Fisheries Assessment
to accompany a Foreshore Licence Application
for
Marine Surveys
Off the Co. Wexford Coastline

October 2019

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1. Baseline Data

1.1. Fisheries

The area that is the focus of Energia's application for site investigation surveys overlaps part of the South East Regional Inshore Fisheries Forum (RIFF) area. The South East RIFF area comprises the coastal zone of Wicklow, Wexford and Waterford from Greystones Co. Wicklow to the River at Youghal, Co. Cork. The fishing fleet in the South East RIFF area represents approximately 12% of the national fleet according to the national fleet register in July 2104. There are approximately 257 vessels included in the polyvalent general, potting, specific and beamer sectors. Forty-two of these vessels were over 18m while nine were between 12 and 18m. There were 206 vessels under 12m; Wexford accounts for 44% of these while Waterford accounts for 39.5% and Wicklow 16.5 %.

The key areas for inshore fishing are in West Waterford including An Rinn, between Dungarvan and Tramore, adjacent to and including within the Waterford Estuary from Dunmore East to the Hook head on to Kilmore Quay, Rosslare and north of the county Wexford around Arklow and Wicklow towns.

The main larger fishing ports/harbours are Wicklow, Arklow, Wexford town, Rosslare harbour, Kilmore Quay, Dunmore East, a National Fishery Harbour Centre and Helvick. Smaller piers/harbours include; Greystones, Courtown, Rosslare cot safe, Carne, Fethard On Sea, Slade, Duncannon, Arthurstown, Ballyhack, Cheekpoint, Passage, Tramore, Dunbrattin, Ballinagoul and Ardmore.

The fisheries in the South East area include:

- Lobster and brown crab (also spider and velvet crab) is mainly fished along the south Wexford and East Waterford coast. Green crab is also fished within the Waterford Estuary.
- Shrimp is fished from Helvick and Dunmore East on the Waterford coast and Rosslare and Fethard Bay on the Wexford coast.
- Whelk fishing mainly occurs in Wicklow and North/East Wexford, also pockets adjacent to the Waterford estuary and Helvick.
- Scallop dredging mainly occurs on the south Wexford and Waterford coast, off Saltees, Baginbun and Hook Head (main inshore activity) with some pockets up the east coast such as at Wicklow Head.
- Razor clams are fished from Rosslare harbour and Cahore with potential beds also in the Co. Waterford coastal area.

- Surf clams are dredged in the Waterford Estuary.
- Cockles are dredged in the Waterford Estuary, with potential beds elsewhere (e.g. Tramore back strand).
- Line fishing, primarily jigging for mackerel mainly at Dunmore East with some line fishing for Whitefish throughout the RIFF area, including some trolling.
- Gill netting off the South Wexford and Waterford coasts (for Pollack & Cod, seasonal Aug-Feb & Feb-Oct).
- Inshore trawling inside the Waterford estuary and generally throughout the southeast.
- Herring and sprat trawling by inshore and offshore boats in the Waterford estuary area.

Fish sales take place throughout the South East RIFF area, with Kilmore Quay the largest centre for employment through added value/processing of fish.

Figures 1.1 to 1.4 below show the fishing grounds in the vicinity of the proposed wind farm area according to the Marine Institutes Ireland's Marine Atlas. The Marine Institute was contacted about the accuracy of these areas and they are in general agreement with what they know to occur in the area. Prior to the commencement of any geophysical and geotechnical surveys which may interact with fishing activity, Energia will appoint a Fisheries Liaison Officer who will engage with the local fishermen and fisheries groups to identify the potential for interactions and to identify appropriate actions to avoid or minimise these interactions.

As can be seen from these maps, there is a direct overlap with the following fisheries:

- Whelk (It is likely that crab and lobster potting occurs in this area also)
  Whelk are fished using top entrance pots year-round. Highest densities of whelk are in waters <20m deep and in strong tidal currents (SEAI, 2010). Whelk prefer sand, sandy mud or stony bottoms (FAO, 2019). Whelks are active predators that mainly feed on live bivalves (Nielsen, 1975) and can therefore be associated with the mussel beds in the area. The whelk fishery overlaps a small portion of the western boundary of the proposed wind farm area (32km^2) (see Figure 1.1). This represents 1.7% of the whelk fishery from Dublin to Wexford. The majority of the proposed cable route corridor overlaps with the whelk fishery, 324km^2. This represents 17.2% of the whelk fishery from Dublin to Wexford. The survey effort within the cable route corridor will not encompass the full extent of the site, it will be limited to a number of viable options. Existing INFOMAR data will be reviewed and used in place of obtaining new survey data where possible. This will minimise the overlap with whelk grounds.
- Seed mussel
  Seed mussel is collected by mussel dredges. Seed mussel bed location are unpredictable to a certain extent, although they do appear at regular places. Figure 1.2 shows the

previous surveyed seed mussel beds from 1970 to 2018 (Source: BIM, October 2019). Figure 1.3 shows those beds surveyed from 2010 to 2018. According to the latest BIM seed mussel surveys, the following resources are available for fishing this year: East of the Long Bank *c.*13km west of the proposed wind farm area (BIM, 2019a), South Cahore Head and the Rusk Channel *c.*1km southwest of the proposed cable route corridor (BIM, 2019b). The South Glassgorman Banks, located within the proposed able route corridor is noted of being no significance for the fishery this year (BIM, 2019c). The fishery is usually opening around late August or mid-September and lasts until there is no seed left to fish. Fishing only occurs on neap tides as tidal currents are usually too strong for efficient fishing during spring tides. There can be up to 10 or 12 vessels (at least 4 are up to 40m long) fishing in the same location, depending on the spread of the seed settlement. There is no overlap between the proposed wind farm area and the mussel seed areas. There is an overlap with a number of small areas and the cable route corridor.

- Razor clam fishery (proposed cable corridor)

  Razor clams live in deep, vertical, permanent burrows in fine, sometimes muddy, sand from extreme low water to the shallow sublittoral. They are fished by hydraulic dredges. The distribution is currently known from the commercial fishery which operates in water depths of 4-14m and from surveys where there are no fisheries (Marine Institute & BIM, 2017). Fishing depth is limited because of the fishing method which uses hydraulically pressurised water to fluidise sediments in front of the dredge. The distribution of razor clams may extend to deeper water outside of the range of the fishery as the species occurs at depths of up to 50m. However, there is no evidence that significant biomass occurs outside of those areas already fished. There is no overlap between the proposed wind farm area and the razor clam grounds (Figure 1.4). A small part (1 km^2) of the southwestern part of the cable route corridor overlaps the razor clam grounds. This overlap represents 0.96% of the razor calm grounds along that section of coastline. It should be noted that while the cable route to shore has not being identified at this stage, it is highly unlikely that it will overlap this razor clam fishery.

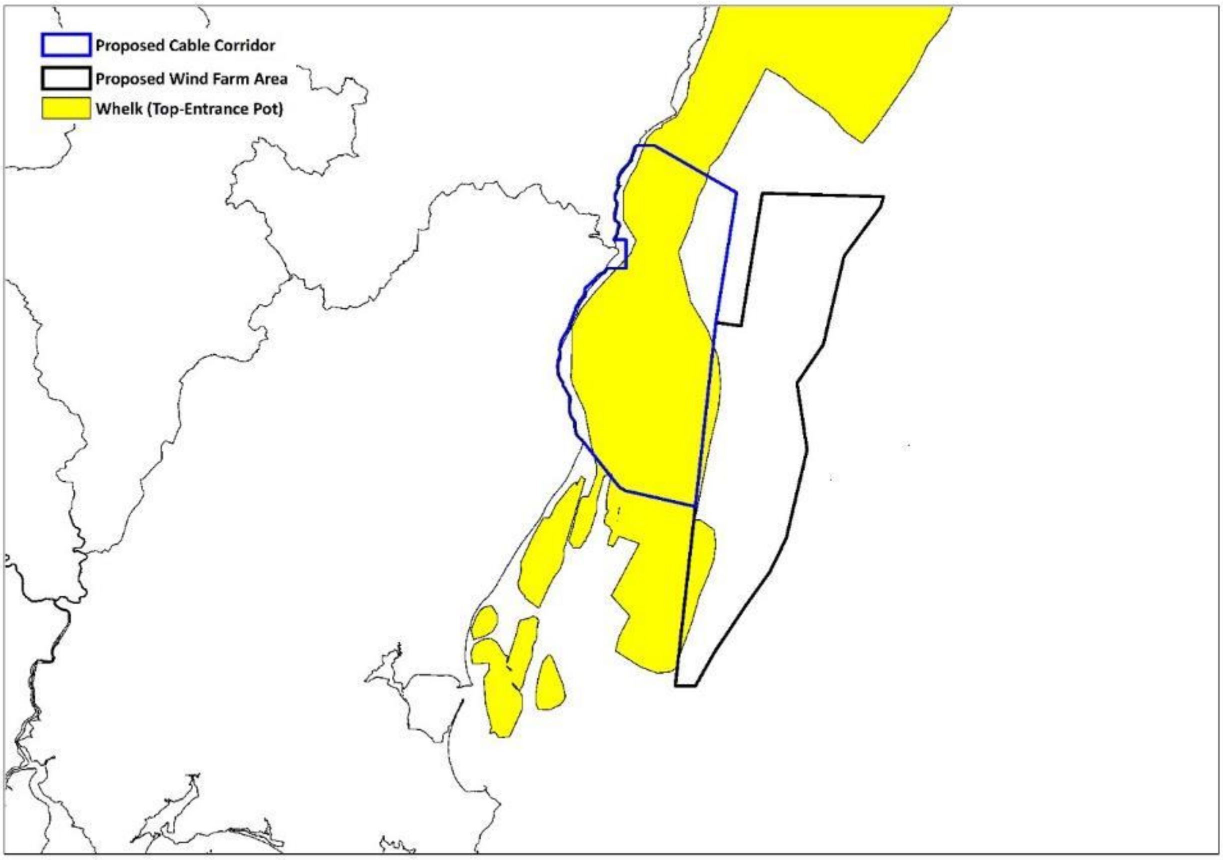


Figure 1.1: Whelk fishing grounds with respect to the proposed survey areas

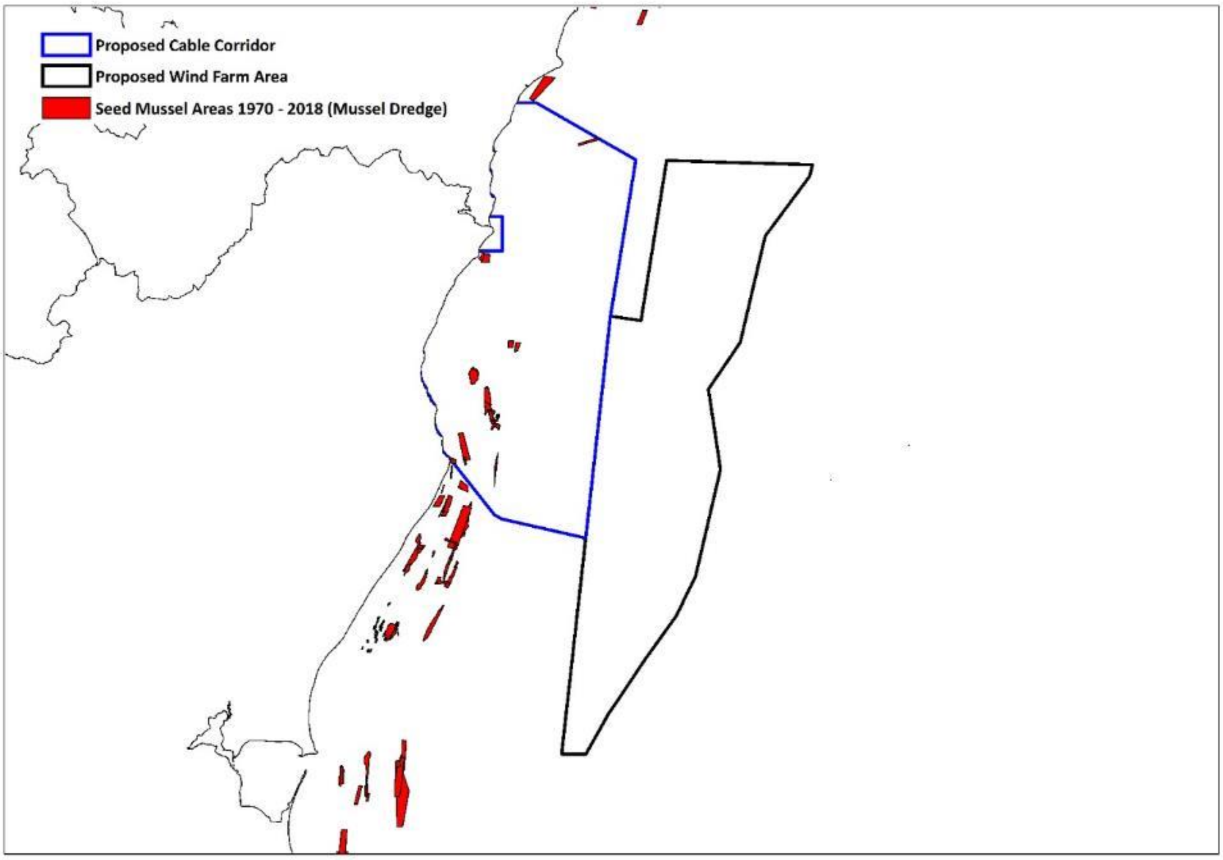


Figure 1.2: Seed mussel beds surveyed by BIM from 1970 to 2018 with respect to the proposed survey areas

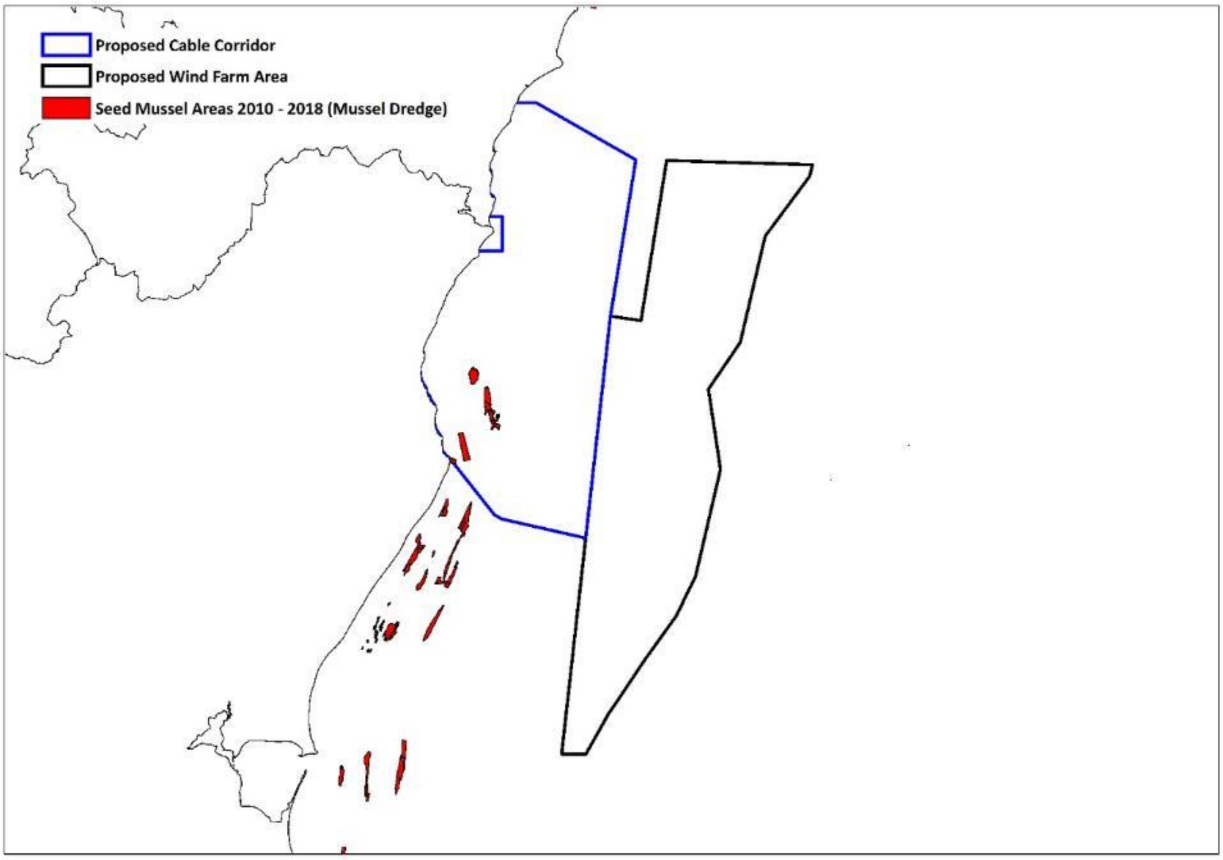


Figure 1.3: Seed mussel beds surveyed by BIM from 2010 to 2018 with respect to the proposed survey areas

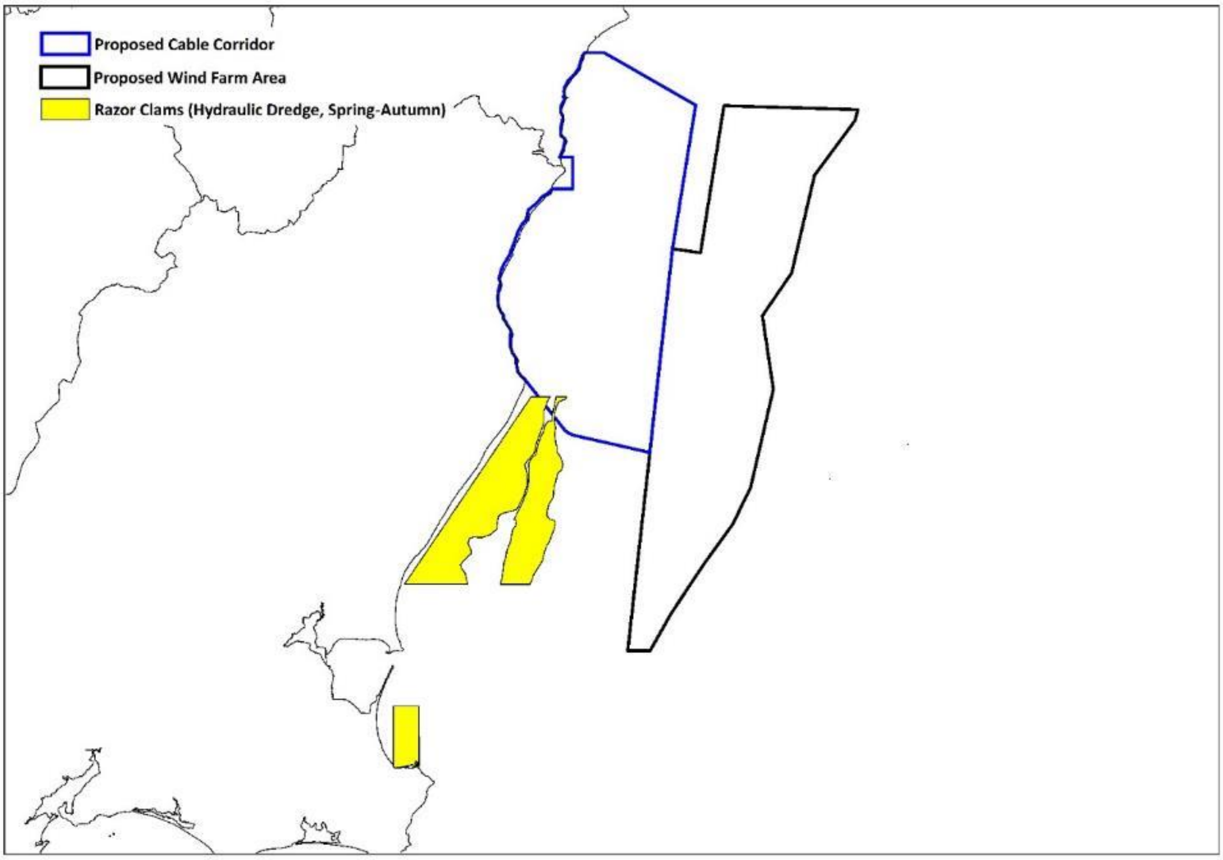


Figure 1.4: Razor clam fishing grounds with respect to the proposed survey areas

1.2. *Spawning & Nursery Grounds*

There is no overlap with any spawning grounds according to CEFAS 2010 study (Ellis *et al.,* 2012) and Lordan & Gerritsen (2009). With respect to nursery areas, there is an overlap with the following species (see Figures 1.5 – 1.14 below): whiting, cod, mackerel, horse mackerel, herring, sandeel, tope shark, thornback ray and spotted ray. Whelk, mussels and razor clams will also spawn in the area as they are resident on the seabed below.

Figure 1.5: Whiting nursery areas with respect to the proposed survey areas

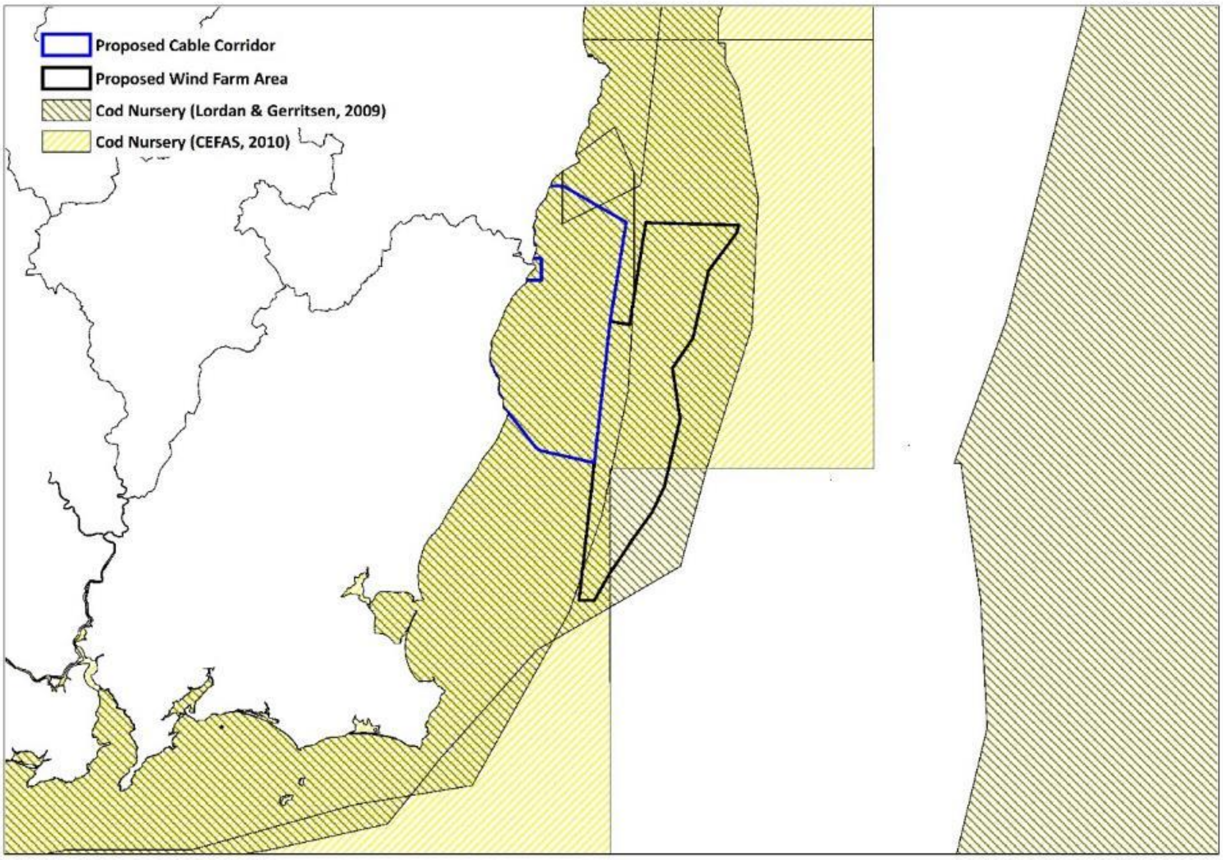


Figure 1.6: Cod nursery areas with respect to the proposed survey areas

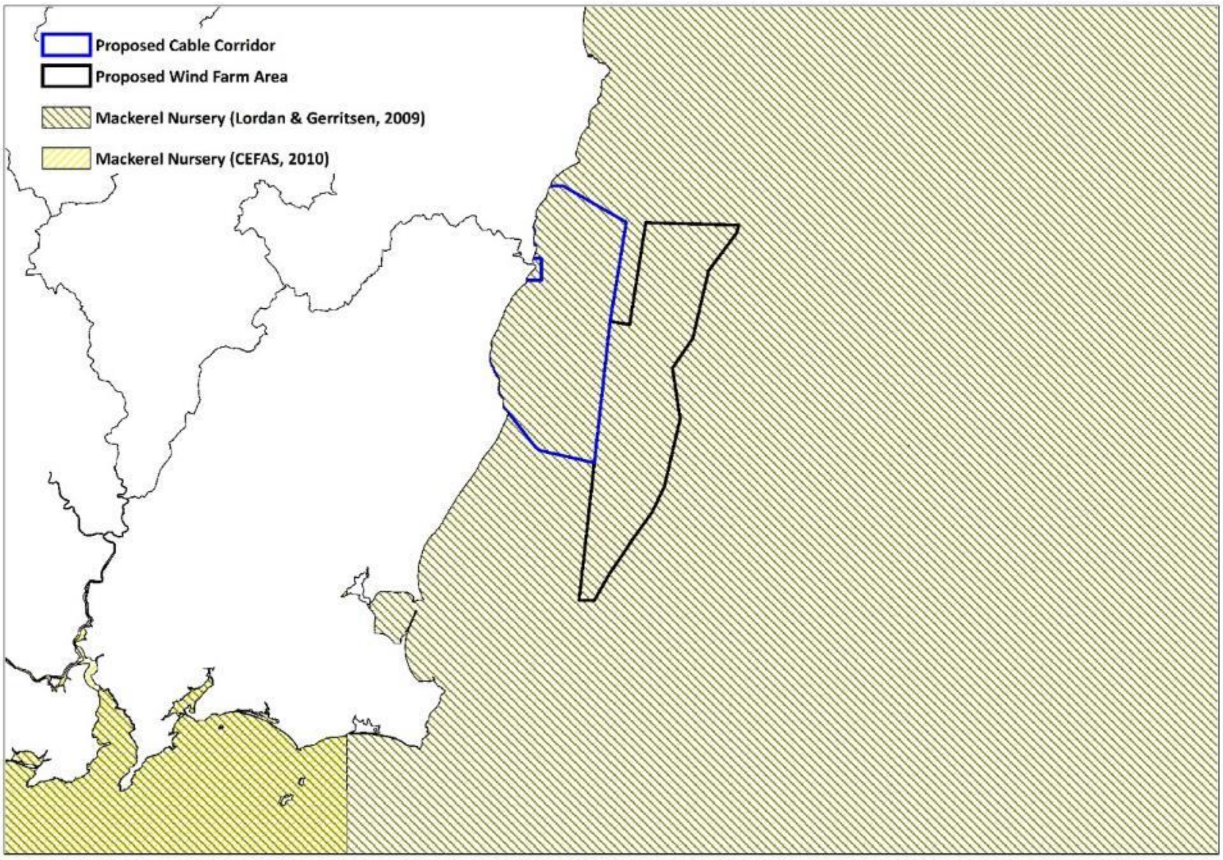


Figure 1.7: Mackerel nursery areas with respect to the proposed survey areas

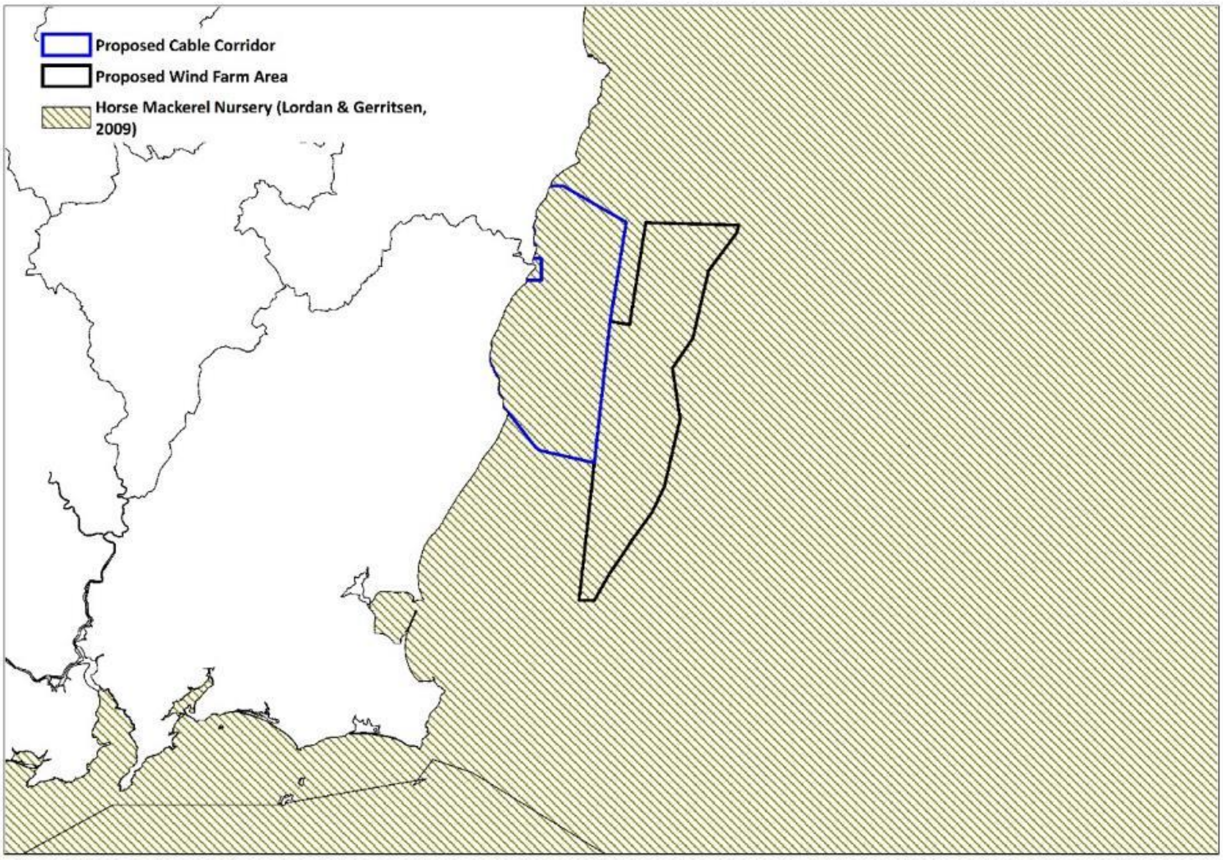


Figure 1.8: Horse mackerel nursery areas with respect to the proposed survey areas

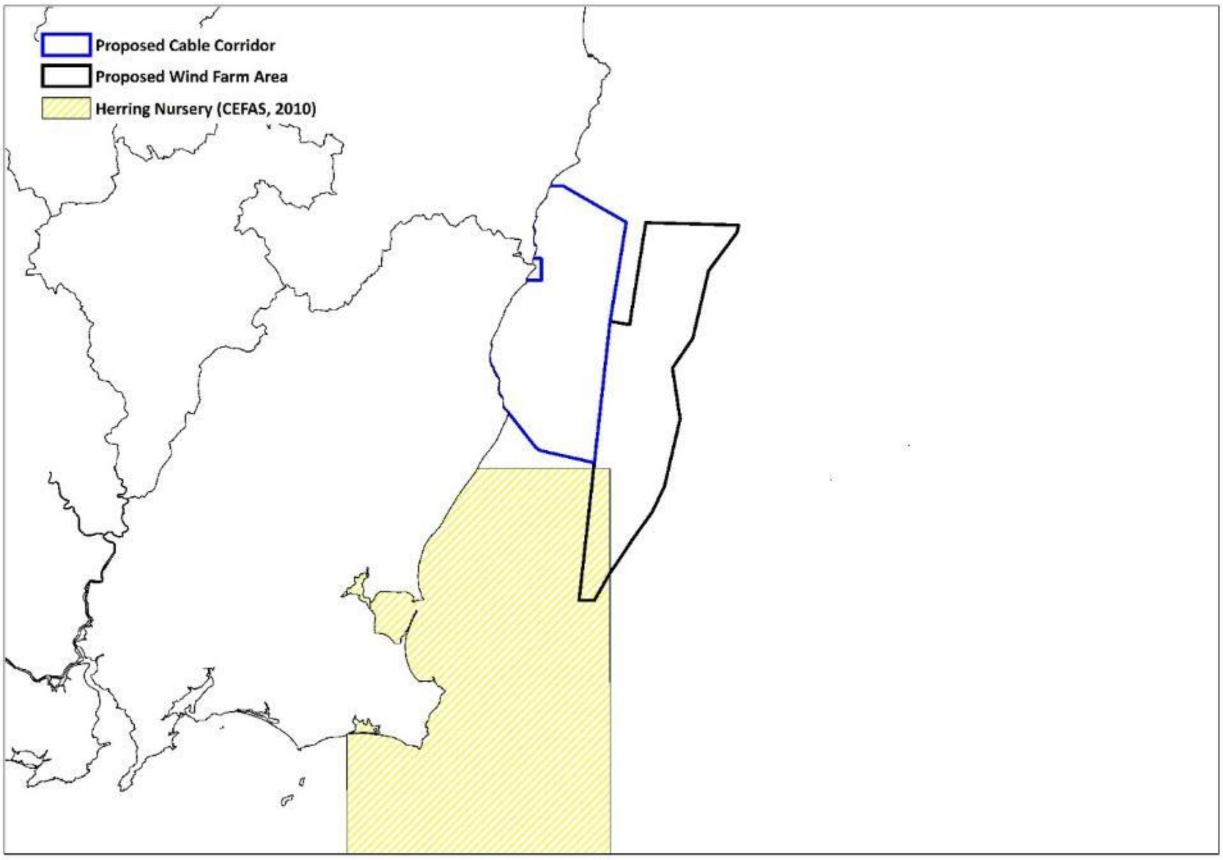


Figure 1.9: Herring nursery areas with respect to the proposed survey areas

Figure 1.10: Sandeel nursery areas with respect to the proposed survey areas

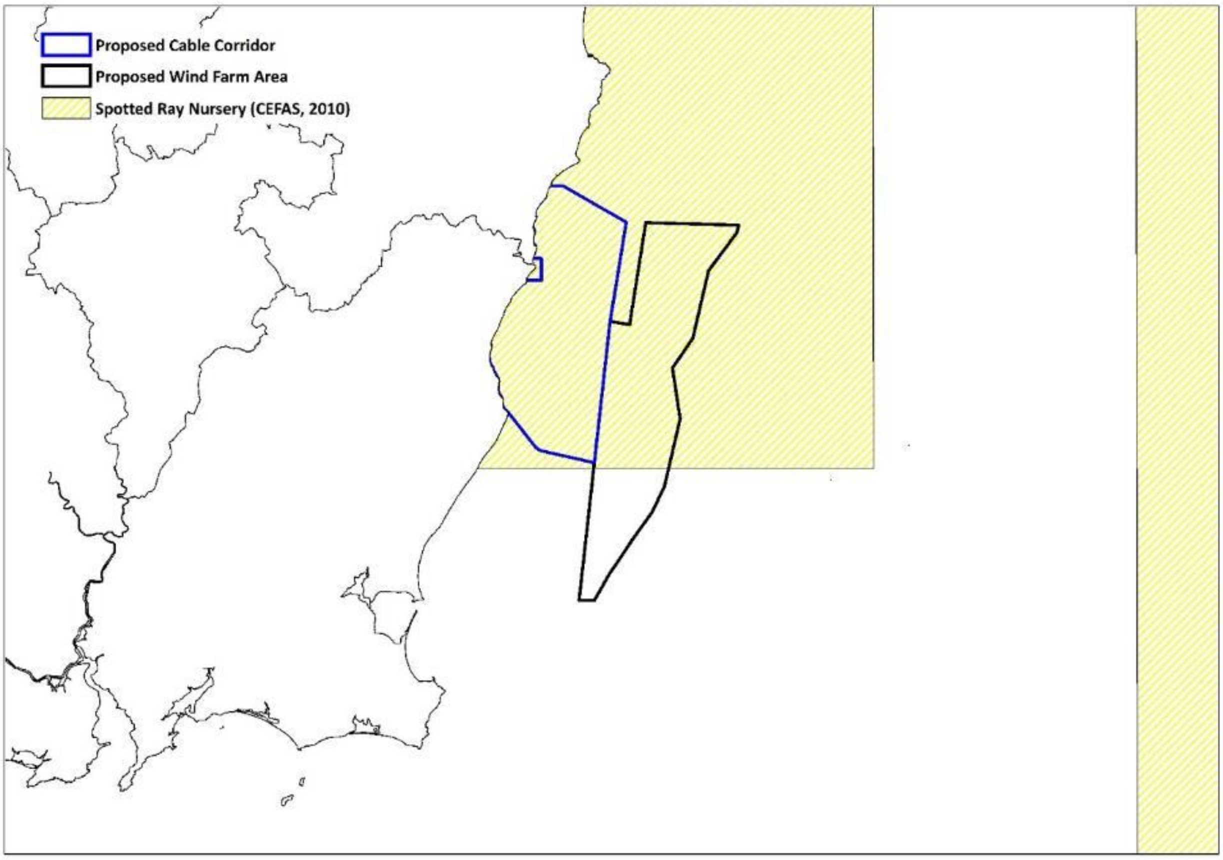


Figure 1.11: Spotted ray nursery areas with respect to the proposed survey areas

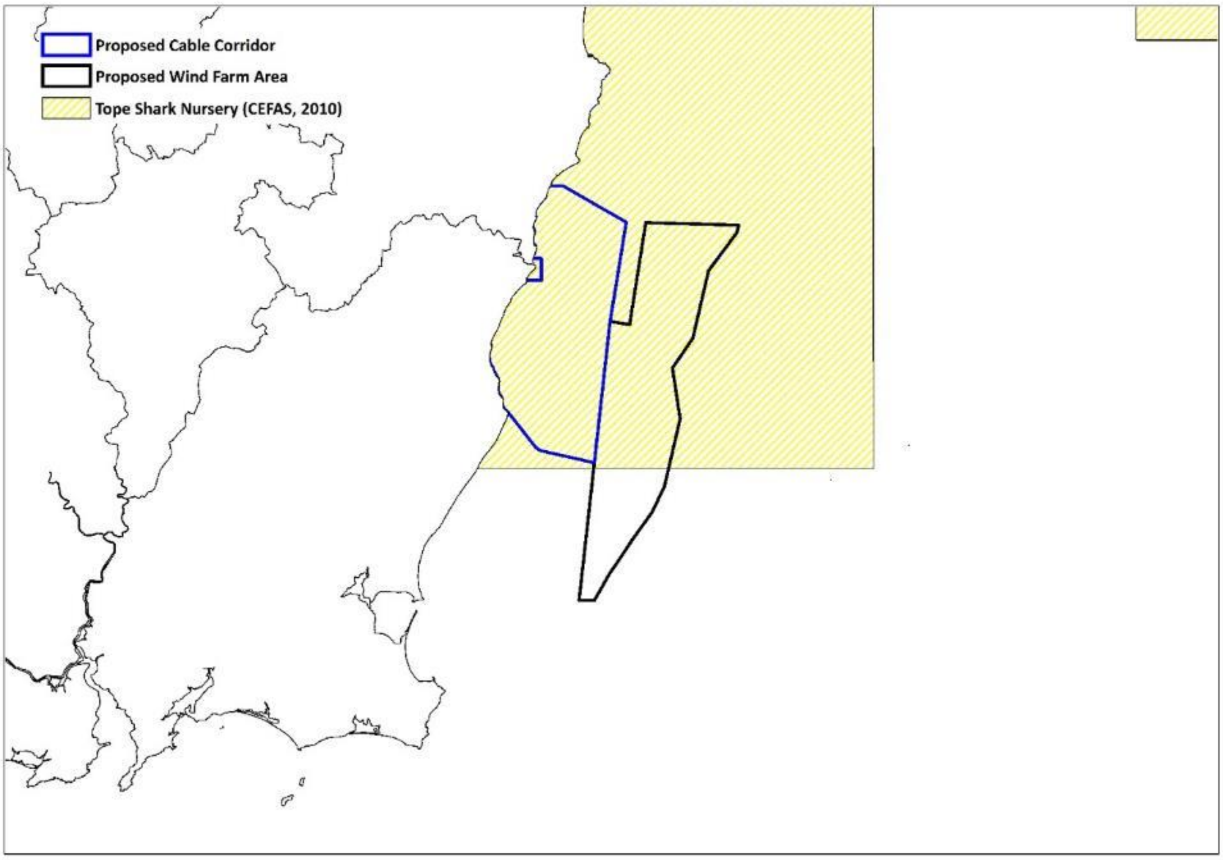


Figure 1.12: Spotted ray nursery areas with respect to the proposed survey areas

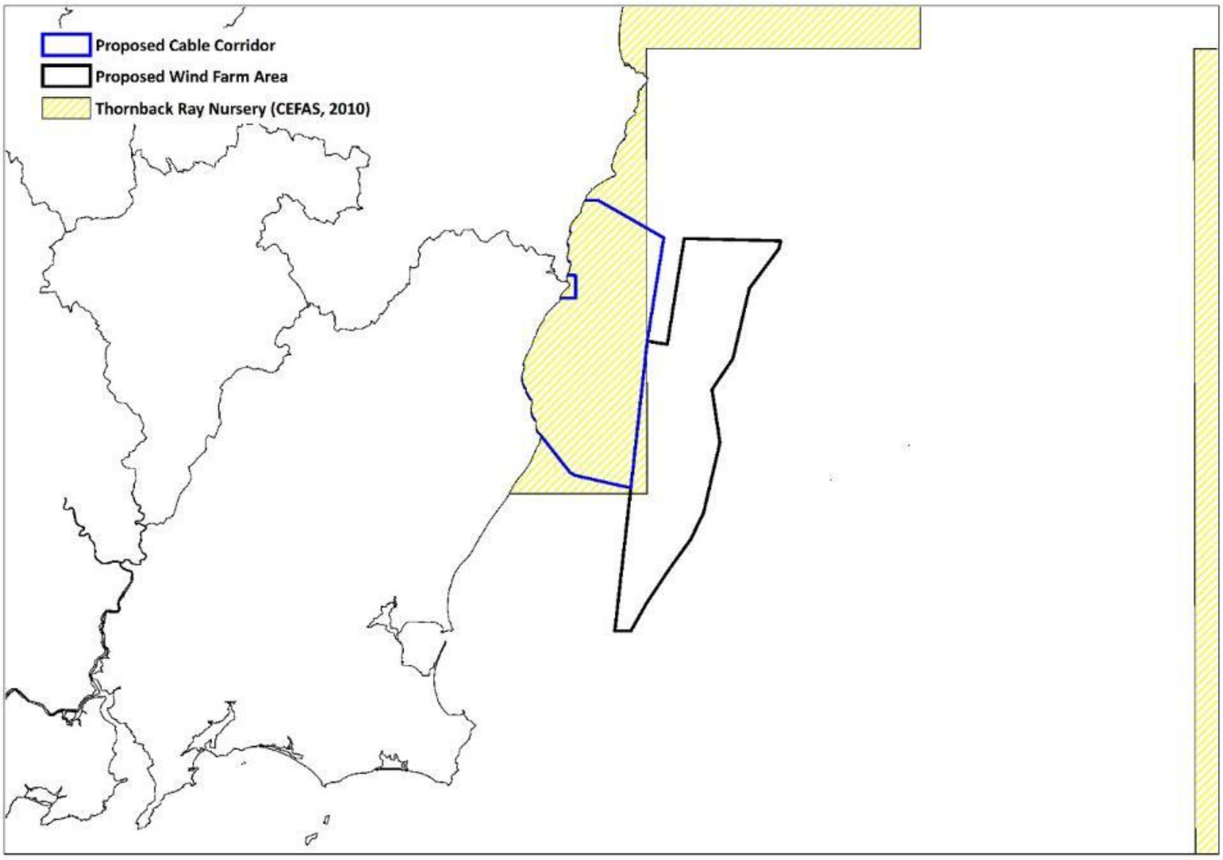


Figure 1.13: Thornback ray nursery areas with respect to the proposed survey areas

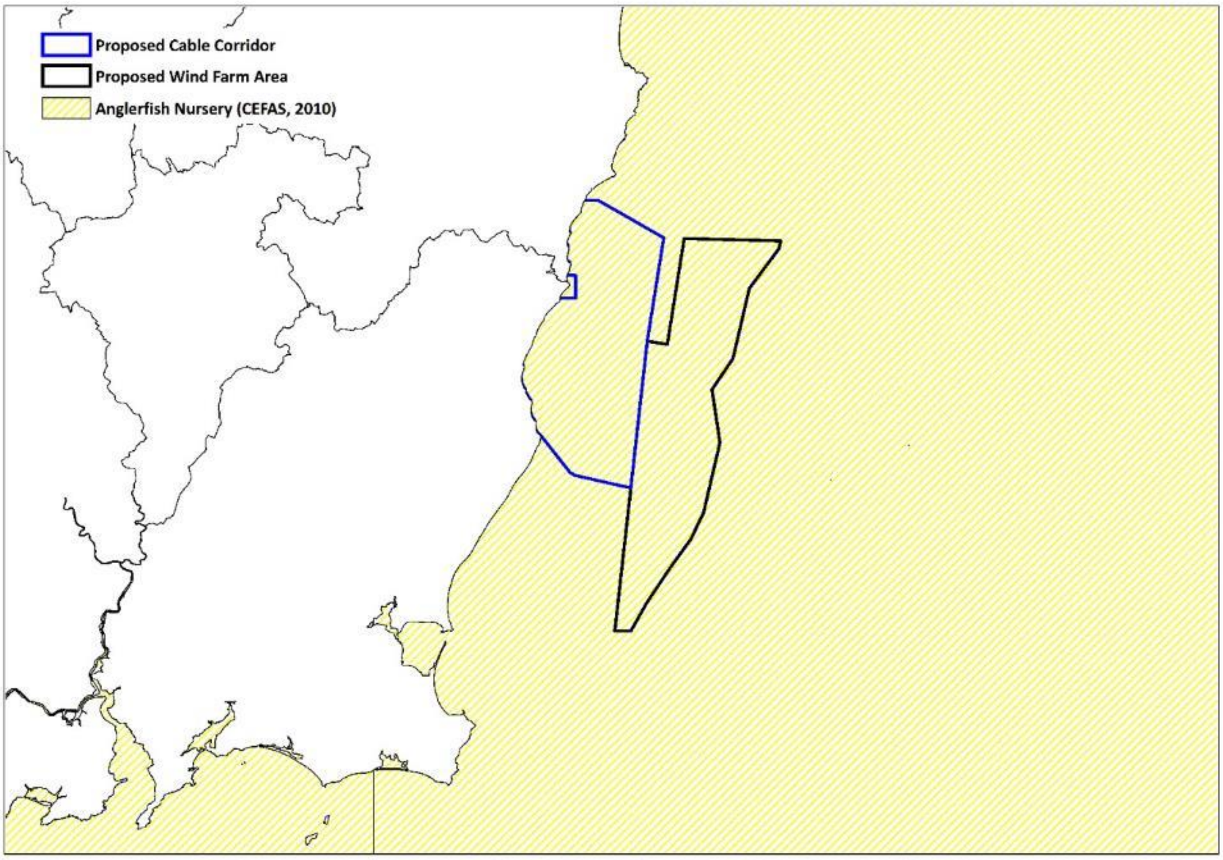


Figure 1.14: Anglerfish nursery areas with respect to the proposed survey areas

1.3. Aquaculture

There is a licenced aquaculture site located within the cable corridor northeast of Kilmichael Point. This site is licenced for the collection of mussel spat using a long line system on the subtidal area and covers an area of 66 Ha. There is bottom mussel aquaculture in Wexford Harbour, a distance of 22 km from the proposed wind farm area. Figure 1.15 shows the location of the aquaculture activity. Wexford Harbour Outer Shellfish Waters is 21.7km inshore of the proposed wind farm area. Wexford Harbour Inner Shellfish Waters is 27.8km inshore of proposed wind farm area. Shellfish waters are designated under the Shellfish Waters Directive to protect the aquatic habitat of bivalve and gastropod molluscs. These shellfish waters can also be seen in Figure 1.15. Figure 1.16 shows the Bivalve Mollusc Production Areas (BMPA) in the vicinity of the proposed survey areas. BMPA designates the production areas from which live bivalves may be taken. The proposed cable route corridor, along its southwestern boundary, overlaps 15.65km^2 of the Curracloe BMPA. Rosslare Bay BMPA is 19.5km inshore of the proposed wind farm area. Wexford Harbour Outer BMPA is 20.5km inshore of the proposed wind farm area. Wexford Harbour Inner Bivalve Mollusc Production Area is 26.9km inshore of the proposed wind farm area.

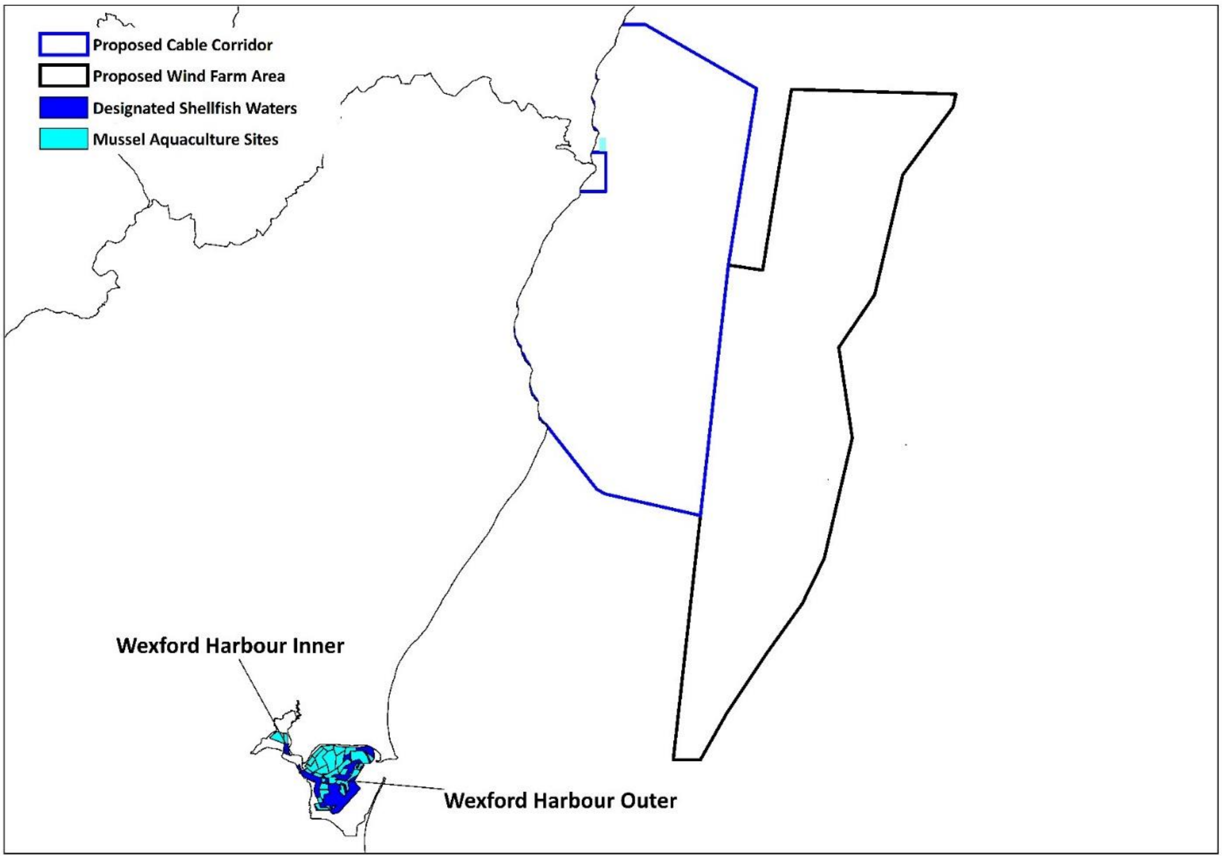


Figure 1.15: Aquaculture and shellfish waters with respect to the proposed survey areas

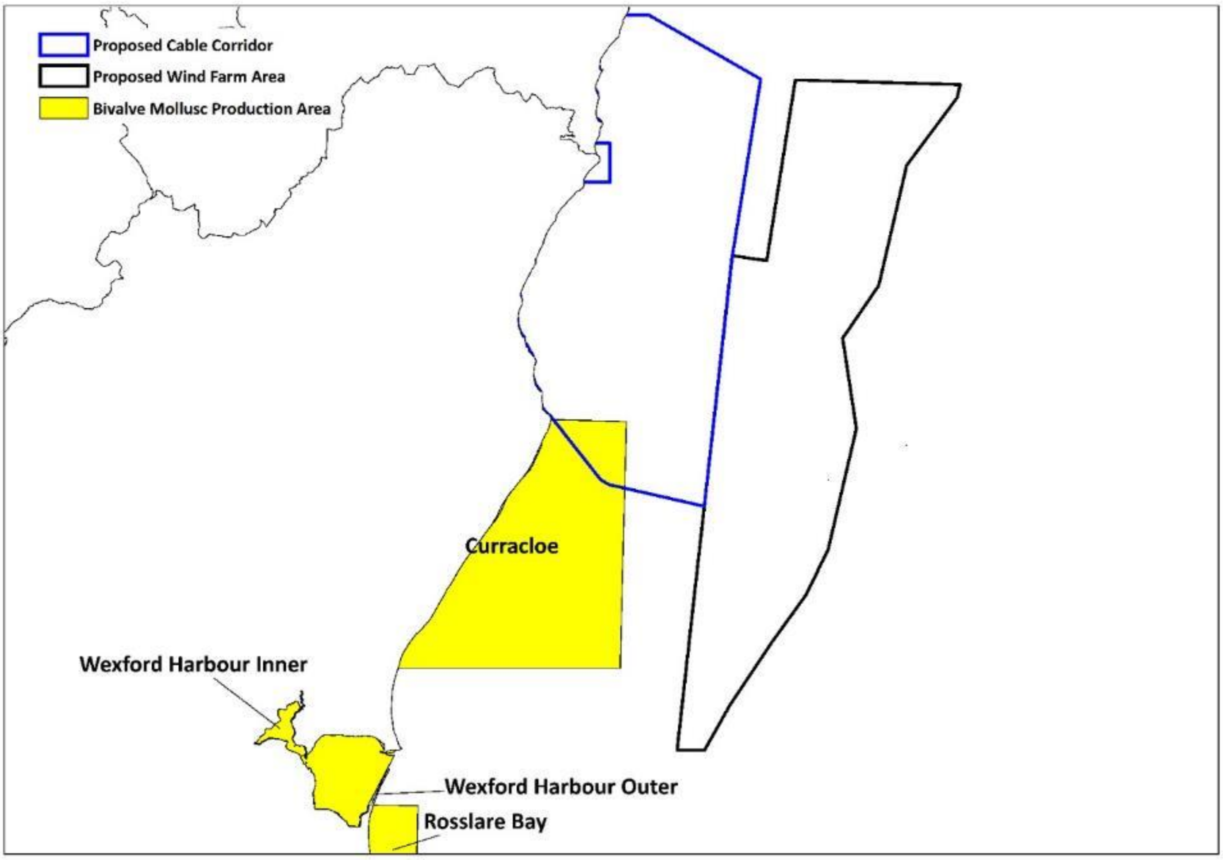


Figure 1.16: BMPAs with respect to the proposed survey areas

1.4. *Annex I Species*

Sea lamprey, river lamprey, Twaite shad and Atlantic salmon are all Annex I species of the nearby Slaney River Valley SAC (IE000781). These are all migratory species which may be found in the proposed development area at certain times of the year

The Slaney River Valley SAC (IE000781) is *c.* 20.3 km inshore of the proposed wind farm area and it is designated for the protection of the following Annex II species; Atlantic salmon (*Salmo salar),* sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*) and Twaite shad (*Alosa fallax fallax*). The sea lamprey (*Petromyzon marinus*) is a migratory species which grows to maturity in the sea and migrates to freshwater to spawn. They migrate through the estuary from the sea in April and May (Hardisty, 1969) and spawn in rivers in late May or June and then return to sea. The river lamprey (*Lampetra fluviatilis*) is a migratory species which grows to maturity in estuaries and migrates to freshwater to spawn from October to December (Maitland, 2003). Spawning occurs in the rivers in March and April. Between July and September young adults at 3-5 years of age migrate during darkness to the estuary. Both species have the potential to occur within the survey area.

Atlantic salmon also has the potential to pass through the proposed wind farm area when migrating to and from their natal rivers, in this case the Slaney River. Smolts typically head out to sea between March and June and adults return to the river between March and August.

Twaite shad is a member of the herring family. It is mostly a marine species, but it migrates into freshwater to spawn. Mature adults gather in estuaries in April and May and move upstream to spawn from mid-May to mid-July. In the marine environment they are mainly coastal and pelagic and have been recorded from depths of 10-110m with a preference for waters 10-20m deep (Taverny, 1991). Estuarine habitats are important for passage of adults and as a nursery ground for juveniles.

The Dargle, Liffey, Glyde, Boyne, Dee, Castletown and Fane rivers are located north of the proposed survey area and are all salmonid rivers.

2. Description of the Proposed Surveys

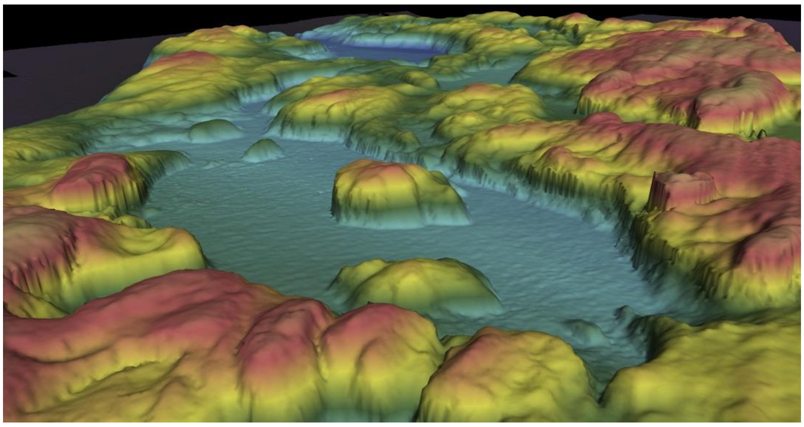
There are two distinct types of marine surveys proposed as part of the site investigation works. The first are non-intrusive geophysical surveys the purpose of which are to describe the physical features of the seabed which includes measuring water depth, definition of seabed structures (e.g. sand waves), identifying sediment type and distribution (sand, mud, gravel, rock) both on and below the seabed. These surveys include the following: multibeam echosounder, side scan sonar, magnetometer survey and sub-bottom profiler (sparker/boomer).

The second are intrusive geotechnical surveys, where by samples of the seabed are collected and returned to the vessel. These include grab / core sampling, boreholes and cone penetration testing (CPT).

2.1. Non-Intrusive Geophysical Surveys

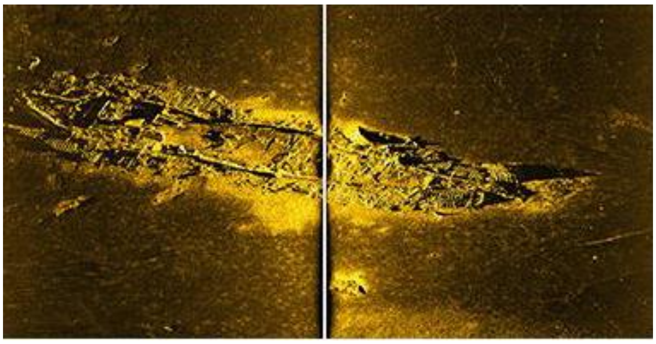
Geophysical surveys involve using acoustic devices to emit sound energy into the water column. This sound energy creates sound waves which travel through the water column. When these sound waves encounter an object or the seabed they are reflected and the returning echoes are then detected on board the vessel. This is called sonar. Different echo strengths indicate different seabed features and different physical characteristics. By knowing the speed at which sound travels through water (*c.* 1500m per second), depth can be calculated from the echo return time. This method produces extremely accurate measurements, which when coupled with accurate positioning systems can produce very accurate seafloor maps. Similarity by knowing the speed of sound through different rock and sediment layers under the seabed, these acoustic systems can measure the thickness of these layers to map the sub-surface structure of the seabed.

Multibeam echosounder (MBES)



A multibeam echosounder is a remote sensing device usually attached to a vessels hull. It uses sound waves to measure water depth. MBES can measure a swath four times the water depth (i.e. 25m water depth, MBES can measure a track 100m wide on the seabed). The sound source used is loud at between 200-228dB and the sound is of a very high frequency (300 – 500kHz). High frequency waves are lost in deep water and are therefore best suited to shallow water surveys where they provide high resolution imagery (see above Source: Infomar, red = shallower depth, blue = deeper depths). Lower frequency sound travels further underwater but provides less resolution. MBES also collects backscatter data which allows different sediment types to be distinguished (different seafloor types return a signal with different levels of energy i.e. they scatter the sound differently). Vessel speed for a MBES survey is typically 8-9kn (provided no other activity is being carried out that requires a slower vessel speed).

Side Scan Sonar (SSS)



Side scan sonar is a remote sensing acoustic device attached to the vessel hull or as part of a towed array. SSS produces very high-resolution mapping of the seabed in order to investigate a wreck, carry out habitat mapping and to investigate the status of a cable/pipeline (see right Source: Infomar). The sound source used is loud at between 235dB and the sound is of a very high frequency (100 – 500kHz). Higher frequencies yield better resolution but have less range. High frequency means little penetration away from the source vessel. Vessel speed 4 kn, in deeper water slower speeds are needed.

Magnetometer

A magnetometer is a passive remote sensing device that detects magnetic fields from ferrous objects such as lost anchors, sunken ships and buried pipes on/in the seabed which may present an obstruction or risk to intrusive seabed works such as geotechnical surveys. A magnetometer is usually towed behind the survey vessel.

Sub-Bottom Profiler (Pinger) / Shallow Seismic (Sparker/Boomer)

A sub bottom profiler is a remote sensing device, or array of devices, that are towed behind a vessel. Sub bottom profiling, as the name suggests provides information on the rock and sediment layers beneath the seabed. These systems use lower sound frequencies that can penetrate further into the sediment and examine sediment layers and the extent of bedrock. The extent of penetration depends on the seabed type. If the bottom is hard and compact like bedrock or thick sand, then most of the acoustic energy will be reflected. If the bottom sediments are soft or loose some acoustic energy will continue to travel through the various sub-surface layers. This results in a series of sound waves returned to the vessel at slightly different times.

Sub bottom profiling Pinger systems transmit a single low frequency (*c.* 4kHz) at a sound source level of 200dB in a single pulse. Penetration depth ranges from 10-50m (depending on bottom type).

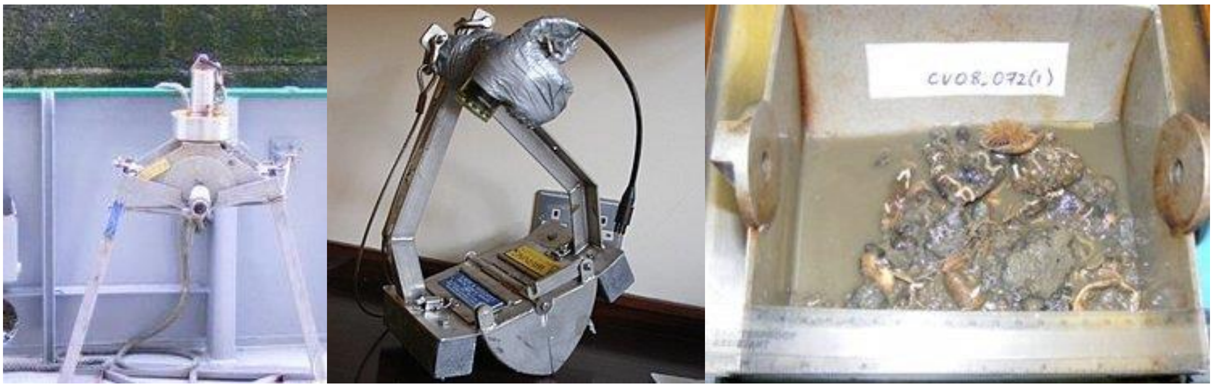
Shallow Seismic (Ultra High Resolution Seismic) Sparker/Boomer systems are used where deeper penetration is needed (up to 500m). It is more powerful than SBP and often used in very coarse/compacted sediments. The system is towed behind the vessel at relatively low speed (~ 4 knots) while an array of hydrophones (called streamers) are towed near the acoustic source to receive the returning signals. Sound source generates a low frequency broadband (300Hz – 4kHz) omnidirectional pulse which can penetrate a few 100m in to the subsurface (Sound source level of 226dB).

2.2. *Intrusive Geotechnical Surveys*

The acoustic geophysical surveys allow for the accurate prediction of the type of material present on the seabed (e.g. rocks, pebbles, sand/mud). In order to confirm the predictions, representative samples need to be collected (ground-truthing).

Grab Sampling

Grab samplers sample the top 15-20cm of the seabed. Grab samples do not preserve the sedimentary layers within the sample and therefore are appropriate for ground-truthing multibeam echosounder and side scan sonar data but are inadequate for ground-truthing sub bottom profile data. Depending on the type and size of grab sampler used, volumes of sediment recovered per grab will range from between 3 and 15 litres (0.003 – 0.015m^3).



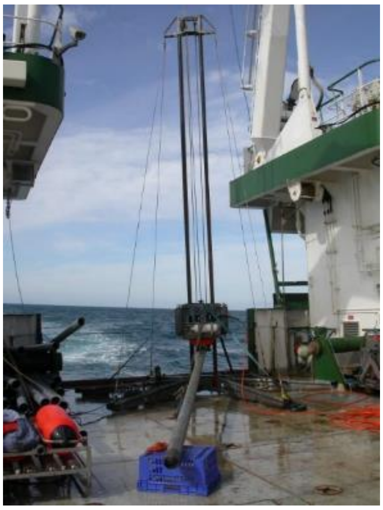
Shipek grab (left), van Veen grab (middle) and grab sample (right) Source: Infomar https://www.infomar.ie/sites/default/files/pdfs/INFOMAR%20Ground%20Truthing%20techniques_1.pdf).

Core Sampling A range of different cores may be employed depending on the contractor and ground conditions. Coring methods are capable of preserving the sediment layers and penetrating to greater depths than a grab. Cores are adequate for ground-truthing sub bottom profiler data. Cores can be cylinder or box shaped, with a weight attached that free falls through the water column and under the force of gravity is driven down into the seabed. A hinged plate traps the sediment within the core which is then recovered. Average penetration depth is 30-40 cm, but this depends on sediment type. Depending on the type and size of core sampler used, volumes of sediment recovered per core will range from between 20 and 100 litres (0.02 – 0.1m^3).

Box corer (left) and preserved sediment layers of coarse shelly sand (right) (Source: Infomar https://www.infomar.ie/sites/default/files/pdfs/INFOMAR%20Ground%20Truthing%20techniques_1.pdf

A vibrocore can recover cores 3 to 6m deep depending on the sediment type, with deepest penetration in fine grained sediments.

A vibrocorer uses an electrical motor that creates vibrations that allow a metal cylinder to penetrate the soft seabed. The sound source level of the motor is 187.4dB (LGL & Jasco, 2010) with a nominal frequency of 50Hz. A catcher prevents the sediment escaping form the core. Right: Vibrocore awaiting deployment (Source: Infomar https://www.infomar.ie/sites/default/files/pdfs/INFOMAR%20Ground%20Truthing%20techniques_1.pdf). When the core is recovered, it is cut in half, photographed, scanned and analysed to provides data on historical sediment layers (deposition) in the area (see below, Source: Infomar https://www.infomar.ie/sites/default/files/pdfs/INFOMAR%20Ground%20Truthing%20 techniques_1.pdf). A standard size vibrocore will obtain an 86mm diameter core but some can obtain cores up to 150mm diameter. At a depth of 6m deep, a 150mm diameter core would result in the recovery of 106l (0.106m^3) of sediment. It is expected that 1 vibrocore will take 0.5 days to recover.



A piston corer can take cores up to 15 – 30m deep in muddy to slightly sandy sediment. Typical core diameter is 63 to 67mm. Piston corers are a modification of a gravity corer where by a piston pushes the cylinder into the seabed and the piston creates a suction to hold the sediment in place.

Boreholes

Boreholes involve drilling into the seabed to retrieve samples and allow geotechnical testing to be conducted. Drilling is typically performed from a specialised drilling vessel, barge or jack-up rig. The focus of geotechnical drilling is not to achieve great depth quickly but to drill to a specific depth while minimising soil disturbance below the drill bit. Typical borehole depths range from 10 to 30m.

A drill head is lowered to the seabed by a drill string and stabilised using a seabed frame. The drill string is then rotated to begin boring. Various tools can be lowered into the drill string to retrieve samples or carry out *in situ* soil testing. While the majority of drilling flush and drill cuttings are returned to the vessel and reused, some loss can be expected. All drilling fluids used will comply with environmental requirements.

Each borehole will acquire a core sample *c.* 100mm in diameter, creating a hole *c.* 150mm in diameter. Each borehole will have a footprint of 0.018m^3. Assuming a maximum borehole depth of 30m, the core sample removed will be *c.* 240l (0.24m^3). Drill cutting will be dispersed around the drill site and these will have a volume of *c.* 300l (0.3m^3). Assuming that the cuttings will form a simple cone with an 18° slope angle around the drill head, it is estimated that they will cover an area of *c.* 2m^2. Following completion of the drilling, the borehole will be left to fall back in on itself. It is anticipated that 1 borehole will be completed in 1 day.

The noise generated from drilling is low frequency (1-600 Hz) with a sound source level of 145-190dB.

Cone Penetration Testing (CPT)

CPT is widely used for *in-situ* geotechnical characterisation of the ground. The testing is performed with a cylindrical penetrometer with a conical tip (cone) penetrating into the ground at a constant rate of penetration. During the penetration, the forces on the cone and the friction sleeve are measured. The measurements can be used to delineate soil types and soil permeability. Sound levels are typically within the range 118 -145 dB (BOEM, 2012). CPT is expected to only have minor acoustic impacts, primarily from vessel engines. Approximately 6 CPT locations per day will be surveyed.

3. Potential Impacts

3.1. Noise & Vibration

Sound has a dualistic nature and may be described as fluctuations in pressure (pressure waves) or particle fluctuations in a medium (DNV Energy, 2007). When regarding the perception of sound, there are significant differences from species to species both on land and at sea concerning the relevant stimulus parameter, pressure or particle movement, and what sound frequencies can be perceived. There are also substantial differences in the strength required at different frequencies in order to perceive the sound. Table 3.1 shows the noise levels and frequency range of the proposed survey works.

Table 3.1: Noise levels and frequency range of proposed surveys.

Survey Type	Source Level	Frequency
Multibeam Echosounder	235 dB	300 – 500 kHz
Sidescan Sonar	235	100 – 500 kHz
Sub-bottom Profiling (Pinger)	200	3.4 – 12 kHz
UHRS (Sparker/boomer)	226	300 Hz – 1.2 kHz
Drilling (Boreholes)	145 - 190	1 – 600 Hz
Vibrocoring	186	50 Hz
Shipping Noise (medium size <50m)	160-175	50 – 300 Hz
Shipping Noise (DP vessel)	190	50 – 300 Hz

3.1.1. Molluscs

Whelks, razor clams and mussels like all other invertebrates do not respond to sound pressure (Hawkins & Popper, 2014) as they have no hearing abilities. They do have statocysts (sensory organs that function in the sense of balance / equilibrium) which may suggest a sensitivity to particle motion. Bivalve and gastropod molluscs may detect sound rather than hear it.

The very high frequencies associated with multibeam and side-scan sonar surveys suggests there will be little penetration away from the source vessel (Berrow, 2019). This and the fact that BIM regularly use side scan sonar to survey the seed mussel beds in the area suggests that any impacts on bottom dwelling molluscs are of minimal concern. The lower frequency sub bottom profiling surveys may induce particle motion that may be detected by the bottom dwelling molluscs. As can be seen in Figure 1.4, the overlap with the proposed cable route corridor and the razor clam fishery is minimal and in reality, given the location of the overlap area, it is unlikely to be surveyed.

The whelk fishery and small seed mussel areas overlap the cable route corridor. While this overlap is extensive for whelk, it must be noted that the entire cable route corridor will not be surveyed. The area surveyed will be confined to a small number of viable cable route options. No unnecessary surveys will be carried out and where possible reliance on existing INFOMAR data will be used in place of obtaining new survey data. Therefore, given the scale, duration and timing of the surveys it is not believed that there will be a significant impact on gastropod and bivalve mollusc populations.

3.1.2. Salmon

Atlantic salmon are functionally deaf above 0.38 kHz (Hawkins & Johnstone, 1978) with best hearing at 0.16 kHz (threshold 95 dB re 1μPa). Salmon therefore are not sensitive to the very high frequencies associated with multibeam and single beam surveys and they will not be impacted by them. The poor hearing of salmon also means that they will not be impacted by the lower frequencies of sub-bottom profiling. Salmon will hear vessel noise, however noise from an additional vessel will not significantly impact on salmon passing through the area. Salmon will also hear borehole drilling, however as this will occur at one stationary location at a time over a short duration, disturbance caused to salmon will be minimal. The same is true for vibrocoring.

3.1.3. Shad

All fish in the order Clupeiformes have swimbladders and inner ear structures that have led to the suggestion that these fish have special hearing capabilities (e.g. O'Connell, 1955; Denton & Blaxter, 1979; Denton & Gray, 1979; Best & Gray, 1980; Blaxter *et al*., 1981; Astrup, 1999). Shad and herring are members of the Clupeiformes. As there is no information available on the hearing sensitivity of Twaite shad, sensitivity of herring as being used instead. Herring have a hearing range between 30 Hz and 4 kHz, with a peak frequency of between 50 and 200 Hz at 75dB re 1μPa (Nedwell *et al.,* 2004). Shad are not sensitive to the very high frequencies associated with multibeam and single beam surveys and they will not be impacted by them. Shad will hear the low frequency noise from sub-bottom profiling, particularly ultra-high resolution sonar (UHRS) if it is required at the site. If UHRS is required at the site during the sensitive April – May period, the employment of the soft-start procedure (as required for marine mammals) will ensure sufficient warning is given to individuals in the area so that they can temporarily vacate the area if they are sensitive to the noise.

Shad will also hear vessel noise, however noise from an additional vessel will not significantly impact on shad passing through the area. Shad will also hear borehole drilling, however as this will occur at one stationary location at a time over a short duration, disturbance caused to shad will be minimal. The same is true for vibrocoring.

3.1.4. Lamprey

While there are no data available for hearing in lamprey, it is highly unlikely that they detect sound close to 10 kHz (Popper, 2005). The lamprey ear is relatively simple and there is nothing within the structure of the ear or associated structures to suggest any specialisations that would make them into anything but a hearing generalist, with maximum hearing to no more than several hundred Hz. Lamprey are not sensitive to the very high frequencies associated with multibeam and single beam surveys and they will not be impacted by them. Likewise, the poor hearing in lamprey mean they will not be impacted by sub-bottom profiling. Lamprey will hear vessel noise, however noise from an additional vessel will not significantly impact on lamprey passing through the area. Lamprey will also hear borehole drilling, however as this will occur at one stationary location at a time over a short duration, disturbance caused to lamprey will be minimal. The same is true for vibrocoring.

3.1.5. Spawning & Nursery

The three species known to spawn in the area are razor clams, whelk and mussels.

Whelk spawn in the area in December/January. Females retreat to hard substrate areas to deposit their egg capsules (FAO, 2019) and release strings of eggs which attach to the substratum for 3-5 months before hatching into benthic juveniles, rendering a limited dispersion of offspring. There are no larval stages.

Razor clams appear to breed in spring/summer (Hayward *et al*., 1996; Fish & Fish, 1996) although one study showed breeding in the Irish Sea beginning in January and peaking in March (Cross *et al.,* 2014). Following spawning, fertilised eggs develop into mobile larvae hours after fertilisation, and spend approximately one month as plankton passing through several larval stages (Fraser *et al.,* 2018)). The larvae then settle, attaching themselves to sediment by byssal threads, before burrowing into the sand as juveniles.

Mussel spawning is protracted in many populations, with a peak of spawning in spring and summer (Tyler-Walters, 2008). A partial spawning in spring is followed by rapid gametogenesis, gonads ripening by early summer, resulting in a less intensive secondary spawning in summer to late August or September (Seed, 1969a). Mussels also produce planktonic larvae which settle on suitable substrata within approximately 2 months.

Eggs and larvae of species that drift in, or close to, the upper sea surface can potentially be at risk from geophysical survey operations as their habitat coincides with the depths at which devices are either mounted on the hull of a vessel or are towed behind a vessel (usually *c.* 5m below the surface), and they actively cannot avoid these sound sources. The eggs and larvae of both razor clams and mussels fall into this category.

A review of the scientific literature compiled by DNV Energy (2007) outlines that the research has shown that there are potential impacts to fish eggs, larvae and fry that are present at distances of less than 5m to a seismic sound source with the most frequent and serious impacts occurring at distances out 1.5m and earlier life stages are more vulnerable. The report also examined the effects at a population level by comparing seismic mortality to natural mortality during these early life stages. The findings of the research indicated that seismic mortality of commercial species is so low that it is not considered to have any (significant) negative impact on recruitment to the populations (Dalen *et al.,* 1996).

The survey sites also act as a nursery ground for whiting, cod, mackerel, horse mackerel, herring, sandeel, tope shark, thornback ray and spotted ray. Nursery grounds are less sensitive than spawning grounds as juvenile species can temporarily move away from the noise source if they are disturbed by it. Best practice guidelines for managing the risk to marine mammals form man-made sound sources (DAHG, 2014) will be employed as part of the proposed surveys. While specifically aimed at marine mammal species, one procedure known as the 'soft-start' procedure will also benefit fish species. The soft-start procedure involves the slow ramping up of the noise level allowing sensitive species to temporarily vacate the area in advance of the full noise level being emitted.

Energia will only carry out surveys that are absolutely required, we will rely on existing Infomar data if suitable and available in place of carrying out new surveys. In addition, Energia will only survey areas that are realistic options and we will use the lowest sound sources possible to achieve the desired results.

Given the scale and duration of the proposed surveys and in light of the above, it is not believed that these surveys would have a significant impact on spawning and nursery grounds in the area.

3.2. Presence of Survey Vessel

As there is commercial fishing activity within the proposed survey area some interaction with fishing activity and the survey vessel may occur. However, given the duration, scale and timing of the proposed surveys it is considered that such interaction will be limited and overall will not be significant. Energia will appoint a Fisheries Liaison Officer who will consult with the SFPA, relevant fisheries groups and charter boat skippers in order that appropriate actions can be taken to avoid or minimise any interactions with ongoing fishing activities in the area.

Energia will only carry out surveys that are absolutely required, we will rely on existing Infomar data if suitable and available in place of carrying out new surveys. In addition, Energia will only survey areas that are realistic options and we will use the lowest sound sources possible to achieve the desired results.

3.3. Suspended Sediments

The volume of sediment released during the intrusive works (vibrocoring, boreholes, grab sampling), the scale of the intrusive works and the timeframes involved (e.g. 1 borehole over the course of 1 day) will result in an insignificant increase in suspended sediments in the water column. Any intrusive works in the vicinity of existing aquaculture operations will be avoided / mitigated against.

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