13.0 Fish and Shellfish Ecology

Introduction

13.1 In addition to the terrestrial environment, the proposed development will occupy subtidal and intertidal areas of Loch Ryan that may provide suitable habitat for fish and shellfish species. This chapter of the Environmental Impact Assessment (EIA) therefore provides an assessment of the potential impacts on these receptors.

13.2 Potential impacts considered within this chapter include:

- Potential for water quality impacts (increased suspended sediment concentrations) due to dredging;
- Potential for resuspension of contaminated sediments with effects on marine ecology receptors;
- Effects of underwater noise arising from construction activities (e.g. dredging, vessel noise, and potential piling) on fish including migratory fish species; and
- Potential impacts of creating new artificial habitat surrounding the new berths and breakwater extension on fish and shellfish species.

Competency Statement

13.3 This Chapter has been prepared by David Alexander, BSc (Hons) MSc, and Bethany Reed, BSc (Hons) MSc. David has over 15 years of experience providing consultancy advice to development projects and working on marine ecological assessments, including Nationally Significant Infrastructure Projects in the UK. David has principally worked within ports and harbours sector, the aggregates/dredging industry and various renewable energy development and interconnector projects. He has been the lead author for numerous publications and has overseen the conduct of multiple published research works. Bethany is a Senior Consultant with numerous years of experience working on infrastructure development projects. She is experienced in a wide range of essential skills including survey techniques, statistical data analysis, literature reviews and reporting, all which have been developed through involvement in multi-sectoral projects.

Legislation, Policy and Guidance

13.4 The fish and shellfish assessment has been undertaken within the context of the following relevant legislation, planning policies, and guidance documents:

- **Marine (Scotland) Act 2010**[1]

[1] Scottish Government: Marine (Scotland) Act 2010: February 2010.

Framework for managing Scotland's seas through marine planning, licensing, and conservation, with the goal of achieving sustainable development and protection of the marine environment;

- **Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017**[2]
  Regulations requiring environmental impact assessments for certain marine works to ensure potential environmental effects are considered before development consent is granted;
- **The Harbour Works (Environmental Impact Assessment) Regulations 1999**[3]
  Legislation mandating environmental impact assessments for harbour-related developments that may significantly affect the environment, aiming to minimize harm through early-stage planning;
- **Wildlife and Countryside Act 1981**[4]
  Legislation for the protection of native species, habitats, and Sites of Special Scientific Interest, in addition to supporting biodiversity conservation and the control of invasive species;
- **Conservation of Habitats and Species Regulations 2010 (commonly referred to as the Habitats Regulations)**[5]
  Regulations to transpose the EU Habitats and Birds Directives into UK law, protecting important habitats and species through designated sites and legal safeguards;
- **National Marine Plan (Scotland)**[6]
  Policies to guide sustainable development and decision-making in Scottish marine areas;
- **UK Marine Policy Statement**[7]
  Guides for the development of marine plans across the UK, setting principles for sustainable use of marine resources and ecosystem protection;
- **Scottish National Planning Framework 4 (NPF4)**[8]
  Scotland's long-term spatial strategy integrating land use planning with national policies on climate change, biodiversity, and sustainable development; and
- **Dumfries and Galloway Local Development Plan 2**[9]

[2] Scottish Government: Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017: May 2017
[3] UK Government: The Harbour Works (Environmental Impact Assessment) Regulations 1999: February 2000
[4] UK Government: Wildlife and Countryside Act, 1981: November 2019
[5] UK Government: Conservation of Habitats and Species Regulations 2010 (commonly referred to as the Habitats Regulations: March 2010
[6] Scottish Government: National Marine Plan (Scotland): March 2015
[7] UK Government: UK Marine Policy Statement: March 2011
[8] Scottish Government: National Planning Framework 4: February 2023
[9] Dumfries and Galloway Council: Local Development Plan 2: October 2019

Local level plan outlining land use policies and proposals specific to Dumfries and Galloway, guiding development and protecting natural and cultural assets in the region.

Methodology Used for Assessment

Study Area

13.5 The study area for this EIA topic comprises the predicted maximum area, in which potential environmental effects may occur. The study area for this impact assessment has been informed by the hydrodynamic and sedimentary plume modelling undertaken, as well a consideration for underwater noise levels during construction phase works.

Methodology

13.6 This assessment has been prepared in accordance with the Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment[10], the Institute of Ecological and Environmental Management (IEEM) Guidelines for Ecological Impact Assessment (Marine and Coastal)[11].

13.7 The methodology is summarised below:

- Data are obtained on the fish and shellfish communities in the vicinity of the proposed development which will potentially be affected through specific desk-based study;
- The value and sensitivity of the identified fish and shellfish communities that have been defined are determined;
- Potential impacts on fish and shellfish communities are quantified on the basis of their magnitude, nature, probability, duration, and reversibility. The potential for cumulative and combined effects are also considered where appropriate;
- Where potential significant environmental effects are identified in the assessment process, mitigation and/or compensation measures are identified alongside specific monitoring needs, and the residual effects after mitigation/compensation are evaluated; and
- The significance of any residual effects is reported.

13.8 The sensitivity of the identified receptors is determined according to the relative importance of the existing environmental features or the potential susceptibility of the receptors to change.

[10] CIEEM. (2018). Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 1.3. Chartered Institute of Ecology and Environmental Management, Winchester.
[11] IEEM. (2010). Guidelines for Ecological Impact in Britain and Ireland. Marine and Coastal. Council of the Institute of Ecology and Environmental Management.

The criteria for the determination of sensitivity/value of the receptors are established based on relevant guidance, legislation, statutory designation, and/or professional judgment.

13.9 The definitions of receptor sensitivity/value for the purposes of fish and shellfish ecology are shown in Table 13-1.

Table 13-1: Criteria used to define receptor value/sensitivity.

Sensitivity/ Value Criteria	Definition
High	The receptor is of high environmental value or contains species/habitats of international or national importance. There is likely to be little capacity for the receptor to absorb change without considerable alterations to the current state.
Medium	The receptor has some environmental value or contains species/habitats of regional importance. There is likely to be medium capacity for the receptor to absorb change without considerable alterations to the current state.
Low	The receptor is of low environmental value or contains species/habitats of local importance. The receptor is tolerant of change without detriment to its character.
Negligible	The receptor is of limited environmental value and is resistant to change.

13.10 The impact assessment considers impacts during both construction and operation of the proposed development (as identified in the Scoping Opinion), defined as short to medium term impacts and long-term impacts. Short to medium term impacts are considered to be those associated with the construction phase of the proposed development, and long-term impacts are those associated with the development once operational. These factors are considered along with the scale of potential changes and reversibility in the definition of magnitude. Table 13-2 shows the definitions of impact magnitude adopted for the assessment of fish and shellfish ecology.

Table 13-2: Criteria used to define the magnitude of impacts

Magnitude Criteria	Definition
High	Total loss or substantial alteration to the integrity of the receptor or key features of baseline conditions that are likely to be irreversible, even in the long-term, such that the fundamental character of the receptor is permanently changed.
Medium	Loss or clear impact on one or more key features of the baseline conditions resulting in a material change to the character of the receptor, though likely to be reversible in the long-term.
Low	Slight shift away from baseline conditions such that any changes to the baseline conditions will be detectable but not material and similar to the pre-development situation. Changes likely to be reversible in the short to medium term.
Negligible	Very slight change from baseline conditions. Any impacts likely to be reversible in the very short term.

13.11 A combination of the value/sensitivity of the identified receptors and the magnitude of potential impacts will be used determine the significance of the resulting effects. Table 13-3 illustrates the matrix based on these parameters which will be used for guidance in the assessment of significance, which will be informed by professional judgement.

Table 13-3: Significance of Effects Matrix

Magnitude of impact	Sensitivity of Receptor			
	High	**Medium**	**Low**	**Negligible**
High	Substantial	Substantial	Moderate	Slight
Medium	Substantial	Moderate	Slight	Negligible
Low	Moderate	Slight	Negligible	Negligible
Negligible	Slight	Negligible	Negligible	Negligible

13.12 Significance criteria will be based on the type of potential consequences, the probability of the consequence occurring, and the magnitude of the consequence. Table 13-4 identifies the scale that will be used to evaluate significance of effect.

Table 13-4: Definitions of sensitivity used in the fish and shellfish ecology assessment.

Significance Criteria	Definition
Substantial Adverse/ Beneficial Effect	Substantial deterioration/improvement compared to the current scenario e.g. high impact on a regionally or nationally importance resource
Moderate Adverse/ Beneficial Effect	Noticeable deterioration/improvement compared to the current scenario e.g. moderate to high impact on a locally important resource
Slight Adverse/ Beneficial Effect	Slight deterioration/improvement compared to the current scenario e.g. low impact on a locally important resource
Neutral	No noticeable alterations to the current scenario

13.13 The following potential impacts on fish and shellfish ecology have been identified for the marine works associated with the proposed development:

- Potential for water quality impacts (increased suspended sediment concentrations) due to dredging;
- Potential for resuspension of contaminated sediments with effects on marine ecology receptors;
- Effects of underwater noise arising from construction activities (e.g. dredging, vessel noise, and potential piling) on fish including migratory fish species; and
- Potential impacts of creating new artificial habitat surrounding the new berths and breakwater extension on fish and shellfish species.

Desk Study

13.14 In order to ascertain the baseline conditions in the vicinity of the study area, a range of sources have been consulted as part of a desktop study. No primary data collection has been proposed due to the inherent difficulties in accurately quantifying fish and shellfish communities and the existing knowledge base being deemed suitable. Additional sources of information have been gained through consultation with relevant bodies.

13.15 The principal data sources used in the assessment of impacts on fish and shellfish are as follows:

- Marine Scotland National Marine Plan interactive (NMPi) maps[12];
- Fisheries sensitivity maps for UK waters[13, 14];
- Stranraer Marine Environmental Impact Assessment Scoping Report[15];
- Scottish Sea Fisheries Statistics 2021 - Fishing Effort and Quantity and Value of Landings by the International Council for the Exploration of the Sea (ICES) Rectangles[16];
- UK Sea Fisheries Statistics 2022[17];
- Geodatabase of Marine features adjacent to Scotland (GeMS) - Scottish Priority Marine Features: Species Point Dataset[18];
- Loch Ryan Management Plan 2014[19];
- Scottish Environment Protection Agency (SEPA) - Shellfish Water Protected Areas (SWPA) Data Sheet 85: Loch Ryan[20];
- Scottish National Marine Plan[6]; and
- European Union Designated Sites Standard Data Forms.

[12] Marine Scotland. (2024). Marine Scotland Maps NMPi part of Scotland's environment. Available at: Marine Scotland - National Marine Plan Interactive (atkinsgeospatial.com). Accessed on: 4th November 2024.
[13] Coull, K. A., Johnstone, R., and Rogers, S. I. (1998). Fisheries Sensitivity Maps in British Waters. United Kingdom Offshore Operators Association (UKOOA).
[14] Ellis, J.R., Milligan, S.P., Readdy, L., Taylor, N., and Brown, M.J. (2012). Spawning and nursery grounds of selected fish species in UK waters. Sci. Ser. Tech. Rep., Cefas Lowestoft, 147: 56pp.
[15] RPS Consulting Engineers. (2021). Environmental Impact Assessment Scoping Report - Stranraer Marina. Prepared on behalf of Dumfries and Galloway Council. NI2285. 93pp.
[16] Marine Scotland. (2022). 2021 Scottish Sea Fisheries Statistics - Fishing Effort and Quantity and Value of Landings by ICES Rectangles. Available at: https://data.marine.gov.scot/dataset/2021-scottish-sea-fisheries-statistics-fishing-effort-and-quantity-and-value-landings-ices. Accessed on: 7th November 2024.
[17] MMO. (2023). UK Sea Fisheries Statistics 2022. National Statistics. 68pp.
[18] NatureScot. (2024). GeMS - Scottish Priority Marine Features: Species Point Dataset - GEMS V10 (i27). Available at: https://opendata.nature.scot/maps/0e722e3e911e424f8dacac5a587c0dfb/about. Accessed on: 7th November 2024.
[19] Solway Firth Partnership. (2014). Loch Ryan Management Plan 2014. Using marine planning to identify management needs and opportunities for enhanced community amenity and economic regeneration of the surrounding area. Solway Firth Partnership. 58pp.
[20] SEPA. (2022). Shellfish Waters Data Sheet SWPA 85: Loch Ryan. Available from: https://www.sepa.org.uk/environment/water/shellfish-water-protected-areas/. Accessed on 2nd December 2024.

Underwater Sound Propagation Modelling

13.16 The details and full results of the underwater noise assessment that has been completed are set out within **Chapter 20.0** of this EIA Report (EIAR).

13.17 Underwater noise calculations were undertaken based on fixed parameters to estimate the levels of noise likely to be generated by the proposed development which have the potential to affect fish and shellfish communities.

13.18 The outputs from the calculations have been used to assess the potential significance of construction noise on sensitive marine receptors specifically including fish and shellfish, as discussed in this chapter.

Dredge Plume Modelling

13.19 The details and full results of the dredge plume modelling exercise that has been completed are set out within the Coastal Processes Chapter (**Chapter 7.0** of this EIAR).

13.20 Modelling was undertaken to identify the potential zone of influence in which suspended sediment concentration and sedimentation would be elevated compared to background levels during and subsequent to the dredging programme. The modelling examined realistic worst-case scenarios to ensure any method proposed by the contractor would be well within the envelope of effects. To give an accurate assessment, plumes were modelled under conditions representative of both the beginning of the dredging programme, e.g. offshore sediment deposition and existing breakwater layout, and near the end, e.g. onshore sediment reclamation and the new breakwater layout, as well as at all states of tide. The models also incorporated the potential of material being resuspended on subsequent tides after the cessation of dredging.

13.21 Within this chapter, the outputs of these models have been used to aid in assessing the potential effects of changes in the levels of suspended sediment and water quality on sensitive marine receptors, specifically fish and shellfish.

Limitations

13.22 Due to the comparatively low importance of Loch Ryan as a commercial fishing ground, there was limited detailed data or information found regarding fish abundance and distribution specific to the immediate proposed development area.

13.23 Spawning and nursery areas show notable variation spatially and temporally[13, 14] and as such the defined boundaries are not definite but instead are representative of when the data was captured. Therefore, for the following analysis, if data showed spawning and/or nursery areas present within Loch Ryan or in the waters adjacent to the northern entrance to the loch within the Solway Firth, then these species have been included within the assessment. The exception to this pertains to species with ecological characteristics which are unsuited to Loch Ryan, such as freshwater species.

13.24 The underwater noise calculations used several assumptions as part of the computation process, including that fish flee in straight lines and that fish flee at a constant speed of 0.5m/s. The model also assumed a maximal fleeing time of two hours.

Summary of Consultation

13.25 Consultation responses of relevance to this chapter were received from the organisations in Table 13.5 below in the form of a Scoping Opinion.

Table 13.5: Summary of Consultation Responses with Relevance to Fish and Shellfish Ecology

Consultee	Summary Response	Comment/Action Taken
Marine Scotland	Impacts are likely on fish species. In particular spawning areas. The potential impacts of new artificial habitat on fish and shellfish species should be scoped into the EIA report.	Potential effects from these activities on fish and shellfish are considered in this chapter.
	The applicant should engage with the Stinchar District Salmon Fishery Board to determine if any sea trout or salmon netting rights have the potential to be affected by the proposed works which must be included in the EIA.	Contact sought with Stinchar District Salmon Fishery Board to determine if any sea trout or salmon netting rights are present in the area.
	In addition to the effects of underwater noise arising from construction activities, the potential impact on diadromous fish from underwater noise and disturbance arising from the operation of the Proposed Works must also be scoped in for further assessment.	Underwater noise assessments from both construction and operation are included in this chapter.

Baseline Conditions

13.26 A desk-based study has been carried out to characterise, where possible, the fish communities expected to be present within the vicinity of Stranraer and the wider Loch Ryan area using available data sources.

Commercial Fish Species

13.27 Loch Ryan is largely located within ICES rectangle 38E4 with the northern portion of the Loch and adjacent waters being within rectangle 39E4 and a minor section of the southeast boundary crossing into 38E5. Loch Ryan is also entirely within ICES subarea VII, division VIIa Irish Sea.

13.28 UK fleet landings data by ICES rectangle indicate low catch data for rectangle 38E4 and 39E4 for demersal and pelagic species between 2017 and 2022[16, 17] relative to that of the coasts around Scotland. Between 2017 and 2021, the top three commercial fish species captured by tonnage landed in ICES rectangle 38E4 were herring *Clupea harengus*, hake *Merluccius*

merluccius, and haddock *Melanogrammus aeglefinus*, and in 39E4 were hake, haddock, and lesser spotted dogfish *Scyliorhinus canicular*[16].

13.29 In the wider Solway Firth area, a number of commercially important fish species have been recorded, including those listed above as well as cod *Gadus morhua,* anglerfish *Lophius piscatorius*, whiting *Merlangius merlangus,* plaice *Pleuronectes platessa*, saithe *Pollachius virens*, mackerel *Scomber scombrus*, sprat *Sprattus sprattus*, spurdog *Squalus acanthias* and horse mackerel *Trachurus trachurus*[12, 21] . A number of these species are Priority Marine Features (PMFs), including cod, anglerfish, whiting, saithe, mackerel, spurdog, and horse mackerel.

13.30 Loch Ryan and the adjacent Solway firth area also provides spawning and/or nursery grounds for some commercial species. Within Loch Ryan this includes sprat (spawning), hake (nursery), and plaice (nursery), as well as the PMF species anglerfish (nursery), spurdog (nursery), cod (spawning and nursery), whiting (spawning and nursery), and mackerel (spawning and nursery) [12, 13, 14]. Additionally, the following species have recorded spawning and/or nursery grounds in the adjacent Solway firth area: sole *Solea solea* (spawning and nursery) and haddock (spawning), as well as the PMF species horse mackerel (nursery), blue whiting *Micromesistius poutassou* (nursery), and herring (spawning and nursery)[12, 13, 14]. This would indicate that these species may be present in the area of the proposed development at key life stages.

13.31 Fishing effort is low within Loch Ryan itself due to the prohibition of fishing for sea fish with mobile or active gear (such as dredge and bottom/midwater trawl fishing) according to The Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 2004[22]. The exception to this being for dredging of mussels and oysters.

13.32 Salmon and sea trout netting was historically undertaken within Loch Ryan, however the Stinchar District Salmon Fishery Board has confirmed that all nets have now been removed from Loch Ryan (pers. Comm.).

Recreational Fish Species

13.33 Sea angling is popular within Loch Ryan and the surrounding Solway Firth area, with rod and line fishing undertaken mainly in the summer months. There is an active angling association and charter boats operate from Stranraer Marina[19]. A number of species are targeted by local sea anglers, including typical coastal species such as flat fish, mullet, haddock, pollock, smooth hounds, tope *Galeorhinus galeus* and thornback rays *Raja clavata,* as well as the PMF species

[21] McIntyre, F., Fernandes, P.G., and Turrell W.R. (2012). Scottish Marine and Freshwater Science Volume 3 Number 3: Clyde Ecosystem Review. Marine Scotland Science. ISSN 2043-7722. 123pp.
[22] Scottish Government: The Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 2004: July 2004.

spurdog, mackerel, and whiting[2319]. These species are therefore likely to be present in the vicinity of the proposed development, though in relatively low numbers.

13.34 Atlantic salmon *Salmo salar*, and sea trout *Salmo trutta* are present within Loch Ryan[12], each species is a PMF and Atlantic salmon are also listed under Annex II and Annex V of the Habitats Directive. Loch Ryan has three rivers which have recorded Atlantic salmon and sea trout: the Water of App at Finnarts Bay, the Sole Burn, and one stream near Innermessan[12, 19]; the closest of which is approximately 3km from the development site. Migration routes to the closest river to the proposed development therefore could pass within its vicinity. Salmon netting has previously occurred within Loch Ryan; however, these sites have since ceased operation[19]. A recreational/heritage industry is still ongoing in the wider Solway Firth area[24].

Shellfish Species

13.35 UK fleet landings data between 2017 and 2022 by ICES rectangle indicate average landed weight data for rectangle 38E4 and high for 39E4 for shellfish species[16, 17] relative to that of the coasts around Scotland. Between 2017 and 2021, the top three commercial shellfish species captured by tonnage landed in ICES rectangle 38E4 were scallops, edible crabs *Cancer pagurus,* and Norway lobster *Nephrops norvegicus,* and in 39E4 were Norway lobster, scallops, and edible crabs[16]. Vessel Monitoring System (VMS) average intensity data shows that vessels fishing for Norway lobster and other crustaceans have a high effort in the waters adjacent to Loch Ryan but do not fish within Loch Ryan[25]. Data also shows towed dredges occur for scallops within Loch Ryan, though only 1-3 vessels operate in the area[26].

13.36 Loch Ryan and the adjacent Solway firth area also provides spawning and nursery grounds for some shellfish species, including native oysters and Norway lobster[12, 13, 19].

13.37 Under 'The Water Environment (Shellfish Water Protected Areas: Designation) (Scotland) Order 2016'[27] Loch Ryan was designated SWPA 85 for the production of native oysters *Ostrea edulis*. Native oyster beds form a PMF habitat and occur throughout the loch[12, 19], forming the largest extant native oyster bed in Scotland[28]. The main aquaculture site within Loch Ryan is the commercial fishery for native oysters, run by the Loch Ryan Oyster Fishery Company Ltd. The native oysters are dredged from the seabed, using the vessel 'Vital Spark', on the eastern

[23] Solway Firth Partnership. (2024). Fisheries - Recreational Sea Angling. (https://www.solwayfirthpartnership.co.uk/fisheries/recreational-sea-angling/). Accessed on: 7th November 2024.
[24] EKOS. (2020). Socio-Economic Analysis of the Scottish Solway (SEASS). Final Report. March 2020. Prepared for the Solway Firth Partnership. 136pp.
[25] ICES. (2022). VMS - Average intensity (hours) - Nephrops and crustaceans with bottom trawls (OT CRU) - 2010-2020. Available at: https://marine.gov.scot/maps/1832. Accessed on: 7th November 2024.
[26] Scottish Government. (2021). Inshore Fishing - ScotMap (2013) - Scallop Towed Dredges - Number of Vessels. Available from: https://marine.gov.scot/maps/311. Accessed on: 7th November 2024.
[27] Scottish Government: The Water Environment (Shellfish Water Protected Areas: Designation) (Scotland) Order 2016: September 2016.
[28] Cunningham, C. and Hunt, C. (2023). Scottish Blue Carbon - a literature review of the current evidence for Scotland's blue carbon habitats. NatureScot Research Report 1326. 135pp.

side of the loch near to Lefnoll Point. The Lefnoll area is home to a native oyster bed that covers 1.6km^2 alone [28].

13.38 A fishery for razor clams *Ensis* spp. has previously been present in the north of Loch Ryan[29], though it appears to no longer be classified as a harvesting area[30]. The northwestern area of Loch Ryan is currently classified for sand gapers *Mya arenaria*[30], though no commercial fisheries currently harvest in the area to our knowledge.

13.39 There are also records of common cockle *Cerastoderma edule* beds and blue mussel *Mytilus edulis* beds within Loch Ryan. Blue mussel beds are listed as a PMF habitat and are listed in Annex I of the Habitats Directive[31]. They are known to exist in the southeast and western areas of the loch, while common cockle beds are thought to be based solely along the southeastern shore[12, 19]. Historically cockles and blue mussels have been harvested in the Solway Firth area, however, neither fishery remains. For cockles, the fishery closed under the 'Inshore Fishing (Prohibition of Fishing for Cockles) (Solway Firth) (Scotland) Order 2011'[32] which stipulated the fishery be closed for five years due to concerns over sustainability of the species in the region; the fishery has not reopened since due to low stock.

Other Species of Conservation Importance

13.40 A number of non-commercial PMF fish and elasmobranch species are present within Loch Ryan. This includes sandeels *Ammodytes* spp., basking shark *Cetorhinus maximus*, blue skate *Dipturus batis*, flapper skate *Dipturus intermedius*, porbeagle shark *Lamna nasus*, sandy ray *Leucoraja circularis*, ling *Molva molva* and sand goby *Pomatoschistus minutus*[12]. Additionally, basking sharks are afforded protection under Schedule 5 of the Wildlife and Countryside Act[4]. Blue skate and flapper skate have previously been recorded as the single species common skate *Dipturus batis*, however, they have since been revealed to be separate species[33]. Therefore, both species are listed as present in Loch Ryan.

13.41 Loch Ryan and the adjacent Solway Firth area are part of the spawning and nursery grounds for a number of non-commercial important species. Within Loch Ryan this includes the PMF species: blue skate (nursery), flapper skate (nursery), and ling (spawning)[12, 14]. Additionally, sandeels (PMF species) have recorded nursery grounds in the adjacent Solway firth area[14].

[29] Cefas. (2010). Scottish Sanitary Survey Project. Restricted Sanitary Survey Report. Loch Ryan North. DG 500. November 2010. 59pp.
[30] Dumfries and Galloway. (2024). Harvesting of shellfish. Available at: https://www.dumgal.gov.uk/article/15197/Harvesting-of-shellfish. Accessed on: 7th November 2024.
[31] EU Council: Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora: May 1992.
[32] Scottish Government: Inshore Fishing (Prohibition of Fishing for Cockles) (Solway Firth) (Scotland) Order 2011: September 2011.
[33] Iglésias, S.P., Toulhoat, L., and Sellos, D.Y. (2010). Taxonomic Confusion and Market Mislabelling of Threatened Skates: Important Consequences for Their Conservation Status. Aquatic Conservation: Marine And Freshwater Ecosystems, 20: 319–333.

This would indicate that these species may be present in the area of the proposed development at key life stages.

13.42 European eel (*Anguilla anguilla*) has not been recorded within Loch Ryan; however, it is a PMF species and has been observed in the wider Solway Firth and Firth of Clyde area[34].

13.43 As noted above, basking sharks are known to be present in the adjacent waters to Loch Ryan. NatureScot observation records of individuals are all outside of Loch Ryan, with the exception of one being within the entrance to Loch Ryan[18]. Of the nine observations of basking sharks within 15km of Loch Ryan between 1987 and 2020, the most recent was recorded in 2011[18, 35]. Therefore, it is likely that basking sharks are not present within 10km of the proposed development. Additionally, they are only likely to be present within the vicinity of Loch Ryan itself occasionally, and in very low abundance. As basking sharks are elasmobranchs, they therefore have no swim bladder and so are considered to have low sensitivity to underwater sound[36].

Identification of Receptor Value and Sensitivity

13.44 The information presented above highlights the fish and shellfish communities found in the vicinity of Loch Ryan and the surrounding area. Whilst a range of species are found within the wider fisheries management areas, the available information suggests that the waters surrounding Stranraer are less important, especially for sound sensitive species such as herring. Nonetheless, in light of the potential presence of a number of fish species which are listed as PMFs in the vicinity of the proposed development, the sensitivity of fish is considered to be high.

13.45 Migratory Atlantic salmon and sea trout are present in the Loch Ryan area and are known to use river systems in moderately close proximity to the Stranraer area. Atlantic salmon are protected under Annex II of the Habitats Directive[31] and sea trout are a PMF species.

13.46 The area surrounding Stranraer is not thought to be important for basking sharks, though occasional sightings have been recorded outside of Loch Ryan.

13.47 Data indicate that the wider Loch Ryan area is of some importance for spawning fish and as a nursery ground. Sprat, mackerel, whiting, and Nephrops are known to spawn inside Loch Ryan; mackerel and whiting are PMF species and the spawning intensity of both of these taxa in this location is low. Multiple species use Loch Ryan as a nursery area, including the PMF species cod, whiting, anglerfish, mackerel, spurdog, and common skate, though all of these are low

[34] RPS Consulting Engineers. (2023). Dumfries & Galloway Shoreline Management Plan. Prepared for Dumfries and Galloway Council. IBE1622/AP. 168pp.
[35] Pikesley, S.K., Carruthers, M., Hawkes, L.A., and Witt, M.J. (2024). Analysis of Basking Shark Watch Database 1987 to 2020. NatureScot Research Report 1279. 44pp.
[36] Andersson, M.H., Andersson, B.L., Pihl, J., Persson, L.K., Sigray, P., Andersson, S., Wikström, A., Ahlsén, J., and Hammar, J. (2017). A framework for regulating underwater noise during pile driving. A technical Vindval report, ISBN 978-91-620-6775-5, Swedish Environmental Protection Agency, Stockholm, Sweden. 115pp.

intensity with the exception of spurdog. Loch Ryan is located at the fringe of known nursery areas for most species which utilise the area for this purpose.

13.48 Native oyster beds are present in the vicinity of the proposed development. Native oysters are included in the Oslo and Paris (OSPAR) Commission list of 'Threatened and/or Declining Species and Habitats'[37] and are a PMF. Due to the sessile nature of oyster beds, the potential impacts to this species from the proposed development are considered in Chapter 12.0 Benthic Ecology.

13.49 Table 13-5 provides a summary of the fish and shellfish receptors relevant to the proposed development which will be considered in this assessment, together with their assigned value/sensitivity.

Table 13-5: Sensitivity of fish and shellfish potentially in proximity to the proposed development.

Receptor	Representative species	Description	Value/Sensitivity of Receptor
Commercial and recreational fish species	Herring*, hake, haddock, cod*, mackerel* and other commercial fish	Numerous commercial fish species are found in Loch Ryan. Several species are also listed as Scottish PMFs.	High
Spawning or nursery grounds in Loch Ryan	Sprat, hake, plaice, anglerfish*, spurdog*, cod* whiting*, mackerel*, blue skate*, flapper skate*, ling* and *Nephrops*.	Spawning and/or nursery grounds for multiple fish and shellfish species are found within Loch Ryan, including those for numerous PMF species.	High
Spawning or nursery grounds in the adjacent Solway Firth area	Herring*, sole, haddock, horse mackerel*, blue whiting*, and sandeels*	Spawning and/or nursery grounds for fish species not found within Loch Ryan have been recorded in the adjacent Solway Firth area, including those for PMF species.	High
Migratory fish species	Atlantic salmon* and sea trout*	Both Atlantic salmon and sea trout are found in Loch Ryan and potentially in close proximity to Stranraer. Atlantic salmon is protected under Annex II of the Habitats Directive, and both are PMF species.	High
Elasmobranchs	Basking shark*, thornback ray, tope, spurdog, smooth hounds, blue	Basking sharks are protected under Schedule 5 of the Wildlife and Countryside Act (1981) and are also a Scottish PMF species	High

[37] OSPAR Commission: OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR Agreement 2008-06): June 2008

Receptor	Representative species	Description	Value/Sensitivity of Receptor
	skate*, and flapper skate*	along with blue skate and flapper skate.	
Shellfish species	Native oysters*	Loch Ryan is designated a Shellfish Water Protected Area (SWPA) for native oyster beds. Native oysters are also a PMF and are listed under OSPAR Annex V.	High

** = PMF species.*

Impact Assessment

Embedded Mitigation

13.50 In order to lessen any environmental effects from the proposed development, embedded mitigation measures have been proposed where appropriate. These features are incorporated into the project design and construction methods.

13.51 For fish and shellfish ecology, embedded mitigation is related to the use of underwater lighting. Underwater lighting has the potential to negatively influence fish behaviour, potentially causing stress, disruption to natural physiology, and potentially resulting in localised decreases in the abundance of some taxa. As such, the project will incorporate no elements of underwater lighting in order to minimise impacts on fish and shellfish populations in the immediate vicinity of the development. All other lighting to be installed on pontoons within the marina and surrounds will be of industry standard.

13.52 Additional 'non-embedded' mitigation is also proposed as detailed in the Mitigation section of this chapter.

Construction Phase

Suspended Sediment and Water Quality

13.53 The proposed development at Stranraer may result in a range of potential direct and indirect impacts on the identified receptors. The assessment of these potential impacts follows the methodology outlined in this chapter.

13.54 Part of the proposed development includes a capital dredging programme, followed by land reclamation within Stranraer Harbour as a means of dredge spoil disposal, plus an extension of the existing breakwater. These activities both have the potential to increase the concentration of suspended sediments, sediment deposition, and the release of any seabed contaminants into the water column.

13.55 Dredging across the harbour will be undertaken to varying degrees. Approximately 132,616m^3 of sediment will be dredged, of which approximately 48,340m^3 will be utilised in the land reclamation area and breakwater extension with the remainder to be disposed at sea. Sea disposal will be at the Beaufort Dyke. Other options for on land remediation will also be explored as part of the project.

13.56 The main approach channel will be dredged to minus 3.5 mCD, with the main pontoon areas being dredged to minus 4.5 mCD, minus 3.5 mCD, minus 3.0 mCD, or minus 2.0 mCD depending on the berth sizes. The gradient of change between depths is assumed to be 1:5 at this stage, with the area around the existing breakwater extension and a small area on the northern edge of the marina being 1:4, though this may be adjusted subject to ground investigation. A detailed description of the proposed dredge design is presented in **Chapter 2.0**.

13.57 The final method of dredging will be confirmed once the dredging contractor has been appointed. However, for the purpose of undertaking this EIA, it has been assumed that a cutter suction dredger (CSD) will be deployed to undertake the dredging required for the Proposed Development. During CSD operations, dredged material is drawn up through the cutterhead and suction pipe and discharged in a hopper barge for transport. Overflowing will not be allowed from the hopper barges during dredging operations.

13.58 Alternatively, a backhoe dredger may be used for some areas of the harbour depending on seabed/ground conditions. Taking a conservative approach, the utilisation of CSD methods is also considered to be a worst-case scenario, therefore this assessment has been based on this method alone.

13.59 Results of the initial ground investigation works indicates that surface sediments from within the dredge area predominantly comprise sand and silt material. However, sediments obtained from below the surface (i.e. borehole and vibrocore samples) indicate a slightly increased proportion of coarser material (sand and gravel) with fewer fines.

13.60 Sediment samples were analysed for concentrations of contaminants as part of the ground investigation works and also as part of the Best Practicable Environmental Option (BPEO) assessment. Concentrations of heavy metals, tributyltin (TBT), polyaromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs), as well as total hydrocarbons (THC), were assessed at Stranraer, the methods of which are detailed in Chapter 21. Within Stranraer Marina, sediment contamination was found to be widespread, with elevated levels of chromium and nickel found to be above action level (AL) 1[38] at all three stations sampled for the GI works. Concentrations of chromium, copper, PAHs, and THC were found to be above Revised Action Level (RAL) 1 in the BPEO report, whilst concentrations of nickel were found to be above Revised Action Level 2 at one site and above RAL 1 at the majority of sites tested. Action levels

[38] Marine Scotland. (2017). Pre-disposal Sampling Guidance. Version 2 – November 2017. 5pp.

are generally used to determine the suitability of sediments for disposal at sea, however, in the proposed project it is anticipated that some dredge spoil sediments will be re-utilised within the development with the rest being disposed at sea. Action levels have been referred to in order to give a representation of the scale of contamination.

13.61 The breakwater extension will be constructed using dredge material as fill, with a rock armour exterior to match the existing structure. This activity will be completed by specialist contractors using marine dredging equipment, stabilisation of the dredge material using a secondary treatment process to alter the properties of the material to the desired specification. Heavy excavation equipment will be used to place and form the rock armour revetment, with subsequent heavy duty compaction plant used to stabilise the final formation level in layers as infilling progresses to the desired finished level, likely in layers of 250mm to 300mm in depth.

13.62 In addition to the dredging works, the placement of dredge spoil in the construction of the breakwater extension, rock armour placement, and land reclamation activities all have the potential to increase sediment loading in the water column.

Changes in Suspended Sediment Concentration

13.63 Changes in suspended sediment concentration as a result of dredging and land reclamation have been considered and the impact assessment is presented in Chapter 11. The following assessment relates specifically to the impact on fish and shellfish.

13.64 Increased sediment loading in the water column has the potential to impact upon fish and shellfish receptor behaviour. Filter feeding organisms in particular may suffer from clogging of feeding mechanisms, and increased turbidity has been shown to ultimately impair the growth of some filter feeding bivalves[39]. The gill functionality of fish and shellfish may also be affected by clogging, and increased sediment loading may provoke an avoidance response, potentially limiting foraging areas and efficiencies. Areas of increased sedimentation may also act to cause barrier effects for any migrating fish[40, 41].

13.65 The effects of increased turbidity are likely to be lessened in areas with a naturally high level of sediment loading, such as around coastal areas and within shallow sheltered bays not dissimilar to Loch Ryan, where the fish and shellfish communities present may be better adapted to tolerating such conditions.

13.66 Several studies have indicated that effects on fish and shellfish from increased sediment loading are dependent on the exposure time and concentration of elevated sediments in the water column, with increased chances of avoidance behaviours noted where concentrations

[39] Widdows, J., Fieth, P., and Worral, C.M. (1979). Relationship between seston, available food and feeding activity in the common mussel *Mytilus edulis*. Marine Biology, 50(3): 195-207.
[40] Stuart-Smith, R.D., Richardson, A.M.M., and White, R.W.G. (2004). Increasing turbidity significantly alters the diet of brown trout: a multi-year longitudinal study. Journal of Fish Biology, 65(2): 376-388.
[41] Wenger, A.S., Harvey, E., Wilson, S., Rawson, C., Newman, S.J., Clarke, D., Saunders, B.J., Browne, N., Travers, M.J., Mcilwain, J.L., and Erftemeijer, P.L. (2017). A critical analysis of the direct effects of dredging on fish. Fish and Fisheries, 18(5): 967-985.

are relatively high[41]. Past studies have identified changes in the abundance of salmonids associated with increased sediment loading, however these only occurred when concentrations of suspended sediments remained elevated for several years[41, 42]. Seaward migrating juvenile salmon are known to be particularly sensitive to elevated turbidity[41].

13.67 Dredging, land reclamation, and rock placement will all take place within or immediately adjacent to Stranraer Harbour. Modelling of the anticipated dredge plume arising from the works has been undertaken and is presented in **Chapter 7.0**. Suspended sediment concentration plumes were calculated under two modelled scenarios which were representative of conditions at the beginning of the dredging programme (scenario one, e.g. offshore sediment deposition and existing breakwater layout) and near the end (scenario two, e.g. onshore sediment reclamation and the new breakwater layout). The maximum plume envelopes for suspended sediment, which represented the maximum value calculated by the models at any given location across the study area, showed for both scenarios that the zones of influence (minimum of 0.5mg/l) extended approximately 1.2km north from the mouth of the harbour and was approximately 500m across at the widest point. The material to be dredged is mixed sand and silt with a smaller gravel fraction and is likely to settle moderately quickly, minimising the duration of increased sediment in the water column associated with dredging. There are also no strong tidal currents in the area which could transport suspended sediments significantly further from the site. Snapshots of the suspended sediment concentrations during ebb and flood tides showed that the zone of influence fluctuated in extent with the tides, however these fluctuations were minor and only varied in extent by approximately 100m in any direction. As such, the extent of the increase in sediment loading is expected to be confined to the local vicinity of the works.

13.68 Migratory diadromous fish are present in Loch Ryan, with potential routes in moderately close proximity to the proposed development (approximately 3km). The dredge plume modelling indicates that the area of increased turbidity will be confined to the local area, and that the proposed development lies perpendicular to the closest potential migration stream (Innermessan) and does not block sea access. Migratory fish are of a high sensitivity, however given that any sedimentation resulting from development activity will settle out relatively quickly over a limited area, coupled with the short timescales of dredge activity, the magnitude of this impact is assessed as being negligible. The resulting effect on migratory fish is therefore described as **slight adverse**, which is not significant in EIA terms.

13.69 The negligible increases in suspended sediment concentrations associated with the proposed works are not anticipated to result in detrimental impacts to fish or elasmobranchs. Increased sediments in the water column may result in temporary avoidance behaviour away from the zone of influence or short-term cleaning of gills or similar structures. The magnitude of the

[42] de Jonge, V.N., Essink, K., and Boddeke, R. (1993). The Dutch Wadden Sea: a changed ecosystem. Hydrobiologia, 265: 45-71.

impact of increased suspended sediments on fish and elasmobranch populations (which have been assigned a high sensitivity) is therefore negligible, leading to overall significance of **slight adverse**.

13.70 Several fish species are noted to utilise the loch Ryan area as spawning and nursery grounds and the sensitivity of these areas to potential impacts has been assessed as high. However, none of the species observed have a strict affinity for specific seabed types when spawning in the way that taxa such as herring display. Therefore, given the negligible increase in suspended sediments over a short time period, the limited zone of influence from the dredge plume model, and the total area of Loch Ryan likely to be available for spawning/nursery activity, it is considered that the magnitude of the impact of increased suspended sediments on fish spawning and nursery utilisation of the area is negligible, leading to overall significance of **slight adverse**.

13.71 It is not thought that any extensive shellfish beds or populations are present either within Stranraer Marina or within the area likely to be affected by increased suspended sediments mobilised as part of the proposed development (further explored in Chapter 12). Any shellfish present within the secondary impact zone are likely to be sensitive to smothering from sediment deposition, however as observed in Chapter 7, these changes are likely to be localised and short-scale. As such, the magnitude of the impact of increased suspended sediments shellfish populations (which have been assigned a high sensitivity) is therefore negligible, leading to overall significance of **slight adverse**.

Changes in Water Quality

13.72 Changes in water quality as a result of dredging and land reclamation have been considered and the impact assessment is presented in Chapter 11. The following assessment relates specifically to the impact on fish and shellfish.

13.73 Heavy metals, PAHs, and PCBs are common in sediments exposed to shipping activity and/or industrial development. Dredging has the potential to release contaminants into the water column through disturbance of the sediments. Contaminants released into the water column can affect fish through direct exposure or they may accumulate in marine fauna and transfer up the food chain[43, 44]. If present at high enough levels, effects can include behavioural changes and physiological impacts at sublethal and lethal levels on a range of life stages[41, 45, 46].

[43] Johnson, L.L., Anulacion, B.F., Arkoosh, M.R., Burrows, D.G., da Silva, D.A., Dietrich, J.P., Myers, M.S., Spromberg, J., and Ylitalo, G.M. (2013). Effects of legacy persistent organic pollutants (POPs) in fish—current and future challenges. Fish physiology, 33: 53-140.
[44] Losada, S., Roach, A., Roosens, L., Santos, F.J., Galceran, M.T., Vetter, W., Neels, H., and Covaci, A. (2009). Biomagnification of anthropogenic and naturally-produced organobrominated compounds in a marine food web from Sydney Harbour, Australia. Environment International, 35(8): 1142-1149.
[45] Carls, M.G., Holland, L., Larsen, M., Collier, T.K., Scholz, N.L., and Incardona, J.P. (2008). Fish embryos are damaged by dissolved PAHs, not oil particles. Aquatic toxicology, 88(2): 121-127.
[46] Sogbanmu, T.O., Nagy, E., Phillips, D.H., Arlt, V.M., Otitoloju, A.A., and Bury, N.R. (2016). Lagos lagoon sediment organic extracts and polycyclic aromatic hydrocarbons induce embryotoxic, teratogenic and genotoxic effects in *Danio rerio* (zebrafish) embryos. Environmental Science and Pollution Research, 23: 14489-14501.

13.74 Ground investigation has shown that the sediments within Stranraer Marina are contaminated. Sampling undertaken for the BPEO assessment indicated that several contaminants of concern exceed RAL 1, with a single exceedance recorded of RAL 2. However, it was considered in the BPEO report that there was a low risk of the contaminants within the sediments impacting on the overall status of the water body surrounding Stranraer. Further, the exceedance of RAL 2 for nickel was deemed to be due to naturally occurring concentrations and was unlikely to have arisen from anthropogenic sources. When data were averaged across the site, no exceedances of RAL 2 were observed for any contaminants tested. This aligns with the initial ground investigation surveys, which concluded that many contaminants were only marginally over the RAL1 threshold and upon averaging no longer exceeded the guide limits. Therefore, the contaminants can be seen to be largely present at relatively low levels.

13.75 The maximum dissolved fraction of these metals in the water column has been calculated based on recognised sediment-water partition coefficients. This analysis, described in full in Chapter 11.0, indicates that dredging and disposal will result in increases in the concentration of these metals in the water. However, they will be very localised, largely restricted to the areas in which the activities occur, and they will be short-lived due to the rapid settlement of sediments, the partition to which they are mostly bound. Thus, the magnitude of the impact of project activities on water quality has been assessed as low.

13.76 Water quality indicators such as dissolved oxygen (DO) and biological and chemical oxygen demand can also be affected by the release of sediments into the water column via dredging. This is due to elevated suspended sediment concentrations increasing chemical and biological oxygen demand, which can reduce DO concentrations. However, due to the short-term nature of the proposed dredging activity and the low organic content of the marine deposits, the potential magnitude of the change in DO in the water column has been assessed as negligible (Chapter 11.0).

13.77 Sediments are likely to exist within the water column for a short period of time; this is largely due to the types of sediments present, to which the contaminants are mostly bound, being likely to settle moderately quickly as well as the low tidal currents present in the area creating a limited zone of influence.

13.78 Therefore, these factors indicate a low ecotoxicological risk to fish and shellfish species in the area and, considering the short-term nature of the increases, the magnitude of the impact on fish and shellfish has subsequently been assessed as being negligible. As fish and shellfish have been identified to be a receptor of high sensitivity this results in an impact of **slight adverse** significance.

Underwater Noise

13.79 Underwater noise will be generated by the construction activities for the marina expansion, including impact piling, both in and out of the water (within the intertidal zone). Underwater

noise has the potential to result in disturbance, displacement, and injury of fish receptors. Underwater noise levels associated with the construction activities for the proposed works are presented in Chapter 20 Underwater Noise.

13.80 Chapter 20 has established that the greatest potential underwater noise impacts on fish are derived from impact piling. This activity is therefore considered as the worst-case scenario in terms of underwater noise generation arising from the proposed development and thus is taken forward for detailed ecological assessment below. Other noise sources likely to arise from the project, such as those associated with land reclamation and works to extend the breakwater, were considerably less powerful than impact piling, hence they are not considered further.

13.81 Fish may be impacted by sound in several ways, and the extent to which particular species are influenced by sound is determined to a large extent by the physiology of the fish, in particular the presence or absence of a swim bladder and the role the swim bladder plays in hearing sensitivity[47].

13.82 Morphological features have been used to define functional hearing groups of fish taxa to determine how various species may be affected by the increased sound likely to be generated, based on information presented in Popper *et al.*[47]. These are shown in Table 13-6 and will be used when assessing the impact of underwater sound on the different fish species that may be present in proximity to Stranraer.

[47] Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L., Halvorsen, M.B., Løkkeborg, S., Rogers, P.H., Southall, B.L., Zeddies, D.G., and Tavolga, W.N. (2014). Sound Exposure guidelines for fishes and sea turtles: A technical Report. Cham. Switzerland: ANSI - Accredited Standards Committee S3/SC1. Springer and ASA Press.

Table 13-6 Functional hearing groups and relevant fish receptors. Based on information presented in Popper et al.[47].

Hearing Group	Sensitivity to Underwater Noise	Relevant Fish Receptor
Fish with no swim bladder	Low – these species are less susceptible to barotrauma and do not detect sound pressure. May be susceptible to barotrauma from exposure to sound pressure.	Elasmobranchs, flatfish.
Fish with swim bladder not involved in hearing	Medium - fish with swim bladders in which hearing does not involve the swim bladder or other gas chamber. These species are susceptible to barotrauma though hearing does not involve sound pressure.	Atlantic salmon and sea trout (migratory species). Commercial species.
Fish with swim bladder involved in hearing	High - fish in which hearing involves a swim bladder or other gas chamber. These species are susceptible to barotrauma and detect sound pressure as well as particle motion.	Herring, cod, Otophysi and some commercial species.

13.83 Information on the impacts of underwater noise on shellfish and marine invertebrates is limited, though they are believed to respond to the particle motion elements of sound, including seabed vibration. Shellfish that are exposed to seabed vibration from anthropogenic noise (such as piling activities) may react by closing their shells, which in turn may reduce their water filtering and thus feeding capacity[48]. However, response to underwater noise in shellfish appears to vary greatly between scenarios, locations, and species, with some studies suggesting tissue damage from increased noise, whilst others suggesting no change[49].

13.84 Studies have shown that many marine invertebrate species are likely to perceive sound at very close range (up to 20m) to high intensity sources via mechano-receptors[50, 51]. Crustaceans in particular are believed to detect the particle motion component of sound[52] and the prevalence

[48] Roberts, L., Harding, H.R., Voellmy, I., Bruintjes, R., Simpson, S.D., Radford, A.N., Breithaupt, T., and Elliott, M. (2016). Exposure of benthic invertebrates to sediment vibration: from laboratory experiments to outdoor simulated pile-driving. In Proceedings of Meetings on Acoustics 4ENAL (Vol. 27, No. 1, p. 010029). Acoustical Society of America.
[49] Carroll, A.G., Przeslawski, R., Duncan, A., Gunning, M., and Bruce, B. (2017). A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. Marine Pollution Bulletin, 114(1): 9-24.
50 Hirst, A.G. and Rodhouse, P.G. (2000). Impacts of geophysical seismic surveying on fishing success. Reviews in Fish Biology and Fisheries, 10: 113-118.
[51] McCauley, R.D. (1994). Seismic Survey / environmental implications of offshore oil and gas development in Australia. Sydney: Australian Petroleum Exploration Association. 123pp.
[52] Lovell, J.M., Findlay, M.M., Moate, R.M., and Yan, H.Y. (2005). The hearing abilities of the prawn *Palaemon serratus*. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 140(1): 89-100.

of sounds from aquatic crustaceans suggests that sounds are important for communication between individuals[53].

13.85 No underwater sound threshold data are currently available for invertebrates to indicate limits of exposure. However, based on current evidence, significant impacts are likely to be experienced only in very close proximity to any sound sources.

13.86 Underwater noise effects on fish include the following:

- Disturbance, which may cause a species to exhibit avoidance behaviour or to behave differently from normal, without the presence of any specific physical harm;
- Temporary threshold shift, where hearing is temporarily affected though recovery is anticipated once the sound has abated; and
- Permanent threshold shift, where hearing is permanently damaged or lost.

13.87 A summary of the effects that high intensity sound can have on fish receptors is below (after Popper *et al.*[47]):

- Death and injury: mortality and serious injury can result from exposure to very high amplitude sounds and changes in pressure (barotrauma), especially for impulsive sounds;
- Effects on hearing: either permanent or temporary hearing loss can occur, through a permanent threshold shift or temporary threshold shift (TTS). Permanent loss of hearing may be a consequence of the loss of the sensory cells in the ear, damage to the auditory nerve fibres or other tissues in the auditory pathway such as the swim bladder in fish that utilise this method of hearing. A TTS occurs where hearing is temporarily affected though recovery is anticipated once the sound has abated. The extent is of variable duration and magnitude;
- Effects on behaviour: intense noise may influence fish behaviours, causing a species to exhibit avoidance behaviour or to behave differently from normal, without the presence of any specific physical harm.

13.88 Information from Popper *et al.*[47] has been used to define the impact thresholds for impulsive sound (impact piling). The injury threshold criteria are expressed as dual criteria of a single strike peak sound pressure level (SPL) and cumulative sound exposure level (SEL). These thresholds, with reference to the sensitivity of fish functional hearing groups, are shown in Table 13-7, and are used to determine the onset of mortality, potential mortality injury, recoverable injury, and TTS. Also shown are sensitivities to masking (the reduction in the detectability of a given sound as a result of the simultaneous occurrence of another sound) and behavioural thresholds; specific values are not available for these thresholds, thus a relative risk is given for

[53] Spiga, I., Cheesman, S., Hawkins, A., Perez-Dominguez, R., Roberts, L., Hughes, D., Elliott, M., Nedwell, J., and Bentley, M. (2012). Understanding the Scale and Impacts of Anthropogenic Noise upon Fish and Invertebrates in the Marine Environment. SoundWaves Consortium Technical Review (ME5205).

fish at relative distance from sound sources as near (N; tens of metres), intermediate (I; hundreds of metres) and far (F; thousands of metres).

Table 13-7: Injury and disturbance thresholds for fish from noise arising from impact piling. Data are based on 960 sound events at 1.2 second intervals. After Popper et al.[47].

Receptor Group	Mortality and potential mortal injury	Recoverable injury	TTS	Masking	Behaviour
Low sensitivity fish (no swim bladder)	>213 dBpeak	>213 dBpeak	>186 dB SELcum	(N) Medium (I) Low (F) Low	(N) High (I) Medium (F) Low
	>219 dB SELcum	>216 dB SELcum			
Medium sensitivity fish (swim bladder not involved in hearing)	>207dBpeak	>207dBpeak		(N) Medium (I) Low (F) Low	(N) High (I) Medium (F) Low
	>210 dB SELcum	>203 dB SELcum			
High sensitivity fish (swim bladder involved in hearing)	>207dBpeak	>207dBpeak		(N) High (I) High (F) Medium	(N) High (I) High (F) Medium
	207 dB SELcum	203 dB SELcum			
Eggs and larvae	>207dBpeak	(N) Medium (I) Low (F) Low	(N) Medium (I) Low (F) Low	(N) Medium (I) Low (F) Low	(N) Medium (I) Low (F) Low
	>210 dB SELcum				

13.89 Table 13-7 shows that high behavioural responses (e.g. avoidance and exclusion) for fish of all sensitivities are expected in the nearfield, which is likely to reduce with increasing distance from the source, with the exception of high sensitivity fish, where effects are only likely to lessen in the far field. For medium and low sensitivity fish, behavioural impacts from sound sources are likely to be low in excess of 1000m of the source. Fish eggs and larvae on the whole are expected to be subject to only moderate level effects on behaviour even within tens of metres of the sound source.

13.90 The underwater sound modelling exercise conducted as part of this assessment and presented in full in Chapter 20.0 indicates a maximum sound source level of 212 dB SEL / 212 dB SPL from impact piling. In addition to impact piling, it has also been proposed that an aspect of vibropiling is utilised in order to help with the installation of piles. This involves the piles being vibrated at high speeds to assist with the install into the ground material. The noise generated by vibropiling is thought to be considerably less than that generated by impact piling, thus this assessment assumes that impact piling alone will be utilised as a worst-case scenario.

13.91 Potential impacts to fish species from impact piling have been assessed based on exposure calculations which incorporate the anticipated levels of noise to be generated, the sensitivity of fish species to noise, and the swim speeds of fish in avoidance of impacts. As fish move away from sound sources, the noise they experience will become progressively more attenuated; calculations have therefore been undertaken to estimate the appropriate minimum start distance for an animal for it to be exposed to sufficient sound energy to result in impacts. Details of the calculation undertaken, their limitations, and assumptions are presented in Chapter 20.0.

13.92 The results of the underwater noise assessment are presented in this report as geographical risk ranges which specify the expected range within which a fleeing receiver would exceed the relevant injury thresholds, as specified in Table 13-7. Results are presented as both 'one second exposures', a one second exposure model presented to indicate instantaneous risk, and as 'minimal starting ranges for fleeing animals', which assumes the minimal range a fleeing fish needs to start fleeing from to avoid being exposed to noise levels greater than injury/TTS thresholds. For the purposes of this assessment, a fleeing swim speed of 0.5m/s for fish has been utilised, based on the information presented in Popper *et al*.[47]. The distance ranges based on the sound source levels to be generated by impact piling at Stranraer are shown in Table 13-8.

Table 13-8: Distance ranges (m) from impact piling noise at which threshold criteria is met

Fish sensitivity	Mortality and potential mortal injury	Recoverable injury	TTS	Behavioural disturbance
One seconds' exposure				
Low	<10	>10	60	4,200
Medium	<10	>10	60	4,200
High	<10	>10	60	4,200
Fleeing receiver, no soft start				
Low	-	90	450	4,200
Medium	30	>30	450	4,200
High	30	>30	450	4,200
Peak pressure level				
Low	200	>200	1,000	-
Medium	200	>200	1,000	-
High	200	>200	1,000	-

13.93 The results indicate that the impact piling for the proposed development at Stranraer has the potential to cause mild behavioural disturbance to fish across a maximum range of 4.2km. Acute impacts on fish from piling noise indicate that any fish less than 10m from the source are likely to suffer mortality or potential mortal injury. Any fish within 60m are likely to suffer temporary threshold shifts to acute noise impacts.

13.94 When fleeing receivers are considered, the risk ranges increase to 30m for the risk of mortality/mortal injury for medium and high sensitivity fish. The mortality threshold for low sensitivity fish is unlikely to be exceeded by impact piling when fleeing is considered, though recoverable injury is anticipated up to 90m from source. Fleeing receivers, regardless of sensitivity, are likely to suffer temporary threshold shifts within 450m of the noise source.

13.95 The risk of TTS in fish of all sensitivities from peak pressure levels extends to 1km from the source, reducing to 200m when mortality or mortal injury (permanent threshold shift) is considered.

13.96 When a 15 minute soft start process is adopted for impact piling, the risk ranges reduce to those shown in Table 13-9. A soft start where the impact power is slowly ramped up at the start of any piling operations ensures that sound levels increase gradually and that any fish in the immediate area of the activity can move away before any permanent injury can occur.

Table 13-9: Distance ranges (m) from impact piling noise at which threshold criteria is met.

Fish sensitivity	Mortality and potential mortal injury	Recoverable injury	TTS
Fleeing receiver, 15 min soft start			
Low	-	20	420
Medium	<10	20	420
High	<10	20	420

13.97 Noise sources other than impact piling are expected during the development of the project, including sound arising from dredging operations and rock dumping. The distance ranges based on the sound source levels to be generated by dredging and rock dumps at Stranraer are shown in Table 13-10.

Table 13-10: Distance ranges (m) from dredging and rock dump noise at which threshold criteria is met.

Fish sensitivity	Mortality and potential mortal injury	Recoverable injury	TTS	Behavioural disturbance
1 seconds' exposure				
Low	Threshold not reached	<10	<10	1,500
Medium	Threshold not reached	<10	<10	1,500
High	Threshold not reached	<10	<10	1,500

13.98 For both acute noise sources and modelled results assuming a fleeing receiver, distance ranges for recoverable injury and TTS impacts are all less than 10m from source for dredging or rock dumps. Mild behavioural disturbance may be expected up to 1.5km for fish of all sensitivities. The threshold for mortality of fish of any sensitivity is unlikely to be breached by dredging or

rock dumping activities. As a result of these lower noise levels, the impact assessment of underwater noise on fish is modelled on impact piling alone, given the greater potential for this activity to cause harm to fish communities.

13.99 Aside from any potential underwater noise impacts that may arise from construction, underwater noise is likely to be generated during the operational phase of the proposed development. Underwater noise sources during this phase are likely to be limited to increased vessel movements, to which it is expected that fish are likely to quickly get habituated to, thus startle responses are expected to be low. Stranraer is already a working harbour, and whilst marine traffic is likely to increase following construction, it should be considered that fish species present will have some tolerance to the low-level impacts likely to accompany the operational stage. Sound source levels from such vessel movements are likely to be far lower than those expected from dredging or rock dumping activities, which showed temporary threshold shifts at less than 10m range only. As such, effects such as changes in behaviour, altered foraging grounds, or reproduction patterns are not anticipated during the operational stage of the project. In addition, underwater noise generated by any future maintenance dredging is not likely to be greater than that generated during the capital dredge, provided similar methods are utilised.

13.100 The maximum TTS impact range for fish species in the vicinity of Stranraer is 450m for fish of all sensitivities, assuming a fleeing receiver and no mitigation. Mortality of medium and high sensitivity fish within 30m of the source may be expected, though mortality is unlikely for low sensitivity fish when fleeing. A mild behavioural disturbance may be expected over 4.2km.

13.101 When a 15 minute soft start mitigation measure is applied to impact piling, mortality/mortal injury to medium and high sensitivity fish reduces to less than 10m from source, and TTS impacts on fish of all sensitivities reduce to 420m. Any injury or impairment to hearing is therefore likely to occur in any fish species, including those sensitive fish which utilise swim bladders in hearing. Whilst fish are known to congregate around artificial underwater structures, the number of sensitive fish present in very close proximity to the piling operations is expected to be low (see ‘Additional Mitigation’).

13.102 Due to the localised and temporary nature of the predicted underwater noise impacts on fish, together with the low expected densities of these receptors within the risk range areas, the magnitude of the impact of underwater noise sediments on fish and elasmobranch populations is therefore likely to be low. The sensitivity of fish has been assessed as high, leading to overall significance of **moderate** adverse.

13.103 Rivers are present within Loch Ryan which may be of importance for diadromous migrating fish; however, the closest of these is approximately 3km from the location of impact piling, and thus outside of the range of any TTS impacts. The river is within the range for behavioural disturbances, though are towards the outer extent of this range, thus any impacts are likely to be very mild. Migratory fish fall into the medium sensitivity hearing category, and with a soft

start to operations would have to swim within 10m of the impact piling operations for mortality to be likely. Given the relatively small area of Loch Ryan over which TTS impacts on medium sensitivity hearing fish may be encountered, the magnitude of this impact is assessed as being negligible. The resulting effect on high sensitivity migratory fish is therefore described as **slight adverse**.

13.104 Several fish species are noted to utilise the Loch Ryan area as spawning and nursery grounds. However, the risk ranges for mortality for fish/shellfish eggs and larvae align with medium sensitivity fish and as such are likely to be affected only over a very small area of less than 10m from the noise source. The range of behavioural disturbance to fish with mitigation is likely to be less than 4.2km from the source and it is not expected that fish spawning will be unduly affected by underwater noise outside of this area to the extent that spawning is interrupted.

13.105 Therefore, given the negligible distance over which increases in noise levels are likely to cause harm to fish and shellfish eggs/larvae over a short time period and the total area of Loch Ryan likely to be available for spawning/nursery activity, it is considered that the magnitude of the impact of increased underwater noise on fish spawning and nursery utilisation of the area is negligible, leading to overall significance of **slight adverse** when receptor sensitivity is considered high.

13.106 As a further protection, where possible, impact piling should be planned to avoid coinciding with peak spawning times of fish species, especially PMFs, which for those species present in Loch Ryan is likely to be between February to June[13].

13.107 The sensitivity of shellfish to underwater noise sources has not been well studied and limited information is available to inform the impact assessment on these taxa. Some studies do indicate that there is potential for injury or impact in marine invertebrates at very close levels to sound sources[54, 55], and where evidence was available, the thresholds suggested that impacts were likely to occur at levels in excess of 217 dB re 1µPa for crustaceans and molluscs[55]. This is higher than those levels likely to be produced by impact piling, so any significant harm to shellfish is considered unlikely.

13.108 The magnitude of impacts to shellfish from underwater noise is therefore considered to be negligible, which coupled with low receptor sensitivity to sound results in an impact of **negligible** significance.

[54] McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., and McCabe, K. (2000). Marine Seismic Surveys: Analysis and Propagation of Air-Gun Signals; and effects of Air-Gun exposure on humpback whales, sea turtles, fishes and squid. Centre for Marine Science and Technology for Australian Petroleum Production Exploration Association. 203pp.

[55] McCauley, R., Fewtrell, J., Duncan, A., Jenner, C., Jenner, M.N., Penrose, J., Prince, R., Adhitya, A., Murdoch, J., and McKabe, K. (2003). Marine seismic surveys: analysis and propagation of air-gun signals; and effects of exposure on humpback whales, sea turtles, fishes and squid. In (Anon) Environmental implications of offshore oil and gas development in Australia: further research: a compilation of three scientific marine studies, pp. 364-521. Canberra, ACT: Australian Petroleum Production and Exploration Association.

Operational Phase

Underwater Noise

13.109 It is anticipated that maintenance dredging may be required at Stranraer marina, though it should be noted that the current design includes an over-dredge allowance so that maintenance dredging is delayed. The details of any likely maintenance dredging required will form part of the overall maintenance strategy that will be developed. Underwater noise generated by any future maintenance dredging is not likely to be greater than that generated during the capital dredge, provided similar methods are utilised.

13.110 Given the current usage of Stranraer Harbour by marine traffic and the likelihood of fish becoming habituated to any increases in vessel traffic, in addition to the comparatively low noise levels likely to be generated by such traffic, it is considered that the magnitude of impacts to fish and shellfish from underwater noise generated during the operational stage of the project is negligible, which coupled with high receptor sensitivity results in an impact of **slight adverse** significance.

Habitat Creation

13.111 Part of the proposed works at Stranraer includes an extension to the existing breakwater and the installation of new pontoons and marine structures, such as revetment steps along the reclaimed land area. These new structures are likely to provide additional habitat for the settlement of epibenthic taxa, which in turn can lead to fish aggregating effects over time. The new underwater structures will increase habitat complexity by adding new hard substrates which will replace existing area of finer sediments. These will have the potential to provide new shelter for fish present within the vicinity as well as eventually also providing a food source for fish due to new settlement of epifaunal species. New artificial reefs have been shown to be colonised by fish within weeks and when existing reefs were nearby that timeframe was reduced to days[56].

13.112 Most available information relating to fish aggregation effects is focussed on offshore installations, particularly windfarms[57]. However, fish aggregating effects have been noted at several other breakwater, marina, and similar artificial structure installations.

13.113 Artificial structures have been shown to have varied effects in terms of fish aggregation, with positive, no difference, and negative effects being found across the literature; effects have been

[56] Kramer, S.H., Hamilton, C.D., Spencer, G.C., and Ogston H.D. (2015). Evaluating the Potential for Marine and Hydrokinetic Devices to Act as Artificial Reefs or Fish Aggregating Devices, Based on Analysis of Surrogates in Tropical, Subtropical, and Temperate U.S. West Coast and Hawaiian Coastal Waters. OCS Study BOEM 2015-021. U.S. Department of Energy, Energy Efficiency and Renewable Energy, Golden, Colorado. 90pp.
[57] Xoubanova, S. and Lawrence, Z. (2022). Review of fish and fisheries research to inform ScotMER evidence gaps and future strategic research in the UK. Commissioned by Marine Scotland. 130pp.

found to be highly site specific and can vary over different spatial scales[58]. Fish aggregation has the potential to be detrimental to the local marine habitats, due to increasing nutrient loading, amassing fringe populations of fish resulting in barrenness elsewhere, or by introducing new species[59]. Studies have also shown that artificial structures can change the communities present within an area, though the impacts were considered limited[60].

13.114 However, many studies also indicate positive effects. For example, studies have shown that marina structures have been proven to increase the numbers of juvenile and young fish in an area, through attracting them from other areas and through increasing their survival due to providing shelter and food resources[61, 62, 63]; though responses have often been found to be species specific[64]. Additionally, through attracting smaller demersal species, artificial structures subsequently also potentially attract their predators which may include larger commercially important fish[65].

13.115 Details of the design of the pontoons and the extent of the breakwater extension are shown in Chapter 2.0 of this report. In summary the upgraded marina layout will include up to 185 new berths, around 14 of which will be for commercial use, in addition to the current approximately 45 existing berths available. The existing breakwater is approximately 80m in length (measured at seabed level) and is proposed to extend another approximately 32m.

13.116 The majority of fish and elasmobranch species are agile and highly mobile, and are therefore tolerant of, and adaptable to, fish aggregation effects, especially considering the existing structures and environment at Stranraer. Some increases in demersal fish numbers may be expected. However, natural population dynamics are likely to act as a controlling factor to some

[58] Macura, B., Byström, P., Airoldi, L., Eriksson, B.K., Rudstam, L., and Støttrup, J.G. (2019). Impact of structural habitat modifications in coastal temperate systems on fish recruitment: a systematic review. Environmental Evidence, 8(1): 1-22.
[59] Bulleri, F. and Chapman, M.G. (2010). The introduction of coastal infrastructure as a driver of change in marine environments. Journal of Applied Ecology, 47(1): 26-35.
[60] Raoux, A., Tecchio, S., Pezy, J.P., Lassalle, G., Degraer, S., Wilhelmsson, D., Cachera, M., Ernande, B., Le Guen, C., Haraldsson, M., and Grangeré, K. (2017). Benthic and fish aggregation inside an offshore wind farm: which effects on the trophic web functioning?. Ecological Indicators, 72: 33-46.
[61] Bosch, N.E., Gonçalves, J.M., Tuya, F., and Erzini, K. (2017). Marinas as habitats for nearshore fish assemblages: comparative analysis of underwater visual census, baited cameras and fish traps. Scientia Marina, 81(2): 159-169.
[62] Bouchoucha, M., Darnaude, A.M., Gudefin, A., Neveu, R., Verdoit-Jarraya, M., Boissery, P., and Lenfant, P. (2016). Potential use of marinas as nursery grounds by rocky fishes: insights from four *Diplodus* species in the Mediterranean. Marine Ecology Progress Series, 547: 193-209.
[63] Wehkamp, S. and Fischer, P. (2013). Impact of coastal defence structures (tetrapods) on a demersal hard-bottom fish community in the southern North Sea. Marine environmental research, 83: 82-92.
[64] Fowler, A.M. and Booth, D.J. (2013). Seasonal dynamics of fish assemblages on breakwaters and natural rocky reefs in a temperate estuary: consistent assemblage differences driven by sub-adults. PLoS One, 8(9): e75790.
[65] Wilhelmsson, D., Malm, T., and Öhman, M.C. (2006). The influence of offshore windpower on demersal fish. ICES Journal of Marine Science, 63: 775-784.

extent, whereby any localised increase in prey species may also drive an increase in predators which may act to limit the population until a new equilibrium is formed[66].

13.117 The scale of the proposed development is small compared to the total habitat area available to fish species. Given that there is already an existing breakwater and existing marina structures in place, it is not considered that the proposed works are likely to have a large absorbing effect on fish from surrounding areas. The breakwater extension is small in nature (approximately 32m in length) and will be of a similar construction to the existing structure. Within the marina area, the footprint of proposed infrastructure that will traverse the entire water column is low, given that most pontoons will be floating structures supported by piles where appropriate. The foundations for these will potentially cause fish to aggregate, though the complexity to habitats that is added is limited due to the smooth and solid nature of the piles. The magnitude of fish aggregating impacts on migratory, pelagic and demersal fish and elasmobranchs from the proposed works is therefore considered negligible. All fish and elasmobranch species have a high sensitivity to change; however the negligible magnitude of this impact leads to an overall significance of **slight adverse**.

Upgrading and Installation of New Lighting

13.118 As per the embedded mitigation identified for the project, no use of underwater lighting will be employed as part of the development. Any additional lighting to be installed as part of the project will be industry standard and will follow the same style and set-up as currently in place, thus it is not considered that there is an impact pathway to fish and shellfish. As such, this potential impact has been scoped out of this assessment.

Do Nothing Scenario

13.119 Under the 'Do Nothing' scenario, in which the proposed development is not taken forward, conditions affecting the fish and shellfish in Loch Ryan are likely to remain unaffected and no ongoing processes of change have been identified.

Mitigation, Monitoring and Residual Effects

Additional Mitigation

13.120 In addition to the embedded mitigation specified in Section 13.51, the following section outlines additional mitigation measures proposed to reduce the significance of potential impacts on fish and shellfish ecology arising from the project.

13.121 As part of the proposed development, a Construction Environmental Monitoring Plan (CEMP) will be developed in order to ensure that the construction methods used are appropriate and so

[66] Leitão, F., Santos, M.N., Erzini, K., and Monteiro, C.C. (2008). The effect of predation in artificial reef juvenile demersal fish species. Marine Biology, 153: 1233-1244.

that any additional mitigation measures may be applied. This should include soft-start measures for piling operations with reference to fish and shellfish populations.

13.122 The adoption of a soft start to impact piling operations will reduce any potential impacts on fish in the vicinity of Stranraer Marina. The application of this protocol allows for the gradual increasing of piling power over a 15 minute timeframe, enabling fish to move from the affected area prior to any injuries being sustained. It is suggested that the Joint Nature Conservation Committee (JNCC) guidelines on minimising the risk of injury to marine mammals[67] are followed; the protocol is designed with marine mammals in mind, though the adoption of a soft start prior to impact piling will also have the effect of helping to minimise the impact of underwater sound on fish. Underwater noise sources can cause behavioural changes in fish, however fish are known to rapidly habituate to repeated similar sounds, effectively minimising any response[68].

13.123 It is also suggested that piling operations are timed to avoid peak fish spawning, likely to occur within Loch Ryan for the relevant receptors (including PMF species) between February and June[13]. Whilst impacts from piling operations on fish populations are low as described in this chapter, avoidance of underwater noise generation will further help to minimise any detrimental effects on populations.

13.124 After mitigation the impact of underwater noise is considered to be low significance for all groups of fish.

Residual Effects

Construction and Operation

13.125 Prior to additional mitigation, the potential impact on fish populations from underwater noise was assessed as moderate, owing to a low magnitude of potential impacts combined with high receptor sensitivity.

13.126 Application of the measures described in 'Additional Mitigation' (Paragraphs 13.119 – 13.122) would serve to reduce the magnitude of the impacts of underwater noise on fish populations. Avoidance of piling operations within the peak fish spawning time between February and June, in addition to the adoption of a 15 minute soft start protocol, would reduce the overall magnitude of impacts from underwater noise associated with the proposed development to negligible, and the resulting significance to **slight adverse**.

13.127 It should be noted that following the application of additional mitigation, the overall effect significance of underwater noise on migratory fish species and fish spawning appears unchanged in terms of the effect level. As high sensitivity receptors, the lowest possible effect

[67] JNCC. (2010). Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise. Peterborough: JNCC.
[68] Pearson, W. H., Skalalski, J. R., and Malme, C. I. (1992). Effects of sound from a geophysical survey device on behaviour of captive rockfish (*Sebastes* ssp.). Canadian Journal of Fish Aquatic Science, 49: 1343 - 1356.

significance rating that can be assigned to migratory fish and fish spawning in accordance with the significance of effects matrix (Table 13-3) is slight, despite the additional mitigation measures likely reducing the level of potential impacts by a considerable margin.

13.128 The residual impact of construction and operational activities is considered to be slight for all groups of fish and negligible for invertebrates.

Cumulative Effects

13.129 This section considers the potential for cumulative effects arising from the proposed development in combination with other planned activities that have the potential to impact the marine environment, potentially increasing the overall magnitude of individual impacts.

13.130 Known additional projects that are committed to or reasonably foreseeable and may potentially provide cumulative effects in combination with the proposed development include:

- Deposition of oyster shells within Loch Ryan (Loch Ryan Oyster Fishery Co Ltd);
- Capital dredging and sea disposal of sediments from the Loch Ryan Port approach channel, berth pocket, and swinging area (Stena Line Ports);
- The construction of a platform for instructor shelter and removal of redundant sewer outfall pipes, debris, unlit beacon and boulders as well as beach clearance at Stranraer Marina (Stranraer Watersports Association);
- Marine construction and pontoon deposit for eight pontoons and three racing markers at Stranraer Marina (Stranraer Watersports Association); and
- An additional 18 moorings at Stranraer Marina (Stranraer Watersports Association).

13.131 The above projects are either located considerably further up Loch Ryan and outside the zone of influence from any predicted impacts associated with the proposed development, or else consider that that their actions will result in no detrimental impact on the marine environment. This is based on the information provided in the Marine Licence applications made to Marine Scotland for the relevant projects.

13.132 Chapter 11 of this EIAR assesses that any cumulative/in-combination effects arising from the above projects are unlikely to alter any of the potential impact assessments made in relation to the proposed works in terms of water quality. Chapter 7 of this EIAR likewise concludes that localised, temporary increases in suspended sediment levels may occur in relation to the other planned developments in the area, however that cumulative impacts with the proposed development are very unlikely and, should they occur will be of negligible magnitude. Any underwater noise generated by these additional is also likely to be considerably less than that generated by the proposed development, as stated in Chapter 20. Given these conclusions, and considering that the construction phases of these projects will not necessarily be concurrent with the proposed development, it is assessed that none of the potential impacts from any of the proposed additional projects will significantly alter the assessment made in this chapter, thus the effects of potential impacts on fish and shellfish ecology will remain as described.

Summary & Conclusions

13.133 This chapter assesses potential effects of the proposed development on fish and shellfish ecology. The assessment of potential impacts is summarised in **Table 13-11.**

13.134 No significant impacts to fish or shellfish as a result of the construction or operation of the Stranraer Marina development, after control and mitigation measures, are predicted.

Table 13-11: Summary of Impact Assessment for Fish and Shellfish.

Potential Effect	Receptor	Receptor Sensitivity	Impact Magnitude	Effect Significance (prior to mitigation)	Additional Mitigation Measures	Post Mitigation Effect Significance (Residual Effects)
Construction Phase						
Changes in water quality due to dredging	All fish & shellfish including elasmobranchs & migratory species	High	Negligible	Slight	-	Slight
Increase in suspended sediments	All fish species including elasmobranchs	High	Negligible	Slight	-	Slight
	Migratory fish species	High	Negligible	Slight	-	Slight
	Fish spawning	High	Negligible	Slight	-	Slight
	Shellfish	High	Negligible	Slight	-	Slight
Increase in underwater sound from impact piling	All fish species including elasmobranchs	High	Low	Moderate	CEMP Soft start Avoidance of peak spawning times	Slight
	Migratory fish species	High	Negligible	Slight		Slight
	Fish spawning	High	Negligible	Slight		Slight
	Shellfish/ invertebrates	Low	Negligible	Negligible	-	Negligible
Operational Phase						
Artificial habitat creation	All fish including migratory species	High	Negligible	Slight	-	Slight
Increase in underwater noise	All fish including migratory species	High	Negligible	Slight	-	Slight