Project Title	Seagreen Wind Energy Ltd
Document Reference Number	LF000009-CST-OF-REP-0025

Seagreen Alpha and Seagreen Bravo Offshore Wind Farms

Marine and Migratory Fish Monitoring Plan

Rev	Date	Reason for Issue	Originator	Checker	Approver
01	25/06/2019	For information	[Redacted]		

Document Change Summary

Rev	Date	Detail of Change	Changed by

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1. Introduction

Seagreen Wind Energy Ltd (Seagreen) is progressing the development of the Seagreen Alpha and Seagreen Bravo offshore wind farms (OWFs) off the east coast of Scotland in the outer Firth of Forth and Firth Tay area (Figure 1.1). The projects received consent under Section 36 of the Electricity Act 1989 from the Scottish Ministers in 2014 (the S.36 Consents) (subsequently varied to remove capacity limits, Aug 2018) and were granted three Marine Licences from the Scottish Ministers in 2014, one for the Seagreen Alpha Generating Station, one for the Seagreen Bravo Generating Station, and one for the Offshore Transmission Works (OfTW). The project consents were confirmed in November 2017 following a legal challenge. The Onshore Transmission Asset (the onshore export cable and onshore substation) was granted Planning Permission in principle by Angus Council in 2013 (subsequently extended in 2016).

The Seagreen Alpha and Seagreen Bravo OWFs will together comprise up to 150 wind turbine generators (WTGs) with associated foundations, inter-array cables, Offshore Substation Platforms (OSPs) and meteorological masts. The OfTW cable corridor makes landfall at Carnoustie, in Angus (Figure 1.1).

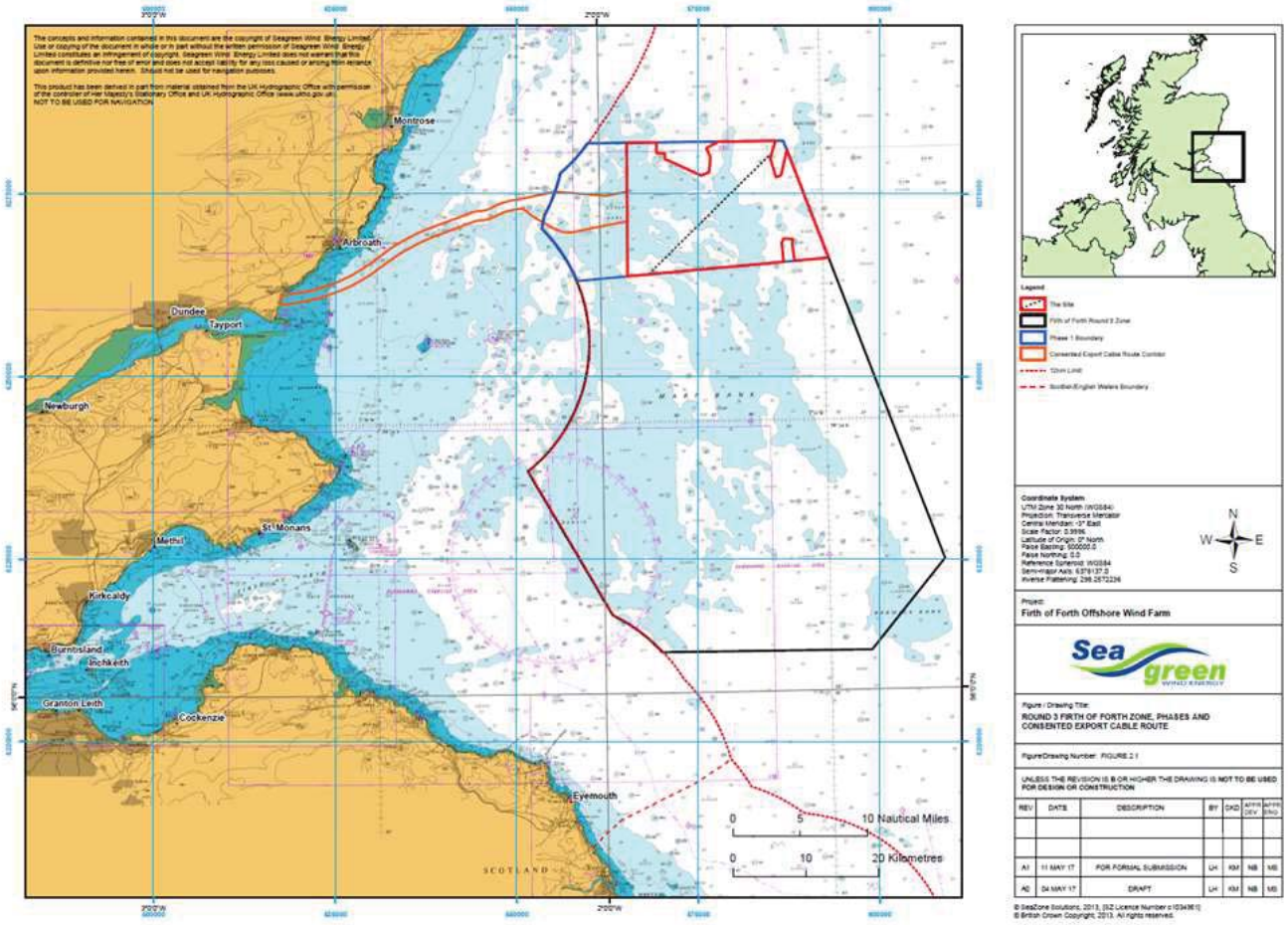

Figure 1.1: Firth of Forth Zone, Seagreen Alpha and Seagreen Bravo OWFs and the OfTW.

1.1 Document Purpose

This document has been prepared by RPS Energy on behalf of Seagreen Wind Energy Ltd. (referred to as 'Seagreen'). It outlines the rationale and specification for the planned fish monitoring for the Seagreen Alpha and Seagreen Bravo OWFs and OfTW. The programme of monitoring has been designed in accordance with the Conditions of the Seagreen Alpha and Seagreen Bravo OWF Section 36 consents (Condition 26 in both consents) and the Marine Licence for the OfTW (Condition 3.2.1.1).

The marine and migratory fish monitoring strategy has been informed by a comprehensive review of monitoring requirements across the Seagreen Alpha and Seagreen Bravo OWF sites which was undertaken by RPS Energy, on behalf of Seagreen. This review was undertaken to evaluate and provide justification for the need for surveys in relation to marine and migratory fish species at the Seagreen Alpha and Seagreen Bravo OWFs and OfTW site to discharge the Marine Licence and Section 36 consent Conditions. The review considered the degree of certainty in the predictions made within the Seagreen Alpha and Seagreen Bravo OWF Offshore Environmental Statements (ES) (Seagreen, 2012). A summary of the findings of this review and how it has informed the rationale for any monitoring for marine and migratory fish species for the Seagreen Alpha and Seagreen Bravo OWFs is also provided within this document.

1.2 Consultation

The report Seagreen Fish Monitoring Strategy (LF000009-CST-REP-0019, Seagreen (2019a)), outlining Seagreen's preliminary proposals for the marine and migratory monitoring strategy, was prepared in advance of a consultation between Seagreen, Marine Scotland and Scottish Natural Heritage (SNH) held on 21st March 2019. The report was circulated to attendees prior to the meeting and formed the basis of subsequent discussions at the meeting.

During the meeting, Marine Scotland Science confirmed that they agreed with the monitoring strategy presented by Seagreen. This was followed by confirmation from Marine Scotland Science that they were content with the marine and migratory fish monitoring strategy on 15th April 2019 via e-mail. SNH also confirmed that they agreed with the contents of the marine and migratory fish monitoring strategy on 21st March 2019 via e-mail.

The proposed monitoring strategy was then discussed and agreed at the Forth and Tay Regional Advisory Group meeting on 24th June 2019. This report therefore has been completed following feedback received from the consultees and confirms the agreed monitoring plan for marine and migratory fish.

2. Marine and Migratory Fish Baseline Summary

The following provides a brief summary of the baseline environment for marine and migratory fish as summarised in the 2012 Offshore ES (Seagreen, 2012) and updated with the latest available information.

2.1 Marine Fish

A wide range of fish species occur within the Seagreen Alpha and Seagreen Bravo OWFs, along the OfTW corridor and throughout the wider region including the Firth of Forth and the east coast of Scotland. Several species of commercial and ecological importance are known to be present across the region including cod *Gadus morhua*, lemon sole *Microstomus kitt*, herring *Clupea harengus*, mackerel *Scomber scombrus*, plaice *Pleuronectes platessa*, sandeel *Ammodytes* sp., saithe *Pollachius virens*, sprat *Sprattus*, spotted ray *Raja montagui*, spurdog *Squalus acanthias*, tope *Galeorhinus galeus*, and whiting *Merlangius merlangus.* There are also a number of shellfish species present, including *Nephrops norvegicus*, lobster *Homarus gammarus*, crabs *Cancer pagarus* and *Necora puber* and squid *Loligo* sp.

A number of different fish species were identified during epibenthic trawls conducted during the benthic survey undertaken in 2011 including pogge *Agonus cataphractus*, dab *Limanda*, goby *Pomatoschistus norvegicus*/*lozanoi*, lesser sandeel *Ammodytes marinus*, butterfish *Pholis gunnellus*, plaice, whiting and cod (Seagreen, 2012). Dab, goby, and lesser sandeel were generally the most abundant species.

Herring and sandeel were identified as the key species for the Seagreen Alpha and Seagreen Bravo OWF sites and along the OfTW as they were considered to be ecologically important or potentially sensitive in the 2012 Offshore ES. This was due to their presence in the survey area, their sensitivity to potential impacts from the construction of the OWFs and in the case of herring, the moderate adverse (and therefore significant) behavioural impacts identified in the 2012 Offshore ES (Seagreen, 2012) as a result of underwater noise from piling and the proximity of spawning grounds. However, based on the latest criteria for underwater noise exposure for fish from Popper *et al*., (2014) and the most recent underwater noise modelling in the 2018 Offshore EIA Report (Seagreen, 2018) undertaken by Cefas, potential impacts to herring were considered to be minor adverse and not significant. It should also be noted that if the installation of the selected foundation option does not involve driven piles then potential noise impacts will no longer be relevant.

For sandeel the 2012 Offshore ES concluded no significant impacts from construction (piling noise) or from habitat loss or disturbance, but that there remained some uncertainty with regard their potential sensitivity to the installation of gravity based foundations and both the permanent loss and temporary disturbance of habitat from this foundation option. However, gravity based foundations are not now being considered for the final project design and therefore issues regarding potential habitat loss are significantly reduced and no longer relevant in the context of requiring monitoring. All other species are not considered due to the lack of significant effects concluded in the 2012 Offshore ES and a lack of uncertainty regarding potential impacts.

2.1.1 Herring

As identified in the 2012 Offshore ES, the key marine fish species of potential concern is herring, due to its sensitivity to noise and the potential proximity of herring spawning to the Seagreen projects (Seagreen, 2012). Herring is a commercially and ecologically important (Fauchald *et al*., 2011 and Casini *et al*., 2004) pelagic fish species, common across much of the North Sea and is listed as a Scottish Priority Marine Feature (PMF). The species is considered to be hearing specialists, with an intimate connection between the swim bladder and hearing system and are a 'Group 3'[1] species after Popper *et al*. (2014).

As shown in Figure 2.2 the noise propagation modelling in the 2012 Offshore ES, for pin piled jackets with 1800kJ maximum hammer energy, suggested noise from piling had the potential to affect the Buchan herring stock spawning area to the north of Seagreen Alpha and Seagreen Bravo. The modelling suggesting that 24% of the high intensity spawning grounds being affected with strong avoidance reactions expected to affect up to 3% of the area.

However, remodelling of the potential underwater noise for a monopile driven using maximum 3,000kJ hammer energy in the Seagreen 2018 EIA Report (Seagreen, 2018) and utilising the most recent criteria from Popper *et al*., (2014) shows a significant reduction in the extent of predicted noise propagation. It is important to note that the 2018 and 2012 underwater noise modelling approaches are different. However, the reduction in predicted noise propagation significantly reduced the predicted overlap with the Buchan spawning area to the north (see Figure 2.3). Comparative figures in terms of the percentage of area of spawning grounds affected were not produced for the 2018 Offshore EIA Report (Seagreen, 2018) based on the more qualitative guidelines (Popper *et al*., 2014) that were applied.

It should be noted that if driven pile foundations are not used then potential impacts from underwater noise will no longer be of concern.

[1] Group 3 from Popper *et al.,* (2014) includes fish in which hearing involves a swim bladder or other gas volume (e.g. Atlantic cod, herring and relatives). These species are susceptible to barotrauma and detect sound pressure as well as particle motion.

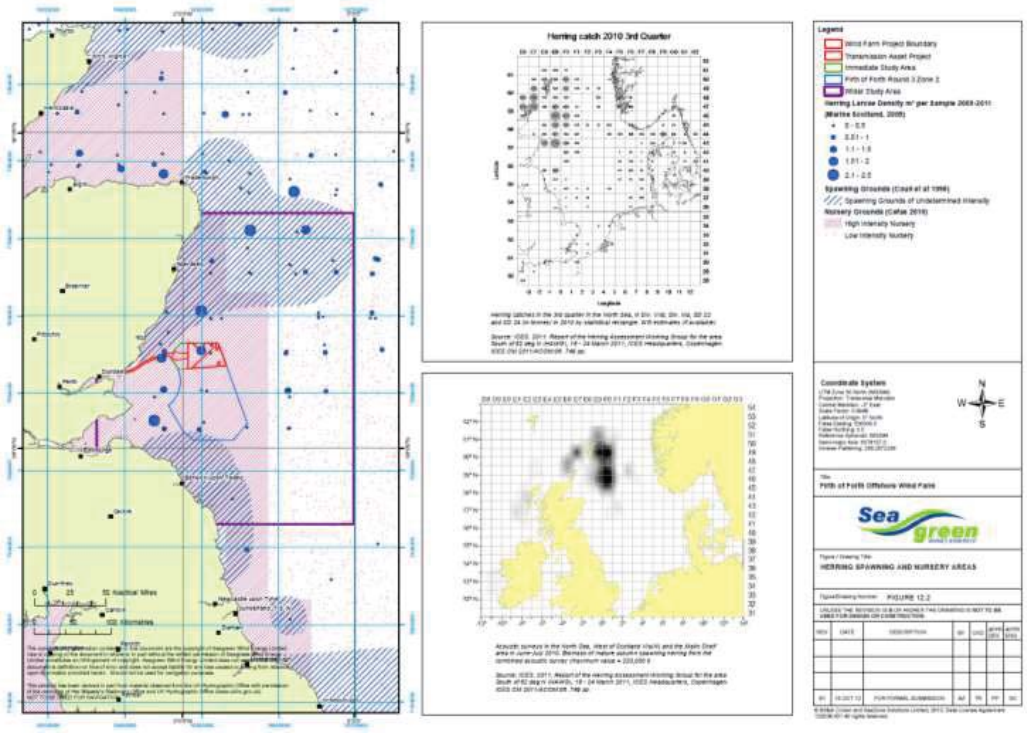

Figure 2.1: Herring Spawning and Nursery Areas (taken from Figure 12.2 of the original ES; Seagreen, 2012)

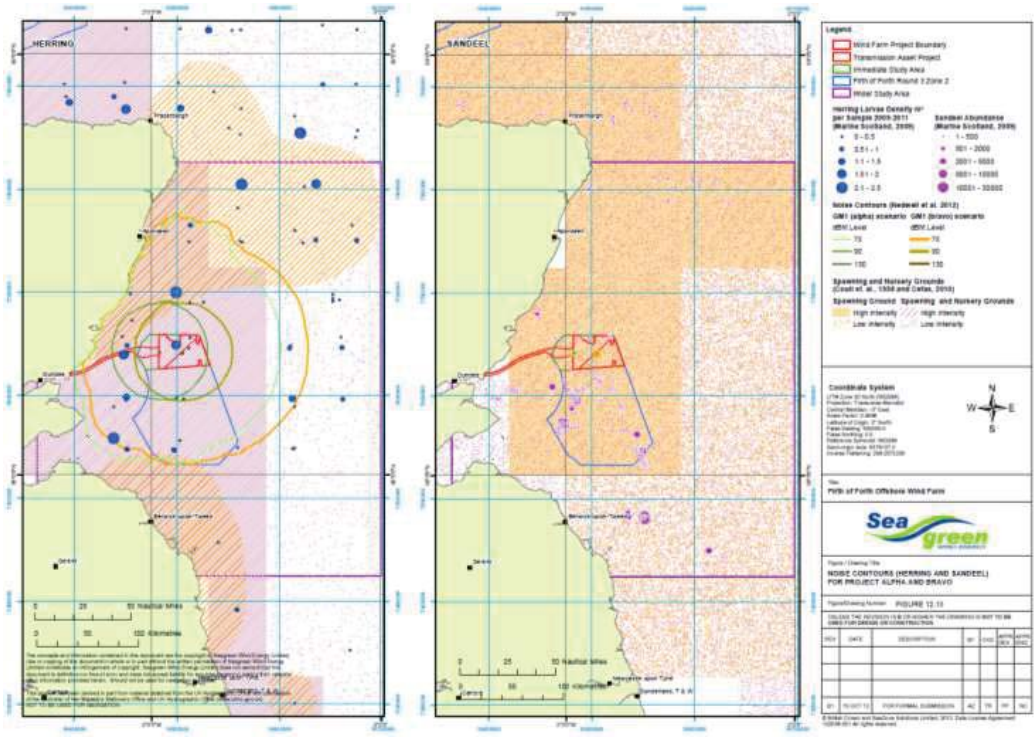

Figure 2.2:Noise Contours for Herring for Seagreen Alpha and Seagreen Bravo (right hand figure, taken from Figure 12.13 of the original ES; Seagreen, 2012)

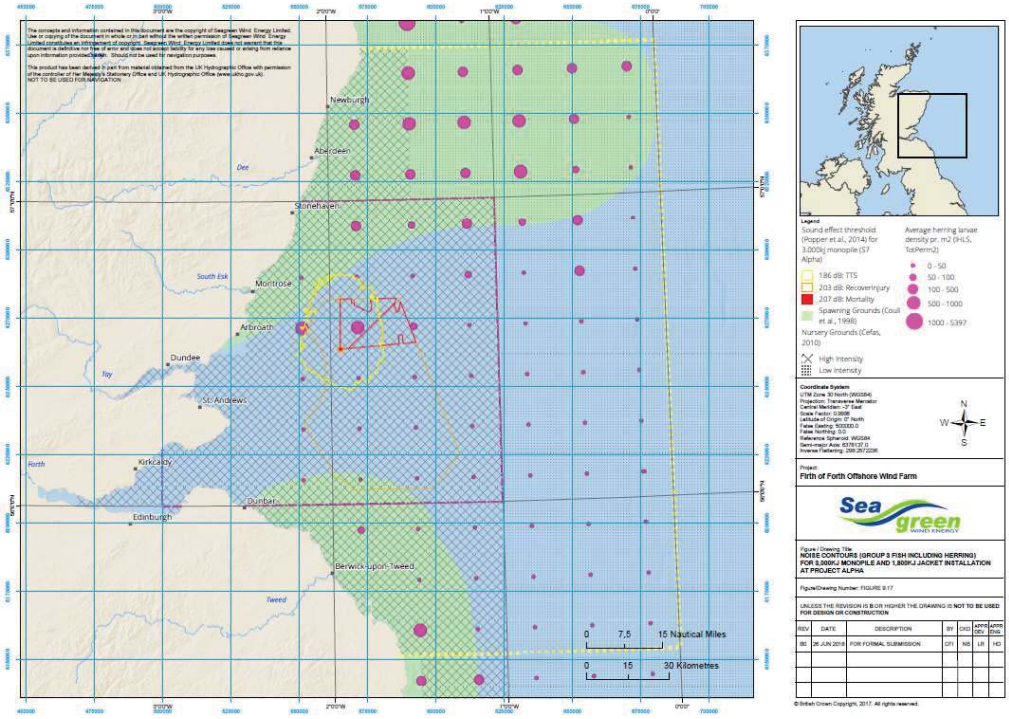

Figure 2.3: Noise Contours (Group 3 Fish Including Herring) for 3,000Kj Monopile and 1,800Kj Jacket Installation at Project Bravo (taken from Figure 9.18 of the 2018 Offshore EIA Report; Seagreen, 2018)

Based on the available data presented above, Seagreen Alpha and Seagreen Bravo OWF sites are not within any herring spawning grounds (as identified by Coull *et al*., 1998; Ellis *et al*., 2012; ICES, 2016, Marine Scotland (unpublished)) with herring spawning grounds located approximately 6.3 km to the north and 80 km to the south of these OWF sites, with the main spawning areas further to the north (Ellis *et al*., 2012). Unpublished data provided by Marine Scotland for the original 2012 Offshore ES (shown in Figures 2.1 and 2.2) demonstrated that herring larvae were present within the vicinity of both the Seagreen Alpha and Seagreen Bravo OWFs in Autumn 2011. However, it was uncertain at what development stage the larvae were. If the yolk sac was still present this would indicated that the larvae were only a few days old and likely to be from a local spawning stock rather than drifting from spawning grounds further afield. More recent work by the Working Group of International Pelagic Surveys (WGIPS) has reported that the main concentration of herring larvae occurs to the north, which suggests that the larvae present in the Marine Scotland data may have drifted south from a more concentrated area of spawning activity (ICES, 2016). In addition, the densities of larvae recorded by Marine Scotland (unpublished) (between 1.2 to 2 per m^2) when compared to the ICES data (up to 3,000 per m^2 recorded to the north) (ICES, 2016) would suggest a much lower larval density and therefore lower likelihood of being a spawning area.

Further analysis of 10 years of International Herring Larvae Survey (IHLS) data provided in Boyle and New (2018) further show that the Seagreen Alpha and Seagreen Bravo OWFs do not overlap with any spawning grounds and that the highest intensity spawning may be further north than previously thought (Figure 2.4). As a result, there is likely to be no or very little overlap between the potential area for behavioural impacts and the northerly spawning area as the highest intensity spawning activity is beyond the limit of propagated noise at levels predicted to cause behavioural disturbance.

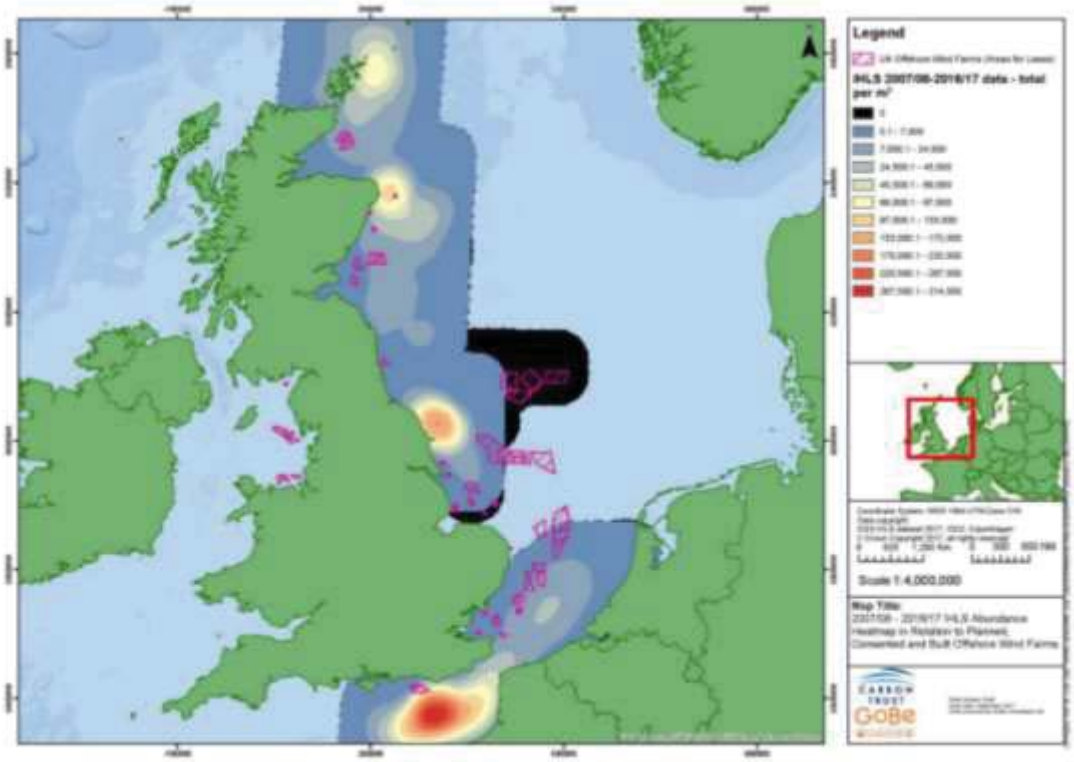

Figure 2.4: IHLS 10 year data in relation to planned, consented and built OWFs. Source Boyle and New, 2018.

It is therefore concluded that herring spawning activity does not take place within the Seagreen Alpha and Seagreen Bravo OWFs and OfTW and that the nearest spawning activity is likely to be further north than suggested by the data from Coull *et al*., (1998) and Ellis *et al*., (2012). This combined with the reassessment of piling noise impacts (Seagreen ,2018) suggests that any overlap with noise generated by piling activity and spawning activity is likely to be minimal and not of concern.

The Seagreen Alpha and Seagreen Bravo OWFs and OfTW are however more likely to be representative of herring nursery grounds, with the Firth of Forth considered to be a nursery ground of high intensity, with another area, of lower intensity, to the east (Ellis *et al*, 2012). Nursery grounds will support young fish that do not form part of the main adult stock but will maintain the stock in future years. Due to their small size and lower mobility than adults they can be more vulnerable to noise and other disturbance as they are unable to move away and have less resilience than adult fish. However the extent of potential herring nursery grounds is very large and, if piling occurs, the potential overlap with piling noise is limited to a small proportion of the grounds. No further consideration of nursery grounds is therefore required.

2.1.2 Sandeel

The wider Firth of Forth region has long been known to support important sandeel populations. The highest density of this population is focused on the Wee Bankie, some 30 km south of the Seagreen Alpha and Seagreen Bravo OWF sites, however sandeels do range across much of the wider North Sea. The commercial fisheries technical report for the ES (Appendix 11A; Seagreen, 2012) identified some limited sandeel trawling activity by Danish vessels to the south of the Seagreen Alpha and Seagreen Bravo OWFs.

Three species of sandeel were found to be present within the Seagreen Alpha and Seagreen Bravo OWFs during the 2011 benthic survey (Seagreen, 2012). By far the most abundant was the lesser sandeel, with smooth sandeel *Gymnammodytes semisquamatus* and the greater sandeel *Hyperoplus lanceolatus* also present at lower frequencies and abundance. Lesser sandeel were also recorded in the dropdown video and benthic grab surveys across the Seagreen Alpha and Seagreen Bravo OWFs and OfTW.

As part of the 2011 benthic survey, Particle Size Analysis (PSA) was undertaken and used to map particle size composition across the Seagreen Alpha and Seagreen Bravo OWFs and OfTW. Using the categories defined by Greenstreet *et al*., (2010b) it was possible to determine that the majority of the Seagreen Alpha and Seagreen Bravo sites contain Prime or Subprime habitat for sandeel (Figure 2.5).

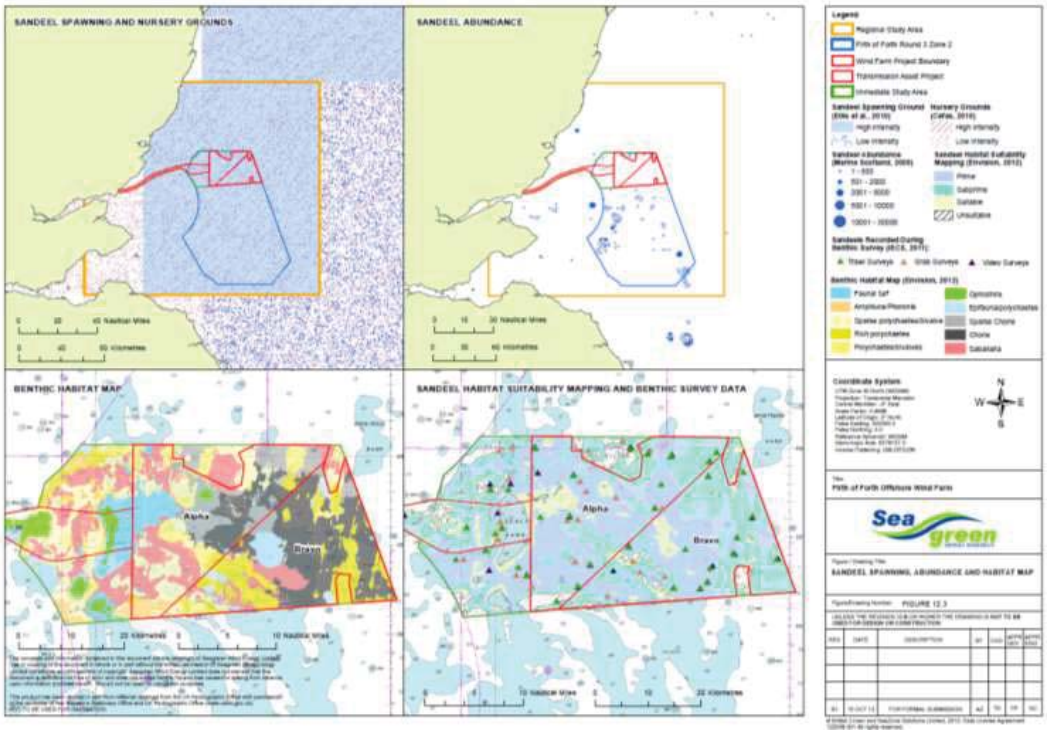

Figure 2.5: Sandeel Spawning, Abundance and Habitat Map (taken from Figure 12.3 of the original ES; Seagreen, 2012)

2.2 Migratory Fish

Seven species of migratory, or diadromous fish were identified in the 2012 Offshore ES as relevant to the Seagreen Alpha and Seagreen Bravo OWFs and OfTW, including Atlantic salmon *Salmo salar*, sea trout *Salmo trutta*, European eel *Anguilla anguilla*, sea lamprey *Petromyzon marinus*, river lamprey *Lampetra fluviatilis*, Allis and twaite shad *Allosa fallax* and *Alosa alosa* and sparling (European smelt) *Osmerus eperlanus*. Of these species it is expected that Atlantic salmon, sea trout, eels and the lampreys have the potential to be present.

Atlantic salmon were considered to be of medium sensitivity to sound in the 2012 Offshore ES and potential impacts from noise were considered to be negligible and not significant. However, due to uncertainty regarding potential effects on behaviour from underwater noise (Seagreen, 2012) Atlantic salmon are considered further below. The remaining species were assessed as either not being present in the Seagreen Alpha and Seagreen Bravo OWFs and OfTW, having low sensitivity to noise and all other effects were considered as not significant (e.g. to EMF, suspended sediment etc.). Therefore, they are not considered further in this document.

2.2.1 Atlantic salmon

Atlantic salmon is an Annex II species under the Habitats Directive and is therefore a qualifying feature for designation of Special Areas of Conservation (SACs).

Atlantic salmon smolts and adults are rarely caught at sea and were not recorded in any of the surveys conducted at the Seagreen Alpha and Seagreen Bravo OWFs (Seagreen, 2012). The presence of salmon within the Seagreen Alpha and Seagreen Bravo OWFs and OfTW was therefore considered through the review of other data sources, which provide some indication that salmon smolts and adults may pass through the site as they migrate to and from their natal rivers (e.g. Malcolm *et al*., 2010).

Rod catch data from rivers on the east coast of Scotland can provide an insight into the general trends of salmon populations within the region of the Seagreen Alpha and Seagreen Bravo OWF sites. Data from the Tweed, Forth, Tay, South Esk and Dee were examined to identify trends in populations and to understand potential baseline conditions for Atlantic salmon (Marine Scotland, 2017). At a simple level, evidence suggests that salmon migrate to/from a number of rivers in the vicinity of the Seagreen Alpha and Seagreen Bravo OWFs and OfTW (Figure 2.6) and it is therefore assumed that adult and juvenile salmon potentially pass through or close to the Seagreen Alpha and Seagreen Bravo OWFs and OfTW. This is consistent with the assumptions made within the ES (Seagreen, 2012), and is further supported by new evidence, which suggests smolts will move out to sea upon leaving a river (rather than moving along the coast as had previously been thought) as they migrate to their feeding grounds within the north Atlantic (Newton *et al*., 2017).

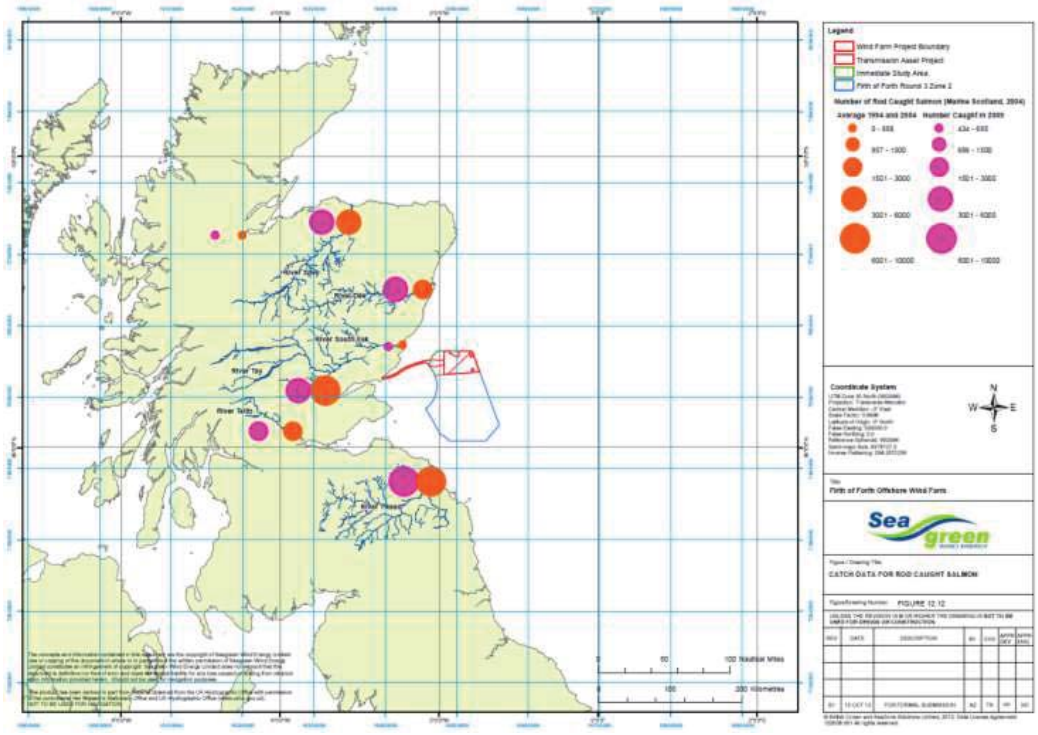

Figure 2.6: Catch Data for Rod Caught Salmon (taken from Figure 12.12 of the original ES; Seagreen, 2012)

3. Monitoring

3.1 Relevant Conditions

Condition 26 of both the Seagreen Alpha and Seagreen Bravo OWF Section 36 consents state that the Project Environmental Monitoring Programme (PEMP) must cover, but not be limited to:

> *a. Pre-construction, construction (if considered appropriate by the Scottish Ministers) and post-construction monitoring surveys for*
>
> *1….*
> *2. sandeels*
> *3. marine fish*
> *4. diadromous fish.*

Condition 30 of both the Seagreen Alpha and Seagreen Bravo OWF Section 36 consents state that Seagreen must:

> *…. to the satisfaction of the Scottish Ministers, participate in the monitoring requirements as laid out in the 'National Research and Monitoring Strategy for Diadromous Fish' so far as they apply at a local level. The extent and nature of the Company's participation is to be agreed by the Scottish Ministers in consultation with the FTRAG.*

Part 3, Condition 3.2.1.1 of the Marine Licence for the OfTW also has the same condition, worded slightly differently, which requires that the PEMP must cover, but not be limited to:

> *a) Pre-construction, construction (if considered appropriate by the Scottish Ministers) and post-construction monitoring surveys as relevant in terms of the Application and any subsequent surveys for:*
>
> *1 diadromous fish*
> *….*
> *4 sandeels (if using Gravity Bases).*

Beyond the PEMP condition, there are no specific conditions in the Section 36 consents for Seagreen Alpha and Seagreen Bravo or in the OfTW Marine Licence for specific surveys targeting particular fish species.

3.2 Monitoring Commitments in ES

The 2012 Offshore ES (Seagreen, 2012) outlined the following monitoring commitments with respect to marine and migratory fish which have been considered as part of the process of defining the monitoring strategy for Seagreen Alpha and Seagreen Bravo OWFs:

> *The Applicants make a commitment to development of monitoring plan if appropriate and requested by the regulators. This is likely to form part of the conditions for consent of the Marine Licence.*

Any monitoring survey programs will be agreed with Marine Scotland and SNH to ensure that they provide suitable data to answer the appropriate questions. It is suggested that monitoring of natural fish is more suited to a regional approach to monitoring building upon strategic work being conducted at the wider Scottish and UK levels.

3.3 Monitoring Plan

The monitoring plan for marine fish, sandeel and migratory fish for the Seagreen Alpha and Seagreen Bravo OWF sites and along the OfTW is designed to provide supporting evidence to demonstrate that the potential construction impacts to those species identified in the 2012 Offshore ES as having the highest sensitivity are as predicted. The species in question were herring, sandeel and Atlantic salmon (see section 2). Based on the available evidence, and the current understanding within the offshore wind industry of these potential impacts, generic pre- and post-construction monitoring for marine fish, sandeels and migratory fish species will not be undertaken for the Seagreen Alpha and Seagreen Bravo OWFs sites. This approach is consistent with the commitments outlined in the 2012 Offshore ES and summarised in section 3.2 of this note. A full justification for this rationale and for not undertaking any further monitoring surveys is provided in section 3.4 below. Consideration is also given to the current design status of the project in setting out the monitoring proposals.

3.4 Justification for Marine Fish, Sandeel and Migratory Fish Monitoring approach

The following sections outline, in the first instance, Seagreen's justification for not proposing monitoring for marine and migratory fish at the Seagreen Alpha and Seagreen Bravo OWF sites or OfTW.

3.4.1 Justification for Marine Fish (herring)

1. A full review of the 2012 Offshore ES has been undertaken which has confirmed that with the exception of behavioural effects related to underwater noise for herring, all effects during construction, operation and decommissioning were considered to be not significant in EIA terms. On a precautionary basis the 2012 Offshore ES considered that the impact on herring would be of low magnitude on a species of high sensitivity resulting in a moderate adverse impact. At this stage, until final engineering design is completed, it is not possible to understand how future design changes and potential reductions in noise emissions may potentially reduce any effects. However, the 2018 Offshore EIA Report (Seagreen, 2018) remodelled the noise produced from piling (albeit using different criteria) and demonstrated that behavioural effects of noise were likely to be minor adverse and not significant.
2. The 2012 Offshore ES concluded that during construction significant behavioural effects were expected to affect up to 3% of the herring spawning area located 6km to the north and approximately 9% of herring nursery grounds. In addition, piling events were likely to only occur for a very small proportion of the time (<5%) during the construction phase, with piling taking place intermittently over an estimated two year construction period. Therefore, the majority of the time during the construction phase will have little to no potential for disturbance due to piling activity. Further, Popper *et al*., (2014) suggest that the sensitivity of herring and other Group 3 species to behavioural effects of underwater noise is likely to be medium and therefore lower than predicted in the 2012

Offshore ES, as shown by the 2018 Offshore EIA Report. There may also be increased ability to tolerate noise during spawning, together with a likely return to normal behaviour shortly after piling ceases, which is likely to confer some degree of resilience (Popper *et al.*, 2014).

3. Marine mammal preconstruction monitoring will include noise monitoring through extension of the East Coast Marine Mammal Acoustic Study (ECOMMAS)[2] acoustic arrays. The results from this monitoring will provide useful data for understanding noise propagation for marine mammals. The data collected will also be able to provide insights into the actual noise produced during the installation of foundations and will be able to be compared with the predicted noise from both the 2012 Offshore ES and the 2018 Offshore EIA Report noise modelling studies for fish species.
4. As the Seagreen Alpha and Seagreen Bravo OWFs and OfTW are not within herring spawning grounds and are now considered likely to be further from the main spawning area than originally considered in the 2012 Offshore ES (see section 2.1.1), the temporary nature of the impact, the amount of time when piling does not occur and the potential recovery of spawning individuals (Popper *et al.*, 2014) it can be concluded that any effects are likely to remain of low magnitude. In addition, if non-piled foundations were to be used in the final design then effects from underwater noise generated during piling activity would no longer be considered relevant.
5. Evidence from the Beatrice OWF suggests that effects are likely to be less than predicted in the 2012 Offshore ES, through the final design reducing noise effects and based on surveys of larvae undertaken in the Moray Firth (BOWL, 2016). In this instance larvae were again noted in the vicinity of the Beatrice OWF, but surveys demonstrated that the larvae had drifted some distance from spawning grounds much further to the north and that spawning took place some distance from the Beatrice OWF (BOWL, 2016). In addition, it was demonstrated that, based on the results of noise modelling, effects on the spawning herring population were unlikely (BOWL, 2016). This example, in addition to the study undertaken by Boyle and New (2018) suggests a similar situation at the Seagreen Alpha and Seagreen Bravo OWFs, with larvae originating from a spawning population to the north with little or no potential overlap between behavioural effects from piling noise and spawning activity. This is further reinforced by the results from the 2018 Offshore EIA Report which demonstrates a much smaller area over which behavioural effects would occur. These examples suggest any potential effect is likely to be much less than predicted within the 2012 Offshore ES.
6. Following detailed engineering design, it is likely that many of the parameters used in both the 2012 Offshore ES and the 2018 Offshore EIA Report assessments will be refined with the potential to further reduce noise impacts. Further, if driven pile foundations are not used this would remove the potential for significant effects from noise during foundation installation.

In is noted that the MMO (2014a) review states that monitoring should be used where there is uncertainty in the significance of an impact which could lead to a potentially significant impact on a sensitive receptor. Surveys should be designed so that data collected can reduce uncertainty in impact significance statements. It also states that monitoring should not be required for impacts where there is already high certainty. In addition, the MMO (2014a) review states that if species of commercial, ecological or

[2] https://www2.gov.scot/Resource/0050/00507404.pdf

conservation importance are of concern at a development site and the ES identifies likely significant impacts on these populations, then targeted monitoring should be focused upon the specific receptor and the impact or uncertainty in question. Based on the lack of herring spawning ground in the vicinity of Seagreen Alpha and Seagreen Bravo OWFs, the further conclusions drawn above regarding potential effects and the most recent data (BOWL, 2016; Boyle and New, 2018, Seagreen, 2018) suggesting the overlap with any spawning areas is significantly reduced, further monitoring above the potential utilisation of ECOMMAS data is not considered necessary.

3.4.2 Justification for Sandeel

1. A full review of the 2012 Offshore ES confirmed that potential impacts to sandeels from construction activity were assessed as minor adverse which is not significant in EIA terms. This is on the basis that the magnitude of any effect is low due to approximately 4% of sandeel habitat being disturbed and less than 1% of sandeel habitat being permanently lost due to the presence of Gravity Based Structure (GBS) foundations on the seabed. Sandeel are considered to be of medium sensitivity to habitat loss/disturbance because of their importance to the North Sea ecosystem and their ability to recover quickly from habitat disturbance (Stenberg *et al*., 2011). No mitigation was considered necessary (Seagreen, 2012). Seagreen will not be using a Gravity Based Structure (GBS) option as the foundation design for the project. As a result, the worst case impacts predicted in the 2012 Offshore ES will be significantly lower.
2. As outlined in the 2012 Offshore ES much of the Seagreen Alpha and Seagreen Bravo OWFs and OfTW and the wider area have been, and continue to be, heavily fished by bottom contacting gears, particularly by scallop dredges (Figure 3.1). These are activities which are known to physically disturb sediments and associated benthic habitats. On this basis, and as concluded in the 2012 Offshore ES, the benthic habitats present (and sandeel habitats) are subject to regular disturbance. The disturbance from scallop dredges has also been shown to increase between 2012 and 2018 (Seagreen, 2012, see Figure 3.2). On the basis that the worst case scenario assessed in the 2012 Offshore ES (Seagreen, 2012) assumed that the Seagreen Alpha and Seagreen Bravo OWFs would coexist with existing fisheries activities, it can be assumed that there will be a level of ongoing physical disturbance to the benthic habitats within the site over the lifetime of the project, which are independent of any activities associated with any phase of the Seagreen project. Therefore, it is considered that any generic monitoring programme of sandeel populations would be ineffective at detecting any variations in sandeel populations (and their habitat) that were attributable to the OWFs rather than ongoing disturbance from commercial fishing activity. On this basis it would be potentially difficult for any monitoring to validate monitoring hypotheses.

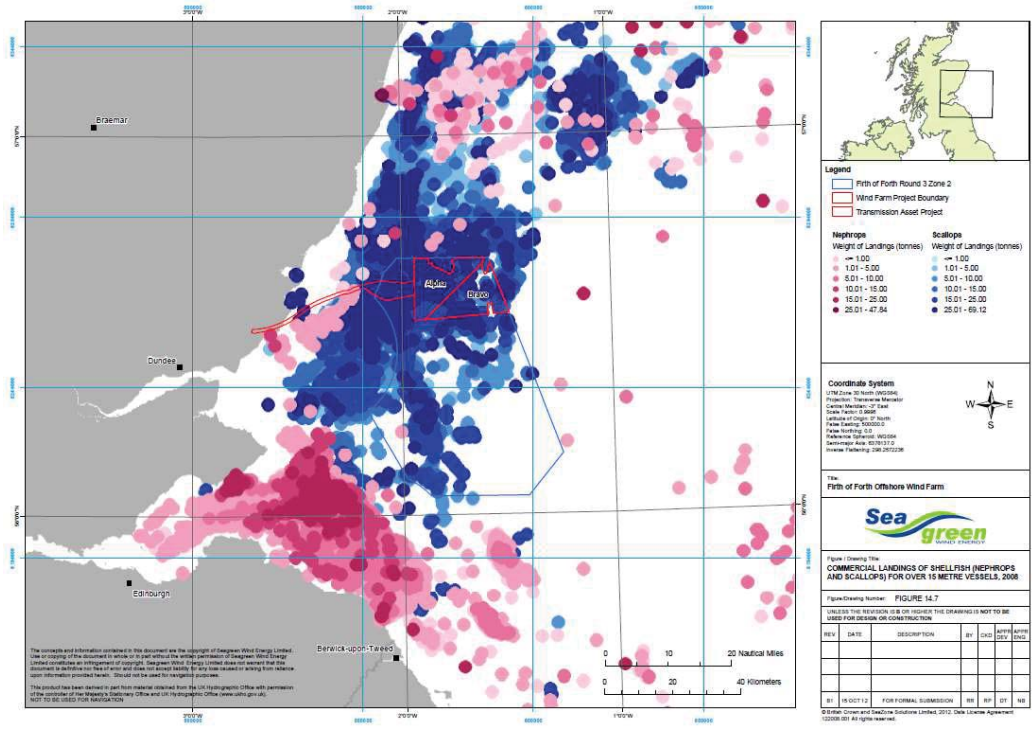

Figure 3.1: Commercial Landings of Shellfish (Nephrops and Scallops) for over 15 metre Vessels, 2008 (taken from Figure 14.7 of the original ES; Seagreen, 2012)

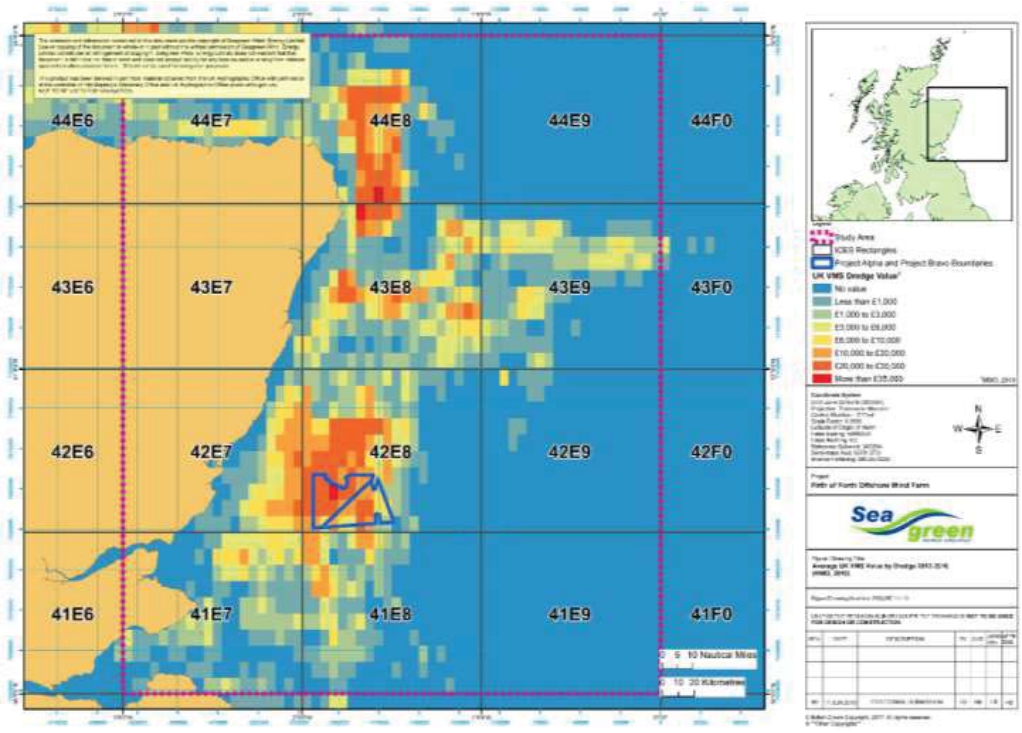

Figure 3.2: Average UK VMS Value by Dredge 2012 – 2016 (MMO, 2018) (taken from Figure 11.10 of the 2018 Offshore EIA Report; Seagreen, 2018)

3. Impacts associated with the construction and operation of OWFs are, on the whole, well understood. For example, published studies undertaken for the OWF industry (e.g. Jensen *et al*., 2004; Stenberg *et al*., 2011; van Deurs *et al*., 2012) have shown that offshore wind farm construction and operation has not led to significant negative effects on sandeel populations. Further information on recovery potential of sandeel can also be inferred from a study by Jensen *et al*. (2010), which examined mixing of adult sandeel populations at different fishing grounds within the entire North Sea. This study showed evidence of mixing between sandeel populations from grounds located up to 5km apart and in some cases mixing between sandeel populations within grounds to distances of up to 28km. This suggests that some recovery of adult populations would be predicted following construction operations, with adults recolonising suitable sandy substrates from adjacent un-impacted areas. Recovery may also occur through larval recolonisation of suitable sandy sediments (which was not investigated in the Jensen *et al*. (2010) study) with sandeel larvae likely to be distributed throughout the adjacent areas of the North Sea.
4. On this basis, monitoring of sandeel populations is not deemed necessary to address areas of uncertainty with respect to the recovery of populations from the impacts predicted to occur as these impacts are well understood and documented in available scientific literature. It should be noted that the requirement for monitoring of sandeels in the OfTW Marine Licence under condition 3.2.1.1 was in relation to GBS foundations (noting that condition 30 in the section 36 consent was not related to GBS foundations). This option is no longer being considered for the Offshore Substation Platforms (OSP) and the wind turbine foundations. Therefore, the worst case scenario assessed in the ES (Seagreen, 2012) has been significant reduced through only considering jackets with driven pile or suction pile foundations. This significantly reduces the potential effects from habitat loss and habitat disturbance.
    - The independent review of post-consent environmental monitoring data (MMO, 2014a) recommended that monitoring requirements are driven to ensure compliance with measures identified in assessments to mitigate significant impacts and address uncertainty. On the basis that there are no significant effects and evidence from other studies shows that offshore wind farm construction and operation has not led to significant negative effects on sandeel populations confidence in the predictions of the ES (Seagreen, 2012) is high. Further, the removal of GBS foundations from the project design reduces the potential effect of both habitat loss and temporary habitat disturbance. As a result, Seagreen have confidence that the effects will be much less than those predicted with the ES and that there is now high certainty with regard to the significance of effect and the ability of sandeel populations to recover from habitat loss and disturbance. Therefore, based on the available evidence and the recommendations of the MMO (2014a) study Seagreen believe monitoring is not required for sandeel.

3.4.3 Justification for Migratory Fish

1. As previously outlined, the MMO (2014a) review concluded that the main impacts to fish populations are displacement and injury as a result of pile-driving noise (noting the uncertainty surrounding these impacts). It follows that monitoring should focus on these behavioural and physiological effects. In addition, the review (MMO, 2014a) suggests that targeted monitoring of significant impacts and or uncertainties as suggested by the EIA should be undertaken to provide adequate data necessary for the determination of impacts. Monitoring should be used where there is uncertainty in impact significance which could lead to a potentially significant impact on a sensitive receptor. Surveys should be designed so that data collected can reduce uncertainty in impact significance statements.
2. A full review of the 2012 Offshore ES confirmed that potential impacts to Atlantic salmon from construction, operation and decommissioning of the Seagreen Alpha and Seagreen Bravo OWFs were considered to be not significant, including from underwater noise generated during piling activity. This is on the basis that although salmon may pass through the Seagreen Alpha and Seagreen Bravo sites during their migration as smolts and adults, the range of potential behavioural impact is relatively small (approximately 1.3 km, see Figure 3.3) and that it is likely that the proportion of the population affected would therefore also be small. Salmon have medium sensitivity to sound and Popper et al., (2014) suggest there is a low risk of behavioural effects beyond hundreds of metres. Popper *et al*.,2014 also considers salmon as a Group 2 species, of lower sensitivity than a hearing specialist species such as herring, which is Group 3. Therefore, given the small area of effect the population expected to be affected is also small, resulting in a negligible magnitude of impact that is considered to be not significant in EIA terms. The 2018 Offshore EIA Report also examined potential impacts to salmon and demonstrated a much lower sensitivity than herring. The 2018 EIA Report concluded that behavioural effects would occur over much shorter distances than for more sensitive Group 3 species and that effects on Group 2 species such as salmon would be negligible and not significant. This further supports the conclusions of the 2012 Offshore ES that any effects will be minor adverse or less and not significant.

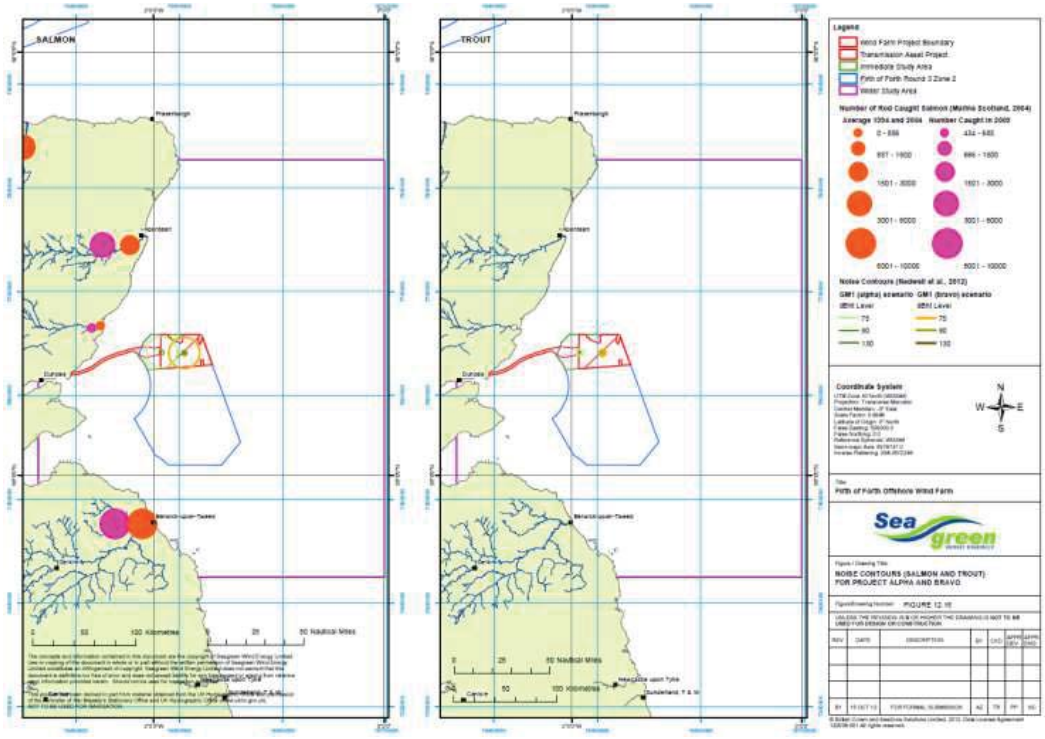

Figure 3.3: Noise Contours (Salmon and Trout) for Seagreen Alpha and Seagreen Bravo OWFs (taken from Figure 12.15 of the 2012 Offshore ES; Seagreen, 2012)

3. Recent evidence from the Moray Firth (Newton *et al*., 2017; Gardiner *et al*., 2018a) suggests that smolts migrating from their rivers in the Moray Firth head directly across the North Sea relatively rapidly. It is thought that this route, rather than moving in a coastal direction upon leaving their natal rivers, allows them to take advantage of east flowing currents which cross the North Sea. This fast progress away from the coast limits exposure to predators close to the coast. It also reduces the potential for interaction with marine renewables developments (including offshore wind). Similar evidence of a rapid easterly migration out into the North Sea has also been shown for the River Dee in Aberdeenshire (Gardiner *et al*., 2018b). Therefore, it could be assumed that smolts from other east coast rivers (e.g. Tay, Forth and North and South Esk) would move in a similar fashion. In relation to Seagreen Alpha and Seagreen Bravo OWFs, these studies suggest that smolts from the Forth, Tay, North and South Esk river systems may migrate across the Seagreen Alpha and Seagreen Bravo OWFs as they head east towards the North Sea. The most recent evidence suggests smolts are likely to move through the area relatively rapidly (Newton *et al*., 2017) and that smolts will only be present for a short period of time in the vicinity of the Seagreen Alpha and Seagreen Bravo OWFs, reducing their potential exposure to any piling noise generated during construction. Therefore, the potential impact is likely to remain not significant. This new evidence does however reduce the level of uncertainty present in the assessment, as it demonstrates that smolts are likely to be present (as assumed in the ES (Seagreen, 2012)) and move rapidly through the site towards the North Sea.
    - As previously outlined, the independent review of post-consent environmental monitoring (MMO, 2014a) recommended that monitoring requirements are driven to ensure compliance with measures identified in assessments to mitigate significant impacts and to reduce uncertainty in relation to the assessment. On the basis that there were no significant effects (Seagreen, 2012) and that more recent evidence (Newton eta l., 2017; Gardiner *et al*., 2018b) confirms what was assumed in the assessment, i.e. that adults and smolts potentially pass through in the Seagreen Alpha and Seagreen Bravo OWFs during migration, it is not deemed necessary to address this area of previous uncertainty. Further, the revised underwater noise modelling undertaken for the 2018 Offshore EIA Report (Seagreen, 2018) demonstrates a much reduced area where behavioural effects could occur, demonstrating that any potential impacts are likely to be less than predicted in the 2012 Offshore ES (Seagreen, 2012). Therefore, based on impacts being predicted as not significant no specific monitoring will be undertaken in relation to migratory species.
4. Seagreen are conscious of the requirement under Condition 30 of the Section 36 consent to participate in the monitoring requirements as laid out in the 'National Research and Monitoring Strategy for Diadromous Fish' (NRMSDF). A similar study to those of Newton *et al*., (2017) and reported in Gardiner *et al*., (2018b) might be expected to provide similar results indicting that migrating smolts head directly out to sea rather than along the coast. However, this would not provide any more confidence than at present that smolts may be present within the Seagreen Alpha and Seagreen Bravo sites, which is already assumed, and an equivalent study is unlikely to provide anything new to the evidence base that is already available from the Moray Firth and the River Dee. It is noted that the NRMSDF cited under Condition 30 of the Section 36 consent has been superseded by the Scottish Marine Energy Research (ScotMER) Programme which includes a specialist research group in relation to diadromous fish. The ScotMER Diadromous fish Evidence Map was published by

Marine Scotland on 5th June 2019[3]. Seagreen will investigate with Marine Scotland potential areas to contribute to the ScotMER programme to further understanding of Atlantic salmon ecology and behaviour in offshore areas.

[3] https://www2.gov.scot/Topics/marine/marineenergy/mre/research/diadromous/EvMap

4. Conclusions

A requirement for a monitoring plan for marine fish, sandeel and migratory (diadromous) fish currently forms part of the conditions attached to the Seagreen Alpha and Seagreen Bravo OWFs Section 36 consents and the Marine Licence for the OfTW. A review has been undertaken of the requirement for marine fish, sandeel and migratory fish monitoring surveys based on consideration of the predictions made within the 2012 Offshore ES (Seagreen, 2012), the level of certainty in these assessments and the most recently available data including the 2018 Offshore EIA Report (Seagreen, 2018). These findings have been considered in the context of existing data on the sensitivity and recoverability of fish receptors, to determine if areas of uncertainty exist, against which potential monitoring could be targeted.

The conclusions of this review are that the significance of any effects for the majority of potential impacts is considered to be negligible to low and there is a high level of certainty in the impact assessments presented within the 2012 Offshore ES and supported by the more recent assessment in the 2018 Offshore EIA Report. This is due to the well understood nature of many of the impacts and the certainty of the predicted extents of the impacts.

For herring, a potentially significant behavioural effect from piling activity during construction was assessed in the 2012 Offshore ES. The most recent data (BOWL, 2016; Boyle and New, 2018) provides further evidence that the Seagreen Alpha and Seagreen Bravo OWFs are not located within a spawning area and the highest concentration of spawning is likely to be much further north than originally predicted. In addition, the most recent noise modelling presented in the 2018 Offshore EIA Report predicts a much reduced extent of noise propagation, further reducing potential behavioural effects of noise generated during piling activity. Combined with detailed design refinement of many of the parameters used in the assessment this gives Seagreen confidence that the effects that will arise due to construction noise will be less than those predicted within the 2012 Offshore ES if driven pile foundations are used. Furthermore, if foundations which do not require driven piles are used the potential for such effects is removed altogether. The evidence therefore suggests that there is no requirement for herring surveys based on the conclusions of the MMO (2014a) study. It is noted, however, that there may be an opportunity to investigate underwater noise propagation data from marine mammal monitoring undertaken by Seagreen to understand differences between predicted and recorded noise at the Seagreen Alpha and Seagreen Bravo OWFs in relation to fish species of concern. This is described in the document LF000009-CST-OF-RPT-0024 Seagreen Pre-construction Marine Mammal Monitoring Plan (Seagreen, 2019b)

For sandeel, evidence from other OWFs demonstrates that offshore wind farm construction and operation has not led to significant negative effects on sandeel populations. In addition, the removal of GBS foundations from the project design reduces the potential effect of both habitat loss and temporary habitat disturbance significantly below that assessed in the 2012 Offshore ES. As a result, Seagreen have confidence that the effects will be much less than those predicted within the 2012 Offshore ES and are confident that monitoring is not required for sandeel. In addition, it is considered that any generic monitoring programme would be ineffective at detecting any variations in sandeel populations (and their habitat) that were attributable to the OWFs and the OfTW due to ongoing disturbance from commercial

fishing activity for scallops using bottom dredges across both Seagreen Alpha and Seagreen Bravo and much of the OfTW.

In the 2012 Offshore ES, there was some uncertainty regarding the presence of salmon smolts within the Seagreen Alpha and Seagreen Bravo OWFs and OfTW. Recent evidence (e.g. Newton et al., 2017; Gardiner *et al*., 2018a; Gardiner *et al*., 2018b) suggests smolts from rivers on the coast adjacent to the projects are likely to migrate directly out to the North Sea from their natal rivers. This validates the hypothesis in the 2012 Offshore ES and the 2018 Offshore EIA Report that smolts (and adults) may be present within the Seagreen Alpha and Seagreen Bravo OWFs and OfTW and reduces uncertainty for this aspect of the assessment. In addition, given the reduction in the potential extent of noise propagation and subsequent behavioural effects predicted in the 2018 Offshore EIA Report, any potential impacts are likely to be less than predicted in the 2012 Offshore ES (Seagreen, 2012). Again, if foundations which do not require driven piles are used the potential for such effects is removed altogether.

On this basis, Seagreen are not proposing a programme of generic pre- and post-construction monitoring for marine fish, sandeel and migratory fish species.

Seagreen are conscious of the requirement to participate in the NRMSDF (now superseded by ScotMER) as laid out in the Section 36 consents. Seagreen will explore potential studies through the ScotMER Evidence Maps once they are published which could be supported and will work with Marine Scotland to identify the most suitable opportunities.

Seagreen considers that the monitoring plan for fish set out in this document is consistent with the requirements of the Section 36 consents and the Marine Licence conditions and is also consistent with the commitments for monitoring/mitigation outlined in the ES (Seagreen, 2012).

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