the Downs component has consistently increased, making it the major component of the North Sea stock of late.

65. Whilst stock size has increased, in recent years, herring recruitment in the North Sea has been low, particularly since 2002 (ICES 2018j). An ICES Herring Assessment Working Group (HAWG) report for 2018 indicates that spawning in the North Sea was lower in 2017 than previous years due to the decreased number of fish in stock, as the stock was dominated by young fish (approximately 3-4 years) (ICES 2018l). ICES has advised that total catches should be no more than 311,572 tonnes in the North Sea and Eastern Channel for herring for 2019 (ICES 2018j).

66. Herring is an important prey for many predators such as piscivorous fish (like cod and other large gadoids), sharks, marine mammals and seabirds; this trophic importance puts enormous pressure on stocks from its continuous exploitation (ICES 2018l).

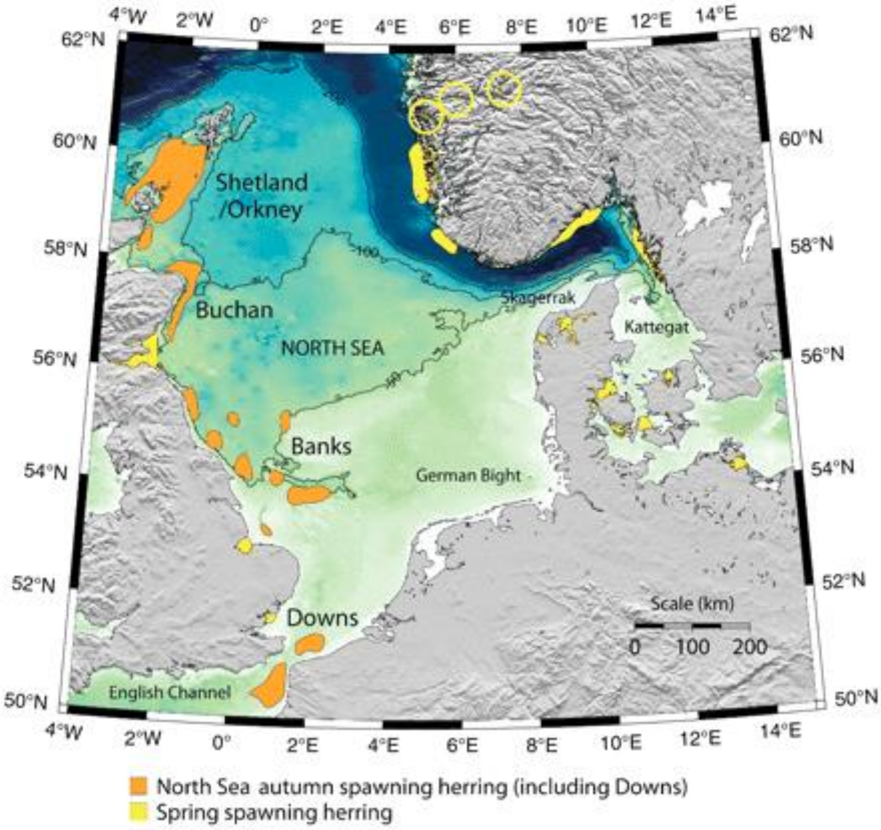


Plate 10.1.9 Atlantic herring spawning sub-populations in the North Sea (Payne 2010)

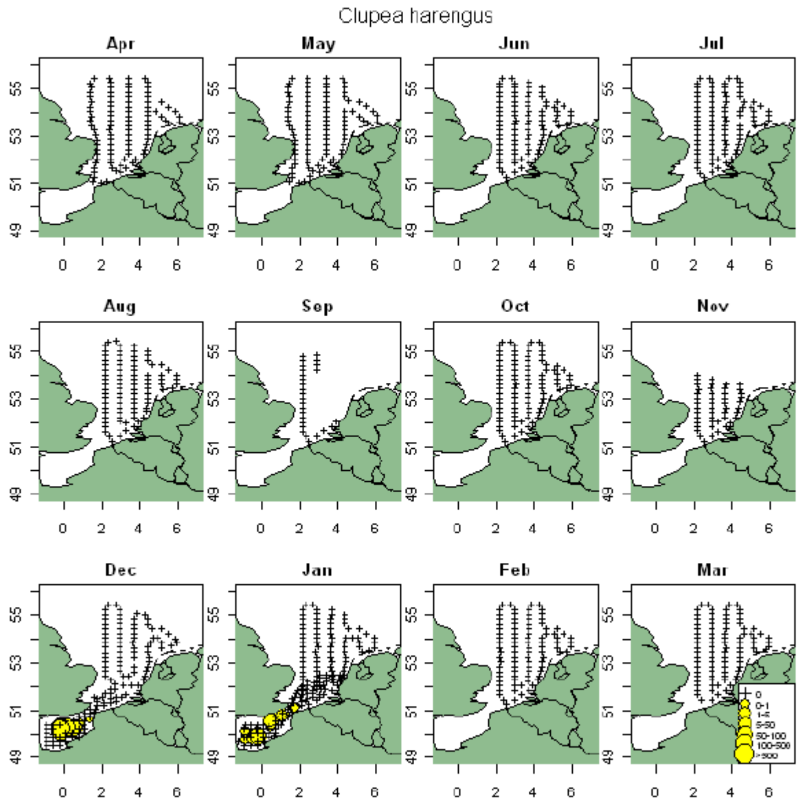


Plate 10.1.10 Spatial and temporal distribution of herring yolk sac larvae (van Damme et al. 2011)

10.1.3.2 Sprat

67. Sprat is common throughout the North Sea, particularly in and around the Dogger Bank, the German and Southern Bights (***Figure 10.20***) and the Firth of Forth and Moray Firth. Their distribution is determined by hydrographic conditions, as they are tolerant of low salinities and low-oxygen conditions (Sundby et al. 2017). Large seasonal migrations towards inshore waters along the British coast and central North Sea are undertaken for overwintering. In spring sprat depart coastal waters to offshore spawning grounds during the summer (Nedreaas et al. 2015).

68. Landings of sprat during 2012 to 2016 were from the inshore ICES rectangle (33F1) only as shown by ***Table 10.1.2***, contributing 0.15% towards the total catch in ICES rectangle 33F1.

69. Spawning areas encompass most of the southern North Sea, from the Southern and German Bights to Jutland and Kattegat. As well as occurring along the English and Scottish coasts. The main areas are found in the German and Southern Bight and the English Channel (Sundby et al. 2017) and displayed in ***Figure 10.21***.

70. Spawning takes place in both coastal waters and offshore up to 100km from shore (FAO 2011) between January and September, with a peak between May and August (Coull et al. 1998; van Damme et al. 2011; Sundby et al. 2017) (***Figure 10.21***). Females spawn repeatedly in batches throughout the spawning season (ICES 2006f). As sprat are pelagic spawners, their eggs and larvae are often abundant near tidal mixing fronts and are subject to larval drift, directing movement to inshore nursery areas (ICES 2006f; NVL 2018).

71. 78% of the offshore development area falls within the broadly defined spawning grounds for sprat (Coull et al. 1998) (***Figure 10.21***), however this overlap equates to less than 1% of the entirety of sprat spawning areas. All of the offshore development area lies within sprat nursery grounds (Coull et al. 1998) (***Figure 10.21***).

72. Ichthyoplankton surveys conducted by van Damme et al. in 2011, identified sprat stage one eggs within the offshore development area and the wider North Sea from March to June (***Plate 10.1.11***), however yolk sac sprat larvae were only identified in June (***Plate 10.1.12***).

73. Sprat is not listed as a species of conservation importance, but is of commercial importance. The spawning stock biomass (SSB) has been well above B_{pa}[2] since 2008 with recruitment remaining high since 2015 to 2017 (ICES 2018l). ICES

[2] Precautionary reference point for Spawning Stock Biomass

has advised, on the basis of precautionary considerations, that catches of sprat from 1st July 2018 to 30th June 2019 should be no more than 177,545 tonnes (ICES 2018m).

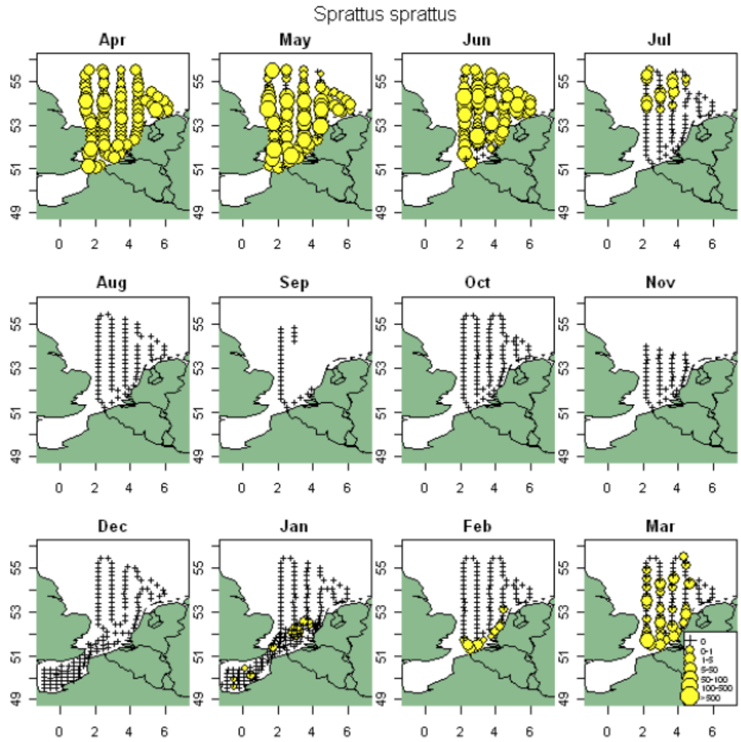


Plate 10.1.11 Spatial and temporal distribution of sprat stage one eggs (van Damme et al. 2011)

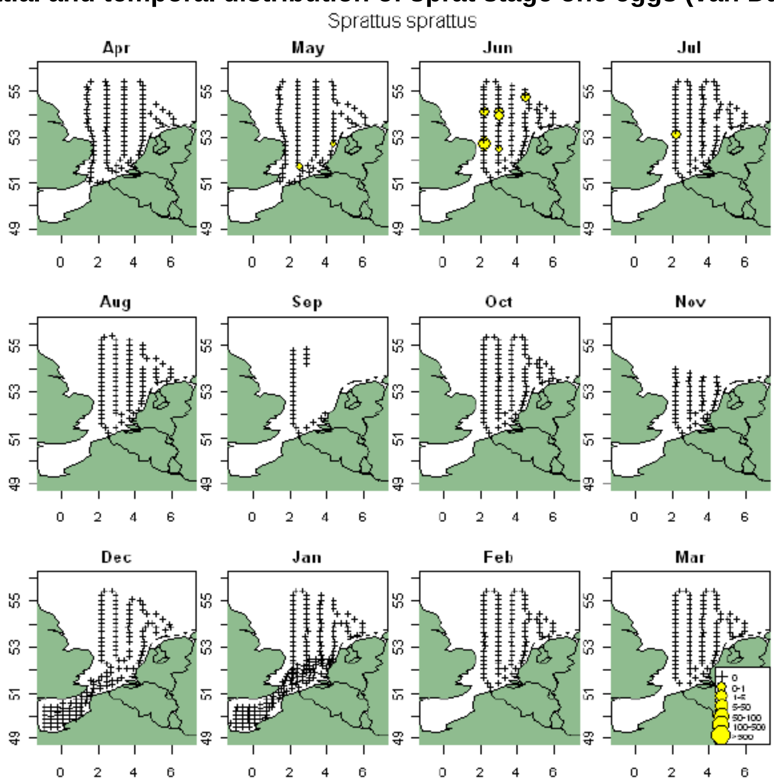


Plate 10.1.12 Spatial and temporal distribution of sprat yolk sac larvae (van Damme et al. 2011)

10.1.3.3 Sandeel

74. The North Sea sandeel population has been divided into a number of sub-populations rather than an individual homogeneous stock (ICES 2018l). For the purposes of stock management, ICES divided the North Sea and Kattegat into seven sandeel areas (SAs). The offshore development area is within the boundaries of Sandeel Assessment Area 1r.

75. Three species of sandeel were recorded in the site specific scientific beam trawl surveys undertaken in the East Anglia THREE and former East Anglia FOUR sites: small sandeel, greater sandeel and smooth sandeel (EATL 2015). Smooth sandeel, greater sandeel and lesser sandeel have also been recorded in the study area by the IBTS (***Table 10.1.1***). Within the study area, the CPUE of greater sandeel was particularly high in ICES rectangle 33F2, where the East Anglia TWO windfarm site is to be located. Analysis of IBTS data in the wider North Sea (***Figures 10.22*** to ***10.25***), however, suggest that sandeel is found in the offshore development area in relatively low numbers.

76. When overwintering, sandeel spend approximately eight months (August to April) buried in sandy bottom habitats, emerging at dawn during spring to commence feeding (ICES 2016b; Sundby et al. 2017). Their distribution is limited to shallow, turbulent areas of sediment at depths of 20-70m (***Figures 10.22*** to ***10.25***) (Greenstreet et al. 2010; Jensen et al. 2011).

77. In 2000, Wright et al. reported an inverse correlation between lesser sandeel densities and sediment samples with an increasing silt fraction, with a total absence of the species in samples with a silt fraction greater than 10%. In 2005, Holland et al. revealed a preference for samples of a high medium and coarse sand and low silt content. This has been attributed to a lower proportion of interstitial water, thus a lower oxygen supply in silty sediments than coarser sandy sediments (Holland et al. 2005). Additionally, lesser sandeel occupies areas with bottom temperatures of 8.5-9.0°C and surface salinities of 34.90-35.0 ppt (van der Kooij et al. 2008). Sandeel habitat preferences are shown in ***Table 10.1.3*** (as adapted from Marine Space 2013).

78. Female lesser sandeel usually spawn where they live, between November and February, laying their eggs in clumps on sandy sediment (Coull et al. 1998). Upon hatching around February – March, larvae remain in the water column before eventually settling near the seabed approximately 2 – 5 months later (Macer 1965; Wright and Bailey 1996). Recruitment to individual fishing banks is mostly related to the local (sub-) stock, some interchange can occur between these sub-stocks before larvae settle due to prevailing sea circulation. Following settlement, sandeel form a complex of local (sub-) stocks in the North Sea and are largely sedentary (Heath et al. 2012).

79. ***Figure 10.26*** demonstrates that the offshore development area falls within low intensity sandeel spawning and nursery grounds defined by Ellis et al. (2010). 75% of the offshore development area overlaps with spawning and nursery grounds defined by Coull et al. (1998), however this overlap is less than 1% of the whole area for spawning and nursery.

80. Ichthyoplankton surveys (van Damme et al. 2011) found lesser sandeel yolk sac larvae throughout the offshore project area in February and March, whilst early larval stages of small sandeel, greater sandeel and smooth sandeel were not found in significant numbers (***Plate 10.1.13*** to ***Plate 10.1.16***).

81. Particle Size Analysis (PSA) of the sediment samples from previous surveys across the East Anglia Zone area suggest the presence of sub-prime sandeel habitat (***Table 10.1.3***). However, the presence of suitable or preferred habitat (prime / sub-prime) does not mean that there will be significant numbers of sandeel present. As mentioned above, spawning and nursery grounds for this species in areas relevant to the offshore development area are considered of low intensity and information from commercial fishing in terms of both, fishing grounds and fishing density does not suggest that the offshore project area is of key importance to sandeel stocks (***Chapter 13 Commercial Fisheries***). Similarly, data from the IBTS survey (***Figures 10.22*** to ***10.25***) does not suggest that sandeel is found in significant numbers in the offshore development area.

82. Sandeel stocks are assessed based on landings data from international commercial fisheries combined with biological sampling by scientific institutes e.g. Fisheries Research Services' Marine Laboratory (Fisheries Research Services No date). Due to high substrate specificity and limited larval exchange between sandeel populations, they are particularly vulnerable to overfishing (Jensen et al. 2011).

83. Sandeel is not a commercially important stock within the offshore development area according to UK landings data (***Table 10.1.2***). Important sandeel fishing grounds within the North Sea are located in the Dogger Bank area, far north of East Anglia TWO (see ***Chapter 13 Commercial Fisheries***). Sandeel is a high-lipid food source and form the diet of most seabirds in the North Sea (Davis et al. 2005; Wanless et al. 2005). They are caught for fish meal predominantly by the non-UK fleets including Denmark, Norway, Sweden and Germany.

84. ICES provide annual advice on fishing opportunities, catch and effort within defined Sandeel Areas within the North Sea. Recruitment within Sandeel Area 1r, central and southern North Sea and Dogger Bank plummeted to its lowest level since 1983, following an above-average recruitment in 2016 (ICES 2018n). In February 2018, ICES advised that the sandeel catch should not

exceed 134,461 tonnes in 2018 (ICES 2018n).

85. As a significant number of marine top predators rely on their population, coupled with their vulnerability to changes in habitat, sandeel is of increasing conservation interest and listed as species of principal importance in the UK (Ormerod 2003). Additionally, they are designated as a nationally important marine feature (Furness 1990; Hammond et al. 1994; Tollit and Thompson 1996; Wright and Tasker 1996; Greenstreet et al. 1998; Engelhard et al. 2013).

Table 10.1.3 The partition of sandeel species (ammodytidae) potential spawning habitat sediment classes (Source: Folk 1954; adapted from Marine Space 2013)

% Particle contribution (Muds = clays and silts <63µm)	Habitat sediment preference	Folk sediment unit	Habitat sediment classification
<1% muds, >85% sand	Prime	Part sand, part slightly gravelly sand and part gravelly sand	Preferred
<4% muds, >70% sand	Sub-prime	Part sand, part slightly gravelly sand and part gravelly sand	Preferred
<10% muds, >50% sand	Suitable	Part gravelly sand and part sandy gravel	Marginal
>10% muds, <50% sand	Unsuitable	Everything excluding gravel, part sandy gravel and part gravelly sand	Unsuitable

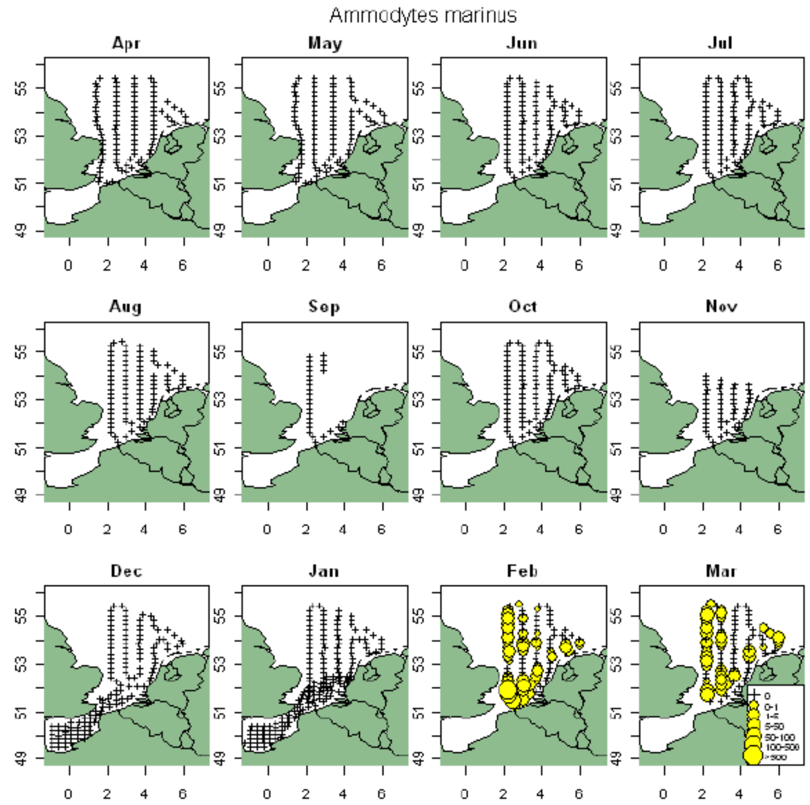


Plate 10.1.13 Spatial and temporal distribution of lesser sandeel yolk sac larvae (van Damme et al. 2011)

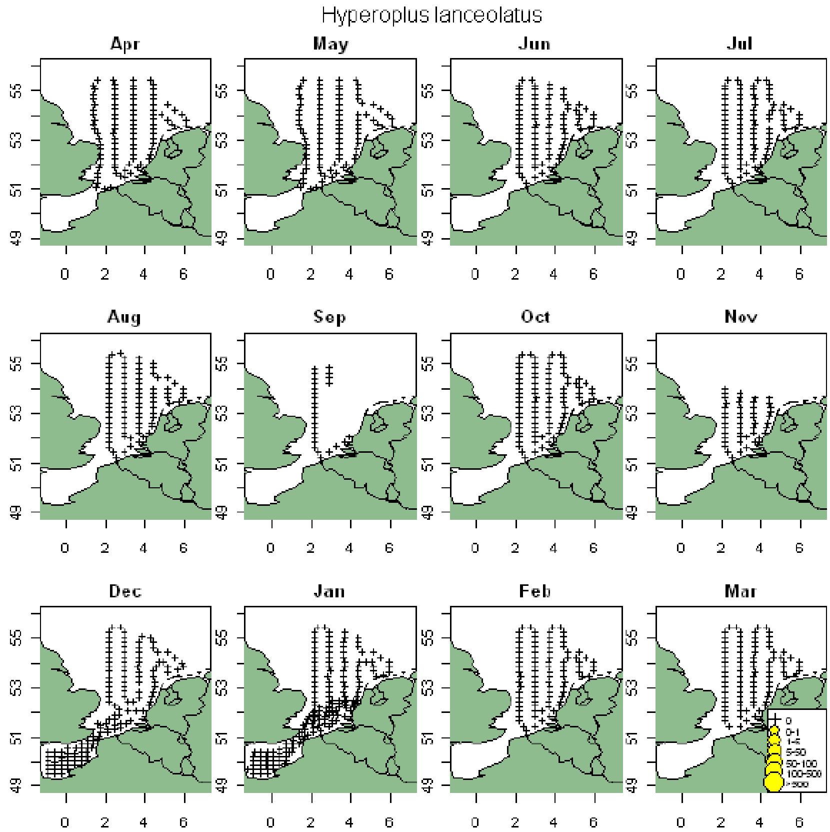


Plate 10.1.14 Spatial and temporal distribution of greater sandeel yolk sac larvae (van Damme et al. 2011)

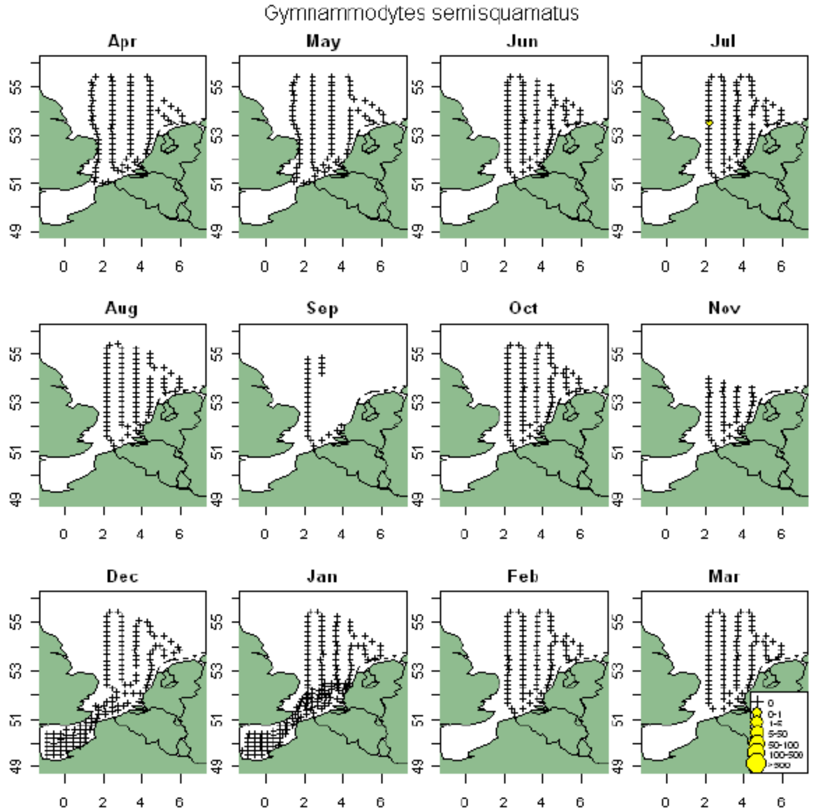


Plate 10.1.15 Spatial and temporal distribution of smooth sandeel yolk sac larvae (van Damme et al. 2011)

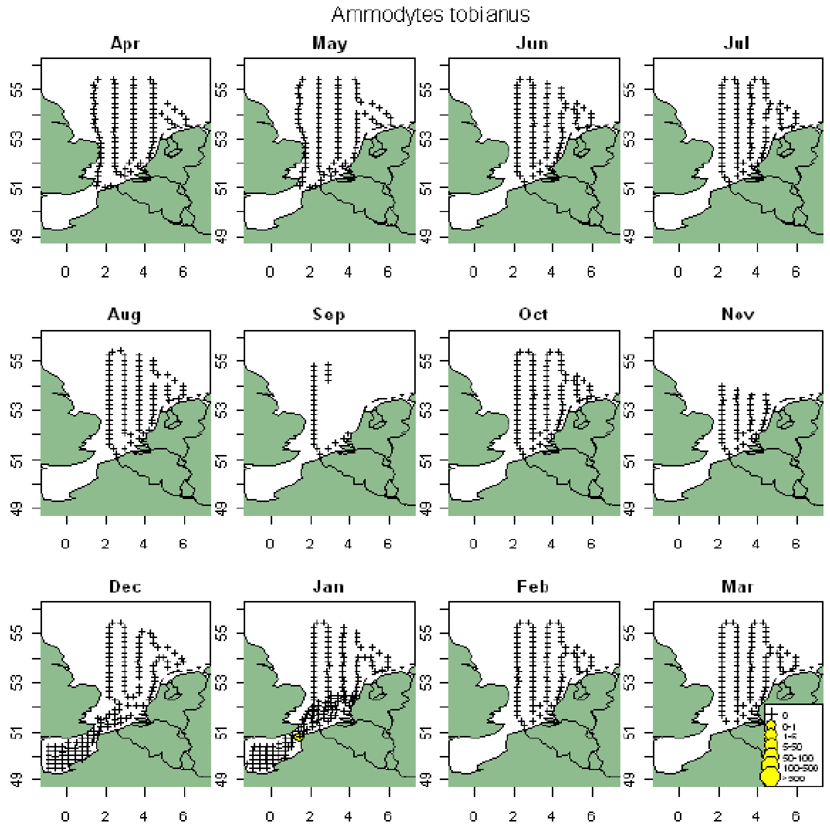


Plate 10.1.16 Spatial and temporal distribution of small sandeel yolk sac larvae (van Damme et al. 2011)

10.1.4 Elasmobranchs – Skates and Rays

10.1.4.1 Thornback Ray

86. Thornback ray is one of the most abundant elasmobranchs in the north-east Atlantic, inhabiting a broad range of soft sediments including mud, sand, shingle and gravel at depths of 10-60m (Shark Trust 2009b). It is less frequently documented on coarser sediments (Wilding and Snowden 2008). Before 1950, they were abundant in the North Sea, however populations have decreased due to a combination of factors including slow growth rate, late maturity and low fecundity (Chevolot et al. 2006). The average distribution of thornback ray in the North Sea between 2008 and 2018 is indicated in ***Figure 10.28***.

87. Thornback ray exhibits seasonal migration, moving from deeper waters in the winter (20-35m) to shallower areas in late spring and summer to spawn (<20m) (Hunter et al. 2005). A maximum of 140-160 egg cases are laid per year, although it is more typically 48-74 (Fishmap No date). Fertilised egg cases are deposited on the seabed, followed by a 4 to 5-month incubation period. After incubation, juveniles emerge as fully formed rays (Chevolot et al. 2006).

88. The western section of the offshore cable corridor is found within a defined low intensity nursery area for thornback ray (***Figure 10.29***). There are insufficient data on the occurrence of egg-bearing females during the spawning season, however it is generally believed that spawning and nursery grounds broadly overlap (Ellis et al. 2012).

89. Thornback ray represents the most common elasmobranch species landed in the East Anglia TWO offshore development area (***Table 10.1.2***). Landings were primarily recorded in the offshore cable corridor (33F1; 3.21%), with comparatively lower landings in the East Anglia TWO site (33F2; 0.42%).

90. In terms of conservation importance, thornback ray are included in the OSPAR list of threatened and / or declining species and has been classified as 'Near Threatened' by the IUCN (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***).

10.1.4.2 Spotted Ray

91. Spotted ray is most commonly found on soft sediments in coastal and shelf waters (majority of the population inhabit depths of 100-500m), although it can also be found in deeper waters in the southern areas of its range (Ellis et al. 2007). Their distribution around the British Isles is like that of thornback ray (Ellis et al. 2005).

92. Spotted ray lay their egg cases between April and July in shallow coastal waters, like the thornback ray (Whitehead et al. 1986; Ellis et al. 2005). They can lay up to 70 eggs per year, although it is more commonly between 24 and

60 eggs (Ellis et al. 2007). Juveniles emerge after an incubation period of 5-6 months (Kay and Dipper 2009). Ellis et al. (2012) found that juvenile thornback ray was more common than juvenile spotted ray in areas such as the Greater Thames Estuary.

93. IBTS survey data (***Figure 10.30***) has shown that spotted ray is present within the offshore project area. In comparison to thornback ray, spotted ray is considered of secondary importance in UK landings data (contributing 0.22% and 0.07% respectively to the total catch within ICES rectangles 33F1 and 33F2.

94. Spotted ray is included in the OSPAR list of threatened and / or declining species and have been classified as of 'Least Concern' by the IUCN (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***).

10.1.4.3 Blonde Ray

95. Blonde ray is a large bodied skate inhabiting sandy seabed areas of the north-east Atlantic and western Mediterranean Sea (***Figure 10.31***). They are common in inshore and shelf waters (at a depth of 10-150m) such as the English Channel, Bristol Channel, St George's Channel and Irish Sea (Ellis et al. 2005).

96. Blonde ray has a low fecundity, laying 30 egg cases per year, and a long incubation period of seven months, rendering them vulnerable to localised over-exploitation (Kay and Dipper 2009). As a result, the species is classified as 'Near Threatened' in the IUCN Red List of threatened species (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***)

97. In terms of UK landings, blonde rays are less commercially important in comparison to thornback rays (Ellis et al. 2009). Nevertheless, Dutch beam trawl fleets often land blonde ray together with thornback ray and spotted ray (ICES 2007). IBTS survey data has shown that blonde ray is present within the offshore project area (***Figure 10.31***) and comprised 0.63% and 0.37% of MMO landings respectively to the total catch within ICES rectangles 33F1 and 33F2.

10.1.4.4 Common Skate Complex

98. The common skate complex was amongst the most abundant ray species in the north-east Atlantic, demonstrating a broad distribution around the British Isles. However, fisheries data shows the species have dramatically reduced around the central British Isles since early 1900s, with only a small number of individual specimens reported occasionally from those areas. (Dulvy et al. 2000). They are no longer observed in inshore areas, with only occasional sightings off northern and north-western Scotland, Celtic Sea and along the edge of the continental shelf (more than 150m deep) (Dulvy et al. 2000).

99. The common skate complex is oviparous, laying egg-cases in spring and summer (Dulvy et al. 2000).

100. Common skate complex is classified as 'Critically Endangered' by the IUCN Red List of threatened Species. In addition, they are listed as species of principal importance and in the OSPAR list of threatened and/or declining species (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***). There were no landings of these species within the offshore development area (***Table 10.1.2***).

10.1.4.5 Small Spotted Catshark/Lesser Spotted Dogfish

101. Small spotted catshark, also known as lesser spotted dogfish, is one of the most abundant elasmobranchs in the north-east Atlantic and Mediterranean Sea and can be found on a range of substrates, including rocky reefs, algal, gravelly and muddy sediments (Kay and Dipper 2009). It is bottom-dwelling, usually found in waters <150m around the British Isles (Ellis et al. 2005).

102. The lesser spotted dogfish is oviparous, depositing an egg-case within shallow coastal waters and macroalgae (Compagno 1984). Spawning occurs year-round, although in several places spawning activity exhibits season patterns (Ellis and Shackley 1997).

103. Lesser spotted dogfish is a moderately important commercial species around the British Isles, primarily caught in bottom trawls in several demersal fisheries. Larger individuals are landed for human consumption or as bait for whelk fisheries, however, most are discarded and studies have shown they possess a high survivorship (Revill et al. 2005). They are listed as 'Least Concern' on the IUCN Red list of threatened species.

104. Site specific otter trawl and beam trawl surveys conducted for East Anglia THREE and East Anglia FOUR found that lesser spotted dogfish was one of the more abundant species found within the area (EATL 2015). Commercial landings of the species are relatively low near the offshore development area, contributing 2.26% and 0.50% respectively of the total catch within ICES rectangles 33F1 and 33F2 (***Table 10.1.2***).

10.1.4.6 Smoothhounds

105. There are two species of smoothhound sharks recorded in the north-east Atlantic; the starry smoothhound and common smoothhound. Smoothhound are primarily found in depths of up to approximately 50m (Kay and Dipper 2009). Starry smoothhound is widely distributed across the North Sea (***Figure 10.32***), whereas the distribution of common smoothhound is much smaller (***Figure 10.33***) being rarely recorded in the North Sea (Ellis et al. 2005).

106. There is considerable debate over whether both species are present in British waters, with growing evidence that the spots on the back of the smoothhound are not a reliable method of distinguishing between the species (British Sea Fishing 2018a). Genetic studies of 800 smoothhound captured in the north-east Atlantic determined that all specimens were starry smoothhound, regardless of the presence of spots (Farrell et al. 2009). This debate requires further research to determine beyond doubt the presence or absence of common smoothhound in British waters.

107. IBTS data shows that both starry and common smoothhound have been recorded in the offshore development area (***Table 10.1.1; Figures 10.32*** and ***10.33***), particularly the starry smoothhound in ICES rectangle 33F1. Starry smoothound is listed as 'Least Concern' on the IUCN Red List of Threatened Species, in contrast to the common smoothhound which is assessed as 'Vulnerable' due to the high commercial fishing pressure in the Mediterranean and off the coast of Africa (British Sea Fishing 2018a) (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***).

10.1.4.7 Tope

108. Tope is found within subtropical and temperate waters across the globe and frequently documented around the British Isles (Morato et al. 2003; Ellis et al. 2005). It is most common along the west coast of Scotland, the south and south-west coast of England and Wales (British Sea Fishing 2018b). Tope is usually found in packs or 'schools' of similarly sized individuals, often segregated by sex (Kay and Dipper 2009), although larger tope tend to be solitary (British Sea Fishing 2018b).

109. The offshore development area falls within defined low intensity nursery grounds for this species (***Figure 10.29***). Tope is of conservation interest, being listed as a species of principal importance. The species is assessed as 'Vulnerable' in the IUCN Red List of Threatened Species (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***).

10.1.4.8 Spurdog

110. Spurdog has a worldwide distribution and is an abundant species within the North Sea, however they are most common in western regions and off Orkney and Shetland. They occur throughout the water column (commonly from 10-200m), but have been recorded to depths of 900m (Compagno 1984; McEachran and Branstetter 1986).

111. Spurdog tagging studies in the North Sea revealed relatively little mixing between northern and southern water populations, with many recaptures occurring in Norwegian and Scottish waters (Holden 1968). Studies also revealed a movement of mature males to the north and east of the British Isles

in spring time, with a southern movement in autumn. The distribution of immature females in all seas appears to be evenly distributed throughout the year, annually moving in a clockwise direction around the British Isles. During winter and spring, adult females congregate to spawn in the Celtic Sea, vacating rapidly in late spring (Pawson 1995).

112. Once the most abundant shark species in British waters, an increasing demand for spurdog on the European market resulted in plunging stocks in the 1970s (Heessen and Daan 1996). They are now listed as a species of principal importance, are included on the OSPAR list of threatened and / or declining species and are assessed as 'Vulnerable' in the IUCN Red List of Threatened Species (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***).

113. Protective measures are now in force to protect spurdog. Since 2010, TAC was set to 0 by the European Union, however landings were still permitted under a by-catch TAC, provided certain conditions were met (ICES 2010a). This decision has resulted in the substantial reduction in fisheries targeting this species (Clarke 2009). ICES advice published in 2016 for spurdog in the north-east Atlantic advised there should be no targeted fisheries on this stock in 2017 and 2018 (ICES 2016a). Any possible provision for the landing of bycatch should be part of a management plan, including close monitoring of the stock and fisheries (ICES 2016a).

10.1.4.9 Basking Shark

114. As one of the most widely protected and managed sharks in UK and EU waters, the basking shark usually visits British waters between May and October. Sightings are concentrated in waters of the Outer Hebrides, Isle of Skye, Isle of Mull, Isle of Man, Malin Head, Devon and Cornwall, whilst sightings off East Anglia are considered extremely rare (Bloomfield and Solandt 2007).

115. Basking shark is considered 'Vulnerable' by the IUCN and are on a Red List of Threatened Species (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***). Additionally, it is protected under UK legislation (Wildlife and Countryside Act 1981) as well as the Bern Convention, where it is listed as a species of principal importance. It features on the OSPAR list of threatened and/or declining species.

10.1.5 Diadromous Fish Species

10.1.5.1 River and Sea Lamprey

116. River lamprey and sea lamprey are parasitic anadromous migratory species, records of these species in East Anglian rivers are relatively scarce compared with other areas of the UK (Kelly and King 2001).

117. Both species spawn in fresh water environments in spring or early summer.

This is followed by a larval phase (ammocoetes) within appropriate silt beds in streams and rivers before migrating out to sea, to feed as adults (Laughton and Burns 2003). Transformation from larval to adult stage is characterised by the development of functional eyes and a fully formed sucker for a mouth (Waldman et al. 2008). After transformation, river and sea lampreys migrate to sea, where they use their suction cup-like mouth to attach to the skin of fish and feed (Waldman et al. 2008).

118. River lamprey generally inhabits coastal waters, estuaries and accessible rivers. Following one to two years occupancy in an estuarine environment, river lamprey ceases feeding in the autumn and move upstream between October and December (Waldman et al. 2008), returning to fresh water to spawn (Laughton and Burns 2003).

119. Sea lamprey is recorded in low abundance in estuarine and inshore waters (Maitland and Herdson 2009), and as shown in ***Table 10.1.1***, were found in the offshore cable corridor. In the open sea, adults attach to host species, becoming parasitic on a variety of marine mammals and fish, including basking shark and occasionally sperm whale (Maitland and Herdson 2009), herring, salmon, cod, haddock and sea bass (Kelly and King 2001; ter Hofstede and Rijnsdorp 2008). Their distribution is therefore largely dictated by their hosts (Waldman et al. 2008). Homing behaviour is not apparent in this species (Waldman et al. 2008) and unlike salmonids and shads, lamprey do not have specific river populations (ter Hofstede and Rijnsdorp 2008).

120. River and sea lamprey are both of conservation interest, being listed as species of principal importance and protected under the Habitats Directive (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***).

10.1.5.2 Allis and Twaite Shad

121. Allis shad and twaite shad are anadromous migratory species which school in shallow coastal waters and estuaries at depths between 10 and 20m before entering rivers to spawn. Adults migrate from the sea to fresh water in spring and early summer (April to June), travelling to higher, middle watercourses of rivers to spawn from mid-May to mid-July (Maitland and Hatton-Ellis 2003; Acolas et al. 2004; Patberg et al. 2005). Following spawning, adults return to the sea while juveniles remain in rivers over the summer months prior to their migration downstream in the autumn.

122. Spawning stocks of the twaite shad are only found in a few rivers in and around the southern Welsh border (JNCC 2018). In contrast to twaite shad, the majority of allis shad only spawn once and then, after spawning, the adults die (ter Hofstede and Rijnsdorp 2008). With the exception of a recently confirmed

spawning site in the Tamar Estuary (MMO 2017), there are no known spawning sites for allis shad in the UK, although both sub-adults and sexually mature adults are still regularly found around the UK coast (Maitland and Lyle 2005). It can therefore be assumed that allis and twaite shad are unlikely to be present and do not spawn in the vicinity of the offshore development area

10.1.5.3 Atlantic Salmon

123. Atlantic salmon is an abundant species in EU waters, with the UK's salmon population representing a substantial proportion of total European stock. Although they are widely distributed across the UK, the East Anglian region with rivers of low gradient does not support important salmon populations (NASCO 2009).

124. The life cycle of Atlantic salmon comprises both freshwater and seawater stages. Individuals spend up to five years at sea, subsequently returning to their natal rivers to spawn (JNCC 2013). Young salmon "smolts" migrate downstream from spawning areas to enter the sea and continue the process.

125. Scottish rivers are the most important in terms of spawning sites. There are 79 rivers in England and Wales that support salmon populations. No rivers south of the Esk in Yorkshire or east of the Itchen in Hampshire are classified as salmon rivers (Salmon Atlas 2011).

126. Salmon was not recorded in the regional study area during the IBTS (2008-2018), although there have been rare occurrences recorded in MMO landings data from rectangle 33F2 (East Anglia Offshore Wind ZEA 2012). Salmon may therefore very occasionally transit the offshore devlopment area, but is not considered to be located in important migratory pathways for salmon.

10.1.5.4 Sea Trout

127. Sea trout is the migratory counterpart of the common and widely distributed brown trout. Juvenile sea trout begin in a freshwater habitat, where they then migrate to sea as smolts to mature (at least one year), and subsequently return to freshwater for spawning (Pawson 2013).

128. The East Anglian coast is thought to be a feeding area for post-smolt sea trout originating from rivers in north-east England and south-east Scotland such as the Esk, Wear, Coquet, Tyne and Tweed (Pawson 2013). Sea trout populations have also been recorded in many East Anglian rivers, including the Glaven, Wensum and Yare (Tingley et al. 1997).

129. Sea trout was once targeted by local fisheries off Norfolk but underwent decline from the 1950s (Pawson 2013). Projects have been implemented in recent years to restore and improve access for migratory trout within a number of East Anglian rivers including the Stiffkey, Glaven, Burn, Nar, Great Eau and Welland (Everard 2010).

130. Sea trout is described as 'Least Concern' in the IUCN Red List of Threatened Species (***Table 10.17*** of ***Chapter 10 Fish and Shellfish Ecology***) and a species of principal importance in the OSPAR list of threatened and/or declining species. As a result, sea trout fisheries are being phased out.

131. This species has not been recorded within the ICES rectangles relevant to the offshore development area (33F1 or 33F2) by the IBTS nor the MMO (***Table 10.1.1*** and ***Table 10.1.2***).

10.1.6 Non Commercial Fish Species

10.1.6.1 Grey Gurnard

132. Grey gurnard is one of the more abundant demersal species in the North Sea, inhabiting a range of sediment and rocky areas to depths of 140m (Barnes 2008a; Floeter and Temming 2005; Kay and Dipper 2009). It occurs in dense clusters in the western part of the central North Sea and north-west of the Dogger Bank (at 50-100m) in winter months, before widespread summer dispersal (Mackinson and Daskalov 2007; Floeter and Temming 2005). Low abundances of grey gurnard in the southern North Sea during winter and distinct shift in their centre of distribution between winter and summer indicates a preference for higher sea temperatures (Daan et al. 1990).

133. Grey gurnard is of limited commercial importance and is predominantly caught as a by-catch species in demersal fisheries (Mackinson and Daskalov 2007).

134. Grey Gurnard was recorded in both the otter and beam trawl surveys carried out for East Anglia THREE and the former East Anglia FOUR (EATL 2015).

10.1.6.2 Lesser Weaver

135. Lesser weever inhabits inshore areas off the east coast of England and is abundant on sandy substrates in shallower, warmer waters from less than 5m depth, down to 50m (Rogers et al. 1998).

136. Weever spawn in summer (***Plate 10.1.17***) and both eggs and larvae float in the plankton (Maitland and Herdson 2009). Nursery grounds are commonly found along sandbank crests in the North Sea (Ellis et al. 2010). Increasing North Sea temperatures have led to a clear temporal extension for the species (Tulp et al. 2006).

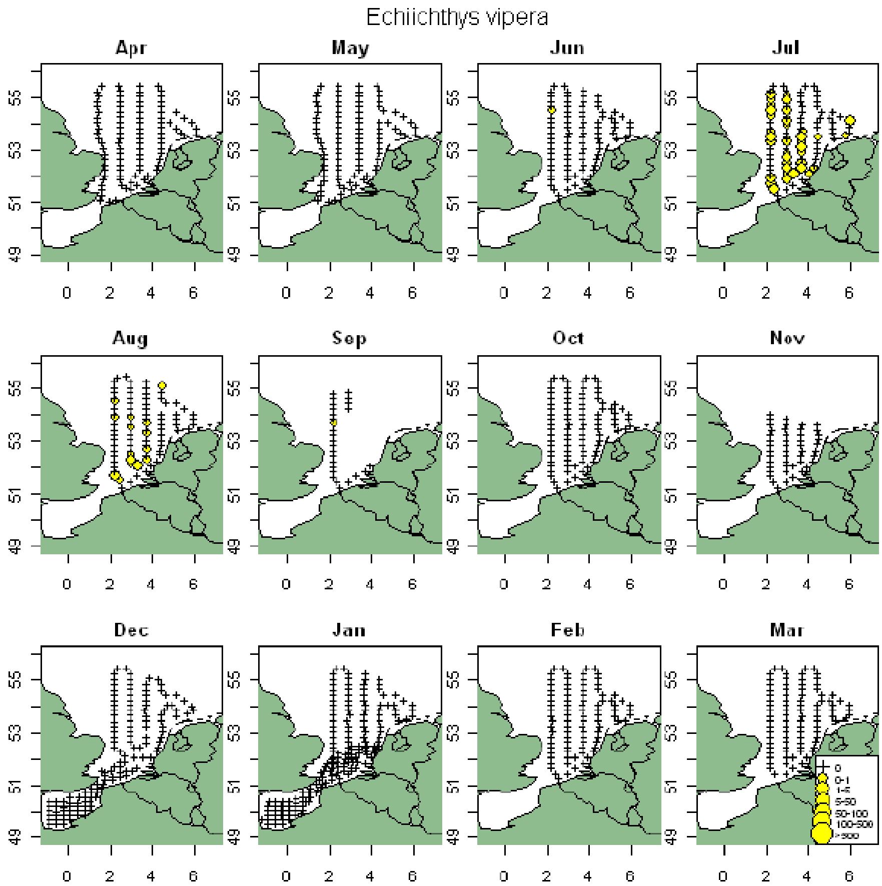


Plate 10.1.17 Spatial and temporal distribution of non-yolk sac lesser weever larvae (van Damme et al. 2011)

10.1.6.3 Solenette

137. Solenette, the smallest species of the Soleidae family, can be found from the Mediterranean, along the west coast of Europe and around the British Isles (Baltus and Van der Veer 1995). It is traditionally found on sandy sediments offshore (at depths from 9 to 37m) and rarely found inshore. In the North Sea it can be found in association with its prey species (Sell and Kröncke 2013; Callaway et al. 2002) and there is no dietary distinction between juveniles and adults (Baltus and Van der Veer 1995).

138. In contrast to sole and plaice, which tend to have a euryhaline tendency, it is suggested that solenette may be intolerant of the physical conditions encountered in shallow, warmer waters, inshore and at large riverine outflows (Amara et al. 2004). Spawning generally occurs in early summer (***Plate 10.1.18***), however the location of spawning areas is not known (Kay and Dipper 2009). Upon hatching, solenette larvae are present in the plankton until settlement at the seabed at around 12mm (Kay and Dipper 2009).

139. Solenette does not make pronounced migrations and its abundance is not seasonal (Amara et al. 2004). Since the late 1980s, its abundance has

increased and moved northwardly in the North Sea, a trend which has been attributed to the effects of increasing temperatures from milder winters on adult habitat conditions (van Hal et al. 2010).

140. East Anglia THREE and former East Anglia FOUR fish surveys recorded solenette as one of the more abundant non-commercial species in the catch samples (EATL 2015).

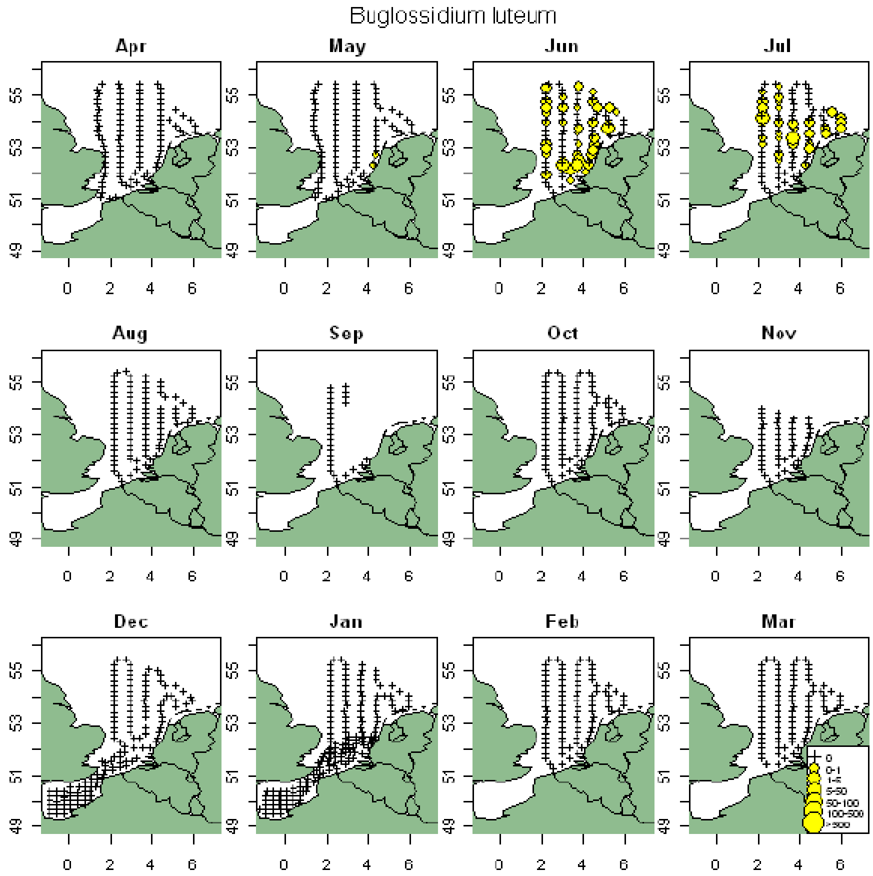


Plate 10.1.18 Spatial and temporal distribution of non-yolk sac solenette larvae (van Damme et al. 2011)

10.1.7 Shellfish Species

10.1.7.1 Brown (Edible) Crab

141. Edible brown crab is found on a range of intertidal and subtidal habitats, on bedrock, under boulders, mixed coarse grounds and offshore in muddy sand (Neal and Wilson 2008). Based on CPUE within the development area, edible crab is not commercially important in the offshore cable corridor (33F1), (***Table 10.1.1***).

142. Edible crab is known to migrate over significant distances to hatch their eggs in offshore overwintering grounds (Edwards 1979; Bennett 1995). Tagging analysis has shown that mature females are more likely to undertake long-distance migrations in comparison to males and immature females whose movements are more random and localised (Edwards 1979; Bennett

1995). Suture tagging experiments carried off the Norfolk coast (Edwards 1979) suggest mature females undergo a northerly long-distance movement. These long-distance movements correspond to the spawning process (Cefas 2011).

143. Typically, females mate around July to September, with subsequent spawning occurring in October to December. Following this, egg bearing ("berried") females travel to offshore over-wintering grounds where they remain mostly inactive until their eggs hatch in spring and summer. Studies carried out in the English Channel by Thompson et al. (1995) suggest that although berried female crabs exhibit a preference of incubating their eggs in hollows of sand and gravel, they are not necessarily confined to such areas, and eggs may be hatched over a wide variety of sediment types from fine sands to pebbles. Female brown crabs will subsequently return inshore to being the process over in spring and summer.

144. The hatched larvae remain in the plankton offshore prior to settlement on the sea bed, following which young crabs are then considered to migrate inshore (Neal and Wilson 2008). Mating activity peaks in summer following female moulting, with spawning occurring late autumn or winter in offshore areas (Cefas 2011a).

145. Commercial landings of crab in the offshore cable corridor (33F1) are insignificant at 0.14 tonnes (ave. 2012-2016), representing 0.73% of the catch within ICES rectangle 33F1 (***Table 10.1.2***).

10.1.7.2 Lobster

146. European lobster has a wide distribution along the UK and European coasts (Bennett et al. 2006) and is commonly found on a range of habitats from rocky grounds, soft sediments and shelf areas from below MLW to depths of 150m (Buchholz et al. 2012; Bennett and Nichols 2007).

147. Whilst they are considered predominantly inactive, local competition for food or requirement to relocate to a different habitat may result in localised inshore/offshore movement (Cefas 2011; Pawson 1995). Smith et al. (2001) conducted tagging experiments off the south coast of England and found that 95% of recaptured lobsters had travelled less than 3.8km from their original positions over a period of 852 days. Some individuals, however, moved distances up to 45km, with little difference between female and male movements. Bannister et al. (1994) analysed tagged hatchery reared lobster behaviour after release into the wild. Results suggested strong site fidelity, with most recaptures being recorded within six kilometres of release sites (Bannister et al. 1994).

148. Berried females generally appear from September to December in areas where lobster is normally present, with eggs carried externally on females until April/May. Eggs usually hatch within the same vicinity in spring and early summer (Pawson 1995). Larval distribution and abundance is subject to local hydrographical conditions and is therefore very variable (Cefas 2011b), it is however, thought to be released close inshore in July to October being dependent on water temperature (Bennett and Nichols 2007).

149. Lobster nursery grounds commonly occur on rocky grounds in coastal waters (Pawson 1995), with juveniles seeking shelter in crevices and soft sediment. As shown in ***Table 10.1.2***, lobster is commercially important in the offshore cable corridor (33F1) but not in the East Anglia TWO windfarm site (33F2).

10.1.7.3 Brown Shrimp

150. Brown shrimp has high productivity and is an important food source for many birds, fish and crustaceans. Brown shrimp are commercially exploited for human consumption (Neal 2008). Landings data provided by the MMO suggest that shrimp does not support important fisheries in the offshore development area.

10.1.7.4 Whelk

151. The common whelk can be found off all British coasts on a range of hard and soft subtidal substrates and occasionally in intertidal fringes (Ager 2008; Lawler and Vause 2009). There are no known specific whelk migrations for spawning although they show aggregating behaviour and the distribution of juvenile whelks tends to be limited to areas close to the adult stock (Lockwood 2005). Breeding occurs by copulation in late autumn following which demersal egg-cases are laid in masses from November until April (Lawler and Vause 2009). Egg development is intracapsular whereby they do not have pelagic eggs but instead lay clumps of demersal egg-cases from which juveniles hatch as a fully formed whelk during February and March (Smith and Thatje 2013; Hancock 1967).

152. Whelk landings have substantially decreased from 410 tonnes in 2015 to 152 tonnes in 2016. This decrease is believed to be associated with the emergency Whelk Permit Byelaw in April 2016 by Eastern IFCA, followed by the Whelk Permit Byelaw in late October 2016.

153. ***Table 10.1.2*** indicates a moderate to high percentage probability of the presence of whelk near East Anglia TWO, and a high percentage probability within the vicinity of the offshore cable corridor (data 2012 to 2016).

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